ANNUAL (2015) PERFORMANCE REPORT
January 1 – June 30, 2015

SURVEY AND MANAGEMENT OF MARYLAND'S FISHERY RESOURCES

Maryland Department of Natural Resources
Fisheries Service
Inland Fisheries Division
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SURVEY AND MANAGEMENT OF FRESHWATER FISHERIES RESOURCES

USFWS Federal Aid Grant F-48-R-25

Study I

Management of Fisheries Information Resources

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Management of Fisheries Information Resources

State: Maryland

Project Number: F-48-R-25
Study No.: I
Job No.: 1

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Fisheries Information Resources

Job Title: Technical Guidance and Environmental Review

Introduction

Environmental reviews and technical guidance are important tools to use in fisheries management. Many activities that occur in and around waterways that could impact those bodies frequently require permits or environmental assessments. Managers provide input through environmental reviews to protect waters from adverse impacts of watershed disturbance. Technical guidance is provided to other agencies and the general public on waterway improvement and protection.

Objectives

- Conduct environmental reviews of construction projects, discharges, quarrying and mining activities and other activities that may impact water quality, biodiversity or the aquatic environment.
- Ensure that regulatory agencies adhere to state and federal laws which protect water quality, habitat and aquatic resources.
- Provide technical guidance to the general public and other government agencies on existing fish populations, habitat improvement and water quality assessment.

Methods

The Inland Fisheries Division is involved both directly and indirectly with technical guidance and environmental review activities. Staff gathers information and then provides comment and guidance to regulatory agencies, technical committees, advisory boards, private industry and the general public on activities that can include waterway construction, timber harvest, storm water management, road construction, mining, water discharges, and environmental catastrophe mitigation.

Within the Department of Natural Resources (DNR), Inland Fisheries personnel provide input and guidance to members of the DNR Integrated Policy and Review Unit (IPR), (former Environmental Review Unit (ERU)) on construction and waterway activities that require permitting by DNR or the Department of the Environment. Inland Fisheries Division has an Environmental Review Coordinator (ERC) who provides guidance to the IPR Unit through permit and project review. Resource managers in the field assist the ERC when needed. Staff reviews each project, checks historical data on the area in

question, and conducts site visits as needed to determine potential impacts on fish populations and other aquatic organisms in their associated habitats. Work on projects includes site visits and on-site sampling of fish populations and the surrounding ecosystem. Monitoring studies are developed for key projects to show the condition of a fishery before, during and after a project. This information not only helps with a current project but will also provide information on similar projects in the future. If required, staff uses this information to develop a Fisheries position statement. In cases where no relevant data have been collected, staff members conduct a literature search of similar projects to develop a best course of action statement. If a project cannot be avoided, recommendations are made to minimize and/or mitigate natural resource impacts.

Reviews and guidance are provided to other groups including: Bureau of Mines on mine drainage issues and mine development; Army Corps of Engineers on water discharges from dams and waterway blockage or realignment; State Highway Administration on road construction, bridges and storm water management; and local jurisdictions for sediment and erosion control around construction projects.

Mining projects and activities are governed by MDE/Bureau of Mines (BOM). In the past, BOM maintained a near autonomous role managing mining activities. Recently, the expansion of the IPR staff has allowed DNR and Fisheries Service to become more involved with mining permit review. The ERC and the Regional Fishery Manager play crucial roles in evaluating mine permit applications.

With increasing interest in environmental projects, staff has been reviewing an increasing number of permits for collecting sampling and introducing aquatic species. Plans need to be reviewed to insure that: permitted activities will not interfere with existing Fisheries studies; will not impact aquatic species; and, will not introduce invasive or exotic species, and any introduced species will not carry any pathogens or parasites.

Fisheries staff provides direction and input into the planning and construction process of road and highway projects when requested by the IPR Unit. Many of the projects are site-specific and unique and each presents a wide range of issues to address. Many road projects span extended periods of time and require close monitoring and frequent consultation with staff. Smaller, short-term projects may require less time but must still be monitored to prevent major impacts on local waters. Staff works closely with highway engineers and consultants to provide input concerning roadway and stream restoration design. Standards established by MDE for stream classifications are used to protect fish, associated aquatic species, and water quality during construction projects. They also prohibit construction during critical life stages to prevent loss of fish.

Concerns over the extraction of natural gas from Marcellus Shale formations in western Maryland continued in 2015. Executive Order 01.01.2011.11 established the Marcellus Shale Safe Drilling Initiative in 2011. The Advisory Commission continued to assist State policymakers and regulators to determine whether gas production from gas extraction from Marcellus Shale can be accomplished without the risks of adverse

impacts on the aquatic community. An interim report from the Commission was issued in August of 2014; the final report was issued December 19, 2014. The Commission's appointed tasks endeavored to provide the following:

- findings and related recommendations regarding sources of revenue and standards of liability for damages caused by gas exploration and production
- recommendations for best management practices (BMPs) for all aspects of natural gas exploration and production in the Marcellus Shale in Maryland
- findings and recommendations regarding the potential impact of Marcellus Shale drilling in Maryland

Based on information provided by the December 2014 report, regulations were proposed to address oil and gas exploration in Maryland.

Fisheries and volunteer groups continued baseline sampling of streams targeted as potential Marcellus Shale drilling sites.

Results and Discussion

The following narrative section describes the environmental review and technical guidance activities conducted by staff from January 1 through June 30, 2015. A summary of all environmental review and technical guidance activities for the past 5 years are shown in Table 1. Reporting this year shows activities combined for each category since staff cooperated across units for many reviews. Also, the Environmental Review Coordinator assigned reviews and worked with field staff to evaluate projects.

Table 1. Environmental review activities for Inland Fisheries Division of Maryland Fisheries Service from 2011 through June 2015.

	Yearly Activity				
Environmental Review Category	**2011**	**2012**	**2013**	**2014**	**2015**
Nontidal wetlands alteration	1	18	24	23	31
Inland Dredging	5		1		
Tidal water/wetlands alteration	4	3	3	6	6
Comprehensive plans	19	9	9	9	7
Strip mining	3	12	5	6	4
Strip mine reclamation	11	14	29	47	5
Timber sales/harvest	11	21	11	12	9
Reservoirs/water allocation/mgt.	18	18	9	18	17
Land acquisition	51	57	35	39	22
Bridge projects	5	13	11	22	18
Road projects	16	11	7	43	36
Stream and habitat restoration	15	12	21	33	16
Storm water management pond		3		9	2
Aquaculture permit	13	7	4	1	4
Collection permit	40	44	41	47	43
Stocking permits					49
Wastewater treatment plant permit review	4	1	4	16	9
Fish passage	2				3
Public safety assessment	5				
Gas wells/pipelines/Marcellus Shale	9	3	2	36	7
Groundwater withdrawal	1	2	4	2	5
Dam repairs/removals	1		2	12	2
Deep mines	3	6	2	1	1
Hydroelectric projects	2				
USGS monitoring gages					1
Utility Line stream crossings		2	1	3	6
Invasive species	14	12	15	2	6
Illegal discharges	1				
NPDES effluent permits					4
Stream Channel Alteration				9	
Handicapped Access projects			2		
Water appropriation	2				
Trout in the Classroom		24			4
Internal Review – FMA		2	6	12	5
Stream closure waiver	9	13	11	19	4
Green Infrastructure	1				
State Lands		7	5	16	7
Abandoned Mine Land Reclamation		6			
Public Safety Assessment		2			
Large Woody Debris in Stream review			5	7	2
Housing development plans			4		
Hazardous waste spills			1		
Power plant licensing				2	
Wind power development				2	

Table 1. Environmental review activities for Inland Fisheries Division of Maryland Fisheries Service from 2011 through June 2015. (continued)

	Yearly Activity				
Environmental Review Category	**2011**	**2012**	**2013**	**2014**	**2015**
Technical Guidance	28				30
Pond assessment	9	16	27	7	3
Population assessment	8	17	9	2	2
Fish kills	3				1
Share expertise with other agencies/institutions					
General guidance to Landowners		26	2	7	
Stocking assessments/permits		55	48	126	
Resource information		2			
Education activity		1			
Wildlife assistance		1			
Water quality consultation			7		
Flow curve analysis					1
Fish collection					2
Flow alteration					1

Nontidal Wetlands Alteration

- Provided comments on sewer line and manhole replacements in Cunningham Falls State Park adjacent to managed trout stream Big Hunting Creek (Frederick County).
- Provided comments on herbicide applications on electric power right-of-ways adjacent to managed trout waters statewide.
- Provided comments on realignment of Roddy Road on Owens Creek to accommodate park construction (Frederick County).
- Opposed a plan to fill an area in the Monocacy River floodplain on property scheduled for development to protect in-river fish populations and prevent future sedimentation and flooding problems (Frederick County).
- Reviewed construction of shallow marsh wetlands to provide water quality control on stormwater runoff from Mill Island Community to the Monocacy River (Frederick County).
- Reviewed trail and bridge repairs in Saint Mary's River State Park (St. Mary's County) needed after flooding to minimize changes to the surrounding watershed.
- Provided comments on a flood control project on Western Branch near Upper Marlboro (Prince George's County).

Tidal Water Wetland Alteration

- Prepared drawings for semi-permanent habitat structures to be installed in Smoot's Bay on the Potomac River (Prince George's County). A cooperative

project is planned to install reef balls to provide habitat for game species in the vicinity of National Harbor.

Comprehensive Plans

- Provided comments to the Integrated Policy and Review Unit regarding powerline right-of-way vegetation control within the Savage River State Forest, Youghiogheny River Wild and Scenic Corridor, and Mt. Nebo Wildlife Management Area. Recommendations were made not to allow herbicide treatment within 100 feet on either side of a stream or wetland, no herbicide allowed within the Youghiogheny River Wild and Scenic Corridor (manual removal only), and no herbicide use within the Mt Nebo Wildlife Management Area as DNR staff will manage the ROW as wildlife habitat using mowers (Garrett County).
- Conducted field reviews of potential stormwater restoration sites along Deep Creek Lake as part of the Deep Creek Lake Watershed Management Plan (Garrett County).
- Represented Fisheries on the review panel for the Mallow's Bay National Marine Sanctuary (Charles County). This area contains historical and natural resources, including the "Ghost Fleet", an underwater burial ground for ships built, but not needed for World War I. Comments from staff served to preserve both these archival remnants and the natural resources of the area.
- Attended meetings and provided comments on fisheries resources addressed in the Upper Jones Falls and Loch Raven North Small Watershed Action Plan (SWAP).

Strip Mine Reclamation

- Provided comments on a proposed 72 acre amendment to an existing permitted coal strip mine within the Moore's Run sub-basin of the Georges Creek. Moore's Run is a Use-III stream, and has been impacted with excessive sediment from mining in the past. Recommendations included strict sediment control as well as temperature controls in the stormwater runoff ponds. The reclamation plan included a forestry restoration plan in the steeper portions of the site and pasture land on the flat area of the property. The committee accepted the re-vegetation plan and applauded the efforts of the landowner to re-forest the steep portion of the property to provide watershed protection (Allegany County).
- Provided comments to the IPR Unit regarding two Abandoned Mine Land Division (AMLD) Restoration Projects in the Aarons Run Watershed (Garrett County) and in the Jennings Run Watershed (Allegany County). Recommended that the post land-use especially for any AMLD project - should be forestland. Quite a bit of water quality restoration work has been done in the Aaron's Run watershed, including the re-introduction of brook trout and other native coldwater fish species. It is imperative to have as much forest cover in the watershed to keep water temperature regimes as cold as possible. Brook trout restoration project are being conducted in the Jennings Run Watershed, and recommended forested post land-use as well.
- Western Region Manager participated in the Land Reclamation Committee's re-vegetation bond release reviews of two reclaimed strip mines in the Georges

Creek Watershed (Allegany County). Site 1 totaling 43 acres met the criteria for post-land use of trees by having adequate numbers and survival of trees planted using the FRA (forestry reclamation approach) method, that is the area is rough backfilled with mounds and pits to reduce water run-off from the site. Site 2 was 10 acres with grassland as the post land use, however trees were planted on portions of the site. This site also met re-vegetation requirements.

Timber Harvests

- Provided comments to MD DNR Wildlife Service regarding proposed timber harvests on the Mt. Nebo Wildlife Management Area. All streams and wetlands were adequately buffered (Garrett County).
- Reviewed and commented on forest clearing project to restore Civil War "viewshed" at Wise's Field. Work would impact the Antietam Creek watershed (Washington County).

Reservoirs / Water Allocation

- Reviewed water discharge permit renewal from commercial aquaculture facility to Little Hunting Creek and Fishing Creek– both are Class III-P Natural trout waters. The discharge consisted of 760,000 gallons of water per day. Staff provided comments on content and temperature of the discharged water in view of the fact that the receiving streams are both natural trout waters and those populations needed to be protected (Frederick County).
- Participated in long-term drawdown planning for Triadelphia Reservoir in Howard County. The reservoir supports numerous game species and comments were made to diminish the impacts on these fishes.
- Attended meetings and provided comments regarding a proposed "green" cemetery that could impact water quality in Prettyboy Reservoir (Baltimore County).
- Reviewed plans and provided comments to Washington Suburban Sanitary Commission regarding pending repairs to Brighton Dam at Triadelphia Reservoir (Howard County).

Land Acquisition Reviews

- The Trout Unlimited property along Bear Creek in Garrett County. This five acre parcel borders the Bear Creek Put and Take Trout Fishing Area for about 790 feet. Bear Creek is one of Maryland's top trout fishing destinations. The stream supports naturally reproducing populations of brook trout and brown trout, and is stocked with adult trout to support a very popular recreational trout fishery. The purchase of this property is consistent with Maryland Department of Natural Resources' 2006 Brook Trout Fisheries Management Plan strategies designed to conserve and protect critical brook trout habitat in this watershed. By increasing public land ownership within this brook trout stream drainage basin, the stream riparian zone is protected from development impacts. Acquisition of this property will also provide continued angler public access to Bear Creek.

- A 90 acre tract adjoining Green Ridge State Forest in the Fifteen Mile Creek Watershed. Inland Fisheries Division supports this potential land acquisition as it will provide water quality protection in the Upper Potomac River Watershed (Allegany County).
- A 26.5 acre in-holding within Dan's Mountain WMA. Inland Fisheries Division supports this acquisition, as the parcel contains springs that feed into the tributaries of the North Branch Potomac River. Public ownership of this parcel will provide long-term water quality protection in the Upper Potomac River Watershed (Allegany County).
- A 20 acre parcel adjoining Green Ridge State Forest containing a headwater tributary in the Fifteen Mile Creek Watershed. The Fifteen Mile Creek watershed supports a diverse native stream fish community, as well as a high recreational value put and take trout fishing area. Inland Fisheries Division supports this acquisition as public ownership of the property will ensure long-term water quality and stream habitat protection in the Upper Potomac River Watershed (Allegany County).
- Provided comments and resource information on a property on Beaver Creek in Washington County. The property is on the special trout management area on the creek. Staff has worked hard in the watershed to improve habitat and water quality and the preservation of this land would further the efforts to protect the reproducing brown trout population that has developed in the area. Staff recommended that the state acquire the property to protect the aquatic resources.
- Commented on proposed land acquisition surrounding the Cedar Point Wildlife Management Area. The area in Charles County is home to tidal marsh and nontidal wetlands. Preservation of these resources would help to protect and preserve fish species and their habitats in the adjacent Potomac River.

Bridge Projects

- Reviewed requests for time-of year waivers for two streams in Frederick County – Little Pipe Creek and Flat Run. The waivers were requested to allow the collection of soil boring samples in advance of bridge replacement on both streams.

Road Projects

- Provided comments on a time of year waiver request on an emergency road repair along an unnamed tributary of Jennings Run near Frostburg. Brook trout were collected downstream of this site, and concerns were raised regarding sediment inputs resulting from the project. The Allegany County Department of Public Works notified Fisheries Service biologists when the construction began, and we met with the engineer on-site in order to make sure sediment inputs were minimized.
- Provided comments for a time of year waiver request for a road bank stabilization project along Hill Run in the Georges Creek watershed. Fish sampling efforts showed that brook trout were not present in this stream, and the project may

reduce sediment inputs, so no objection was made for this request (Allegany County).

- Provided comments to the IPR Unit regarding an application to remove an unused gas-line in northern Garrett County. There will be stream crossings of two small tributaries in the Mill Run watershed using a temporary bridge and no fill. A brook trout population was documented near these sites, so BMPs are imperative, work within the construction time period (no TOY waivers on this one due to the presence of brook trout), and require a re-vegetation plan of tree plantings adjoining any stream once the access roads are no longer needed.
- Reviewed plans by Greenbrier State Park to replace a culvert in the headwaters of Little Beaver Creek, a stream that contains a reproducing brown trout population. They also reviewed planned trail improvements within the park that could impact the lake biota (Washington County).
- Reviewed proposed parking lot alteration and bridge replacement on Blue Blazes Creek, a tributary to Big Hunting Creek in Catoctin Mountain Park. They also reviewed culvert replacement on a tributary to Hauver Branch in adjacent Cunningham Falls State Park. Both projects could impact Big Hunting Creek where reproducing brown and brook trout reside (Frederick County).
- Reviewed the road resurfacing project for the left fork of Fishing Creek (Frederick County). The project would improve the road surface and the cross drainage system by preventing roadway surface materials from entering the stream. The stream contains seasonally stocked and year-round native trout species (Frederick County).
- Reviewed road projects on Fishing Creek in Calvert County to minimize impacts on the Chesapeake Bay.

Stream Restoration Projects

- Inland Fisheries staff attended a meeting with the MDE Abandoned Mine Land Division (AMLD) regarding a study to assess stream sealing in the upper Georges Creek Watershed. The AMLD would like to perform a geologic and hydrologic assessment of the upper Georges Creek Watershed to determine the extent and amount of stream flow lost to underground mines. After the assessment is completed, plans will be developed to reduce the amount of water loss in Georges Creek and tributary streams to underground mines. This would allow for baseline flows during low flow conditions and improved water quality in the Georges Creek Watershed. Currently, the underground mines funnel water from the Georges Creek Watershed into the Braddock Run and Jennings Run Watersheds via the Hoffman Tunnel and Allegany Ditch. Concerns were raised by Fisheries Service regarding reduced flows into Braddock Run, a unique reproducing brook trout stream, resulting from the stream sealing project. Reduced flows could impact the existing brook trout population by loss of habitat and increased water temperatures. The study proposal will address these concerns and we will be able to make informed decisions regarding the stream sealing projects (Allegany County).

- Provided comments regarding hazardous scrap material removal along the West Virginia bank of the North Branch Potomac River near Pinto, MD. A ballistic plant on the WV side of the river has decades-old scrap deposits in the bank and floodplain area, and will be removing these potentially hazardous materials. Comments were made to use BMPs to eliminate the possibility of any materials or sediment for entering the river as well as protect time of year for spawning black bass (Allegany County).
- Reviewed plans to construct a stable stream channel on an unnamed tributary to Carroll Creek (Frederick County). The work was scheduled for the state managed Youth Put-and-Take Trout Fishing Area on Carroll Creek and was needed to reduce stream bank erosion and to establish a forested, riparian buffer.
- Conducted a pre-construction assessment of fish populations on Beaver Creek (Washington County) at the entrance to the Albert Powell State Trout hatchery. The stream had badly eroded banks and was endangering some buildings on private property adjacent to the hatchery.
- Reviewed and provided comments on stream restoration on an unnamed tributary to Piney Run - a managed trout water (Carroll County).
- Reviewed plans for proposed restoration projects on the North Branch of Jones Falls and on Bee Tree Run in Baltimore County.

Stormwater Management Retrofit

- Reviewed plans to install a stormwater management complex in the headwaters of Jabez Branch in Anne Arundel County. Jabez Branch supports Maryland's only coastal plain brook trout population and staff submitted comments and made site visits to help insure protection of this unique population.

Collections Permits

Staff received requests from various research groups for permits to collect specimens from Maryland's Inland waters. Permits allow staff not only to protect our resources but also to share information with other groups and to provide educational opportunities.

Permit requests included:

- Educational research
    - Frederick County Public Schools to collect macroinvertebrates from the special trout management area on Big Hunting Creek
    - Hood College – monitor invasive rusty crayfish in the upper Monocacy River watershed (Frederick County).
- Government agencies
    - Interstate Commission of the Potomac River Basin (ICPRB) – freshwater mussel survey of the Potomac River
    - United State Geological Survey/Leetown Science Center
        - Collect planktonic organisms to assess *Didymosphenia geminata* in Big Hunting Creek (Frederick County).

        - Collect water temperature and fish species to assess thermal refuges for brook trout in Hunting and Owens Creeks with Catoctin Mountain Park (Frederick County).
- Private industry
    - Versar, Inc – macroinvertebrates and electrofishing for fish to assess Frederick County streams as part of NPDES permit requirements.

Wastewater Treatment Plant Permits/NPDES Permit Review

- Reviewed and commented on National Pollutant Discharge Elimination System (NPDES) Permit Application for Verso Corporation for the North Branch Potomac River Use I-P and Savage River Use III-P. Storm water runoff is generated at the Savage River woodyard site, an area now used for vehicle maintenance, parts and scraps storage, other waste storage (indoors), and parking. It is also used for overflow storage of logs. Currently no sediment controls or treatment facilities exist at this site. Suggested that DNR should highly recommend to MDE that the storm water pollution plans and implementation be expedited by the applicant. In addition, the temperature limits on the cooling waters being released into the North Branch Potomac River for outfalls 001 through 006 – the maximum daily temperature limit is 95º F, with outfall 004 allowed to be 114º F, based on a mixing zone of 50 feet. While the North Branch Potomac River (NBPR) is classified by MDE as a Use I-P, in reality is should be treated at least as a Use IV-P. MD DNR manages the NBPR as a recreational trout stream, receiving several thousand adult trout each year since about 1989, and the river is one of Maryland's top trout fishing destinations. We have document year-round survival of trout in this section of the river as well as wild trout represented by multiple year-classes. DNR should request that Use IV-P temperatures standards (75 º F) be considered for this application (Garrett County).
- Provided comments to the Washington Suburban Sanitary Commission (WSSC) on plans to increase holding capacity for their Western Branch Facility in Prince George's County. The Branch is a tributary to the Patuxent River, where black bass, catfish and some tidal species reside.

Marcellus Shale Issues

- Attended a meeting between Fisheries, IPR, and The Nature Conservancy. The Nature Conservancy has developed a siting tool that maps all resources in a given area to evaluate the siting of Marcellus Shale support infrastructure. The tool is intended to identify critical resources and sensitive areas to be avoided by drilling, holding areas and water withdrawal areas.

Groundwater Withdrawals

- Provided comments to the IPR Unit regarding Garrett County Department of Public Works' groundwater withdrawal application for 302,000 gallons per day (gpd) and 511,000 gpd during months of maximum use from the Hoyes Run watershed to supply potable water in the Deep Creek Lake McHenry Area. A previous application by private industry requested about the same amount of

groundwater, however MDE was only going to allow 90,000 gpd and 150,000 gpd during months of maximum use to protect Hoyes Run (Use-III, Tier 2) from experiencing low flows during non-drought conditions.

- Assisted MDE Compliance Inspector with a field review of illegal dams and water withdrawals from Hoyes Run. The landowner was ordered to remove the dams and water withdrawal piping from the stream or face penalties. While the dams were breached and piping was removed, felt liners on the face of the dam were still present and the landowner was sent a compliance letter once again to remove them (Garrett County).

USGS Monitoring Gages

- Reviewed the list of current USGS gages in Maryland and confirmed those that are being used to monitor flow and temperature on key waters managed by Inland Fisheries Division.
- Reviewed a proposal to install a flow monitoring station on Bear Creek in Garrett County. The Monitoring and Non-tidal Assessment Division (MANTA) within DNR was planning the installation to be part of the US EPA's Global Change Assessment Group's Regional Monitoring Network (RMN). The goal of the monitoring is to evaluate long-term trends that may give information on global climate change.

Invasive species

- Reviewed National Control Plan for snakeheads, provided comments to USFWS Maryland Fisheries Resources Office; Wrote and currently reviewed Statewide ANS Management Plan.
- Worked to document and study invasive catfish species and northern snakehead. Provided materials and signage to inform and educate public on how to deal with these species. Currently involved in a campaign to increase recreational angling for these species, including promoting harvest for consumption and the value of these fish as a food source.
- Participated in multi-agency collaboration on management, study and control of invasive fish species in Maryland.

Large Woody Debris

- Reviewed on-going issues with woody debris on Gunpowder Falls in Gunpowder Falls State Park (Baltimore County). The river is a multi-use resource in this area and is used for fishing, canoeing and kayaking, hiking and biking. Debris in the water provides good habitat for fish species but can be a hazard for boating and swimming. Staff reviews numerous debris piles each year in an attempt to reach a safe alternative where all resources are served.

Pond assessment

- Assessed pond on eastern shore to evaluate control methods of aquatic vegetation and life support for black bass (Queen Anne's County).

Population assessment

- Provided information to MDE regarding the brief history of the North Branch Potomac River downstream of Piney Swamp Run to Pinto, including trout management, trout stocking information, and temperature regimes. This information is needed to consider redesignating the current classification of Use-I to an existing use of Use-III (from Laurel Run to Piney Swamp Run) and Use-IV (Piney Swamp Run to Pinto) (Garrett County).
- Provided Potomac River resource information to USGS Leetown Science Center for assessing long-term temporal changes in fish community

Fish kill reports

- Investigated fish kill report in Braddock Run near the confluence with Wills Creek. No evidence was observed. MDE also investigated, also indicating they found no evidence of the reported fish kill. A recent combined sewage overflow event was evident though (Allegany County).

Flow Curve

- Validated the Hunting Creek gauging station flow curve for Cunningham Falls State Park. The curve is necessary to maintain cold water flow discharges from the Cunningham Falls Lake (Frederick County).

Fish Collection

- Collected golden redhorse from the Potomac River at Cumberland for USGS algal toxin study (Allegany County).
- Staff collected 20 mature smallmouth bass for USGS regional fish health studies.

Flow Alteration

- Provided oversight and flow alteration guidance to Cunningham Falls State Park during and following a Frederick County culvert repair project at Catoctin Hollow Road over Hunting Creek.

Recommendations

Staff needs to continue these efforts to provide the maximum protection and preservation of the State's fishery resources.

Conclusions

All of the projects in environmental review and technical guidance helped with efforts to protect, preserve, and enhance fish populations and their associated habitats. As development continues to expand, the number of environmental review projects continues to increase. Staff will need to work to incorporate these functions into the regular workload and will need to provide training to the IPR Unit to allow more rapid response and processing of project and permit submittals.

State: Maryland

Project Number: F-48-R-25
Study No.: I
Job No.: 2

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Fisheries Information Resources

Job Title: Creel Surveys

Introduction

An understanding of the level of fishing effort and harvest is critical to evaluating the effectiveness of regulations and other management efforts. Angler preferences and trip expenditures will also enhance the State's efforts to maximize recreational fishing opportunities and provide key information regarding the economic impact of recreational fishing in Maryland. These are crucial elements in Maryland's ability to preserve, protect, improve, and properly manage its freshwater resources.

Objectives

Angler Preference Survey

- Describe catch and harvest, including target species, catch and harvest rates, age, and weight of kept and released fish.
- Estimate fishing effort by area.
- Estimate total harvest and catch by area.
- Identify angler preferences and satisfaction associated with Maryland inland angling experience.
- Provide information on anglers and trip expenditures by area.
- Provide background necessary for future surveys.

Volunteer Angler Survey

- Determine the number of competitive sportfishing tournaments and angler participation.
- Assess angling effort on the stock of largemouth bass during the spawning (15 inch) and non-spawning season (12 inch).
- Quantify and evaluate annual trends in mortality during tournaments.
- Assess angling effort directed at largemouth bass by recreational anglers using a Volunteer Angler Survey and the Angler's Log. The Potomac River and upper Chesapeake Bay are the two most targeted watersheds by recreational and tournament anglers for tidal largemouth bass fishing in the Chesapeake Bay watershed.

Methods

Angler Preference Survey

Staff met to discuss information needed to adequately evaluate angler preferences. The staff economist provided advice on study design and structure. The survey conducted in 2003 provided information for additional guidance to develop the new outreach survey.

The Angler Preference Survey will survey general angler preferences and economic and social aspects of angling. Several key areas were identified that would require more in-depth information and analyses and separate surveys will be conducted for more in-depth brook trout and tidal black bass preferences.

The survey will use the nontidal fishing license and trout stamp data for 2014 or 2015 depending upon availability. A multi-stage stratified non-uniform probability survey design will be used. Stratification will reduce sampling variance by dividing sampling units into more homogeneous populations. Random selection within strata will eliminate bias. Previous angler surveys will be examined to estimate sample sizes necessary for precision of indices. Coefficients of variation of 20% or less will be strived for; however, sample size will be constrained by available manpower and budget. This will make probability estimates more accurate and make sufficient sample sizes more achievable. Use of non-uniform probabilities will allow sampling effort to be allocated proportional to angler activity thus providing the most efficient use of personnel.

Angler preferences will be investigated using questions in a "Choice Experiment" format. This type of questioning describes hypothetical fishing trips and characteristics of those trips (e.g., driving distance, catch rate) and asks anglers to choose between the two options. This information will provide information on how anglers value a given fishery and the fishing experience.

Scott Knoche began working with the Angler Preference Survey as the Fisheries staff economist. He accepted a job with Morgan State University in Maryland but will continue to work on this survey as part of a Memorandum of Understanding.

Volunteer Angler Survey

The methods for the Volunteer Angler Survey can be found in Study V, Job 4 of this report.

Results

Angler Preference Survey

Staff met under the previous segment of this grant to begin discussions on the Angler Preference Survey. The discussion centered on the design of effective questions that would yield the needed data. Discussion in early 2015 identified both general and special fishery data needed for management. Information that needed to be identified included: angler habits and expenditures; angler understanding of existing regulations;

angler views on population conservation; brook trout management; tidal black bass management; nontidal Potomac River management; and invasive species. Tidal black bass and brook trout proved to be hot topics where data was needed as soon as possible, so these two fisheries were separated out for independent in-depth surveys to be developed. Discussion continued on the remaining topics and needs were further refined. The staff economist assisting with the survey development accepted a job with Morgan State University, but remained committed to developing this survey. Meetings were scheduled after June 30, 2015 to refine and finalize the survey. The general survey was scheduled to be administered in February of 2016.

Volunteer Angler Survey

The results for the Volunteer Angler Survey can be found in Study V, Job 4 of this report.

Discussion

Angler Preference Survey

Creel surveys will provide information necessary for the evaluation of fishing effort and harvest, as well as angler preference and trip expenditures. These data will improve Maryland's ability to evaluate fishing pressure, the response of fish stocks to fishing, and the economic value of inland sport fisheries. They will also improve the State's capability to develop effective management strategies and determine the impact of fishing regulation changes on fisheries.

Volunteer Angler Survey

The discussion for the Volunteer Angler Survey can be found in Study V, Job 4 of this report.

Recommendations

Angler Preference Survey

- Continue work toward the survey to be administered in 2016
- Establish an MOU with Morgan State for survey development and analysis

Volunteer Angler Survey

The discussion for the Volunteer Angler Survey can be found in Study V, Job 4 of this report.

State: Maryland

Project Number: F-48-R-25
Study No.: I
Job No.: 3

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Fisheries Information Resources

Job Title: Database Management

Introduction

In order to fulfill its responsibility to manage, restore, and enhance Maryland's freshwater resources, the Inland Fisheries Division is improving its data and information management system by creating a centralized data repository.

Objectives

A number of objectives were defined as necessary to achieve a better system:

- Improve the efficiency and accuracy of data entry; provide utility for summary and reporting.
- Provide methods of geographically projecting and querying data.
- Provide data summaries.

The system would also provide uniformity of data across management areas and be accessible to fisheries offices statewide, while allowing multiple users to interface with the system at the same time.

Methods

Maryland Department of Natural Resources (DNR) Inland Fisheries Division and the Information Technology Service (ITS) staff developed a data management system referred to as the Geographic Inland Fisheries Survey (GIFS) system. The platform for the system is Microsoft's SQL Server. For several years data entry has been through forms in MDI (Multiple Document Interface) on the internal DNR network. Recently a change to a web-based interface was implemented.

The GIFS system was designed to incorporate nearly all standardized aquatic surveys performed by the Inland Fisheries staff. This included streams, inland and tidal rivers, and freshwater impoundments. Finfish, invertebrate, water quality and physical habitat fields were all included. In addition, the GIFS system provided a way to export a "snapshot" of the data from the SQL Server through the internal DNR network to an Access database on local PCs for the purpose of querying records.

Results / Discussion

Programming for a new version of the GIFS database began in 2013 by Maryland DNR's IT team. The new version, known as GIFSv2, went live in March 2014 using a web-based interface and the old version was discontinued.

Several new features were designed into GIFSv2 including a means of protecting records from accidental deletion and a way to upload individual fish from an Excel spreadsheet which allows faster data entry of large numbers of fish. The mapping feature, which is still being developed, will have a much improved base map and show all the Sites with links to the data. The process of improving and debugging the new interface has been ongoing and will continue for some time.

In the process of converting to GIFSv2, many fields of data had to be "cleaned up" by updating bad values into a consistent format. For instance the input mask for start time and stop time required a 24-hour format and hundreds of records were corrected that were in various other formats. Many fields controlled with dropdown lists, including maturity, target age group, and aquatic vegetation species, had variations of values that had been entered prior to the dropdown list that were not acceptable and therefore numerous records had to be updated.

An issue that was created with the conversion to GIFSv2 was that the daily copy of the database in Microsoft Access had a problem where many former "text" fields were changed to "memo" data types. This change caused problems for many existing Access queries that are run each year for data analysis. This issue is currently being corrected.

In addition to the effort to refine the features of the GIFSv2, other ongoing database projects continued as well. One such project has focused on adding location coordinates for each Site where missing. Coordinates were added to approximately 30 Sites using Google Earth to estimate locations during the year. In addition, coordinates for 1,659 Sites of the Tidal Bass project were appended to the Site table from an ArcGIS file. There are about 864 Sites with no related coordinates that need to be updated. Another ongoing project is to complete summary catch data in instances where it was left blank and to verify that it matches with the individual fish data. Many records were added or checked in the summary catch data.

Routine data entry/editing continued in 2014 for annual surveys with entries made using both the old and new system. A summary of new records entered included 90 Sites with 529 Passes, and 7,698 Individual Fish records. Many of the records were collected in past years but entered in 2014. For instance, 4,677 new Individual Fish records were from data collected in prior years. The number of Passes entered was lower in 2014 than previous and was likely due to the change over to the new GIFSv2 and the associated learning required. The years 2010 to 2013 averaged 1360 new Passes entered per year compared to 529 for 2014. An update of the invertebrate species lookup table was completed in 2014 and the table increased in size from 287 records to 591 records.

With the change to the GIFSv2, there was no update prepared for the Multistate Aquatic Resource Information System (MARIS) in 2014. The latest snapshot of the data was dated July 31, 2013. Data within MARIS are available at the web site (http://www.marisdata.org/). A new update will likely be posted in 2015.

A priority with the conversion to the new GIFSv2 was to get the basic functionality up and running. With a system that attempts to fill the needs of multiple survey types and users, updates and refinements are a continuous process. Some issues remain such as getting all dropdown menus in place and to making certain required fields such as Region and Watershed are within the Site table. A work order to install a new fish injuries tab was requested by the Tidal Bass Program and should be completed in 2015. The injuries tab will allow multiple health issues along with severity to be attributed to an individual fish. A future goal is to develop a procedure to check for outlying values for length and weight fields by species. Another goal is to capture a subset of data to download in Access rather than the whole of the data. In addition, the speed of the system is slow when adding data especially when a large number of individual fish has been added under a particular Pass and editing of the individual fish or adding summary catch data is needed.

iPad tablets were purchased and issued to field offices in June, 2015 to allow data to be entered and saved to a spreadsheet by biologists in the field. The data can then be uploaded to GIFSv2 when back in the office. There is also a possibility that data will be directly recorded into GIFSv2 with mobile broadband internet enabled devices that are using a VPN, or Virtual Private Network, connected to Maryland DNR's internal network.

Recommendations

Further enhancements are needed to address several issues with the new GIFSv2. These enhancements will include:

- Creating a uniform format for Site ID and requiring a unique number to be chosen.
- Require a Region to be selected from a dropdown list.
- Create a new tab for fish injuries to be attributable to individual fish.
- Connect GIS mapping to GIFSv2.
- Change data types from memo to text for many fields.
- Address concerns of speed during data entry and editing.
- Learn to use iPads to enter and save data.

State: Maryland **Project Number:** F-48-R-25

Project Title: Survey and Management of Freshwater Fisheries Resources

Supplemental Information - Regulations

The following information covers work <u>not charged</u> to any federal aid project, but describes outcomes resulting from data and research collected in this and other projects.

Introduction

Each year the Maryland Inland Fisheries Division uses information gathered on fish populations and related resources across the State to develop management strategies to insure the perpetuation of fish species, and to provide maximum fishing opportunities and quality of the experience. The development of regulations helps meet these strategies by guiding anglers to help maintain the fishery.

Methods

In the spring of 2015, the Inland Fisheries Division developed regulation changes that were needed to meet the management needs of freshwater fish species and the angling public. Staff considered species and waterway characteristics, current population data, and fishing pressure information to develop regulations for a given body of water or for statewide application. The potential regulations were posted on the Fisheries website for review and comment by the public. Potentially affected individuals (PAIs) were notified of the posting. Comments were accepted until the end of July. After receiving all comments and following scoping meeting in September, staff will complete final regulations and submit to Maryland Register, for regulations to take effect by January 1, 2016.

Results and Discussion

The following regulations were under discussion in the spring:

- Place restrictions on northern pike in Deep Creek Lake.

This proposal was presented to the Sportfish Advisory Commission but was withdrawn from consideration since the Commission and staff recognized that more population data were needed to make a regulatory change to benefit both the fishery and anglers.

- Remove the #1 Put-and-Take Trout Stocking closure dates from Herrington Manor and New Germany Lake.

These areas were proposed for removal to increase fishing opportunity, decrease impacts from poaching on New Germany and to avoid fish kills on Herrington Manor when acid deposition from precipitation during the closure would significantly impact water quality.

By allowing immediate fishing here, anglers could harvest before such an event would occur.

- Close the season for river herring in nontidal waters.

The current open season for river herring conflicts with a regulation prohibiting the possession of river herring statewide. This change corrects that oversight.

- Place the Pennsylvania regulations for the Youghiogheny Reservoir in Garrett County back in the Code of Maryland Regulations (COMAR) and in the Maryland Sportfishing Guide.

The Youghiogheny Reservoir lies within the state of Maryland but is governed by the state of Pennsylvania by written agreement. For calendar year 2015, the Youghiogheny Reservoir regulations were removed from COMAR, but this caused confusion for both anglers and law enforcement. The decision was made to submit the regulations again for inclusion in COMAR until such time as a formal, reciprocal agreement is drafted and signed that will more clearly define the roles of each state.

Recommendations

Fisheries will continue to use survey data to continually update and modify regulations to preserve and protect fish populations and their associated habitat, while striving to meet the needs of the angling public.

ANNUAL (2015) PERFORMANCE REPORT
January 1 to June 30, 2015

Maryland Department of Natural Resources
Fisheries Service
Inland Fisheries Management Division

SURVEY AND MANAGEMENT OF FRESHWATER FISHERIES RESOURCES

Management of Freshwater Impoundments

USFWS Federal Aid Grant F-48-R-25

Study II

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Management of Freshwater Impoundments

State: Maryland

Project Number: F-48-R-25
Study No.: II
Job No.: 1

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Freshwater Impoundments

Job Title: Survey and Inventory

Introduction

Maryland's public impoundments, which exceed 100 in number and 10,000 hectares in surface area, provide a wide diversity of recreational fishing opportunities. Most of the bodies of water larger than 4 hectares also afford the option of boating to supplement shoreline fishing. The physical diversity of habitats and fish species variety, combined with wide distribution and easy access, make these impoundments valuable resources promoting healthy and enjoyable outdoor recreation for citizens in Maryland and neighboring states. Surveys of fish habitat and inventory of fish populations guarantee the continued maintenance, protection and enhancement of State fishery resources.

Objectives

The objective of this job is to obtain baseline physical, chemical, and fish species information to describe a new or existing impoundment with limited or no survey history. This includes identifying and describing new fisheries resources and management opportunities; monitoring and evaluating the impact of increasing white perch populations in reservoirs; and documenting and evaluating the effects of changing aquatic habitat, fishing pressure, and management programs.

Results/Discussion

The wide diversity of lake size and morphology across geographical regions required the development and adaptation of several different strategies for electrofishing surveys. Reservoir drawdown and periodic or seasonal aquatic vegetation impacts have presented recurring sampling challenges. In small impoundments the entire accessible shoreline is sampled; smaller impoundments having heavy infestations of vegetation and/or lack adequate depth present sampling limitations. The combination of shoreline seining and fall electrofishing surveys has been effective in documenting natural reproduction of sportfish and newly introduced fish species. Each kind of assessment has been accurate enough to monitor and track large-scale trends and the general health of these populations. The large impoundment survey methodology has improved data reliability by establishing sampling protocol that has provided coverage across all habitat types and has lowered the chance of bias in site selection. The precision of length category (PSD)

and condition indices has been found to be adequate for describing targeted fish populations in impoundments.

“Initial Survey and Inventory” studies were conducted on Wick Farm Pond in 2015.

Eastern Region
(Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Wicomico, and Worcester Counties)

Wick Farm Pond
(Kent County)

Introduction

The Wick Farm Pond is a 1 hectare impoundment in Kent County, Maryland. The impoundment and surrounding land was recently acquired by the Maryland Department of Natural Resources. Wick Farm Pond is very shallow with a maximum depth of 3 feet and an average depth of approximately 2 feet. The shoreline substrate is comprised of sand-gravel with the middle portion of the pond having a fine silt-muck substrate. The area around the pond is primarily agricultural, contributing to sedimentation and shallow water depth. The pond consists of mostly open water habitat and patchy woody structure in the form of fallen trees on the south shoreline, providing some habitat for largemouth bass, bluegill, and black crappie.

Objective

- Conduct an assessment to obtain baseline information on the status of the fish populations and existing habitat conditions in Wick Farm Pond.

Methods

Assessments of the fisheries resources in Wick Farm Pond were conducted on April 16, 2015. Surveys were conducted at two sites using boat electrofishing. The amount of shoreline sampled was limited by water depth. Total electrofishing effort was 931 seconds.

All largemouth bass were collected, measured for total length in millimeters (TL mm), and weighed in grams (g). Mean lengths and weights were calculated using only adult fish >150 mm (Reynolds and Babb 1978). All bluegill encountered at the first site were collected and measured (TL mm). Black crappie and pumpkinseed sunfish were collected and measured (TL mm).

Population or community parameters that were addressed included: length (TL mm), weight (g), growth, relative abundance, and size and age structure. Condition of the stock was determined by examining relative weight (W_r) (Wege and Anderson 1978). Stock structure was addressed by computing the index of proportional size distribution (PSD) (Guy et al. 2006). Relative abundance was determined by calculating the catch-per-unit-effort statistic (CPUE) and reported as number of fish per hour.

Results

A total of 14 largemouth bass were collected during the survey, equating to a CPUE value of 54 fish/ hour. Largemouth bass ranged from 208-520 mm (Figure 1). The proportional stock distribution (PSD) for largemouth bass was 79, indicating that larger (quality length) bass are relatively abundant. The mean relative weight for the largemouth bass in this population was 101, above acceptable levels of 90 (Wege and Anderson 1978). This suggests that these fish are in above average condition.
A total of 177 bluegill were collected at the first survey site, and were abundant throughout the pond. Bluegill ranged from 35-145 mm (Figure 2). The PSD for bluegill in this population was 0, indicating that all of the fish captured were less than quality length (150 mm). The desirable PSD range for bluegill is 20 to 50 where the management objective is to create good largemouth bass fishing opportunities in largemouth bass-bluegill dominated fisheries (Weithman et al. 1979). Despite the PSD value of bluegill falling outside of this range in Wick Farm Pond, a PSD value of 0 indicates a population that is comprised entirely of smaller fish that may provide a good forage base for largemouth bass or other piscivorous predators.

Black crappie were scarce overall (N=10), and ranged from 97-222 mm. Only one pumpkinseed was collected that was 76 mm. A table showing other species encountered with observed abundance estimates are included in Table 1.

Discussion

Although largemouth bass were not overly abundant in Wick Farm Pond, the population consists of larger fish in excellent condition. It appears that the large forage base of small bluegills may be benefitting largemouth bass condition and growth. However, very few small largemouth bass were present suggesting that recruitment may be stymied. A number of factors may be causing recruitment failure, including limited available space due to shallow water depth, limited complex habitat availability, predation of eggs or larvae by overabundant bluegill, disturbance of nests by the abundant common carp population, or cannibalism by adult largemouth bass. It may be possible to improve in-pond habitat by dredging to increase depth in some areas and adding Christmas trees to increase habitat complexity. Wick Farm Pond has ample access on the north shoreline, which may make this pond an excellent location to host children's fishing rodeo events.

Recommendations

Once it is determined how the Wick Farm property is going to be managed by Maryland Department of Natural Resources, it would be beneficial to investigate the possibility of performing a small-scale dredging operation to increase the depth in portions of the pond. Furthermore, addition of Christmas trees would increase the amount of complex habitat in the pond, which is currently limited. Largemouth bass can be stocked into Wick Farm

Pond to potentially increase sportfishing opportunities and control the overabundance of small bluegill.

Table 1. Common and scientific names, and observed abundance estimates of species sampled from Wick Farm Pond, spring 2015.

Common Name	**Scientific Name**	**General Occurrence**
Largemouth bass	*Micropterus salmoides*	Common
Bluegill	*Lepomis macrochirus*	Abundant
Gizzard shad	*Dorsoma cepedianum*	Common
Golden shiner	*Notemigonus crysoleucas*	Rare
Pumpkinseed sunfish	*Lepomis gibbosus*	Rare
Common carp	*Cyprius carpio*	Common
Black crappie	*Pomoxis nigromaculatus*	Common
Brown bullhead	*Ameiurus nebulosus*	Rare

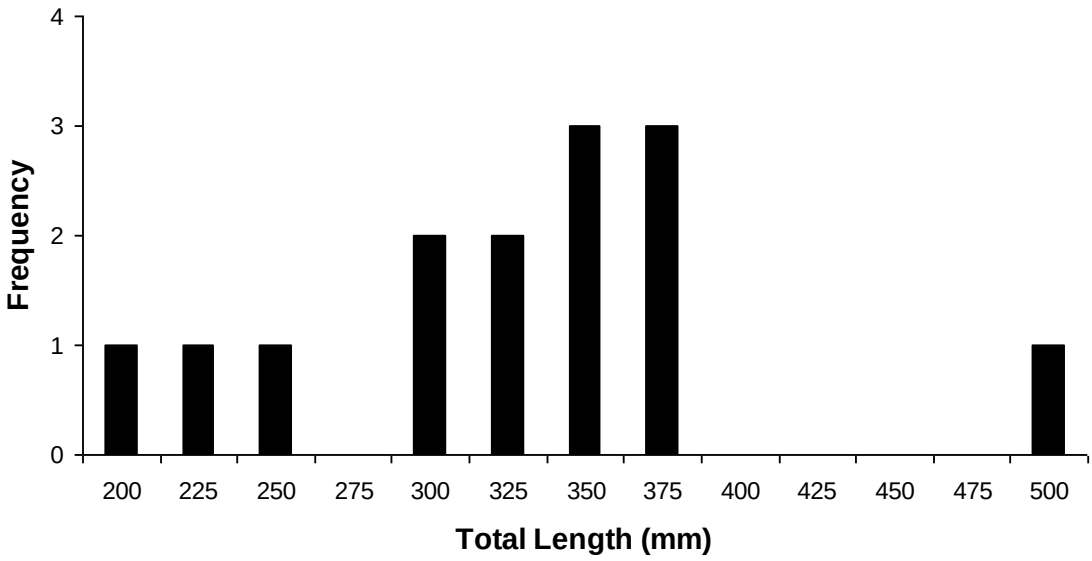

Figure 1. Length-frequency distribution of Largemouth Bass collected from Wick Farm Pond, spring 2015.

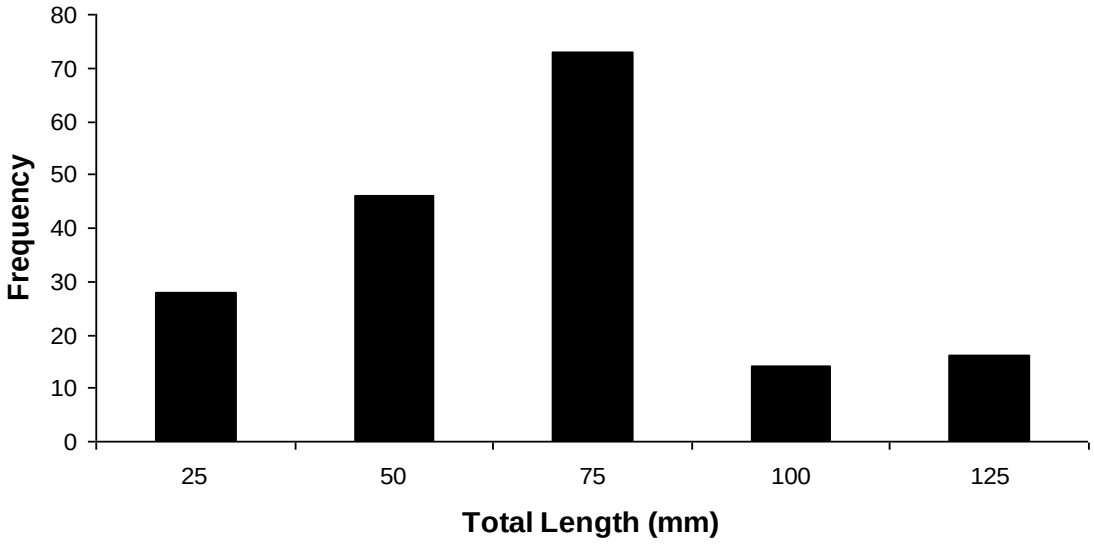

Figure 2. Length-frequency distribution of Bluegill collected from Wick Farm Pond, spring 2015.

State: Maryland

Project Number: F-48-R-25
Study No.: II
Job No.: 2

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Freshwater Impoundments

Job Title: Monitor Trends in Fish Populations

Objectives

The objective of this job is to obtain fish population information on previously surveyed impoundments to monitor for changes that may require immediate or future corrective fish management action and collect aquatic habitat information for evaluation relative to changes in fish populations.

Methods

Procedures followed are cited in each impoundment report if different from those described in this Methods section. Monitoring studies were conducted on Conowingo Reservoir, Cedarville Pond, Deep Creek Lake, Youghiogheny River Reservoir. In addition, stocking efforts are reported for Triadelphia Reservoir and Rocky Gorge Reservoir.

A. Impoundment Methods

The wide range of target species and impoundment morphology across Maryland required a variety of gears and methods to achieve project goals. In addition, new electrofishing methods, introduced in 2002, were employed and evaluated in some but not all impoundments. Within Study II, these new methods are referred to as 'Random Site Electrofishing'. All other methods are referred to as 'Single Sample Electrofishing'. Individual reports cite which of these methods were used and describe variations or additional protocols in detail.

B. General Electrofishing Procedures

Field Procedures

These procedures were common to both electrofishing methods described below. Sampling was conducted with 16- or 18-foot Smith-Root electrofishing boats equipped with 5.0 kilowatt (kw) gasoline generators. Crews consisted of one driver and two netters. Target species were netted and held in a live-well until a site was completed or the live-well reached capacity. Fish were measured for total length (TL) by pressing the mouth shut against the end of the measuring board or cradle and depressing the tail to determine the greatest possible length. Weights were measured and reported in grams. Fish scales

were collected for aging from the left side after the tip of the pectoral fin and below the lateral line.

Analytical Procedures

Catch rate (catch per unit effort or CPUE) was standardized to fish per hour ($CPUE_{60}$) and was calculated as an index of relative abundance. $CPUE_{60}$ was further calculated for various length categories as proposed by Gablehouse (1984). Proportional and relative stock densities (PSD and RSD), the percentages of fish sampled within each of these length categories, were used to describe population size structure in terms of species balance and angling quality.

Relative weights (W_r) were estimated for various species and size groups. Relative weight was developed by Wege and Anderson (1978) as a method to determine fish condition. This index of relative weight is:

$$W_r = W/W_s \text{ X } 100$$

Where:

W_r = Relative weight of a fish
W = Actual weight of a fish
W_s = Standard weight for a fish of same length (from table)

C. Random Site Electrofishing

Field Procedures

The shoreline was divided into 400-meter sites. This was done with maps or with Global Positioning System (GPS) units prior to the start of sampling. When an impoundment was too large to sample every site, a sub-set of sites was randomly chosen. Unless otherwise noted, site selections were based upon the systematic method of allocation (Miranda et al., 1996; Nielsen and Johnson, 1983; Snedecor and Cochran, 1968). The sample size was determined and then sites were numbered to provide consecutively numbered groups equal to the desired number of samples. A random choice was made from the range of consecutive numbers and that site was sampled. Electrofishing started at the first station coordinate reached and continued for 600 seconds. Actual start/stop waypoints were entered and uploaded to a PC to accurately determine linear sample distance. All size groups of largemouth bass and other game species of moderate or low density were targeted for collection during the 600-second samples (see reports for target species list).

A subset of these stations was randomly chosen for full species community sampling. All species and sizes were collected during the first 100 seconds of electrofishing at these stations.

Analytical Procedures

Relative abundance indices were estimated as the mean of $CPUE_{60}$ across all sites. Both arithmetic and geometric mean estimates were made. Geometric means were based on the natural log of CPUE +1. Log-transformation served to stabilize the variance and provide more precise indices.

D. Composite Site Electrofishing

Field Procedures

Sampling was conducted around the perimeter of the lake, but did not include the entire shoreline. Instead it focused on areas of habitat suitable for black bass. When the live-well was full, sampling stopped, individual fish data were recorded, and the fish were released. Sampling then resumed until the lake had been circumnavigated or the sample size was determined to be sufficient. A high percentage of shoreline was actually sampled in small impoundments, while as little as 5% of the shoreline may have been sampled in larger impoundments. The location of samples, although not specifically predetermined, generally remained constant unless changes in habitat or water levels required a change in location. This most closely resembled a fixed site strategy.

Analytical Procedures

Analyses were as described under 'Random Site Electrofishing' except that all parameters were estimated from the pooled samples. This did not allow for the calculation of variance, confidence intervals, or tests for significant differences.

Seining

Shoreline sites were sampled for young-of-year (YOY) black bass species using a 9.1 m x 1.2 m, 3.2 mm mesh beach seine. Site locations were generally fixed but varied with changes in shoreline, bottom habitats, or from water level variation. Initial selections were made to facilitate gear effectiveness and to sample representative habitat. A seining index was used to quantify YOY abundance based on the number of YOY collected from 30.5 m of shoreline (three hauls):

Number of YOY per 30.5m of shoreline	**Seining Index**
0 - 0.50	Poor
0.51 - 2.50	Fair
2.51 - 5.50	Good
5.51 +	Excellent

Western Region District I
(Garrett and Allegany Counties)

Deep Creek Lake
(Garrett County)

Introduction

Deep Creek Lake (DCL), located in Garrett County, is Maryland's largest freshwater impoundment with a surface area of 1579 hectares (3,901 acres), an average depth of 9 m (29.5 feet), a maximum depth of 22.8 m (74.75 feet), and a surface elevation of about 445 m (1460 feet) at full pool. The MD Department of Natural Resources, Resource Assessment Service (MD DNR RAS 2010) reports that DCL exhibits patterns of a typical deep, temperate zone reservoir with two mixed seasons and two stratified seasons, pH levels > 6.5 and < 7.3, and low turbidity levels (< 100 NTU) which do not exceed Maryland Department of the Environment water quality criteria for its Use III-P designated use. The lake stratifies in the summer when dissolved oxygen concentrations approach zero ppm at depth > 10 m; however, a zone of cold and oxygenated water sufficient to support two-story fishery management exists in all seasons. DCL contains a diverse fish species assemblage supporting coldwater, coolwater, and warmwater fisheries. Largemouth bass *Micropterus salmoides*, smallmouth bass *Micropterus dolomieu*, and walleye *Sander vitreus* are the most popular sport fish. Annual stocking of adult brown trout *Salmo trutta* and rainbow trout *Oncorhynchus mykiss* provide a put and take trout fishing opportunity. Warmwater gamefish and panfish, except walleye and yellow perch *Perca flavescens*, are managed under Maryland's statewide regulations (MD DNR, 2015). Walleye and yellow perch are managed in DCL by special regulations. Walleye regulations include a closed season from March 1 through April 15, a five fish daily creel limit, and a 381 mm minimum size limit the remainder of the year. Yellow perch regulations include a ten fish creel limit, no closed season, and no minimum size restriction. Trout fishing is managed under Put and Take regulations as described in the 2015 Maryland Fishing Guide (MD DNR, 2015).

Objectives

- Determine fish species composition, proportional stock density (PSD), relative stock density (RSD), relative weight (W_r), length frequency distribution, and relative abundance of important gamefish and panfish species.
- Determine black bass, walleye, and yellow perch reproductive success.

Methods

Fish community survey
A Smith-Root SR-16H, 5.0 kw, pulsed DC electrofishing boat was used to sample twenty established sites after dark on May 13 and 14, 2015 for fish species composition and relative abundance. Each station was sampled for 600 seconds of electrofishing effort.

Fish were identified to species, measured for total length (TL) in mm, and weighed to the nearest gram. Relative abundance of fish species was recorded as catch per unit of electrofishing effort ($CPUE_{60}$). Observed abundance estimates were derived from sample size and fish were rated as abundant (>100 individuals), common (5-100 individuals), or scarce (< 5 individuals). Proportional stock density (PSD) and relative stock density (RSD) were calculated using methods described by Anderson (1980). Confidence intervals for proportional stock density and relative stock density were calculated using the formula described by Gustafson (1988). Relative weight (W_r), a measure of fish condition, was calculated using methods described by Anderson (1980).

Walleye surveys
A Smith-Root SR-16H, 5.0 Kw, pulsed DC electrofishing boat was used to sample for walleye after dark on April 6, 2015 along the dam breast and the Deep Creek State Park shoreline. Relative abundance of adult walleye was recorded as catch per unit of electrofishing effort ($CPUE_{60}$).

Results

Fish community
The list of common names, scientific names, observed abundance estimates, and pooled CPUE abundance of seventeen fish species collected in DCL during 2015 is contained in Table 1. These species represent six families and are indicative of a coldwater, coolwater, warmwater fishery. The panfish species: bluegill, pumpkinseed, and yellow perch were regarded as common to abundant. Smallmouth bass and walleye were the most abundant gamefish species. Fish species composition in DCL was largely unchanged from that observed during the last five-year study period (MD DNR, 2011).

Walleye
Summaries of walleye population data are contained in Table 2. The $CPUE_{60}$ value show walleye were the most abundant gamefish species in the 2015 sample (Table 1).
The PSD_{38} value for walleye was within the suggested range of 30 to 60% (Anderson and Weithman, 1978). The W_r of the combined walleye population was less than the suggested range for good condition of 95 to 100% (Wege and Anderson, 1978). Walleye length frequency distribution (Figure 1) shows diverse size classes from YOY to trophy-size fish (690 mm maximum size), with a large proportion of the population within the 351 mm to 475 mm size classes.

Yellow perch
Summaries of yellow perch population data are contained in Table 3. The $CPUE_{60}$ value shows yellow perch were the most abundant panfish in the 2015 sample. The PSD_{20} value for yellow perch was greater than the range of 30 to 50% suggested by Anderson and Weithman (1978). The RSD_{25} value shows a high percentage of the population is of preferred (250 mm) size or larger. Yellow perch relative weights were less than the 95 to 100% expected range for good condition (Wege and Anderson, 1978), although the fish did not appear to be in poor condition. The length frequency distribution (Figure 2)

shows a population characterized by a diverse size structure. Yellow perch from YOY to memorable size (355 mm) were collected in 2015.

Smallmouth bass
Summaries of smallmouth bass population data are contained in Table 4. The PSD_{28} value for smallmouth bass was greater than the expected range of 30 to 60% for a balanced population, while the RSD_{35} was just below the suggested range of 10-25% (Anderson and Weithman, 1978). The W_rs for smallmouth bass in all size categories were below the 95 to 100% expected range for good condition (Wege and Anderson, 1978). Smallmouth bass length frequency distribution collected by electrofishing is contained in Figure 3. Smallmouth bass show a diverse length frequency distribution from YOY to 430 mm.

Largemouth bass
Summaries of largemouth bass population data are contained in Table 5. The PSD_{30} and RSD_{38} values were greater than the optimal range of 40 to 60% for a balanced population. The W_rs in all size categories were below the 95 to 100% expected range for good condition (Wege and Anderson, 1978). The length frequency distribution (Figure 4) shows a diverse size structure with an abundance of 301 mm to 500 mm size fish.

Bluegill
Bluegill population data are contained in Table 6. The PSD_{15} and RSD_{20} values were greater than the suggested ranges described by Anderson and Weithman (1978), indicating a population comprised of an abundance of quality and preferred size fish. Length frequency distribution (Figure 5) shows a diverse size and age structure from YOY to memorable size (275 mm) fish in the population. The W_rs of bluegill were within the expected 95 to 100% range for a balanced population.

Pumpkinseed
Pumpkinseed population data are contained in Table 7. The PSD_{15} and RSD_{20} values were greater than the suggested ranges described by Anderson and Weithman (1978). Length frequency distribution (Figure 6) and high PSD_{15} and RSD_{20} values indicate population with a large portion of fish > 200 mm. The W_rs for all size categories were within the expected range of 95 to 100% described by Wege and Anderson (1978).

Chain pickerel
Chain pickerel population data are contained in Table 8. The PSD_{38} and RSD_{51} values are indicative of a balanced population (Anderson and Weithman, 1978). Length frequency distribution shows a diverse age and size structure with trophy-sized fish > 600 mm in the population (Figure 7).

Trout species
A combined total of 4,800 brown trout, rainbow trout, and golden trout were stocked in DCL in 2015. Only three rainbow trout were collected during electrofishing sampling efforts primarily due to their pelagic, deeper water habitat preferences.

Discussion

Deep Creek Lake supports a popular walleye fishery. Regulation modifications first implemented in 1993 (increased the minimum size limit from 355 mm to 381 mm) and 1995 (established a closed season from March 1 through April 15) have resulted in improved age and size structures as well as improved annual reproduction. The electrofishing sample indicates that the majority of legal-size walleye are between 351 and 400 mm TL, with occasional opportunities to catch trophy size fish.

The yellow perch population in DCL is well balanced with stock (≥ 130 mm), quality (≥ 200 mm), preferred (≥ 250 mm), and memorable (≥ 300 mm) sized fish represented in the population. A 10 fish daily creel limit/20 fish possession limit was implemented for DCL effective January 1, 2010. The regulation change, which was based on electrofishing sampling and creel census data from angler interviews, should maintain and enhance the yellow perch population in DCL.

Smallmouth bass are one of the most sought after gamefish species in DCL and was the third most abundant gamefish observed. Smallmouth bass continue to maintain sustainable harvest levels and adequate survival to older year-classes as evidenced by the diverse age and size structure in the electrofishing samples.

Largemouth bass abundance collected by electrofishing for years 2011 (N=10), 2012 (N=12), 2013 (N=40), and 2014 (N=30) has been low. In July 2010, the Maryland Department of the Environment determined that abnormal high water temperatures aided the bacterium *Aeromonas hydrophila* and a protozoan gill parasite to cause a large fish kill in DCL. Most DCL fish species were affected, and an estimated 10,000 fish died. The reduced abundance of largemouth bass for those years may indicate the 2010 fish kill had an adverse effect on the population size. In response, a corrective stocking of 10,000 largemouth bass fingerlings (source – Manning Hatchery) was conducted in 2012. The stocking, coupled with three years of "good" reproduction, has improved largemouth bass abundance in DCL. The $CPUE_{60}$ for largemouth bass in 2015 (N = 55) was highest since the fish kill event. An abundant YOY index in 2015 should further improve the largemouth bass population in Deep Creek Lake.

Bluegills and pumpkinseeds are common to abundant in DCL and the populations are characterized by having adequate quality size fish to provide angler interest. Chain pickerel are very abundant; however angler interest in this species is relatively low. Golden shiners were found to be the most abundant forage fish species in DCL. Common carp are also common and reach very large sizes, and there is increased angler interest in this species. Brown trout, rainbow trout, and golden trout are stocked annually in DCL and adequate coldwater and oxygen in the hypolimnion during summer allows for year-round survival, creating angling opportunities in all seasons. Northern pike, although considered scarce, are becoming more common in electrofishing samples. This increase in abundance may be a result of the increased minimum size restriction (610 mm TL to 762 mm TL, enacted in 2001). The increase in the minimum size allows the northern pike

to reach sexual maturity before reaching harvestable size. Increasing the minimum size and a spring closed season to allow northern pike to reach trophy size (1016 mm or 40 inches) is currently being investigated.

Recommendations

All project work objectives were accomplished during this study period; however further monitoring studies will be required to further assess the development of fish populations in DCL. Recommended studies for 2016 include:

- Conduct springtime walleye and comprehensive fish population surveys to monitor the status of resident game and non-game fish species including relative abundance, age and size structures, and reproductive indices.
- Obtain tournament capture data on largemouth bass, smallmouth bass, and walleye.
- Conduct summer seining surveys to monitor reproductive success for black bass and yellow perch.
- Conduct fall electrofishing surveys to monitor walleye reproductive success.
- Continue annual adult brown trout and rainbow trout stocking, and consider increasing the annual allocation if trout production in MD DNR Coldwater Hatcheries increases.
- Conduct fall/spring electrofishing surveys targeting northern pike in order to expand population data indices to make future fisheries management decisions.

Table 1. The list of common names, scientific names, observed abundance estimate, and relative abundance of seventeen fish species collected in Deep Creek Lake, 2015 (Robins *et al* 1991).

Common name	**Scientific name**	**Observed abundance Estimate**	**Pooled $CPUE_{60}$**
common carp	*Cyprinus carpio*	Common	Observed not collected
golden shiner	*Notemigonus crysoleucas*	Abundant	Observed not collected
yellow bullhead	*Ameiurus natalis*	Common	2
brown bullhead	*Ameiurus nebulosus*	Common	7
northern pike	*Esox lucius*	Scarce	1
chain pickerel	*Esox niger*	Abundant	20
rainbow trout	*Oncorhynchus mykiss*	Scarce	<1
brown trout	*Salmo trutta*	Scarce	Stocked not collected
rock bass	*Ambloplites rupestris*	Abundant	98
pumpkinseed	*Lepomis gibbosus*	Common	18
bluegill	*Lepomis macrochirus*	Abundant	34
smallmouth bass	*Micropterus dolomieu*	Abundant	53
largemouth bass	*Micropterus salmoides*	Abundant	17
black crappie	*Pomoxis nigromaculatus*	Scarce	<1
yellow perch	*Perca flavescens*	Abundant	108
walleye	*Sander vitreus*	Abundant	61
Total species = 17			

Table 2. Summary of walleye population indices in Deep Creek Lake, 2015.

Pooled April and June Electrofishing and Tournament data					
Indices	**Overall**	**Stock$_{25}$**	**Quality$_{38}$**	**Preferred$_{51}$**	**Memorable$_{63}$**
W$_r$ (%)	77	79	77	67	86
N =	347	84	250	7	3

Pooled April and May Electrofishing data		
PSD$_{38}$ (%) with 95% CI	**RSD$_{51}$ (%) with 95% CI**	**N**
59 ± 8	1.5 ± 2	197

Individual data sets				
Sample	**Mean TL mm (range)**	**Mean W g (range)**	**CPUE$_{60}$**	**N**
April nighttime	394 (280-645)	507 (172-2870)	174	174
May nighttime	331 (137-690)	410 (18-3256)	9	29
Fall YOY	NA	NA	NA	NA

Table 3. Summary of yellow perch population indices in Deep Creek Lake, 2015.

Indices	**Value**	**N**
W$_r$, overall (%)	88	176
W$_r$, stock (%)	95	54
W$_r$, quality (%)	88	63
W$_r$, preferred (%)	85	33
W$_r$, memorable (%)	80	26
PSD$_{20}$ (%)	81± 7	150
RSD$_{25}$ (%)	39± 9	150
Mean TL mm (range)	231 (120-355)	176
Mean W g (range)	181(18-520)	176
CPUE$_{60}$	108	361

Table 4. Summary of smallmouth bass population indices in Deep Creek Lake, 2015.

Indices	Value	N
Electrofishing only		
W_r, overall (%)	87	166
W_r, stock (%)	90	90
W_r, quality (%)	84	52
W_r, preferred (%)	73	12
W_r, memorable (%)	77	1
Electrofishing only		
PSD_{28} (%)	42 ± 9	155
RSD_{35} (%)	8 ± 5	155
Mean TL (mm) of fish ≥ 305 mm (range)	340 (305-430)	46
Mean W (g) of fish ≥ 305 mm (range)	462 (326-974)	46
$CPUE_{60}$	53	176
Tournaments only		
Mean TL mm (range)	NA	NA
Mean W g (range)	NA	NA

Table 5. Summary of largemouth bass population indices in Deep Creek Lake, 2015.

Indices	Value	N
Electrofishing only		
W_r, overall (%)	92	55
W_r, stock (%)	92	6
W_r, quality (%)	92	26
W_r, preferred (%)	93	21
W_r, memorable (%)	80	1
Electrofishing only		
PSD_{30} (%)	88 ± 11	54
RSD_{38} (%)	41 ± 15	54
Mean TL (mm) of fish ≥ 305 mm (range)	380 (307-510)	48
Mean W (g) of fish ≥ 305 mm (range)	810 (378-1766)	48
$CPUE_{60}$	17	58
Tournaments only		
Mean TL mm (range)	NA	NA
Mean W g (range)	NA	NA

Table 6. Summary of bluegill population indices in Deep Creek Lake, 2015.

Indices	Value	N
W_r, overall (%)	100	111
W_r, stock (%)	95	4
W_r, quality (%)	97	30
W_r, preferred (%)	102	73
W_r, memorable (%)	82	4
PSD_{15} (%)	96± 5	111
RSD_{20} (%)	69 ± 10	111
Mean TL mm (range)	207 (125-275)	111
Mean W g (range)	215 (40-406)	111
$CPUE_{60}$	34	112

Table 7. Summary of pumpkinseed population indices in Deep Creek Lake, 2015.

Indices	Value	N
W_r, overall (%)	112	61
W_r, stock (%)	102	2
W_r, quality (%)	113	21
W_r, preferred (%)	112	38
PSD_{15} (%)	97 $\pm$ 6	61
RSD_{20} (%)	62 $\pm$ 14	61
Mean TL mm (range)	200 (110-230)	61
Mean W g (range)	211 (26-330)	61
$CPUE_{60}$	18	61

Table 8. Summary of chain pickerel population indices in Deep Creek Lake, 2015.

Indices	Value	N
PSD_{38} (%)	82 $\pm$ 12	56
RSD_{51} (%)	13 $\pm$ 11	56
Mean TL mm (range)	433 (180-610)	57
Mean W g (range)	434 (28-1006)	57
$CPUE_{60}$	20	67

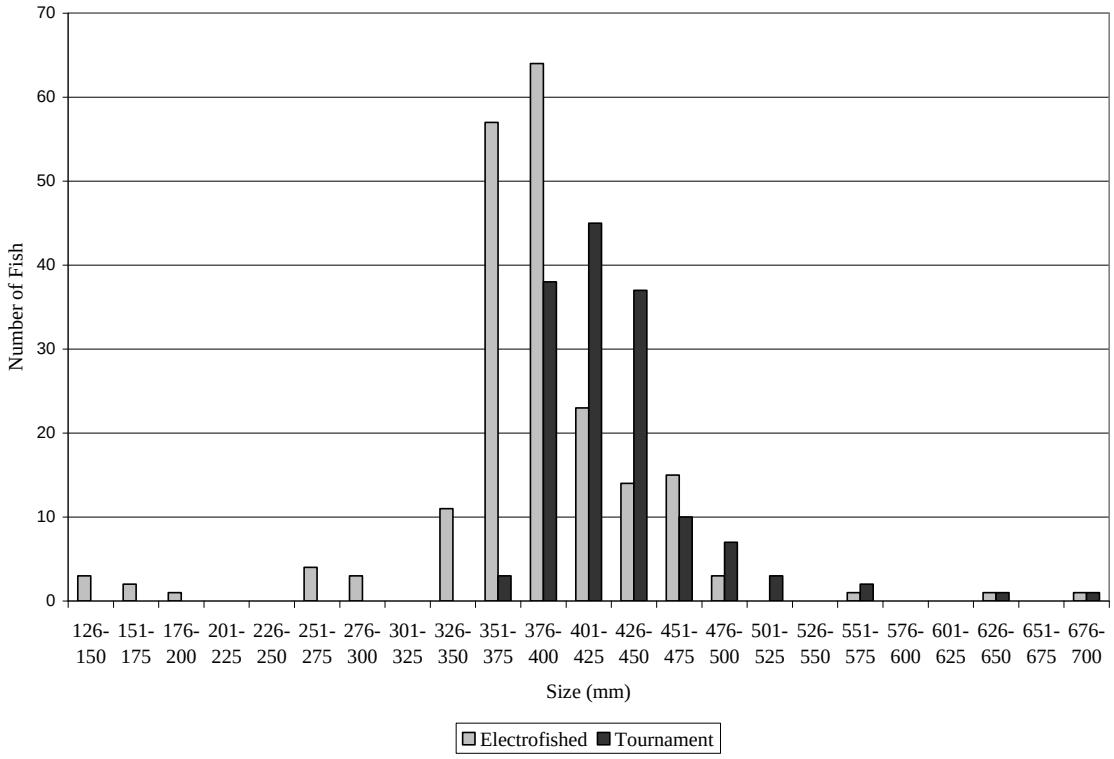

Figure 1. Length frequency distribution of walleye collected by electrofishing (N=203) and tournament catch (N=147) in Deep Creek Lake, 2015.

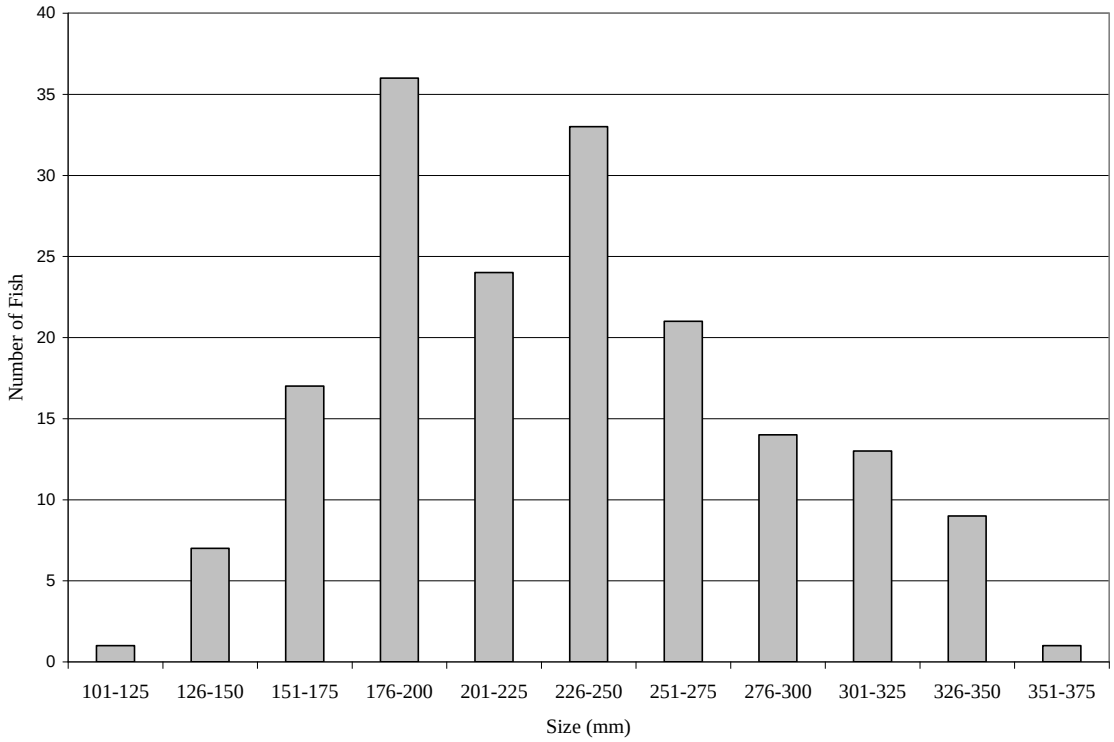

Figure 2. Length frequency distribution of yellow perch collected by electrofishing (N=176) in Deep Creek Lake, 2015.

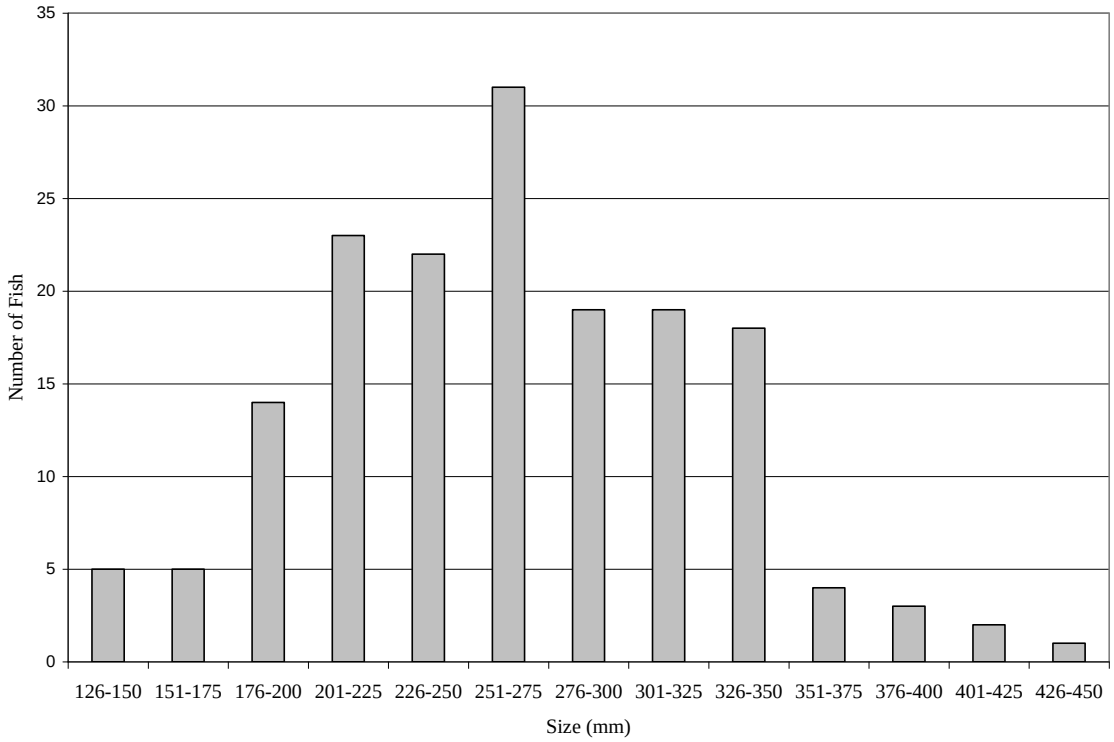

Figure 3. Length frequency distribution of smallmouth bass collected by electrofishing (N=166) in Deep Creek lake, 2015.

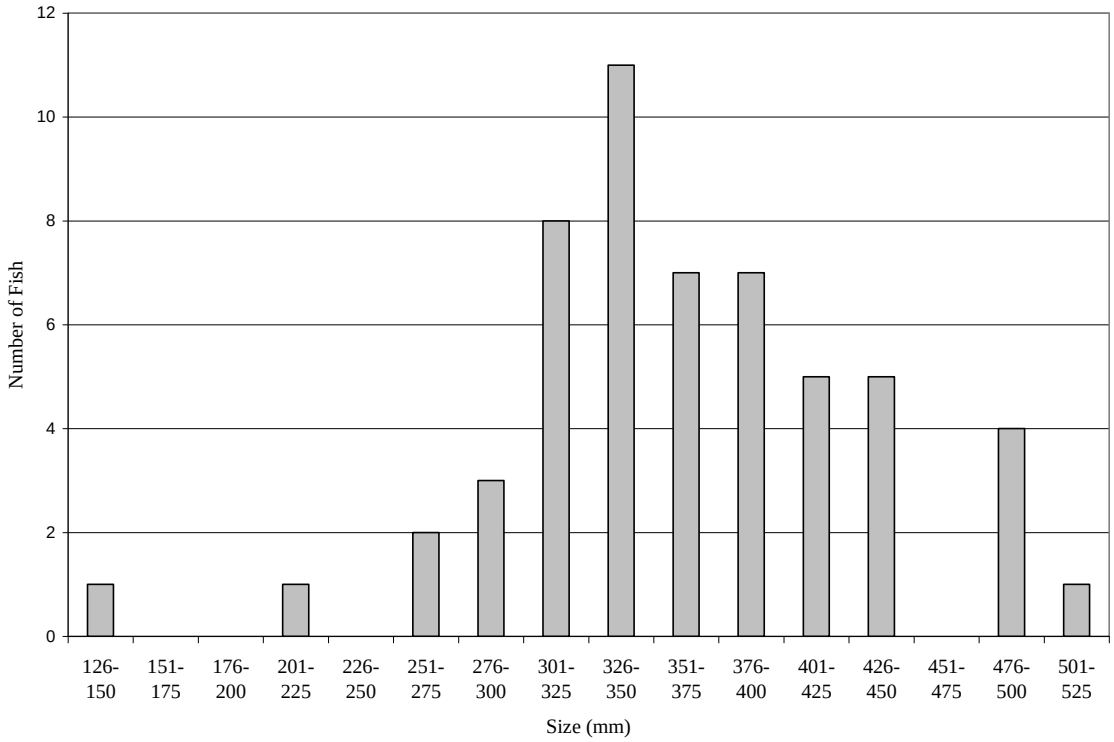

Figure 4. Length frequency distribution of largemouth bass collected by electrofishing (N=55) in Deep Creek Lake, 2015.

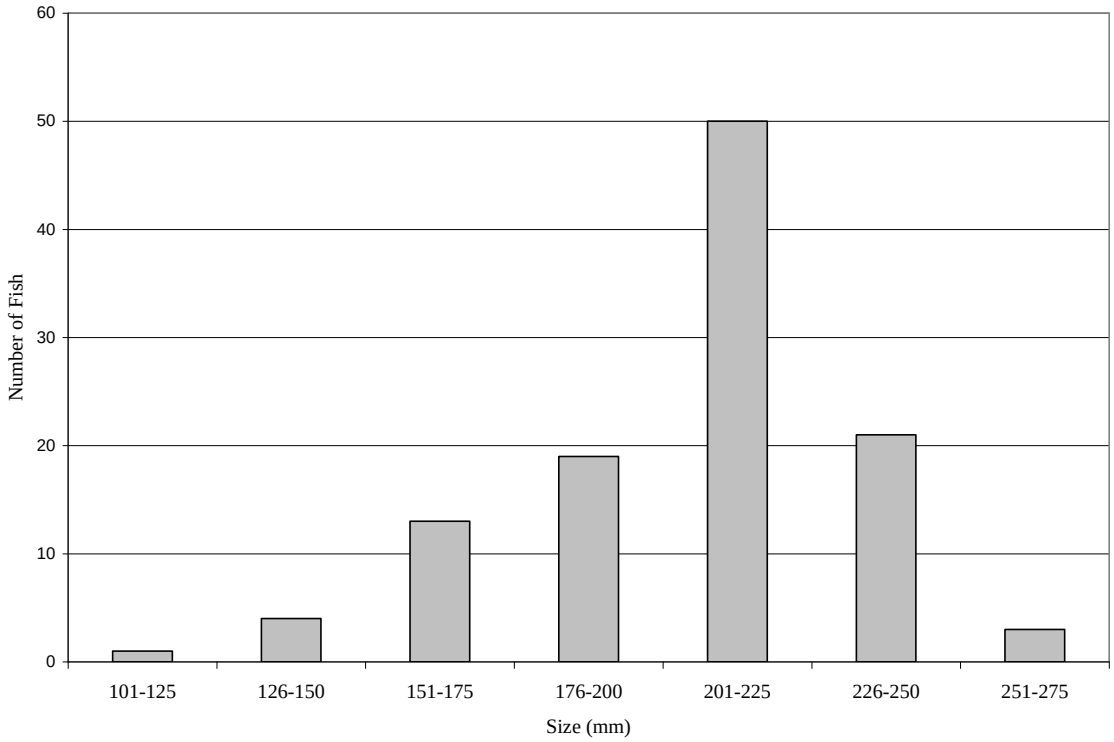

Figure 5. Length frequency distribution of bluegill collected by electrofishing (N=111) in Deep Creek Lake, 2015.

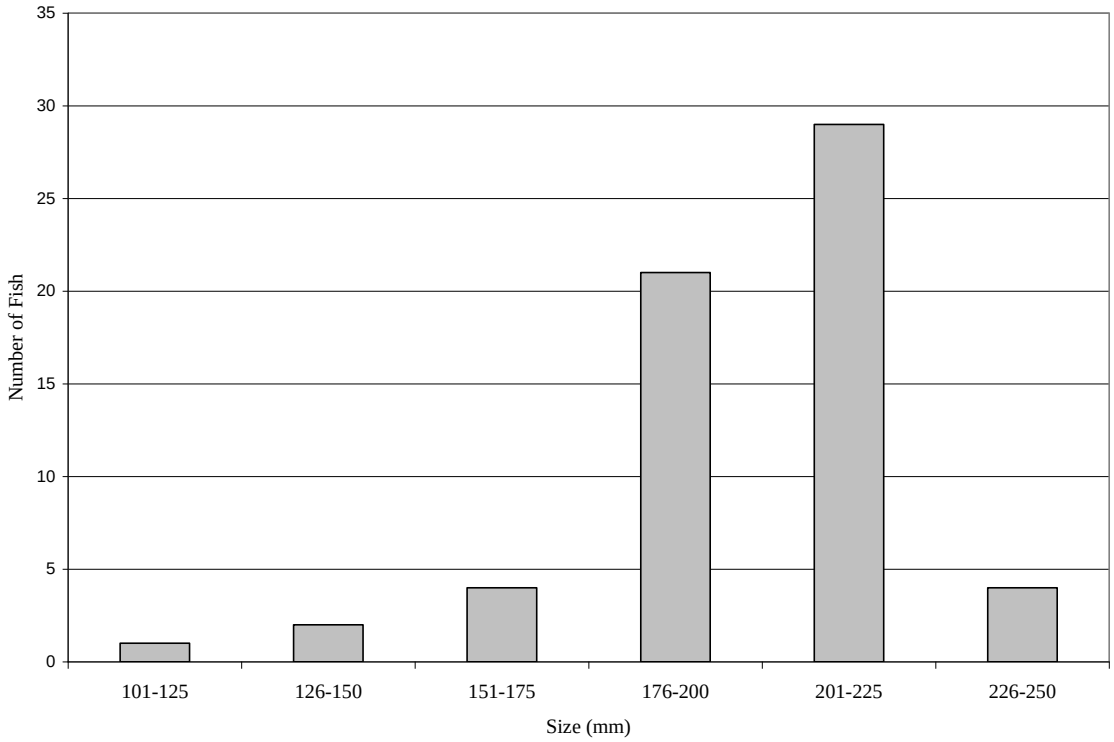

Figure 6. Length frequency distribution of pumpkinseed collected by electrofishing (N=61) in Deep Creek Lake, 2015.

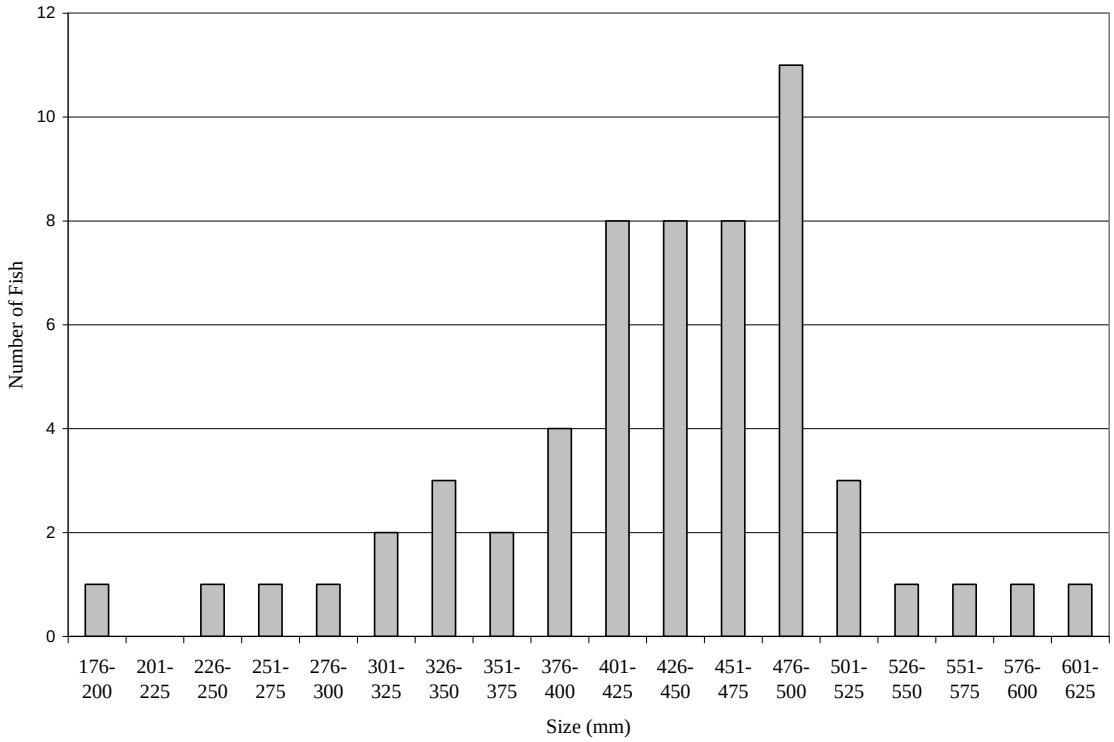

Figure 7. Length frequency distribution of chain pickerel collected by electrofishing (N=57) in Deep Creek Lake, 2015.

Youghiogheny River Reservoir
(Garrett County)

Introduction

The Youghiogheny River Reservoir is an 1133 hectare man-made impoundment built in 1943 for flood control and hydroelectric power. The Youghiogheny River Reservoir is 16 miles long with 38 miles of shoreline, an average depth of 54 ft, and a maximum depth of 121 ft. The Youghiogheny River Reservoir straddles the PA – MD border, starting north of Friendsville, MD and extending north to the dam in Confluence, PA. About 239 hectares of the reservoir are located in Maryland. The Youghiogheny River Reservoir is operated by the United States Army Corps of Engineers (USACE) and fish populations are monitored and managed by the Pennsylvania Fish and Boat Commission (PFBC).

Objective

- Determine fish species composition, length frequency distribution, and relative abundance of important gamefish and panfish species found in the Maryland portion of the reservoir.

Methods

Fish community survey
A Smith-Root SR-16H, 5.0 kw, pulsed DC electrofishing boat was used to sample six randomly chosen sites in Maryland on May 12, 2015 for fish species composition and relative abundance. Each station was sampled for 600 seconds of electrofishing effort. Fish were identified to species, measured for total length (TL) in mm, and weighed to the nearest gram. Relative abundance of fish species was recorded as catch per unit of electrofishing effort ($CPUE_{60}$).

Results

Fish community
The list of common names, scientific names, and CPUE abundance of nine fish species collected in the Youghiogheny River Reservoir is contained in Table 1. Smallmouth bass, yellow perch, and walleye were the most abundant fish species collected.

Walleye
Summaries of walleye relative abundance are contained in Table 1. The $CPUE_{60}$ value show walleye were the third most abundant game fish species in the 2015 sample (Table 1). Walleye length frequency distribution (Figure 1) shows all the fish collected were of quality (380 mm) size or greater and five out of the 18 fish collected were preferred (510 mm) size or greater.

Yellow perch
Summaries of yellow perch relative abundance are contained in Table 1. The $CPUE_{60}$ value shows yellow perch were the most abundant fish collected in the 2015 sample. The length frequency distribution (Figure 2) shows a population characterized by a diverse size structure. Yellow perch from YOY to quality size (>200 mm) were collected in 2015.

Smallmouth bass
Summaries of smallmouth bass relative abundance are contained in Table 1. The $CPUE_{60}$ value show smallmouth bass were the most abundant gamefish in the 2015 sample. The length frequency distribution (Figure 3) shows a diverse size and age structure. Smallmouth bass from YOY to memorable size (430 mm) were collected.

Discussion

The Youghiogheny River Reservoir supports a popular walleye fishery. The 2015 electrofishing sample indicated a walleye population comprised of quality and preferred size fish. PFBC has been stocking walleye fry and fingerlings in the Youghiogheny River Reservoir every year since 2003. MD DNR regulations include a closed season for walleye in the Youghiogheny River downstream of the MD Rt. 42 Bridge to the reservoir between March 1 and April 15 (MD DNR, 2015). This closed season protects the river spawning stock, and increases recruitment potential into the reservoir population.

Yellow perch were the most abundant fish species collected in the 2015 electrofishing survey. Yellow perch from YOY to quality size (200 mm) were abundant and should spark angler interest as well as provide a vital forage base for other gamefish such as walleye and smallmouth bass.

Smallmouth bass is also a popular game fish species in the Youghiogheny River Reservoir. The smallmouth bass population is characterized by diverse size classes, from YOY to fish exceeding 450 mm TL.

The Youghiogheny River Reservoir also offers anglers opportunities to catch northern pike, channel catfish, brown bullhead, bluegill, pumpkinseed, and black crappie.

Table 1. The list of common names, scientific names, and relative abundance of eight fish species collected in the Maryland portion of the Youghiogheny River Reservoir, 2015 (Robins *et al* 1991).

Common Name	**Scientific Name**	**$CPUE_{60}$**
brown bullhead	*Ameiurus nebulosus*	1
channel catfish	*Ictalurus punctatus*	2
northern pike	*Esox lucius*	observed not collected
pumpkinseed	*Lepomis gibbosus*	1
bluegill	*Lepomis macrochirus*	2
smallmouth bass	*Micropterus dolomieu*	20
black crappie	*Pomoxis nigromaculatus*	2
yellow perch	*Perca flavescens*	34
walleye	*Sander vitreus*	18

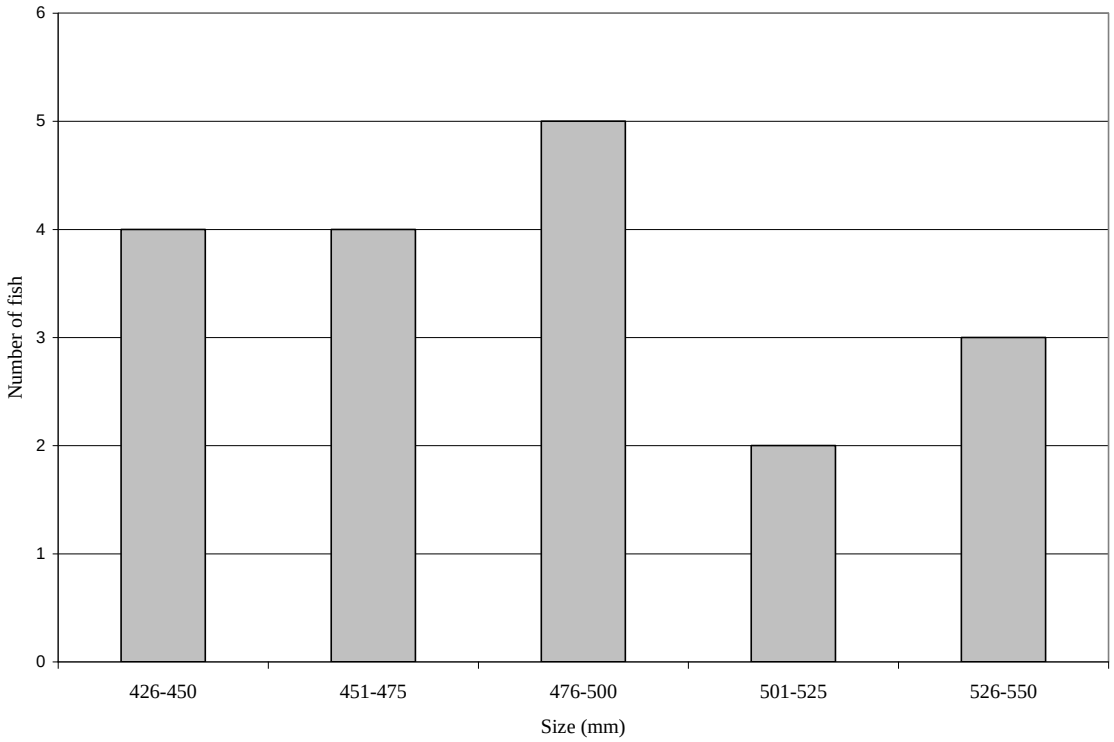

Figure 1. Length frequency distribution of walleye collected by electrofishing (N=18) in the Youghiogheny River Reservoir, 2015.

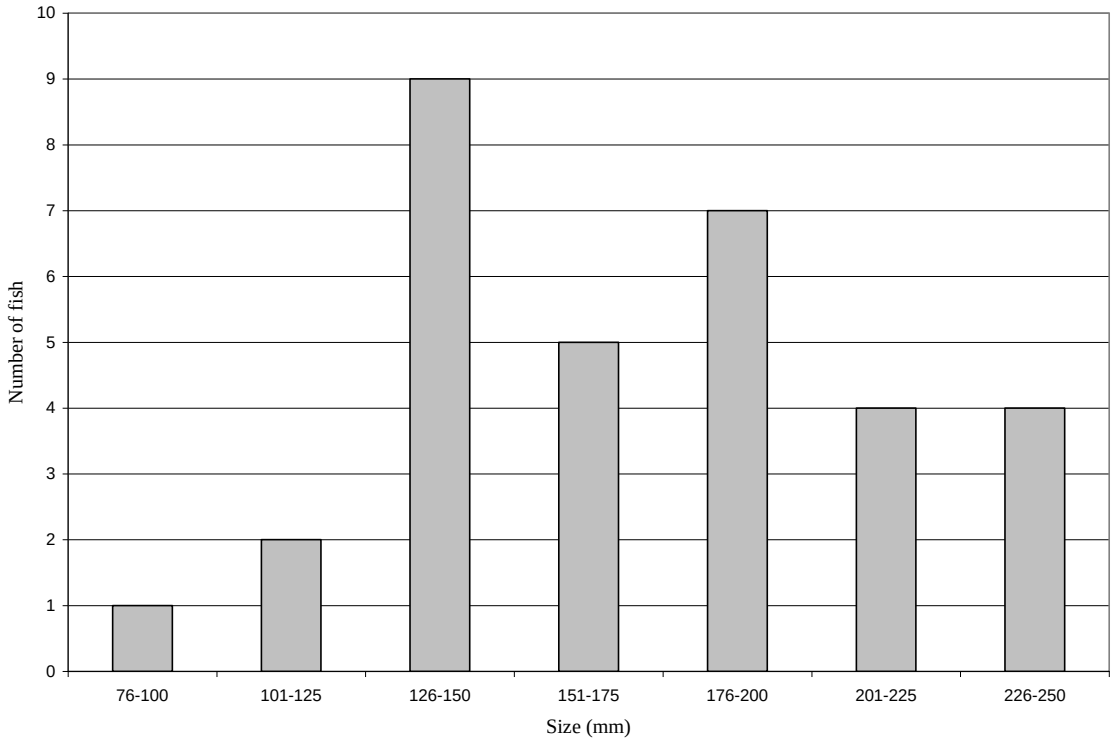

Figure 2. Length frequency distribution of yellow perch collected by electrofishing (N=32) in the Youghiogheny River Reservoir, 2015.

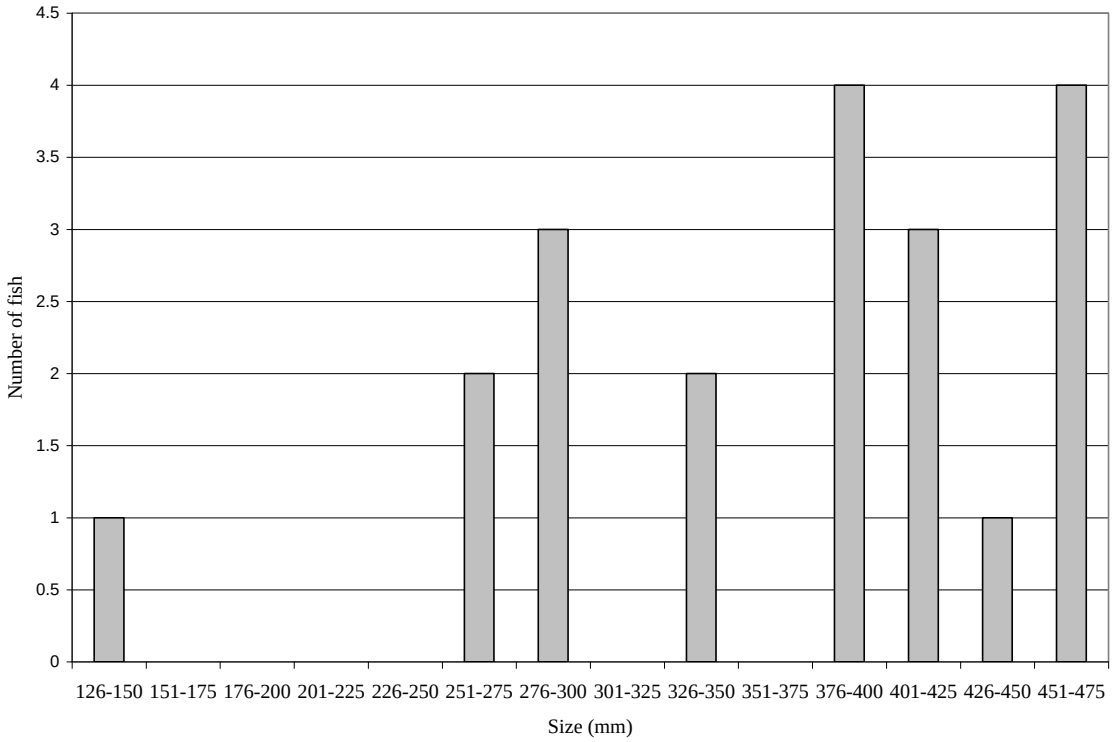

Figure 3. Length frequency distribution of smallmouth bass collected by electrofishing (N=20) in the Youghiogheny River Reservoir, 2015.

Southern Region
(Charles, Prince George's, and Saint Mary's Counties)

Cedarville Pond
(Charles County)

Introduction

Cedarville Pond is located within Cedarville State Forest. Like most southern Maryland impoundments, Cedarville Pond suffers from a lack of limestone and other base elements that produce a healthy aquatic environment. Alkalinity and hardness are also low which can cause unstable pH levels following heavy rainfall, seasonal die-off of vegetation and other natural or man-made impacts to the watershed. As a result, biological productivity is considered poor and management of fish populations can be difficult.

Methods

On June 11, 2015, a general fish survey was conducted on Cedarville Pond using a small Jon boat equipped with a 2500 watt Smith Root electrofisher. Largemouth bass and bluegill sunfish were the target species, but all fish species were recorded.

Results and Discussion

Only 21 largemouth bass were collected during the survey. Proportional stock density (PSD) was 75%, above the recommended level of 40-60% as recommended by Reynolds & Babb (1978) for small impoundments that are managed for bass/bluegill populations. Substock size bass (<199 mm in length) were most common in the survey indicating that bass reproduction was excellent in Cedarville Pond.

Bluegill PSD was 29%, meaning that there was an adequate number of both stock and quality size bluegill within the population. Substock size bluegill (<80 mm in length) dominated the survey showing that good bluegill reproduction occurs in Cedarville Pond.

Also present in Cedarville Pond were American eel, green sunfish, hybrid sunfish, warmouth and flier. Both warmouth and flier are described in the Rare, Threatened, and Endangered Animals of Maryland publication (published by MD DNR's Wildlife and Heritage Service) because of their rarity in the state. The flier is highly state rare and considered Threatened in Maryland, meaning that this species could be ranked Endangered in the foreseeable future. Warmouth are considered rare to uncommon in Maryland and are a Watchlist species, but are relatively common in some counties. Fliers may have been inadvertently introduced in Maryland during the initial stocking of several southern impoundments.

Triadelphia and Rocky Gorge Reservoirs – Stocking Activities
(Montgomery, Howard, and Prince George's Counties)

Spring and early summer activities on Triadelphia and Rocky Gorge Reservoirs in 2015 included smallmouth bass brood collections and supplemental stocking of some gamefish species.

Twelve smallmouth bass adults were collected from Triadelphia Reservoir and placed in a grow-out pond maintained by Washington Suburban Sanitary Commission (WSSC) personnel. Fathead minnows were stocked in the pond prior to the addition of the brood smallmouth. Native crayfish populate the pond and provide good natural forage for stocked adult bass. After the smallmouth brood spawned, WSSC personnel removed the adult fish through periodic hook and line fishing trips. All adult smallmouth bass were released back into the main reservoir. Young smallmouth will remain in the pond as long as possible in order to provide sanctuary from predators and allow optimal growth before being released. Triadelphia Reservoir is fitted with a large pipe that will allow the pond and fish to drain directly into the main reservoir. This reduces handling stress and provides a quick release of young fish.

Other Stocking activities in Rocky Gorge and Triadelphia are listed in Table 1.

Table 1. List of fish stocked in Rocky Gorge and Triadelphia Reservoirs during 2015.

Reservoir	Species	# Fish Stocked	Size	Date Stocked
Rocky Gorge	Walleye	55,000	fry	4/13 & 5/1
Rocky Gorge	Walleye	10,000	fingerling	5/11
Rocky Gorge	Tiger Musky	500	fingerling	5/15
Rocky Gorge	Striped Bass	1,00	fingerling	6/1
Triadelphia	Walleye	25,000	fingerling	5/2
Triadelphia	Tiger Musky	500	fingerling	5/15
Triadelphia	Striped Bass	10,000	fingerling	6/1

Eastern Region
(Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Wicomico, and Worcester Counties)

Conowingo Reservoir
(Cecil and Harford Counties)

Introduction

Conowingo Reservoir is a 1618 hectare impoundment of the Susquehanna River. The River and subsequent impoundment create a border between Harford and Cecil Counties in northern Maryland. It was created in 1928 as a source of hydroelectric power for the Philadelphia Electric Company (PECO). The reservoir is owned by PECO (now called Exelon) and Maryland Department of Natural Resources Fisheries Service, Inland Fisheries Division manages the sportfish populations. The reservoir supports a variety of warm and cool water fisheries; however the black bass fisheries are the most popular. Stocking of fingerling walleye and tiger muskellunge was conducted in the past by both agencies to provide additional angling opportunities. The fall survey conducted in 2014 marked the first formal fisheries management activities conducted on Conowingo Reservoir by Fisheries Service since 2005. The lack of recent management activities and ongoing Federal Relicensing of Peach Bottom Nuclear Power Plant and Conowingo Hydroelectric Plant required a comprehensive fisheries survey to be conducted in summer 2015. The ultimate goal of this annual survey will be to create a long-term data set to track and estimate the abundance of gizzard shad and other forage and non-game species. These data will also be used to help track the invasive flathead catfish population and their impacts, as well as guiding management decisions for the panfish species that are found in Conowingo Reservoir. The summer 2015 effort marks the first comprehensive electrofishing survey to assess the entire fish community in Conowingo Reservoir.

Objectives

- Conduct a summer electrofishing survey to assess the status of the fish community in Conowingo Reservoir.

Methods

A comprehensive fish population assessment was completed on June 10 and 16, 2015. A SR-18 electrofishing boat was used to conduct 600 seconds of effort at 10 randomly selected 400 m stations around the perimeter of the reservoir. Additional details can be found in the Study II, Job 2 Methods section of this report. All fish encountered were collected during each 600-second sample with one exception. Because some young of year (YOY) fish were too small to be affected by the electrofishing gear, netted, or identified easily, these fish were not collected. All fish collected were identified to

species and counted. Largemouth bass and smallmouth bass were measured for total length in millimeters (TL mm) and weighed in grams (g). Bluegill, channel catfish, green sunfish, hybrid sunfish, pumpkinseed, rock bass, and yellow perch were measured (TL mm). Adult gizzard shad were measured to fork length (FL mm). Flathead catfish were measured, weighed and sacrificed for otolith extraction and gut content analysis.

Population or community parameters that were addressed included: length (mm TL), weight (g), growth, relative abundance and size structure. Condition of the stock was determined by examining length-weight relationships such as relative weight (W_r) (Wege and Anderson 1978). Stock structure was addressed by computing the index of proportional size distribution (PSD) (Guy et al. 2006). Confidence intervals (95%) for PSD values were computed using the tables developed by Gustafson (1988). Relative abundance was determined by calculating the catch per-unit-effort statistic (CPUE) and reported as fish per hour.

Results

A diverse fish community consisting of 18 species was present in Conowingo Reservoir during this survey. Centrarchid species dominated the total sample with green sunfish being most abundant, followed by bluegill, smallmouth bass, and largemouth bass (Table 1).

A total of 90 largemouth bass were collected during the survey. Of the 90 largemouth bass captured in this survey, 83 (92%) were 2015 YOY (Figure 1). The relative abundance of stock sized fish ($CPUE_s$) was 4±2/hour and of quality sized fish ($CPUE_q$) was 3±1 fish/hour, which is eight times lower than $CPUE_s$ and four times lower than $CPUE_q$ observed in the fall 2014 survey (Table 2).

Smallmouth bass were captured at all 10 sampling sites during the survey. A total of 136 smallmouth bass were collected. The relative abundance of stock sized fish ($CPUE_s$) was 37±10/hour and of quality sized fish ($CPUE_q$) was 14±5 fish/hour, which is more than half of the abundance levels observed for smallmouth bass during the fall 2014 survey (Table 2). Smallmouth bass ranged from 34-502 mm. The PSD for smallmouth bass was 39±9. The mean relative weight for the smallmouth bass in this population was 89, just below acceptable levels of 90 (Wege and Anderson 1978), suggesting that these fish are just below average condition.

Bluegill sunfish were also captured at all 10 sampling locations. A total of 150 bluegills were captured during the survey, equating to a CPUE value of 87 fish/hour. Bluegill ranged from 50-205 mm (Figure 2). The PSD for bluegill in this population was 28±8, which falls within the desirable PSD range of 20 to 50, where the management objective is to create good bass fishing opportunities in bass-bluegill dominated fisheries (Weithman et al. 1979). A total of 153 green sunfish were also collected in the survey. A length-frequency distribution is presented in Figure 3.

Channel catfish were captured at six of ten sampling sites during the survey. A total of 20 adult channel catfish were collected, ranging from 220-489 mm (Figure 4). Relative abundance of channel catfish was 11 fish/hour. Flathead catfish were also captured during the survey, but were only encountered at 2 sample locations. A total of 7 flathead catfish were captured, ranging from 132-615 mm (Figure 4). Relative abundance of flathead catfish was 4 fish/hour.

Two Chesapeake logperch, which are state listed in Maryland, were captured at the site located near the mouth of Broad Creek during the survey.

Discussion

Conowingo Reservoir is one of the most diverse freshwater fisheries in Maryland. Sport fish, non-game, and forage species are abundant in the reservoir. The large amount of forage in the reservoir is likely responsible for the excellent condition of predatory fish.

A major motivation for the summer community survey was to monitor the abundance of gizzard shad in the reservoir. Adult gizzard shad were captured at all but one of the sites that were surveyed (Figure 5). Although they were not netted, YOY gizzard shad were extremely abundant and are likely the primary forage species in the reservoir, especially seasonally.

Another stimulus for the establishment of the summer community survey was to monitor the invasive flathead catfish population in the reservoir and their potential effects on the fish community. Although flathead catfish were encountered during this survey, the electrofishing settings used may not be ideal for the collection of catfish. Further investigation into the most effective electrofishing settings for the collection of flathead catfish in Conowingo Reservoir are scheduled for summer 2015.

The smallmouth bass population in Conowingo Reservoir appears to be very robust. Despite the recent problems with poor recruitment and disease in the Susquehanna River watershed, the population in Conowingo Reservoir does not appear to be affected at similar levels. Based on the large number of young smallmouth bass observed during this survey, anglers should have tremendous bass fishing opportunities for years to come. The largemouth bass population appears to have been affected by several years of poor reproduction or high mortality rates, as adult largemouth bass were infrequently encountered during this survey. However, large numbers of YOY largemouth bass were encountered during this survey. If this year-class recruits to adulthood, it will greatly bolster the population and provide anglers with increased fishing opportunities. Results from the summer 2015 survey indicate a substantial reduction in largemouth and smallmouth bass abundance compared to the fall 2014 survey. This may be attributed to differences in the design of these surveys. The fall nighttime electrofishing survey may be the best method to estimate bass abundance.

Bluegill and green sunfish were the most abundant species in Conowingo Reservoir, and large individuals of both species were commonly encountered. Although not abundant, sizeable rock bass were also captured. Based on the abundance of catchable size panfish in this population, anglers should experience fantastic fishing opportunities for these species.

Recommendations

A summer community survey should be conducted annually to monitor the entire fish community in Conowingo Reservoir. A traditional, fall night electrofishing survey targeting sportfish should be conducted in 2016. Sampling methodology and survey design should be investigated to monitor flathead catfish population abundance in Conowingo Reservoir.

Table 1. Common names, scientific names, and number captured for species collected during electrofishing surveys from Conowingo Reservoir, summer 2015.

Common Name	Scientific Name	Total Number Caught
Bluegill	*Lepomis macrochirus*	150
Channel catfish	*Ictalurus punctatus*	20
Chesapeake logperch	*Percina bimaculata*	2
Common carp	*Cyprinus carpio*	11
Flathead catfish	*Pylodictus olivaris*	7
Gizzard shad	*Dorosoma cepedianum*	45
Green sunfish	*Lepomis cyanellus*	153
Hybrid sunfish	*L. cyanellus x L. gibbosus*	1
Largemouth bass	*Micropterus salmoides*	90
Pumpkinseed	*Lepomis gibbosus*	1
Quillback	*Carpiodes cyprinus*	1
Redbreast sunfish	*Lepomis auritus*	2
Rock bass	*Ambloplites rupestris*	9
Shorthead redhorse	*Moxostoma macrolepidotum*	8
Smallmouth bass	*Micropterus dolomieu*	136
Spotfin shiner	*Cyprinella spiloptera*	17
Spottail shiner	*Notropis hudsonius*	4
Yellow perch	*Perca flavescens*	1

Table 2. Summary of largemouth and smallmouth bass data collected from fall 2014 and summer 2015 electrofishing surveys on Conowingo Reservoir. NA=Not enough fish to calculate PSD.

	Largemouth Bass		**Smallmouth Bass**	
	Fall 2014	**Summer 2015**	**Fall 2014**	**Summer 2015**
Number of sites	8	10	8	10
Number of bass collected	105	90	158	136
$CPUE_s \pm SE$	32±7	4±2	81±20	37±10
$CPUE_q \pm SE$	13±4	3±1	32±8	14±5
PSD ± 95% CI	20±10	NA	40±10	39±9

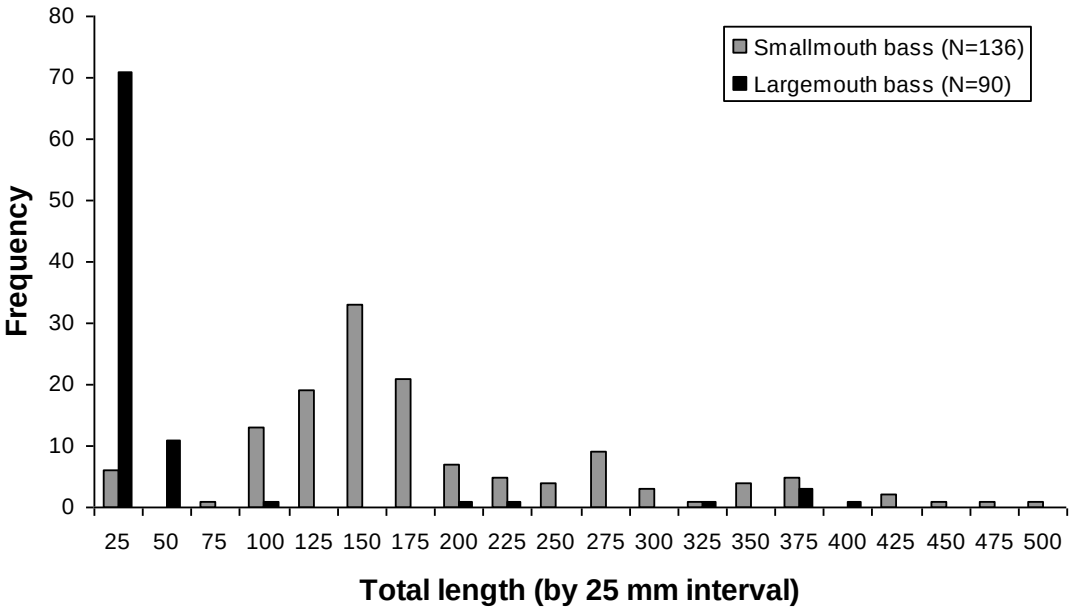

Figure 1. Length-frequency distribution of largemouth bass and smallmouth bass collected during electrofishing surveys from Conowingo Reservoir, summer 2015.

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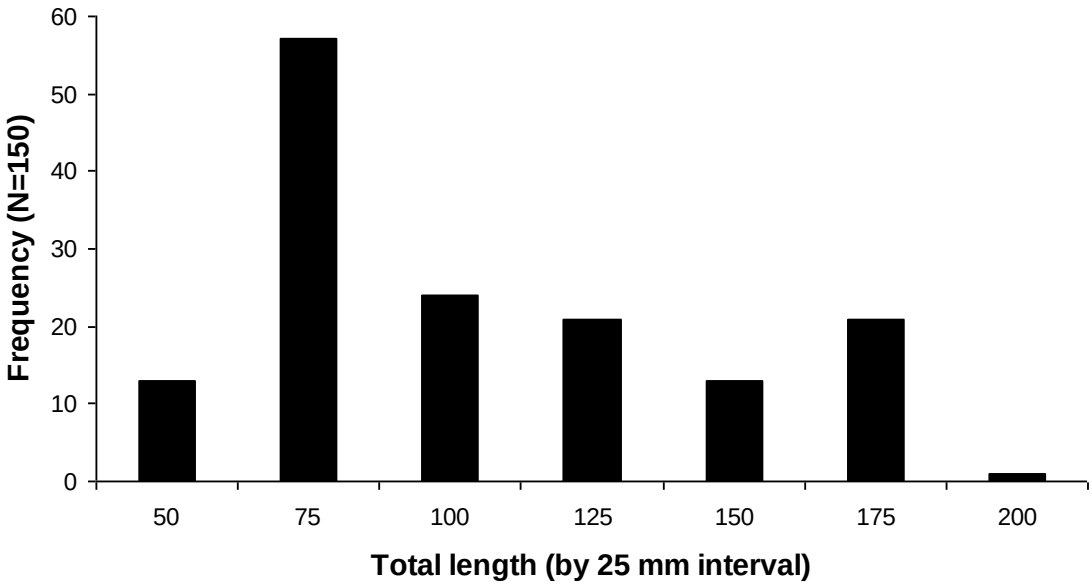

Figure 2. Length-frequency distribution of bluegill collected during electrofishing surveys from Conowingo Reservoir, summer 2015.

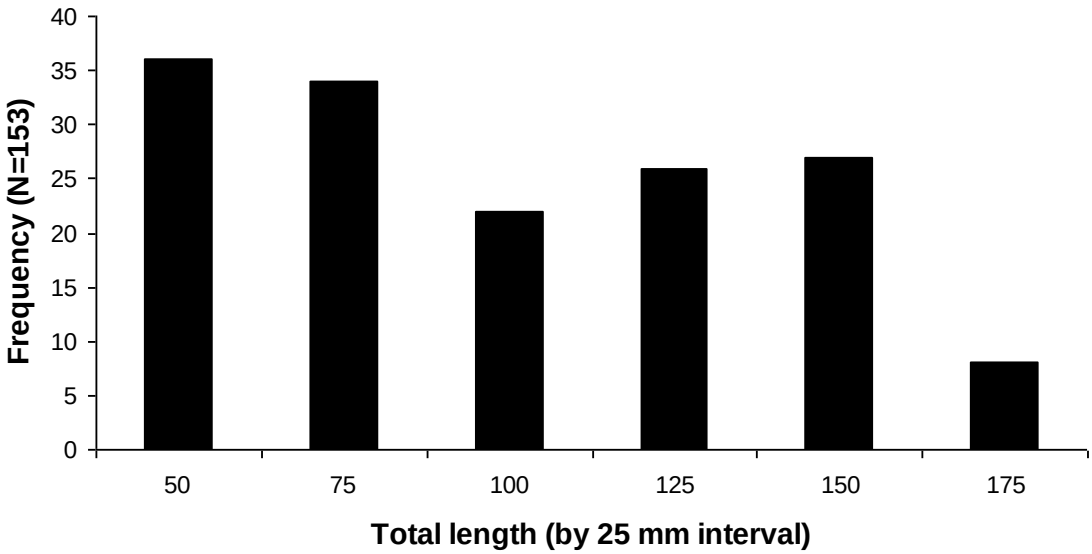

Figure 3. Length-frequency distribution of green sunfish collected during electrofishing surveys from Conowingo Reservoir, summer 2015.

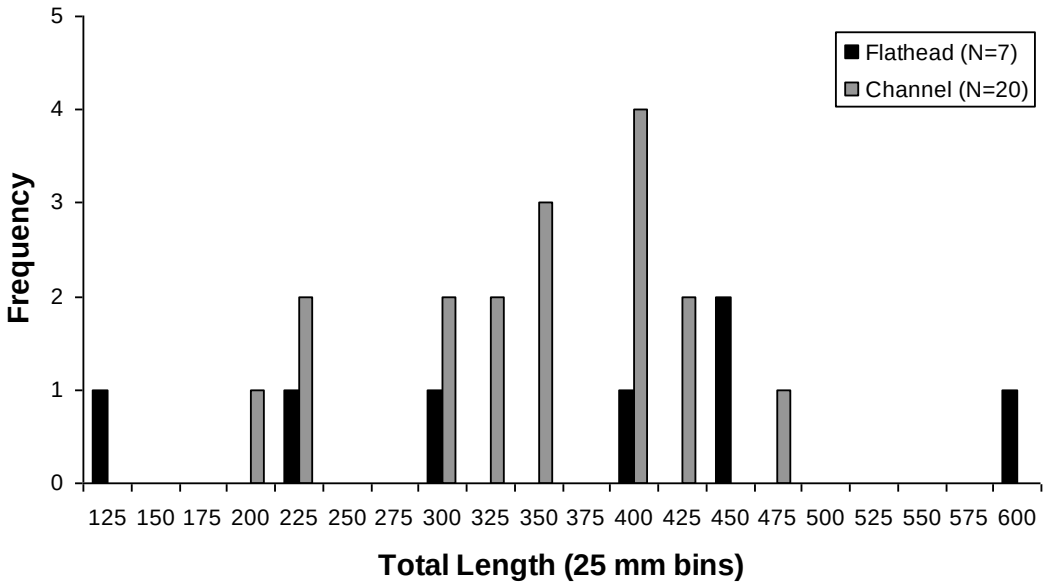

Figure 4. Length-frequency distribution of channel catfish and flathead catfish collected during electrofishing surveys from Conowingo Reservoir, summer 2015.

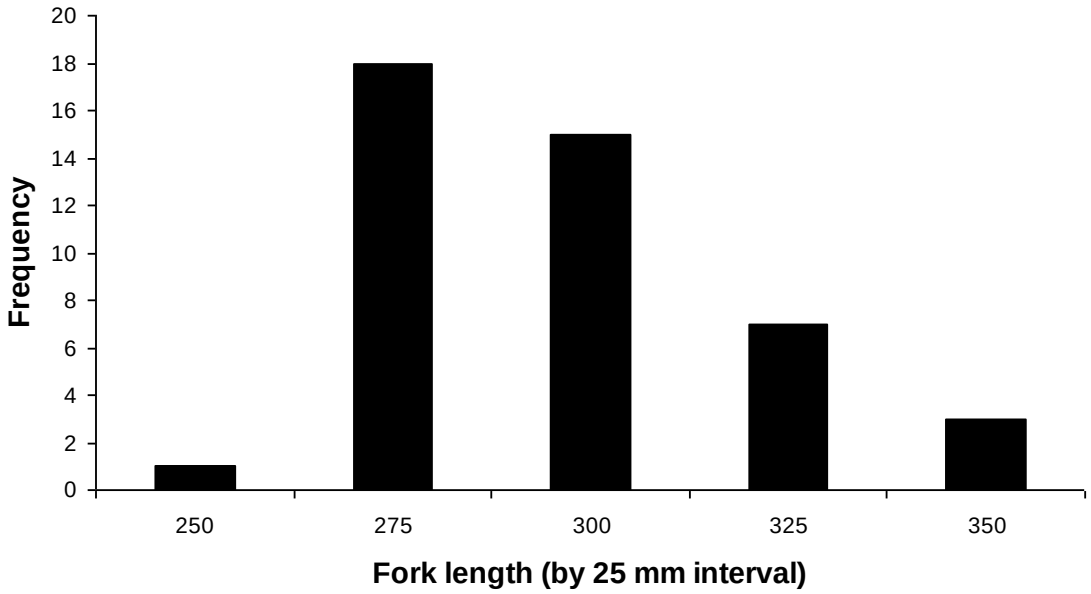

Figure 5. Length-frequency distribution of gizzard shad collected during electrofishing surveys from Conowingo Reservoir, summer 2015.

ANNUAL (2015) PERFORMANCE REPORT
January 1 to June 30, 2015

Maryland Department of Natural Resources
Fisheries Service
Inland Fisheries Division

SURVEY AND MANAGEMENT OF FRESHWATER FISHERIES RESOURCES

Management of Maryland's Coldwater Streams

USFWS Federal Aid Grant F-48-R-25

Study III
Jobs 1 and 2

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Table of Contents
Management of Maryland's Coldwater Streams

State: Maryland

Project Number: F-48-R-25
Study No.: III
Job No.: 1

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Coldwater Streams

Job Title: Trout Population Statistics

Job Objectives:

The objectives of this study are:

- To determine the distribution and abundance of trout, and to identify physical, chemical and biological parameters affecting densities of trout for those waters of the state which are known to support natural trout populations, may have the potential to support natural trout populations, or may be utilized to provide public recreational trout fishing.

- To monitor environmental conditions in order to detect changes in environmental quality to prevent or reduce environmental degradation as well as to document any improvement in environmental quality.

- To provide data for the development of effective management plans.

Methods

The methods described here are those used in all sample areas. In the event that the methodology had to be modified in an individual area, it is noted in the methods section for that area.

Trout Populations
Sampling stations are selected to include all the habitat types present in the stream reach to be surveyed (pool, riffle, run, etc.). The total length and width of the station are then measured to the nearest tenth of a meter. Stream surface area is computed and expressed in hectares. Fish populations are estimated using the three pass regression technique ($P \leq 0.05$) outlined by Zippin (1958). Fish are collected using dip nets and a Smith-Root backpack electrofishing unit (LR-24, Model 12-A POW) or a Smith-Root barge/bank mounted electrofishing unit (1.5KW or 2.5 GPP). The survey begins at the downstream end of the station and three electrofishing passes are made through the entire station. During each pass all the sportfish are collected and placed in a separate float box. The relative abundances of non-game species are observed and recorded. Observed abundance estimate is expressed as scarce (< 5 individuals), common (5-100 individuals) or abundant (> 100 individuals). All sportfish are anesthetized with Aqui S-20E, identified to the species level, measured for total length to the nearest millimeter,

weighed to the nearest gram, and returned alive to the stream at the end of the survey. Population estimates for each species collected are made using the MICROFISH 2.2 software package (Van Deventer and Platts 1985). The coefficient of condition factor (K) was used to assess physical condition for trout species (Lagler 1952).

Benthic macroinvertebrates

Samples were collected using a 600 µm kick net and three, 30 second kicks in the riffle habitat at each station. Macroinvertebrates were sieved through a three sieve system with a mesh sequence of 13.2 mm, 1 mm, and 600 µm. Specimens were then separated from stream sediment and detritus in white pans and preserved in labeled sample bottles containing 90% isopropyl alcohol. In the laboratory, all specimens were identified to the lowest possible taxon (Merritt and Cummins 1996; Pennak 1978; Wiggins 1977) and counted using an Olympus 10x/22 dissecting microscope. Specimens were further described and categorized by tolerance, feeding group, and habit. The tolerance of a taxon was defined by its ability to survive exposure to physicochemical stressors that result from chemical pollution, hydrologic alteration, or habitat degradation (Stribling et al. 1998). Tolerance values were obtained from Southerland et al. (2005). Feeding group is the dominant mechanism or strategy used for food acquisition (Merritt and Cummins 1996, Stribling et al. 1998). Habit is an organism's method of locomotion or its behavior in relation to its habitat (Merritt and Cummins 1996, Stribling et al. 1998). Data analysis of the macroinvertebrate specimens was performed using the methods outlined by the Maryland Department of Natural Resources' Inland Fisheries Division in MD DNR (2004) and by the Maryland Biological Stream Survey (Southerland et al. 2005).

Results & Discussion

Table 1 summarizes the results of all trout population studies funded within Federal Aid Project F-48-R-25 from January 1 to June 30, 2015. An individual description of results for each sampling area follows, however in order to provide a quick reference of coldwater fishery resources of the State, Fisheries Service staff prepared the following table summarizing the results of all trout population studies funded with Federal Aid Project F-48-R-25. Population studies were conducted by Inland Fisheries personnel and the results are grouped by watersheds. Agencies of Federal, State, and local government with resource management, land-use planning, and environmental protection responsibilities are encouraged to use this information to provide the maximum degree of protection for those streams that are within their jurisdiction.

Table 1. Results of trout population surveys in Maryland from January 1 to June 30, 2015.

Stream/Station	Species/ Origin	Adult Kg/ha	Adult Trout/ha	Adult Trout/km	95% CI	YOY/ ha	YOY/ km	95% CI
Youghiogheny River Watershed								
Ginseng Run								
Heslop Property	Bk-n	50	2095	587	3.53	429	120	2.50
Block Run								
Below Culvert	Bk-n	47	1619	453	6.50	1190	333	23.00
Unnamed Tributary to Block Run								
Mouth	Bk-n	3	267	53	0	0	0	0
Smith Run								
Lakeshore Dr.	Bk-n	22	1294	587	4.82	206	93	41.80
Weimer Run								
Oakland Sang Run Rd	Bk-n	12	278	67	66.00	944	227	63.50
Fork Run								
Hunters Camp	Bk-n	16	704	253	24.61	593	213	12.00
	Bn-n	4	37	13	0	0	0	0
	Rt-n	3	37	13	0	0	0	0
	Total	24	778	280	19.98	593	213	12.00
Antietam Creek Watershed								
Beaver Creek								
Put and Take	Bn-n	216	1459	877	4.63	1662	999	3.30
	Rt-s,n	7	27	16	0	0	0	0
	Total	223	1486	894	4.55	1662	999	3.30
Upper	Bn-n	121	716	459	14.46	172	110	20.00
Jackson	Rt-s,n	27	95	61	9.09	0	0	0
	Total	148	802	514	10.75	172	110	20.00
Lower	Bn-n	93	789	536	2.91	2186	1469	11.00
Jackson	Rt-s,n	0	0	0	0	8	5	0
	Total	93	789	536	2.91	2202	1479	11.30
Zimmerman	Bn-n	129	876	656	5.66	851	638	5.80
	Rt-s,n	14	33	25	0	8	6	0
	Total	144	917	686	6.31	860	644	5.80
Little Beaver Creek								
Rt. 66	Bn-n	159	897	292	0	793	258	0
Lower Martz Farm	Bn-n	66	400	160	8.33	667	267	20.00
Black Rock								
Heaton	Bn-n	66	500	160	0	500	160	3691
Rt. 66	Bn-n	213	1364	400	3.33	318	93	42.9

Key: Bk = brook trout; Bn = brown trout; Rt = rainbow trout; n = naturally reproduced; s = stocked as adults; f = stocked as fingerlings.

State: Maryland

Project Number: F-48-R-25
Study No.: III
Job No.: 2

Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Coldwater Streams

Job Title: Individual Stream Studies

Western Region District I
(Garrett and Allegany Counties)

Youghiogheny River Catch and Return Trout Fishing Area
(Garrett County)

Introduction

The portion of the Youghiogheny River (Garrett County, MD) from the Deep Creek Hydro Station (DCHS) tailrace downstream approximately 6.4 km to the Sang Run Bridge was designated a Catch and Return Trout Fishing Area (C&R TFA) in 1993. Regulations limit terminal tackle to artificial lures and flies. Fishing is permitted year-round. Prior to 1993, this portion of the river was managed under Maryland's Designated Trout Stream regulations, which specified a two-fish daily creel limit with no minimum size, bait, or tackle restrictions. The fishery in the C&R TFA is maintained through put-and-grow stockings of fingerling brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*).

The current operating license for the DCHS requires temperature control (maintenance of < 25° C in the Youghiogheny River measured at Sang Run during June, July, and August), minimum flow maintenance (40 cfs in the Youghiogheny River measured at the DCHS tailrace outflow), and dissolved oxygen augmentation to meet State standards (> 6 ppm average, 5 ppm minimum in the DCHS discharge) for downstream coldwater fisheries enhancement. These combined measures were implemented beginning in 1995 as part of an operating license renewal agreement with the Maryland Department of the Environment (MDE 1994), Water Resource Administration -Deep Creek Lake Project - Water Appropriation Permit No. GA92S009(01) and re-issued in 2007 with Water Appropriation Permit No. GA1992S009(07) (MDE 2007).

Objectives

- Monitor river water temperatures during the critical summer period.
- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.

- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Temperature Enhancement
Onset StowAway® temperature loggers were deployed in the river at nine sites from Swallow Falls to Sang Run between June and September to assess the effectiveness of water temperature control by the DCHS. The temperature monitors were programmed to record at thirty-minute intervals. One temperature logger was deployed at the DCHS to record ambient air temperatures. Temperature data were forwarded to Versar, Inc., a MD DNR consultant, for analysis. Temperature enhancement and flow augmentation protocols for the DCHS are described in the licensing agreement (MDE 2007).

Benthic macroinvertebrates
Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1, with the exception that six, 30 second kicks were used to collect samples. Benthic macroinvertebrates were surveyed at two stations in the C&R TFA of the Youghiogheny River. The stations include an upstream site below Hoyes Run and a downstream site below Sang Run.

Results

The benthic macroinvertebrate sample collected below Hoyes Run contained 1481 specimens belonging to 53 unique taxa (Tables 1 and 2). There were 621 individuals and 27 taxa identified to Ephemeroptera, Plecoptera, or Trichoptera (EPT). An index generated by comparing total EPT individuals to total specimens identified to Chironomidae (EPT/C) yielded a value of 1.19. Examination of the scraper filterer ratio and the proportion of shredders in the sample (CPOM) yielded values of 2.22 and 0.08, respectively. The Shannon Weaver Diversity calculation was 4.44 with an equitability of 0.60. The Hilsenhoff Biotic Index (HBI) score was 4.50. The Maryland Biological Steam Survey (MBSS) IBI produced a score of 4.25 with a "good" rating.

The sample collected below Sang Run contained 547 total specimens identified to 45 taxa (Tables 3 and 4). There were 361 EPT specimens representing 22 taxa. The EPT/C was 5.23. Examination of functional feeding groups yielded 1.12 for the scraper filterer ratio and 0.09 for the CPOM. The diversity of the sample was 4.39 with an equitability of 0.69. The HBI score was 4.28 with a MBSS IBI score of 4.25. The MBSS IBI rated the sample as "good".

Discussion

The benthic community was diverse and abundant in the C&R TFA of the Youghiogheny River, with habitat and water quality that appear to be in good condition. Taxa Richness at both sample stations was high, with ample and diverse representation of EPT taxa.

The abundance of EPT taxa and overall richness was indicative of a benthic community that is not impacted by habitat degradation. The EPT/C index for both stations supported this, with EPT individuals accounting for more of the sample than specimens identified to the Chironomidae.

The examination of functional feeding groups also indicated good habitat and water quality. Scrapers were in greater abundance than filterers at both stations. Scrapers tend to thrive in streams and rivers with abundant unicellular algae attached to the benthic substrate. As nutrient enrichment increases, filamentous algae become dominant and provide the resources for filterers to thrive. The success of scrapers at the sample stations suggested that there is little nutrient enrichment occurring in C&R TFA of the Youghiogheny River. The CPOM scores were lower, with shredders accounted for just under 10% of the community at both stations. This result is expected since shredders tend to be more prevalent in the headwaters of forested streams where coarse particulate organic matter is readily available.

The diversity and equitability for both samples were high, indicating very little disturbance to the benthic community. Diversity was particularly high, with samples receiving a value of 4.39 or greater. Equitability was not quite as high, but was 0.60 or higher at both stations. While this is relatively lower than the diversity values, the results still indicated an undisturbed community.

The HBI measures the relative tolerance of the community to stresses caused by organic contaminants. HBI scores for both samples were 4.50 or lower and indicated a community with a balance of benthic macroinvertebrates that are tolerant to organic pollutants. The scores were very good and suggest that there is little organic pollution influencing the benthic community at the sampled locations. These results are supported by the MBSS IBI. Both MBSS IBI scores were greater than 4.00 and were rated "good".

The benthic macroinvertebrate community was relatively undisturbed in the C&R TFA of the Youghiogheny River, indicating that habitat and water quality were in good condition. The results suggested that the communities have high richness and diversity, and are not subjected to the stress of high levels of organic pollutants. Monitoring should be continued to observe changes in the benthic community that may result from new developments in the Youghiogheny watershed.

Table 1. Benthic macroinvertebrate data collected from the Youghiogheny River below Hoyes Run on June 16, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	39	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	113	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	3	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	91	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	15	2.8	Collector	cn
Ephemeroptera	*Stenacron*	3	2	Collector	cn
Ephemeroptera	*Stenonema*	60	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	58	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	2	2	Collector	sw, cn, sp
Plecoptera	*Leuctra*	101	0.4	Shredder	cn
Plecoptera	*Amphinemura*	2	3	Shredder	sp, cn
Plecoptera	*Acroneuria*	36	2.5	Predator	cn
Plecoptera	*Paragnetina*	5	2.2	Predator	cn
Trichoptera	*Brachycentrus*	2	2.3	Filterer	cn
Trichoptera	*Micrasema*	5	2.3	Shredder	cn, sp
Trichoptera	*Glossosoma*	3	0	Scraper	cn
Trichoptera	*Goera*	1	3.4	Scraper	cn
Trichoptera	*Cheumatopsyche*	16	6.5	Filterer	cn
Trichoptera	*Diplectrona*	4	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	28	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	8	5.7	Filterer	cn
Trichoptera	*Chimarra*	5	4.4	Filterer	cn
Trichoptera	*Dolophilodes*	12	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	2	2.6	Filterer	cn
Trichoptera	*Polycentropus*	3	1.1	Filterer	cn
Trichoptera	Unid. Polycetropodidae	3	0.2		
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Ancyronyx*	1	7.8	Scraper	cn, sp
Coleoptera	*Optioservus*	77	5.4	Scraper	cn
Coleoptera	*Oulimnius*	67	2.7	Scraper	cn
Coleoptera	*Promoresia*	29	0	Scraper	cn
Coleoptera	*Stenelmis*	49	7.1	Scraper	cn
Coleoptera	*Psephenus*	21	4.4	Scraper	cn
Diptera	*Bezzia*	2	3.3	Predator	bu
Diptera	SF Orthocladiinae	182	7.6	Collector	
Diptera	SF Tanypodinae	25	7.5	Predator	
Diptera	TR Chironomini	216	5.9		
Diptera	TR Tanytarsini	87	3.5	Collector	
Diptera	Unid. Chironomidae	13	6.6		
Diptera	*Hemerodromia*	11	7.9	Predator	sp, bu
Diptera	Unid. Empididae	13	7.5	Predator	sp, bu
Diptera	*Simulium*	2	5.7	Filterer	cn
Diptera	*Antocha*	6	8	Collector	cn
Diptera	*Dicranota*	1	1.1	Predator	sp, bu
Diptera	*Hexatoma*	1	1.5	Predator	bu, sp
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Megaloptera	*Nigronia*	1	1.4	Predator	cn, cb
Odonata	Unid. Coenagrionidae	1	9	Predator	cb
Amphipoda	*Gammarus*	4	6.7	Shredder	sp
Arachnoidea	Hydracarina	2	6	Predator	sw
Decapoda	*Cambarus*	4	0.4	Collector	sp
Isopoda	*Caecidotea*	37	2.6	Collector	sp
Unid. Oligochaeta		7	10	Collector	bu

S = 53 N = 1481

Table 2. Analysis and Results of the benthic macroinvertebrate data collected from the Youghiogheny River below Hoyes Run on June 16, 2015.

Fisheries Analysis	**MBSS Analysis – Highlands**
Richness = 53	Number of Taxa = 27 (5)
EPT = # 621 Taxa 27	Number of EPT Taxa = 9 (5)
EPT/C = 1.19	Number of Ephemeroptera Taxa = 9 (5)
Dominant Family = Chironomidae, 35.31%	% Intolerant Urban = 33.15% (1)
Scraper Filterer Ratio = 2.22	% Tanytarsini = 5.87% (5)
CPOM = 0.08	% Scrapers = 21.00% (5)
Diversity = 4.44	% Swimmers = 20.59% (5)
Equitability = 0.60	% Diptera = 37.81% (3)
HBI = 4.50	IBI = 4.25 Good

Table 3. Benthic macroinvertebrate data collected from the Youghiogheny River below Sang Run on June 16, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	38	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	94	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	4	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	17	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	16	2.8	Collector	cn
Ephemeroptera	*Ephemera*	2	3	Collector	bu
Ephemeroptera	*Stenonema*	46	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	47	2.5	Filterer	sw, cn
Plecoptera	*Leuctra*	18	0.4	Shredder	cn
Plecoptera	*Acroneuria*	9	2.5	Predator	cn
Plecoptera	*Perlesta*	20	1.6	Predator	cn
Trichoptera	*Brachycentrus*	2	2.3	Filterer	cn
Trichoptera	*Glossosoma*	2	0	Scraper	cn
Trichoptera	*Goera*	1	3.4	Scraper	cn
Trichoptera	*Cheumatopsyche*	11	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	24	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	4	5.7	Filterer	cn
Trichoptera	*Pycnopsyche*	1	3.1	Shredder	sp, cb, cn
Trichoptera	*Chimarra*	1	4.4	Filterer	cn
Trichoptera	*Neureclipsis*	1	0.2	Filterer	cn
Trichoptera	Unid. Polycetropodidae	1	0.2		
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Coleoptera	*Dubiraphia*	1	5.7	Scraper	cn, cb
Coleoptera	*Optioservus*	5	5.4	Scraper	cn
Coleoptera	*Oulimnius*	7	2.7	Scraper	cn
Coleoptera	*Promoresia*	2	0	Scraper	cn
Coleoptera	*Stenelmis*	17	7.1	Scraper	cn
Coleoptera	*Psephenus*	14	4.4	Scraper	cn
Diptera	*Atherix*	1	2	Predator	sp, bu
Diptera	SF Orthocladiinae	8	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	50	5.9		
Diptera	TR Tanytarsini	4	3.5	Collector	
Diptera	Unid. Chironomidae	6	6.6		
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Antocha*	18	8	Collector	cn
Diptera	*Hexatoma*	1	1.5	Predator	bu, sp
Diptera	*Tipula*	1	6.7	Shredder	bu
Diptera	Unid. Tipulidae	13	4.8	Predator	bu, sp
Megaloptera	*Nigronia*	1	1.4	Predator	cn, cb
Amphipoda	*Gammarus*	1	6.7	Shredder	sp
Basommatophora	*Ferrissia*	2	7	Scraper	cb
Decapoda	*Cambarus*	1	0.4	Collector	sp
Decapoda	*Orconectes*	28	2.8	Shredder	sp
Unid. Oligochaeta		3	10	Collector	bu

S = 45 N = 547

Table 4. Analysis and Results of the benthic macroinvertebrate data collected from the Youghiogheny River below Sang Run on June 16, 2015.

Fisheries Data	**MBSS Data – Highlands**
Richness = 45	Number of Taxa = 45 (5)
EPT = # 361 Taxa 22	Number of EPT Taxa = 22 (5)
EPT/C = 5.23	Number of Ephemeroptera Taxa = 8 (5)
Dominant Family = Baetidae, 24.13%	% Intolerant Urban = 33.27% (1)
Scraper Filterer Ratio = 1.12	% Tanytarsini = 0.73% (3)
CPOM = 0.09	% Scrapers = 18.46% (5)
Diversity = 4.39	% Swimmers = 35.83% (5)
Equitability = 0.69	% Diptera = 19.01% (5)
HBI = 4.28	IBI = 4.25 Good

Upper Savage River
(Garrett County)

Introduction

The upper Savage River provides critical, continuous habitat for brook trout (*Salvelinus fontinalis*), the only trout native to Maryland. Concerns over population declines have generated much interest in conservation efforts for brook trout statewide. In the Upper Savage River watershed (Savage River mainstem upstream of the confluence with Poplar Lick Run and all tributaries upstream of the Savage River Reservoir dam), fisheries managers have established a Zero Creel Limit Area for brook trout, where anglers may only use artificial lures and flies (no bait) to protect the resident populations of brook trout. In addition, continuous monitoring is performed to observe changes in the resident brook trout populations. Water quality and habitat conditions are also observed to determine any environmental stressors that may negatively influence the brook trout populations. Benthic macroinvertebrate surveys provide information about habitat and water quality, and may be used as an indicator for habitat degradation.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at three stations in the Zero Creel Limit Area for brook trout of the Upper Savage River watershed on April 23, 2015. The stations included an upstream site above Blacklick Run, a middle site above Elk Lick Run, and a downstream site below Westernport Road.

Results

There were 541 specimens identified to 34 unique taxa in the benthic macroinvertebrate sample collected above Blacklick Run (Table 1). The sample included 405 individuals identified to 21 taxa in Ephemeroptera, Plecoptera, or Trichoptera (EPT). The ratio of EPT specimens to specimens identified to Chironomidae (EPT/C) was 3.79. Analyses of benthic macroinvertebrate functional feeding groups yielded 1.77 for the scraper filterer ratio and 0.01 for the proportion of shredders (CPOM). The Shannon Weaver Diversity value was 3.76 with an equitability of 0.59. The Hilsenhoff Biotic Index (HBI) score was 3.65. The Maryland Biological Stream Survey IBI was calculated to 4.50 with a rating of "good".

The sample collected above Elk Lick Run contained 378 individuals identified to 32 taxa (Table 2). There were 378 EPT individuals identified to 32 taxa. The EPT/C was 3.46. The analysis of functional feeding groups produced a scraper filterer ratio of 2.00 and a CPOM of 0.00. The diversity value for the sample was 3.65 with an equitability of 0.56. The sample received an HBI score of 3.84 and an MBSS IBI score of 4.50. The MBSS rating for the sample was "good".

The sample collected at the downstream station located below Westernport Road contained 411 total specimens and 30 unique taxa (Table 3). There were 17 EPT taxa represented by 281 individuals in the sample. The EPT/C was 2.65. An examination of functional feeding groups produced a scraper filterer ratio of 1.15 and a CPOM of 0.00. The diversity value was calculated to 3.70 with an equitability of 0.63. The HBI score for the sample was 3.87. The MBSS IBI score was 4.25 with a "good" rating.

Discussion

Benthic macroinvertebrate samples collected from the upper Savage River watershed indicated that the benthic habitat was relatively undisturbed and water quality was in good condition. This conclusion is supported by almost all tests performed on the sample data. All samples contained a taxa richness of 30 or greater suggesting a diverse benthic community that is undisturbed by habitat degradation. The EPT taxa richness supported this conclusion, with 17 or more unique EPT taxa present at all three stations. EPT/C ratios were 2.65 for or greater, revealing that EPT specimens were well represented in the samples relative the Chironomidae. This also supports the idea that the habitat and water quality are in good condition. EPT taxa tend to dominate benthic communities that are undisturbed by habitat degradation, while the Chironomidae tend to thrive under stressed conditions.

The examination of functional feeding groups represented in the samples produced variable results. The scraper filterer ratios were high at all stations, ranging from 1.15 to 2.00. Scrapers tend to thrive in habitats that are low in nutrient enrichment and have abundant unicellular algae attached to the benthic substrate. Filterers tend to dominate in nutrient enriched waters where filamentous algae are abundant and available as a food source. High scraper filterer ratios suggested that scrapers are more prevalent in the community and that the stream receives lower levels of nutrient enrichment. CPOM proportions were low at all three stations, revealing an underrepresentation of shredders in the upper Savage. Shredders consume coarse particulate organic matter that is readily available in the headwaters of forested streams.

Diversity was high for all samples collected in the Upper Savage River watershed. Diversity ranged from 3.65 to 3.76, indicating a benthic community that is undisturbed by habitat degradation or poor water quality. Equitability was slightly lower, ranging from 0.56 to 0.63. These values reflect that there may be slightly reduced distribution of taxa representation within the sample, potentially due to habitat disturbance. However, the

disturbance appears to be minor as equitability is close to what is expected from an undisturbed community.

The HBI scores for all samples suggested that the community was in very good condition. All samples scored below 3.90, indicating that the samples contained a balanced representation of taxa that are intolerant to organic pollution. The high representation of intolerant taxa indicates that organic pollution at the sample stations was relatively low and not a major influence on the benthic community. The MBSS IBI scores supported this conclusion, with all three samples scoring higher than 4.00 and receiving a rating of "good".

Table 1. Data and results for the Upper Savage River watershed benthic macroinvertebrate sample collected above Blacklick Run on April 23, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Baetis*	9	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	37	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	120	2.3	Collector	cn, sw
Ephemeroptera	*Cinygmula*	51	1.6	Scraper	cn
Ephemeroptera	*Epeorus*	17	1.7	Scraper	cn
Ephemeroptera	*Stenonema*	1	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	2	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	72	2	Collector	sw, cn, sp
Plecoptera	*Haploperla*	2	1.6	Predator	cn
Plecoptera	*Sweltsa*	2	1.9	Predator	cn
Plecoptera	*Leuctra*	2	0.4	Shredder	cn
Plecoptera	*Amphinemura*	1	3	Shredder	sp, cn
Plecoptera	*Acroneuria*	10	2.5	Predator	cn
Plecoptera	*Isoperla*	11	2.4	Predator	cn, sp
Trichoptera	*Cheumatopsyche*	34	6.5	Filterer	cn
Trichoptera	*Diplectrona*	1	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	23	7.5	Filterer	cn
Trichoptera	*Psilotreta*	5	0.9	Scraper	sp
Trichoptera	*Dolophilodes*	1	1.7	Filterer	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Trichoptera	*Neophylax*	3	2.7	Scraper	cn
Coleoptera	*Psephenus*	2	4.4	Scraper	cn
Diptera	*Atherix*	3	2	Predator	sp, bu
Diptera	*Blepharicera*	1	4	Scraper	cn
Diptera	*Bezzia*	1	3.3	Predator	bu
Diptera	SF Orthocladiinae	77	7.6	Collector	
Diptera	SF Tanypodinae	2	7.5	Predator	
Diptera	TR Chironomini	22	5.9		
Diptera	TR Tanytarsini	6	3.5	Collector	
Diptera	*Prosimulium*	5	2.4	Filterer	cn
Diptera	*Antocha*	5	8	Collector	cn
Diptera	*Hexatoma*	7	1.5	Predator	bu, sp
Megaloptera	*Nigronia*	3	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	2	6	Predator	sw
		S = 34 N = 541			

Fisheries Data	**MBSS Data – Highlands**
Richness = 34	Number of Taxa = 34 (5)
EPT = # 405 Taxa 21	Number of EPT Taxa = 21 (5)
EPT/C = 3.79	Number of Ephemeroptera Taxa = 8(5)
Dominant Family = Ephemerellidae, 29.02%	% Intolerant Urban = 65.80% (3)
Scraper Filterer Ratio = 1.77	% Tanytarsini = 1.11% (3)
CPOM = 0.01	% Scrapers = 21.63% (5)
Diversity = 3.76	% Swimmers = 37.89% (5)
Equitability = 0.59	% Diptera = 23.84% (5)
HBI = 3.65	IBI = 4.50 Good

Table 2. Data and results for the Upper Savage River watershed benthic macroinvertebrate sample collected above Elk Lick Run on April 23, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Baetis*	12	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	34	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	99	2.3	Collector	cn, sw
Ephemeroptera	*Cinygmula*	29	1.6	Scraper	cn
Ephemeroptera	*Epeorus*	12	1.7	Scraper	cn
Ephemeroptera	Unid. Heptageniidae	1	2.6	Scraper	cn
Ephemeroptera	*Isonychia*	3	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	26	2	Collector	sw, cn, sp
Plecoptera	*Haploperla*	1	1.6	Predator	cn
Plecoptera	*Amphinemura*	1	3	Shredder	sp, cn
Plecoptera	*Acroneuria*	17	2.5	Predator	cn
Plecoptera	*Phasganophora*	2	2.2	Predator	cn
Plecoptera	*Isoperla*	3	2.4	Predator	cn, sp
Trichoptera	*Cheumatopsyche*	19	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	15	7.5	Filterer	cn
Trichoptera	*Psilotreta*	2	0.9	Scraper	sp
Trichoptera	*Dolophilodes*	1	1.7	Filterer	cn
Trichoptera	Unid. Polycetropodidae	1	0.2		
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Trichoptera	*Neophylax*	1	2.7	Scraper	cn
Coleoptera	*Optioservus*	1	5.4	Scraper	cn
Coleoptera	*Psephenus*	2	4.4	Scraper	cn
Diptera	SF Orthocladiinae	67	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	5	5.9		
Diptera	TR Tanytarsini	5	3.5	Collector	
Diptera	Unid. Chironomidae	3	6.6		
Diptera	*Clinocera*	2	7.4	Predator	cn
Diptera	*Prosimulium*	3	2.4	Filterer	cn
Diptera	*Antocha*	2	8	Collector	cn
Diptera	*Hexatoma*	3	1.5	Predator	bu, sp
Unid. Oligochaeta		4	10	Collector	bu
		S = 32 N = 378			

Fisheries Data	**MBSS Data – Highlands**
Richness = 32	Number of Taxa = 32 (5)
EPT = # 280 Taxa 20	Number of EPT Taxa = 20 (5)
EPT/C = 3.46	Number of Ephemeroptera Taxa = 8 (5)
Dominant Family = Ephemerellidae, 35.19%	% Intolerant Urban = 63.49% (3)
Scraper Filterer Ratio = 2.00	% Tanytarsini = 1.32% (3)
CPOM = 0.00	% Scrapers = 21.69% (5)
Diversity = 3.65	% Swimmers = 37.04% (5)
Equitability = 0.56	% Diptera = 24.07% (5)
HBI = 3.84	IBI = 4.5 Good

Table 3. Data and results for the Upper Savage River watershed benthic macroinvertebrate sample collected below Westernport Road on April 23, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acerpenna*	4	2.6	Collector	sw, cn
Ephemeroptera	*Baetis*	8	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	9	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	107	2.3	Collector	cn, sw
Ephemeroptera	*Cinygmula*	33	1.6	Scraper	cn
Ephemeroptera	*Epeorus*	11	1.7	Scraper	cn
Ephemeroptera	*Stenacron*	3	2	Collector	cn
Ephemeroptera	*Stenonema*	7	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	7	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	46	2	Collector	sw, cn, sp
Plecoptera	*Sweltsa*	2	1.9	Predator	cn
Plecoptera	*Acroneuria*	4	2.5	Predator	cn
Plecoptera	*Phasganophora*	1	2.2	Predator	cn
Plecoptera	*Isoperla*	4	2.4	Predator	cn, sp
Trichoptera	*Cheumatopsyche*	27	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	7	7.5	Filterer	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Oulimnius*	1	2.7	Scraper	cn
Diptera	*Probezzia*	1	3	Predator	bu
Diptera	SF Orthocladiinae	63	7.6	Collector	
Diptera	SF Tanypodinae	5	7.5	Predator	
Diptera	TR Chironomini	20	5.9		
Diptera	TR Tanytarsini	16	3.5	Collector	
Diptera	Unid. Chironomidae	2	6.6		
Diptera	*Prosimulium*	12	2.4	Filterer	cn
Diptera	*Hexatoma*	1	1.5	Predator	bu, sp
Diptera	*Tipula*	2	6.7	Shredder	bu
Megaloptera	*Nigronia*	1	1.4	Predator	cn, cb
Rhynchobdellida	*Helobdella*	1	6	Predator	sp
Unid. Oligochaeta		5	10	Collector	bu
		S = 30 N = 411			

Fisheries Data	**MBSS Data – Highlands**
Richness = 30	Number of Taxa = 30 (5)
EPT = # 281 Taxa 17	Number of EPT Taxa = 17 (5)
EPT/C = 2.65	Number of Ephemeroptera Taxa = 10 (5)
Dominant Family = Ephemerellidae	% Intolerant Urban = 60.34% (3)
Scraper Filterer Ratio = 1.15	% Tanytarsini = 3.89% (3)
CPOM = 0.00	% Scrapers = 14.84% (5)
Diversity = 3.70	% Swimmers = 41.85% (5)
Equitability = 0.63	% Diptera = 29.68% (3)
HBI = 3.87	IBI = 4.25 Good

Western Region District II
(Washington and Frederick Counties)

Beaver Creek
(Washington County)

Introduction

Beaver Creek is one of the largest limestone streams in Maryland. Originating as a freestone stream on the west slope of South Mountain, the majority of the flow during the summer months is influenced by the numerous springs in the Hagerstown Valley. The largest spring (~11,356 l/min) influencing Beaver Creek is used as the water supply for the Albert Powell State Trout Hatchery, which rears adult and YOY rainbow trout (*Oncorhynchus mykiss*) for stocking into Maryland streams. Upstream of the spring's influence, Beaver Creek is considered a warmwater stream and flows underground much of the year due to local Karst geology. Intensive agricultural operations (dairy and row crop) within the Hagerstown Valley have severely impacted Beaver Creek throughout its length. Various stream improvement projects have been completed on the mainstem and its tributaries to correct harmful effects of improper land management practices.

Beaver Creek has historically been managed as a Put-and-Take trout (P&T) fishery with a five trout per day creel limit. Effective January 1, 2004, approximately one mile of Beaver Creek formerly under the management of the Antietam Fly Anglers was established as a catch-and-return/fly-fishing-only area (C&R) open to the public. This area extends from the mouth of Black Rock Creek downstream to the upper boundary of the Perini property, approximately 161 m above Beaver Creek Road. The special regulation area is entirely on private property. Wild YOY brown trout *(Salmo trutta*) were transplanted from the Gunpowder River tailwater from 2002 to 2005 to address inadequate natural reproduction from hatchery stock. Due to favorable year-round water temperatures and excellent spawning substrate, a self sustaining brown trout population has developed and this area is now managed for wild trout. Trout populations have been monitored annually since 2004 at two established stations within the C&R area (upper and lower Jackson) and one within the P&T area since 2005. In 2009 an additional station was established within an extensive stream restoration project completed during the summer of 2010 (Zimmerman property). Trout population data is collected annually to document the response of the wild brown trout population to habitat restoration projects in the C&R section.

Objectives

Fisheries management activities conducted during 2015 consisted of monitoring the status of the existing trout populations with the following objectives:

- Obtain estimates of biomass and abundance for adult and YOY trout within the C&R and P&T areas at four established stations.
- Record basic water chemistry at electrofishing sites.

- Record non-gamefish species observed during electrofishing efforts.

Methods

Methodology for monitoring fish populations follow that described in the Study III Job 1 Methods section. Basic water quality was measured using a HACH test strips and YSI EXO1 sonde and multi meter.

Results/Discussion

Catch and Release Area
As completed stream and riparian restoration projects mature, trout population parameters within the C&R area have shown remarkable improvement. Standing crop (kg/ha) and density (trout/ha) of yearling and older brown trout have stabilized since 2013 within the C&R area (Table 1). This is believed to be the combined result of increased reproduction and the movement of adult trout into the more favorable habitat afforded by the recently completed stream improvements projects. Despite the high density, mean condition factor K for brown trout remains within the optimal range of 0.9 – 1.1 suggested by Lagler (1952) indicating that current population densities have not resulted in a decline in physical condition. Density of YOY brown trout increased significantly in 2015 within the C&R area reaching record levels.

Upper Put-and-Take Area
Despite heavy seasonal fishing pressure and a five trout per day creel limit in the P&T area, adult brown trout populations continue to be much higher then those in the C&R area, but have generally followed the same trends (Table 1, 2).

In spite of the annual stocking of adult rainbow trout within the Put and Take area, few were collected at any sample site. Adult rainbow trout accounted for only 3% of the total catch in 2015. The constant potential of fingerling rainbow trout escapees from the Albert Powell Hatchery makes identifying natural reproduction difficult. Nevertheless, only two rainbow trout YOY were collected during 2015.

Temperature and Water Quality Data
Basic water quality was measured within the P&T and C&R areas at the time of the electrofishing surveys. Beaver Creek was slightly basic with high conductivity and hardness, characteristic of limestone influenced streams in the Hagerstown Valley (Table 3). Interestingly water temperatures decreased in a downstream progression indicating influence of stream restoration projects, riparian plantings and natural springs within this section of stream.

A list of non-gamefish species observed during the electrofishing surveys is shown in Table 4.

Recommendations

- Conduct electrofishing depletion surveys annually to obtain population estimates for adult and YOY trout populations within the C&R and P&T areas at four established sites.
- Conduct electrofishing depletion surveys in 2017 at Route 40, Alternate Route 40, and the Baker Farm to assess the expansion of the wild brown trout population.
- Survey macroinvertebrate populations at least once every 3 years (2017) to assess stream habitat and water quality trends.

Table 1. Beaver Creek adult and YOY brown trout population data (95% CI) collected within the C&R area 2011 - 2015.

STATION	2011	2012	2013	2014	2015
C&R Area					
Standing Crop (kg/ha)	71 ± 14	83 ± 2	115 ± 4	112 ± 3	112 ± 4
Density – (trout/ha)	454 ± 89	469 ± 14	894 ± 30	829 ± 19	786 ± 27
YOY/ha	72 ± 6	270 ± 8	431 ± 30	285 ± 52	1087±73
Mean K Factor	0.99±0.01	1.01±0.01	0.97±0.01	0.98±0.01	0.99±0.01

Table 2. Adult and YOY brown trout population data (95% CI) collected by electrofishing within the Beaver Creek P&T area 2011 - 2015.

STATION	2011	2012	2013	2014	2015
Put and Take					
Standing Crop (kg/ha)	139 ± 8	151 ± 7	359 ± 14	265 ± 8	216 ± 10
Density – (trout/ha)	711 ± 39	836 ± 41	3014± 121	2243±67	1459±67
YOY/ha	1053±147	2904 ±136	2635± 108	1392±108	1662±55
Mean K Factor	1.09±0.02	1.07± 0.02	1.02± 0.01	1.03±0.01	1.02±0.02

Table 3. Beaver Creek water quality parameters measured during 2015 electrofishing surveys.

Site	P&T	UJ	LJ	Zimm
Date	6/24/2015	6/25/2015	6/24/2015	6/25/2015
Time(24hr)	1549	1410	1230	1210
Temperature (ºC)	18.6	16.4	16.7	15.6
pH	7.3	7.7	7.2	7.4
Alkalinity (ppm)	210	150	120	150
Hardness (ppm)	250	300	250	250
Conductivity (µS/cm)	391	459	382	468

Table 4. Non-gamefish species observed and recorded during electrofishing within Beaver Creek, 2015.

Common Name	**Scientific name**
blue ridge sculpin	*Cottus caeruleomentum*
Potomac sculpin	*Cottus girardi*
checkered sculpin	*Cottus sp. n.*
blacknose dace	*Rhinichthys atratulus*
longnose dace	*Rhinichthys cataractae*
white sucker	*Catostomus commersoni*
fantail darter	*Etheostoma flabellare*
pearl dace	*Margariscus margarita*
bluegill	*Lepomis macrochirus*
rock bass	*Ambloplites rupestris*

Black Rock Creek
(Washington County)

Introduction

Black Rock Creek is a small (< 3m wide) tributary to Beaver Creek in Washington County. Although originating as a freestone stream on the west slope of South Mountain, limestone springs influence the flow and water chemistry in the lower reaches. This influence begins just north of Route 70 and continues downstream to the confluence with Beaver Creek.

The abundance of trout in Black Rock Creek had been limited by degraded habitat resulting from over-grazing in the watershed. During 2002 and 2003, many of the landowners enrolled in the Conservation Reserve Enhancement Program (CREP), fencing cattle from the stream and allowing riparian areas to regenerate. An in-stream irrigation pond supplying water to the Beaver Creek Country Club golf course had dramatically increased stream temperatures downstream (Maryland DNR, 2006). A stream restoration project to remove the irrigation pond was completed in 2008. The dam was breached and the pond was allowed to slowly drain, limiting the amount of sediment loss downstream. Eliminating the pond from the stream channel reduced stream temperatures significantly. A newly formed stream channel was constructed with vegetated riparian areas during 2010. In 2009 a smaller scale in stream restoration project was completed involving the removal of a small concrete and stone dam, upstream of the electrofishing site on the Heaton's property. Bank stabilization and stream improvement devices were incorporated to allow unimpeded upstream migration of fish species. An additional stream improvement project was completed in 2009 by the Maryland State Highway Administration (SHA). Prior to 2009, runoff from Route 70 flowed into Black Rock Creek via concrete drainage channels. The SHA replaced the concrete drainage system with a vegetated channel allowing greater infiltration.

Brown trout *(Salmo trutta*) are not stocked into Black Rock Creek and most likely migrated upstream from Beaver Creek. Rainbow trout (*Oncorhynchus mykiss),* once naturally reproducing from stocked fingerlings, have not been collected since 2006. Historically, electrofishing surveys had been conducted at various locations on Black Rock Creek. Beginning in 2003, electrofishing efforts were concentrated to one established station upstream of Black Rock Road on the Heaton's property. Once the stream reclamation project in the drained irrigation pond was completed, an additional station was established in 2012.

Objectives

Management efforts conducted during 2015 consisted of electrofishing to assess the trout populations following the establishment of conservation programs and restoration efforts with the following objectives:

- Obtain estimates of standing crop and abundance for adult and YOY trout.

- Record relative abundance estimate of non-game fish species.
- Record basic water quality.

Methods

Methodology for sampling fish populations follow that described in the Study III Job 1 Methods section. Basic water quality was measured using a HACH test strips and YSI Model Pro multi meter.

Results and Discussion

The completion of multiple stream improvement projects within the watershed has provided substantial benefits for trout populations in Black Rock Creek. Electrofishing was completed at two established stations in 2015 (Heatons and Rt.66). Despite its small size, adult brown trout populations in Black Rock Creek continue to exceed those found within the Catch and Release area of Beaver Creek (Table 1). Brown trout YOY collection has remained consistent since 2012. No rainbow trout were collected at either station.

Brown trout and five non-game fish species were observed during electrofishing efforts (Table 2). Blacknose dace (*Rhinichthys atratulus*) and checkered sculpin (*Cottus sp.*) were the most abundant fish species observed.

Water quality was recorded at both stations at time of survey and recorded in Table 3. Black Rock Creek is a relatively hard, high conductivity stream, indicative of karst geology and limestone influence.

Management Recommendations

- Monitor the status of the adult and YOY brown trout populations annually.

Table 1. Adult and YOY brown trout population data (95% C.I.) collected by electrofishing in Black Rock Creek (Heatons, Rt.66) and the Beaver Creek C&R Area (upper Jackson, lower Jackson and Zimmerman stations) during 2012 - 2015.

Black Rock Creek	**2012**	**2013**	**2014**	**2015**
Standing Crop (kg/ha)	69 ± 60	162 ± 6	143 ± 3	133 ± 3
Density (trout/ha)	533 ± 466	1316 ± 53	979 ± 21	894 ± 21
YOY/ha	400	316	340 ± 42	362 ± 148
Condition Factor K	1.06 ± 0.07	1.04 ± 0.03	1.03 ± 0.02	0.91 ± .005
Beaver Creek C&R				
Standing Crop (kg/ha)	87 ± 3	115 ± 4	112 ± 3	112 ± 4
Density (trout/ha)	516 ± 16	894 ± 30	829 ± 19	786 ± 27
YOY/ha	357 ± 12	431 ± 30	285 ± 52	1087 ± 73
Condition Factor K	1.01 ± 0.01	0.97 ± 0.01	0.96 ± 0.01	0.99 ± 0.01

Table 2. Abundance estimate of non-game fish species observed while electrofishing Black Rock Creek, 2015.

Common name	**Scientific name**	**Abundance estimate**
blacknose dace	*Rhinichthys atratulus*	abundant
checkered sculpin	*Cottus sp.n.*	abundant
longnose dace	*Rhinichthys cataractae*	common
Potomac sculpin	*Cottus girardi*	common
white sucker	*Catostomus commersoni*	common
fantail darter	*Etheostoma flabellare*	common
pearl dace	*Margariscus margarita*	common
bluegill	*Lepomis macrochirus*	scarce

Table 3. Water Quality measured at the Heaton and Rt 66 stations, Black Rock Creek, June 30, 2015.

	Heatons	**Rt. 66**
Temperature (°C)	15.9	15.7
pH	7.4	7.68
Alkalinity (ppm)	180	200
Hardness (ppm)	200	180

Little Beaver Creek
(Washington County)

Introduction

Little Beaver Creek is a small (mean width 3.6 m) spring creek in Washington County. Originating from the overflow of Greenbrier Lake, Little Beaver Creek flows west and is influenced by several springs before its junction with Beaver Creek. Sampling sites are limited due to access to private land. One survey station was established just upstream of Rt. 66 on the Martz farm in 2002. Extensive restoration projects were implemented on this private farm in 2001 to improve stream bank erosion caused by over grazing and nutrient management issues. Livestock were excluded from the stream and vegetation was re-established in the riparian zone. Little Beaver Creek supports an excellent self-sustaining population of brown trout. The most recent fisheries survey was conducted in 2011.

Objectives

Fish management activities in 2015 consisted of monitoring the status of the brown trout population with the following objectives:

- Obtain population estimates for adult and YOY brown trout.
- Obtain physical condition data for adult brown trout.
- Determine baseline population estimates for adult and YOY brown trout downstream of established electrofishing station where riparian buffers and stream bank stabilization is to be completed.
- Obtain relative abundance of non-gamefish species.

Methods

Methodology for sampling fish populations follow that described in the Study III Job 1 Methods section. Basic water quality was measured using an YSI EXO sonde and multi meter.

Results and Discussion

The combination of fencing of cattle from the stream and riparian plantings has resulted in the establishment of an extensive canopy and over head cover providing ample shade and protection for trout populations. Electrofishing effort was limited to a single pass within the established station upstream of Rt. 66 due to a combination of high water levels and extensive vegetative growth reducing efficiency. Little Beaver Creek continues to support an excellent population of brown trout. Adult brown trout population indices as well as mean size have remained consistent since 2011 suggesting stable environmental conditions over the past several years (Table 1, 2) and a population that is at carrying capacity. Natural reproduction was considered excellent in 2015. Physical

condition (K) of adult brown trout continues to be excellent and within the 0.9 to 1.10 range suggested by Lagler (1952) (Table 2).

To determine the downstream extent and baseline population estimates for adult and YOY brown trout in Little Beaver Creek, an electrofishing survey was conducted approximately 1 km downstream of the Rt. 66 station (Lower Martz Farm). Despite the absence of a riparian buffer and anthropogenic stream channel restructuring, both adult and YOY brown trout were collected. Standing crop and density of adult brown trout were found to be 66 ± 5 kg/ha and 400 ± 33 trout/ha respectively. YOY brown trout reproduction was considered excellent (600 ± 133 YOY/ha). Future riparian plantings and stream bank stabilization should only strengthen brown trout populations in this section of stream.

Non-gamefish species observed at both electrofishing sites, in order of relative abundance, are shown in Table 3. Blacknose dace and checkered sculpin were found to be the most abundant non-gamefish species present. The collection of numerous warmwater species are the result of several ponds within the watershed. Basic water quality was measured at Rt. 66 and the Lower Martz Farm at the time of survey and recorded in Table 4. Little Beaver Creek is a relatively hard, high conductivity stream.

Recommendations

Little Beaver Creek is currently supporting an exceptional brown trout resource with strong year-classes and multiple age classes. To continue documenting the response of this population to the developing habitat, the following management activities are recommended:

- Continue monitoring the brown trout population at the established station every third year.
- Monitor the response of fish populations to stream bank stabilization and riparian plantings at the lower Martz Farm property.

Table 1. Little Beaver Creek adult and YOY brown trout population data (95% CI) collected by electrofishing at Rt.66 during 2011 and 2015.

Year	Standing Crop (kg/ha)	Density (trout/ha)	YOY Density (yoy/ha)
2015	159**	897**	483**
2011	155*	897*	793 ± 34

* - all trout collected on first pass; ** - single pass.

Table 2. Mean size and condition (95% CI) of Little Beaver Creek adult brown trout collected by electrofishing at Rt. 66 during 2011 and 2015.

Year	N	Mean TL (mm)	Mean W (g)	Mean K Factor
2015	26	242 ± 23	177 ± 52	1.0 ± 0.03
2011	26	240 ± 25	173 ± 67	1.0 ± 0.05

Table 3. Non-gamefish species observed in order of relative abundance during electrofishing surveys at Rt.66 and Lower Martz Farm in Little Beaver Creek, 2015.

Common Name	Scientific Name
blacknose dace	*Rhinichthys atratulus*
checkered sculpin	*Cottus sp.n.*
white sucker	*Catostomus commersoni*
fantail darter	*Etheostoma flabellare*
longnose dace	*Rhinichthys cataractae*
bluegill	*Lepomis macrochirus*
green sunfish	*Lepomis cyanellus*
common carp	*Cyprinus carpio*
American eel	*Anguilla rostrata*
creek chub	*Semotilus atromaculatus*
golden redhorse sucker	*Moxostoma erythrurum*

Table 4. Basic water quality measured in Little Beaver Creek at Rt. 66 and lower Martz Farm on July 1, 2015.

Parameter	**Rt. 66**	**Lower Martz Farm**
Temperature (°C)	17.2	18.5
Hardness (mg/l CaCO3)	-	200
Alkalinity (mg/l CaCO3)	-	160
Dissolved Oxygen (ppm)	9.3	9.5
Conductivity (µS /cm)	291	371

Hunting Creek
(Frederick County)

Introduction

Hunting Creek is one of Maryland's most popular and historic trout resources, enjoyed by a wide range of user groups including Presidents, wild trout anglers, fly-fishing enthusiasts and park visitors who come to see trout in a scenic natural setting. Originating on Catoctin Mountain, Hunting Creek flows easterly into Cunningham Falls Reservoir, a 17-hectare impoundment completed in 1972. A tailwater fishery exists downstream of Cunningham Falls Dam. Tailwater release guidelines established in 1984 have provided more flexibility to optimize water quality for trout. Hunting Creek was the first Maryland trout stream under special management regulations; catch-and-return, fly-fishing-only regulations currently apply within the boundaries of Catoctin Mountain Park and Cunningham Falls State Park. An excellent population of wild brown trout (*Salmo trutta*) is found throughout the mainstem downstream to the town of Thurmont while native brook trout (*Salvelinus fontinalis*) are limited to the headwaters upstream of Cunningham Falls Reservoir. Adult rainbow trout (*Oncorhynchus mykiss*) are stocked annually within the tailwater. A comprehensive management plan was formulated in 1993, which limits the annual stocking to a maximum of 1000 hatchery trout. In May of 2012 the presence of Didymo (*Didymosphenia geminata*), an invasive algae, was confirmed within the tailwater of Hunting Creek.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at seven stations along the mainstem of Hunting Creek on May 26 and 27, 2015. From upstream to downstream, the stations were located at Hemlock Bridge, downstream of Cunningham Falls, at the Brooks Monument, below Elbow Pool, at Camp Peniel Bridge, below Bear Branch, and at Route 15.

Results

The sample collected from the Hemlock Bridge station contained 28 unique taxa identified from 209 total specimens (Table 1). There were 171 specimens and 18 taxa identified within the Orders of Ephemeroptera, Plecoptera, and Trichoptera (EPT). The comparison of EPT taxa to specimens identified to the Chironomidae (EPT/C) yielded a

value of 28.5. Comparison of functional feeding groups produced 0.56 for the scraper filterer ratio and 0.09 for proportion of shredders, or consumers of coarse particulate organic matter (CPOM). The Shannon Weaver Diversity score was 3.91, while the equitability score was 0.79. Using tolerance values generated by Maryland Biological Stream Survey (MBSS), the sample received a Hilsenhoff Biotic Index (HBI) score of 3.74. The sample received a 4.00 using the MBSS IBI and was rated "good".

The station below Cunningham Falls contained 213 specimens identified to 26 unique taxa (Table 2). There were 176 EPT specimens identified to 16 different taxa. The EPT/C ratio was 11.73. Comparisons using functional feeding groups yielded 0.37 for the scraper filterer ratio and 0.02 for CPOM. The diversity value was 3.11 with an equitability value of 0.46. The HBI score for the sample was 4.10, while the MBSS IBI score was 4.00. The sample received a MBSS IBI rating of "good".

The station located at the monument on Route 77 contained 407 specimens identified to 35 taxa (Table 3). There were 215 EPT specimens and 18 taxa. The EPT/C ratio was 2.34. Analyses using functional feeding groups generated values of 0.51 for the scraper filterer ratio and 0.10 for CPOM. The sample diversity was 4.23 and the equitability was 0.80. The sample received a score of 4.46 using the HBI and 4.00 using the MBSS IBI. The MBSS IBI rating was "good".

There were 279 specimens and 25 taxa in the sample collected below Elbow Pool (Table 4). The total number of EPT specimens was 240 belonging to 14 taxa. The EPT/C ratio was 13.33. Analysis of functional feeding groups yielded 0.61 for the scraper filterer ratio and 0.03 for the CPOM. The sample diversity was 3.14 with an equitability of 0.52. The HBI score was 4.55 while the MBSS IBI score was 4.00. The MBSS IBI rating was "good".

The sample collected at Camp Peniel Bridge contained 308 specimens belonging to 31 taxa (Table 5). The total number of EPT specimens was 237 identified to 17 taxa. The EPT/C ratio was 5.78. The analysis of functional feeding groups yielded 1.41 for the scraper filterer ratio and 0.04 for the CPOM. The sample diversity was 3.48 and the equitability was 0.52. The sample scored 4.52 for the HBI and 4.00 for the MBSS IBI with a "good" rating.

A total of 137 specimens and 20 taxa were collected at the station below Bear Branch (Table 6). Of those collected, 122 were EPT specimens belonging to 13 taxa. The EPT/C ratio was 20.33. The scraper filterer ratio was 2.14, while the CPOM was 0.01. The diversity of the sample was 2.28 with an equitability of 0.35. The HBI score was 4.55 and the MBSS IBI was 3.25. The MBSS IBI rating was "fair".

There were 206 specimens from 29 unique taxa collected at the Route 15 station (Table 7). The total number of EPT specimens was 169 belonging to 16 taxa. The EPT/C ratio was 7.68. Analyses of functional feeding groups yielded a scraper filterer ratio of 0.81

and a CPOM of 0.00. The diversity value was 3.53 with an equitability value of 0.59. The HBI score was 4.60, while the MBSS IBI was 4.00 with a "good" rating.

Discussion

Collection and analysis of benthic macroinvertebrate samples from Hunting Creek indicated a healthy benthic community that may be slightly influenced by habitat degradation. The taxa richness ranged from 20 to 35 with only two stations scoring less than 26. The two stations with richness below 26 were below Elbow Pool and below Bear Branch. While these lower scores suggest some minor habitat degradation, the richness is still high and indicative of a benthic community that is only slightly impacted. The taxa richness at the remaining stations appears to be non-impacted by habitat degradation.

The EPT taxa richness was high in all samples. Specimens identified within Baetidae dominated all samples with the exception of the monument station sample. The total EPT taxa were 13 or greater in all samples, indicating that the community was not impacted by habitat degradation. The EPT/C ratios ranged from 2.34 at the monument station to 28.50 at the Hemlock Bridge station. These are high scores that further support the conclusion that the macroinvertebrate community is not greatly influenced by habitat degradation in Hunting Creek.

Analyses of functional feeding groups revealed some minor concerns that may or may not be indicative of some habitat degradation. The scraper filterer ratio ranged from 0.37 to 2.14 with a general trend of the score increasing downstream. This contrasts with expected trends, in which scrapers tend to dominate in headwaters where there is less nutrient enrichment and unicellular algae are abundant. Filterers tend to dominate downstream where nutrient enrichment is greater and filamentous algae are usually more prevalent. CPOM proportions were fairly low stream wide, and ranged from 0.10 at the monument station to 0.00 at Route 15. Shredders do not appear to be abundant in Hunting Creek.

The diversity of the benthic community was strong along the entire length of stream that was sampled. The only station that scored below a 3.00 using the Shannon Weaver Diversity formula was the station below Bear Branch. While that station does appear to have some loss of diversity due to habitat degradation, the score was 2.28 and does not suggest a severe problem. The remaining stations had scores that indicate high diversity and undisturbed communities. Equitability scores suggested that there may be some degradation, with five stations scoring below 0.60 and one station scoring below 0.40. The unequal distribution of specimens was particularly noteworthy in the sample collected below Bear Branch. The equitability value was 0.35, which may indicate a serious problem at this location. The dominant family in the sample was Baetidae, which accounted for more 70% of the specimens counted. This is the only concerning observation in the survey, and should be closely monitored in future surveys.

The HBI and MBSS IBI both indicated that Hunting Creek is in good condition. HBIs ranged from 3.74 at the Hemlock Bridge station to 4.60 at the Route 15 station, with scores showing a decreasing trend from upstream to downstream. In all samples, the HBI calculation suggests that there may be some organic pollution influencing the community. However, intolerant taxa were well represented so the impacts of the pollution are minor. The MBSS IBI supports this, with all stations scoring 4.00 and rating as "good" with one exception. The station below Bear Branch scored 3.75 and was rated as "fair" using MBSS criteria.

The benthic community samples taken from Hunting Creek indicated that the benthic community is relatively undisturbed by habitat degradation and poor water quality. While there may be some minor problems, as indicated by the functional feeding group analyses and the equitability value, over all the results suggest that the community is healthy and diverse.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek at Hemlock Bridge on May 26, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Isonychia*	13	2.5	Filterer	sw, cn
Ephemeroptera	*Ephemerella*	4	2.3	Collector	cn, sw
Ephemeroptera	*Stenonema*	8	4.6	Scraper	cn
Ephemeroptera	*Epeorus*	1	1.7	Scraper	cn
Ephemeroptera	*Baetis*	61	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	17	4.9	Collector	sw, cn
Ephemeroptera	*Procloeon*	4	2.3	Collector	
Ephemeroptera	*Paraleptophlebia*	4	2	Collector	sw, cn, sp
Plecoptera	*Acroneuria*	9	2.5	Predator	cn
Plecoptera	*Perlesta*	1	1.6	Predator	cn
Plecoptera	*Leuctra*	12	0.4	Shredder	cn
Plecoptera	*Isoperla*	3	2.4	Predator	cn, sp
Trichoptera	*Diplectrona*	11	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	4	7.5	Filterer	cn
Trichoptera	*Cheumatopsyche*	10	6.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Dolophilodes*	7	1.7	Filterer	cn
Trichoptera	*Polycentropus*	1	1.1	Filterer	cn
Coleoptera	*Psephenus*	11	4.4	Scraper	cn
Coleoptera	*Oulimnius*	7	2.7	Scraper	cn
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	Unid. Chironomidae	3	6.6		
Diptera	*Simulium*	1	5.7	Filterer	cn
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Antocha*	3	8	Collector	cn
Diptera	*Hexatoma*	1	1.5	Predator	bu, sp
Amphipoda	*Gammarus*	7	6.7	Shredder	sp
Decapoda	*Cambarus*	1	0.4	Collector	sp
		S = 28 N = 209			

Fisheries Data	**MBSS Data – Highlands**
Richness = 209	Number of Taxa = 28 (5)
EPT = # 171 Taxa 18	Number of EPT Taxa = 18 (5)
EPT/C = 28.50	Number of Ephemeroptera Taxa = 8 (5)
Dominant Family = Baetidae, 39.23%	% Intolerant Urban = 37.80% (1)
Scraper Filterer Ratio = 0.56	% Tanytarsini = 1.44% (3)
CPOM = 0.09	% Scrapers = 12.92% (3)
Diversity = 3.91	% Swimmers = 47.37% (5)
Equitability = 0.79	% Diptera = 5.74% (5)
HBI = 3.74	IBI = 4.00 Good

Table 2. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek below Cunningham Falls on May 26, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Baetis*	80	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	47	4.9	Collector	sw, cn
Ephemeroptera	*Ephemerella*	13	2.3	Collector	cn, sw
Ephemeroptera	*Epeorus*	1	1.7	Scraper	cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Plecoptera	*Acroneuria*	2	2.5	Predator	cn
Plecoptera	*Perlesta*	1	1.6	Predator	cn
Plecoptera	*Amphinemura*	3	3	Shredder	sp, cn
Plecoptera	*Isoperla*	4	2.4	Predator	cn, sp
Plecoptera	*Leuctra*	1	0.4	Shredder	cn
Trichoptera	*Dolophilodes*	9	1.7	Filterer	cn
Trichoptera	*Rhyacophila*	6	2.1	Predator	cn
Trichoptera	*Cheumatopsyche*	1	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	1	7.5	Filterer	cn
Trichoptera	*Diplectrona*	5	2.7	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Coleoptera	*Oulimnius*	7	2.7	Scraper	cn
Coleoptera	*Psephenus*	2	4.4	Scraper	cn
Diptera	SF Orthocladiinae	14	7.6	Collector	
Diptera	TR Tanytarsini	1	3.5	Collector	
Diptera	*Simulium*	8	5.7	Filterer	cn
Diptera	*Prosimulium*	1	2.4	Filterer	cn
Diptera	*Unid. Simuliidae*	1	3.2	Filterer	cn
Diptera	*Antocha*	1	8	Collector	cn
Diptera	*Bezzia*	1	3.3	Predator	bu
Unid. Oligochaeta		1	10	Collector	bu
		S = 26 N = 213			

Fisheries Data	**MBSS Data – Highlands**
Richness = 213	Number of Taxa = 26 (5)
EPT = # 176 Taxa 16	Number of EPT Taxa = 16 (5)
EPT/C = 11.73	Number of Ephemeroptera Taxa = 5 (5)
Dominant family = Baetidae, 59.62%	% Intolerant Urban = 25.35% (1)
Scraper Filterer Ratio = 0.37	% Tanytarsini = 0.47% (3)
CPOM = 0.02	% Scrapers = 4.69% (3)
Diversity = 3.11	% Swimmers = 66.20% (5)
Equitability = 0.46	% Diptera = 12.68% (5)
HBI = 4.10	IBI = 4.00 Good

Table 3. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek at the Brooks Monument on May 26, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	32	2.3	Collector	cn, sw
Ephemeroptera	*Drunella*	26	1.9	Scraper	cn, sp
Ephemeroptera	*Epeorus*	3	1.7	Scraper	cn
Ephemeroptera	*Stenonema*	7	4.6	Scraper	cn
Ephemeroptera	*Acentrella*	53	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	9	3.9	Collector	sw, cb, cn
Ephemeroptera	*Paraleptophlebia*	4	2	Collector	sw, cn, sp
Plecoptera	*Acroneuria*	18	2.5	Predator	cn
Plecoptera	*Amphinemura*	10	3	Shredder	sp, cn
Plecoptera	*Leuctra*	29	0.4	Shredder	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Trichoptera	*Polycentropus*	1	1.1	Filterer	cn
Trichoptera	*Cheumatopsyche*	4	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	12	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	Unid. Trichoptera	1	4.6		
Trichoptera	*Dolophilodes*	2	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	1	2.6	Filterer	cn
Coleoptera	*Oulimnius*	5	2.7	Scraper	cn
Coleoptera	*Psephenus*	1	4.4	Scraper	cn
Diptera	Unid. Chironomidae	21	6.6		
Diptera	SF Tanypodinae	12	7.5	Predator	
Diptera	TR Tanytarsini	21	3.5	Collector	
Diptera	SF Orthocladiinae	38	7.6	Collector	
Diptera	*Simulium*	56	5.7	Filterer	cn
Diptera	*Prosimulium*	9	2.4	Filterer	cn
Diptera	*Bezzia*	1	3.3	Predator	bu
Diptera	*Antocha*	5	8	Collector	cn
Diptera	*Hexatoma*	1	1.5	Predator	bu, sp
Megaloptera	*Nigronia*	2	1.4	Predator	cn, cb
Odonata	*Gomphus*	1	2.2	Predator	bu
Arachnoidea	Hydracarina	6	6	Predator	sw
Basommatophora	*Ferrissia*	2	7	Scraper	cb
Tricladida	*Cura*	9	6.5		sp
Unid. Oligochaeta		2	10	Collector	bu
		S = 35 N = 407			

Fisheries Data	**MBSS Data – Highlands**
Richness = 35	Number of Taxa = 35 (5)
EPT = # 215 Taxa 18	Number of EPT Taxa = 18 (5)
EPT/C = 2.34	Number of Ephemeroptera Taxa = 7 (5)
Dominant family = Chironomidae, 22.60%	% Intolerant Urban = 35.87% (1)
Scraper Filterer Ratio = 0.51	% Tanytarsini = 5.16% (5)
CPOM = 0.10	% Scrapers = 10.81% (3)
Diversity = 4.23	% Swimmers = 25.55% (5)
Equitability = 0.80	% Diptera = 40.29% (3)
HBI = 4.46	IBI = 4 Good

Table 4. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek below Elbow Pool on May 26, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Drunella*	17	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	26	2.3	Collector	cn, sw
Ephemeroptera	*Epeorus*	2	1.7	Scraper	cn
Ephemeroptera	*Stenonema*	2	4.6	Scraper	cn
Ephemeroptera	*Acentrella*	115	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	10	3.9	Collector	sw, cb, cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Plecoptera	*Isoperla*	19	2.4	Predator	cn, sp
Plecoptera	*Amphinemura*	4	3	Shredder	sp, cn
Plecoptera	*Leuctra*	4	0.4	Shredder	cn
Plecoptera	*Acroneuria*	1	2.5	Predator	cn
Trichoptera	*Hydropsyche*	37	7.5	Filterer	cn
Trichoptera	Unid. Trichoptera	1	4.6		
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Promoresia*	5	0	Scraper	cn
Diptera	Unid. Chironomidae	7	6.6		
Diptera	SF Orthocladiinae	7	7.6	Collector	
Diptera	TR Tanytarsini	2	3.5	Collector	
Diptera	TR Chironomini	2	5.9		
Diptera	*Antocha*	3	8	Collector	cn
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Diptera	*Simulium*	7	5.7	Filterer	cn
Diptera	*Blepharicera*	1	4	Scraper	cn
Arachnoidea	Hydracarina	3	6	Predator	sw
Tricladida	*Cura*	1	6.5		sp
		S = 25 N = 279			

Fisheries Data	**MBSS Data – Highlands**
Richness = 25	Number of Taxa = 25 (5)
EPT = # 240 Taxa 14	Number of EPT Taxa = 14 (5)
EPT/C = 13.33	Number of Ephemeroptera Taxa = 7 (5)
Dominant family = Baetidae, 44.80%	% Intolerant Urban = 28.67% (1)
Scraper Filterer Ratio = 0.61	% Tanytarsini = 0.72% (3)
CPOM = 0.03	% Scrapers = 9.68% (3)
Diversity = 3.14	% Swimmers = 55.56% (5)
Equitability = 0.52	% Diptera = 10.75% (5)
HBI = 4.55	IBI = 4.00 Good

Table 5. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek at Camp Peniel Bridge on May 27, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	22	2.3	Collector	cn, sw
Ephemeroptera	*Drunella*	17	1.9	Scraper	cn, sp
Ephemeroptera	*Baetis*	53	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	101	4.9	Collector	sw, cn
Ephemeroptera	*Paraleptophlebia*	2	2	Collector	sw, cn, sp
Plecoptera	*Pteronarcys*	2	1.1	Shredder	cn, sp
Plecoptera	*Leuctra*	8	0.4	Shredder	cn
Plecoptera	*Acroneuria*	15	2.5	Predator	cn
Plecoptera	*Paragnetina*	1	2.2	Predator	cn
Plecoptera	*Amphinemura*	1	3	Shredder	sp, cn
Plecoptera	*Alloperla*	1	1.6	Predator	cn
Plecoptera	*Isoperla*	1	2.4	Predator	cn, sp
Trichoptera	*Hydropsyche*	4	7.5	Filterer	cn
Trichoptera	*Cheumatopsyche*	3	6.5	Filterer	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Trichoptera	*Dolophilodes*	3	1.7	Filterer	cn
Trichoptera	*Leucotrichia*	1	5	Scraper	cn
Coleoptera	*Psephenus*	3	4.4	Scraper	cn
Diptera	Unid. Chironomidae	8	6.6		
Diptera	SF Tanypodinae	3	7.5	Predator	
Diptera	TR Tanytarsini	1	3.5	Collector	
Diptera	TR Chironomini	1	5.9		
Diptera	SF Orthocladiinae	28	7.6	Collector	
Diptera	*Hexatoma*	1	1.5	Predator	bu, sp
Diptera	*Antocha*	5	8	Collector	cn
Diptera	*Blepharicera*	2	4	Scraper	cn
Diptera	*Simulium*	7	5.7	Filterer	cn
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Arachnoidea	Hydracarina	7	6	Predator	sw
Basommatophora	*Ferrissia*	1	7	Scraper	cb
Unid. Oligochaeta		3	10	Collector	bu
		S = 31 N = 308			

Fisheries Data	**MBSS Data – Highlands**
Richness = 31	Number of Taxa = 31 (5)
EPT = # 237 Taxa 17	Number of EPT Taxa = 17 (5)
EPT/C = 5.78	Number of Ephemeroptera Taxa = 5 (5)
Dominant family = Baetidae, 50.00%	% Intolerant Urban = 24.68% (1)
Scraper Filterer Ratio = 1.41	% Tanytarsini = 0.32% (3)
CPOM = 0.04	% Scrapers = 7.79% (3)
Diversity = 3.48	% Swimmers = 60.06% (5)
Equitability = 0.52	% Diptera = 18.51% (5)
HBI = 4.52	IBI = 4.00 Good

Table 6. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek below Bear Branch on May 27, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	88	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	9	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	10	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	1	2.3	Collector	cn, sw
Ephemeroptera	*Stenonema*	1	4.6	Scraper	cn
Plecoptera	*Amphinemura*	1	3	Shredder	sp, cn
Plecoptera	*Perlesta*	4	1.6	Predator	cn
Plecoptera	*Paragnetina*	1	2.2	Predator	cn
Plecoptera	*Isoperla*	1	2.4	Predator	cn, sp
Trichoptera	*Cheumatopsyche*	3	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	1	7.5	Filterer	cn
Trichoptera	*Dolophilodes*	1	1.7	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Coleoptera	*Promoresia*	2	0	Scraper	cn
Coleoptera	*Psephenus*	2	4.4	Scraper	cn
Diptera	*Antocha*	2	8	Collector	cn
Diptera	Unid. Tipulidae	2	4.8	Predator	bu, sp
Diptera	SF Orthocladiinae	3	7.6	Collector	
Diptera	Unid. Chironomidae	3	6.6		
Diptera	*Simulium*	1	5.7	Filterer	cn
		S = 20 N = 137			

Fisheries Data	**MBSS Data – Highlands**
Richness = 20	Number of Taxa = 20 (3)
EPT = # 122 Taxa 13	Number of EPT Taxa = 13 (3)
EPT/C = 20.33	Number of Ephemeroptera Taxa = 5 (5)
Dominant family = Baetidae, 70.80%	% Intolerant Urban = 15.33% (1)
Scraper Filterer Ratio = 2.14	% Tanytarsini = 0.00% (1)
CPOM = 0.01	% Scrapers = 10.95% (3)
Diversity = 2.28	% Swimmers = 71.53% (5)
Equitability = 0.35	% Diptera = 8.03% (5)
HBI = 4.55	IBI = 3.25 Fair

Table 7. Data and results for the benthic macroinvertebrate sample collected from Hunting Creek at Route 15 on May 27, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Stenonema*	9	4.6	Scraper	cn
Ephemeroptera	*Baetis*	17	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	81	4.9	Collector	sw, cn
Ephemeroptera	*Drunella*	7	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	19	2.3	Collector	cn, sw
Ephemeroptera	*Isonychia*	5	2.5	Filterer	sw, cn
Plecoptera	*Perlesta*	2	1.6	Predator	cn
Plecoptera	*Acroneuria*	5	2.5	Predator	cn
Plecoptera	*Isoperla*	1	2.4	Predator	cn, sp
Plecoptera	*Amphinemura*	1	3	Shredder	sp, cn
Trichoptera	*Dolophilodes*	4	1.7	Filterer	cn
Trichoptera	*Cheumatopsyche*	8	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	6	7.5	Filterer	cn
Trichoptera	*Psychomyia*	1	4.9	Collector	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Trichoptera	*Leucotrichia*	2	5	Scraper	cn
Coleoptera	*Stenelmis*	1	7.1	Scraper	cn
Diptera	SF Tanypodinae	5	7.5	Predator	
Diptera	SF Orthocladiinae	7	7.6	Collector	
Diptera	TR Tanytarsini	2	3.5	Collector	
Diptera	TR Chironomini	1	5.9		
Diptera	Unid. Chironomidae	7	6.6		
Diptera	*Simulium*	3	5.7	Filterer	cn
Diptera	*Blepharicera*	2	4	Scraper	cn
Megaloptera	*Corydalus*	1	1.4	Predator	cn, cb
Odonata	*Gomphus*	1	2.2	Predator	bu
Arachnoidea	Hydracarina	4	6	Predator	sw
Tricladida	*Cura*	2	6.5		sp
Unid. Oligochaeta		1	10	Collector	bu
		S = 29 N = 206			

Fisheries Data	**MBSS Data – Highlands**
Richness = 29	Number of Taxa = 29 (5)
EPT = # 169 Taxa 16	Number of EPT Taxa = 16 (5)
EPT/C = 7.68	Number of Ephemeroptera Taxa = 6 (5)
Dominant family = Baetidae, 47.57%	% Intolerant Urban = 22.82% (1)
Scraper Filterer Ratio = 0.81	% Tanytarsini = 0.97% (3)
CPOM = 0.00	% Scrapers = 10.19% (3)
Diversity = 3.53	% Swimmers = 61.17% (5)
Equitability = 0.59	% Diptera = 13.11% (5)
HBI = 4.60	IBI = 4.00 Good

Owens Creek
(Frederick County)

Introduction

Owens Creek begins as a small (mean width 4.4 m) headwater stream located in northern Frederick County. Once leaving the Catoctin Mountains the stream meanders southeast before directly joining the Monocacy River. The headwaters are encompassed by Catoctin Mountain Park and support a population of native brook trout (*Salvelinus fontinalis*) and small population of naturalized brown trout (*Salmo trutta*). Management is for wild trout; no stocking has taken place in this area since 1990. Anglers may possess 2 trout/day. Further downstream, below Foxville/Deerfield Road, rainbow trout (*Oncorhynchus mykiss*) and brown trout stocking occurs in conjunction with the Put and Take/Catch and Return program.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to the benthic community and habitat quality over time.

Methods

Methodology for benthic macroinvertebrate collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at four stations along the mainstem of Owens Creek on May 15, 2015. From upstream to downstream, the stations were located at the Owens Creek Campground, the lower park boundary for Catoctin National Park, the Put–and-Take management area along Route 550, and at the Put–and-Take management area at Roddy Road.

Results

The sample collected from the Owens Creek Campground station contained 39 unique taxa represented by 582 total specimens (Table 1). There were 18 taxa and 316 specimens collected from Ephemeroptera, Plecoptera, and Trichoptera (EPT). The comparison of EPT taxa to specimens identified to Chironomidae (EPT/C) yielded a value of 2.72. Comparison of functional feeding groups produced 0.32 for the scraper filterer ratio and 0.22 for proportion of shredders, or consumers of coarse particulate organic matter (CPOM). The Shannon Weaver Diversity score was 4.23, while the equitability score was 0.72. Using tolerance values generated by Maryland Biological Stream Survey (MBSS), the sample received a Hilsenhoff Biotic Index (HBI) score of 4.39. The sample received a 3.75 using the MBSS IBI and was rated “fair”.

The station at the lower park boundary contained 406 specimens identified to 30 unique taxa (Table 2). There were 298 EPT specimens from 14 different taxa. The EPT/C ratio was 5.14. Comparisons using functional feeding groups yielded 1.00 for the scraper filterer ratio and 0.16 for CPOM. The diversity value was 4.13 with an equitability value of 0.87. The HBI score for the sample was 4.00, while the MBSS IBI score was 4.25 with a "good" rating.

The station at the Put and Take management area along Route 550 contained 316 specimens identified to 30 taxa (Table 3). There were 251 EPT specimens and 16 taxa. The EPT/C ratio was 7.38. Analyses using functional feeding groups generated values of 0.56 for the scraper filterer ratio and 0.04 for CPOM. The sample diversity was 3.82 and the equitability was 0.67. The sample received a score of 4.09 using the HBI and 4.00 using the MBSS IBI. The MBSS IBI rating was "good".

There were 396 specimens and 30 taxa collected in the Roddy Road sample (Table 4). The total number of EPT specimens was 306 belonging to 16 taxa. The EPT/C ratio was 4.50. Analysis of functional feeding groups yielded 0.13 for the scraper filterer ratio and 0.01 for the CPOM. The sample diversity was 3.39 with an equitability of 0.50. The HBI score was 4.19 while the MBSS IBI score was 3.75. The MBSS IBI rating was fair.

Discussion

The analysis of the benthic macroinvertebrate community in Owens Creek provided evidence that habitat and water quality were in good condition and the community was relatively undisturbed. Taxa richness was greater than 30 at all stations, indicating a diverse benthic community uninhibited by degradation. The Campground station was of particular interest, containing the highest richness and including stonefly specimens identified to the genus *Sweltsa*. This information is important because *Sweltsa* has been identified as a cold water obligate species in the Code of Maryland Regulations (COMAR 26.08.02.02). The presence of this taxon suggests that water temperatures remain consistently cold and suitable for the maintenance of a stable trout population.

There were 14 or more EPT taxa identified at each station. This suggests a benthic community that is not impacted by stream degradation. The EPT/C ratio was 2.72 or greater at all stations, supporting the idea that the stream community is not subject to degradation. EPT/C values were highest at the two middle stations, while the lowest value was observed at the Campground station that was farthest upstream. While the number of EPT specimens was higher at the Campground station than all other stations, there was a particularly high representation of the Chironomidae observed as well.

The scraper filterer ratios for the Owens Creek samples ranged from 0.32 to 1.00. The relatively low number of scrapers relative to filterers indicates that there may be some nutrient enrichment in the stream. The lowest values were observed at the upstream Campground station and the downstream Roddy Road station. The low scraper filterer ratio at the Roddy Road station is expected, as nutrient enrichment tends to increase

downstream. However, the lower scraper filter value at the Campground station should be noted and observed in future samples to determine if this is an anomaly.

The CPOM values declined from 0.22 at the Campground station to 0.01 at the Roddy Road station. The higher CPOM at the upstream stations were expected, as both stations have substantially more canopy cover that likely supplies more leaf litter for shredders to consume. The downstream sites have less canopy coverage and are likely to receive less leaf liter, resulting in lower CPOM values.

The Shannon Weaver Diversity was high at all stations. The lowest diversity value was 3.39 at the Roddy Road station. The values increased at each upstream station, with the highest value of 4.23 observed at the Campground station. Higher diversity scores are expected in the more pristine head waters of the stream, but high diversity at the downstream stations indicated a healthy community downstream as well. Equitability scores further supported this, particularly at the upstream stations. Equitability values at the Campground, lower park boundary, and Route 550 stations were all greater than 0.6, suggesting an undisturbed distribution of taxa within the community. The equitability score at the Roddy Road station was 0.50 and revealed signs of moderate degradation at this location. Baetidae represented 41% of the taxa collected in the sample.

The HBI and MBSS IBI scores were indicative of a stream in good condition with low levels of organic pollution. The HBI values were between 4.00 and 4.39 at all stations, with taxa that are intolerant of organic pollution well represented. The MBSS IBI scores were slightly lower, but also suggested that the stream that was only slightly disturbed. The Campground and Roddy Road stations both scored 3.75 and rated as Fair, while the lower park boundary and Route 550 stations scored 4.25 and 4.00, respectively, and were rated as good.

Benthic macroinvertebrate samples from Owens Creek indicate a stream community that is in good condition with little disturbance from organic pollution. While the scraper filterer ratio, HBI, and MBSS IBI suggest that there may be some slight disturbance that has influenced the community, the damage appears relatively minor and has had little effect on diversity and richness.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Owens Creek at the Owens Creek Campground on May 15, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	97	2.3	Collector	cn, sw
Ephemeroptera	*Baetis*	39	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	40	4.9	Collector	sw, cn
Ephemeroptera	*Epeorus*	1	1.7	Scraper	cn
Plecoptera	*Acroneuria*	5	2.5	Predator	cn
Plecoptera	*Amphinemura*	22	3	Shredder	sp, cn
Plecoptera	*Sweltsa*	3	1.9	Predator	cn
Plecoptera	*Haploperla*	28	1.6	Predator	cn
Plecoptera	*Leuctra*	23	0.4	Shredder	cn
Plecoptera	*Isoperla*	3	2.4	Predator	cn, sp
Plecoptera	Unid. Perlodidae	1	2.2	Predator	cn
Trichoptera	*Cheumatopsyche*	16	6.5	Filterer	cn
Trichoptera	*Diplectrona*	5	2.7	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Dolophilodes*	24	1.7	Filterer	cn
Trichoptera	*Unid. Philopotamidae*	2	2.6	Filterer	cn
Trichoptera	*Rhyacophila*	5	2.1	Predator	cn
Trichoptera	*Lepidostoma*	1	0	Shredder	cb, sp, cn
Coleoptera	*Psephenus*	6	4.4	Scraper	cn
Coleoptera	*Oulimnius*	12	2.7	Scraper	cn
Diptera	SF Orthocladiinae	42	7.6	Collector	
Diptera	TR Chironomini	32	5.9		
Diptera	SF Tanypodinae	9	7.5	Predator	
Diptera	TR Tanytarsini	16	3.5	Collector	
Diptera	Unid. Chironomidae	17	6.6		
Diptera	*Prosimulium*	1	2.4	Filterer	cn
Diptera	*Simulium*	14	5.7	Filterer	cn
Diptera	*Antocha*	20	8	Collector	cn
Diptera	*Tipula*	1	6.7	Shredder	bu
Diptera	*Hexatoma*	3	1.5	Predator	bu, sp
Diptera	Unid. Tipulidae	6	4.8	Predator	bu, sp
Diptera	*Blepharicera*	1	4	Scraper	cn
Diptera	Unid. Blephariceridae	1			
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Amphipoda	*Gammarus*	79	6.7	Shredder	sp
Arachnoidea	Hydracarina	1	6	Predator	sw
Decapoda	*Cambarus*	1	0.4	Collector	sp
Tricladida	*Cura*	2	6.5		sp
Unid. Oligochaeta		1	10	Collector	bu
		S = 39 N = 582			

Fisheries Data	**MBSS Data – Highlands**
Richness = 39	Number of Taxa = 39 (5)
EPT = # 18 Taxa 316	Number of EPT Taxa = 18 (5)
EPT/C = 2.72	Number of Ephemeroptera Taxa = 4 (3)
Dominant family = Chironomidae, 19.93%	% Intolerant Urban = 40.72% (3)
Scraper Filterer Ratio = 0.32	% Tanytarsini = 2.75% (3)
CPOM = 0.22	% Scrapers = 3.44% (3)
Diversity = 4.23	% Swimmers = 30.41% (5)
Equitability = 0.72	% Diptera = 28.18% (3)
HBI = 4.39	IBI = 3.75 Fair

Table 2. Data and results for the benthic macroinvertebrate sample collected from Owens Creek at the lower park boundary in Catoctin National Park on May 15, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	62	2.3	Collector	cn, sw
Ephemeroptera	*Baetis*	53	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	32	4.9	Collector	sw, cn
Ephemeroptera	*Stenonema*	31	4.6	Scraper	cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Plecoptera	*Haploperla*	18	1.6	Predator	cn
Plecoptera	*Leuctra*	40	0.4	Shredder	cn
Plecoptera	*Amphinemura*	7	3	Shredder	sp, cn
Plecoptera	*Acroneuria*	10	2.5	Predator	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Trichoptera	*Cheumatopsyche*	23	6.5	Filterer	cn
Trichoptera	*Diplectrona*	11	2.7	Filterer	cn
Trichoptera	*Dolophilodes*	6	1.7	Filterer	cn
Trichoptera	*Polycentropus*	3	1.1	Filterer	cn
Coleoptera	*Psephenus*	3	4.4	Scraper	cn
Coleoptera	*Oulimnius*	9	2.7	Scraper	cn
Diptera	Unid. Chironomidae	13	6.6		
Diptera	SF Tanypodinae	18	7.5	Predator	
Diptera	SF Orthocladiinae	15	7.6	Collector	
Diptera	TR Chironomini	7	5.9		
Diptera	TR Tanytarsini	5	3.5	Collector	
Diptera	Unid. Empididae	2	7.5	Predator	sp, bu
Diptera	*Antocha*	3	8	Collector	cn
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Odonata	*Gomphus*	1	2.2	Predator	bu
Amphipoda	*Gammarus*	16	6.7	Shredder	sp
Arachnoidea	Hydracarina	2	6	Predator	sw
Decapoda	*Cambarus*	1	0.4	Collector	sp
Tricladida	*Cura*	8	6.5		sp
Unid. Oligochaeta		4	10	Collector	bu
		S = 30 N = 406			

Fisheries Data	**MBSS Data – Highlands**
Richness = 30	Number of Taxa = 30 (5)
EPT = # 298 Taxa 14	Number of EPT Taxa = 14 (5)
EPT/C = 5.14	Number of Ephemeroptera Taxa = 5 (5)
Dominant family = Baetidae, 20.94%	% Intolerant Urban = 41.87% (3)
Scraper Filterer Ratio = 1.00	% Tanytarsini = 1.23% (3)
CPOM = 0.16	% Scrapers = 10.59% (3)
Diversity = 4.13	% Swimmers = 36.95% (5)
Equitability = 0.87	% Diptera = 15.76% (5)
HBI = 4.00	IBI = 4.25 Good

Table 3. Data and results for the benthic macroinvertebrate sample collected from Owens Creek at the Put–and-Take management area along Route 550 on May 15, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	23	2.3	Collector	cn, sw
Ephemeroptera	*Stenonema*	28	4.6	Scraper	cn
Ephemeroptera	*Baetis*	51	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	60	4.9	Collector	sw, cn
Ephemeroptera	*Isonychia*	4	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Plecoptera	*Acroneuria*	15	2.5	Predator	cn
Plecoptera	*Perlesta*	6	1.6	Predator	cn
Plecoptera	*Leuctra*	12	0.4	Shredder	cn
Plecoptera	*Isoperla*	2	2.4	Predator	cn, sp
Plecoptera	*Amphinemura*	1	3	Shredder	sp, cn
Trichoptera	*Dolophilodes*	43	1.7	Filterer	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Hydropsyche*	1	7.5	Filterer	cn
Trichoptera	*Cheumatopsyche*	1	6.5	Filterer	cn
Coleoptera	*Oulimnius*	2	2.7	Scraper	cn
Coleoptera	*Stenelmis*	1	7.1	Scraper	cn
Diptera	Unid. Chironomidae	8	6.6		
Diptera	SF Tanypodinae	5	7.5	Predator	
Diptera	SF Orthocladiinae	13	7.6	Collector	
Diptera	TR Chironomini	7	5.9		
Diptera	TR Tanytarsini	1	3.5	Collector	
Diptera	*Antocha*	2	8	Collector	cn
Diptera	*Tipula*	1	6.7	Shredder	bu
Diptera	*Simulium*	5	5.7	Filterer	cn
Megaloptera	*Corydalus*	1	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	8	6	Predator	sw
Tricladida	*Cura*	2	6.5		sp
Unid. Oligochaeta		9	10	Collector	bu
		S = 30 N = 316			

Fisheries Data	**MBSS Data – Highlands**
Richness = 30	Number of Taxa = 30 (5)
EPT = # 251 Taxa 16	Number of EPT Taxa = 16 (5)
EPT/C = 7.38	Number of Ephemeroptera Taxa = 6 (5)
Dominant family = Baetidae, 35.13%	% Intolerant Urban = 35.44% (1)
Scraper Filterer Ratio = 0.56	% Tanytarsini = 0.32% (3)
CPOM = 0.04	% Scrapers = 9.81% (3)
Diversity = 3.82	% Swimmers = 46.52% (5)
Equitability = 0.67	% Diptera = 13.29% (5)
HBI = 4.09	IBI = 4.00

Table 4. Data and results for the benthic macroinvertebrate sample collected from Owens Creek at the Put–and-Take management area at Roddy Road on May 15, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	72	2.3	Collector	cn, sw
Ephemeroptera	*Drunella*	1	1.9	Scraper	cn, sp
Ephemeroptera	*Baetis*	124	3.9	Collector	sw, cb, cn
Ephemeroptera	*Acentrella*	39	4.9	Collector	sw, cn
Ephemeroptera	*Isonychia*	24	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Ephemeroptera	*Stenonema*	1	4.6	Scraper	cn
Plecoptera	*Acroneuria*	4	2.5	Predator	cn
Plecoptera	*Perlesta*	9	1.6	Predator	cn
Plecoptera	*Isoperla*	3	2.4	Predator	cn, sp
Plecoptera	*Amphinemura*	4	3	Shredder	sp, cn
Trichoptera	*Cheumatopsyche*	5	6.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Dolophilodes*	16	1.7	Filterer	cn
Trichoptera	*Chimarra*	1	4.4	Filterer	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Psephenus*	3	4.4	Scraper	cn
Coleoptera	*Stenelmis*	1	7.1	Scraper	cn
Diptera	Unid. Chironomidae	19	6.6		
Diptera	SF Orthocladiinae	35	7.6	Collector	
Diptera	SF Tanypodinae	5	7.5	Predator	
Diptera	TR Chironomini	6	5.9		
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Diptera	*Antocha*	3	8	Collector	cn
Diptera	*Hemerodromia*	2	7.9	Predator	sp, bu
Diptera	*Simulium*	1	5.7	Filterer	cn
Megaloptera	*Corydalus*	1	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	3	6	Predator	sw
Unid. Oligochaeta		7	10	Collector	bu
		S = 30 N = 396			

Fisheries Data	**MBSS Data – Highlands**
Richness = 30	Number of Taxa = 30 (5)
EPT = # 306 Taxa 16	Number of EPT Taxa = 7 (5)
EPT/C = 4.50	Number of Ephemeroptera Taxa = 7 (5)
Dominant family = Baetidae, 41.16%	% Intolerant Urban = 34.34% (1)
Scraper Filterer Ratio = 0.13	% Tanytarsini = 0.76% (3)
CPOM = 0.01	% Scrapers = 1.52% (1)
Diversity = 3.39	% Swimmers = 66.41% (5)
Equitability = 0.50	% Diptera = 18.94% (5)
HBI = 4.19	IBI = 3.75

Central Region
(Baltimore, Carroll, Harford, Howard, and Montgomery Counties**)**

Gunpowder Falls Tailwater
(Baltimore County**)**

Introduction

Since a coldwater agreement between Trout Unlimited (T.U.) and Baltimore City went into effect on November 5, 1986, a thriving self-sustaining brown trout fishery has developed and dominated the fish species composition of the Gunpowder Falls tailwater for twenty-eight years. The agreement obligates Baltimore City to provide a minimum discharge of 11.5 cubic feet per second, however; Baltimore City reserves the right to notify T.U. if the minimum cannot be delivered due to municipal water supply constraints or water shortage.

The Gunpowder Falls tailwater is managed under three different regulation strategies along its 28.2 km length. The upper 11.6 km of river is managed as a Catch-and-Return (C&R) area, restricted to the use of artificial lures and flies only. The first C&R area was established January 1, 1989 between Prettyboy dam and Falls Road. The second C&R portion was added January 1, 1991 from York Road downstream to Blue Mount Road. The third and final addition included the section from Falls Road to York Road on January 1, 1993. The middle 6.8 km portion of tailwater was established as a two trout/day harvest area for wild trout on January 1, 1997. This section is not stocked with hatchery trout and allows the use of bait. This management area was extended another 2.5 km to 9.3 km in January 2006. The change was made to reduce the harvest of wild brown trout in a section of Put-and-Take (P&T) water that was not being stocked and was determined not to be suitable for conventional P&T stocking. The remaining 7.3 km of tailwater has been managed as a P&T area since 1989. The P&T portion is stocked annually in the spring and fall with hatchery reared adult rainbow trout. A creel limit of five trout/day applies in the P&T area and there are no restrictions on terminal tackle.

Objectives

The objectives of the fisheries activities conducted in the Gunpowder Falls tailwater in 2015 were to:

- Monitor population and recruitment trends of the wild trout fishery within 28.2 km of the Gunpowder Falls tailwater managed under various fishing regulation strategies.
- Monitor response and success of rainbow trout fingerling stockings between Falls Road and Prettyboy dam.
- Monitor tailwater temperatures in response to water release strategies employed since 2004.
- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.

- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology follows that described in the Study III Job 1 Methods section. Only variations from that methodology are described here.

Water Temperature Monitoring
Tailwater temperatures are monitored every twenty minutes using continuous recording data loggers manufactured by Onset Computer Corporation. Temperature data are downloaded and graphed using the HOBOware software package. Devices are located approximately 1.9 and 12.5 km below Prettyboy dam in the Falls Road and Blue Mount Road electrofishing stations, respectively. The information is collected annually and is used to monitor and evaluate thermal conditions from water release protocol activities first implemented in 2004.

Swim-up Fry Survey
Brown trout fry counts are conducted in April in the Gunpowder Falls tailwater below York Road and below Blue Mount Road within the Blue Mount Road electrofishing station. Swim-up brown trout fry counts are conducted by walking along the stream or wading up through the stream and counting the identifiable fry. The number of observed brown trout fry is recorded to determine the success of the annual hatch.

Benthic macroinvertebrates
Benthic macroinvertebrates were surveyed at six stations along the mainstem of the Gunpowder Falls on June 3 and 4, 2015. The station located farthest upstream was at Gunpowder Road above Prettyboy Reservoir. This station was used as a reference point. All other stations were located below the reservoir. From upstream to downstream, the sample stations below the reservoir were at Falls Road, Masemore Road, York Road, Blue Mount Road, and Glencoe Road.

Results

Water Temperature Monitoring
HOBO Water Temp Pro loggers were deployed above Falls Road and below Blue Mount Road within the Blue Mount electrofishing station on May 27, 2015. Stream temperatures are being monitored every 20 minutes and will be evaluated after the loggers are removed in the fall.

Swim-up Fry Survey
A swim-up fry count was conducted on April 20, 2015 below York Road. Sixty-nine trout fry were counted within a 50 meter section of stream indicating an excellent hatch. A second fry count was conducted in the Blue Mount Road station on April 22, 2015.

Nineteen trout fry were identified within the station indicating a successful hatch in the middle portion of the tailwater.

Benthic macroinvertebrates

The sample collected from the station located at Gunpowder Road contained 514 specimens identified to 28 unique taxa (Table 1). The number of specimens identified to the orders of Ephemeroptera, Plecoptera, or Trichoptera (EPT) was 407, representing 14 taxa. An index that compares total EPT specimens to total specimens belong to the Chironomidae (EPT/C) yielded a result of 6.36. The functional feeding groups of the taxa were used to generate a scraper filterer ratio and a proportion of shredders, or consumers of coarse particulate organic matter (CPOM). The results were 0.08 and 0.00, respectively. The Shannon Weaver Diversity score for the sample was 3.68, with an equitability of 0.64. The sample received a Hilsenhoff Biotic Index (HBI) score of 4.87 and MBSS IBI score of 4.33. The MBSS IBI score was rated "good".

The sample from the Falls Road station in the tailwater of Prettyboy Reservoir contained 480 total specimens belonging to 17 different taxa (Table 2). There were 276 individuals belonging to 5 EPT taxa. The EPT/C index was 1.77. Functional feeding group analyses yielded 0.07 for the scraper filterer ratio and 0.03 for the CPOM. The diversity value for the sample was 2.45 with an equitability of 0.41. The sample received an HBI score of 4.63 and an MBSS IBI of 3.00. The MBSS IBI rating was "fair".

The Masemore Road sample contained 514 total specimens identified to 28 taxa (Table 3). There were 276 individuals classified to 13 EPT taxa. The EPT/C index was 2.75. The scraper filterer ratio was 0.13, while the CPOM was 0.03. The sample had a diversity value of 2.73 with an equitability of 0.32. The HBI score was 4.65, while the MBSS IBI was 4.00 with a "good" rating.

There were 399 specimens in the sample collected at York Road (Table 4). These specimens were identified to 26 unique taxa, including 251 individuals identified to 12 EPT taxa. The EPT/C index was 2.18. Comparisons of functional feeding groups yielded 0.26 for the scraper filterer ratio and 0.08 for the CPOM. The diversity of the sample was 2.95 with an equitability of 0.42. The sample received an HBI score of 5.12 and an MBSS IBI score of 3.67. The MBSS IBI rated the sample as "fair".

The sample at Blue Mount Road contained 321 specimens belonging to 24 unique taxa (Table 5). There were 107 individuals identified to 10 EPT taxa. The EPT/C index was 0.68. The scraper filterer ratio was calculated to 5.33 and the CPOM was 0.17. Sample diversity was 2.89 with an equitability of 0.42. The HBI score for the sample was 5.71. The MBSS IBI score was 3.33 and rated the sample as "fair".

The sample collected from the downstream station at Glencoe Road contained 202 total specimens identified to 28 different taxa (Table 6). Specimens belonging to EPT orders included 120 total individuals representing 12 taxa. The EPT/C index was 3.24. The analyses of functional feeding groups yielded 1.00 for the scraper filterer ratio and 0.02

for the CPOM. The sample diversity was 3.99 with an equitability of 0.82. The HBI score for the sample was 4.87. The MBSS IBI score was 4.00 with a rating of "good".

Discussion

The results of benthic macroinvertebrate sampling along the Gunpowder Falls suggested that habitat and water quality in the stream are good, though there are some signs of habitat degradation. The taxa richness varied from 17 to 28, with the lowest score at the Falls Road station. There appears to be some moderate habitat degradation that has influenced richness at Falls Road. All other samples had a taxa richness of 24 or greater, indicating little to no impact to richness at these stations.

EPT and EPT/C indices were high at most of the sample stations, suggesting healthy EPT communities that do not appear to be impacted by degradation. The exceptions to this were the stations at Falls Road and Blue Mount Road. The Falls Road sample contained only 5 EPT taxa, which may indicate some moderate impacts due to habitat degradation. The Blue Mount Road station contained 10 EPT taxa and an EPT/C that was 0.68. There was a particularly high number of the Chironomidae represented at this location, accounting for almost 50% of the community. There appeared to be some moderate impact to this location as well.

The results of the functional feeding group analysis suggest that scrapers and shredders do not play a large role in the benthic community of the Gunpowder Falls. The scraper filterer ratio was relatively low from the Gunpowder Road station to the York Road station. The ratio was particularly high at the Blue Mount Road station, but that was largely due to the fact that almost no filterers were present. The scraper filterer ratio was also high at the Glencoe Road station, though there was some diversity in both scrapers and filterers in this sample. The CPOM index was also low at all locations. The Blue Mount Road station had the highest proportion of shredders due to a particularly high number of stoneflies identified to the genus *Leuctra*.

Benthic community diversity was high at most stations. Diversity for the Gunpowder Road and Glencoe Road stations were above 3.50 and indicated relatively undisturbed communities. The diversity at the remaining stations ranged between 2.45 and 2.95, suggesting that there may be some minor decrease in diversity due to habitat degradation. Equitability values varied more than the diversity values. The Gunpowder Road and Glencoe Road stations had equitability values above 0.60, supporting the idea that these communities were undisturbed. The Falls Road, York Road, and Blue Mount Road stations all had equitability values above 0.40, showing some signs of moderate degradation. The Falls Road station had an equitability value of 0.32, likely due to the abundance of *Ephemerella* identified in the sample. This station also received the lowest diversity value, suggesting that there is substantial degradation influencing the community structure.

The HBI scores ranged from 4.63 to 5.71 along the sampled length of stream and showed little variation. With the exception of the Blue Mount Road station, the HBI scores are considered to be those of a healthy stream community that may be impacted by some minor habitat degradation. The Blue Mount Road station received the lowest score and appears to be slightly more impacted by degradation than the other stations. The MBSS IBI scores seem to corroborate this at the Gunpowder Road, Masemore Road, and Glencoe Road stations. All of these stations received a "good" rating. While the York Road station received an MBSS IBI rating of "fair", the index value was 3.67 and appears to support the conclusion drawn from the HBI scores. The Falls Road and Blue Mount Road stations were both rated as "fair" and had lower IBI scores, suggesting slightly more disturbance at these locations.

The Gunpowder Falls benthic community appeared to be healthy, but indicated some degradation in habitat and water quality. Of particular interest are the Falls Road and Blue Mount Road stations. These stations appeared to be suffering slightly more impacts from habitat degradation than the remaining stations. These stations should be a focus of sampling in future efforts.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Gunpowder Falls at Gunpowder Road on June 3, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	118	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	71	3.9	Collector	sw, cb, cn
Ephemeroptera	*Serratella*	27	2.8	Collector	cn
Ephemeroptera	*Leucrocuta*	3	1.8	Scraper	cn
Ephemeroptera	*Stenonema*	5	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	37	2.5	Filterer	sw, cn
Plecoptera	*Acroneuria*	2	2.5	Predator	cn
Plecoptera	*Phasganophora*	2	2.2	Predator	cn
Plecoptera	*Isoperla*	1	2.4	Predator	cn, sp
Trichoptera	*Cheumatopsyche*	19	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	55	7.5	Filterer	cn
Trichoptera	*Chimarra*	47	4.4	Filterer	cn
Trichoptera	*Dolophilodes*	18	1.7	Filterer	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Coleoptera	*Optioservus*	4	5.4	Scraper	cn
Coleoptera	*Oulimnius*	3	2.7	Scraper	cn
Diptera	SF Orthocladiinae	14	7.6	Collector	
Diptera	SF Tanypodinae	2	7.5	Predator	
Diptera	TR Chironomini	41	5.9		
Diptera	TR Tanytarsini	6	3.5	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	*Simulium*	17	5.7	Filterer	cn
Diptera	*Antocha*	3	8	Collector	cn
Megaloptera	*Corydalus*	1	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	7	6	Predator	sw
Tricladida	*Cura*	1	6.5		sp
Tricladida	*Dugesia*	1	9.3	Predator	sp
Unid. Oligochaeta		6	10	Collector	bu
		S = 28 N = 514			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 28	Number of Taxa = 28 (5)
EPT = # 407 Taxa 14	Number of EPT Taxa = 14 (5)
EPT/C = 6.36	Number of Ephemeroptera Taxa = 6 (5)
Dominant Family = Baetidae, 36.77%	% Intolerant Urban = 18.68% (3)
Scraper Filterer Ratio = 0.08	% Chironomidae = 12.45% (3)
CPOM = 0.00	% Clingers = 84.63% (5)
Diversity = 3.68	IBI = 4.33
Equitability = 0.64	
HBI = 4.87	

Table 2. Data and results for the benthic macroinvertebrate sample collected from Gunpowder Falls at Falls Road on June 3, 2015.

Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Acentrella*	48	4.9	Collector	sw, cn
Ephemeroptera	*Ephemerella*	219	2.3	Collector	cn, sw
Trichoptera	*Cheumatopsyche*	2	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	1	7.5	Filterer	cn
Trichoptera	*Rhyacophila*	6	2.1	Predator	cn
Coleoptera	*Optioservus*	1	5.4	Scraper	cn
Diptera	SF Orthocladiinae	111	7.6	Collector	
Diptera	TR Tanytarsini	15	3.5	Collector	
Diptera	Unid. Chironomidae	30	6.6		
Diptera	*Hemerodromia*	1	7.9	Predator	sp, bu
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Simulium*	11	5.7	Filterer	cn
Diptera	*Antocha*	7	8	Collector	cn
Diptera	*Dicranota*	1	1.1	Predator	sp, bu
Amphipoda	*Gammarus*	12	6.7	Shredder	sp
Arachnoidea	Hydracarina	1	6	Predator	sw
Unid. Oligochaeta		13	10	Collector	bu
		S = 17 N = 480			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 17	Number of Taxa = 17 (3)
EPT = # 276 Taxa 5	Number of EPT Taxa = 5 (3)
EPT/C = 1.77	Number of Ephemeroptera Taxa = 2 (3)
Dominant Family = Ephemerellidae 45.63%	% Intolerant Urban = 47.08% (3)
Scraper Filterer Ratio = 0.07	% Chironomidae = 32.50% (3)
CPOM = 0.03	% Clingers = 61.46% (3)
Diversity = 2.45	IBI = 3.00
Equitability = 0.41	
HBI = 4.63	

Table 3. Data and results for the benthic macroinvertebrate sample collected from Gunpowder Falls at Masemore Road on June 3, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	64	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	2	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	1	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	244	2.3	Collector	cn, sw
Ephemeroptera	*Stenonema*	2	4.6	Scraper	cn
Plecoptera	*Alloperla*	3	1.6	Predator	cn
Plecoptera	*Leuctra*	2	0.4	Shredder	cn
Plecoptera	*Acroneuria*	3	2.5	Predator	cn
Plecoptera	*Phasganophora*	1	2.2	Predator	cn
Trichoptera	*Cheumatopsyche*	1	6.5	Filterer	cn
Trichoptera	*Diplectrona*	1	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	44	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Coleoptera	*Optioservus*	4	5.4	Scraper	cn
Coleoptera	*Oulimnius*	1	2.7	Scraper	cn
Diptera	SF Orthocladiinae	108	7.6	Collector	
Diptera	TR Chironomini	1	5.9		
Diptera	TR Tanytarsini	9	3.5	Collector	
Diptera	Unid. Chironomidae	16	6.6		
Diptera	*Hemerodromia*	1	7.9	Predator	sp, bu
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Simulium*	14	5.7	Filterer	cn
Diptera	*Antocha*	2	8	Collector	cn
Diptera	*Tipula*	3	6.7	Shredder	bu
Amphipoda	*Gammarus*	14	6.7	Shredder	sp
Arachnoidea	Hydracarina	2	6	Predator	sw
Tricladida	*Cura*	1	6.5		sp
Unid. Oligochaeta		10	10	Collector	bu
		S = 28 N = 556			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 556	Number of Taxa = 28 (5)
EPT = # 369 Taxa 13	Number of EPT Taxa = 13 (5)
EPT/C = 2.75	Number of Ephemeroptera Taxa = 5 (5)
Dominant Family = Ephemerellidae 44.06%	% Intolerant Urban = 46.04% (3)
Scraper Filterer Ratio = 0.13	% Chironomidae = 24.10% (3)
CPOM = 0.03	% Clingers = 70.14% (3)
Diversity = 2.73	IBI = 4.00
Equitability = 0.32	
HBI = 4.65	

Table 4. Data and results for the benthic macroinvertebrate sample collected from Gunpowder Falls at York Road on June 4, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	111	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	8	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	69	2.3	Collector	cn, sw
Plecoptera	*Alloperla*	1	1.6	Predator	cn
Plecoptera	*Haploperla*	2	1.6	Predator	cn
Plecoptera	*Leuctra*	29	0.4	Shredder	cn
Plecoptera	*Acroneuria*	2	2.5	Predator	cn
Plecoptera	*Phasganophora*	1	2.2	Predator	cn
Plecoptera	*Pteronarcys*	1	1.1	Shredder	cn, sp
Trichoptera	*Hydropsyche*	24	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Optioservus*	5	5.4	Scraper	cn
Coleoptera	*Oulimnius*	2	2.7	Scraper	cn
Diptera	SF Orthocladiinae	107	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	1	5.9		
Diptera	TR Tanytarsini	5	3.5	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Simulium*	1	5.7	Filterer	cn
Diptera	*Antocha*	2	8	Collector	cn
Amphipoda	*Gammarus*	1	6.7	Shredder	sp
Arachnoidea	Hydracarina	8	6	Predator	sw
Tricladida	*Cura*	2	6.5		sp
Unid. Oligochaeta		11	10	Collector	bu
		S = 26 N = 399			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 26	Number of Taxa = 26 (5)
EPT = # 251 Taxa 12	Number of EPT Taxa = 12 (5)
EPT/C = 2.18	Number of Ephemeroptera Taxa = 3 (3)
Dominant Family = Baetidae, 29.82%	% Intolerant Urban = 27.07% (3)
Scraper Filterer Ratio = 0.26	% Chironomidae = 28.82% (3)
CPOM = 0.08	% Clingers = 65.41% (3)
Diversity = 2.95	IBI = 3.67
Equitability = 0.42	
HBI = 5.12	

Table 5. Data and results for the benthic macroinvertebrate sample collected from the Gunpowder Falls at Blue Mount Road on June 4, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	19	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	16	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	6	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	1	2.8	Collector	cn
Plecoptera	*Alloperla*	2	1.6	Predator	cn
Plecoptera	*Leuctra*	53	0.4	Shredder	cn
Plecoptera	*Phasganophora*	6	2.2	Predator	cn
Trichoptera	*Cheumatopsyche*	2	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	1	7.5	Filterer	cn
Trichoptera	*Hydroptila*	1	6	Scraper	cn
Coleoptera	*Optioservus*	13	5.4	Scraper	cn
Coleoptera	*Oulimnius*	2	2.7	Scraper	cn
Diptera	Unid. Diptera	1	6		
Diptera	SF Orthocladiinae	145	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	7	5.9		
Diptera	TR Tanytarsini	4	3.5	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	*Hemerodromia*	1	7.9	Predator	sp, bu
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Antocha*	6	8	Collector	cn
Amphipoda	*Gammarus*	1	6.7	Shredder	sp
Arachnoidea	Hydracarina	9	6	Predator	sw
Unid. Oligochaeta		22	10	Collector	bu
		S = 24 N = 321			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 24	Number of Taxa = 24 (3)
EPT = # 107 Taxa 10	Number of EPT Taxa = 10 (3)
EPT/C = 0.68	Number of Ephemeroptera Taxa = 4 (5)
Dominant Family = Chironomidae, 49.22%	% Intolerant Urban = 21.81% (3)
Scraper Filterer Ratio = 5.33	% Chironomidae = 49.22% (3)
CPOM = 0.17	% Clingers = 39.88% (3)
Diversity = 2.89	IBI = 3.33
Equitability = 0.42	
HBI = 5.71	

Table 6. Data and results for the benthic macroinvertebrate sample collected from Gunpowder Falls at Glencoe Road on June 4, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	43	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	12	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	29	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	7	2.8	Collector	cn
Ephemeroptera	*Epeorus*	1	1.7	Scraper	cn
Ephemeroptera	*Stenonema*	2	4.6	Scraper	cn
Plecoptera	*Leuctra*	4	0.4	Shredder	cn
Plecoptera	*Acroneuria*	2	2.5	Predator	cn
Plecoptera	*Phasganophora*	4	2.2	Predator	cn
Trichoptera	*Glossosoma*	4	0	Scraper	cn
Trichoptera	*Hydropsyche*	10	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	cn
Coleoptera	*Optioservus*	4	5.4	Scraper	cn
Coleoptera	*Oulimnius*	3	2.7	Scraper	cn
Coleoptera	*Stenelmis*	1	7.1	Scraper	cn
Diptera	Unid. Diptera	4	6		
Diptera	*Probezzia*	2	3	Predator	bu
Diptera	SF Orthocladiinae	15	7.6	Collector	
Diptera	TR Chironomini	18	5.9		
Diptera	TR Tanytarsini	2	3.5	Collector	
Diptera	Unid. Chironomidae	2	6.6		
Diptera	Unid. Empididae	3	7.5	Predator	sp, bu
Diptera	*Simulium*	3	5.7	Filterer	cn
Diptera	*Protoplasa*	2		Collector	
Diptera	*Antocha*	2	8	Collector	cn
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Arachnoidea	Hydracarina	10	6	Predator	sw
Unid. Oligochaeta		10	10	Collector	bu
		S = 28 N = 202			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 28	Number of Taxa = 28 (5)
EPT = # 120 Taxa 12	Number of EPT Taxa = 12 (5)
EPT/C = 3.24	Number of Ephemeroptera Taxa = 6 (5)
Dominant Family = Baetidae, 27.23%	% Intolerant Urban = 27.72% (3)
Scraper Filterer Ratio = 1.00	% Chironomidae = 18.32% (3)
CPOM = 0.02	% Clingers = 65.84% (3)
Diversity = 3.99	IBI = 4.00
Equitability = 0.82	
HBI = 202	

Little Falls
(Baltimore County)

Introduction

Little Falls is a tributary to the Gunpowder Falls located in Baltimore County, MD. Little Falls provides recreational fishing opportunities for anglers from Valley Mill Road downstream to Wiseburg Road. The stream is managed as a Put-and-Take fishery and is stocked with hatchery raised rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*). In addition to stocked trout, there are resident populations of wild brown trout that provide additional fishing opportunities for anglers. Benthic macroinvertebrates are surveyed for use as an indicator for habitat and water quality. The data will be maintained in a database to observe changes in the benthic community over time and to detect any loss in habitat quality.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed in the Put–and-Take management area of Little Falls at Dairy Road.

Results

There were 456 specimens identified to 35 taxa in the benthic macroinvertebrate sample collected at Dairy Road (Table 1). There were 369 specimens and 21 taxa identified to Ephemeroptera, Plecoptera, or Trichoptera. Comparison of EPT specimens to specimens identified to the Chironomidae (EPT/C) yielded an index of 11.18. Analyses of functional feeding groups provided a scraper filterer ratio of 0.23 and a proportion of scrapers (CPOM) of 0.01. The Shannon Weaver Diversity value for the sample was calculated to 4.07, while the equitability was 0.69. The Hilsenhoff Biotic Index (HBI) score for the sample was 4.38. The Maryland Biological Stream Survey (MBSS) IBI score was 4.33 and was rated “good”.

Discussion

The benthic macroinvertebrate survey for Little Falls indicated that the habitat and water quality are in good condition. Taxa richness was high with 35 unique taxa represented,

including 21 EPT taxa. This suggests that the benthic community was relatively undisturbed. The EPT/C index supported this, with EPT taxa substantially out representing the Chironomidae.

The results of functional feeding group analyses were mixed. The scraper filterer ratio was low, suggesting that filterers were more dominant in the sample. Filterers tend to be more prevalent in nutrient enriched streams where filamentous algae thrives, while scrapers tend play a greater role in stream communities that receive less nutrient enrichment and unicellular algae tends to be abundant. The CPOM was also very low with shedders, consumers of coarse particulate organic matter, underrepresented in the sample.

According to the Shannon Weaver Diversity and equitability calculation, the benthic community in Little Falls was highly diverse with a relatively even distribution of representation among the taxa. The diversity score was indicative of a community that is relatively undisturbed by habitat degradation. The equitability score was also high, with none of the taxa being over represented in the sample. The dominant family in the community was Isonychiidae, which accounted for only 18% of the sample.

The HBI and MBSS IBI scores indicated a benthic community in good condition. The HBI score was 4.38, which suggests a high representation of taxa that tend to be intolerant of organic pollution. This implies that the community is healthy and is influenced by a relatively low level of organic pollution. The MBSS IBI supported this, with the sample receiving a rating of "good".

The benthic macroinvertebrate community in Little Falls appeared to be in good condition and indicated little habitat degradation and good water quality. While the functional feeding group analyses suggest that there may be some influence of nutrient enrichment in the community, all other tests performed supported the idea that the stream community is in good condition. Future monitoring should be considered to observe any changes in the community and to determine the functional feeding group results are consistent.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Little Falls at Dairy Road on June 9, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	52	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	12	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	2	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	26	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	6	2.8	Collector	Cn
Ephemeroptera	*Epeorus*	2	1.7	Scraper	Cn
Ephemeroptera	*Leucrocuta*	13	1.8	Scraper	Cn
Ephemeroptera	*Stenonema*	25	4.6	Scraper	Cn
Ephemeroptera	*Isonychia*	83	2.5	Filterer	sw, cn
Plecoptera	*Leuctra*	3	0.4	Shredder	Cn
Plecoptera	*Acroneuria*	4	2.5	Predator	Cn
Plecoptera	*Phasganophora*	42	2.2	Predator	Cn
Trichoptera	*Glossosoma*	1	0	Scraper	Cn
Trichoptera	*Cheumatopsyche*	24	6.5	Filterer	Cn
Trichoptera	*Hydropsyche*	49	7.5	Filterer	Cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	Cn
Trichoptera	Unid. Limnephilidae	1	3.4	Shredder	cb, sp, cn
Trichoptera	*Chimarra*	12	4.4	Filterer	cn
Trichoptera	*Dolophilodes*	3	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	2	2.6	Filterer	cn
Trichoptera	*Rhyacophila*	5	2.1	Predator	cn
Coleoptera	*Oulimnius*	1	2.7	Scraper	Cn
Coleoptera	Unid. Elmidae	1	4.8	Collector	Cn
Coleoptera	*Psephenus*	3	4.4	Scraper	cn
Diptera	*Bezzia*	1	3.3	Predator	Bu
Diptera	SF Orthocladiinae	15	7.6	Collector	
Diptera	TR Chironomini	15	5.9		
Diptera	TR Tanytarsini	1	3.5	Collector	
Diptera	Unid. Chironomidae	2	6.6		
Diptera	*Simulium*	32	5.7	Filterer	Cn
Diptera	*Antocha*	3	8	Collector	Cn
Arachnoidea	Hydracarina	3	6	Predator	Sw
Hemiptera	*Rhagovelia*	2	6	Predator	Skater
Hoplonemertea	*Prostoma*	3	7.3	Predator	
Unid. Oligochaeta		5	10	Collector	bu
		S = 35 N = 456			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 35	Number of Taxa = 35 (5)
EPT = # 369 Taxa 21	Number of EPT Taxa = 21 (5)
EPT/C = 11.18	Number of Ephemeroptera Taxa = 9 (5)
Dominant Family = Isonychiidae, 18.20%	% Intolerant Urban = 42.32% (3)
Scraper Filterer Ratio = 0.23	% Chironomidae = 7.24% (3)
CPOM = 0.01	% Clingers = 89.69% (5)
Diversity = 4.07	IBI = 4.33 Good
Equitability = 0.69	
HBI = 4.38	

Patuxent River, Brighton Dam Tailwater
(Montgomery and Howard Counties)

Introduction

The Patuxent River tailwater stretches from Brighton Dam to Mink Hollow Road on the border of Montgomery County and Howard County. The tailwater is stocked with rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), and is managed under Catch-and-Return, artificial fly only fishing regulations. Additional recreational opportunities include largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*). Benthic macroinvertebrates were surveyed in the tailwater for use as an indicator for habitat degradation and water quality. The data will be used to assist biologists in making management decisions for the Catch-and-Return section. The data will also be maintained in a database to monitor changes in the benthic community over time.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at two stations in the Catch-and-Return management area in the Brighton Dam tailwater. The stations included an upstream site in the tailwater of Brighton Dam that was sampled on May 28, 2015, and a downstream site at Haviland Mill Road that was sampled on May 21, 2015.

Results

There were 398 specimens identified to 10 taxa collected in the Brighton Dam tailwater sample (Table 1). Only two specimens and one taxon belonged to the Ephemeroptera, Plecoptera, or Trichoptera (EPT). The ratio of EPT specimens to individuals identified to the Chironomidae was 0.03 (EPT/C). The functional feeding group analyses yielded 0.01 for the scraper filterer ratio and 0.00 for the proportion of shredders in the sample (CPOM). The Shannon Weaver Diversity calculation for the sample was 1.98 with an equitability of 0.50. The sample received a Hilsenhoff Biotic Index (HBI) score of 6.98. The Maryland Biological Stream Survey IBI score was 1.67 with a rating of "very poor".

The Haviland Mill Road sample contained 125 specimens identified to 15 taxa (Table 2). There were 42 individuals identified to 3 EPT taxa. The EPT/C index was 0.84.

Examination of filter feeding groups produced 0.06 for the scraper filterer ratio and 0.01 for the CPOM. The diversity value was 2.91 with an equitability value of 0.73. The HBI score was 6.86 and the MBSS IBI score was 2.33. The MBSS IBI score was rated "poor".

Discussion

The benthic community in the Catch-and-Return section of the Brighton Dam tailwater appears to subsist in a stressed condition. Taxa richness was poor at both locations, suggesting moderate to severe impacts due to habitat degradation. The lack of EPT taxa and the disproportionate occurrence of the Chironomidae relative to EPT specimens supported the idea that these stations suffer from substantial habitat degradation.

The analyses of filter feeding groups also suggested severe problems in the Catch-and-Return area. Both scraper and shredder feeding groups were virtually absent at both sample stations. Filterers were more prevalent, suggesting that filamentous algae were readily available as a food source. Filter feeders tend to dominant in nutrient enriched systems that have a high abundance of filamentous algae.

The diversity and equitability values for the samples suggested moderate impacts from habitat degradation and poor water quality. Diversity and equitability were lowest in the tailwater sample, where filter feeding specimens identified to the Simuliidae accounted for 50% of all individuals collected. Diversity and equitability improved downstream at Haviland Mill Road, though the diversity value in particular still showed signs of moderate stress on the community.

HBI scores were higher than 6.50 for both samples, indicating that taxa that are tolerant of organic pollution were dominant in the samples. This suggested that the community is under significant pressure from organic pollutants. The MBSS IBI scores supported this with both stations receiving poor or very poor ratings.

The results of benthic macroinvertebrate sampling in the Catch-and-Release section of the Brighton Dam tailwater suggested that there is moderate to severe habitat degradation, most likely due to organic pollution. While there was some improvement at the Haviland Mill station, the benthic community appeared to be under a considerable amount of stress and was dominated by pollution tolerant taxa at both locations. Future monitoring should be focused on observing if the poor habitat and water quality conditions are consistent before moving forward with management efforts.

Table 1. Data and results for the benthic macroinvertebrate sample collected from the Brighton Dam tailwater on May 28, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Trichoptera	*Hydropsyche*	2	7.5	Filterer	cn
Coleoptera	*Stenelmis*	2	7.1	Scraper	cn
Diptera	SF Orthocladiinae	23	7.6	Collector	
Diptera	TR Chironomini	36	5.9		
Diptera	Unid. Chironomidae	10	6.6		
Diptera	*Simulium*	199	5.7	Filterer	cn
Amphipoda	*Gammarus*	1	6.7	Shredder	sp
Tricladida	*Dugesia*	113	9.3	Predator	sp
Unid. Oligochaeta		8	10	Collector	bu
Veneroida	*Corbicula*	4	6	Filterer	bu
		S = 10 N = 398			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 10	Number of Taxa = 10 (1)
EPT = # 2 Taxa 1	Number of EPT Taxa = 1 (1)
EPT/C = 0.03	Number of Ephemeroptera Taxa = 0 (1)
Dominant Family = Simuliidae, 50.00%	% Intolerant Urban = 0% (1)
Scraper Filterer Ratio = 0.01	% Chironomidae = 17.33% (3)
CPOM = 0.00	% Clingers = 51.01% (3)
Diversity = 1.98	IBI = 1.67 Very Poor
Equitability = 0.50	
HBI = 6.98	

Table 2. Data and results for the benthic macroinvertebrate sample collected from the Patuxent River at Haviland Mill Road on May 21, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Trichoptera	*Diplectrona*	1	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	35	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	6	5.7	Filterer	cn
Coleoptera	*Ancyronyx*	1	7.8	Scraper	cn, sp
Coleoptera	*Stenelmis*	2	7.1	Scraper	cn
Diptera	SF Orthocladiinae	23	7.6	Collector	
Diptera	TR Chironomini	23	5.9		
Diptera	TR Tanytarsini	1	3.5	Collector	
Diptera	Unid. Chironomidae	3	6.6		
Diptera	*Hemerodromia*	1	7.9	Predator	sp, bu
Diptera	Unid. Empididae	18	7.5	Predator	sp, bu
Diptera	*Simulium*	7	5.7	Filterer	cn
Megaloptera	*Nigronia*	2	1.4	Predator	cn, cb
Amphipoda	*Gammarus*	1	6.7	Shredder	sp
Unid. Oligochaeta		1	10	Collector	bu
		S = 15 N = 125			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 15	Number of Taxa = 15 (3)
EPT = # 42 Taxa 3	Number of EPT Taxa = 3 (3)
EPT/C = 0.84	Number of Ephemeroptera Taxa = 0 (1)
Dominant Family = Chironomidae, 40.00%	% Intolerant Urban = 2.40% (1)
Scraper Filterer Ratio = 0.06	% Chironomidae = 40.00% (3)
CPOM = 0.01	% Clingers = 43.20% (3)
Diversity = 2.91	IBI = 2.33 Poor
Equitability = 0.73	
HBI = 6.86	

Patuxent River Catch-and-Return Area
(Howard and Montgomery Counties)

Introduction

The Patuxent River is managed as a Catch-and-Return (C&R) trout stream from Route 27 downstream to Route 97, a distance of approximately 17.7 kilometers. The entire length of river forms the dividing line between Howard and Montgomery Counties. From 1 January 1974 until 31 December 1982, one trout over fifteen inches (381 mm) could be harvested a day and bait was permitted. As of 1 January 1983, the regulations were changed to the present management of C&R, lures and/or flies permitted. No bait is permitted within the C&R section. Fisheries activities conducted in the Patuxent River C&R Area from January through June 2015 included the stocking of adult brown and rainbow trout and a brown trout swim-up fry count above Mullinix Mill Road.

Objectives

The objectives of the fisheries activities in the Patuxent River in 2015 were to:

- Monitor the population characteristics of wild brown trout to evaluate management strategies aimed at maximizing recreational fishing opportunities.
- Monitor habitat and environmental conditions affecting the trout population dynamics in the Patuxent River for the purpose of preventing or reducing environmental degradation and documenting any improvement in environmental quality.
- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology follows that described in the Study III Job 1 Method section. Only variations from the methodology are described here.

Swim-up Fry Survey
Brown trout fry counts are conducted in April in the Patuxent River above Mullinix Mill Road within the 189.7 meter electrofishing station. Swim-up brown trout fry counts are conducted by walking along the stream or wading up through the stream and counting the identifiable fry. The number of observed brown trout fry is recorded to determine the success of the annual hatch.

Benthic macroinvertebrates
Benthic macroinvertebrates were surveyed at two stations in the C&R area of the Patuxent River on May 21, 2015. The stations include an upstream site at Mullinix Mill Road and a downstream site at Hipsley Mill Road.

Results

Stocking
Trout stocking activities in 2015 consisted of stocking 900 adult brown trout from the Cushwas State Trout Hatchery and 1,000 rainbow trout adults from the Albert Powell State Trout Hatchery in Hagerstown, MD. The trout were float stocked from above Annapolis Rock Road downstream to Howard Chapel Road with the assistance of the Potomac-Patuxent Chapter of Trout Unlimited. Adult hatchery trout are stocked from approximately 90 meters above Annapolis Rock Road downstream to approximately 90 meters below Howard Chapel Road to provide trout fishing opportunities to anglers where wild trout numbers are too low to provide a fishable population. No adult trout are stocked above Mullinix Mill Road due to the presence of a self-sustaining wild brown trout population.

Swim-up Fry Survey
Central Region staff conducted a swim-up brown trout fry survey in the Patuxent River above Mullinix Mill Road on April 30, 2015. Sixty-five brown trout fry were observed within the 189.7 meter electrofishing station indicating a good hatch. Fry counts are conducted to determine if there is a successful hatch of brown trout in the spring.

Benthic macroinvertebrates
The Mullinix Mill Road sample contained 370 specimens that were identified to 40 taxa (Table 1). There were 302 individuals representing 19 taxa identified to the orders Ephemeroptera, Plecoptera, or Trichoptera (EPT). The ratio of EPT specimens to specimens from the Chironomidae (EPT/C) was 12.08. Analyses of functional feeding groups produced a scraper filterer ratio of 0.56 and a proportion of shredders (CPOM) of 0.11. The Shannon Weaver Diversity value was 4.08 and the equitability value was 0.63. Maryland Biological Stream Survey (MBSS) tolerance values were used to generate a Hilsenhoff Biotic Index (HBI) score of 3.64. The MBSS IBI score was 4.33 and was rated as "good".

The Hipsley Mill Road sample contained 293 specimens that were identified to 39 unique taxa (Table 2). There were 193 EPT specimens belong to 17 different taxa. The EPT/C was 4.49. The analyses of functional feeding groups resulted in a scraper filterer ratio of 0.18 and a CPOM of 0.02. The sample diversity was 4.16 with an equitability of 0.67. The sample received an HBI score of 5.44 and a MBSS IBI score of 4.33. The MBSS IBI score was rated as "good".

Discussion

The data collected from benthic macroinvertebrate sampling in the C&R area of the Patuxent River suggests that the stream is in good condition but may be subject to some habitat degradation. Taxa richness at both stations was very high and indicative of an undisturbed stream. This is further supported by the high richness of EPT taxa and

substantially more EPT individuals when compared to individuals from the Chironomidae.

Examination of functional feeding groups revealed some possible habitat degradation. While the scraper filterer ratio and CPOM were fairly good at the Mullinix Mill Road station, they were much lower at the Hipsley Mill Road station. A decreasing downstream trend is expected as nutrient enrichment generally increases downstream. These results suggest that the benthic community at the Hipsley Mill station may be impacted by nutrient enrichment.

The Shannon Weaver Diversity calculation produced high diversity values at both stations. The scores suggested that the benthic community was not impacted by habitat degradation at either location. The equitability values supported this and are indicative of undisturbed communities as well.

The HBI score for the Mullinix Mill Road station indicated a community in very good condition and relatively undisturbed by habitat degradation. The MBSS IBI score and rating supported this conclusion. The HBI score decreased to 5.44 at the Hipsley Mill Road station, suggesting a slight increase in habitat degradation and disturbance to the benthic community. However, the MBSS score was the same as the Mullinix Mill station and was rated as "good". While there may be some habitat degradation, the benthic community does not appear to show significant signs of stress.

According to the results of the benthic macroinvertebrate survey, the C&R area of the Patuxent River appears to be in good condition. The habitat and water quality are particularly undisturbed upstream. While there does appear to be some habitat degradation and a decrease in water quality downstream, the benthic community data indicates that the impacts are relatively minor and the stream is healthy.

Table 1. Data and results for the benthic macroinvertebrate sample collected from the Patuxent River at Mullinix Mill Road on May 21, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	Acentrella	21	4.9	Collector	sw, cn
Ephemeroptera	Baetis	107	3.9	Collector	sw, cb, cn
Ephemeroptera	Drunella	4	1.9	Scraper	cn, sp
Ephemeroptera	Ephemerella	24	2.3	Collector	cn, sw
Ephemeroptera	Leucrocuta	6	1.8	Scraper	cn
Ephemeroptera	Stenonema	6	4.6	Scraper	cn
Ephemeroptera	Paraleptophlebia	9	2	Collector	sw, cn, sp
Plecoptera	Leuctra	27	0.4	Shredder	cn
Plecoptera	Amphinemura	9	3	Shredder	sp, cn
Plecoptera	Acroneuria	13	2.5	Predator	cn
Plecoptera	Phasganophora	25	2.2	Predator	cn
Trichoptera	Cheumatopsyche	8	6.5	Filterer	cn
Trichoptera	Hydropsyche	6	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	cn
Trichoptera	Lepidostoma	1	0	Shredder	cb, sp, cn
Trichoptera	Dolophilodes	30	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	1	2.6	Filterer	cn
Trichoptera	Polycentropus	2	1.1	Filterer	cn
Trichoptera	Unid. Polycetropodidae	1	0.2		
Coleoptera	Optioservus	1	5.4	Scraper	cn
Coleoptera	Oulimnius	4	2.7	Scraper	cn
Coleoptera	Stenelmis	1	7.1	Scraper	cn
Coleoptera	Psephenus	6	4.4	Scraper	cn
Diptera	Bezzia	1	3.3	Predator	bu
Diptera	SF Orthocladiinae	11	7.6	Collector	
Diptera	SF Tanypodinae	4	7.5	Predator	
Diptera	TR Chironomini	6	5.9		
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	Clinocera	2	7.4	Predator	cn
Diptera	Unid. Empididae	2	7.5	Predator	sp, bu
Diptera	Simulium	1	5.7	Filterer	cn
Diptera	Antocha	5	8	Collector	cn
Diptera	Hexatoma	5	1.5	Predator	bu, sp
Diptera	Tipula	3	6.7	Shredder	bu
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Megaloptera	Nigronia	1	1.4	Predator	cn, cb
Odonata	Gomphus	1	2.2	Predator	bu
Arachnoidea	Hydracarina	1	6	Predator	sw
Unid. Oligochaeta			8	10	Collector
		S = 40 N = 370			

Fisheries Data	MBSS Data – Piedmont
Richness = 40	Number of Taxa = 40 (5)
EPT = # 302 Taxa 19	Number of EPT Taxa = 19 (5)
EPT/C = 12.08	Number of Ephemeroptera Taxa = 7 (5)
Dominant Family = Baetidae, 34.59%	% Intolerant Urban = 44.05% (3)
Scraper Filterer Ratio = 0.56	% Chironomidae = 6.76% (3)
CPOM = 0.11	% Clingers = 87.03% (5)
Diversity = 4.08	IBI = 4.33 Good
Equitability = 0.63	
HBI = 3.64	

Table 2. Data and results for the benthic macroinvertebrate sample collected from the Patuxent River at Hipsley Mill Road on May 21, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	Acentrella	16	4.9	Collector	sw, cn
Ephemeroptera	Baetis	40	3.9	Collector	sw, cb, cn
Ephemeroptera	Drunella	2	1.9	Scraper	cn, sp
Ephemeroptera	Ephemerella	11	2.3	Collector	cn, sw
Ephemeroptera	Serratella	1	2.8	Collector	cn
Ephemeroptera	Stenonema	6	4.6	Scraper	cn
Ephemeroptera	Isonychia	1	2.5	Filterer	sw, cn
Ephemeroptera	Paraleptophlebia	2	2	Collector	sw, cn, sp
Plecoptera	Leuctra	3	0.4	Shredder	cn
Plecoptera	Acroneuria	2	2.5	Predator	cn
Plecoptera	Phasganophora	4	2.2	Predator	cn
Plecoptera	Isoperla	1	2.4	Predator	cn, sp
Trichoptera	Glossosoma	1	0	Scraper	cn
Trichoptera	Cheumatopsyche	55	6.5	Filterer	cn
Trichoptera	Hydropsyche	22	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	5	5.7	Filterer	cn
Trichoptera	Dolophilodes	21	1.7	Filterer	cn
Coleoptera	Helichus	1	6.4	Scraper	cn
Coleoptera	Optioservus	3	5.4	Scraper	cn
Coleoptera	Oulimnius	3	2.7	Scraper	cn
Coleoptera	Stenelmis	2	7.1	Scraper	cn
Coleoptera	Psephenus	1	4.4	Scraper	cn
Diptera	SF Orthocladiinae	24	7.6	Collector	
Diptera	SF Tanypodinae	4	7.5	Predator	
Diptera	TR Chironomini	5	5.9		
Diptera	TR Tanytarsini	2	3.5	Collector	
Diptera	Unid. Chironomidae	8	6.6		
Diptera	Unid. Empididae	3	7.5	Predator	sp, bu
Diptera	Simulium	1	5.7	Filterer	cn
Diptera	Antocha	25	8	Collector	cn
Diptera	Dicranota	1	1.1	Predator	sp, bu
Diptera	Erioptera	1	4.8	Collector	bu
Diptera	Tipula	2	6.7	Shredder	bu
Diptera	Unid. Tipulidae	5	4.8	Predator	bu, sp
Megaloptera	Corydalus	1	1.4	Predator	cn, cb
Odonata	Gomphus	1	2.2	Predator	bu
Amphipoda	Gammarus	1	6.7	Shredder	sp
Arachnoidea	Hydracarina	1	6	Predator	sw
Unid. Oligochaeta		5	10	Collector	bu
		S = 39 N = 293			

Fisheries Data	MBSS Data – Piedmont
Richness = 39	Number of Taxa = 39 (5)
EPT = # 193 Taxa 17	Number of EPT Taxa = 17 (5)
EPT/C = 4.49	Number of Ephemeroptera Taxa = 8 (5)
Dominant Family = Hydropsychidae, 27.99%	% Intolerant Urban = 18.77% (3)
Scraper Filterer Ratio = 0.18	% Chironomidae = 14.68% (3)
CPOM = 0.02	% Clingers = 78.50%(5)
Diversity = 4.16	IBI = 4.33 Good
Equitability = 0.67	
HBI = 5.44	

Paint Branch
(Montgomery County)

Introduction

Paint Branch was the first stream in the State of Maryland to be managed as a Special Wild Trout Management Area on January 1, 1980. The use of bait was prohibited and only single hook flies and lures were permitted. All trout caught were to be returned to the water. The area subject to this provision included the mainstem and all tributaries above Fairland Road. On January 1, 1989, regulations were changed statewide to allow multiple hooked lures and flies in all Catch-and-Return trout waters to include the Paint Branch from Fairland Road upstream. The Catch-and-Return management strategy is aimed at providing maximum protection to Maryland's longest surviving urban brown trout population. The fisheries activities conducted in the Good Hope tributary to Paint Branch from January through June 2015 included swim-up fry counts and water temperature monitoring.

Objectives

The objectives of the fisheries activities were to:

- Monitor the distribution and population characteristics of brown trout in the Paint Branch.
- Monitor habitat and environmental conditions affecting the brown trout population dynamics in the Paint Branch for the purpose of preventing or reducing environmental degradation and documenting any improvement in environmental quality.

Methods

Methodology followed that described in the Study III Methods section. Only variations from that methodology are described here.

Swim-up Fry Survey
Brown trout fry counts are conducted in March and/or April in the Good Hope tributary to Paint Branch from the confluence of the Paint Branch upstream to the Montgomery County Highway Depot tributary, a distance of 1.45 kilometers. Swim-up brown trout fry counts are conducted by walking along the stream or wading up through the stream and counting the identifiable fry. The number of observed brown trout fry is recorded to determine the success of the annual hatch.

Water Temperature Monitoring
An Onset WaterTemp Pro logger monitors water temperatures. The logger is wired under a stream bank and covered with boulders to prevent loss due to a potential high stream flow event. Stream temperatures (°C) are recorded every twenty minutes. Temperature data will be downloaded and graphed using the HOBOware software package.

Results and Discussion

Swim-up fry survey
Central Region staff conducted a swim-up brown trout fry survey in the Good Hope tributary on April 6 and April 27, 2015. No fry were found throughout the 1.45 kilometers of observed stream on April 6. On April 27, five brown trout fry were observed within the 1.45 kilometer site. Fry counts are conducted to determine if there is a successful hatch of brown trout in the spring.

Water Temperature Monitoring
A single Onset WaterTemp Pro logger was deployed in the Hobbs Drive electrofishing station in the Good Hope tributary on May 27. Water temperatures in the Good Hope tributary are being recorded every 20 minutes and will be analyzed after removal in the fall, 2015.

Little Seneca Creek
(Montgomery County)

Introduction

Little Seneca Creek is located in the tailwater of Little Seneca Lake in Montgomery County, MD. The creek flows about 6.5 miles southwest to the Seneca Creek. While the creek has not been stocked in recent years, there are small populations of wild brown trout (*Salmo trutta*) and wild rainbow trout (*Oncorhynchus mykiss*) in the mainstem. Benthic macroinvertebrates were sampled to determine habitat and water quality conditions in the creek. The data will be used to assist biologists in making management decisions about the Little Seneca Creek fishery. The data will also be maintained in a database for use in monitoring changes in habitat and water quality.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at two stations along Little Seneca Creek on May 12, 2015. The stations included an upstream site at Clopper Road and a downstream site at Hoyles Mill Road.

Results

The sample collected at Clopper Road contained 225 specimens identified to 21 unique taxa (Table 1). There were 5 Ephemeroptera, Plecoptera, or Trichoptera (EPT) taxa present, represented by 54 specimens. The EPT to Chironomidae index (EPT/C) was 1.02. Analyses of functional feeding groups yielded results of 0.09 for the scraper filterer ratio and 0.36 for the proportion of shredders, or processors of coarse particulate organic matter (CPOM). The sample received a Shannon Weaver Diversity value of 3.20 and an equitability of 0.62. The Hilsenhoff Biotic Index (HBI) generated a score of 6.25 for the sample. The Maryland Biological Stream Survey (MBSS) IBI produced a score of 2.00 with a rating of "poor".

The Hoyles Mill Road sample contained 218 specimens representing 24 taxa (Table 2). There were 91 individuals belonging to the EPT, with 8 taxa present. The EPT/C index was 1.52. The results of the analysis of functional feeding groups provided 0.03 for the scraper filterer ratio and 0.10 for the CPOM. The diversity value was 3.79 with an

equitability of 0.83. The sample received a HBI score of 6.31 and a MBSS IBI score of 2.75. The MBSS IBI rated the sample as "poor".

Discussion

Benthic macroinvertebrate samples collected from Little Seneca Creek indicated that the stream has substantial degradation to habitat and water quality. Despite this, taxa richness at the stations sampled were fairly high and suggested that this particular factor was only slightly impacted by the degradation. The EPT indices were not quite as high. While the EPT richness at the Hoyles Mill station suggested only slight degradation, the EPT richness at Clopper Road was much lower and may indicate a more degraded condition. Both stations had EPT/C scores that suggested slight to moderate degradation.

The analyses of functional feeding groups produced mixed results. Scraper filterer ratios were low at both stations, with filterers much more dominant than scrapers. Filterers tend to be more prevalent when filamentous algae are abundant. This is usually the case in nutrient enriched streams. Shredders, or consumers of coarse particulate organic matter, appeared to play a significant role in the benthic community at both stations. CPOM proportion tends to be higher is streams that receive more leaf litter, frequently in the forested headwaters of streams. The higher CPOM proportions at the stations are influenced by an abundance of *Gammarus*, particularly at Clopper Road. *Gammarus* accounted for 34% of the specimens at that site.

Diversity and equitability appeared to show no degradation at either station. Both communities have the diversity expected in a healthy benthic community and the representation of taxa was relatively even. Most of the analyses performed on the samples are indicators for the tolerance of the community to organic pollution. Diversity and equitability are unique to the other tests performed in that they are measures only for balance in the community. The fact that diversity and equitability were undisturbed while the other tests reveal moderate levels of degradation may imply that the cause of habitat degradation at Little Seneca Creek is organic pollution.

This is further supported by the HBI and the MBSS IBI. The HBI scores for both stations were similar and indicated a benthic community that is likely under moderate stress due to organic pollution. There was a high representation of pollution tolerant taxa within the samples. The MBSS IBI scores support this, with both stations received a poor rating.

The results generated from benthic community samples collected from Little Seneca Creek suggested that the stream is moderately degraded from organic pollution. While the benthic community remains diverse, many of the taxa that are present are tolerant to organic pollution and other stressors that cause habitat degradation. Continuing monitoring may determine if the current condition is persistent or if the habitat is in decline.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Little Seneca Creek at Clopper Road on May 12, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	24	2.3	Collector	cn, sw
Trichoptera	*Micrasema*	1	2.3	Shredder	cn, sp
Trichoptera	*Cheumatopsyche*	14	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	12	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	3	5.7	Filterer	cn
Tricladida	*Cura*	2	6.5		sp
Coleoptera	*Stenelmis*	1	7.1	Scraper	cn
Diptera	SF Orthocladiinae	38	7.6	Collector	
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	Unid. Chironomidae	12	6.6		
Diptera	*Chelifera*	1	7.1	Predator	sp, bu
Diptera	Unid. Empididae	9	7.5	Predator	sp, bu
Diptera	*Simulium*	5	5.7	Filterer	cn
Diptera	*Antocha*	4	8	Collector	cn
Diptera	*Tipula*	1	6.7	Shredder	bu
Lepidoptera	*Crambus*	1	5		
Megaloptera	*Nigronia*	4	1.4	Predator	cn, cb
Amphipoda	*Gammarus*	78	6.7	Shredder	sp
Arachnoidea	Hydracarina	9	6	Predator	sw
Basommatophora	*Physella*	2	7	Scraper	cb
Unid. Oligochaeta		1	10	Collector	bu
		S = 21 N = 225			

Fisheries Data	**MBSS Data – Highlands**
Richness = 21	Number of Taxa = 21 (3)
EPT = # 54 Taxa 5	Number of EPT Taxa = 5 (1)
EPT/C = 1.02	Number of Ephemeroptera Taxa = 1 (1)
Dominant Family = Gammaridae, 34.67%	% Intolerant Urban = 12.89% (1)
Scraper Filterer Ratio = 0.09	% Tanytarsini = 1.33% (3)
CPOM = 0.36	% Scrapers = 1.33% (1)
Diversity = 3.20	% Swimmers = 14.67% (3)
Equitability = 0.62	% Diptera = 32.44% (3)
HBI = 6.25	IBI = 2.00

Table 2. Data and results for the benthic macroinvertebrate sample collected from Little Seneca Creek at Hoyles Mill Road on May 12, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Ephemerella*	10	2.3	Collector	cn, sw
Plecoptera	*Amphinemura*	5	3	Shredder	sp, cn
Trichoptera	*Micrasema*	1	2.3	Shredder	cn, sp
Trichoptera	*Cheumatopsyche*	15	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	45	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	13	5.7	Filterer	cn
Trichoptera	*Chimarra*	1	4.4	Filterer	cn
Trichoptera	Unid. Philopotamidae	1	2.6	Filterer	cn
Coleoptera	*Oulimnius*	2	2.7	Scraper	cn
Diptera	SF Orthocladiinae	41	7.6	Collector	
Diptera	TR Tanytarsini	12	3.5	Collector	
Diptera	Unid. Chironomidae	7	6.6		
Diptera	Unid. Empididae	3	7.5	Predator	sp, bu
Diptera	*Simulium*	3	5.7	Filterer	cn
Diptera	*Antocha*	13	8	Collector	cn
Diptera	*Pseudolimnophila*	1	2.8	Predator	bu
Diptera	*Tipula*	1	6.7	Shredder	bu
Diptera	Unid. Tipulidae	3	4.8	Predator	bu, sp
Megaloptera	*Nigronia*	4	1.4	Predator	cn, cb
Amphipoda	*Gammarus*	15	6.7	Shredder	sp
Arachnoidea	Hydracarina	8	6	Predator	sw
Isopoda	*Caecidotea*	4	2.6	Collector	sp
Tricladida	*Cura*	5	6.5		sp
Unid. Oligochaeta		5	10	Collector	bu
		S = 24 N = 218			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 24	Number of Taxa = 24 (5)
EPT = # 91 Taxa 8	Number of EPT Taxa = 8 (3)
EPT/C = 1.52	Number of Ephemeroptera Taxa = 1 (1)
Dominant Family = Hydropsychidae, 33.49%	% Intolerant Urban = 12.84% (1)
Scraper Filterer Ratio = 0.03	% Tanytarsini = 5.50% (5)
CPOM = 0.10	% Scrapers = 0.92% (1)
Diversity = 3.79	% Swimmers = 8.26% (3)
Equitability = 0.83	% Diptera = 38.53% (3)
HBI = 6.31	IBI = 2.75

Deer Creek
(Harford County)

Introduction

The Put–and-Take area of Deer Creek stretches from Maryland Route 23 to 1 mile south of Rocks State Park in Harford County. The area is stocked annually with rainbow trout (*Oncorhynchus mykiss*) and is a popular destination for recreational fishing. While the habitat in Deer Creek is suitable for a stocking program, conditions become too warm during summer months to sustain a reproducing trout population. Maryland Department of the Environment has designated Deer Creek as a Class III nontidal cold water stream above the confluence with Falling Branch, however, the creek is designated as Class IV below Falling Branch. Benthic macroinvertebrate sampling was performed to assess the habitat health of Deer Creek and will be used by fisheries biologists as management strategies are considered.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at two stations in the Put–and-Take management area of Deer Creek. The stations included an upstream site below Eden Mill Dam and a downstream site at Rocks State Park.

Results

The benthic macroinvertebrate sample collected downstream of Eden Mill Dam contained 569 specimens identified to 37 unique taxa (Table 1). There were 18 taxa and 653 specimens identified to the orders Ephemeroptera, Plecoptera, or Trichoptera (EPT). The EPT specimens were compared to individuals identified to the Chironomidae (EPT/C) to produce an index of 19.48. Examination of functional feeding groups produced a scraper filterer ratio of 0.10 and a proportion of scrapers (CPOM) of 0.00. The Shannon Weaver Diversity value for the sample was 3.46 with an equitability value of 0.43. The sample received a Hilsenhoff Biotic Index (HBI) score of 5.40 and a Maryland Biological Stream Survey (MBSS) IBI score of 4.67. The MBSS IBI rating was “good”.

There were 653 specimens identified to 34 taxa counted in the sample collected from Rocks State Park (Table 2). There were 20 EPT taxa represented by 544 specimens identified in the sample. The EPT/C was 68.00. The scraper filterer ratio was 0.41 and the CPOM was 0.01. The diversity value for the sample was 3.91 and the equitability was 0.65. The sample received a HBI score of 4.69 and a MBSS IBI score of 4.67. The MBSS IBI rating was "good".

Discussion

Benthic macroinvertebrate sampling in thePut-and-Take section of Deer Creek indicated that habitat and water quality are in good condition. Both sample locations had taxa richness values of 34 or greater, suggesting that the richness of the community is not influenced by habitat degradation. The EPT taxa richness supported this, with 18 or more unique EPT taxa identified at both stations. The EPT/C index was high for both samples, indicating that the community is dominated by EPT taxa that are less tolerant of habitat degradation rather than more tolerant members of the Chironomidae.

The analysis of functional feeding groups revealed some imbalance within the benthic community. The scraper filterer ratios were low, particularly at the station below Eden Mill Dam. The dominant family in the Eden Mill Dam sample was the filter feeding Hydropsychidae. Filterers tend to be more dominant in streams with prolific filamentous algae, usually due to nutrient enrichment. The CPOM were negligible and suggested that scrapers, a feeding group that consumes coarse particulate organic matter, were virtually absent from the community.

The diversity and equitability for the samples were high and indicative of a benthic community that is undisturbed by habitat degradation. Both samples received diversity values higher than 3.40, which is expected in a relatively undisturbed community. The equitability value for the Rocks State Park sample was 0.65, suggesting that the composition of taxa was equally distributed and undisturbed. The equitability value in the Eden Mill Dam sample was 0.43 and suggested that there may be some disturbance at this location. The lower score indicated that the distribution of the collected specimens within the sample was less equitable and that some taxa were more dominant than others. The Hydropsychidae accounted for greater than 50% of all individuals sampled.

HBI scores for both stations supported the idea that the habitat and water quality of Deer Creek was in good condition. Both samples had HBI scores that indicated a benthic community that may have some elevated tolerance to organic pollutants, but is still well balanced. The MBSS IBI scores supported the HBI results and indicated a benthic community that is relatively undisturbed and in good condition.

While there may be some impact to habitat and water quality due to organic pollution, the Deer Creek benthic community appears to be in good condition and indicative of a healthy stream. Imbalance in the representation of functional feeding groups and in the

presence of pollution tolerant taxa provided evidence for possible organic pollution. However, the impacts of this pollution appear to be minor.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Deer Creek below Eden Mill Dam on June 23, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	12	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	18	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	8	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	33	2.8	Collector	cn
Ephemeroptera	*Stenonema*	6	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	67	2.5	Filterer	sw, cn
Ephemeroptera	*Tricorythodes*	11	4	Collector	sp, cn
Plecoptera	*Perlesta*	3	1.6	Predator	cn
Trichoptera	*Brachycentrus*	3	2.3	Filterer	cn
Trichoptera	*Micrasema*	1	2.3	Shredder	cn, sp
Trichoptera	*Cheumatopsyche*	171	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	126	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	3	5.7	Filterer	cn
Trichoptera	*Hydroptila*	2	6	Scraper	cn
Trichoptera	*Oecetis*	1	4.7	Predator	cn, sp, cb
Trichoptera	*Chimarra*	20	4.4	Filterer	cn
Trichoptera	*Dolophilodes*	1	1.7	Filterer	cn
Trichoptera	*Neureclipsis*	1	0.2	Filterer	cn
Coleoptera	*Optioservus*	14	5.4	Scraper	cn
Coleoptera	*Oulimnius*	4	2.7	Scraper	cn
Coleoptera	*Promoresia*	10	0	Scraper	cn
Coleoptera	*Stenelmis*	3	7.1	Scraper	cn
Coleoptera	*Dineutus*	3	4	Predator	sw, dv
Diptera	SF Orthocladiinae	5	7.6	Collector	
Diptera	TR Chironomini	3	5.9		
Diptera	TR Tanytarsini	16	3.5	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	*Hemerodromia*	1	7.9	Predator	sp, bu
Diptera	*Simulium*	5	5.7	Filterer	cn
Diptera	*Antocha*	4	8	Collector	cn
Diptera	Unid. Tipulidae	2	4.8	Predator	bu, sp
Odonata	*Boyeria*	1	6.3	Predator	cb sp
Odonata	*Gomphus*	1	2.2	Predator	bu
Arachnoidea	Hydracarina	2	6	Predator	sw
Hoplonemertea	*Prostoma*	2	7.3	Predator	
Tricladida	*Cura*	1	6.5		sp
Unid. Oligochaeta		4	10	Collector	bu
		S = 37 N = 569			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 37	Number of Taxa = 37 (5)
EPT = # 487 Taxa 18	Number of EPT Taxa = 18 (5)
EPT/C = 19.48	Number of Ephemeroptera Taxa = 7 (5)
Dominant Family = Hydropsychidae, 52.75%	% Intolerant Urban = 23.20% (3)
Scraper Filterer Ratio = 0.10	% Chironomidae = 4.39% (5)
CPOM = 0.00	% Clingers = 92.62% (5)
Diversity = 3.46	IBI = 4.67 Good
Equitability = 0.43	
HBI = 5.40	

Table 2. Data and results for the benthic macroinvertebrate sample collected from Deer Creek in Rocks State Park on June 23, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	34	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	108	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	28	2.3	Collector	cn, sw
Ephemeroptera	*Serratella*	51	2.8	Collector	cn
Ephemeroptera	*Leucrocuta*	1	1.8	Scraper	cn
Ephemeroptera	*Stenonema*	38	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	21	2.5	Filterer	sw, cn
Ephemeroptera	*Tricorythodes*	5	4	Collector	sp, cn
Plecoptera	*Acroneuria*	3	2.5	Predator	cn
Plecoptera	*Perlesta*	13	1.6	Predator	cn
Trichoptera	*Brachycentrus*	34	2.3	Filterer	cn
Trichoptera	*Goera*	1	3.4	Scraper	cn
Trichoptera	*Cheumatopsyche*	95	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	99	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	4	5.7	Filterer	cn
Trichoptera	*Lepidostoma*	4	0	Shredder	cb, sp, cn
Trichoptera	*Ceraclea*	2	4.1	Collector	sp, cb
Trichoptera	*Oecetis*	1	4.7	Predator	cn, sp, cb
Trichoptera	*Chimarra*	1	4.4	Filterer	cn
Trichoptera	*Neureclipsis*	1	0.2	Filterer	cn
Coleoptera	*Optioservus*	19	5.4	Scraper	cn
Coleoptera	*Oulimnius*	1	2.7	Scraper	cn
Coleoptera	*Promoresia*	32	0	Scraper	cn
Coleoptera	*Stenelmis*	8	7.1	Scraper	cn
Coleoptera	*Dineutus*	4	4	Predator	sw, dv
Coleoptera	*Psephenus*	6	4.4	Scraper	cn
Diptera	SF Orthocladiinae	4	7.6	Collector	
Diptera	TR Chironomini	1	5.9		
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	*Simulium*	1	5.7	Filterer	cn
Diptera	*Antocha*	14	8	Collector	cn
Arachnoidea	Hydracarina	1	6	Predator	sw
Hoplonemertea	*Prostoma*	6	7.3	Predator	
Unid. Oligochaeta		9	10	Collector	bu
		S = 34 N = 653			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 34	Number of Taxa = 34 (5)
EPT = # 544 Taxa 20	Number of EPT Taxa = 20 (5)
EPT/C = 68.00	Number of Ephemeroptera Taxa = 8 (5)
Dominant Family = Hydropsychidae, 30.32%	% Intolerant Urban = 28.94% (3)
Scraper Filterer Ratio = 0.41	% Chironomidae = 1.23% (5)
CPOM = 0.01	% Clingers = 95.41% (5)
Diversity = 3.91	IBI = 4.67 Good
Equitability = 0.65	
HBI = 4.69	

Morgan Run
(Carroll County)

Introduction

Morgan Run provides recreational fishing opportunities for fishermen in Carroll County, Maryland. It is managed as a Catch-and-Return trout stream, with the management area starting at Route 97 and stretching approximately 5.2 miles downstream to London Bridge Road. Artificial lures and flies are permitted, however the use of bait is strictly prohibited. The catch and return area is annually stocked with rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) to enhance the recreational fishing experience. Benthic macroinvertebrates are sampled in the Catch-and-Return area to monitor habitat and water quality and to provide habitat data for fisheries management planning and decision making.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at two stations in the Catch–and-Return management area of Morgan Run on May 28, 2015. The stations included an upstream site at Jim Bowers Road and a downstream site at Klees Mill Road.

Results

The sample collected from the station located at Jim Bowers Road contained 276 specimens identified to 37 taxa (Table 1). There were 124 specimens and 18 taxa belonging to the Ephemeroptera, Plecoptera, or Trichoptera (EPT). An index that evaluated the ratio of total EPT specimens against individuals identified to the Chironomidae (EPT/C) yielded a value of 1.25. Comparisons of functional feeding groups produced 0.32 for the scraper filterer ratio and 0.03 for the proportion of scrapers (CPOM). The Shannon Weiner Diversity value was 3.96 with an equitability of 0.62. The Hilsonhoff Biotic Index (HBI) for the sample was 5.06 and the Maryland Biological Stream Survey (MBSS) IBI was 4.00 with a "good" rating.

There were 464 specimens identified to 33 taxa in the Klees Mill Road sample. There were 16 total EPT taxa that included 183 specimens. The EPT/C index was 0.88. Analyses of functional feeding groups yielded a scraper filterer ratio of 0.11 and a CPOM

of 0.02. The diversity and equitability of the sample was 3.59 and 0.52, respectively. The sample received a HBI score of 5.46 and a MBSS IBI score of 4.00. The MBSS IBI was rated "good".

Discussion

The results of the benthic macroinvertebrate survey suggested that Morgan Run has a healthy community richness and diversity, but the community structure appeared to be slightly impacted by organic pollution. The taxa richness at both of the surveyed stations was 33 or higher, suggesting that richness was not affected by habitat degradation. The EPT taxa richness was also high for both stations and supported this conclusion. The EPT/C index at both stations was low, particularly at the Klees Mill Road site. This suggested that there may be a disproportionate representation of the Chironomidae at that station.

The analysis of functional feeding groups suggested some influence of nutrient enrichment at the sample sites. The scraper filterer ratios were fairly low, with filterers having a much higher representation in the samples. Filterers tend to thrive in streams that have an abundance of filamentous algae due to nutrient enrichment. CPOM values were also low, with shredders making up only a small proportion of the community. Shredders appear in higher proportions in the high quality forested headwaters of streams where coarse particulate organic matter is readily available for consumption.

The diversity and equitability scores for both stations were relatively high. Diversity and equitability at the Jim Bowers Road station were particularly high and indicated a community that is undisturbed by habitat degradation. While the diversity was lower at the Klees Mill station, it also indicated an undisturbed community. The equitability was also lower and suggested that there may be some inequity due to degradation. The Chironomidae was the dominant family, accounting for almost 45% of the specimens counted.

The HBI scores for both stations were considered to be good, but indicated that the community may be composed of slightly more tolerance taxa than expected in a stream with no organic pollution. This suggested that the benthic community may be under some slight stress due to organic pollution. However, the MBSS IBI scores were high and were reflective of a healthy benthic community.

The Catch-and-Return management area of Morgan Run appears to be in good condition. While it is likely that organic pollution has altered the benthic community structure, the resulting degradation appears to minor. Future sampling will determine if these conditions remain stable.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Morgan Run at Jim Bowers Road on May 28, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	23	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	4	3.9	Collector	sw, cb, cn
Ephemeroptera	*Baetisca*	1	4	Collector	sp
Ephemeroptera	*Drunella*	2	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	15	2.3	Collector	cn, sw
Ephemeroptera	*Leucrocuta*	2	1.8	Scraper	cn
Ephemeroptera	*Stenonema*	7	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	3	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Plecoptera	*Leuctra*	7	0.4	Shredder	cn
Plecoptera	*Acroneuria*	1	2.5	Predator	cn
Trichoptera	*Glossosoma*	4	0	Scraper	cn
Trichoptera	*Cheumatopsyche*	14	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	13	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	4	5.7	Filterer	cn
Trichoptera	*Dolophilodes*	21	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	1	2.6	Filterer	cn
Trichoptera	*Polycentropus*	1	1.1	Filterer	cn
Coleoptera	*Optioservus*	2	5.4	Scraper	cn
Coleoptera	*Oulimnius*	2	2.7	Scraper	cn
Coleoptera	*Dineutus*	1	4	Predator	sw, dv
Diptera	*Bezzia*	1	3.3	Predator	bu
Diptera	SF Orthocladiinae	15	7.6	Collector	
Diptera	SF Tanypodinae	4	7.5	Predator	
Diptera	TR Chironomini	76	5.9		
Diptera	TR Tanytarsini	2	3.5	Collector	
Diptera	Unid. Chironomidae	2	6.6		
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Simulium*	2	5.7	Filterer	cn
Diptera	*Antocha*	3	8	Collector	cn
Diptera	*Dicranota*	1	1.1	Predator	sp, bu
Diptera	*Tipula*	1	6.7	Shredder	bu
Diptera	Unid. Tipulidae	2	4.8	Predator	bu, sp
Megaloptera	*Nigronia*	2	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	30	6	Predator	sw
Tricladida	*Cura*	1	6.5		sp
Unid. Oligochaeta		4	10	Collector	bu
		S = 37 N = 276			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 37	Number of Taxa = 37 (5)
EPT = # 124 Taxa 18	Number of EPT Taxa = 18 (5)
EPT/C = 1.25	Number of Ephemeroptera Taxa = 9 (5)
Dominant Family = Chironomidae, 35.87%	% Intolerant Urban = 22.83% (3)
Scraper Filterer Ratio = 0.32	% Chironomidae = 35.87% (3)
CPOM = 0.03	% Clingers = 48.55% (3)
Diversity = 3.96	IBI = 4.00 Good
Equitability = 0.62	
HBI = 5.06	

Table 2. Data and results for the benthic macroinvertebrate sample collected from Morgan Run at Klees Mill Road on May 28, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	25	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	19	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	2	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	12	2.3	Collector	cn, sw
Ephemeroptera	*Stenonema*	6	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	6	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	1	2	Collector	sw, cn, sp
Plecoptera	*Leuctra*	6	0.4	Shredder	cn
Plecoptera	*Acroneuria*	9	2.5	Predator	cn
Plecoptera	*Phasganophora*	3	2.2	Predator	cn
Trichoptera	*Cheumatopsyche*	25	6.5	Filterer	cn
Trichoptera	*Diplectrona*	2	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	18	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Dolophilodes*	43	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	5	2.6	Filterer	cn
Coleoptera	*Optioservus*	1	5.4	Scraper	cn
Coleoptera	*Oulimnius*	1	2.7	Scraper	cn
Coleoptera	*Stenelmis*	2	7.1	Scraper	cn
Diptera	*Bezzia*	2	3.3	Predator	bu
Diptera	SF Orthocladiinae	29	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	169	5.9		
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	Unid. Chironomidae	5	6.6		
Diptera	*Simulium*	15	5.7	Filterer	cn
Diptera	*Antocha*	4	8	Collector	cn
Diptera	*Tipula*	1	6.7	Shredder	bu
Diptera	Unid. Tipulidae	2	4.8	Predator	bu, sp
Megaloptera	*Nigronia*	1	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	11	6	Predator	sw
Basommatophora	*Ferrissia*	1	7	Scraper	cb
Unid. Oligochaeta		33	10	Collector	bu
		S =	N =		

Fisheries Data	**MBSS Data – Piedmont**
Richness = 33	Number of Taxa = 33 (5)
EPT = # 183 Taxa 16	Number of EPT Taxa = 16 (5)
EPT/C = 0.88	Number of Ephemeroptera Taxa = 7 (5)
Dominant Family = Chironomidae, 44.61%	% Intolerant Urban = 19.61% (3)
Scraper Filterer Ratio = 0.11	% Chironomidae = 44.61% (3)
CPOM = 0.02	% Clingers = 44.61% (3)
Diversity = 3.59	IBI = 4.00 Good
Equitability = 0.52	
HBI = 5.46	

Jabez Branch
(Anne Arundel County)

Introduction

Jabez Branch is a very unique coldwater habitat as it contains Maryland's only existing brook trout population within the coastal plain province. The fisheries activities conducted in Jabez Branch between January and June 2015 included a brook trout fry count in the Left and Right Forks of Jabez Branch and water temperature logger deployment and monitoring in the Left and Right Forks as well as the left and right branches of the Right Fork.

Objectives

The objectives of the fisheries activities in Jabez Branch are to:

- Monitor the distribution and population characteristics of brook trout.
- Monitor habitat and environmental conditions affecting the brook trout population dynamics in Jabez Branch for the purpose of preventing or reducing environmental degradation and documenting any improvement in environmental quality.

Methods

Methodology follows that described in the Study III Job 1 Method section. Only variations from the methodology are described here.

Swim-up Fry Survey and Redd Count
Swim-up brook trout fry counts are conducted in March in the Left and Right Forks. The Left Fork count begins at a culvert pipe 50 meters above the confluence of the Left and Right Forks and continues upstream approximately 305 meters. The Right Fork count extends from the confluence of the two Forks upstream 577 meters to a split in the Right Fork. Swim-up brook trout fry counts are conducted by walking along or wading through the station and counting the identifiable fry. The number of observed brook trout fry are recorded to determine the success of the annual hatch.

Water Temperature Monitoring
Onset WaterTemp Pro loggers monitor water temperatures in the Left and Right Forks of Jabez Branch and the left and right headwater branches of the Right Fork. The loggers are wired under the stream bank to prevent loss due to a potential high stream flow event. Stream temperatures (°C) are recorded every twenty minutes. Temperature data are downloaded and graphed using the HOBOware software package.

Results and Discussion

Swim-Up Fry Count

Central Region Inland Fisheries staff conducted a swim-up brook trout fry count in the Left and Right Forks of Jabez Branch on March 31, 2015. No brook trout fry were observed in the Left Fork and 85 brook trout fry were observed in the Right Fork indicating an excellent hatch.

Water Temperature Monitoring

Stream temperatures are monitored in the Left and Right Forks of Jabez Branch as well as the left and right headwater branches of the Right Fork. Single Onset WaterTemp Pro loggers were deployed on May 29, 2015 and are monitoring water temperatures at the four sites every twenty minutes. Water temperature data will be analyzed after loggers are removed in the fall of 2015.

Eastern Region
(Caroline, Cecil, Dorchester, Kent, Queen Anne's, Somerset, Wicomico, and Worcester Counties)

Rock Run
(Cecil County)

Introduction

Cecil County, Maryland is home to several wild trout streams, and two stocked (Put-and-Take) trout streams. All have weathered repeated environmental insults in recent years, including a sediment pond embankment failure on a federally funded supersite, several 100-year floods, a 500-year flood, and the worst recorded drought in Maryland's history. Despite these events, the wild trout populations continue to sustain themselves. Rock Run is of particular interest, having been redesignated to a Use-III stream by Maryland Department of the Environment in 2002. Redesignation came as the result of Maryland Department of Natural Resources, Fisheries Service trout population surveys and stream temperature data. Efforts to monitor trout populations and habitat quality in Rock Run are continuing. To support these efforts, benthic macroinvertebrate sampling has been included for additional habitat and water quality data.

Objectives

- Sample the benthic macroinvertebrate community and analyze the results for use as an indicator of habitat and water quality.
- Maintain a database of benthic macroinvertebrate data and repeat the survey to monitor changes to community structure and habitat quality over time.

Methods

Methodology for benthic macroinvertebrates collection and analysis are described under Study III, Job 1. Only additional information is described here. Benthic macroinvertebrates were surveyed at four stations along Rock Run on June 22, 2015. The stations include a site on the right fork at Route 276, a site about 0.4 miles up the right fork at the Candy Property, a site on the left fork at Rowland Road, and a downstream site at Route 222.

Results

The sample collected from the station located on the right fork of Rock Run at Route 276 contained 245 specimens identified to 29 taxa (Table 1). The sample contained 202 specimens and 15 that belonged to Ephemeroptera, Plecoptera, or Trichoptera (EPT). The ratio of EPT specimens to specimens identified to the Chironomidae (EPT/C) was 16.83. Comparisons of functional feeding groups produced 0.54 for the scraper filterer ratio and 0.46 for the proportion of shredders, or consumers of coarse particulate organic

matter (CPOM). The Shannon Weaver Diversity score was 3.87 and the equitability score was 0.48. Using tolerance values generated by the Maryland Biological Stream Survey (MBSS), the sample received a Hilsenhoff Biotic Index (HBI) score of 2.73. The MBSS IBI score was 4.67 and was rated "good".

The station on the right fork at the Candy property contained 71 specimens that were identified to 18 unique taxa (Table 2). There were 8 EPT taxa represented by 49 individuals. The EPT/C was 9.80. Examining functional feeding groups yielded 0.10 for the scraper filterer ratio and 0.08 for the CPOM. The diversity value was 3.37 and the equitability was 0.83. The sampled received a HBI score of 5.71 and a MBSS IBI score of 3.33. The MBSS IBI rating was "fair".

The sample collected at the Rowland Road station on the left fork contained 232 individuals and 32 different taxa (Table 3). There were 158 EPT specimens identified to 15 different taxa. The EPT/C ratio was 79.00. The analyses of functional feeding groups resulted in a 0.42 for the scraper filterer ratio and a score of 0.21 for the CPOM. The diversity of the sample was 3.95 with an equitability of 0.72. The HBI score was 4.78 and the MBSS IBI score was 4.33 with a rating of "good".

There were 171 specimens and 17 unique taxa observed in the sample collected from the Route 222 station (Table 4). The total number of EPT specimens was 139 belonging to 11 different taxa. The EPT/C ratio was 69.50. Functional feeding group calculations yielded 1.35 for the scraper filterer ratio and 0.01 for the CPOM. The sample diversity value was 2.86 with an equitability of 0.59. The sample received an HBI score of 4.17 and an MBSS IBI score of 4.00. The MBSS IBI rating was "good".

Discussion

The results generated from benthic macroinvertebrate samples collected from Rock Run indicated that habitat and water quality are in good condition, though there is some habitat degradation. Taxa richness was 29 or greater at the Route 276 station and the Rowland Road station. The high richness values at these locations are indicative of a non-impacted, healthy stream. The taxa richness at the Candy Property station and the Route 222 station were substantially lower and suggested some moderate habitat degradation at these locations.

The Route 222, Rowland Road, and Route 276 stations all had 11 or more taxa belonging to EPT orders. This suggests that the EPT orders are not impacted by habitat degradation. Only 8 EPT taxa were identified in the Candy Property sample, supporting the idea that there may be some habitat degradation at this location. The EPT/C ratios were high at all stations, reflecting a healthy balance between the EPT orders and the Chironomidae.

The analyses performed on functional feeding groups provided varying insight into the health of the benthic community. The scraper filter ratio for the sample collected from

the Route 222 station was particularly high, indicating the dominance of scrapers and unicellular algae at this location. Scrapers usually have a higher occurrence in the headwaters of streams where nutrient enrichment is minimal and unicellular algae are prevalent. The stations at Rowland Road and Route 276 had ratios of 0.42 and 0.54, respectively, indicating that there may be some minor nutrient enrichment at these stations. The scraper filterer ratio at the Candy Property station was 0.10, suggesting that there may be substantial nutrient loading at this location. CPOM scores reflected a predictable pattern, with the upstream stations at Rowland Road and Route 276 receiving the highest values. These stations also had more canopy cover than the downstream stations. The CPOM was particularly low at the Route 222 station, likely due to the lack of canopy coverage and no riparian buffer.

The results of the Shannon Weaver Diversity test revealed that diversity was high at all four stations. The Route 276, Candy Property, and Rowland Road stations all received values of 3.25 or greater, suggesting that community diversity was undisturbed. The diversity value was 2.86 at the Route 222 station, suggesting that there may be some slight habitat degradation that may be reducing the diversity at this location. Equitability scores supported the idea that benthic community is relatively undisturbed, though there was some indication of slight degradation. The community structure at the Rowland Road and Candy Property stations were equitable and indicative of a healthy community. However, equitability was slightly lower at the Route 276 and Route 222 stations and suggested some minor disturbances to the benthic communities.

The HBI scores ranged from 2.73 at the Route 276 station to 5.71 at the Candy Property. The score at the Route 276 station may have been inflated by the dominance of the stonefly taxa *Leuctra* at this location. However, the score was exceptionally high and the station appears to be in excellent condition with little influence of organic pollution. This is corroborated by the MBSS IBI score and rating of "good". The Rowland Road and Route 222 stations both received HBI scores that are considered to be good but may be indicative of some minor habitat degradation. The MBSS IBI scores at these locations were rated as good and would suggest that these stations contain relatively healthy benthic communities. The Candy Property HBI score suggested that there may be some moderate habitat degradation at this station. This is supported by the MBSS IBI score.

The use of the benthic community as an indicator for habitat and water quality in Rock Run suggests that the stream is in good condition, though there may be some minor stressors on the stream community. The station at the Candy Property is of particular concern. Almost all of the analyses performed implied that there was moderate habitat degradation at this station.

Table 1. Data and results for the benthic macroinvertebrate sample collected from Rock Run at Route 276 on June 22, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Baetis*	7	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	1	2.3	Collector	cn, sw
Ephemeroptera	*Stenonema*	19	4.6	Scraper	cn
Ephemeroptera	*Paraleptophlebia*	5	2	Collector	sw, cn, sp
Plecoptera	*Leuctra*	112	0.4	Shredder	cn
Plecoptera	*Acroneuria*	5	2.5	Predator	cn
Plecoptera	*Phasganophora*	1	2.2	Predator	cn
Trichoptera	*Glossosoma*	2	0	Scraper	cn
Trichoptera	*Cheumatopsyche*	20	6.5	Filterer	cn
Trichoptera	*Diplectrona*	5	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	13	7.5	Filterer	cn
Trichoptera	*Chimarra*	2	4.4	Filterer	cn
Trichoptera	*Dolophilodes*	8	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	1	2.6	Filterer	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Oulimnius*	5	2.7	Scraper	cn
Coleoptera	*Psephenus*	1	4.4	Scraper	cn
Diptera	SF Orthocladiinae	4	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	2	5.9		
Diptera	TR Tanytarsini	4	3.5	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	*Clinocera*	1	7.4	Predator	cn
Diptera	*Simulium*	1	5.7	Filterer	cn
Diptera	*Antocha*	9	8	Collector	cn
Diptera	*Dicranota*	5	1.1	Predator	sp, bu
Megaloptera	*Nigronia*	6	1.4	Predator	cn, cb
Arachnoidea	Hydracarina	1	6	Predator	sw
		S = 29 N = 245			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 29	Number of Taxa = 29 (5)
EPT = # 202 Taxa 15	Number of EPT Taxa = 15 (5)
EPT/C = 16.83	Number of Ephemeroptera Taxa = 4 (5)
Dominant Family = Leuctridae, 45.71%	% Intolerant Urban = 64.08% (5)
Scraper Filterer Ratio = 0.54	% Chironomidae = 4.90% (3)
CPOM = 0.46	% Clingers = 91.84% (5)
Diversity = 3.25	IBI = 4.67 Good
Equitability = 0.48	
HBI = 2.73	

Table 2. Data and results for the benthic macroinvertebrate sample collected from Rock Run at the Candy Property on June 22, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Baetis*	2	3.9	Collector	sw, cb, cn
Ephemeroptera	*Stenonema*	1	4.6	Scraper	cn
Plecoptera	*Leuctra*	1	0.4	Shredder	cn
Trichoptera	*Cheumatopsyche*	14	6.5	Filterer	cn
Trichoptera	*Diplectrona*	3	2.7	Filterer	cn
Trichoptera	*Hydropsyche*	21	7.5	Filterer	cn
Trichoptera	*Dolophilodes*	5	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	2	2.6	Filterer	cn
Coleoptera	*Oulimnius*	3	2.7	Scraper	cn
Coleoptera	*Psephenus*	1	4.4	Scraper	cn
Diptera	SF Orthocladiinae	4	7.6	Collector	
Diptera	Unid. Chironomidae	1	6.6		
Diptera	*Simulium*	5	5.7	Filterer	cn
Diptera	*Dicranota*	1	1.1	Predator	sp, bu
Diptera	*Tipula*	3	6.7	Shredder	bu
Hemiptera	*Aquarius*	1			
Amphipoda	*Gammarus*	2	6.7	Shredder	sp
Unid. Oligochaeta		1	10	Collector	bu
		S = 18 N = 71			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 18	Number of Taxa = 18 (3)
EPT = # 49 Taxa 8	Number of EPT Taxa = 8 (3)
EPT/C = 9.80	Number of Ephemeroptera Taxa = 2 (3)
Dominant Family = Hydropsychidae, 53.52%	% Intolerant Urban = 21.13% (3)
Scraper Filterer Ratio = 0.10	% Chironomidae = 7.04% (3)
CPOM = 0.08	% Clingers = 81.69% (5)
Diversity = 3.37	IBI = 3.33 Fair
Equitability = 0.83	
HBI = 5.71	

Table 3. Data and results for the benthic macroinvertebrate sample collected from Rock Run at Rowland Road on June 22, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Baetis*	4	3.9	Collector	sw, cb, cn
Ephemeroptera	*Serratella*	2	2.8	Collector	cn
Ephemeroptera	*Stenonema*	3	4.6	Scraper	cn
Plecoptera	*Leuctra*	28	0.4	Shredder	cn
Plecoptera	*Acroneuria*	15	2.5	Predator	cn
Plecoptera	*Phasganophora*	2	2.2	Predator	cn
Trichoptera	*Glossosoma*	5	0	Scraper	cn
Trichoptera	Unid. Glossosomatidae	2	1	Scraper	cn
Trichoptera	*Cheumatopsyche*	22	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	61	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Chimarra*	8	4.4	Filterer	cn
Trichoptera	*Dolophilodes*	1	1.7	Filterer	cn
Trichoptera	Unid. Philopotamidae	2	2.6	Filterer	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Coleoptera	*Dubiraphia*	1	5.7	Scraper	cn, cb
Coleoptera	*Optioservus*	8	5.4	Scraper	cn
Coleoptera	*Oulimnius*	1	2.7	Scraper	cn
Coleoptera	*Stenelmis*	7	7.1	Scraper	cn
Coleoptera	*Psephenus*	13	4.4	Scraper	cn
Coleoptera	*Anchytarsus*	7	3.1	Shredder	cn
Diptera	SF Orthocladiinae	1	7.6	Collector	
Diptera	TR Chironomini	1	5.9		
Diptera	*Antocha*	2	8	Collector	cn
Diptera	*Dicranota*	6	1.1	Predator	sp, bu
Diptera	*Tipula*	2	6.7	Shredder	bu
Hemiptera	*Metrobates*	1	6	Predator	skater
Hemiptera	*Rhagovelia*	1	6	Predator	skater
Megaloptera	*Nigronia*	5	1.4	Predator	cn, cb
Odonata	*Gomphus*	3	2.2	Predator	bu
Amphipoda	*Gammarus*	12	6.7	Shredder	sp
Unid. Oligochaeta		3	10	Collector	bu
		S = 32 N = 232			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 32	Number of Taxa = 32 (5)
EPT = # 158 Taxa 15	Number of EPT Taxa = 15 (5)
EPT/C = 79.00	Number of Ephemeroptera Taxa = 3 (3)
Dominant Family = Hydropsychidae, 36.21%	% Intolerant Urban = 31.90% (3)
Scraper Filterer Ratio = 0.42	% Chironomidae = 0.86% (5)
CPOM = 0.21	% Clingers = 87.07% (5)
Diversity = 3.95	IBI = 4.33 Good
Equitability = 0.72	
HBI = 4.78	

Table 4. Data and results for the benthic macroinvertebrate sample collected from Rock Run at Route 222 on June 22, 2015.

Order	Family/genus	Count	Tolerance	Feeding	Life habit
Ephemeroptera	*Acentrella*	4	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	63	3.9	Collector	sw, cb, cn
Plecoptera	*Leuctra*	1	0.4	Shredder	cn
Plecoptera	*Acroneuria*	1	2.5	Predator	cn
Plecoptera	*Phasganophora*	1	2.2	Predator	cn
Trichoptera	*Glossosoma*	36	0	Scraper	cn
Trichoptera	*Cheumatopsyche*	10	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	19	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Chimarra*	1	4.4	Filterer	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Coleoptera	*Oulimnius*	6	2.7	Scraper	cn
Coleoptera	*Hydrobius*	1	4.1	Collector	cb, cn, sp
Diptera	TR Chironomini	2	5.9		
Diptera	*Antocha*	15	8	Collector	cn
Diptera	Unid. Tipulidae	2	4.8	Predator	bu, sp
Unid. Oligochaeta		6	10	Collector	bu
		S = 17 N = 171			

Fisheries Data	**MBSS Data – Piedmont**
Richness = 17	Number of Taxa = 17 (3)
EPT = # 139 Taxa 11	Number of EPT Taxa = 11 (5)
EPT/C = 69.50	Number of Ephemeroptera Taxa = 2 (3)
Dominant Family = Baetidae, 39.18%	% Intolerant Urban = 27.49% (3)
Scraper Filterer Ratio = 1.35	% Chironomidae = 1.17% (5)
CPOM = 0.01	% Clingers = 94.15% (5)
Diversity = 2.86	IBI = 4.00 Good
Equitability = 0.59	
HBI = 4.17	

State: Maryland

Project Number: F-48-R-25
Study No.: III
Job No.: 2

Project Title: Survey and Management of Maryland's Fishery Resources

Study Title: Management of Maryland's Coldwater Streams

Job Title: Statewide Brook Trout Management

Regional Brook Trout Population Monitoring

Brook trout population monitoring was not initiated regionally until July 2015 in relation to sustained high water flows during June. These flows and associated cold water temperatures precluded the start of sampling efforts until conditions met the parameters as described in the brook trout sampling manual developed by the Inland Fisheries Division. Annual brook trout sampling results will be reported in the next Federal Aid Report.

Brook Trout GIS Database Management

The brook trout database was updated with 2014 sampling data from the Inland Fisheries Division and Maryland Biological Stream Survey (MBSS) monitoring efforts. In addition, staff time was spent on continuing to enter historical data from Inland Fisheries Division offices and proofing this data (for location, coordinates, nomenclature). Most of the historical data has to be reviewed and appropriate coordinates and names corrected and assigned, so as to standardize the database. Brook trout staff conducted field visits to regional offices to review and proof data for which there were questions, and then incorporated these edits to the database. This effort will be continued annually until all historical data available has been incorporated and proofed.

Brook Trout Fisheries Management Plan

Introduction

Eastern brook trout *Salvelinus fontinalis* populations have been declining throughout their native range (Maine to Georgia) in the eastern United States, and Maryland's populations are no exception. In the most recent status review (Eastern Brook Trout Joint Venture 2011) brook trout are now extirpated from 62% of historically occupied subwatersheds in Maryland, a 5% increase since the initial assessment (57%) completed in 2005 (Hudy et al. 2005). Additionally the vast majority of Maryland's brook trout populations (84%) are considered to be "greatly reduced" from their historic levels. The only subwatershed in Maryland that is considered to be "intact" (brook trout present in > 90% of historical habitat) is the upper Savage River watershed, located in western Maryland (Garrett County). The upper Savage River is also considered to be the last remaining stronghold

for brook trout in Maryland and one of the only unfragmented brook trout resources in the entire mid-Atlantic region.

Brook trout populations east of Garrett County are highly fragmented and greatly diminished from their historic range. Of the remaining 47 subwatersheds where brook trout still occur in central and western counties, none are "intact", 10% are "reduced" (only 50 - 90% of historic habitat occupied), and the majority (90%) are "greatly reduced" (only 1 – 50% of historic habitat occupied). Anthropogenic impacts have been identified as the primary reason for the documented declines, with increasing urbanization, deforestation, exotic species, and mining being identified as a few of Maryland's most imminent threats. Likewise the future of Maryland's brook trout remains uncertain in the face of increasing water temperatures in response to climate change, the development of Marcellus shale natural gas resources, and an ever-increasing human population.

Opportunity to reestablish extirpated brook trout populations is very limited, particularly in the eastern and central portion of the state where anthropogenic impacts of human population growth continues; however, strengthening existing populations in these areas through habitat restoration and conservation projects can be a realistic goal for some of these streams. In western Maryland, there are opportunities to reestablish extirpated populations in streams where the water quality has been degraded by relict mining impacts (AMD, acid mine drainage) but the physical habitat is suitable. Since the implementation of the Maryland Brook Trout Fisheries Management Plan (BT FMP), two brook trout reintroductions have occurred in streams where mitigation of AMD impacts has sufficiently improved water quality. Both streams are in Garrett County, Aaron Run (Savage River watershed) and Winebrenner Run (Georges Creek watershed). In addition, AMD mitigation work has been done in the Mill Run watershed (completed) and is ongoing in the Casselman River watershed, with the goal of improving water quality and increasing brook trout population density, distribution, and connectivity. In the eastern portion of their range there is a developing partnership being led by Trout Unlimited with state and federal partners building momentum to pursue restoring brook trout to the upper Gunpowder River watershed.

The DNR's Wildlife and Heritage Service lists brook trout on the "Rare, Threatened, and Endangered Animals" list, ranked as S3S4. The S3 ranking places some brook trout populations on the "Watch List", defined as rare to uncommon with the number of occurrences typically in the range of 21 to 100. They may have fewer occurrences but with a large number of individuals in some populations, and they may be susceptible to large-scale disturbances. Species with this rank are not actively tracked by the Wildlife and Heritage Service. The S4 ranking places some brook trout populations as "Secure", with typically more than 100 occurrences or fewer occurrences if they contain large numbers of individuals. Brook trout in this category are apparently secure under present conditions, although they may be restricted to only a portion of the State (www.dnr.maryland.gov/wildlife/). Brook trout are also listed as a "Species in Greatest

Conservation Need (GCN)" in Maryland's Wildlife Diversity Conservation Plan and as a Regional Species of GCN by the Northeast Regional synthesis for Conservation Need.

Fishery management plans (FMP) provide a framework for how a fishery resource will be managed based on a species life history, habitat, ecosystem considerations and fishery utilization. Over time, the status of a resource can change and new issues arise. Strategies and actions within a plan need to be periodically reviewed and evaluated to ensure the management framework is still appropriate or amended/revised to address significant changes. The BT FMP was developed in 2006 (Heft 2006). Since then, the plan has been annually updated and was formally reviewed in 2010 and 2013. An update section for the FMP is prepared annually also for the DNR fishery management webpage.

Brook Trout FMP Work Effort Status

A focus area from the 2013 BTFMP review was the development and implementation of a comprehensive statewide sampling schedule, as described in Action 11.1.1 of the FMP (*Action 11.1.1 Develop a monitoring schedule to insure that all brook trout populations statewide are sampled at least once every 3 years*). The initial sampling effort revealed that a three year rotation was not feasible, so a new five year rotation was developed and initiated in 2014. Regional and Brook Trout Program staff were successful in achieving the goals of the revised sampling schedule and we anticipate that we will achieve the five year sampling schedule goal.

A second recommended focus area was developing a standardized sampling protocol for brook trout population sampling *(Strategy 12.1 Develop a standardized sampling protocol for monitoring brook trout populations that includes: MBSS water quality and habitat data collection components; establishment of permanent sampling stations; number of stations per stream length; and fish collection methodology)*. The Maryland Brook Trout Program Field Sampling Manual (Sell and Heft 2014) was completed in 2014 prior to the annual sampling season and is used by all Inland Fisheries Division staff involved with brook trout sampling efforts.

The third recommended focus area from the 2013 review was to create better ways to provide information to the general public about brook trout conservation and recreational opportunities. A brook trout program webpage (http://dnr2.maryland.gov/fisheries/Pages/brook-trout/index.aspx) was created and put online in 2014 as part of the overall Fisheries Service website. The page provides information on statewide brook trout work, research, and links to numerous other states and national organizations involved with brook trout work.

Table 1 lists the original strategies and actions delineated in the 2006 Brook Trout FMP, and provides status updates and changes and/or additions.

Current Management and Restoration Efforts

As part of the 2014 Chesapeake Bay Agreement brook trout restoration was included as a specific outcome for the Vital Outcomes Goal. The outcome is to *Restore and sustain naturally reproducing Brook Trout populations in Chesapeake headwater streams with an eight percent increase in occupied habitat by 2025.* Staff is working with the Eastern Brook Trout Joint Venture (EBTJV) and the USFWS Habitat Implementation Team on the development of a Brook Trout Management Strategy and subsequently a two year work plan. This strategy will help guide the efforts and direction of brook trout restoration efforts in the Bay watershed to meet the Brook Trout Outcome and will be compatible with Maryland's BT FMP.

Brook Trout Program staff continue to work with Trout Unlimited representatives, Inland Fisheries Division staff, Carroll and Baltimore County natural resources staff, and National Aquarium staff to develop and implement a brook trout restoration effort on a watershed scale for the Upper Gunpowder River watershed (upstream of the Prettyboy reservoir). This watershed has been identified as having a high likelihood of success for brook trout habitat restoration and reintroduction, and at a large scale that has not been attempted before in Maryland. This will be a long term effort with the potential to provide a significant increase in the amount of brook trout occupied habitat by 2025. Work efforts included data synthesis and analysis, map creation, and review of long term plans.

Regional and Brook Trout Program staff are working with the Maryland Department of the Environment's Abandoned Mine Lands Division on a watershed scale restoration effort within the Casselman River watershed. Acid mine drainage mitigation sites have been installed on tributaries within the watershed and tree plantings to restore and protect stream buffers are planned for 2015-2016. Water quality and brook trout monitoring will continue annually. Site visits were conducted to assess tributary habitat status, and GIS was used to determine land ownership in planned restoration areas for making contact with landowners.

Issues of Concern

Initial statewide brook trout population sampling completed in 2014 revealed a substantial loss of historically occupied brook trout habitat in the Central region of Maryland. While not unexpected, this trend will likely continue as the 5 year sampling rotation is completed. Two major factors are likely responsible for this, including increased human development in this portion of the state and competition with invasive brown trout. Additional work in the Gunpowder system is planned for restoration work (Upper Gunpowder River) and research related to brook trout movement within the watershed.

The recent discovery of gill lice *Salmincola edwardsii* in North Carolina brook trout populations is a potential concern for Maryland brook trout populations. This copepod is endemic to brook trout populations in the northern portion of the native range but has not been seen south of New England and Great Lakes states. Typically infestations were not considered significant at a population level but recent increases in parasite loads in

Wisconsin and Minnesota are being suggested as contributing to drastic population declines (Mitro et al. 2014).

Additional issues of concern for Maryland brook trout conservation include angling effort and harvest, climate change impacts, continued human development pressure in brook trout watersheds, runoff of road salt into streams, and energy extraction and development issues (gas and wind).

Water Temperature Monitoring

Instream water temperature logger deployment was delayed until 2016 to meet the needs of the developing Upper Gunpowder River brook trout restoration project and for use in the Upper Savage River watershed water budget research project.

Chesapeake Bay Brook Trout Outcome

The 2014 Chesapeake Bay agreement included, for the first time, a specific goal for Brook Trout restoration. In the *Vital Habitats* section the Brook Trout Outcome is to "*Restore and sustain naturally reproducing brook trout populations in Chesapeake headwater streams with an eight percent increase in occupied habitat by 2025"* (http://www.chesapeakebay.net/chesapeakebaywatershedagreement/page).

As part of the Brook Trout Action Team, the Brook Trout Program took the lead in initiating the development of a two year Outcome work plan by soliciting and collecting work plan needs from the Bay Program's Habitat Implementation Team. Staff also took the lead in obtaining and providing edits and comments from Bay state brook trout managers for the recently created draft two year work plan.

In addition, Brook Trout Program staff conducted tissue collection efforts for genetic sampling for the five statewide brook trout "patches" as part of a cooperative research effort among Bay states to determine the effectiveness of this type of sampling for monitoring populations. This research is being conducted as part of the work effort for the Brook Trout Outcome of the Chesapeake Bay Agreement.

Staff also reviewed and provided comments for a brook trout restoration priority model being developed by researchers at West Virginia University (Downstream Strategies Methodology and Modeling Process: Brook Trout Case Study – Petty et al.).

Upper Savage River Metz-Brawney Properties Stream Restoration Project

Staff provided design review and input for fish habitat structures, and participated in site visits to discuss and refine the Metz-Brawney property streambank restoration project on the Upper Savage River mainstem (Figure 1). The project is being lead by the Canaan Valley Institute (http://www.canaanvi.org/CVI/index.html) with assistance from Maryland Brook Trout Program staff (http://dnr2.maryland.gov/fisheries/Pages/brook-

trout/index.aspx). Grant funds of $275,000 will be used for the project to restore and repair approximately 1,000' of eroded streambank and degraded stream habitat. Additional partners included the Savage River Watershed Association (http://www.savageriverwatershed.org/), National Fish and Wildlife Foundation (http://www.nfwf.org/Pages/default.aspx), Garrett County Maryland, Maryland Department of the Environment, and the Western Maryland RC&D (http://www.wmrcd.org/). Efforts will be directed at repairing a severely eroded bank section and restoring a natural functioning stream channel and associated floodplain. Also included is the creation of fish habitat structures to benefit the native brook trout population. A stipulation of the project funding is that the Metz property owners must sign a maintenance agreement that the restored riparian buffer be kept in place in perpetuity. Future work will include annual fish and invertebrate population sampling.

NAJFM hooking study reports

Maryland Brook Trout Program staff completed draft manuscripts for the wild trout portion of the circle hook study, and began work on the hatchery component manuscript; field work was completed in 2014. Some of the extremely important management implications being discussed as a result of the findings are that, while initial and delayed mortality with both hook types was low, there is likely a seasonal component that will affect these rates that needs to be investigated. Also, larger brook trout are caught by anglers disproportionally to the length structure of the overall population as suspected. The catch rate of brook trout by bait angling was very high and reinforces how susceptible brook trout populations can be to the risk of over exploitation, especially the larger fish. After review, the manuscripts will be submitted for publication as companion papers in the North American Journal of Fisheries Management (NAJFM). The manuscripts are titled "**A comparison of catchability and mortality with circle and J hooks for stream-dwelling Brook Trout *Salvelinus fontinalis***" and "**A comparison of circle hook size on hooking success, deep hooking rate, and post release mortality of hatchery-reared Rainbow Trout *Oncorhynchus mykiss***". The manuscripts were co-authored by Matt Sell, Alan Heft, Dr. Robert Hilderbrand, Dr. David Kazyak, and Ryan Cooper. This project will be continued in FY2016.

Angler Preference Creel Survey

Effort was initiated on developing a brook trout specific angler preference survey, with a focus on obtaining information specific to the Zero Creel Limit Area for brook trout in the Upper Savage River watershed. Work was performed on an initial set of survey questions and researching potential survey methodologies. This project should be completed in June, 2016.

National Brook Trout Genetics Cooperative Research Effort

Past research on Brook Trout genetics has been done typically at a statewide level. To fully understand the importance of Brook Trout genetics to the species' conservation and

restoration, members of the American Fisheries Society's Trout Committee initiated the development of an overarching manuscript describing and summarizing brook trout genetics research for Southern Appalachian brook trout populations. Maryland Brook Trout Program staff are participating in data analysis and manuscript preparation for this effort. The manuscript will be modeled on the following design.

1. Describe baseline genetic attributes of brook trout populations across the southern portion of their distribution.
    a. Compare/contrast differences:
        i. of genetic diversity within and genetic differentiation among drainages,
        ii. relative to population size, spatial distance, drainage,
        iii. related to stocked and unstocked populations,
        iv. in population segments with/without movement barriers,
        v. between genetic attributes of populations found north and south of New River watershed, Virginia, and North Carolina.
2. Describe the evolutionary relationships among brook trout populations at the population and phylogeographic scale across their range.
3. Identify patterns in most recent common ancestry related to within/among streams, drainages and regions.
4. Determine if there is evidence of effective genetic migration of populations within/among watershed(s) (i.e. panmictic populations vs. isolated gene flow vs. isolated fragmented populations).
5. Assess genetic signature and degree of introgression within/among hybrid populations exposed to single vs. repeated stocking of northern hatchery strain brook trout.
6. Determine if repeated removals of brook trout from source streams for translocation to restored stream segments caused significant declines in genetic metrics?
7. Define management units based upon genetic metrics and hydrological patterns.

Work on this collaborative project will continue through FY2016 and 2017.

Upper Gunpowder River Brook Trout Restoration and Telemetry Project

Efforts for the Upper Gunpowder River Brook Trout restoration plan, being led by Trout Unlimited, continued. Regional and Brook Trout Program staff created a map of the watershed (Figure 2), summarized the existing dataset, and participated in several planning meetings. The Upper Gunpowder River watershed currently supports several brook trout populations in tributaries, and the exotic brown trout is not naturalized within the watershed. Long range restoration plans include identifying areas where restoration efforts can be directed to support recolonization/reintroduction of brook trout. Initial work will include water temperature monitoring efforts in tributaries on private land that have not been previously monitored. Efforts will continue into calendar year 2016.

A secondary project is conducting a telemetry study of larger brook trout that are believed to inhabit the mainstem Upper Gunpowder River. Initial effort included a

meeting with Regional and Brook Trout Program staff to discuss feasibility and logistics of the project. It was decided to initiate an effort in the winter/spring of calendar year 2016.

Table 1. 2006 Maryland Brook Trout Fishery Management Plan Implementation Table (updated 6/2015).

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Strategy	Action	Date	Comments
Strategy 1.1 Investigate the life history characteristics, i.e. mortality, longevity, fecundity, growth rate, of Maryland brook trout populations statewide.	**Action 1.1.1** Identify and pursue additional funding sources to accomplish the needed work.	2009 - 2013 Continue **Projected completion 2015**	Joint research project with UMCES Appalachian Laboratory (AL) and MD DNR Fisheries. Funds included a SWG grant. Initiated study of brook trout life history study in the Savage River. This was the number 1 priority action in 2010. **Field work completed in 2013. Modeling and report completion is planned for 2015.**
Strategy 1.2 Investigate angler use and exploitation on Maryland brook trout populations statewide through creel surveys, and relate harvest and incidental angling mortality to brook trout length frequency structure and maximum fish size.	**Action 1.2.1** Identify and pursue additional funding sources to accomplish the needed work.	**2012-2013** **Statewide Pending, possible initiation in 2016**	**Upper Savage River creel survey completed.** **Statewide creel survey will be based on Upper Savage River creel survey. Funding necessary to expand survey statewide has not been identified. Earliest a statewide creel survey would be initiated is 2016.**
Strategy 2.1 Develop a GEP index for brook trout	**Action 2.1.1** Submit a proposal for funding a GEP index research project to the	2007-2009 **Completed**	A SWG project report was completed in 2009. Report directs watershed associations and regional

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populations in the state of Maryland.	Maryland DNR State Wildlife Grant program for FY07.		managers where to target conservation efforts.
Strategy 2.2 Utilize the index to categorize the status of brook trout populations in Maryland and create a priority list of those most at risk, and those for which conservation efforts would have long term potential for long term restoration.		2009 **On-going**	No action was formulated in the BTFMP. GEP index and report (Action 2.1.1) will be used to identify populations at risk by watershed and guide conservation efforts. Priority list will be developed during 2015 – 2016.
Strategy 3.1 Identify and protect at- risk brook trout populations.	**Action 3.1.1** Determine at- risk populations by statewide fisheries region using current data, and then by using GEP index information once it becomes available.	**In progress Projected completion 2016**	This was the number 2 priority action (along with Action 13.1.3) in 2010. **Developing a GIS layer to identify and prioritize at-risk populations based on GEP and other risk factors. Additional resources are needed to continue project.**
	Action 3.1.2 Develop a priority list of populations to be protected, incorporating the GEP index value, land ownership (private	**Pending**	Requires completion of 3.1.1. **The priority list will be generated when the GEP map has been developed.**

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Strategy	Action	Date	Comments
	versus public), upstream watershed size and land use, public resource access, connectivity to other brook trout populations, and recreational value.		
Strategy 4.1 Develop a brook trout management plan for the Savage River watershed upstream of the Savage River dam. This plan will be used as a blueprint for developing plans in other brook trout watersheds.	**Action 4.1.1** Develop a comprehensive Geographic Information System (GIS) database detailing land ownership and usage within the upper Savage River watershed, incorporating summer water temperatures and brook trout population abundance from the Maryland DNR's Inland Fisheries and MBSS databases.	2007 Continue	GIS project underway as a joint effort of MD DNR, Savage River Watershed Association, and the Izaak Walton League. **Final report is being drafted**.
	Action 4.1.2 Utilizing the GIS analysis, identify areas within the Savage River watershed that are negatively impacting brook trout populations and water quality and develop a priority list of restoration/conservation activities.	2007 Continue	Requires completion of 4.1.1. **Final report is being drafted. Report will include prioritized list of impacted brook trout populations.**

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Strategy	Action	Date	Comments
	Action 4.1.3 Identify areas within the Savage River that need additional conservation.	2007 Continue	Requires completion of 4.1.1. **Final report is being drafted. Report will identify focal conservation areas for watershed associations.**
Strategy 4.2 Present the information and recommendations in the BTFMP to the MD DNR Western Regional Team to solicit input and support.		2007 **Discontinued**	No action was formulated in the BTFMP. MD DNR Western Regional team was disbanded in 2007. Strategy is no longer practicable and is not being pursued.
Strategy 4.3 Develop a watershed-wide strategy for protecting habitat, Especially buffer protection and restoration in impacted headwater streams.		**Pending**	No action was formulated in the BTFMP. **Action: Create a stream buffer and land use/land cover map to locate areas of concern. Threshold for negative impacts is 2% impervious surface. The map will incorporate existing state and federal land preservation and buffer strip restoration programs.** **Development of a GIS layer is being explored. Anticipated to begin in 2017.**
Strategy 4.4 Identify adverse			No action was formulated in the BTFMP.

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summer water temperature impact areas (impoundments, etc.) and develop strategies to alleviate the impacts.		**2007 On-going**	**Action: Create a network of temperature loggers to monitor thermal impacts to streams.** Instream water temperature is monitored annually in cooperation with MBSS and the Izaak Walton League. Each Inland Fisheries Region annually rotates 6 to several dozen temperature loggers among priority streams. There are three additional long-term monitoring sites. **Water temperature database development is planned to begin in 2014.**
Strategy 4.5 Designate the upper Savage River watershed a fisheries "Habitat Area of Particular Concern" (HAPC). This designation will allow the development of regulations and monitoring programs to protect the resource on a watershed specific basis. It	**Action 4.5.1** Institute angling regulations to provide for maximum protection of brook trout while still ensuring angler use of the resource, i.e. no closed season, no harvest, single hook barbless lures only, no bait.	2007 2007 – 2013 **On-going**	State fishery regulation was enacted to protect upper Savage River brook trout: COMAR 08.02.11.01. Annual monitoring of trout population response is ongoing through at least 2013. **Data indicate that the regulation has been effective in meeting management objectives to increase the number of fish >200 mm, reduce angler related mortality, and protect the only intact brook trout system in MD (upper Savage River) while optimizing angling use.**

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Strategy	Action	Date	Comments
will also help to develop and foster the public and resource users' support for the management actions that need to occur; it will focus efforts to accomplish necessary research; and it will demonstrate Maryland's commitment to protecting and conserving this unique resource.			**Restoration of trout population densities has been partially successful. Plans for long term continued monitoring will be developed in winter 2014 and implemented in summer 2015.**
Strategy 4.6 Promote and encourage the development of a citizen-based Savage River watershed advocacy organization. MD DNR will provide technical support as needed.		2006 Completed	No action was formulated in the BTFMP. Savage River Watershed Association (SRWA) formed and has partnered with DNR in protecting and restoring the watershed. SRWA framework is being used as a model for other watershed associations. Watershed associations will assist with FMP action implementation.
Objective (Strategy) 5 Encourage riparian buffer habitat	**Action 5.1.1** Develop a list of target watersheds in Maryland that could benefit from the CREP	Pending	Implementation requires completion of Strategy 4.3. Implementation will aid with at-risk population targeting.

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preservation and restoration.	program, rank each system based on brook trout population status (best to worst), headwater agricultural impact, and size and connectedness of the system.		
	Action 5.1.1 Using the list generated from Action 5.1.1, actively recruit and enroll farmers from the targeted watersheds into the CREP program.	Pending	Dependent on the completion of Action 5.1.1
	Action 5.1.2 Create a list of the Federal, state, and NGO conservation and restoration programs that are available to landowners; inform Regional Fisheries managers and biologists of these programs so they can work with private landowners to improve land use and water quality.	Pending	No progress to date.
Strategy 6.1 The information that is needed by regulators and developers to appropriately consider and	**Action 6.1.1** Develop a series of PowerPoint presentations that illustrate the life history needs of brook trout and the adverse impacts that	2011 **Completed**	This is the number 4 priority action. **Eastern Brook Trout Joint Venture (EBTJV) developed educational and outreach materials such as**

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plan activities so they do not adversely impact brook trout populations is available. Developing an outreach strategy to convey this information will provide key agencies and developers with the understanding necessary to make appropriate decisions.	can occur from anthropogenic activities. Provide an ecosystem perspective by including a description of how brook trout serve as indicators of overall stream health; and what a healthy brook trout population means to the health of a watershed and the lives of those who reside there.	2011 **On-going**	**videos, webinars, maps, and reports with a national perspective. More information is available at http://easternbrooktrout.org/** **Information from brook trout research and similar efforts is now available to fully develop communication and education tools for protection of brook trout and their habitat in MD. Action 6.1.1 is scheduled for completion in 2016 – 2017.**
	Action 6.1.2 Meet with county and local government officials/agencies and commercial developers to present the information and to establish a dialog on the issues relating to the conservation and value of Maryland's native brook trout.	Pending	Requires completion of 6.1.1.
	Action 6.1.3 Make presentations available to the general public through appropriate pathways, i.e. website, libraries, etc.	Pending	Requires completion of 6.1.1.

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Strategy	Action	Date	Comments
	Action 6.1.4 Work cooperatively with other state agencies to insure adherence to state water quality standards.	2007 Continue	Better communication fostered between MDE and DNR. DNR environmental review expanded to include teams that address specific water quality issues. Direct negotiations between Inland Fisheries and MDE focused primarily on stream classification.
Strategy 7.1 Develop statewide restoration guidelines for restoring extirpated brook trout populations.	**Action 7.1.1** Adopt and modify the guidelines developed for brook trout restoration by the American Fisheries Society's Southern Division Trout Committee.	**Pending**	This is the number 3 priority action. **Implementation is pending information from the life history and genetic research projects (Actions 1.1.1 and 7.1.2) and review of the Southern Division of the American Fisheries Society Technical Committee's (SDAFS TC) guidelines for brook trout restoration. Work is scheduled for 2015 - 2016.**
	Action 7.1.2 Incorporate a genetic component into the guidelines to direct brood fish selection location.	2010 - 2013 2014 Continue	UMCES Appalachian Lab has collected and inventoried brook trout genetics in all watersheds. **Laboratory work and analysis scheduled for winter 2014.**
Objective (Strategy) 8 Complete genetic inventory of	**Action 8.1** Secure funding (an estimated $10,000) to complete the statewide brook trout genetic	Pending	Funds are being sought to complete the genetic inventory. **Partially completed for the USR in 2014, if funding secured**

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Strategy	Action	Date	Comments
discrete brook trout populations.	inventory. The USFWS State Wildlife Grant Program and EBTJV are two possible funding sources for completing this work.		**will be completed in 2016.**
Strategy 9.1 Establish pathways to inform the general public about brook trout conservation and protection.	**Action 9.1.1** Utilize the Maryland Sport Fisheries Advisory Commission (SFAC), DNR Regional Teams, and other appropriate state agencies to solicit input on brook trout conservation measures.	On-going	Strategy 9.1 aligns with Strategy 6.1. Inland Fisheries advised the MD Taskforce on Fisheries Management and regularly updates the SFAC as new research, monitoring, and regulation information becomes available.
	Action 9.1.2 Post the BTFMP on the DNR Fisheries Service webpage and request on-line comments on conservation measures as part of the regular review of the BTFMP.	2006 Continue **Completed**	Strategy 9.1 aligns with Strategy 6.1. BTFMP posted on line. Trout fishing information is available on the DNR Fisheries Service web site. **A DNR Brook Trout webpage is has been completed, and provides program information such as management updates, research highlights, and habitat needs. The webpage includes an interactive public comment interface allowing DNR to solicit public input, opinions, and observations regarding current and proposed**

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Strategy	Action	Date	Comments
			conservation and management actions. Webpage deployment is anticipated in 2016-2016.
Strategy 10.1 Encourage public participation in fishery management through informational and regulatory meetings and the development of organized watershed advocacy groups. Current federal efforts are directed at assisting the formation of advocacy groups by funding startup and operational costs.	**Action 10.1** Develop a list of watershed advocacy organizations in Maryland with current contact information. Evaluate the need for additional groups. Create a list of federal agency contacts that can assist with citizen advocacy groups.	2009 **Completed**	A list of watershed groups and advocacy organizations has been created. These organizations have developed their own lists of federal agency contacts.
Strategy 11.1 Develop a consistent, coordinated monitoring program to: 1) assess and track population abundance and viability; 2)	**Action 11.1.1** Develop a monitoring schedule to insure that all brook trout populations statewide are sampled at least once every 3 years.	2008-2009 Completed **2009 On-going**	Monitoring plan is a Federal Aid requirement. Comments from the MD Task Force on Fisheries Management and SFAC were incorporated in the plan. **Streams will be monitored on a five year rotation from 2014- 2018.**

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Strategy	Action	Date	Comments
monitor and detect environmental changes from anthropogenic (acidification, sedimentation, development/ urbanization, AMD, etc.) and natural causes (floods, drought); 3) monitor and detect exotic species encroachment and impacts; and 4) monitor/detect water flow and temperature changes.		**2012-2013**	**Brook trout in the upper Savage River were tagged and tracked via radio telemetry. Seasonal distribution was documented and tributary connectivity will be important for effective population management. A manuscript was drafted and study results are not yet available pending publication.**
	Action 11.1.2 Coordinate brook trout sampling efforts between Inland Fisheries and the MBSS to maximize efficiency. Where possible, reduce the number of sites Inland Fisheries needs to monitor. Fisheries should focus on monitoring streams for recreational fisheries, MBSS on sampling headwater, privately owned streams.	Began 2006 Formalized 2010 **On-going**	Inland Fisheries and MBSS have increased sampling coordination. **Action will continue annually.**
Strategy 12.1 Develop a standardized sampling protocol for monitoring brook trout	**Action 12.1.1** Create a sampling standardization committee with members from Inland Fisheries and MBSS to develop the	2006 2011	MBSS sampling protocol informally adopted for portions of the Savage River. MBSS sampling protocol requires more discussion before being implemented

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Strategy	Action	Date	Comments
populations that includes: MBSS water quality and habitat data collection components; establishment of permanent sampling stations; number of stations per stream length; and fish collection methodology.	sampling methodology.	**Pending**	statewide. Integration of a multi-layer sampling protocol is being considered as a modification to the MBSS sampling protocol. **Implementation would be in stages. Earliest implementation would be in 2015.**
	Action 12.1.2 Conduct training with Inland Fisheries staff to implement the standardized methodology.	2011	Completion of Action 12.1.1 is required. Some informal training has been done to date.
	Action 12.1.3 Collect summer water temperatures with in-stream temperature.	2007 **On-going**	Strategy 12.1 aligns with Strategy 4.4. Includes Inland Fisheries efforts and data from MBSS.
Strategy 13.1 Develop a database that incorporates, and where possible, standardizes, the historic and current statewide brook trout information available from the Inland Fisheries, the MBSS, and the University of Maryland monitoring	**Action 13.1.1** Establish a data management group that includes a representative from each of the major groups (DNR, UM, and MBSS) to standardize the data collection format and create a statewide database of brook trout information.	2009 Completed **Continue as needed**	Action 13.1.1 is the number 2 priority (along with Action 3.1.3). **Informal data management group has been established and convenes as needed.**
	Action 13.1.2 Identify other sources of brook trout data, such as MD Bureau of Mines, additional academic institutions, and	**Completed**	Requires completion of Action 13.1.1.

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Strategy	Action	Date	Comments
programs.	Federal agencies, and incorporate the data into the statewide format.		
	Action 13.1.3 Develop a GIS database describing BT population boundaries, population information, habitat variable information, and water temperature data.	2009 **On-going**	Action 13.1.3 was the number 2 priority (along with Action 3.1.1) in 2010. **GIS database was completed and functional in 2013. It will be updated annually.**

Acronyms
MD DNR – Maryland Department of Natural Resources
AMD – Acid Mine Drainage
MDE – Maryland Department of the Environment
BTFMP – Brook Trout Fisheries Management Plan
SDAFS – Southern Division of the American Fisheries Society
CREP – Conservation Reserve Enhancement Program
SFAC – Sport Fisheries Advisory Commission
COMAR – Annotated Code of Maryland
SRWA – Savage River Watershed Association
EBTJV – Eastern Brook Trout Joint Venture
SWG – State Wildlife Grant
GEP – Genetic Effective Population
TC – Technical Committee
GIS – Geographic Information System
MBSS – Maryland Biological Stream Survey

Figure 1. Upper Savage River mainstem, Garrett County, Maryland. A stretch of the severely eroded streambank along the Metz property is shown, along with associated impacts including stream widening and shallowing, degraded fish habitat, and lack of canopy cover.

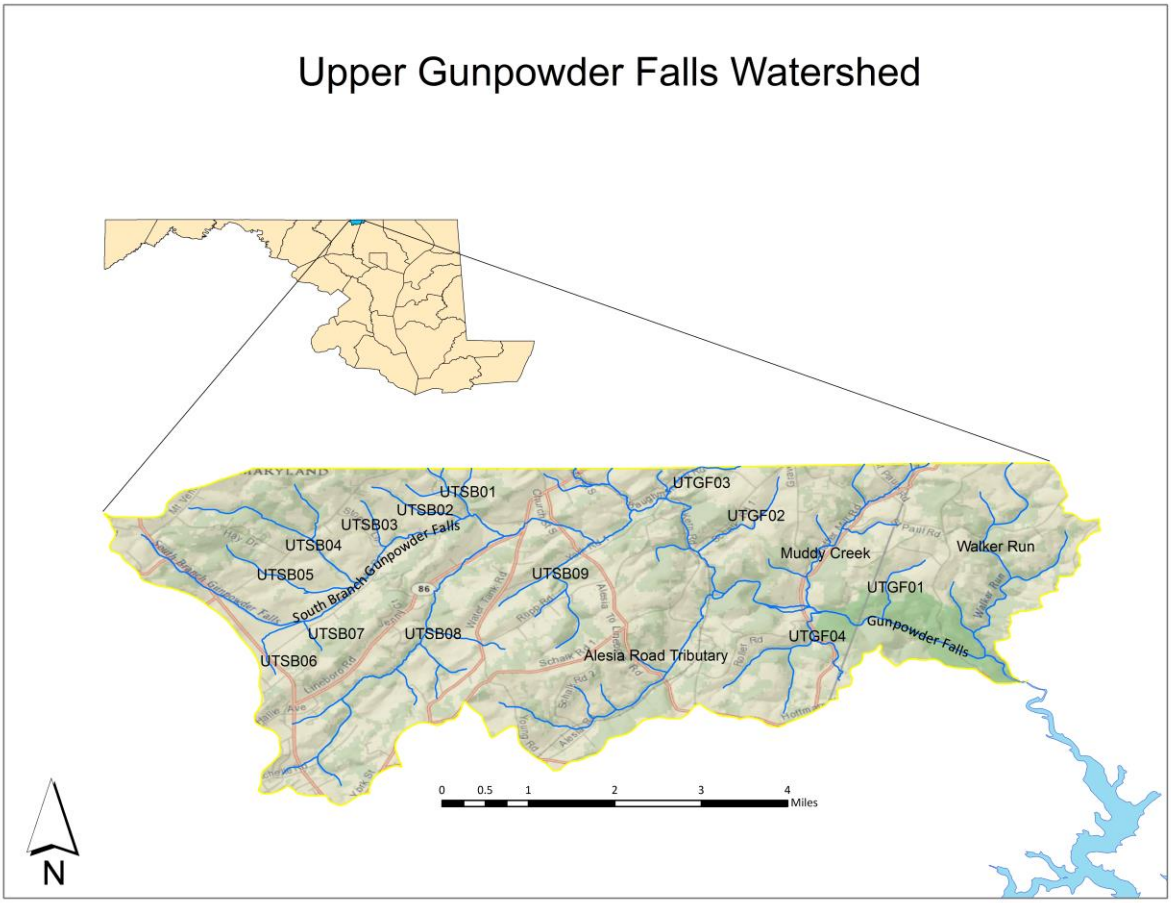

Figure 2. Upper Gunpowder River watershed, Maryland, and Brook Trout restoration project area.

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Maryland Department of Natural Resources
Fisheries Service
Inland Fisheries Division

SURVEY AND MANAGEMENT OF FRESHWATER FISHERIES RESOURCES

Management of Maryland's Major Rivers

USFWS Federal Aid Grant F-48-R-25

Study IV

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State: Maryland

Project Number: F-48-R-25
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Project Title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Major Rivers and Streams

Job Title: Management of Major Rivers and Streams

Introduction

Timely and accurate assessments of the status of riverine fish populations and their habitat are essential to the development of appropriate management policy and strategies. Scientific information must be continuously updated in order to maintain and enhance existing river fisheries, and develop new angling opportunities. This project provides key information to support the fishery management process for Maryland's major rivers and streams.

These are highly dynamic systems with large annual variations in flow, temperatures and other conditions within a given season. Species responses to these conditions include; variability in year-class strength of up to several orders of magnitude, annual differences in rates of growth particularly in juveniles, changes in condition and other factors which affect populations and fishing success over multiple years. In recent years, fish health and water quality have become a concern, with neighboring states within the Potomac River basin experiencing significant fish kill events. Annual monitoring is required to quickly identify and respond to these changes or trends in populations.

General Methods

Fish Surveys

Black Bass YOY Relative Abundance

The relative abundance of young-of-year (YOY) black bass is determined by seining or backpack electrofishing. Electrofishing is generally used when the physical habitat does not permit seining or surveys are specific for black bass species.

Seining

Young-of-year (YOY) fish species were collected using a 9.1 m x 1.2 m, 3.2 mm mesh haul seine. Three locations (general, pool, and riffle) within a station were sampled to account for variable habitats. Smallmouth YOY relative abundance is expressed as the geometric mean YOY per haul. One YOY was added to each haul to compensate for zero values.

Electrofishing

A Smith-Root Model LR-24 backpack electrofisher is used to collect YOY black bass from three 50 m shoreline segments at each sample site. Segments are selected to include all the habitat types present in the river reach to be surveyed (pool, riffle, run, etc.). Sampling begins at the downstream point and proceeds upstream along the shoreline. Electrofishing is most effective using pulsed (120pps) DC current; voltage is adjusted for maximum shocking efficiency; shocking time is automatically recorded. Black bass YOY are held in a bucket until the 50 m segment is completed, measured to the nearest mm, and released. Relative abundance is expressed as the geometric mean number of YOY per 50 m of shoreline sampled and by $CPUE_{60}$. One YOY is added to each run to account for zero values when computing the geometric mean.

Adult Fish Stocks

Adult fish are collected by electrofishing. On navigable rivers, a commercially-built electrofishing boat manufactured by Smith-Root Inc. equipped with a 7.5 GPP (gas powered pulsator) and outboard jet is used to collect fish during a single-pass at fixed stations. Sample stations are selected to include all the habitat types present in the river reach to be surveyed (pool, riffle, run, etc.) that have a reasonable probability of annual access under low flows. Sampling is conducted during daylight hours during the fall once water temperatures fall below 18.3° C (65° F). Electrofishing is accomplished using pulsed DC current (60 pulses per second or pps); voltage is adjusted for maximum shocking efficiency; shocking time is automatically recorded. Timed runs between 1200 and 1700 seconds are conducted to obtain relative abundance data. Electrofishing begins at the upstream limit of the run and proceeds downstream. Sampling is conducted bank to bank to account for mid-river habitat where depth is generally less than 2.1 m. When depths generally exceed 2.1 m, sampling follows the shoreline. Fish are collected using two netters; fish are held in an on-board, aerated live well, measured to the nearest millimeter, weighed to the nearest gram, and released. GPS coordinates are recorded at both the upstream and downstream limits of each run.

Catch-per-unit-effort ($CPUE_{Hr}$) is used as a measure of relative abundance expressed as the number of fish collected per hour of actual electrofishing time. Evaluation of size structure is made using the concept of proportional stock density (PSD) as proposed by Gablehouse (1984). Lengths and weights of collected fish are used to obtain relative weight (W_r), as described by Wege and Anderson (1978). FAST (Fishery Analysis and Simulation Tools) software (FAST, 2005) is used to calculate population parameters.

North Branch Potomac River
From Jennings Randolph Lake Dam Downstream to Cumberland, MD
(Garrett and Allegany Counties)

Introduction

Water quality in the North Branch Potomac River (NBPR) from Jennings Randolph Lake (JRL) downstream to Cumberland, MD (about 60 km), has been historically impacted by acid mine drainage from abandoned coal mines and industrial pollution. Pollution mitigation efforts by Maryland Department of Natural Resources' Fisheries Service, Maryland Department of the Environment (MDE), industry, and the public have been underway for at least three decades. Substantial progress towards improved physical habitat and water quality, enhanced aquatic communities, and sport fishery development in the NBPR has been achieved. However, much work remains in order to develop the full recreational potential of the river.

As part of an ongoing statewide project to establish baseline data characterizing the freshwater fisheries resources of Maryland, Inland Fisheries Division staff initiated a fishery survey in the NBPR from the JRL Dam downstream to Cumberland, MD. The purpose of the work is to describe and monitor the important sport fisheries for trout and black bass in order to maintain and enhance recreational fishing opportunities.

Objectives

- Identify and estimate relative abundance of all fish species in the NBPR study area.
- Monitor reproductive success, and estimate population numbers and standing crop for all trout species when practical, or as an alternative, determine relative abundance in areas where habitat and flow conditions prevent conducting depletion-based population estimates.
- Develop indices of size and physical condition of trout.
- Determine relative abundance, and describe the age and size structure, proportional stock density (PSD), relative weight (W_r), reproductive success, and general distribution of black bass in the Catch-and-Return Black Bass Fishing Area.
- Monitor river temperatures and flows during the critical summer period.
- Monitor the benthic macroinvertebrate communities in the river.

Methods

Fish Population Surveys
Fish populations were surveyed at two stations (Station 4 - Lower C&R Trout Fishing Area and Station 5 - Westernport Put and Take (P&T) Trout Fishing Area) in the NBPR on June 24, 2015. Sampling station location descriptions are contained in Table 1. Sampling stations were selected to include all the habitat types present in the stream reach to be surveyed (pool,

riffle, run, etc.). A 16-foot Cataraft inflatable boat equipped with a Smith/Root 2.5 kilowatt, pulsed DC electro-fishing unit was used to collect fish in stations where the physical size of the NBPR precludes depletion derived population estimates. The Cataraft was operated using four personnel: an individual at the oars, a worker operating the anode petal, and two persons with dip nets collecting fish. A Model LR-24 Smith-Root backpack electro-fisher was used to sample shallow riffle areas for black bass reproductive success indices and fish species relative abundance at stations within the Black Bass Catch-and-Return Fishing Area. Electro-fishing effort (seconds) was recorded to obtain a measure of relative abundance (catch per unit effort) for all fish species. General abundance was derived from sample size and fish were rated as abundant (>100 individuals), common (5-100 individuals), or scarce (< 5 individuals). Black bass reproductive indices were reported as the number of young-of-year (YOY) per 50 meters of shoreline.

At all sampling stations, trout and black bass were anesthetized, identified to the species, measured for total length to the nearest millimeter, weighed to the nearest gram, and returned alive to the stream. The coefficient of condition (K) described by Lagler (1952) was used as a measure of fish condition for trout. Growth histories were determined by length frequency distribution or otolith reading. Proportional stock density (PSD) and relative stock density (RSD) for black bass were calculated using methods described by Anderson (1980). Confidence intervals for PSD and RSD values were calculated using the formula described by Gustafson (1988). Relative weight (W_r), a measure of fish condition, was calculated using the methods described by Wege and Anderson (1978) for black bass. Black bass population data were not obtained by June 30, 2015; however efforts and results will be reported at a later date.

Temperature Monitoring

NBPR water temperatures were monitored in the area of the river from the Lower Catch-and-Return Trout Fishing Area downstream to Black Oak, MD to evaluate coldwater fisheries potential. Temperatures were recorded using Onset StowAway® temperature loggers at 20 minute intervals. Temperature data will be retrieved after the critical summer period, and results will be available at a later date.

Benthic Macroinvertebrates

Benthic macroinvertebrates were sampled at Stations 1, 2, 4, 5, 6, and 7 (Table 1) on June 15, 2015. Samples were collected using a 600 µm kick net and 6, 30 second kicks in riffle habitat at each station. Samples were preserved in 70% isopropyl alcohol on station and taken back to the laboratory for processing. Samples were processed in the laboratory by sorting through a three sieve system; with sieve mesh sizes ordered 13.2 mm, 1 mm, and 600 µm. The sieved samples were then placed into a white tray and macroinvertebrate specimens were separated from any remaining detritus and sediment and preserved in labeled sample bottles containing 70% isopropyl alcohol. The macroinvertebrates were identified to the lowest possible taxon (Merritt and Cummins, 1996; Pennak, 1978; Swecker et al., 2010; Wiggins, 1977) based on condition of the specimens and equipment available. All identifications were made using an Olympus 10x/22 dissecting microscope. Specimens were further described and categorized by

tolerance, feeding group, and habit. The tolerance of a taxon was defined by its ability to survive exposure to physicochemical stressors that result from chemical pollution, hydrologic alteration, or habitat degradation (Stribling et al. 1998). Tolerance values were obtained from Southerland et al. (2005). Feeding group is the dominant mechanism or strategy used for food acquisition (Merritt and Cummins 1996, Stribling et al. 1998). Habit is an organism's method of locomotion or its behavior in relation to its habitat (Merritt and Cummins 1996, Stribling et al. 1998). Specimens for each taxon were counted and the data were analyzed using the methods described by the Maryland Department of Natural Resource's Inland Fisheries Division (MD DNR, 2004) and the Maryland Biological Stream Survey (Southerland et al., 2005). The results and discussion of the analyses are provided in the Appendix of this report.

Results

Fish Population Community

A list of common and scientific names of the nine fish species collected in the NBPR during FY2015 is contained in Table 2. General occurrence for each fish species by station is presented in Table 3. The fish assemblage within the study area of the river is representative of a coldwater community (Steiner, 2000).

Stations 4 and 5 are located within the lower C&R TFA and Westernport P&T TFA river section located from Bluehole downstream to the mouth of the Savage River. Three trout species were collected within area during FY2015 (Table 2). A total of 158 trout were collected or observed for a CPUE of 109 trout/hr. Of the collected trout, 66% were wild trout and 34% were hatchery-origin trout. Rainbow trout data include 47 collected and 46 observed for a total of 93. Wild rainbow trout comprised 57% of the rainbow trout collection with multiple year-classes in the population (Figure 1). Brown trout data include 45 collected and 13 observed for a total of 58. Wild brown trout comprised 71% of the sample, with multiple year-classes present in the population (Figure 2). The remainder of the population was naturalized brown trout from previous fingerling stockings or from recent adult brown trout stockings (Table 4). All five brook trout collected in the river were wild. The mean condition factor for rainbow trout, brown trout, and brook trout was within the optimal range (Table 3). A sample of five juvenile wild rainbow trout was kept to determine the status of whirling disease in the NBPR – results are pending. Separating out the trout data for the Westernport Put and Take Trout Fishing Area (Piney Swamp Run downstream to Savage River section), we obtained a catch per unit effort of 95 trout/hr of electrofishing, and 78% of the collected trout were wild fish.

Discussion

Natural reproduction and multiple year-classes of brook trout, brown trout, and rainbow trout have been documented within the NBPR since trout population surveys began in the early 1990's. The lower C&R TFA is supporting a quality wild trout fishery based on this year's sampling efforts. The Put and Take Trout Fishing Areas at Barnum and

Westernport received more than 10,000 adult trout, making this trout fishing area one of the Maryland's top trout fishing destinations. The economic impact to the local economy of the NBPR's fisheries was recently estimated at nearly $3 million per year (Hanson et al., 2010). The wild and naturalized trout fishery is the major contributor. Therefore, MD DNR will continue to hold discussions with the US Army Corps of Engineers (USACE), MDE, and other user groups within the North Branch Potomac River Advisory Committee to pursue a flow regime and designated uses which will protect this fishery. A flow and temperature model for the critical summer period may be necessary to achieve this objective. The USACE and MD DNR Fisheries Service currently is conducting temperature modeling which will provide guidance in protecting the tailwater trout fishery. A Yellow Springs Instruments water temperature continuous monitor was deployed in the NBPR within the Zero Creel Limit (ZCL) TFA at the Rt. 220 Bridge (Keyser) to measure real-time river temperatures during the critical summer period in 2014.

Management Recommendations

Recommended studies for FY2016 include:

- Continue to monitor for the presence of whirling disease throughout the NBPR trout management areas.
- Trout population surveys for the NBPR should continue in order to monitor the effects of special fishing regulations and water quality enhancements. Coordination of sampling efforts with the USACE will be necessary to arrange for adequate flow levels from JRL Dam. Emergent fry surveys in both C&R TFA should be conducted in May 2016 to access trout reproduction success.
- Fingerling trout stockings should continue in NBPR C&R TFAs (7.3 km) at a suggested rate of 22,500 brown trout fingerlings to supplement the wild trout fishery. About 10,000 adult brown trout and rainbow trout should continue to be stocked in the Put and Take Trout Fishing Areas. A commitment of at least 45,000 brown trout and 45,000 rainbow trout fingerlings annually should be dedicated for the 29 km ZCL TFA.
- Monitoring efforts in the Black Bass Catch-and-Return Fishing Area should be continued to describe age and size structure, physical condition, reproductive success, and distribution of smallmouth bass and largemouth bass.
- Continue temperature monitoring in order to develop a temperature and flow model that would assist resource manager in protection and enhancement of the NBPR's recreational trout fisheries.
- Continue discussions with the Maryland Department of the Environment in order to reclassify the designated use of the river from Laurel Run downstream to Westernport from a Use I to a Use III based on the wild trout and temperature data obtained from this study.

Table 1. North Branch Potomac River sample station locations, 2015.

Station	General Description
1 – Tailrace – Natural Propagation Area	Beginning at a point 123 m downstream from the confluence of the Tailrace and the old river channel and ending 60 m upstream.
2 - Upper C&R Trout Fishing Area	Beginning at a point .4 km upstream of the first power line and ending 183 m upstream.
3 – Barnum P&T Trout Fishing Area	Beginning at the second bridge abutments in Barnum, WV, and ending 183 m upstream.
4 - Lower C&R Trout Fishing Area	Beginning at Bluehole downstream to the mouth of Piney Swamp Run.
5 – Westernport P&T Trout Fishing Area	Beginning at Piney Swam Run downstream to the UPRCWWTP effluent.
5A Westernport to McCoole Zero Creel Limit Trout Fishing Area	Beginning at the UPRCWWTP effluent downstream to the McCoole Boat Ramp.
6 –McCoole (YOY Black Bass)	Beginning at the McCoole Boat Ramp and ending about 300 meters upstream.
6A – McCoole/Black Oak (Zero Creel Trout /C&R Black Bass)	Beginning at the McCoole Boat Ramp downstream to the Black Oak Boat Ramp.
6B – Keyser (YOY Black Bass)	Beginning 300 meters downstream of the Rt. 220 Bridge and ending at the bridge.
7 – Black Oak (YOY Black Bass)	Beginning at the Black Oak Boat Ramp and ending about 300 meters upstream
7A – Black Oak to Pinto (Zero Creel Trout/C&R Black bass)	Beginning at the Black Oak Boat Ramp and ending at the Rt. 956 Bridge in Pinto
8 – Pinto (YOY Black Bass)	Beginning at the Rt. 956 Bridge and ending about 300 m upstream.
8A – Pinto to Cumberland (C&R Black Bass)	Beginning at the Rt. 956 Bridge downstream to the Cumberland Fairgrounds Boat Ramp.
9 – Cumberland Fairgrounds (YOY Black Bass)	Beginning at the Cumberland Fairground Boat Ramp and ending about 300 m upstream.

Table 2. List of common and scientific names of fish collected in the North Branch Potomac River from Lower Catch-and-Return Trout Fishing Area to the upper portion of the Westernport Put and Take Trout Fishing Area, June 24, 2015. General abundance occurrence was derived from sample size and fish were rated as abundant (A), common (C), or scarce (S).

Common name	Scientific name	Station 4	Station 5
blacknose dace	*Rhinichthys atratulus*	A	A
longnose dace	*Rhinichthys cataractae*	S	S
white sucker	*Catostomus commersoni*	C	C
rainbow trout	*Oncorhynchus mykiss*	C	C
brown trout	*Salmo trutta*	C	C
brook trout	*Salvelinus fontinalis*	C	S
blue ridge sculpin	*Cottus caeruleomentum*	S	S
fantail darter	*Etheostoma flabellare*	C	C
walleye	*Sander vitreus*	S	S

Total species = 9

Table 3. Mean total length, weight, and condition factor (K) with ranges for trout species in the North Branch Potomac River Lower Catch-and-Return Trout Fishing Area and upper portion of the Westernport Put and Take Trout Fishing Area, 2015.

Species	N	TL (mm)	W(g)	K
rainbow trout	47	301 (110 -400)	298 (16 -736)	0.98 (0.70 -1.20)
brown trout	45	346 (190-465)	481 (74 -1020)	1.04 (0.81 -1.28)
brook trout	5	172 (155 – 180)	50 (38 -104)	1.17 (0.95-1.03)

Table 4. Fish stocking record for the North Branch Potomac River downstream of Jennings Randolph Lake, 2015.

Date	Species	Number	Size	Area stocked	Source
1/28/15	brown	30,000	425/lb	Zero Creel	Cushwa
Spring	rainbow	5,900	2/lb	Barnum P&T	Albert Powel Hatchery
Spring	rainbow	4,700	2/lb	Westernport P&T	Albert Powell Hatchery
3/18/15	brown	200	1.2/lb	Lower C&R	Cushwa
5/6/15	rainbow	36,000	30/lb	Zero Creel	WV Petersburg Hatchery

Total: Adult rainbow trout = 10,600; adult brown trout = 200; fingerling rainbow trout = 36,000; fingerling brown trout = 30,000

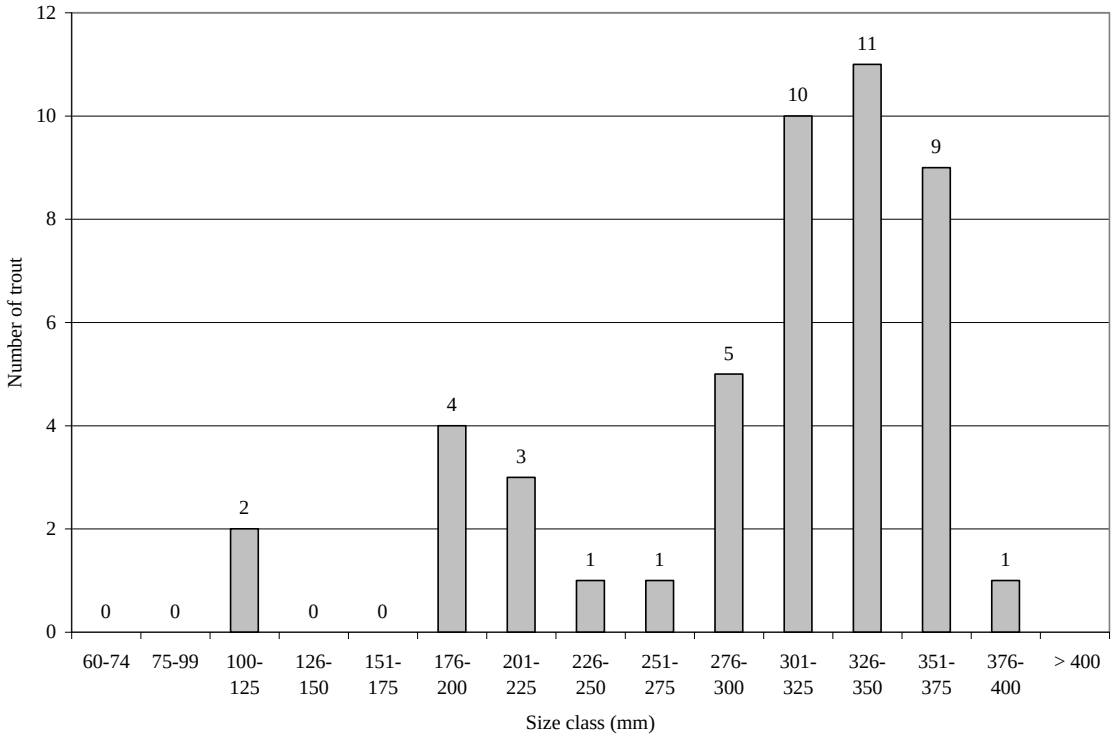

Figure 1. Length frequency distribution of rainbow trout (N = 47) in the Lower Catch-and-Return Trout Fishing Area and the Westernport Put and Take Trout Fishing area (Piney Swamp Run to Savage River) of the North Branch Potomac River, June 2015.

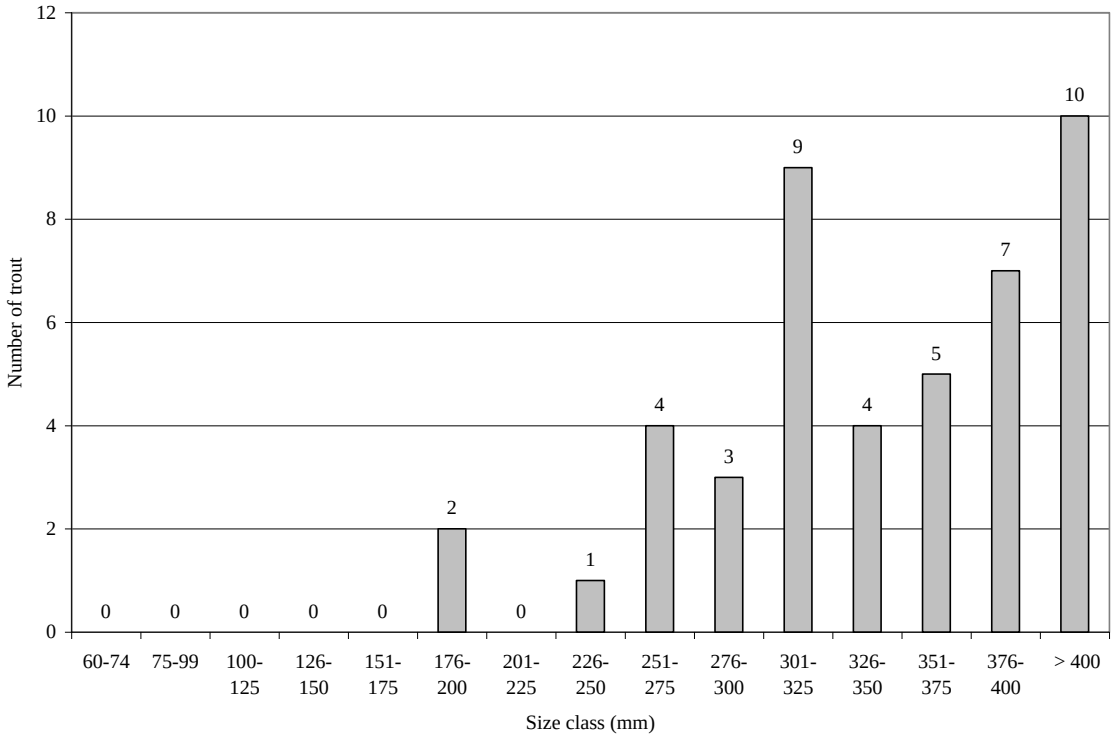

Figure 2. Length frequency distribution of brown trout (N = 45) in the Lower Catch–and-Return Trout Fishing Area and the Westernport Put and Take Trout Fishing area (Piney Swamp Run to Savage River) of the North Branch Potomac River, June 2015.

Appendix: North Branch of the Potomac River Benthic Macroinvertebrate Samples 2015

Benthic macroinvertebrate sampling was conducted on the North Branch of the Potomac River to monitor general habitat and water quality conditions and to observe any impacts on benthic communities resulting from the introduction of *Didymoshenia geminate*. These efforts were continued in 2015, with the additional objective of investigating a decline in water quality conditions below Westernport, MD during the summer of 2014.

Conditions at the farthest upstream station in the Jennings Randolf tailrace indicated moderate habitat degradation. The sample collected at this location had a taxa richness of 20, with 8 taxa representing the orders of Ephemeroptera, Plecoptera, or Trichoptera (EPT). These values reflect a loss in richness that may be caused by habitat degradation. While EPT and taxa richness improved from 2014, this may be due to the earlier survey date in 2015. EPT/C index was the lowest of all sample stations, suggesting that the Chironomidae is may be over represented at this station.

The analysis of functional feeding groups revealed conflicting results, with this station receiving the lowest scraper filterer ratio of all sample stations and the highest proportion of shredders (CPOM) of all sample stations. The dominance of filterers suggested that filamentous algae are abundant and that there may be substantial nutrient enrichment at this location. The high CPOM is usually indicative of forested head water streams and is likely skewed at this station by the disproportionate representation of the amphipod *Gammarus*. This taxon is classified to the shredder functional feeding group and accounted for over 75% of the specimens surveyed.

The dominance of *Gammarus* also explains the particularly low diversity and equitability values at this station, both of which suggest substantial degradation. The Hilsenhoff Biotic Index (HBI) score and Maryland Biological Steam Survey (MBSS) IBI scores also support the idea that this location is degraded. The HBI score was 6.51, indicating fairly poor conditions that are usually the result of organic pollution. The MBSS score was 2.5 with a rating of "poor".

Habitat and water quality conditions improved downstream. Taxa richness increased to 26 with 12 EPT taxa at the upper Catch-and-Return area. The lower Catch-and-Return area had the highest richness surveyed, with a taxa richness of 40 and 21 EPT taxa. Community richness in the upper and lower Catch-and-Return areas appeared to be in good condition with relatively little impact from habitat degradation. The EPT/C index also improved downstream, with the upper Catch-and-Return area receiving an index score of 2.04 and the lower Catch-and-Return area receiving an index score of 4.18.

The analyses of functional feeding groups continued the trend of improving conditions downstream, though the results weren't quite as strong. The scraper filterer ratios at the upper and lower Catch-and-Return areas were 0.07 and 0.40, respectively. This suggests the increasing influence of unicellular algae consuming scrapers at these locations and a

possible reduction in nutrient enrichment. The CPOM values decreased to 0.49 in the upper Catch-and-Return area and 0.43 in the lower Catch-and-Return area. Despite the decrease, shredders remained highly influential in the community and accounted for the dominant family at both stations. Gammaridae remained the dominant family and accounted for almost 50% of the taxa identified in the upper catch and release. However, the community structure shifted downstream in the lower Catch-and–Return area with the family Leutridae accounting for 41% of the sample.

Diversity and equitability improved in the upper and lower Catch-and-Return areas. The diversity in the upper Catch-and-Return area was 2.61 with an equitability of 0.31. While both values suggest that there is still moderate to severe habitat degradation, they did improve from the tailrace. The diversity and equitability in the lower Catch–and-Return area continued to improve to values of 3.49 and 0.40, respectively. The diversity at this location suggested relatively little influence from habitat degradation. While the equitability score was low, the improvement over the upstream locations also suggested that the benthic community at this location is less influenced by habitat degradation.

The HBI and MBSS IBI scores reflected the improvement in habitat and water quality, particularly in the lower Catch-and-Return area. While the HBI score in the upper Catch-and-Return area was only improved slightly over the tailrace station, the MBSS IBI improved to 3.25 and rated "fair". At 3.40, the lower Catch-and-Return area showed substantially more improvement and had the highest habitat and water quality of all stations sampled according to this index. The MBSS IBI score was also higher than all other sample stations, with an index score of 4.00 and "good" rating.

Habitat and water quality appeared to decline in Westernport, with the impacts continuing downstream to varying degrees. Taxa richness decreased to 24, indicating some slight influence of degradation. The EPT richness declined to 13, but was high enough to indicate that the community was under relatively little stress. The decreasing trend continued at the Tritowns station, where richness was lowest of all stations sampled. Taxa richness was 17 and EPT richness was 8, indicating moderate degradation. Taxa richness and EPT richness increased at the downstream stations, suggesting an improvement in habitat and water quality. The taxa richness increased to 22 at the McCoole station and 27 at the Black Oak station. The EPT taxa richness was 10 at the McCoole station and 14 at the Black Oak station. While some slight habitat degradation was observed at McCoole, the improved richness at Black Oak suggested that the community was relatively unaffected by degradation. The EPT/C index generally varied only slightly from the richness trend. The index decreased to 1.06 at the station above George's Creek and increased at each station downstream to 18.14 at Black Oak.

The comparison of functional feeding groups produced slightly varying results in the downstream trend as well. The scraper filterer ratio was 0.55 at the station above George's Creek, higher than all of the upstream stations. However, the ratio declined to 0.03 at Tritowns and 0.04 at McCoole before increasing to 0.83 at Black Oak. While the

community appears to be dominated by filterers immediately downstream of Westernport, scrapers become more significant at the Black Oak station when compared to all other stations. CPOM follows a different trend. No shredders were observed at the station above George's Creek, which is in stark contrast to the abundance of shredders upstream. The CPOM fluctuated at each station downstream, increasing to 0.14 at Tritowns, then decreasing to 0.01 at McCoole before increasing to 0.33 at Black Oak.

Diversity and equitability declined downstream of the lower Catch–and-Return area before improving at Black Oak. Diversity at the station above George's Creek was 3.35 with an equitability of 0.63. These values suggest that community diversity and abundance were not influenced by habitat degradation. Diversity declined to 2.85 at Tritowns and 2.48 at McCoole, suggesting a moderate influence of habitat degradation. Equitability also declined, with the Tritowns sample receiving a score of 0.59 and the McCoole sample receiving a score of 0.36. The diversity and equitability at these stations was influenced by a substantial increase in representation from the Hydropsychidae. Hydropsychids were the dominant family in both samples, accounting for 52% of specimens in the Tritowns sample and 72% of specimens in the McCoole sample. The diversity and equitability increased to 3.71 and 0.70 at the Black Oak station, suggesting that the community structure improved at this location and was not significantly impacted by habitat degradation.

HBI and MBSS IBI scores declined downstream of the lower Catch-and-Return station, but showed some recovery at Black Oak. The HBI score at the station above George's Creek was 5.93, indicating a stream in fair condition with moderate to substantial influence from organic pollutants. The HBI scores declined to 6.01 at Tritowns and 7.22 at McCoole, suggesting that organic pollutants are substantially impacting the community at these locations. The HBI improved to 4.78 at the downstream station at Black Oak, suggesting that conditions improved and the community is less stressed. The MBSS IBI scores supported these results. The station above George's Creek received an index score of 3.75 and rated as "fair". The Tritowns and McCoole sites received scores of 2.75 and 2.5 respectively, and were rated as "poor". The MBSS IBI increased to 3.75 at the Black Oak station, with the rating improving to "fair".

The North Branch of the Potomac River is a diverse system with stretches of river that range from poor water quality that is substantially impacted by habitat degradation to relatively high water quality with little habitat degradation. Direct comparisons can not be made to data collected in 2014 due to sample timing, but the general trends remain similar. Habitat and water quality were relatively poor in the tailrace of Jennings Randolf Lake, but improved substantially downstream in the lower Catch-and-Return area. Conditions then declined in and directly downstream of Westernport before improving at the Black Oak Boat Launch.

Station 1 - North Branch Tailrace, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Acentrella*	1	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	1	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	2	2.3	Collector	cn, sw
Ephemeroptera	*Isonychia*	1	2.5	Filterer	sw, cn
Plecoptera	*Leuctra*	12	0.4	Shredder	cn
Trichoptera	*Cheumatopsyche*	2	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	36	7.5	Filterer	cn
Trichoptera	*Chimarra*	1	4.4	Filterer	cn
Diptera	SF Orthocladiinae	39	7.6	Collector	
Diptera	SF Tanypodinae	2	7.5	Predator	
Diptera	TR Chironomini	4	5.9		
Diptera	TR Tanytarsini	5	3.5	Collector	
Diptera	Unid. Chironomidae	4	6.6		
Diptera	*Hemerodromia*	4	7.9	Predator	sp, bu
Diptera	Unid. Empididae	4	7.5	Predator	sp, bu
Diptera	*Simulium*	5	5.7	Filterer	cn
Diptera	*Pseudolimnophila*	7	2.8	Predator	bu
Amphipoda	*Gammarus*	445	6.7	Shredder	sp
Isopoda	*Caecidotea*	10	2.6	Collector	sp
Unid. Oligochaeta		2	10	Collector	bu
		S = 20 N = 587			

Fisheries Data	**MBSS Data – Highlands**
Richness = 20	Number of Taxa = 20 (3)
EPT = # 56 Taxa 8	Number of EPT Taxa = 8 (3)
EPT/C = 1.04	Number of Ephemeroptera Taxa = 4 (3)
Dominant Family = Gammaridae, 75.81%	% Intolerant Urban = 5.45% (1)
Scraper Filterer Ratio = 0.00	% Tanytarsini = 0.85% (3)
CPOM = 0.78	% Scrapers = 0.00% (1)
Diversity = 1.59	% Swimmers = 0.85% (1)
Equitability = 0.20	% Diptera = 12.61% (5)
HBI = 6.51	IBI = 2.5 Poor

Station 2 - North Branch Upper Catch and Release, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Acentrella*	83	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	1	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	1	2.3	Collector	cn, sw
Ephemeroptera	*Epeorus*	3	1.7	Scraper	cn
Ephemeroptera	*Stenacron*	1	2	Collector	cn
Ephemeroptera	*Paraleptophlebia*	3	2	Collector	sw, cn, sp
Plecoptera	*Leuctra*	9	0.4	Shredder	cn
Plecoptera	*Amphinemura*	2	3	Shredder	sp, cn
Trichoptera	*Hydropsyche*	104	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	cn
Trichoptera	*Hydroptila*	8	6	Scraper	cn
Trichoptera	*Rhyacophila*	15	2.1	Predator	cn
Coleoptera	*Optioservus*	1	5.4	Scraper	cn
Diptera	SF Orthocladiinae	97	7.6	Collector	
Diptera	SF Tanypodinae	6	7.5	Predator	
Diptera	TR Chironomini	1	5.9		
Diptera	TR Tanytarsini	1	3.5	Collector	
Diptera	Unid. Chironomidae	9	6.6		
Diptera	*Chelifera*	6	7.1	Predator	sp, bu
Diptera	Unid. Empididae	11	7.5	Predator	sp, bu
Diptera	*Simulium*	61	5.7	Filterer	cn
Hemiptera	*Palmacorixa*	1	5.6	Predator	
Amphipoda	*Gammarus*	390	6.7	Shredder	sp
Arachnoidea	*Hydracarina*	1	6	Predator	sw
Isopoda	*Caecidotea*	3	2.6	Collector	sp
Unid. Oligochaeta		2	10	Collector	bu
		S = 26 N = 822			

Fisheries Data	**MBSS Data – Highlands**
Richness = 26	Number of Taxa = 26 (5)
EPT = # 232 Taxa 12	Number of EPT Taxa = 12 (3)
EPT/C = 2.04	Number of Ephemeroptera Taxa = 6 (5)
Dominant Family = Gammaridae, 47.45%	% Intolerant Urban = 4.50% (1)
Scraper Filterer Ratio = 0.07	% Tanytarsini = 0.12% (3)
CPOM = 0.49	% Scrapers = 1.46% (1)
Diversity = 2.61	% Swimmers = 10.83% (3)
Equitability = 0.31	% Diptera = 23.36% (5)
HBI = 6.43	IBI = 3.25 Fair

Station 3 - North Branch Lower Catch and Release, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Acentrella*	47	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	8	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	3	2.3	Collector	cn, sw
Ephemeroptera	*Epeorus*	1	1.7	Scraper	cn
Ephemeroptera	*Leucrocuta*	23	1.8	Scraper	cn
Ephemeroptera	*Stenacron*	8	2	Collector	cn
Ephemeroptera	*Stenonema*	16	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	10	2.5	Filterer	sw, cn
Ephemeroptera	*Paraleptophlebia*	25	2	Collector	sw, cn, sp
Plecoptera	Unid. Plecoptera	1	2.4		
Plecoptera	*Leuctra*	371	0.4	Shredder	cn
Plecoptera	*Tallaperla*	2	1.5	Shredder	cn, sp
Plecoptera	*Acroneuria*	8	2.5	Predator	cn
Plecoptera	*Paragnetina*	6	2.2	Predator	cn
Plecoptera	*Phasganophora*	3	2.2	Predator	cn
Trichoptera	*Cheumatopsyche*	9	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	78	7.5	Filterer	cn
Trichoptera	*Hydroptila*	8	6	Scraper	cn
Trichoptera	*Dolophilodes*	9	1.7	Filterer	cn
Trichoptera	*Polycentropus*	2	1.1	Filterer	cn
Trichoptera	*Rhyacophila*	1	2.1	Predator	cn
Coleoptera	*Optioservus*	14	5.4	Scraper	cn
Diptera	SF Orthocladiinae	91	7.6	Collector	
Diptera	SF Tanypodinae	17	7.5	Predator	
Diptera	TR Chironomini	19	5.9		
Diptera	TR Tanytarsini	19	3.5	Collector	
Diptera	Unid. Chironomidae	7	6.6		
Diptera	*Chelifera*	6	7.1	Predator	sp, bu
Diptera	*Hemerodromia*	3	7.9	Predator	sp, bu
Diptera	Unid. Empididae	9	7.5	Predator	sp, bu
Diptera	*Simulium*	46	5.7	Filterer	cn
Diptera	*Antocha*	4	8	Collector	cn
Diptera	*Hexatoma*	6	1.5	Predator	bu, sp
Diptera	*Tipula*	2	6.7	Shredder	bu
Megaloptera	*Nigronia*	1	1.4	Predator	cn, cb
Amphipoda	*Gammarus*	10	6.7	Shredder	sp
Collembola	*Isotomurus*	1	4.8		
Isopoda	*Caecidotea*	1	2.6	Collector	sp
Decapoda	*Cambarus*	1	0.4	Collector	sp
Unid. Oligochaeta		3	10	Collector	bu
		S = 40 N = 899			

Fisheries Data	**MBSS Data – Highlands**
Richness = 40	Number of Taxa = 40 (5)
EPT = # 639 Taxa 21	Number of EPT Taxa = 9 (5)
EPT/C = 4.18	Number of Ephemeroptera Taxa = 9 (5)
Dominant Family = Leuctridae, 41.24%	% Intolerant Urban = 53.62% (3)
Scraper Filterer Ratio = 0.40	% Tanytarsini = 2.11% (3)
CPOM = 0.43	% Scrapers = 6.90% (3)
Diversity = 3.49	% Swimmers = 10.34% (3)
Equitability = 0.40	% Diptera = 25.47% (5)
HBI = 3.40	IBI = 4.00 Good

Station 4 - North Branch Above George's Creek, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Acentrella*	18	4.9	Collector	sw, cn
Ephemeroptera	*Baetis*	36	3.9	Collector	sw, cb, cn
Ephemeroptera	*Drunella*	2	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	3	2.3	Collector	cn, sw
Ephemeroptera	*Epeorus*	3	1.7	Scraper	cn
Ephemeroptera	*Leucrocuta*	4	1.8	Scraper	cn
Ephemeroptera	*Stenonema*	7	4.6	Scraper	cn
Ephemeroptera	*Isonychia*	7	2.5	Filterer	sw, cn
Plecoptera	*Acroneuria*	1	2.5	Predator	cn
Trichoptera	*Cheumatopsyche*	10	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	13	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	1	5.7	Filterer	cn
Trichoptera	*Rhyacophila*	2	2.1	Predator	cn
Coleoptera	*Optioservus*	1	5.4	Scraper	cn
Diptera	SF Orthocladiinae	79	7.6	Collector	
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	1	5.9		
Diptera	TR Tanytarsini	9	3.5	Collector	
Diptera	Unid. Chironomidae	11	6.6		
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Antocha*	5	8	Collector	cn
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Arachnoidea	*Hydracarina*	1	6	Predator	sw
Unid. Oligochaeta		7	10	Collector	bu
		S = 24 N = 224			

Fisheries Data	**MBSS Data – Highlands**
Richness = 24	Number of Taxa = 24 (5)
EPT = # 107 Taxa 13	Number of EPT taxa = 13 (3)
EPT/C = 1.06	Number of Ephemeroptera taxa = 8 (5)
Dominant Family = Chironomidae	% Intolerant Urban = 9.82% (1)
Scraper Filterer Ratio = 0.55	% Tanytarsini = 4.02% (5)
CPOM = 0.00	% Scrapers = 7.59% (3)
Diversity = 3.35	% Swimmers = 29.02% (5)
Equitability = 0.63	% Diptera = 48.21% (3)
HBI = 5.93	IBI = 3.75

Station 5 - North Branch at Tritowns, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Drunella*	1	1.9	Scraper	cn, sp
Ephemeroptera	*Ephemerella*	5	2.3	Collector	cn, sw
Ephemeroptera	*Stenacron*	14	2	Collector	cn
Trichoptera	*Brachycentrus*	1	2.3	Filterer	cn
Trichoptera	*Cheumatopsyche*	7	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	66	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	cn
Trichoptera	*Polycentropus*	2	1.1	Filterer	cn
Coleoptera	*Psephenus*	1	4.4	Scraper	cn
Diptera	SF Orthocladiinae	10	7.6	Collector	
Diptera	TR Chironomini	1	5.9		
Diptera	TR Tanytarsini	3	3.5	Collector	
Diptera	Unid. Chironomidae	2	6.6		
Megaloptera	*Sialis*	1	1.9	Predator	bu, cb, cn
Amphipoda	*Gammarus*	5	6.7	Shredder	sp
Decapoda	*Orconectes*	15	2.8	Shredder	sp
Unid. Oligochaeta		8	10	Collector	bu
		S = 17 N = 144			
Fisheries Data		**MBSS Data – Highlands**			
Richness = 17		Number of Taxa = 17 (3)			
EPT = # 98 Taxa 8		Number of EPT Taxa = 8 (3)			
EPT/C = 6.13		Number of Ephemeroptera Taxa = 3 (3)			
Dominant Family = Hydropsychidae, 52.08%		% Intolerant Urban = 27.08% (1)			
Scraper Filterer Ratio = 0.03		% Tanytarsini = 2.08% (3)			
CPOM = 0.14		% Scrapers = 1.39% (1)			
Diversity = 2.85		% Swimmers = 3.47% (3)			
Equitability = 0.59		% Diptera = 11.11% (5)			
HBI = 6.01		IBI = 2.75 Poor			

Station 6 - North Branch at McCoole Boat Launch, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Baetis*	3	3.9	Collector	sw, cb, cn
Ephemeroptera	*Epeorus*	2	1.7	Scraper	cn
Ephemeroptera	*Stenacron*	2	2	Collector	cn
Ephemeroptera	*Stenonema*	1	4.6	Scraper	cn
Plecoptera	*Leuctra*	1	0.4	Shredder	cn
Plecoptera	*Pteronarcys*	1	1.1	Shredder	cn, sp
Trichoptera	*Brachycentrus*	1	2.3	Filterer	cn
Trichoptera	*Cheumatopsyche*	31	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	121	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	12	5.7	Filterer	cn
Coleoptera	*Optioservus*	1	5.4	Scraper	cn
Coleoptera	*Psephenus*	2	4.4	Scraper	cn
Diptera	SF Orthocladiinae	5	7.6	Collector	
Diptera	SF Tanypodinae	3	7.5	Predator	
Diptera	TR Tanytarsini	4	3.5	Collector	
Diptera	Unid. Chironomidae	2	6.6		
Diptera	Unid. Empididae	1	7.5	Predator	sp, bu
Diptera	*Antocha*	2	8	Collector	cn
Diptera	Unid. Tipulidae	1	4.8	Predator	bu, sp
Megaloptera	*Corydalus*	1	1.4	Predator	cn, cb
Amphipoda	*Gammarus*	1	6.7	Shredder	sp
Unid. Oligochaeta		31	10	Collector	bu
		S = 22 N = 229			

Fisheries Data	**MBSS Data – Highlands**
Richness = 22	Number of Taxa = 22 (3)
EPT = # 175 Taxa 10	Number of EPT Taxa = 10 (3)
EPT/C = 12.50	Number of Ephemeroptera Taxa = 4 (3)
Dominant Family = Hydropsychidae, 71.62%	% Intolerant Urban = 3.49% (1)
Scraper Filterer Ratio = 0.04	% Tanytarsini = 1.75% (3)
CPOM = 0.01	% Scrapers = 2.62% (1)
Diversity = 2.48	% Swimmers = 1.31% (1)
Equitability = 0.36	% Diptera = 7.86% (5)
HBI = 7.22	IBI = 2.50 Poor

Station 7 - North Branch at Black Oak Boat Launch, 6-30 sec kicks on June 15, 2015					
Order	**Family/genus**	**Count**	**Tolerance**	**Feeding**	**Life habit**
Ephemeroptera	*Baetis*	6	3.9	Collector	sw, cb, cn
Ephemeroptera	*Ephemerella*	4	2.3	Collector	cn, sw
Ephemeroptera	*Stenacron*	10	2	Collector	cn
Ephemeroptera	*Stenonema*	25	4.6	Scraper	cn
Plecoptera	Unid. Plecoptera	2	2.4		
Plecoptera	*Perlesta*	23	1.6	Predator	cn
Plecoptera	*Pteronarcys*	2	1.1	Shredder	cn, sp
Trichoptera	*Brachycentrus*	5	2.3	Filterer	cn
Trichoptera	*Cheumatopsyche*	2	6.5	Filterer	cn
Trichoptera	*Hydropsyche*	40	7.5	Filterer	cn
Trichoptera	Unid. Hydropsychidae	2	5.7	Filterer	cn
Trichoptera	*Pycnopsyche*	3	3.1	Shredder	sp, cb, cn
Trichoptera	Unid. Philopotamidae	1	2.6	Filterer	cn
Trichoptera	*Polycentropus*	2	1.1	Filterer	cn
Coleoptera	*Dubiraphia*	1	5.7	Scraper	cn, cb
Coleoptera	*Macronychus*	1	6.8	Scraper	cn
Coleoptera	*Dineutus*	1	4	Predator	sw, dv
Coleoptera	*Psephenus*	16	4.4	Scraper	cn
Diptera	SF Tanypodinae	1	7.5	Predator	
Diptera	TR Chironomini	2	5.9		
Diptera	TR Tanytarsini	4	3.5	Collector	
Hemiptera	*Rhagovelia*	4	6	Predator	skater
Megaloptera	*Sialis*	7	1.9	Predator	bu, cb, cn
Odonata	*Calopteryx*	2	8.3	Predator	cb
Amphipoda	*Gammarus*	51	6.7	Shredder	sp
Decapoda	*Orconectes*	23	2.8	Shredder	sp
Unid. Oligochaeta		1	10	Collector	bu
		S = 27 N = 241			

Fisheries Data	**MBSS Data – Highlands**
Richness = 27	Number of Taxa = 27(5)
EPT = # 127 Taxa 14	Number of EPT Taxa = 14 (5)
EPT/C = 18.14	Number of Ephemeroptera Taxa = 4(3)
Dominant Family = Gammaridae, 21.16%	% Intolerant Urban = 32.78% (1)
Scraper Filterer Ratio = 0.83	% Tanytarsini = 1.66% (3)
CPOM = 0.33	% Scrapers = 17.84% (5)
Diversity = 3.71	% Swimmers = 4.56% (3)
Equitability = 0.70	% Diptera = 2.90% (5)
HBI = 4.78	IBI = 3.75 Fair

Nontidal Potomac River
Cumberland, MD Downstream to District of Columbia
(Allegany, Frederick, Montgomery, and Washington Counties)

Introduction

The non-tidal Potomac River, or Upper Potomac River as it is usually called, provides outstanding angling opportunities for several popular gamefish species. Forming Maryland's southern boundary for over 320 km, the river is readily accessible to residents of Maryland's western-shore counties as well as nonresidents from Virginia and West Virginia. It is no surprise then, that the Potomac River is Maryland's "most fished" and favorite freshwater fishing destination (Rivers, 2004). The invasive flathead catfish (*Pylodictis olivaris*) was first observed in the nontidal Potomac River in 2002. Since 2013 this species has become much more common in fish surveys and angler catches.

Objectives

Surveys were conducted to assemble the fish population data necessary to make appropriate management decisions with the goal of protecting and enhancing the popular Potomac River sport fisheries. Fishery management activities conducted on the Potomac River during the first half of 2015 including electrofishing to assess the adult walleye and flathead catfish stocks with the following objectives:

- Assess walleye (*Sander vitreum*) size structure, year-class strength, and collect brood stock for hatchery production.
- Gather baseline life history and distribution data for flathead catfish to include age and growth and stomach contents.

Methods

Adult fish were collected by electrofishing according to the methods outlined in the Study IV general methods section. Population indices for walleye and flathead catfish were determined using the methods described in the Study IV general methods section.

To obtain length at age data for walleye, five fish from each 2-cm length groups are sacrificed to obtain sagittal otoliths. Highly variable year-class strength has made it necessary to collect otoliths over multiple years so that most age classes were represented. Otoliths were prepared and ages estimated using the method described by Heidinger and Clodfelter, 1987. Length at age was predicted using the vonBertalanffy growth equation. Total annual and instantaneous mortality was estimated using the FAST program by catch-curve regressions and using the formula presented by Gulland (1976) based on the vonBertalanffy growth function and length frequency data.

All flathead catfish captured were sacrificed, measured to the nearest mm, weighed within 10 grams, the lapillus otoliths were removed and prepared following the methods

described by Koch and Quist (2007) for preparing fin rays and spines, and the percent occurrence of stomach contents was recorded.

Results and Discussion

Walleye

The Potomac River walleye population is monitored by spring electrofishing collections below Dams 4 and 5 to obtain length at age and length frequency distributions and during annual fall electrofishing collections at sites throughout the river to obtain measures of adult and YOY relative abundance and proportional size distribution. The primary objective of the daytime fall electrofishing surveys is to assess the smallmouth bass population; however, all walleye observed during the surveys are collected, measured, and weighed.

Spring daytime electrofishing surveys were conducted at Taylors Landing downstream of Dam 4 on 3/19/2015 and 3/23/2015 and at Williamsport downstream of Dam 5 on 3/23/2015. A total of 77 walleye were collected during 1.5 hrs of electrofishing for a $CPUE_{Hr}$ of 52 walleye/hr. A comparison of walleye incremental length frequency from the spring electrofishing collections 2006 - 2015 reveals a current population dominated by large, older age fish and a lack of recent recruitment (Figure 1). The lack of walleye in the stock-quality increment in 2013 (3%), 2014 (2%), and 2015 (0%) reflects poor reproduction and survival of stocked fingerlings since 2012; the median percent walleye in the stock-quality increment 2006 – 2014 was 9%. Frequent spring flooding and high, turbid conditions occurred during this period and likely were the factors most responsible for the poor survival. Mion, et al. (1998) documented a significant, inverse relationship between larval survival and river discharge in the Sandusky and Muamee Rivers in Ohio.

Seventy percent of the 2015 collection consisted of walleye ≥ preferred length (510 mm, 20”). Although the current walleye size distribution should be very attractive to anglers and provide excellent fishing opportunities, continued poor recruitment will reduce catch rates and fishing quality. The largest walleye collected by electrofishing from the Potomac River during an electrofishing survey was collected during the spring of 2013; the pre-spawn female measured 753 mm (29.7”) in total length with an otolith estimated age of 13 years. A 736 mm gravid female weighing 4575 g (10.1 lbs) was collected during the spring 2015 survey.

A total of 31 mature walleye (17 male, 14 female) collected during the 2015 spring surveys were retained and transported to the Manning Warmwater Hatchery for brood stock. A summary of walleye stocking in the nontidal Potomac River since 2001 is presented in Table 1. All walleye fingerlings stocked in the Potomac during 2013, 2014, and 2015 were marked with oxytetracycline hydrochloride (OTC) to differentiate them from wild fish during future surveys following the methods described by Fielder (2002). Initial results suggest that stocking efforts are contributing significantly to year-class strength. Unfortunately, overall year-class strength has been poor since stocking resumed in 2011.

Flathead catfish
Since the first collection of a flathead catfish in the nontidal Potomac River in 2002, flathead catfish were not collected again until 2012. On June 10, 2012 an angler caught a large adult flathead near Williamsport. This fish was verified by a DNR biologist and measured 923 mm (37.5") in total length and weighed 10.98 kg (24.2 lbs) and was subsequently aged at 24 years old by examining the sectioned lapillus otolith. Two additional flathead catfish were collected during the 2012, fall electrofishing survey, also at Williamsport. These fish measured 404 mm and 490 mm in total length and weighed 660 g and 1335 g, respectively and were estimated to be 4 years old based on the sectioned otolith. No flathead catfish were collected during the routine 2013 Potomac River electrofishing surveys.

During 2014, a total of 18 flathead catfish were collected and sacrificed ranging in total length from 370 mm (14.6") to 697 mm (27.4"). Flathead catfish were collected from all established sampling sites between Dam 5 and Dam 3 near Harpers Ferry, WV. Lapillus otoliths were successfully removed from all but one of the fish and examined to estimate age (Table 2).

A total of 26 flathead catfish were collected during the first half of 2015. Other than one flathead collected by low frequency (7.5 pps) boat electrofishing, all others were caught by angling. These fish ranged in length from 360 mm to 813 mm. Otoliths were removed and prepared for analysis. Otoliths collected during the fall 2015 electrofishing surveys will be prepared and analyzed along with the spring samples and the results presented in the FY 2016 Federal Aid Report.

Management Recommendations

The Potomac River mainstem continues to provide excellent fishing opportunities and the following management actions are recommended:

Walleye
- Continue the spring electrofishing surveys below Dams 4, 5, to expand on current walleye length at age data, monitor size structure, and assess the previous years reproductive success.
- Monitor adult and YOY walleye relative abundance using the CPUE of night electrofishing surveys conducted during October. Surveys should be conducted at Dargan, Shepherdstown, and Taylors Landing (2 samples per site).
- Continue spring brood collections.
- To achieve the highest quality walleye fishery from the limited resources available, fingerling walleye stocking efforts should be limited to the 1129 ha stretch between Dam 5 and Dam 3 (Washington County) at a target stocking rate of approximately 35 fingerlings per hectare. The annual stocking of 40,000 fingerlings in this river segment should be adequate to supplement existing

natural reproduction. All fingerlings should be marked with OTC to evaluate the contribution of hatchery fish during future surveys.

Flathead Catfish

- Conduct a low frequency (15 pps) electrofishing surveys at below Dam 5, the Williamsport power dam, and Dam 4 during June to evaluate the expansion of the flathead catfish population.
- Obtain baseline diet data by examining stomach contents and recording items ingested, quantity of items ingested and percent occurrence of identified items.
- Increase length-at-age data by estimating age using sectioned lapillus otoliths from all collected flathead catfish.
- Educate anglers on the ecological dangers of introducing new species through Department media and by posting informational signs at fishing access areas.

Table 1. Summary of walleye stocking in the nontidal Potomac River 2001 – 2015. No stocking occurred from 2001 – 2010.

Year	Source	Number	Stocking Location	% OTC mark (hatchery stock)
2001 - 2010	-	0	-	-
2011	Potomac - Manning	23,000	Dam 4 to Dam 3	-
2012	Potomac - Manning	23,000	Dam 4 to Dam 3	-
2013	Potomac - Manning	33,000	Dam 5 to Dam 3	(4/ 7) 57%
2014	Potomac - Manning	40,000	Dam 5 to Dam 3	(8/21) 38%
2015	Potomac - Manning	67,000	Dam 5 to Dam 3	TBD fall 2015

Table 2. Length, weight, and lapillus otolith estimated age of flathead catfish collected from the nontidal Potomac River.

Location	Date	Length (mm)	Weight (g)	Age
Dargan	10/6/2014	379	550	3
Big Slackwater	3/27/2014	495	1300	6
Williamsport	10/14/2014	389	520	2
Shepherdstown	10/7/2014	610	2505	5
Shepherdstown	10/7/2014	370	465	3
Shepherdstown	10/7/2014	503	1340	3
Shepherdstown	10/7/2014	672	3050	5
Shepherdstown	10/7/2014	682	3920	5
Shepherdstown	10/7/2014	697	3440	5
Taylors	10/28/2014	416	750	3
Taylors	10/28/2014	420	725	3
Taylors	10/28/2014	473	1140	-
Taylors	10/28/2014	575	2200	4
Taylors	10/28/2014	680	3690	4
Taylors	10/28/2014	683	3995	5

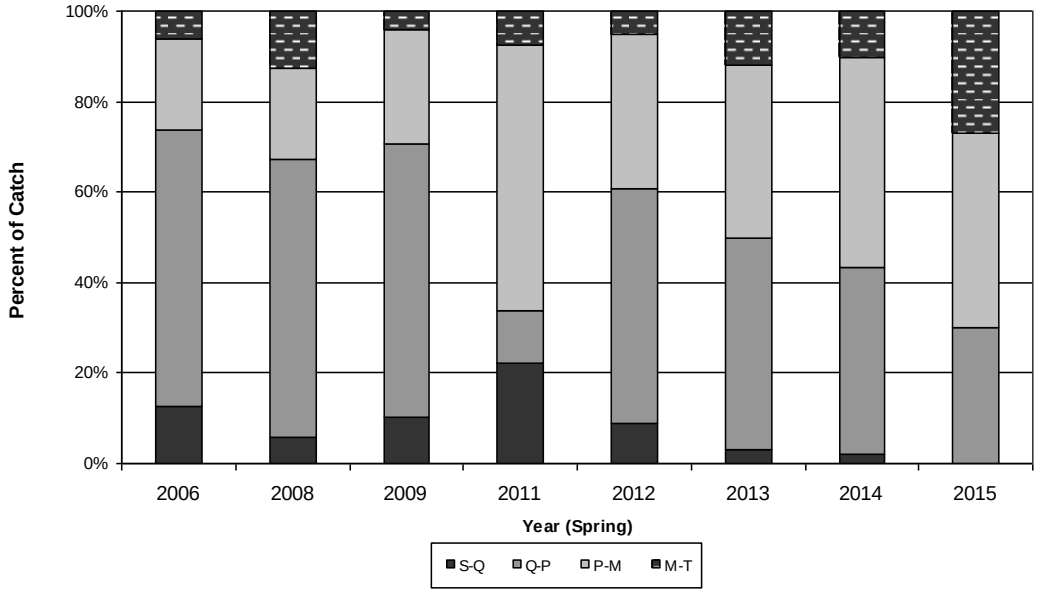

Figure 1. Incremental length frequency distribution of Potomac River walleye collected by spring, daytime electrofishing 2006 – 2015.

State: Maryland

Project Number: F-48-R-25
Study No.: IV
Job No.: 2

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Major Rivers

Job Title: Invasive Species Studies – 2015 Chesapeake and Ohio Canal Investigation

Introduction

Invasive aquatic species can cause ecological and economic harm. Although firmly established in the tidal Potomac River, northern snakehead (*Channa argus*) has yet to be documented from the nontidal Potomac watershed upstream of the natural barrier provided by Great Falls. The 35 km section of the Chesapeake and Ohio (C&O) Canal between Violettes Lock and Georgetown is watered much of the year. A total of 27.5 km of this is within Maryland. The watered canal is believed to be a possible avenue for northern snakeheads to bypass Great Falls. Three sites (Lock 5, Widewater, and Pennyfield Lock) within the Maryland watered section were surveyed by electrofishing in 2008 to assess the sport fisheries and look for the presence of northern snakehead. No northern snakehead were observed or captured from the canal during the 2008 surveys.

During late June of 2014, a National Park Service (NPS) volunteer reported that two snakehead were caught by fishermen from the C&O Canal between mile marker 19 and 22, both upstream of Great Falls. At least one of the fish was killed and removed from the site. In September of 2014, NPS maintenance staff met with Inland Fisheries staff to determine possible sampling access, evaluate the canal habitat with regards to sampling strategy, and discern general water flow into and out of the canal during general canal operation and during flood events. Heavy growth of submerged aquatic vegetation (SAV) limits effective sampling to the spring of the year. It was determined that conducting surveys during May would offer the best opportunity to capture snakeheads from the complex canal environment. Survey efforts focused on sections of the canal upstream of Great Falls (Great Falls to Violets Lock) where snakeheads would have access to the Potomac River.

Methods

During May of 2015, boat electrofishing surveys were conducted in four sections, Violets Lock to Pennyfield Lock, Pennyfield Lock to Swains Lock, Swains Lock to Great Falls, and Widewater downstream of Great Falls. A USFWS crew surveyed the canal from Swains Lock downstream to Great Falls. A 4.3 m (14') jon boat powered by a Mercury 15 hp four stroke outboard motor and equipped with a 2.5 GPP Smith-Root pulsator unit and a single anode dropper was used to collect fish. Due to NPS restrictions, a 12V electric motor was used to power the boat during the 2008 surveys. Electrofishing was

conducted at 60 pulses per second and 5 amps and preceded tight to shoreline areas and visible cover. All centrachid species were collected during the first run. During subsequent runs only largemouth bass were collected. All fish were held in an onboard insulated livewell with a 12 volt recirculating pump until the end of the run. Fish were measured to the nearest mm and weighed in grams (± 5 g) and released. Population indices for largemouth bass and sunfish were calculated using the methods described in the Study IV general methods section.

Results

A total of 25 fish species representing nine families were documented during the 2015 survey. In 2008, a total of 23 species representing eight families were documented. Four species collected during 2008 that were not collected during 2015 were northern hogsucker (*Hypentelium nigricans*), rosyface shiner (*Notropis rubellus*), brown bullhead (*Ameiurus nebulosus*), and walleye (*Sander vitreum*). Six species were collected in 2015 that were not collected during 2008. These species were white sucker (*Catostomus commersoni*), yellow perch (*Perca flavescens*), warmouth (*Lepomis gulosus*), redear sunfish (*Lepomis microlophus*), pumpkinseed sunfish (*Lepomis gibbosus*), and a single juvenile northern snakehead (*Channa argus*) captured between Violets Lock and Pennyfield Lock. The juvenile snakehead measured 178 mm in length and weighed 45 grams. All of these species were considered scarce.

Largemouth bass and sunfish species were the predominant sportfish observed in the C&O Canal. Smallmouth bass, redbreast sunfish, longear sunfish, and sucker species were most abundant between Violets Lock and Pennyfield, but were very scarce or not observed at Widewater (Table 1). These species are abundant in the Potomac River suggesting there is some influx of river species at Violets Lock whereas the presence of gizzard shad and white perch in the lower canal sites imply some exchange from the tidal Potomac River. The absence of these species upstream of Widewater implies that significant barriers to upstream movement exist.

The C&O Canal is currently providing good fishing opportunities for largemouth bass (*Micropterus salmoides*) and sunfish, predominantly bluegill (*Lepomis macrochirus*). The $CPUE_{60}$ for stock and quality-size as well as the size distributions of largemouth bass were fairly consistent between sampling periods, symptomatic of a relatively stable environment (Table 2). Largemouth bass PSD values overall fell within the 40 – 70% range and RSD_{380} values were within the 10 – 25% range suggested by Anderson (1980) for a balanced population. The PSD was highest at Widewater (83) and slightly below the suggested range at Pennyfield (39) and Swains (36), largely due to greater recruitment and percentage of bass in the stock – quality increment.

Bluegill made up nearly the entire sunfish collection at Widewater (a single redbreast sunfish was collected). However, at Pennyfield and Swains Locks, the sunfish population consisted of a combination of bluegill (63%), redbreast sunfish (21%), longear sunfish (12%), pumpkinseed (4%), and a single redear sunfish. The CPUE for stock and

quality size bluegill and sunfish is presented in Table 3 along with size distribution data. The percentage of quality size and greater sunfish (150 mm +) was significantly lower at Widewater than upstream at Pennyfield and Swains (combined). No sunfish ≥ preferred length (200 mm) were collected at any site.

Discussion

The watered sections of the C&O Canal between Violets Lock and Great Falls, including Widewater below Great Falls, are supporting recreational fisheries for largemouth bass and sunfish species. Multiple year-classes of these lentic species implies a fairly stable environment within the canal. However, a greater abundance of lotic species closer to Violettes Lock and tidal species at Widewater suggest that there is some exchange between the Potomac River and the C&O Canal and that the lock system within the canal does impede, to some extent, fish movement within the canal.

Nevertheless, the collection of a juvenile northern snakehead in the Violettes Lock to Pennyfield Lock section of the canal documents that this invasive species is now present upstream of Great Falls. With an abundance of water exchange between the Potomac and the canal, particularly during flood events when water from the canal overtops the towpath, it is nearly certain that the northern snakehead has now gained access to the nontidal Potomac River watershed. Outreach efforts following the discovery of the juvenile snakehead between Violets and Pennyfield Locks have generated several photo documented reports of snakehead guarding schools of fry in the District of Columbia section of the canal. This suggests that snakehead are more widely distributed within the canal than originally thought.

The northern snakehead was listed by the U.S. Fish and Wildlife Service in 2002 as an injurious species to other wildlife and wildlife resources and subject to the provisions of the Lacey Act based on the predatory nature of snakehead fishes, their potential to become established in most of the United States, and the competitive advantage their life history provides. The northern snakehead is an air breather from the late juvenile stages enabling them to tolerate hypoxic conditions. Snakeheads possess suprabranchial chambers for aerial respiration allowing them to remain out of water for considerable periods of time and bury themselves in mud during drought conditions. The northern snakehead is capable of spawning several times during a season and vigorously defends their fry. Okada (1960) reported that the northern snakehead is capable of spawning five times per year. These life history traits increase the difficulty in preventing, eradicating, managing, or controlling their spread in all but small, closed, isolated waters.

The Maryland Department of Natural Resources is working cooperatively with the USFWS and the NPS to develop northern snakehead monitoring and removal programs for the C&O Canal. The canal system is believed to offer habitat more favorable to the establishment and propagation of northern snakehead than the nontidal Potomac mainstem. In the tidal Potomac River, northern snakehead have shown a preference for shallow waters with a soft substrate, little flow, and dense submerged, emergent, and

floating vegetation (Odenkirk and Owens, 2005; Gascho Landis and Lapointe, 2010, Love and Newhard, 2012). Confronting and reducing northern snakehead abundance in the canal offers the best opportunity to limit emigration into the nontidal Potomac River. Manipulation of water levels, electrofishing, and increasing angler harvest through outreach are believed to be the best management options for reducing snakehead abundance in the C&O Canal.

Table 1. Fish species collected by boat electrofishing from the Chesapeake and Ohio Canal at three sites between Violets Lock and Widewater, May 2015. X denotes presence.

Common Name	Scientific Name	Pennyfield Lock	Swains Lock	Widewater
American eel	*Anguilla rostrata*	X	X	X
Gizzard shad	*Dorosoma cepedianum*			X
Spotfin shiner	*Cyprinella spiloptera*		X	
Common Carp	*Cyprinus carpio*	X	X	X
Golden shiner	*Notemigonus crysoleucas*		X	
Spottail shiner	*Notropis hudsonius*	X	X	
Creek chubsucker	*Erimyzon oblongus*	X	X	
White sucker	*Catostomus commersoni*	X		
Golden redhorse	*Moxostoma erythrurum*	X	X	X
Yellow bullhead	*Ameiurus natalis*	X	X	
Channel catfish	*Ictalurus punctatus*			X
White perch	*Morone americana*			X
Warmouth	*Lepomis gulosus*		X	X
Redbreast sunfish	*Lepomis auritus*	X	X	X
Green sunfish	*Lepomis cyanellus*			X
Pumpkinseed	*Lepomis gibbosus*	X		
Bluegill	*Lepomis macrochirus*	X	X	X
Longear sunfish	*Lepomis megalotis*	X	X	
Redear sunfish	*Lepomis microlophus*		X	
Smallmouth bass	*Micropterus dolomieu*	X	X	
Largemouth bass	*Micropterus salmoides*	X	X	X
White crappie	*Pomoxis annularis*		X	X
Black crappie	*Pomoxis nigromaculatus*	X		X
Yellow perch	*Perca flavescens*	X	X	X
N. snakehead	*Channa argus*	X		
Species Richness		16	17	14

* Warmouth also observed in Swains Lock to Great Falls section by USFWS (Josh Newhard, personal communication).

Table 2. Mean catch per unit effort (CPUE) and size distribution of largemouth bass collected by electrofishing from the Chesapeake and Ohio Canal during 2008 and 2015 with 95% CI. * Arithmetic mean. All other CPUEs are geometric means.

Canal Section	Pennyfield & Widewater	Pennyfield, Swains, Widewater
Year	**2008**	**2015**
CPUE (stock+)	37 (16 – 83)	41 (27 – 63)
CPUE (quality+)	17 (5 – 56)	19 (14 – 26)
CPUE (preferred+)	6 (3 – 15)	6* (1-10)
PSD	54 (41 – 67)	46 (36 – 55)
RSD_{380}	18 (8 – 28)	12 (6 – 18)
N (stock +)	96	159

Table 3. Catch per unit effort (CPUE) and size distribution of sunfish collected by electrofishing from the Chesapeake and Ohio Canal during 2015. All sunfish at Widewater were bluegill. Bluegill, redbreast sunfish, longear sunfish, and pumpkinseed combined at Pennyfield and Swains Lock.

Canal Section	Widewater	Pennyfield & Swains
CPUE (stock+)	196	179 (68 – 479)
CPUE (quality+)	18	31 (6 – 151)
CPUE (preferred+)	0	0
PSD	9 (1 – 16)	22 (17 – 27)
N	56	253

State: Maryland

Project Number: F-48-R-25
Study No.: IV
Job No.: 2

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Major Rivers

Job Title: Invasive Species Studies in the Tidal Potomac River and Tributaries

Summary

The population of northern snakehead (*Channa argus*) is monitored in the Chesapeake Bay watershed and was studied for its potential impacts on natural resources. This work was done to help satisfy goals and objectives presented in the Draft National Control and Management Plan for Members of the Snakehead Family (Channidae) as adopted by the Aquatic Nuisance Species Task Force in 2014. The goals and objectives that this project satisfied were: 1) develop long-term adaptive management options to mitigate potential impacts of snakehead in U.S. waters where eradication is not possible; and 2) conduct research to better understand potential impacts of snakehead on aquatic ecosystems, as well as to develop more effective surveillance, control and eradication methods. In order to achieve these goals and objectives in Maryland, the MD DNR monitored an index of relative abundance, angler reports, and creel census to determine whether control initiatives (e.g., public awareness, contests, commercial harvests) lower biomass or contain spread of the species; and conducted experiments to determine the impacts of snakeheads in Maryland waters by examining prey preferences of snakeheads in ponds.

No work has been done to yield an index of relative abundance for 2015 and datasets to examine whether incentives lower biomass are currently incomplete. Twenty-four snakeheads were harvested by agencies in Pomonkey Creek between May and July. During June, a snakehead tournament harvested 1871 pounds of snakeheads from Potomac River. Unfortunately, northern snakehead has spread beyond Potomac River and into neighboring rivers, as far north as the upper Chesapeake Bay. A single individual was collected from the Susquehanna River flats in June 2015.

The data examining impacts of snakeheads in Maryland's non-tidal waters are incomplete. In 2015, three, 2-week pond studies have been conducted with snakeheads to assess prey preferences and impacts to non-tidal fish communities. An additional 2 week pond study was conducted without snakehead. These data will be analyzed similar to data collected in 2014 and a better understanding of impacts, relative to largemouth bass, will be determined.

Introduction

Invasive aquatic species can cause ecological and economic harm. Once a non-native species is introduced, it is necessary to determine its effect on the ecosystem. A broad

consensus may then be reached on its potential or actual impacts, leading to its being regarded as an invasive, nuisance, or injurious species. By determining its relative impacts, fishery managers may need to adjust regulations or effect change in angler behaviors to protect natural resources. Three aquatic species that are widely considered invasive in Maryland's tidal freshwaters include: blue catfish (*Ictalurus furcatus*); flathead catfish (*Pylodictus olivaris*); and northern snakehead (*Channa argus*). Of these, northern snakehead has been given attention as a species that could lead to declines in biodiversity, spread disease (Iwanowicz et al., 2013), and share prey resources or spawning habitats with largemouth bass (*Micropterus salmoides*)(Saylor et al., 2012), possibly leading to problems with the largemouth bass fishery (Love and Newhard, 2012; Love et al., in press).

This present study was done to help satisfy goals and objectives presented in the Draft National Control and Management Plan for Members of the Snakehead Family (Channidae) adopted by the Aquatic Nuisance Species Task Force in 2014. The goals and objectives that this work satisfied were: 1) develop long-term adaptive management options to mitigate potential impacts of snakehead in U.S. waters where eradication is not possible; and 2) conduct research to better understand potential impacts of snakehead on aquatic ecosystems, as well as to develop more effective surveillance, control and eradication methods.

Objectives

Northern snakehead

1) To monitor the relative abundance of northern snakehead in targeted tidal freshwater habitats.
2) To determine how predation by northern snakehead affects fish communities.

Methods

Relative abundance

No work was conducted to obtain this index during the reporting period.

Predation impacts

Predation by snakeheads can impact aquatic ecosystems by directly causing death of individuals, which may be measurable at a population level. This is the primary way that aquatic nuisance species affect the ecosystem. Predation by snakeheads was examined using controlled, laboratory designed studies and field observations.

Lab experiments. Predation impacts of snakeheads on fishes were assessed by adding an adult snakehead to an outdoor pond with a known fish community for two weeks. At the end of the two week period, the remaining fishes were tallied. For comparison, a largemouth bass adult was similarly added to the outdoor pond in separate, replicate experiments. The pond was 1/4 acre, lined and filled with water from a reservoir. It was covered with a 50 mm mesh net to prevent bird or mammal predation. Structure was

added to the pond to include buoys, floats, a 2 m x 3 m plastic structure, 2 nest boxes made of wood (1 m x 1 m), and 2 cinder blocks. The pond was aerated to ensure dissolved oxygen levels exceeded 5 ppm during the experiment.

The fish community differed slightly for each replicate run, but generally included spiny rayed fishes (yellow perch, *Perca flavescens*); sunfish or crappie (redear sunfish, *Lepomis auratus*; pumpkinseed, *Lepomis gibbosus*; and/or bluegill, *Lepomis macrochirus*; black crappie, *Pomoxis nigricans*); juvenile largemouth bass (*Micropterus salmoides*) and soft rayed fishes, which included water column dwellers (goldfish, *Carassius auratus*; gizzard shad, *Dorosoma cepedianum*; creek chubsucker, *Erimyzon oblongus*) and top minnows (banded killifish, *Fundulus diaphanus*). These are species that have been identified in the diet of northern snakehead (unpubl. data, USFWS 2004 - 2013; MD DNR, 2013). Because these species or stages for species are generally invertivores and of relatively similar sizes, predation among them was considered insignificant. Additionally, minimal predation among species was expected to be similar between experiments and not influence these results. All fish in the experiment were measured before and after to learn which species were consumed and what sizes were preferred. In some cases, the predator (either snakehead or largemouth bass) was weighed before and after the experiment.

Field observations. Predation impacts were also assessed by examining gut contents for snakeheads and compare those with published reports (Saylor et al., 2012).

Results and Discussion

General
There were 76 snakeheads caught by agencies in 2015 from the Potomac River. One was captured and killed from Susquehanna River. An additional 6 were captured and killed from Prospect Bay, near Wye River.

Predation impacts.
Lab experiments. Experiments have been conducted during summer (June - August). Changes in mesocosm fish communities were examined during 3, 2-week experiments when northern snakehead was the predator. Because the fish communities differed slightly among experiments, the species in the community were aggregated into 5 levels for analysis: 1) sunfish; 2) golden shiner/goldfish; 3) spiny rayed fish; 4) other minnows; and 5) predator (either northern snakehead or largemouth bass).

In general, snakeheads consumed between 3 and 13 fish in 2 weeks without much evidence of species preference.

Field observations. For 25 snakeheads caught and examined for gut contents by agencies, most were collected with fish in their stomachs (56%). Fish prey, when identified, included sunfish, perch, minnow, snakehead, longnose gar, largemouth bass, and American eel. Crayfish were found in 32% of guts examined. One gut had a

dragonfly larvae in it. About a third of the snakeheads (36%) had multiple prey items in the gut. There were 24% of snakeheads with nothing in the gut.

Recommendations

Response to 2014 Recommendations: As recommended in 2014, data were shared with the snakehead task force. Since 2013, MD DNR and USFWS have partnered to learn whether agency harvest can reduce populations of snakeheads. This partnership has also helped develop other incentives for harvesting, such as joint participation at snakehead tournaments and publications.

2015 Recommendations: 1) Share information with snakehead task force ; 2) Develop and maintain inter-jurisdictional creative ways that encourage harvest of snakeheads; 3) Continue mesocosm design experiments (acclimate adult predator to pond for 1 month prior to the addition of fish; use the same predator throughout the field season, if possible; include tessellated darter and more banded killifish into the mesocosm experiment); 4) Continue field observations of species distributions and develop hypothesis tests that further the defensibility of field and mesocosm work; and 5) Improve upon density estimates of snakeheads in suitable habitats to provide variance estimates that bound population estimate for Potomac River.

State: Maryland

Project Number: F-48-R-25
Study No.: IV
Job No.: 2

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Major Rivers

Job Title: Invasive Catfish in Maryland's Tidal Tributaries

Introduction

Since the late 1990's the blue catfish (*Ictalurus furcatus*) population in Maryland has increased to include many of the tributaries of the Chesapeake Bay. The tidal Potomac River has the largest population of blue catfish in Maryland but the Patuxent River and Upper Bay populations are growing rapidly. Most of the studies involving these big fish have occurred on the Potomac River between the Woodrow Wilson Bridge (near Washington DC) and Mallows Bay in Charles County. Studies have focused on diet composition, age, growth and fecundity. Blue catfish collected in the tidal Potomac River in 2015 were examined for stomach content, age and fecundity of mature fish.

Blue catfish are a concern in Maryland because of their great size, survivability and potential to eat large numbers of fish. They are opportunistic feeders who target fish as a food source at a young age. The initial concern when blue catfish first appeared in Maryland was the impact that they may have on sensitive species, primarily the alosids. American and hickory shad are both protected in Maryland and there has been an aggressive restoration program in place to restore strong numbers of both species in their historical rivers. Blueback herring and alewives are now also protected in Maryland. Research conducted on dietary habits of blue catfish in other states indicates that blue catfish will heavily utilize all these species when present (Graham, 1999).

Methods

Blue catfish were collected from the Potomac River during May and June, 2015 to examine diet, population structure, and life history attributes. All fish were collected using a Smith-Root SR 18 electrofishing boat equipped with a 9,000 Watt generator. Output was set for low frequency electrofishing. Stunned fish were collected and placed on ice to slow down the digestion process. Fish length (total and forked length, mm), weight (g or kg), sex, ovary weight and maturity were determined at the end of each sampling day. Stomachs contents were removed from deceased fish and sorted into one of 24 categories. Empty stomachs were also recorded.

Ovaries of a subsample of mature females were collected to determine fecundity. For each female, both ovaries were removed and weighed to the nearest gram. One ovary was randomly selected, and a subsample of eggs was taken from the anterior, medial, and

posterior sections and weighed. Total weight of each subsample was approximately 5-10% of the total ovary weight. The diameters of ten eggs were measured either immediately, or within 48 hours from a refrigerated sample. The remainder of the sample was preserved in an ethanol solution and later counted. The total number of eggs per fish, and eggs per unit of mass of fish was then calculated. The mean and confidence interval was then determined.

Sagittal otoliths were removed from blue catfish that were collected from the tidal Potomac River between the Woodrow Wilson Bridge and Mattawoman Creek. Each otolith was embedded in a block of Parks Super Glaze Epoxy and sectioned using a South Bay Technology, Inc. Model 650 Diamond Wheel Saw. Polishing was accomplished with a South Bay Technology, Inc. Model 900 wet grinder using 600 and 800 grit wet/dry Silicon Carbide paper. Sectioned otoliths will be examined using a Bausch and Lomb Stereo Zoom dissecting microscope fitted with a Motic 2300 Digital Microscope Camera. Each image will be aged independently by 2 biologists experienced with otolith aging to determine consensus age.

Results

Fecundity

A preliminary investigation into the fecundity of blue catfish in the Potomac River was initiated in the spring of 2015. Mature fish of varying size and age were collected and both ovaries were removed for examination. Eggs from eighteen fish were measured, counted and recorded. Results show that female blue catfish carry an average of 2,617 (95% CI ± 165) eggs per pound of fish at maturity. This study determined that female blue catfish ovaries typically account for 10% of overall fish weight prior to egg release.

Diet

Of the 234 blue catfish that were collected in spring 2015, 65 (28%) had food items in their stomachs. Of those, 14 (22%) were found to have identifiable clupeids in their guts. This is the first survey that Maryland DNR Inland Fisheries has conducted that documented the use of clupeids as a primary food source during the spring. Diet studies done in previous years during the spring failed to document more than a couple prey items in blue catfish stomachs.

Age

The Virginia Department of Game and Inland Fish has demonstrated that a reliable way to determine if a blue catfish population has reached equilibrium is to track the growth rate of each population. Due to differing forage and density of fish, growth differs greatly between rivers. Maryland DNR Inland Fisheries collected otoliths from the blue catfish that were sacrificed for diet studies. Processing of otoliths in previous years applied the simple method of cracking, grinding and examining the final product under a dissecting scope. This method resulted in a high level of disagreement between biologists aging fish. Since 2014, otoliths were subjected to the more rigorous process of mounting otoliths in a solid medium, sectioning them with a diamond-bit saw, polishing with super-

fine grit wet-paper and then examining under a dissecting scope. Otoliths collected in 2015 are still being processed and should be completed in the winter of 2015.

Discussion

Currently, invasive catfish studies deal primarily with blue catfish. This species has shown the highest rate of spread throughout much of the Chesapeake Bay. Flathead catfish, though present since the 1970's, appear to move into new areas at a much slower rate. They are also encountered much less often using electrofishing gear. The Upper Bay population of flathead catfish has expanded beyond the Susquehanna River. Basic life history information on these fish is needed to determine their impact on resident aquatic plants and animals as soon as possible.

State: Maryland

Project Number: F-48-R-25
Study No.: IV
Job No.: 2

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Major Rivers

Job Title: Invasive Species Studies- Eastern Region

Eastern Region responded to two reports of northern snakeheads in community-owned non-tidal impoundments in spring 2015. All confirmed reports were reported to the US Fish and Wildlife Service for tracking purposes. The first was a 1.5 hectare community pond in Salisbury, MD. The impoundment is located within the Wicomico River watershed. Northern snakehead are already established in the watershed; however the impoundment's water control structure design would make it difficult for fish to pass upstream into the impoundment. Three snakeheads (437 mm, 580 mm, 629 mm) were collected with a 100' haul seine with 1/4" mesh. Given the size of the individuals, it is likely that they have been present there for several years. Genetic tests are pending to try to narrow down the source of the fish.

Also in May 2015, a fisherman reported catching and killing a northern snakehead from a 1.1 hectare impoundment in Queen Anne's County, MD. This was a significant report, since no northern snakehead had been reported to date from that county or the Eastern Bay watershed. The Eastern Bay watershed is quite large, and includes the Wye and Miles Rivers, and several smaller tributaries. After securing landowner permission, Regional Staff along with staff from Maryland Biological Stream Survey extensively surveyed the pond on May 5 and June 4. On each day, the impoundment's entire periphery was sampled three times using a boat mounted electrofishing unit using pulsed DC current. Seven adult snakeheads of varying ages were collected in the May sample. Zero snakeheads were collected in the June sample. Total lengths of the fish collected ranged from 256 mm-565 mm, representing several age-classes of fish and making it likely that they have been present there for several years and are reproducing. Unfortunately, the water control device for this impoundment is not a barrier, and tidal water from a tributary of Greenwood Creek can enter the impoundment during higher water levels. Given these two factors, it is likely that some individuals have already left the impoundment and entered tidal waters. Genetic tests are pending to try to narrow down the source of the fish.

ANNUAL (2015) PERFORMANCE REPORT
January 1 to June 30, 2015

Maryland Department of Natural Resources
Fisheries Service
Inland Fisheries Division

SURVEY AND MANAGEMENT OF FRESHWATER FISHERIES RESOURCES

Management of Maryland's Tidal Freshwater Fisheries

USFWS Federal Aid Grant F-48-R-25

Study V

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Table of Contents
Management of Maryland's Tidal Freshwater Streams

State: Maryland

Project Number: F-48-R-25
Study No.: V
Job No.: 1

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Tidal Freshwater Streams

Job Title: Population Assessment

No work has been done with this assessment.

State: Maryland

Project Number: F-48-R-25
Study No.: V
Job No.: 2

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Tidal Freshwater Streams

Job Title: Juvenile Abundance Survey

No work has been done with this assessment.

State: Maryland

Project Number: F-48-R-25
Study No.: V
Job No.: 3

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Tidal Freshwater Streams

Job Title: Hatchery Contribution

Summary

The objective of Job 3 is to contribute hatchery-reared offspring to targeted tidewater. The first objective was achieved between April and July when 18,315 juveniles (fingerlings and advanced fingerlings) were raised by Manning Hatchery and released from spawning of adults that were captured from the Potomac River. The adults or brood stock were released to their home drainages in June. The fingerlings and advanced fingerlings were released to Patuxent River, Fairlee Creek, and Potomac River. An additional 4000 fingerlings were delivered to Wheelabrator Technologies, Inc. These fish will be raised to advanced fingerling stage and be stocked in October.

Introduction

Success of a sustainable fishery depends on the number of juveniles that reach sexual maturity. Habitat conditions in some drainages of the Chesapeake Bay are potentially harrowing for reproducing adults, which can limit reproduction. Reproduction for largemouth bass depends on habitat conditions and the ability of males to defend their nests effectively. High stream discharge from rainstorm events, lack of habitat structure (e.g., grass or snag), and strong fishing pressure may contribute to greater mortality of juveniles and lower percentages of recruits to older age classes. Infrequent stochastic events (e.g., hurricanes and colder than normal winters) also reduce juvenile survivorship. As a result of reduced recruitment, catch levels decline over time and overfishing occurs. To offset increased natural mortality of juveniles, juvenile largemouth bass that were grown in farm ponds were selectively released to targeted tidally freshwater streams.

Objective

Contribute hatchery-reared offspring to targeted tidewater rivers.

Methods

Fingerlings (50 - 100 mm) that were stocked in Mattawoman Creek (Potomac River) were marked with oxytetracycline (OTC). The adults of these fingerlings may be caught during black bass tournaments. A random subset of these fish die during tournaments.

Because many of the moribund and dead fish obtained during these tournaments are routinely dissected and aged by MD DNR, otoliths are extracted and will be examined for OTC marks. A simple proportion of hatchery-reared fish to wild-caught fish will be computed from tournament mortalities to determine the relative success of hatchery-reared fish entering the fishery.

Advanced fingerlings (100 - 150 mm) were stocked to Fairlee Creek (eastern shore of Maryland) and Patuxent River.

Following the stocking policy (MD DNR, 2015), these fish were released by boat at suitable locations (Love, 2011; Love 2015) at a stocking density of approximately 60 fish per hectare.

Results and Discussion

Fairlee Creek—On July 14, 2015, 525 advanced fingerlings were stocked across 9 sites.

Patuxent River— On July 7, 2015, 510 advanced fingerlings were stocked across 8 sites.

Mattawoman Creek—In June 2015, 17,280 OTC marked fingerlings were stocked to many sites upstream of Slavin's Wharf.

Gunpowder River— In June 2015, 4000 fingerlings were delivered to Wheelabrator Technologies, Inc. so that they will be raised to advanced fingerlings and stocked to several areas of Gunpowder River in September or October 2015.

Recommendations

Response to 2014 Recommendations: A watershed with highly suitable habitat and notable fishing pressure, Mattawoman Creek, was stocked with fingerlings, as recommended, and in periodic support of recruitment. Recent declines in recruitment (MD DNR, 2015) have indicated a need to stock fish to Potomac River. Additionally, adults were removed from Potomac River to spawn offspring to be stocked in other drainages and a proportion of those offspring should be returned to their home river. Fairlee Creek, Gunpowder River, and Patuxent River have black bass fisheries with largely poor or less suitable habitat than Potomac River and the upper Chesapeake Bay (Love, 2011). There was desire to continue to grow these fisheries and thus, advanced fingerlings were stocked as recommended in 2014. Stocking densities were achieved as recommended in 2014.

2015 Recommendations: Consider supplements to hatchery reared fish, such as age 1 or age 2 fish raised on fish farms, to create an immediate fishery in some highly targeted streams by stakeholders, such as Middle River or Gunpowder River.

State: Maryland

Project Number: F48-R-25
Study No.: V
Job No.: 4

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Tidal Freshwater Streams

Job Title: Creel Surveys

Summary

The objectives of Job 4 were to: 1) Determine the number of competitive sportfishing tournaments and angler participation; 2) Assess angling effort on the stock of largemouth bass during the spawning (15 inch) and non-spawning season (12 inch); 3) Quantify and evaluate annual trends in mortality during tournaments; and 4) Assess angling effort directed at largemouth bass by recreational anglers using a Volunteer Angler Survey and the Angler's Log. The Potomac River and upper Chesapeake Bay are the two most targeted watersheds by recreational and tournament anglers for tidal largemouth bass fishing in the Chesapeake Bay watershed.

Introduction

The sport of tournament fishing for black bass provides useful data for black bass management. The catch of tournament anglers, while biased for larger and older fish, may be used to support trends observed from fishery independent studies. The mortality of fish during and following tournaments also provides critical insight into fishing mortality.

In addition to a vast audience and participants in tournament sportfishing, large tournaments may generate over 2 million dollars during a week-long event. Baker (2002) reported that large tournaments can generate 2.4 million dollars in a single event at Lake Champlain, largely because the participating anglers spend more than tourists. The impact to local revenue may be modest, however, stemming partially from poor information on the actual economic impact of a large tournament (pers. comm., D. Dudley, Chief of Tourism, Charles County Economic Development and Tourism). In addition to revenue, tournament fishing promotes a sport both locally and nationally. Television programs that promote largemouth bass fishing are regularly aired on local networks and cable networks. Arguably, no other fishery receives as much national attention as that for black bass.

While competitive sportfishing accounts for a large fraction of participation in the largemouth bass fishery, recreational fishing is also highly valued. In some cases, largemouth bass also provides for a subsistence fishery as it is a meaty fish that provides

a mild, white fillet. The participation by recreational anglers in the black bass fishery has been assessed with creel surveys in the past. To complement the existing creel survey of competitive sportfishing, recreational angling data are collected from the Volunteer Angler Survey (VAS) and MD DNR Angler's Log.

Objectives

1. Determine the number of competitive sportfishing tournaments and angler participation.
2. Assess angling effort on the stock of largemouth bass during the spawning (15 inch) and non-spawning season (12 inch).
3. Quantify and evaluate annual trends in mortality during tournaments.
4. Assess angling effort directed at largemouth bass by recreational anglers using the Angler's Log and a VAS.

Methods

CPAH. Catch per angler hour (CPAH) was determined from tournaments (January 1 - July 21, 2015) that utilized a rule of five bass per angler. The CPAH was calculated as the total number of fish anglers weighed during a tournament, divided by the product of the number of anglers and the number of hours the tournament allowed each angler to fish. The CPAH was the number of fish caught per angler-hour. Essentially, this index reflects the number of fish weighed by an angler on a fishing day, when the maximum allowable was five.

These CPAH estimates were averaged among tournament days for the spawning season (i.e., 1 March – 15 June; the 15" minimum harvest size season) and non-spawning season (the 12" minimum harvest size season) and for each river. Average CPAH was plotted for each year and for each season to evaluate pattern trends.

Survivorship. For the purpose of this study, initial mortality (IM) of an individual was defined as the death of an individual during the weigh-in procedure. In some cases, a fish died after its being weighed. When a fish died after the weigh-in procedure and prior to its being released to the habitat, it was also tallied for IM. A MD DNR fishery biologist was present at all large-tournament events and death of fish prior to their release to the river was noted. Estimates of IM were computed as a proportion that was the number of dead fish divided by the total number of weighed-in fish. Initial Mortality was determined for tournaments held during the spawning and non-spawning season.

Volunteer Angler Survey. A VAS was developed for inland tidal and non-tidal fisheries and posted on-line (http://dnr.maryland.gov/fisheries/survey/index.asp) and advertised, along with others, in the spring using press releases. It was also advertised with the Angler's Log whereby anglers who submitted information immediately received a "thank you" and follow-up email encouraging their participation in the VAS. The survey was incentivized with a random drawing of entries for gift certificates at Bass Pro Shops, Inc.

Angler's Log Data. Anglers have been encouraged for several years to send fishing reports to MD DNR via fishingreports@maryland.gov. Each report may be accompanied by pictures, information on where the angler caught the fish, what fish was caught, and the general disposition of the angling day. While this is a highly biased dataset and was never designed to be a recreational creel survey, some information can be gleaned from the database. The metrics reported are the percentage of all reports associated with largemouth bass fishing, in tidal or non-tidal water, and the top three locations that were reported among anglers.

Results

General. Data were collected for 46 tournaments in Potomac River and upper Chesapeake Bay, during which 2956 anglers each fished approximately 8 hours from March – November on Potomac River and the upper Chesapeake Bay (Table 1). The number of tournament activity reports from the Potomac River was 20. Because data included only part of the year because of new reporting requirements in 2015, it is not possible to compare this level of effort with previous years.

Data were also collected for a small number tournaments held in other tidal waters of the state (Gunpowder River, Choptank River, Nanticoke River, Pocomoke River, Wicomico River), but none have a sufficient dataset for evaluating trends.

In total, anglers reported data for 10,160 lbs and 4,248 fish. There were 74 reported mortalities and 98.2% survival. More fish were caught and weighed in the Potomac River (2,135) than other areas. There were 821 fish caught and weighed in the upper Chesapeake Bay.

Angling Effort. The CPAH for the Potomac River during the non-spawning season was 0.28 bass/ang-hr and higher than that reported for the upper Chesapeake Bay (0.20 bass/ang-hr)(Table 2).

Survivorship. For both Potomac River and upper Chesapeake Bay, average initial mortality (IM) at the weigh-in scale was generally lower than 0.05 (Table 2), which is the reference point cited in the Tidal Bass Fishery Management Plan (FMP).

Volunteer Angler Survey. There were 65 volunteer angler surveys submitted and they represented at least 97 anglers. This participation is incomplete for 2015 and was measured between January 1 and July 21.

The average number of hours per trip was 4.3 hours, slightly lower than the estimate of 2014, with a total of 277 hours reported. Of these anglers, there 35 reports in which largemouth bass was targeted (53.8%). There were 5 reports (7.6%) in which northern snakehead was listed as the target and 4 reports (6.1%) in which trout was listed as the target. By far, largemouth bass was the most targeted by anglers who submitted reports.

Of anglers targeting bass, 43% reports were submitted from anglers who fished non-tidal waters and 31.4% reports, tidal waters. The tidal and non-tidal Potomac River was the most highly targeted tidewater areas by bass anglers. Of 63 anglers who were asked whether they would take the trip again, 62 indicated that they would take the trip again. The one person who would not take the trip again caught and kept only 1 white perch. Two anglers declined to answer the question.

Of the 458 fish caught, the majority of the catch was black bass (35.1%) and sunfish (25.5%). There were 6 snakeheads reportedly caught and all were kept. Anglers kept 1 largemouth bass, 21 sunfish, 5 white perch (12.5% of catch), and 12 trout (44% of catch). Chain pickerel were caught and not harvested. Brook trout was not reportedly caught.

The average spent by anglers targeting largemouth bass ($34.34/trip) was slightly more than that spent by anglers who did not target largemouth bass ($20.23/trip). The total annual incurred costs (including boat costs, engine maintenance, fishing license, tackle) was similar between those targeting largemouth bass ($203.86) and those not targeting largemouth bass ($219.20).

Discussion

The Potomac River and upper Chesapeake Bay remain the two most important tidewater fisheries for largemouth bass. Recreational creel data indicate that a large proportion of recreational anglers are targeting largemouth bass, though a small proportion of the fish caught include largemouth bass.

Fewer tournament anglers are fishing the Potomac River than ever in the past 2 decades. The reduced pressure and steady CPAH indicates that the fishery is less utilized now than ever, but the average number of fish weighed-in per angler has not changed. If reproduction or recruitment improves remarkably and habitat conditions continue to improve, then the fishery may be poised for recovery in the next three to five years.

Reported survivorship levels have not changed noticeably in the Potomac River and upper Chesapeake Bay since 2005. Similar to initial mortality in the Potomac River, initial mortality for the upper Bay was less than 5%, on average. Initial mortality occurs because of hooking injury (Wilde and Pope 2008), handling stress and live well conditions (Gilliland 2002; Suski et al. 2006; Siepker et al. 2007). Mortality is also expected to be higher during summer months when water temperatures are relatively high (Wilde 1998). Nonetheless, many anglers have adopted good handling practices; there remain several observed problems at tournaments, though. These problems include: transport bags with insufficient water, improper holding of fish (e.g., from lip, without support of caudal region), and poor live well maintenance. Awareness may help solve these problems, particularly through the on-line permitting and requirements. Additional on-the-ground work is still encouraged.

Recommendations

Response to 2014 Recommendations: The MD DNR developed a policy for attending tournaments with release boats on Potomac River and upper Chesapeake Bay. In addition, increased attention is given to these fisheries by working with popular weigh-in areas and working toward an infrastructure that can support tournaments, as well as a sustainable population that can support a robust and diverse fishery. In the upper Bay, directors spread around fish by using multiple weigh-in areas. We are currently working with Elk Neck State Park to improve use of that facility by tournament directors, which would further spread around fish. Catch–and-Return areas have been recommended to Sport Fisheries Advisory Commission and will be optioned to the public to obtain feedback from bass anglers. These areas will help minimize the impact of tournament angling on the recreational fishery. Currently, three areas are considered for Potomac River and three areas for upper Chesapeake Bay. A black bass stamp will not be instituted in the near future. However, the licensing database is now requesting whether anglers intend on fishing for black bass. This subgroup of anglers may be targeted by electronic media in order to encourage watching selected videos created by BASS on conservation principles and handling strategies. MD DNR is also working on video topics in partnership with Maryland Youth Fishing. Routine submissions by largemouth bass anglers are encouraged to Angler's Log via postings made by Tidal Bass Program. Such participation may also be encouraged through a new MD DNR hire employed to promote recreational fishing. Participation in the Volunteer Angler Survey has not increased by 3-fold, despite a standardized email advertisement in May 2015. Creative approaches to improve participation may be required. Conservation materials may be provided to ponds/lakes in Central Region, but the disposition of those materials is not clear.

2015 Recommendations: Improve participation in the Volunteer Angler Survey. Continue to promote recreational fishing for Largemouth Bass.

Table 1. History of tournament activity in the upper Chesapeake Bay (UBAY) and Potomac River (POTM). The number of tournaments (#TOURNS) and the sum of participating anglers across days (#ANGLERS) are given for each year (1989, 1994 – 2013). Surveys were not routinely conducted until 1994 and less effort was directed toward the upper Chesapeake Bay until 2005. Numbers in parentheses are catch per angler hour (CPAH) during the 12 inch, non-spawning season and are restricted to tournaments with a five fish allowable creel. The CPAH reflects only weighed-in, legally harvestable fish and not those culled.

YEAR	# TOURNS$_{UBAY}$	# TOURNS$_{POTM}$	# ANGLERS$_{UBAY}$	#ANGLERS$_{POTM}$
1989	NA	8*		1056 (0.28)
1994	18[1]	125[1]	906 (0.20)	5538 (0.28)
1995	5[1]	178[1]	403 (0.34)	6958 (0.31)
1996	5[1]	168[1]	412 (0.22)	4919 (0.33)
1997	20[1]	221[1]	1420 (0.32)	5062 (0.31)
1998	7[1]	272[1]	610 (0.32)	5568 (0.28)
1999	12[2]	72[2]	(0.21)	(0.24)[4]
2000	3[3]	77[3]	(0.24)[4]	(0.24)[4]
2001	4	75	318 (0.18)[4]	3750 (0.21)[4]
2002	16	145	(0.34)[4]	(0.26)[4]
2003	12	82	511 (0.22)	3523 (0.35)[4]
2004	3	107	82 (0.31)[4]	4042 (0.23)[4]
2005	30	98	508 (0.23)[4]	5299 (0.29)[4]
2006	14	103	1062 (0.27)[4]	5730 (0.35)[4]
2007	30	102	719 (0.30)[4]	6397 (0.34)[4]
2008	25	103	764 (0.24)[4]	4802 (0.43)[4]
2009	26	85	1500 (0.30)	3594 (0.41)
2010	41	81	2512 (0.29)	3962 (0.36)
2011	51	64	1308 (0.29)	2938 (0.42)
2012	55	73	1254 (0.36)	3043 (0.37)
2013	84	56	1952 (0.28)	3531 (0.39)
2014	72	39	2195 (0.18)	2277 (0.38)
2015[5]	26	20	821 (0.17)	2135 (0.28)

*incomplete dataset obtained prior to dedicated creel survey efforts (pers. comm., M. Groves, Southern Region Manager, MDDNR)
[1]From MDDNR (1999)
[2]From MDDNR (2000)
[3]From MDDNR (2001)
[4]From MDDNR (2009)
[5]Data are incomplete, includes only January 1 - July 21.

Table 2. Black bass tournaments provided estimates of mortality throughout the weigh-in process (M) and catch per angler-hour (CPAH) of largemouth bass in 2015 (January 1, 2015 - July 21, 2015) for targeted drainages of the Chesapeake Bay watershed. Estimates of [M]ortality are given for Large (L, ≥ 100 anglers) and Small (S, < 100 anglers) tournaments. The CPAH estimates were calculated for the spawning (SP; March 1 – June 15) and non-spawning (NS) seasons. NA = not available.

River	M LNS	M LSP	CPAH SP	M SNS	M SSP	CPAH NS
Potomac	NA	0.01	0.22	0.02	0.01	0.28
Upper Bay	NA	NA	0.17	0	0.02	0.20
Choptank	NA	NA	NA	NA	NA	NA
Pocomoke	NA	NA	0.04	0.03	0	0.36
Wicomico	NA	NA	0.32	NA	0.02	NA
Gunpowder	NA	NA	NA	NA	NA	NA
Marshyhope	NA	NA	0.13	0.07	NA	NA
Sassafras	NA	NA	0.17	NA	0.02	NA

State: Maryland

Project Number: F48-R-25
Study No.: V
Job No.: 5

Project title: Survey and Management of Freshwater Fisheries Resources

Study Title: Management of Maryland's Tidal Freshwater Streams

Job Title: Population Genetic Assessment

No work has been done with this assessment.

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