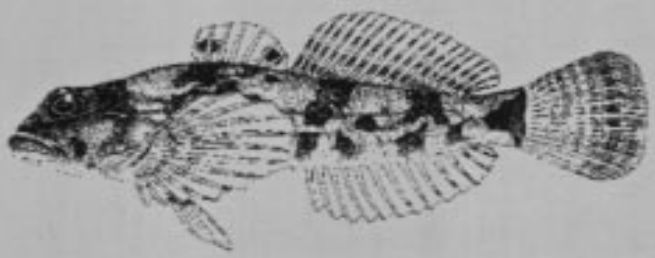
MARYLAND BIOLOGICAL STREAM SURVEY



SAMPLING MANUAL

MONITORING AND NON-TIDAL ASSESSMENT

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MARYLAND BIOLOGICAL STREAM SURVEY

SAMPLING MANUAL

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February 2001

FOREWORD

This report, entitled *Maryland Biological Stream Survey Sampling Manual* dated February 2001, was prepared by the Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources. The purpose of this document is to provide written sampling protocols for the Maryland Biological Stream Survey (MBSS), incorporating changes made to the document after the 1995-97 MBSS was completed. For the most part, the methods described in this manual are identical to the methods used during the 1995-97 MBSS. However, some changes were made to improve the quality and/or usefulness of the data generated. These changes include: modifications to habitat assessment/characterization, the addition of new chemical analytes (total dissolved nitrogen, total particulate nitrogen, nitrite, ammonia, ortho-phosphate, total dissolved phosphorous, total particulate phosphorous, chloride and turbidity), continuous temperature readings in summer, characterization of invasive plant abundance, and the deletion of altitude data collected in the field as a physical variable. In addition, the reach file used to select sites is a 1:100,000 scale map developed by USGS, and survey work has been expanded to include 4th order streams.

Field data collection sheets were modified for the 2001 sampling year to increase their utility. These changes include addition of Golf Course as a Land Use, Leaf Pack as benthic habitat, additional data on culvert size, deletion of field-collected altitude, deletion of sampleabity codes, addition of temp logger information, exotic plants list changed to Phragmites to replace Reed Canary Grass and Microstegium (a.k.a. Japanese Stilt Grass) was added. Flow data was lengthened and the fish crib sheet now has both passes on one page. The Fish Data Sheet now includes anode identification and five anodes instead of four. The corresponding text was also changed to reflect these updates.

ABSTRACT

This manual identifies sampling protocols for the 2000-2004 Maryland Biological Stream Survey (MBSS). Included are sections on quality assurance and quality control, safety and health recommendations, job descriptions, equipment lists, selection of sample sites, sampling methods, sample preservation, and database management. The overall objectives of the MBSS are to assess the current status of biological resources in flowing, non-tidal waters of the state, and secondarily, to examine factors that may explain this current status. Information from the MBSS is used to provide statistical summaries and interpretive reports on ecological status to decision-makers and the public. Selection of variables to be measured during the MBSS was based on applicability across habitats, ease and repeatability of quantification, and known or potential relationship to fishability and/or biological integrity. The procedures and methods outlined in this manual allow unbiased population and subpopulation estimates of aquatic resource quantity and quality to be made on a watershed-specific as well as statewide scale. Repetition of the MBSS in the future will provide data necessary to quantify trends in living resources and habitat in Maryland's streams and rivers. This document supersedes all earlier versions of the manual.

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ATTACHMENTS

RELATED PUBLICATIONS

Provisional Key to the Freshwater Fishes of Maryland

Provisional Key to the Herpetofauna of Maryland

Provisional Key to the Freshwater Mussels of Maryland

Provisional Key to the Aquatic Vegetations of Maryland

Family-Level Key to the Stream Macroinvertebrates of Maryland and Surrounding Areas (CBWP-MANTA-EA-99-2)

MBSS Analytical Laboratory Procedures Manual

Laboratory Methods for Benthic Macroinvertebrate Processing and Taxonomy (CBWP-MANTA-EA-00-6)

MBSS Data Management Manual

MBSS Analytical Procedures Manual

MBSS Design Manual

1.0 PURPOSE OF MANUAL

This document was prepared to support field, laboratory, and data management activities which are part of the Maryland Biological Stream Survey (MBSS). In addition to outlining equipment needs, trip preparation requirements, and sampling and data management procedures to be followed during the MBSS, this manual provides guidance related to the MBSS safety and quality assurance programs as well. To ensure that the objectives of the MBSS are met and potential health risks minimized, it is imperative that all personnel involved in the program read and understand this manual.

The remainder of this chapter provides an overview of the MBSS, including a discussion of the need for a statewide stream survey, the objectives of the MBSS and a description of the survey design.

1.1 NEED FOR A STATEWIDE STREAM SURVEY

The 12,600 miles of streams and rivers in Maryland represent a vital natural resource to the people of the State because of the direct influence of tributaries on Bay water quality, and their importance as habitat for fish and other living resources. In spite of this importance, the current status of most of these waters is unknown, and the relationships between biological conditions and environmental factors are poorly understood. To fill this information need, the State of Maryland designed the Maryland Biological Stream Survey (MBSS) to assess the fishability and biological integrity of streams and rivers in Maryland. The survey will assist decision makers in identifying the geographical distribution of biological resources, prioritizing environmental issues of concern within Maryland's flowing waters, and specifying regions where protection or mitigation activities are warranted. These issues will be of increasing concern as the focus of the Chesapeake Bay restoration program shifts further into tributaries of the Bay.

1.2 MARYLAND BIOLOGICAL STREAM SURVEY OBJECTIVES

One objective of the MBSS is to assess with known confidence the current status of the biological resources in non-tidal streams and rivers in Maryland. Biological resources are evaluated on a local, regional, and statewide basis using two endpoints, fishability and biological integrity. Another objective of the MBSS is to monitor indicators of pollution exposure and habitat condition to identify local, regional, or statewide causes of adverse effects, including acid deposition, point source discharges, and others. Additional objectives of the survey are to provide an inventory of biodiversity in Maryland’s streams and rivers and a means to focus protection and restoration activities. Information from the MBSS is used to provide statistical summaries and interpretive reports on ecological status and fishability to decision-makers and the public.

1.3 DESCRIPTION OF SURVEY DESIGN

1.3.1 General Description

The MBSS is intended to provide estimates of the condition of non-tidal first through fourth order streams and rivers of Maryland on a watershed as well as a statewide scale. The program is based on a probabilistic stream sampling approach-- random selections are made from all sections of streams in the state which can physically be sampled. This approach supports statistically valid population estimation of variables of interest (e.g., trout densities, miles of streams with degraded habitat, etc.). When repeated in later years, the MBSS will also provide a basis for assessing future changes in ecological condition of lotic (flowing) waters in the state.

The MBSS has the following attributes:

- precise definition of target waters and associated sampling units, and determination of an explicit list of all potential sampling units within each target water;
- probability-based sample site selection from a comprehensive list of stream reaches in Maryland, with a tiered sampling approach such that all sample sites have a known, non-zero probability of being sampled;
- standardized sampling methods and index periods for a suite of response, exposure, and habitat measurements; and
- a documented program of ongoing quality control/quality assurance (QA/QC) and assessment.

In combination, the attributes identified above will allow rigorous characterization of sources of variability such as:

- variability among sampling segments within a stream reach;
- variability at a sampling segment within a given index period;
- sample imprecision during collection, processing, and analysis due to sampling crew, laboratory, or other differences; and
- interannual variability.

The MBSS field studies involve collection of biological, physical habitat, and water quality data. In addition, information related to anthropogenic stressors is also recorded. A list of variables measured as part of the MBSS is shown on the data sheets in the ATTACHMENTS Section. Biological variables are used to establish the ecological condition and fishability of streams within a region or watershed. Habitat indicators are used to depict the condition of the riparian and aquatic environment and determine whether habitat is the probable cause of observed ecological conditions. Water quality and

anthropogenic stressor indicators are used to describe and identify potential impairment sources which help to explain the biological conditions observed.

MBSS field studies are conducted during spring and summer. Benthic macroinvertebrates and water quality sampling are conducted during spring, while fish and herpetofauna and evaluation of physical habitat occur during summer. The index periods were selected to:

- obtain water quality data at a time period most pertinent to acidification impacts;
- sample benthic communities at a time of year when community structure provides useful information about environmental stresses at a site;
- sample fish communities during low flow conditions and at a time when major spawning migrations are not in progress; and
- evaluate habitat conditions during the period which is typically most limiting to the abundance of lotic fishes.

To allow statewide, regional, and watershed-specific inferences to be made, the MBSS incorporates a hierarchical probability sampling approach. For logistical reasons, sampling is stratified based on geographic region (west, central and east). Because resource management is increasingly on a watershed basis, sampling is further stratified by watershed (Fig. 1-1).

1.3.2 Site Selection

Sites for sampling are selected from a stream reach file digitized from 1:100,000 scale topographic maps developed by the USGS. Within a basin, the number of sites of each stream order is apportioned based on the total length of that order in the basin relative to the statewide total. To account for landowner refusals, extra sites are selected as backups.

1.3.3 Index Period

To provide a synoptic view of the current ecological status of Maryland streams and provide water quality data pertinent to characterization of acidification effects, MBSS sampling takes place during two index periods, spring and summer. The Spring Index Period extends from 1 March to about 1 May, and the Summer Index Period extends from 1 June to 30 September each year. The duration of index periods was selected to be as broad as possible to accommodate logistical constraints without introducing excessive intra-period variability.

MBSS Watershed Sampling Schedule

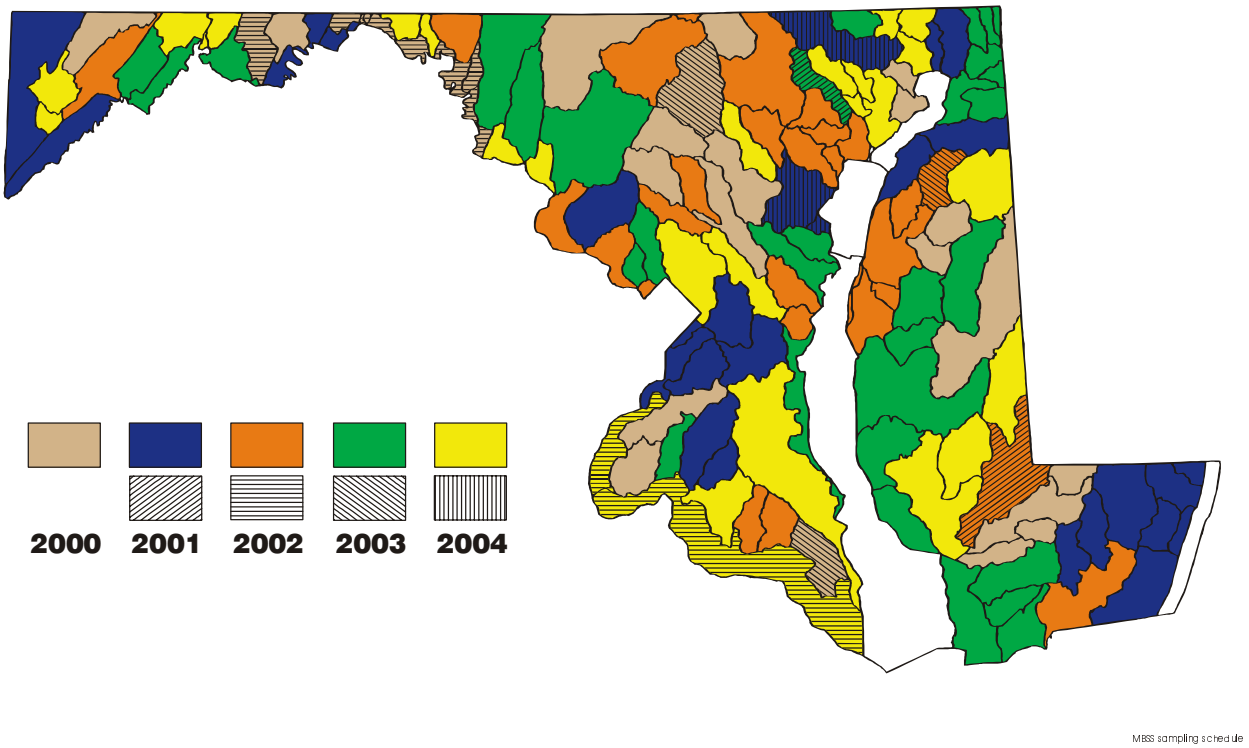

Figure 1-1 Watershed sampling schedule for the 2000-2004 MBSS (watershed names are listed in Table 1-1.

Water quality and benthic macroinvertebrate sampling takes place in spring, with region-specific completion dates developed based on degree-day accumulations of mean air temperatures above 4.5 °C. Fish, herpetofauna and habitat sampling occur in summer. To complete the MBSS across the state, sampling will continue for five years (Table 1-1).

Table 1-1. MBSS 2000-2004 watershed sampling schedule.

Basin	Watershed	Watershed Number (CWAP)	2000	2001	2002	2003	2004
Youghiogheny	Youghiogheny River	135		X			
	Little Youghiogheny/Deep Creek Lake	136/137					X
	Casselman River	138	X				
North Branch Potomac	Potomac River Lower North Branch	129				X	
	Evitts Creek	130					X
	Wills Creek	131					X
	Georges Creek	132				X	
	Potomac River Upper North Branch	133		X			
	Savage River	134			X		
Upper Potomac	Antietam Creek	118				X	
	Potomac WA Co/MarshRun/ Tonoloway/Little Tonoloway	117/119/123/125	X		X		
	Conococheague	120			X		
	Little Conococheague/Licking Creek	121/122					X
	Potomac AL Co/Sideling Hill Creek	124/126		X			
	Fifteen Mile Creek	127	X				
	Town Creek	128	X		X		
Middle Potomac	Potomac River FR Co	112					X
	Lower Monocacy River	113				X	
	Upper Monocacy River	114	X				
	Conewago Creek/Double Pipe Creek	1/115			X		
	Catoctin Creek	116				X	
Potomac Wash Metro	Potomac River MO Co	105			X		
	Piscataway Creek	106		X			
	Potomac Upper Tidal/Oxon Creek	104/107		X			
	Anacostia River	108					X
	Rock Creek/Cabin John Creek	109/110				X	
	Seneca Creek	111		X			
Patapsco	Back River	69			X		
	Bodkin Creek/Baltimore Harbor	70/71		X			X
	Jones Falls	72			X		
	Gwynns Falls	73					X
	Patapsco River Lower North Branch	74	X				
	Liberty Reservoir	75	X			X	
	South Branch Patapsco	76	X				
Patuxent	Little Patuxent River	86	X				
	Middle Patuxent River	87			X		
	Rocky Gorge Dam	88			X		
	Brighton Dam	89	X				
	Patuxent River Lower	82					X
	Patuxent River Middle	83		X			
	Western Branch	84		X			
	Patuxent River Upper	85					X
Lower Potomac	Breton/St. Clements Bays	96/97			X		
	Potomac Lower Tidal/Potomac Middle Tidal	93/94			X		X
	St. Mary's River	95	X			X	
	Wicomico River	98					X
	Gilbert Swamp	99		X			
	Zekiah Swamp	100		X			
	Port Tobacco River	101				X	
	Nanjemoy Creek	102	X				
	Mattawoman Creek	103	X				
West Chesapeake	Magothy River/Severn River	77/78				X	
	South River/West River	79/80			X		
	West Chesapeake Bay	81				X	
Gunpowder	Gunpowder River/Lower Gunpowder Falls/Bird River/Middle River-Browns	62/63/64/68			X		
	Little Gunpowder Falls	65		X		X	
	Loch Raven Reservoir	66			X		
	Prettyboy Reservoir	67	X				
Susquehanna	Lower Susquehanna/Octoraro Creek/Conowingo Dam Susquehanna	2/4/5					X
	Deer Creek	3		X			X
	Broad Creek	6				X	
Bush	Aberdeen Proving Ground/Swan Creek	60/61	X				
	Lower Winters Run/Atkisson Reservoir	57/58					X
	Bush River/Bynum Run	56/59					X

Basin	Watershed	Watershed Number (CWAP)	2000	2001	2002	2003	2004
Elk	Northeast River/Furnace Bay	52/53		X			
	Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek Big Elk Creek/Christina River	45/46/47/48/49/50/51				X	
	Sassafras River/Stillpond-Fairlee	54/55		X			
Chester	Eastern Bay/Kent Narrows/Lower Chester River/Langford Creek/Kent Island Bay	34/37/38/39/44			X		
	Miles River/Wye River	35/36				X	
	Corsica River/Southeast Creek	40/41	X				
	Middle Chester River	42			X	X	
	Upper Chester River	43					X
Choptank	Honga River/Little Choptank/Lower Choptank	29/30/31				X	
	Upper Choptank	32	X				
	Tuckahoe Creek	33				X	
Nanticoke/Wicomico	Lower Wicomico/Monie Bay/Wicomico Creek/Wicomico River Head	21/22/23/24	X				
	Nanticoke River	25		X	X		
	Marshyhope Creek	26					X
	Fishing Bay/Transquaking River	27/28					X
Pocomoke	Pocomoke Sound/Tangier Sound/Big Annemessex/Manokin River	13/18/19/20				X	
	Lower Pocomoke River	14			X		
	Upper Pocomoke River	15		X			
	Dividing Creek/Nassawango Creek	16/17		X			
Ocean Coastal	Assawoman/Isle of Wight/Sinepuxent/ Newport/Chincoteague Bays	8/9/10/11/12		X			

2.0 HEALTH AND SAFETY

The purpose of this chapter is to provide recommendations for health and safety, aspects of the MBSS, primarily to persons involved in field collections for the MBSS. Suggested training and qualifications are described, along with general safety procedures, sampling hazards, provision of first aid, and emergency situations. The recommendations in this chapter are non-binding; the ultimate responsibility for health and safety of field crews lies with the parent organization for each field crew.

2.1 TRAINING AND QUALIFICATIONS

To minimize any potential health and safety risks related to field sampling conducted as part of the MBSS, survey personnel need to be physically able to conduct fieldwork under demanding conditions and be well prepared to handle contingencies or emergencies. The following are suggested requirements for all field survey personnel:

a) Recent (within 1 year) physician's approval to conduct rigorous physical work

b) Recent (within 1 year) CPR certification

c) Recent (within 1 year) Red Cross First Aid Training

d) Complete a satisfactory interview about health and safety aspects of the MBSS with the field crew supervisor, including routine safety precautions and a discussion of actions to be taken in an emergency.

e) Each crew member should be vaccinated for hepatitus and Lyme's disease.

In addition to the recommendations identified for all survey personnel, Crew Leaders should have adequate field sampling experience under rigorous conditions.

2.2 DUTIES AND RESPONSIBILITIES

This section outlines the health and safety responsibilities of persons involved with field activities of the MBSS.

2.2.1 Field Crew Supervisor

The Field Crew Supervisor for each organization involved in sampling has overall responsibility for health and safety aspects of the portion of the MBSS for which that organization is responsible.

2.2.2 Crew Leader

Field Crew Leaders are responsible for ensuring that day to day activities of the field crew are conducted in as safe a manner as possible. Recommended health and safety responsibilities of the Crew Leader include:

- instruction and supervision of the survey team such that sampling and travel at a given site are done in a manner which minimizes health and safety risks;
- reporting to the Field Crew Supervisor or his/her designee any unusual health and safety conditions, emergencies, or accidents encountered during the deployment of the crew. In the case of accidents or emergencies, the Crew Leader should, as soon as the situation permits, notify the Field Crew Supervisor or his/her designee by direct phone contact;
- ensuring that vehicles and sampling equipment are in safe operating condition prior to and during field deployments;
- ensuring that all members of the survey team are fully aware of any potentially hazardous materials used as part of sampling. Examples include preservatives for biological and chemical samples;
- determination as to whether sampling conditions are safe and appropriate;
- informing the survey team of any situation-specific dangers involved at a given site;
- ensuring that vehicles are operated in a safe manner; and
- ensuring that samples and sampling equipment are safely stored prior to vehicle operations.

2.2.3 Field Crew Members

All personnel involved in field sampling or field observations (e.g., QA/QC inspections) should be aware of the risks involved with the routine aspects of MBSS. A number of these potential risks are outlined in section 2.3. When unsafe or hazardous conditions are observed, crew members should inform the Crew Leader at the earliest opportunity. In addition, crew members should notify the Crew Leader if, for any reason, they can not perform an assigned task in a safe manner. Examples include sickness, physical limitations, or a lack of confidence in operating the sampling equipment.

2.2.4 Laboratory Personnel

All personnel involved in laboratory activities should follow guidelines established by OSHA for safe laboratory operations, including: adequate eye protection, transfer of potentially harmful chemicals under a hood, maintenance of a clean and neat work area, and safe storage and disposal of chemicals.

2.3 SAMPLING HAZARDS AND PROCEDURES FOR MINIMIZING RISK

There are a number of potential health and safety considerations specific to the MBSS. A number of these hazards are common to all sampling sites, while others may be site- or region-specific. This section lists a number of hazards likely to be encountered during the MBSS as well as measures to minimize the health and safety risks associated with them.

2.3.1 Vehicle Accident

As with nearly all other field sampling programs, there is a risk of a vehicular accident. To minimize this risk, the following measures should be taken:

- an inspection of the sampling vehicle should be performed by the Crew Leader or a designee prior to sampling departure. This inspection should include tire condition and operability of wipers, defroster, etc.;
- during sampling activities, any potentially unsafe vehicle condition should be reported to the Field Crew Supervisor and corrected as soon as is practicable;
- if, in the judgement of the Crew Leader, the sampling vehicle is not safe to operate, the vehicle should not be operated until the condition is rectified; and
- vehicles should not be operated by crew members who are incapable of safely operating them. No sampling vehicle should be operated by a person not holding a valid drivers license.

2.3.2 Electric Shock

Failure to observe appropriate safety precautions when using backpack electrofishing gear could result in electric shock. Under worst case conditions, this shock could result in cardiac arrest and loss of life. To minimize risks associated with electrofishing during the MBSS, the following measures shall be taken:

- only personnel designated by Field Crew Supervisors should operate the backpack electrofishing unit;
- Watertight rubber gloves should be continuously worn during all electrofishing operations. Gloves should not be taken off to remove fish from the water;
- to minimize the amount of body surface area potentially exposed to electric shock, normal wading gear for the MBSS should be chest waders. When deemed appropriate by the Crew Leader, hip boots may be worn in lieu of chest waders. Standard rubber boots should not be worn during electrofishing. The bare wire portion of the cathode (rattail) should never be touched while the unit is in operation;
- only non-leaking wading gear should be used during electrofishing-- if a leak is discovered, wading gear should be changed and the leaking gear repaired or replaced prior to the next use;
- electrofishing should only be conducted when a minimum of three persons are present at a site. In the event of electric shock, this provides for one person to administer CPR while another seeks medical assistance. Use of a portable phone is also recommended as an effective means to summon emergency medical care if necessary;

- if the Crew Leader determines that stream conditions at the time of the site visit present an abnormal risk of electric shock, he or she will determine that the site is not sampleable and sampling will be conducted at an alternate segment or canceled in that reach;

- prior to each use, electrofishing gear should be verified to be in safe working condition by the Crew Leader. This verification should include an examination of external wiring and electrical connections; and

- in cases where two electrofishing units are used at a segment, extra care should be taken to ensure that unit operators maintain an awareness of all personnel in the water. In addition, unit operators should maintain adequate spacing between units to minimize the risks of shock from both electric fields in the event a crew member slips or falls into the water, or the discharge of one anode completing the switch circuit for another unit.

2.3.3 Hazardous Terrain

A routine part of sampling during the MBSS is traveling over rough terrain to access the sample site. One of the risks arising from this aspect of the MBSS is the possibility of injury from falling. To minimize this risk, the following preventive actions are recommended:

- when necessary, the Crew Leader will make a determination that access to the sampling segment is not possible and the procedures for alternate sampling will be implemented;

- when traveling over any extensive distance, appropriate footwear should be worn instead of waders or hip boots;

- equipment should be distributed equitably among crew members for transport from the vehicle to the site; if determined to be necessary by the Crew Leader, more than one trip to transport equipment should be made;

- to the greatest extent possible, travel between the vehicle and the sample site should occur during daylight hours; and

- only in unusual circumstances (as determined by the Crew Leader) should a crew member travel alone over hazardous terrain.

2.3.4 Fast or Deep Water

During the MBSS, some sampling segments may be visited which have fast and/or deep water in them. Sampling in locations which are too deep or too fast for wading could result in injury or drowning. It should be noted that sampling fast and/or deep waters also increases the likelihood of electrical shock; thus a high degree of caution is imperative for safe operations. To minimize health and safety risks associated with sampling in fast and/or deep waters, the following steps should be taken:

- prior to sampling, the Crew Leader should ensure that all crew members who are to enter the stream are physically fit to do so and are aware of any specific sampling risks at the site;

- prior to sampling, the Crew Leader should make a determination as to whether the site can be sampled by wading without undue risks. If a negative determination is reached, the site should be revisited at another time or not sampled;

- all field crew members should wear chest waders outfitted with waist belts and felt soles or cleats should be used in rocky areas.

2.3.5 Slippery Substrate

During the MBSS, sampling at some sites will be hazardous due to slippery substrate. Examples of streams types which may have treacherous substrates include streams affected by acidic mine drainage and streams with high silt loads. To minimize the risks associated with slippery substrates, the following measures are recommended:

- the Crew Leader should factor the degree of slipperiness of the substrate into decisions as to whether a stream segment can be sampled and any extra precautions to be taken by the field crew; and

- all wading gear should have felt soles and/or cleats.

2.3.6 Dangerous Animals or Plants

Sampling at some sites during the MBSS will include risks associated with dangerous animals and/or plants. Poison ivy is likely to be common along many travel routes used by the sampling crew, as well as in riparian vegetation. Poison ivy roots on tree trunks offer particular risks since they are often unnoticed. Another plant which occurs in boggy areas and should be avoided is poison sumac. Faunal risks in Maryland include northern copperheads, timber rattlesnakes, free-ranging domestic dogs, and rabid mammals of any species. To minimize the risks associated with dangerous animals and plants during the MBSS, the following measures are recommended:

- all field survey personnel should receive training in field identification, avoidance of, and first aid for dangerous plants and animals which may be encountered during the MBSS;

- crew members should inform their Crew Leader of any known allergies and keep appropriate medical relief in the field first aid kit (at a minimum, each crew should keep an emergency supply of benadryl); and

- the Crew Leader should make all crew members aware of site- or situation-specific dangers as they are noted. Similarly, field crew members should inform the Crew Leader as soon as they are discovered.

2.3.7 High Bacterial Levels

When sampling in areas downstream of sewage or other organic waste inputs, potentially dangerous bacterial levels may exist. In urban areas, the presence of such inputs may be clearly evident by smell, observation of solids and floatables, and/or the presence of sewage fungus on bottom substrates. However, in some areas, potentially dangerous bacterial levels could be present in a stream without any direct evidence. To minimize the health risks associated with high bacterial levels in streams, the following measures should be incorporated into field surveys:

- all MBSS field personnel may be exposed to water known or suspected to contain human wastes. Therefore, all crew members should be immunized against tetanus, hepatitis, and other infectious diseases;

- during development of the itinerary, the Crew Leader should examine the list of NPDES discharge permits and investigate through MDE any known pollution problems in the watershed being sampled. Using this information, a determination should be made as to whether special safety precautions are necessary;
- prior to entering the stream, the Crew Leader should make note of any evidence of high bacterial levels and inform the field crew;

- the use of gloves should be maximized during the sampling process;

- open wounds should not be exposed to contact with stream water; and

- after exposure to stream water, all crew members should wash their hands in isopropyl alcohol and clean water prior consuming any food or drink.

2.3.8 Hazardous Waste

Because of historical disposal practices, hazardous wastes may be present at an unknown number of stream segments to be sampled during the MBSS. Risks of relatively brief exposure (such as sampling during the MBSS) to hazardous wastes are likely to be low, but precautions still need to be taken to minimize exposure probabilities. These include:

- prior to commencement of field sampling under the MBSS, the Field Crew Supervisor or his/her designee should review existing information (through MDE and EPA) about known or probable hazardous waste sites in Maryland in relation to MBSS sample sites. After review of available hazardous site information, the Field Crew Supervisor should inform the Project Officer of any hazardous waste sites in areas designated to be sampled. Any such areas identified will be sampled by a crew that has received OSHA hazardous waste safety training (as specified in 29 CFR 1910.120). The crew for sampling segments at hazardous waste sites will be identified by the Project Officer;

- all sampling at hazardous waste sites will be conducted in accordance with site health and safety plans and only after proper advance notice has been given to authorities on site;

- MBSS personnel who participate in sampling should participate in a Medical Monitoring Plan established by the Contractor for the hazardous site sampling crew. Medical Monitoring should include baseline, yearly, and exit examinations;

- after sampling at or in the vicinity of hazardous waste sites, all exposed equipment should be thoroughly rinsed, including waders and any exposed personal equipment;

- no food should be consumed at known hazardous waste sites.

2.3.9 Hypothermia

Many of the sites sampled during the MBSS will be in remote locations. At these locations, the potential for stranding and prolonged exposure to extreme weather conditions is of concern, especially during the spring sampling period. There is also a potential for prolonged exposure to cold water in the case of accidents, emergencies or other unusual conditions. Recommended precautions to reduce the possibility of hypothermia or related illnesses include:

- each field crew should carry several space blankets at all times when in the field during the Spring Index Period;

- Crew Leaders should be responsible for monitoring weather conditions and adjusting or postponing sampling plans as appropriate; and

- prior to leaving the vehicle for a sampling site, the Crew Leader should ensure that crew members are properly clothed and that emergency supplies are taken to the site.

2.3.10 Lightning Strike

As sampling during the MBSS will occur over relatively long periods of time in spring and summer, exposure of field crews to electrical storms is likely. To minimize risks associated with a lightning strike the following measures should be taken:

- Crew Leaders should be responsible for monitoring weather conditions with weatherband radio, adjusting sampling schedules as appropriate to minimize the chance of a field crew being exposed to an electrical storm while in a remote location; and

- in the event of an electrical storm while sampling, sampling activities should be halted and the Crew Leader should determine whether to return to the vehicle or seek local shelter.

2.4 FIRST AID

During any field sampling activity such as the MBSS, there is a possibility that first aid will need to be administered. To meet this need, all personnel should be trained in first aid. In addition, each field crew should maintain a stocked first aid kit, including an injection kit for allergic reactions, in both field sampling equipment and in the sampling vehicle.

2.5 EMERGENCIES

In the event of a medical or other emergency, the Crew Leader or senior technician should take all appropriate immediate actions and should send for appropriate assistance using the fastest available means. In the event the emergency occurs at a remote location, all necessary information to guide assistance personnel should be provided, including map coordinates if known and appropriate. As soon as practicable thereafter, the Field Crew Supervisor and Project Officer should be informed.

3.0 QUALITY ASSURANCE

The purpose of this chapter is to outline QA/QC activities which are part of MBSS field activities. The chapter includes descriptions of documentation procedures, responsibility and accountability of project personnel, training requirements, facilities, and equipment.To achieve the objectives of the MBSS, it is imperative that all project personnel follow the procedures and guidance provided in this chapter.

3.1 INTRODUCTION

Quality assurance and quality control (QA/QC) are integral parts of data collection and management activities of the MBSS. The field QA program for the MBSS was designed to: 1) ensure that data are of known and sufficient quality to meet the project objectives, and 2) provide estimates of various sources of variance associated with the individual variables being measured.

To be effective, the QA program must continually monitor the accuracy, precision, completeness, comparability, and representativeness of the data during all phases of the program. Components of the MBSS field QA program include:

- thorough investigator training;
- development of and adherence to project protocols and guidelines;
- comprehensive field and laboratory data documentation and management;
- verification of data reproducibility; and
- instrument calibration.

3.2 POPULATION OF INTEREST

The current population of interest for the non-tidal component of the MBSS includes all non-tidal, 4th order and smaller stream reaches of the State of Maryland, with the exception of reservoir-like impoundments which substantially alter the riverine nature of the reach.

3.3 COMPARABILITY AND COMPLETENESS

Comparability of data between field crews is maximized by providing standardized training in MBSS techniques prior to sampling. Training requirements are specified by the Project Officer and included in the Scope of Work for each organization involved in field sampling. Training is mandatory for all participants of both the Spring and Summer Index Periods.

To utilize data from a given sampling segment during analyses, all data included on the MBSS data

sheets which pertains to the analysis being conducted must be validated, plus all appropriate site location data.

3.4 DOCUMENTATION

To ensure scientific credibility, study repeatability and cost effectiveness, all project activities of the MBSS need to be adequately documented. These activities include itinerary development, landowner contacts, adherence to sampling protocols, equipment calibration, field sampling, review of data sheets, field notes, information management, data quality assessment, data analyses, and interpretation of data. To minimize the possibility that needed documentation or data is not recorded, standardized forms and on-site verification of form completions by supervisory personnel are included as part of the MBSS. Each of the activities listed above is described in other sections of this manual, including documentation procedures and requirements.

3.5 RESPONSIBILITY AND ACCOUNTABILITY

The purpose of this section is to define the organizational structure and responsibilities of personnel involved in the MBSS. As multiple organizations are involved in the MBSS, adherence to the chain of authority and information outlined below is paramount to successful completion of the MBSS.

A number of personnel report directly to the Project Officer-- the Training Officer, the Quality Control Officer (QC Officer), the Field Crew Supervisor for each organization involved in field sampling, and the Data Management and Analysis Officer (DM Officer). Crew Leaders report to their respective Field Crew Supervisor for day to day activities and emergencies. The responsibilities of each of these personnel are described in the following sections.

3.5.1 Project Officer

The MBSS Project Officer has overall responsibility for successful completion of the MBSS. Specific duties of the Project Officer include selection of subordinates, direction and approval of training activities, contractor oversight, liaison with the public and resource agencies, document review, and peer review solicitation.

3.5.2 Training Officer

The Training Officer is responsible for training of all field sampling personnel. At the direction of the Project Officer, the Training Officer coordinates with the QC Officer and the Field Program Leader to implement remedial or additional training deemed necessary during MBSS field sampling intervals.

3.5.3 Quality Control Officer

The QC Officer is responsible for implementation of all aspects of the MBSS QA/QC program, including inspection of field crews, data validation, taxonomic verification, site confirmation, calibration and maintenance of equipment, adherence to established protocols, and prompt identification of

necessary remedial or corrective actions. The QC Officer is also responsible for oversight of laboratory QA/QC managers to ensure that all MBSS laboratory activities meet MBSS QA/QC requirements.

3.5.4 Field Crew Supervisor

The Field Crew Supervisor is responsible for day to day communication with Crew Leaders, coordination and approval of sampling schedules and itineraries, and other activities designated by the Project Officer.

3.5.5 Crew Leader

The Crew Leader is responsible for crew safety, sample scheduling, equipment maintenance and calibration, and performance of all sample collection activities in accordance with procedures and QA/QC requirements specified in the survey manual.

3.5.6 Field Sampling Crew

Members of the sampling crew are responsible for carrying out the instructions of the Crew Leader and informing the Crew Leader of any unsafe conditions, equipment, or other problems observed which could jeopardize the health and safety of the crew or the quality of sample collections.

3.6 TRAINING REQUIREMENTS

An important aspect of the MBSS QA program is the training program for field personnel which will be conducted prior to sampling. Training ensures consistent implementation of required procedures and attainment by each person of a minimum level of technical competency. **All participants in MBSS field sampling must receive training as specified by the Project Officer, and Crew Leaders must successfully pass examinations administered during annual training.** To verify the competency of MBSS crews, the QC Officer will conduct a one day visit with each crew prior to the Summer Index Period.

For personnel involved in sampling during the Spring Index Period, training will include water quality and benthic macroinvertebrate sampling using MBSS procedures. In addition, at least one member of each Spring sampling crew should be experienced in stream electrofishing techniques and approved as a benthic taxonomist by the Project Officer. For personnel involved in sampling during the Summer Index Period, training will include fish and herpetofauna sampling, habitat assessment, and taxonomy tests for fish, herpetofauna, and habitat assessment.

3.7 FACILITIES AND EQUIPMENT

Preventive maintenance and calibration must be performed on all sampling equipment used as part of the MBSS. Maintenance and calibration procedures should be implemented as per manufacturers instructions. Unless otherwise specified, calibration must be performed daily prior to equipment use and

anytime equipment problems are suspected. Preventative maintenance must be performed at intervals not to exceed the frequency recommended by the manufacturer. **All equipment malfunctions must be fully corrected prior to reuse.** For weighing scales, weekly checks must be conducted during field sampling using NIST standards or other accepted standards to demonstrate that instrument error is within limits specified by the manufacturer.

For each piece of equipment used as part of the MBSS, a bound logbook for calibration and maintenance must be maintained. Entries in the log must be made for all calibration and maintenance activities. Documentation includes detailed descriptions of all calibrations, adjustments, and replacement of parts, and each entry must be signed and dated.

To insure that MBSS equipment is operated within QA/QC requirements, the QC Officer should conduct periodic site equipment audits and promptly advise the Project Officer of any recommended corrective actions.

3.8 IMPLEMENTATION OF STANDARD OPERATING PROCEDURES

All of the standard operating procedures outlined in the MBSS sampling manual must be strictly followed. To insure that all procedures are properly implemented, the QC Officer will conduct periodic crew audits in the field. The audits should include: correctness in locating the sampling segment, field technique evaluations, verification of taxonomic identifications, completeness of data sheets and field notebooks, calibration and maintenance log review, and health and safety critique of crew activities. Documentation of audit results is maintained on file by the QC Officer, and any problems noted are promptly reported to the Project Officer.

3.9 INFORMATION MANAGEMENT

A schematic of general information management procedures is shown in Figure 3-1.

3.9.1 Field Information Management

To facilitate data recording during inclement weather, data sheets should be printed on waterproof pape. Backup copies of all field data sheets must be made at the completion of each sampling week. Digital photographs should be downloaded bi-weekly, labeled appropriately, and backed up.

To ensure that all field data for the MBSS are collected and recorded in a usable manner, all data should be **PRINTED** in the units specified on the MBSS data sheets. No writeovers are permitted on data sheets-- the incorrect entry should be lined out and the correct entry written in an obvious spot next to the line out. Data sheets for a given site must be consecutively labeled so that the total number of data sheets generated for each site is known. Recorded data must be reviewed at the point of entry and the Crew Leader must review and initial all data sheets prior to departure from the site. Legible copies of all data sheets should be provided to the Data Management and Analysis (DM) Officer on a bi-weekly basis during sampling.

Each sample collected as part of the MBSS will be assigned a sample number. The sample

number will contain several unique identifiers to minimize the possibility of misidentification. In addition, chain-of-custody forms should be maintained for all water sample, benthic macroinvertebrate, herpetofauna, and fish collections.

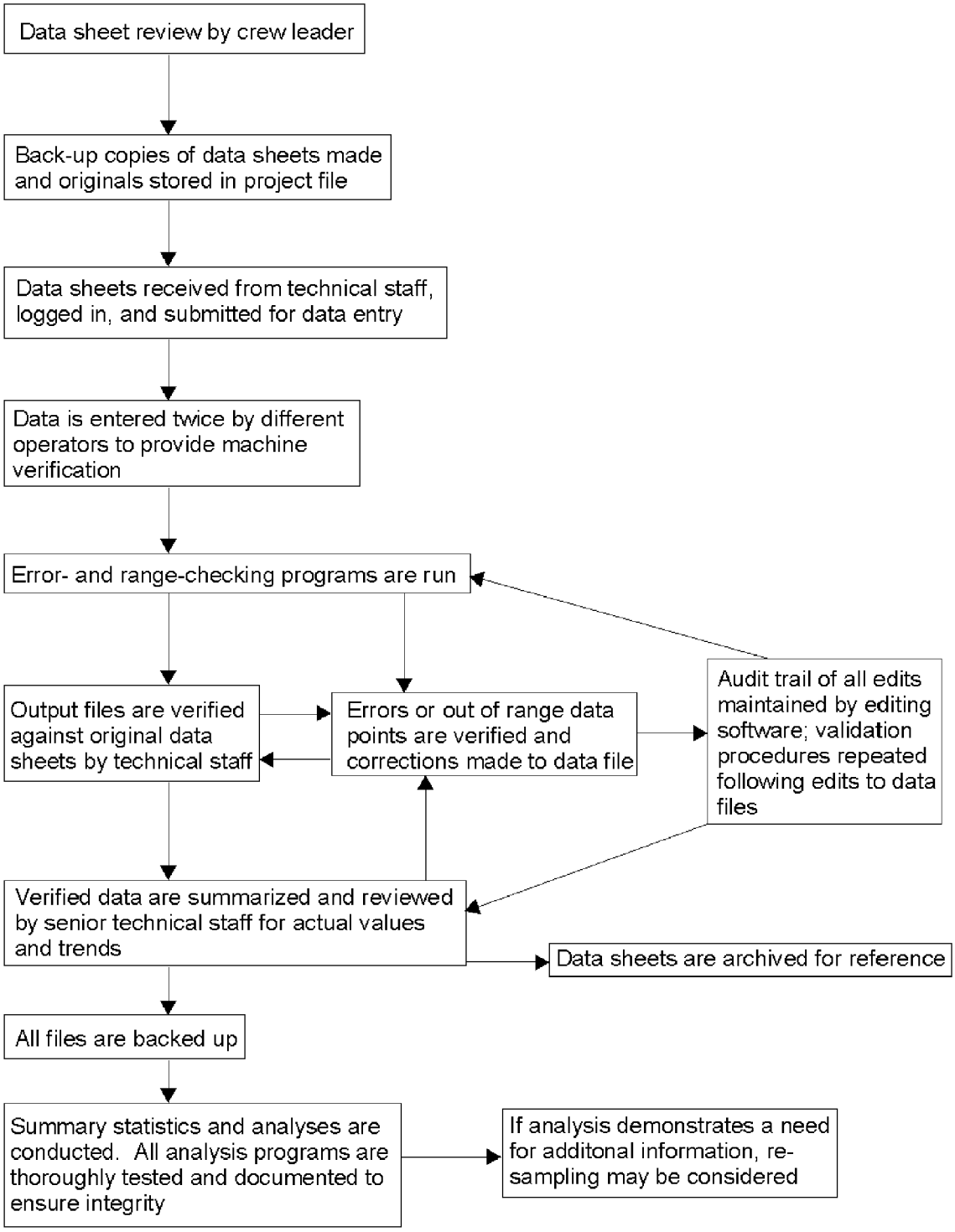

Figure 3-1. General information procedures for the MBSS

3.9.2 Data Entry

To verify that all data collected at a sampling segment is complete and acceptable, data entry of all data sheets will occur within 15 days after data sheets are received by the DM Officer. In the event that data is found to be unacceptable or incomplete, sampling can be repeated within the same index period. The DM Officer will maintain a bound logbook of all data entry information, and a back-up copy of all computerized data will be made and archived.

Data entry will be accomplished using entry screens designed to emulate data sheet format. All data will be double-entered using two different data entry operators and compared for consistency. - Questionable data will be flagged and a determination of validity made by the DM Officer, the QC Officer, and the responsible Crew Leader. For all editing activities, full documentation of all changes is mandatory.

Automated review procedures such as range checks, frequency distribution of coded variables, and other internal consistency checks will be designed by the DM Officer and employed for data entry verification.

3.10 DATA QUALITY ASSESSMENT

Assessment of data quality against established data quality objectives will be conducted to determine the overall performance of the QA program, identify potential limitations to use and interpretation of the data, and to provide information for other data users regarding usability of the data for other purposes.

The quality of MBSS data will be evaluated in several ways. Precision and bias associated with important elements of the sampling and measurement process for each variable measured will be evaluated using results from replicate sampling and performance evaluation studies. Information about precision, bias, and completeness will be used to determine the comparability of data acquired during each sampling year.

Spatio-temporal variability during an index period is potentially confounded by variability or bias resulting from changes in sampling efficiency such as increased experience, increasing inattention to procedures because of perceived familiarity, or reduced sampling effort because of boredom with the sampling protocols. Such crew effects can adversely affect data quality and interpretation of regional patterns, but logistics constrain the degree to which these potential limitations can be evaluated and/or corrected. In general, field crews will be assigned sampling sites within discrete geographic regions, and it is likely that sampling efficiency will not be uniform from the beginning to the end of the index period or between years. To minimize this effect, retention of crew from one year to the next should be a priority.

To verify and document that field and field preparation activities are carried out according to established protocols, field audits are necessary. At a minimum, the QC Officer will make two site audits per index period with each MBSS field crew, and on these visits the QC Officer will independently do a habitat assessment at each site sampled. The QC Officer may conduct other activities such as time and conditions permit, including capture efficiency checks, site location verification, spot checks of taxonomic identifications, etc. The QC Officer will retain on file the results of all field audit activities.

To aid evaluation of precision and bias, 5% of all MBSS sites will have replication of benthic and analytical laboratory samples. For water chemistry samples, one QC sample from each crew will be a blank; the remainder of the 5% will be duplicates. These samples are in addition to other duplicate and blank samples analyzed as part of in-laboratory QA/QC protocols (see standard operating procedures for water chemistry and benthic macroinvertebrates). An annual summary of QA/QC results for benthic macroinvertebrate and analytical chemistry sampling will be prepared and maintained on file.

At the end of each sampling year, specimens of all taxa collected must be verified by an appropriate recognized authority in fish, benthic macroinvertebrate, or amphibian taxonomy. Documentation of this verification should be included with the specimens as well as in tabular summary form. For benthic macroinvertebrates, the QC Officer will arrange for a random subset of at least 5% of the preserved benthic samples to be independently reprocessed in the laboratory. The QC Officer or a designatee will prepare an annual written and tabular summary of all taxonomic-related QC activities.

4.0 PREPARATION FOR SAMPLING

The purpose of this chapter is to outline procedures and provide guidance for pre-deployment activities to be completed prior to each field sampling trip.

4.1 EQUIPMENT

Prior to each field sampling trip, the Crew Leader should ensure that all necessary sampling equipment, site lists, and QC site lists are loaded into the sampling vehicle, including spare or back-up equipment, extra data sheets, etc. A list of equipment for sampling during the Spring Index Period is shown in ATTACHMENT 1, and equipment for the Summer Index Period is listed in ATTACHMENT - 2. **The Field Crew Supervisor and Project Officer should be informed as soon as practicable of any equipment problems which develop during sampling; in no case should faulty equipment continue to be used for sampling.**

The Crew Leader will be responsible for ensuring that all necessary equipment and supplies are loaded into the vehicle. **The crew will depart for sampling only after the Crew Leader has verified the equipment inventory.** During or shortly after completion of the sampling trip, the Crew Leader will inform the Field Crew Supervisor of any equipment needs, repairs, etc., and make arrangements for replacements prior to the next sampling trip.

At the end of each sampling day, the Crew Leader will ensure that all sampling equipment is properly stored and that gear, data sheets, preservatives, sample bottles, etc., needed for the next day are identified. When conducting water quality sampling, the Crew Leader should ensure that water quality instruments are in working order and calibrated prior to use.

To provide access to unimproved roads and thereby reduce travel time to numerous sample segments, four-wheel drive vehicles should be used when possible for MBSS sampling. Prior to use each day, the Crew Leader will visually inspect the sampling vehicle for any evidence of safety or mechanical problems.

4.2 SCHEDULE

Prior to beginning sampling efforts, Crew Leaders should develop a generalized sampling itinerary. In cases where major exceptions or changes to the generalized schedule must be made due to equipment failure, inclement weather, or other problems, the Crew Leader should notify the respective Field Crew Supervisor, who will in turn notify the Project Officer.

Prior to sampling, the Crew Leader should provide the DNR Natural Resources Police and regional fisheries managers with notification of the tentative dates and locations in which sampling is scheduled. Phone numbers for each area are provided in Tables 4-1 and 4-2.

Table 4-1. DNR Freshwater Fisheries Regional Managers

Region	Counties	Biologist	Telephone Number
Western	Garrett, Allegany	Ken Pavol	(301) 334-8218
Central	Montgomery, Howard, Baltimore, Harford, Washington, Frederick, Carroll	Charlie Gougeon	(410) 442-2080
Southern	Anne Arundel, Prince Georges, Charles, Calvert, St. Marys	Mel Beaven	(301) 888-2423
Eastern	Cecil, Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Somerset, Worcester	Alan Heft	(410) 275-9921

Table 4-2. DNR Natural Resources Police

Region	Counties	Telephone Number
Headquarters	N/A	1-800-628-9940 410-260-8880 410-260-8888
Central	Baltimore, Howard, Montgomery, Harford, Carroll	410-356-7060 410-356-7061
Western Region	Frederick, Washington, Allegany, Garrett	301-777-7771 301-777-7645
Southern Region	Anne Arundel, Prince Georges, Charles, Calvert	301-888-1601
Upper Eastern Shore	Queen Anne's, Kent, Cecil, Talbot, Caroline	410-758-2890
Lower Eastern Shore	Dorchester, Wicomico, Worcester, Somerset	410-548-7070

5.0 SAMPLE COLLECTION AND PRESERVATION

5.1 INTRODUCTION

The purpose of this chapter is to outline specific procedures that must be followed during sampling for the MBSS, including water quality, benthic macroinvertebrate, fish, herpetofauna, and habitat sampling. Strict adherence to these protocols is necessary to ensure that 1) data from the MBSS is of known and acceptable quality, and 2) the MBSS can be readily repeated in the future. Of particular importance is diligence in completing and verifying data sheet information while still in the field. The data sheets for the MBSS were designed to ensure that all necessary information is recorded in a standardized manner; only spaces provided for data entry should be used.

The sampling crew for the Spring Index Period (benthic macroinvertebrate and water quality sampling) should consist of two people. Both persons on the spring sampling crew must be trained in water quality sampling, and at least one person must be experienced with field sampling techniques for benthos. Because the water quality/benthic sampling crew will also determine whether electrofishing can be conducted in the sample segment, at least one person on the crew must also be experienced in stream electrofishing. The sampling crew for the Summer Index Period will consist of three or more persons, including at least one person designated by the Training Officer as qualified to assess habitat and identify fish and herpetofauna.

To promote consistency, completeness, and data quality, sampling activities for the MBSS should follow a consistent and defined pattern. Suggested activity flow charts for the Spring and Summer index periods are shown in Figures 5-1 and 5-2, respectively; these flow charts summarize the protocols outlined in the remainder of this chapter.

5.2 SPRING INDEX PERIOD SAMPLING

5.2.1 Site Selection/Location

For the MBSS, a combination of tax maps, topographic and/or road maps are used to generally locate MBSS sample segments, and hand-held Global Positioning System (G.P.S.) receivers are used for exact siting of each sampling segment. In cases where the segment is near a confluence with another stream, the distance upstream may be measured out and used to site and mark the segment. It is important to note that because of map error, locations shown on tax and topographic maps may at times be in conflict with the stream reach file used for site selection. In cases where a conflict exists between maps as to the site location, the Crew Leader must exercise professional judgement as to the correct sampling location and provide written documentation to the QC Officer.

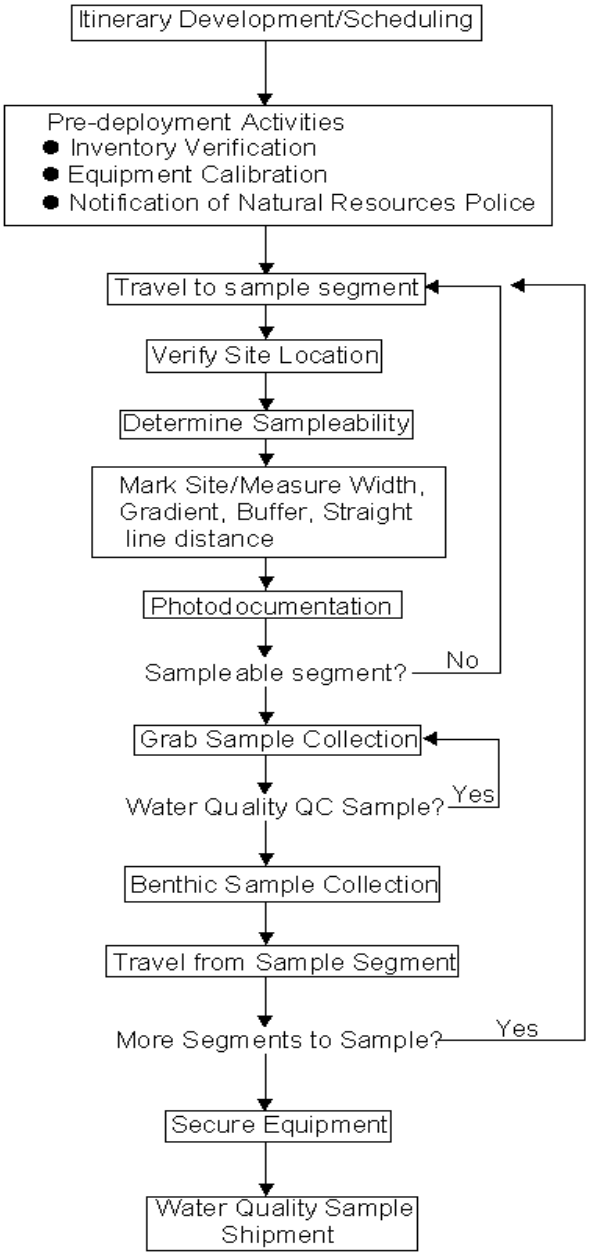

Figure 5-1. Activity flow chart for MBSS Spring Index period sampling.

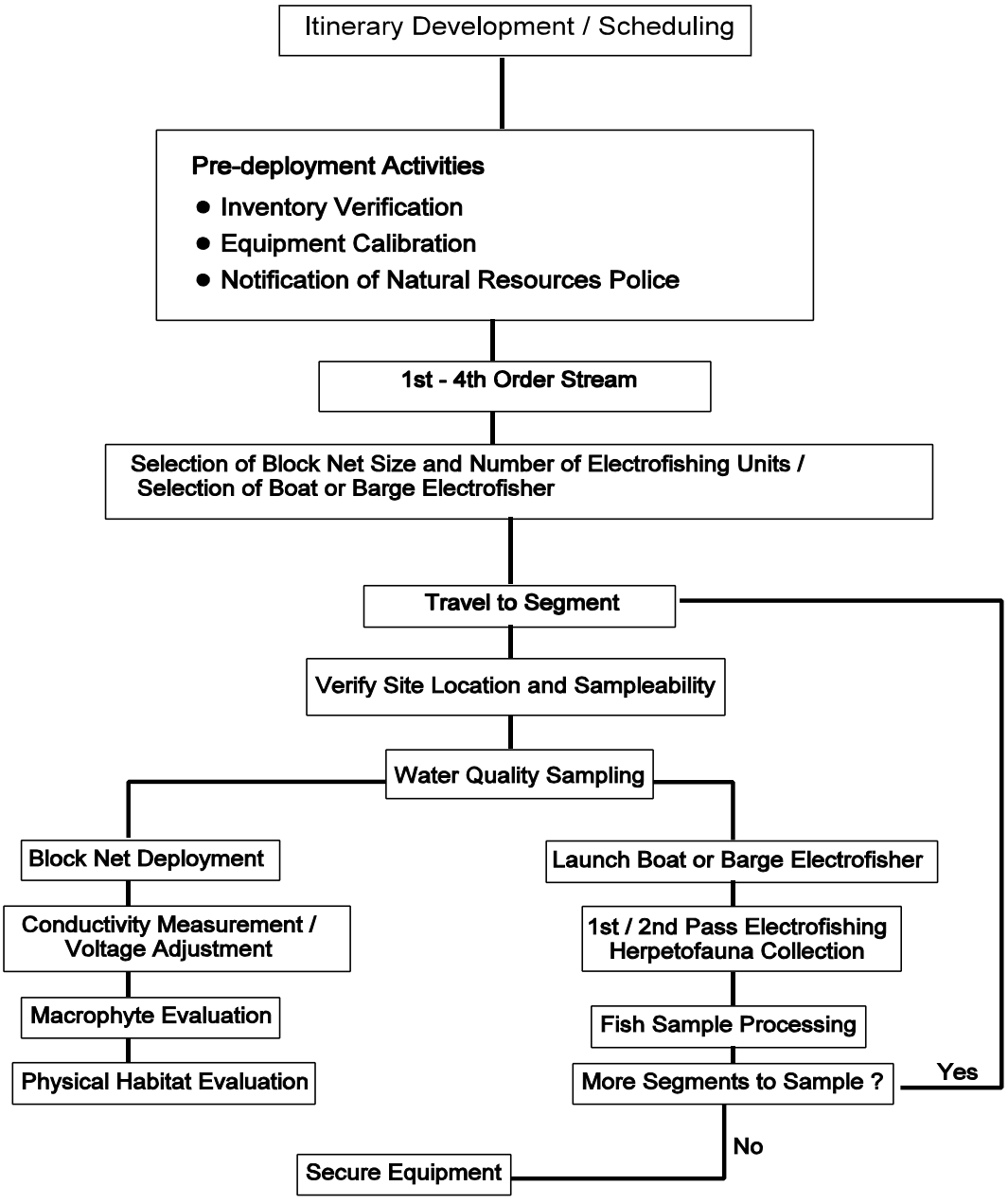

Figure 5-2. Activity flow chart for MBSS Summer Index period sampling.

1. The G.P.S. receiver should be used (in conjunction with a compass if necessary) to locate the sampling site. After the GPS unit acquires a position, observe and record on the Spring Habitat Data Sheet (ATTACHMENT 3) the straight line distance from the road to the site.

2) Use the GPS distance and directional functions to navigate to the site. Once the G.P.S. receiver indicates arrival at the target coordinates,walk directly (shortest distance) to the point in the stream closest to your current position. This position is the midpoint of the sampling segment (37.5 m upstream from the downstream end).

3) If the point where the GPS unit indicates arrival at the site is more than 30 meters from the stream, determine and record on the Spring Habitat Data Sheet (ATTACHMENT 3) the latitude and longitude coordinates from the mid-point of the segment.

Use of Stream Distance: In cases where the midpoint of the segment is listed as being within 138 m from the downstream node (confluence with another stream), the segment can be located by measuring (not pacing) the required distance upstream from the confluence. However, the G.P.S. should still be used as confirmation.

5.2.2 Determination of Sampleability

To ensure that a sampling segment can in fact be sampled, the Crew Leaders for spring sampling will examine the sampling segment prior to initiation of any sampling. Particular emphasis will be placed on determining whether electrofishing can be safely and effectively conducted. General criteria include: safety, landowner permission, ability to electrofish all habitat within the segment, and non-tidal status. **No sampling should take place under dangerous flow conditions**. If the segment that has non-wadeable areas can be safely sampled using a combination of long-handled anodes and/or dipnetters standing in a small boat, that site should be considered sampleable.

[Examples of conditions which could preclude sampling include: a dry stream bed, obvious tidal influence, dense vegetation hanging low over the stream, unsafe velocities/depths, road culverts, etc.]

It should be noted that some segments may still be sampleable even though they include underpasses, beaver dams, large culverts, dry sections, etc. In the case of small culverts which can not be electrofished, the length should be measured and recorded on the data sheet and the length added to the original 75 m segment. If the culvert occurs in the first half of the segment, the additional distance should be added to the downstream end of the segment. Similarly, the additional distance should be added to the upstream end of the segment if the culvert is within the upper half of the original segment. If the culvert can be sampled completely, no change should be made to the original 75 m segment. In other cases, riparian vegetative canopy may be closed over a sampling segment in such a way as to totally preclude quantitative electrofishing. The determination of Sampleability should be noted on the Spring Index Period Data Sheet as shown in ATTACHMENT 4. During the summer visit, Sampleability should be indicated on the Summer Index Period Data Sheet as shown in ATTACHMENT 5.

If a site is determined to be sampleable, place a site marker/orange spray paint/orange flagging at the upstream and downstream boundaries **and place labeled flagging at the 25 and 50 m locations**. Although it is important to mark the segment well enough that it can be relocated in summer, markings should not be so conspicuous as to be eyesores. The spray paint, however, will provide a semi-permanent mark so that a subset of MBSS segments can be re-visited in the future to establish temporal variability. If necessitated by landowner concerns, the orange mark can be painted over in brown or grey during the summer visit. After marking the segment, record on the data sheet the stream width at the upstream and downstream boundaries. If electrofishing is not possible, other activities should still be conducted if possible.

5.2.3 Photodocumentation (Optional)

After arrival at the sampling segment, the Crew Leader should determine whether unusual or unique conditions exist at the segment, and whether photographs should be taken to document these conditions. **In any event, digital photographs should be taken at every site visited to document conditions.**

1) For each photograph taken, record the time and an appropriate title on the Spring Index Period Data Sheet (see ATTACHMENT 4).

2) All photograph files should be named with the site label as it appears on the top of each data sheet.

3) All photographic files should be backed up and then submitted to the Data Management Officer for archiving within two weeks after the Spring Index Period ends.

5.2.4 Water Quality

5.2.4.1 Overview of Water Quality Sampling

Selected water quality variables (pH, ANC, sulfate, nitrite, nitrate, ammonia, total nitrogen (dissolved and particulate), ortho-phosphate, total phosphorous (dissolved and particulate), chloride, conductivity, and DOC) are measured under spring baseflow conditions as part of the MBSS to provide information about the state of acidification and degree of organic loading in the reaches being sampled. In addition, *in situ* measurements of dissolved oxygen, temperature, pH, turbidity, and conductivity should be made during the Summer Index Period. ATTACHMENT 7 has details on analysis methods and holding times for water chemistry samples.

5.2.4.2 Sample Period

Collection of samples for laboratory analyses for the MBSS occurs during the Spring Index Period. The range of dates for the Spring Index Period will be 1 March to approximately 1 May, depending on the region being sampled. The ending date for the Spring Index Period is based on sample degree-day accumulations of mean air temperatures above 4.5°C. For Coastal Plain physiographic regions, spring sampling will be completed prior to degree-day accumulations reaching 440°. For all other physiographic regions, spring sampling will be completed prior to degree-day accumulations reaching 1050°. This approach was chosen because existing studies in Maryland have demonstrated that sampling in spring can estimate the degree of acidification in a stream within acceptable limits and also provide benthic macroinvertebrate data most suited to identifying anthropogenic stresses at a site.

In addition to laboratory water quality sampling in spring, *in situ* measurements of dissolved oxygen, temperature, pH, and conductivity will be made during the Summer Index Period. The Summer Index Period extends from 1 June to 30 September.

5.2.4.3 Sampling Protocols

The basic protocols used to collect samples in spring follow those used in other DNR-sponsored acid deposition studies, including the Western Maryland Stream Survey (Morgan et al., 1991) and the Western Maryland Watershed Mitigation Study (Morgan et al. 1993).

Prior to departure for the sample segment, the Crew Leader must ensure that all equipment needed for water quality and benthic macroinvertebrate sampling is present, in working order, and calibrated.

Necessary equipment for the Spring Index Period is listed in ATTACHMENT 1. The Crew Leader must also ensure that the list of sample blanks and duplicates to be collected (provided the by QC Officer) is present.

All bottles for water sampling should be leached in deionized water for at least 24 hours prior to field use, and syringes should be new and unopened. All sampling equipment should be carefully packed to eliminate potential contamination. If any contamination is suspected, spare sample bottles or syringes should be used.

Water samples should be collected without regard to: stream stage and the amount of precipitation or the time since the last precipitation--the only criteria that must be met are that the stream is safe and a representative benthic sample can be collected. However, sampling during turbid conditions or just after heavy rains should be avoided to ensure that benthic habitat can be properly evaluated.

1) After sampleability of a segment has been determined and the site markers installed, the crew member responsible for water quality sampling should move to the upstream boundary of the sample segment, carefully locating an undisturbed area for sampling.

   [By collecting water quality samples from the upstream boundary, any non-representative, temporary water quality changes caused by benthic macroinvertebrate sampling will be avoided.]

2) Label the 1 liter and 0.5 liter sample bottles and the syringe. The label (see ATTACHMENT 6) should include: "MBSS", the date, and segment identification as recorded on the top of the Spring Index Period Data Sheet. **Each** syringe and sample bottle label must be verified by a member of the field crew for accuracy, with verification indicated on the data sheet (Attachment 4). All labels on water quality samples should be covered with clear plastic tape to ensure the labels are not smudged or lost.

   [Labels for QC samples [see 7) below] should use letter characters in place of numbers in the 'segment' portion of the label (e.g, 1=A; 2=B, 3=C, etc.).]

3) Using care to avoid potential sample contamination from handling, fill the pre-leached 0.5 and 1 liter sample bottles to half-full, rinse, and discard. Repeat the process twice. Then fill the sample containers such that no or a minimum of air space exists in the neck of the bottle. These samples will be used for all analyses except pH.

4) Check to ensure that the seals on both sample bottles are tight.

5) Place a Luer Lock valve on the end of the syringe. Fill the syringe for pH three times, expelling the water each time. Fill the syringe a third time to the 50 ml mark. Hold the syringe in a vertical position and gently tap it until all bubbles are released. After all air is expelled from the syringe, use the plunger to release 5 to 10 ml of sample. When the volume in the syringe is 50 to 55 ml and while still discharging water, carefully close the Luer Lock valve.

   [Syringes should not contain more than 50-55 ml of sample to minimize the possibility of plunger dislodgement during shipping].

6) Place samples on wet or blue ice (e.g., Kool Paks) to maintain samples at 4°C until laboratory analysis is performed.

7) If a blank sample is designated to be taken at the segment being sampled, that sample should be taken before collecting a routine sample at the randomly selected stream reach. Blanks should be collected following collection procedures outlined in steps 2 to 7 above, except

that water from the DI water container should be substituted for stream water. The letter "B" for "blank" should be written in the QC label portion of the Spring Data Sheet. The label for the QC sample should be the same as the original sample, EXCEPT THAT LETTERS SHOULD BE SUBSTITUTED FOR NUMBERS IN THE "SEGMENT" PORTION OF THE LABEL (e.g., A=1; B=2; C=3, etc.).

8) If a duplicate sample is to be taken, that duplicate sample should be collected immediately after the routine sample using steps 2 to 7 above. The letter "D" for "Duplicate" should be entered on the QC label portion of the data sheet.

9) After sample collections are completed, the field data and chain-of-custody forms (see ATTACHMENT 8) should be completed and checked by the field crew for completeness and accuracy.

10) **Sample bottles must be shipped to the analytical laboratory via overnight mail within 48 hours of collection.** FedEx Standard Overnight must be used for weekday deliveries. However if samples are going to be shipped on a Friday, Saturday Delivery and Priority Overnight must be checked on the FedEx form. When a Saturday Delivery is expected, the analytical laboratory **MUST** be notified, either by phone or email to ensure that the shipment is received and processed.

[Special attention should be given to packing samples in such a way that they are unlikely to leak or break during transport. During the packing process, re-verify that data sheets, labels on samples, and chain-of-custody sheets are consistent, and that a complete sample has been taken.]

[NOTE: Because of practical and cost constraints, samples are generally shipped to the lab every other day. This results in an exceedance of filtering time limits for some analytes and some samples, but lab experience has shown that this practice has a negligible influence on results.]

5.2.5 BENTHIC MACROINVERTEBRATES

5.2.5.1 Overview of Benthic Sampling

Benthic macroinvertebrate sampling is conducted within the same 75 m segment utilized for fish, habitat, and water quality sampling. The intent of benthic sampling is to qualitatively describe the community composition and relative abundance in favorable habitat (habitats supporting the greatest benthic diversity) within the sampling segment. The sample collection procedures described below allow for calculation of an Index of Biotic Integrity as described in Stribling et al. (1998).

5.2.5.2 Sample Period

As the usefulness of benthic data to describe environmental stresses (particularly effects of acid deposition) is thought to be reduced in summer, benthic sampling for the MBSS is conducted concurrent with water quality sampling in spring (see section 5.5.2).

5.2.5.3 Habitats to be Sampled

A combination of habitats supporting the most diverse macroinvertebrate community within a sample segment is sampled qualitatively. This habitat often includes a riffle area when one is present. Other habitats, in order of preference, include: gravel/broken peat and/or clay lumps in a run area; snags/logs that create a partial dam or are in run habitat; undercut banks and associated root mats in moving water; SAV and associated bottom substrate in moving water; and detrital/sand areas in moving water.

5.2.5.4. Benthic Sampling Protocols

Prior to departure for the site, the Crew Leader must ensure that all equipment needed for benthic macroinvertebrate sampling is present and in serviceable condition. Necessary equipment is listed in ATTACHMENT 1.

1) After arrival at the sampling segment, ensure that there are no holes or remnants of prior samples in the D-net. **If holes exist, they must be repaired before sampling is continued.** Survey the segment to locate the most productive habitat. This may involve turning over some rocks, examining organic debris, etc. Fill out an internal and external label for the sample bucket (ATTACHMENT 6) with the date, time, and site id from the Spring Index Period Data Sheet (ATTACHMENT 4). Verify the correctness of each label and indicate so on the data sheet. The external label should then be covered with clear plastic tape to prevent smudging and/or loss of the label. **Benthic sample chain-of-custody forms (Attachment 8) should also be filled out at this time, including the name of the sampler, date, time, and sample site number.**

2) In a riffle area, start at the downstream edge and place the net firmly in the substrate. Disturb the substrate with hand and/or foot down to the hardpan (usually 5 to 8 cm) in an area the width of the net and at most two net widths upstream. **Rub by hand any large sticks and/or stones from the disturbed area to dislodge any organisms.** Repeat this process near the upstream edge of the riffle. Repeat as necessary until 20 square feet of substrate has been sampled. As community composition is known to vary with stream velocity and substrate size, attempt to sample the range of substrate types and velocities found within the riffle.

If only log and snag substrates are available, 20 square feet of surface area should be rubbed off by hand or with a small brush.

When sampling habitats other than riffles or snags, the D-net should be used in a jabbing/sweeping motion to dislodge organisms from root mats, SAV, etc. Kicking of the habitat prior to jabbing may also be done as needed to dislodge organisms. A minimum of 20 square feet should be sampled, and the amount of each habitat type indicated on the Spring Index Period Data Sheet (ATTACHMENT 4). In soft substrates the net motion should be more gentle to minimize the collection of detritus. Multiple habitats may be sampled to cover the best available substrates.

When sampling in some large 3rd-4th order streams, sampleable habitat might not be present within the 75m sample segment. If this is the case, moving out of the sample segment in an upstream direction to find habitat that can be sampled using a D-net is permissible. **This should only be done if it is completely impossible to sample within the 75m transect.** This action should be noted in the comments section of the Spring Index Period Data Sheet.

3) When a 20 ft^2 sample has been obtained, or when the D-net becomes filled to the point that water does not pass easily through it, the net should be washed into a sieve bucket. While the sample is in the sieve bucket, all large stone, debris, leaves, etc., should be carefully washed, inspected for organisms, and discarded. If necessary, use forceps to remove any animals remaining on the net. Verify that the net is clean. **At each segment, sample collection should not exceed 15 minutes.**

4) The sample should then be transferred to a labeled sample bucket and preserved in a 70% ethanol solution or equivalent. The lid to the sample bucket should be verified tight and the sample readied for transport.

[Note: Prior to placing the lid on the sample bucket ensure that the lip of the bucket is clean to maximize the integrity of the seal.]

5) Fill out the Chain of Custody Sheet (ATTACHMENT9) and transfer the sample bucket to the Benthic lab. The sample will be processed according to protocols in MBSS Laboratory Methods for Benthic Macroinvertebrate Processing and Taxonomy (EA-00-6).

5.2.6 Physical Habitat

1) Use the Stream Habitat Assessment Guidance Sheet (ATTACHMENT 10) to evaluate and score the sample site for the abundance of trash and other human refuse.

2) Measure and record in meters the width of the vegetated riparian buffer on each side of the stream. (If the buffer is greater than or equal to 50 m, enter 50). Also record the dominant type of land cover adjacent to the buffer.

3) Using the size categories on the back of the Spring Habitat Data Sheet (ATTACHMENT 3), record the dominant stem sizes of riparian vegetation present.

4) Note on the Spring Habitat Data Sheet whether there are any functional breaks in the riparian buffer on each side of the stream. Indicate the type and severity of the type(s) of buffer break that are present.

5) Survey the sample site for evidence of channel dredging or straightening and indicate

presence (Y) or absence (N) on the Spring Habitat Data Sheet. If there is evidence, indicate the type and linear extent (in meters) for each bank and for the stream bottom itself.

6) Classify and record on the Spring Habitat Data Sheet (ATTACHMENT 3) the presence (Y) or apparent absence (N) of land use types immediately visible from the sample segment.

7) While still at the boundaries of the sample segment, use a rangefinder or measuring tape to obtain the straight-line distance between the 0 and 75 m points of the segment (this measurement will provide an accurate assessment of sinuousity). Record the straight-line distance in meters on the Spring Habitat Data Sheet (ATTACHMENT 3).

8) Use the procedures outlined below to measure the stream gradient from the downstream boundary to the upstream boundary of the segment using a Levelometer. When backsiting, insure that siting is done relative to the water's edge. **The intent is to measure water surface slope**. Record this information on the Spring Habitat Data Sheet (ATTACHMENT 3).

[When measuring gradient be sure to record % slope, **not degrees.**]

[With proper care, surveyor's levels provide accurate measurements of stream gradient. To ensure that readings are correct, care must be taken during transport and use of this equipment. When traveling in the vehicle, secure the level in a padded area, not on top of other equipment. Never run when carrying the level. If the level is jarred, the calibration should be tested using the two-peg test (described in the manufacturers instructions). When setting the instrument up for use, find a stable area to set up the tripod. Clean lenses only with lens cloth or compressed air.]

a) At the upstream end of the segment, set the tripod firmly in the substrate of the stream (slow, shallow water is preferred) with about a 1 meter spread between the legs. Carefully remove the level from its case and mount it on the tripod by threading the instrument fastener snug against the underside of the baseplate. Do not overtighten.

b) Level the instrument according to manufacturers instructions. The David White automatic levels purchased for the MBSS are leveled by rotating the level until the bubble vial is between two leveling screws. If the bubble is to the left, turn the right hand leveling screw clockwise and left hand screw counterclockwise until the bubble is close to center. If the bubble is to the right, turn the left screw clockwise and right screw counterclockwise until the bubble is centered left to right. Then use the last leveling screw to center the bubble within the bull's eye ring. The internal leveling device works as long as the bubble remains within the ring.

c) Remove the lens cap, look through the unit and adjust the eyepiece (by rotating) so that the crosshairs are sharply defined. Then, aim the unit at your target and focus the objective lens by rotating the focusing knob on the right side of the unit. Keep both eyes open when sighting. Now check for parallax by slight vertical movement of your eye relative to the eyepiece. If there is apparent movement of the image relative to the crosshairs, repeat Step c).

d) Measure and record (to the nearest centimeter) the height from the middle of the eyepiece to the water surface. This is known as backsiting. Also record the location within the segment– in most cases the level will start from the 75m location unless there is an obstacle, no suitable location for the tripod, etc.

e) The other crew member now takes the measuring staff (stadia) downstream to the 0 meter location. If the bottom of the segment (0 m marker) can be seen from the level, only one reading need be taken. If not, the segment should be broken up and up to 3 separate readings taken. These readings are accomplished by moving the level to the last measurement site, establishing the level 0 meter at the height of the previous reading for the location, and obtaining a stadia reading from a location further downstream. If possible, use the 25 and 50 m locations or a location near them, and in no case take more than 3 readings to establish gradient of the segment.

[To maintain the relative change in height between the upstream boundary and each downstream measurement location, it is important to place the eyepiece at a height equal to the staff height measured for that location before siting on a downstream point.]

f) The stadia bearer then holds the staff vertically from the water surface, and the level operator observes and then records the height of the staff which is corresponds with the crosshairs as viewed from the eyepiece.

[The difference in height between locations will be divided by the distance between the measurement points to arrive at a percent gradient. To calculate a gradient for the entire segment, it is important to include as much of the segment as possible and record this information on the data sheet].

10) Note on the Spring Habitat Assessment Data Sheet (ATTACHMENT 3) the location (latitude and longitude) and height of any **man-made** instream blockages greater than 0.3 m in height in or near the sampling segment. Using the back of the data sheet as a reference, record the type of instream blockage.

[Note: indicate any instream blockages found, whether they are in the segment to be sampled or not.

5.2.7 Herpetofauna

During the spring visit, record in the comments section of the spring data sheet any herpetofauna (positive identifications only) observed or heard at the site. Maintain as vouchers any species not previously collected from the basin being sampled.

5.2.8 Temperature Logger Deployment

Temperature loggers should be deployed at all MBSS sites from 1 June to 30 August and set to record at 20 minute intervals *(the logger should be set to record the highest temperature during each 20 minute interval)*. Temperature loggers should be deployed within the limits of the sample segment, preferably along a bank. **Before deployment, the serial number of each temperature logger, the sample segment ID number for the site in which it is deployed, and a description of the location of deployment should be noted on the MBSS Spring Index Period Data Sheet** (ATTACHMENT 4) ***and*** **on the MBSS Temperature Logger Field Sheet** (Attachment 18) . Loggers should be secured to a well anchored tree root, gabion, or any other stable structure using one or two plastic cable ties **(do not use small cable ties- they may break)**. Care should be taken when selecting the deployment location to ensure that the temperature logger is not in direct current so that during high flows it will not be bombarded by debris. Also, temperature loggers should be placed at a depth to ensure that they will remain submerged until time of recovery.

To promote recovery of as many temperature loggers as possible, orange spray paint should be used to mark the location of the temperature logger (e.g., When anchoring temperature loggers to a tree root, the root should be followed from the temperature logger to the water surface and then that same root should be painted). A photograph should be taken showing the location of the temerature logger. The number of each photograph should be noted on the **MBSS Spring Index Period Data Sheet** (ATTACHMENT 4).

Deployment of a temperature logger might not be possible in some large streams or if spring sampling is conducted at a time when stream discharge is high at a site. In this situation the sampling crew can delay deployment (all temperature loggers should be deployed prior to 15 June). For sites sampled in summer after 15 August, temperature loggers may be retrieved early to eliminate the need for a return visit. In any event, all loggers should be retrieved prior to 15 September.

5.3 SUMMER INDEX PERIOD SAMPLING

5.3.1 Site Selection/Location

As described in Section 5.2.1.

5.3.2 Determination of Sampleability

As described in Section 5.2.2., except that the Sampleability section of the Summer Index Period Data Sheet (ATTACHMENT 5) should be filled out to indicate sampleability for each aspect of sampling and reasons for non-sampleability.

5.3.3 Water Quality

A general description of *in situ* water quality variables measured during summer is provided in APPENDIX A. In general, manufacturer's instructions should be followed for summer water quality measurements. Prior to departure for the sample segment, the Crew Leader must ensure that all equipment needed for water quality measurements is present, in working order, calibrated, and signed for on the Summer Index Period Data Sheet as being calibrated. Necessary equipment for the Summer Index Period is listed in ATTACHMENT 2. **An extra set of *in situ* water quality instruments should be on hand (in the field sampling vehicle) during the Summer Index Period.**

1) After sampleability of a segment has been determined and the blocknets installed (described in 5.3.5), the crew member responsible for water quality sampling should move to the upstream boundary of the sample segment, carefully locating an undisturbed area for sampling. Where possible, the velocity of the selected area should be sufficient to allow a representative sample to be collected.

2) Being careful to avoid direct contact of probes with bottom substrates, instrument probes should be deployed at a representative location at or near mid-stream. If necessary to protect the probes, one crew member should hold the unit off of the bottom while another person records data. The units should be turned on and allowed to equilibrate according to manufacturers specifications.

3) After readings have stabilized, temperature, dissolved oxygen, pH, conductivity, and turbidity data should be recorded on the Summer Index Period Data Sheet (ATTACHMENT 5). **IN NO CASE SHOULD WATER QUALITY INSTRUMENTS BE USED IF THEY HAVE NOT PASSED CALIBRATION OR ARE UNSTABLE.**

4) After *in situ* water quality measurements have been completed, necessary caps for probes should be replaced and the instruments disassembled and stored for transportation. Care should be taken to avoid storing instruments in a moist carrying case.

5.3.4 Fish and Herpetofauna Sampling

5.3.4.1 Overview of Fish and Herpetofauna Sampling

The objective of fish sampling for the MBSS is to assess the fishability and ecological health of fish communities in the non-tidal, flowing waters of Maryland. Quantitative, double-pass electrofishing of 75 m stream segments is used to describe abundance and community composition for ecological health assessment. Information on gamefish lengths is also collected.The objective of herpetofauna sampling is to provide an indication of riparian species diversity.

5.3.4.2 Sampling Period

To characterize fish communities during the low flow period in summer, fish sampling is conducted during the Summer Index Period (1 June to 30 September). Sampling during this period is advantageous because spawning migration effects are minimized, temperatures are conducive to wading and water contact, and capture efficiency is typically best at low flows. Sampling of herpetofauna coincides with fish sampling.

5.3.4.3 Fish and Herpetofauna Sampling Protocols

Prior to departure for the sample segment, the Crew Leader must ensure that all equipment needed for fish and habitat sampling is present and in working order, including nets and electrofishing gear. A list of necessary equipment is provided in Attachment 2.

1) Before departing from the sampling vehicle, the Crew Leader should refer to the spring index period data sheet to determine the previously measured stream width. The Crew Leader should then select appropriate block nets **(repaired and in good condition)** for the segment and determine the number of electrofishing units to be used, whether a "y" connection and 2 anodes is necessary, etc. In streams wider than 10 m, two or more electrofishing units are to be used, each with at least one dipnetter. In smaller streams, a single unit should be generally used, with one or two dipnetters, depending on conditions. In streams with areas too deep to sample by using wading gear, a boat or raft electrofisher should be used to sample these areas in conjunction with the backpack electrofishing units that will still be used to sample the shallow areas.

   [Exceptions include stream reaches with predominantly deep pool or run habitat, or other conditions where two units are necessary for effective electrofishing. In these cases, Crew Leaders should use professional judgement to determine the number of units to be used. In cases such as beaver impoundments with broad expanses and no definable channel, the Crew Leader may decide not to sample fish at the site.]

2) Locate the existing site marker, spray paint, and/or flagging at the downstream boundary using G.P.S. and any notes compiled by the spring sampling crew. Determine whether the site is sampleable **and record Sampleability on the Summer Index Period Data Sheet (ATTACHMENT 5)**. If the marker cannot be located, re-verify the site location with G.P.S. and if necessary place a new site marker and flagging at the downstream boundary. Note the replacement of the site marker in the field notebook. **If a site is determined to be unsampleable by electrofishing, the Fish and Gamefish Data Sheets should not be filled out.** However, all other sampling should be performed if possible.

3) Fill out all appropriate site information on the Summer Index Period Data Sheet

(ATTACHMENT 5), Fish Data Sheet (ATTACHMENT 11) and Gamefish Length Data Sheet (ATTACHMENT 12). **Data sheets for a given segment should be labeled consecutively so that the number of data sheets completed for each site during each Index Period is known.**

4) If the site is sampleable, place a **single** block net across the upstream and downstream boundaries of the sampling segment (in the case of a divided stream channel, two or more nets may need to be used). During placement of each block net, avoid any unnecessary disturbance of fish and work quickly to minimize any redistribution of fish into or out of the sample segment. Use available substrate where possible to anchor and seal gaps between the lead line and the bottom. Where appropriate, tie the ends of the net to a firm anchoring point on each bank, and check/clean the net as necessary to prevent 'blowdown' from leaf accumulation.

[Note: The bottom line of each net should be perpendicular to stream flow at the 0 and 75 meter points of the segment (Tent stakes or large spikes should be used to anchor ends of block nets at sites where trees, roots, or other stable structures are not available).]

If the segment includes a culvert that is too small or too dark to sample in, block nets should be used to isolate the culvert from the sampling segment. The length of the culvert (not the width of the pipe) should then be added to the sample segment so that the sampled segment is 75m long.

[If one boundary of the segment can not be relocated, remeasure the segment from the known boundary, deploy the measuring tape along the bank of the stream, avoiding disturbance to fish. If neither boundary can be relocated, use the G.P.S. to locate the segment and remark the boundaries.]

5) Note on the Fish Data Sheet (ATTACHMENT 11) any observed movement of fish to or from the upstream and downstream boundaries or the sampling segment. Also note whether the bottom is clearly visible in all portions of the segment.

6) Verify that the electrofishing unit is fueled (or sufficient battery capacity exists for battery-powered units), and adjust the output voltage of the electrofishing unit according to the conductivity.

[In waters where conductivity is between 100 to 400 umho/cm, a voltage setting of 300 or 400 volts should be effective. In lower conductivity water, increase the output voltage, and decrease the output voltage in high conductivity water. In waters where conductivity is greater than 1000 umho/cm, the lowest voltage and frequency settings should be used and any observed problems in capture efficiency should be noted on the data sheet. In streams sampled for the MBSS, such high conductivities are most likely to be encountered in reaches impacted by acidic mine drainage or landfill runoff.]

[Gasoline is extremely flammable, and vapors readily ignite on contact with heat, spark, or flame. Always allow the generator to cool before refilling. Keep gasoline out of direct sunlight and store only in approved containers.]

7) Prior to operating the electrofishing unit, ensure that members of the fish sampling crew all have:

a) Polaroid sunglasses to reduce glare and thereby improve capture efficiency. Under cloudy or lower light conditions, amber glasses should be worn, while green or brown glasses are appropriate under sunny conditions;

b) Undamaged rubber gloves; and

c) Watertight chest waders. At the discretion of the Crew Leader, hip boots may be worn for comfort in small streams. In rocky streams, felt soles or boot chains **must** be used.

[The use of gloves and waders/hip boots is MANDATORY for all MBSS electrofishing surveys.]

8) Briefly test the effectiveness of the electrofishing unit in an area downstream of the lower block net. Adjust controls as necessary and record settings on the data sheet (ATTACHMENT 11).

[The unit voltage and waveform settings should be based on conductivity and any observed mortality during testing.]

9) Re-zero and record the electrofishing unit timer reading(s) and the number of anodes used for each electrofishing unit on the Fish Data Sheet (ATTACHMENT 11). If more than four electrofishing units are used, use a second Fish data sheet to record electrofishing times.

10) Beginning at the downstream block net, thoroughly electrofish the entire segment length, bank to bank, including backwater areas, sloughs, and shallows, making an equal attempt to capture every fish observed. An exception is that YOY fish too small to be retained by dip nets (body length less than 30 mm) should not be collected. When necessary to ensure capture of fish, the operator of the electrofishing unit should use the net on the anode ring. For the MBSS, continuous rather than intermittent electrofishing is used to avoid bias introduced by selective placement of the electrode and reduce sampling mortality. All captured fish are placed into 25 liter buckets and then into labeled, covered livecars deployed in the stream.

[In areas where the ability to see fish is reduced by turbidity, tannic acids, or fast water, dipnetters should deploy nets on the bottom downstream of the anode as much as possible to capture unseen fish. **Particular attention should be paid to sighting bottom fishes such as darters, sculpins, and madtoms which are often undersampled.**]

11) Collect/positively identify herpetofauna observed during electrofishing or other activities and record on the Summer Index Period Data Sheet (ATTACHMENT 5). Retain voucher specimens of captured amphibians and smaller reptiles in a labeled plastic jar (ATTACHMENT 12) filled with buffered 10% formalin solution. Do Not attempt to handle venomous snakes or snapping turtles. For specimens too large to be preserved in available jars, or those Federally listed as threatened or endangered **and positively identifiable in the field**, digital photographs are acceptable. Each species photograph should include a title with the date and site identification. During the 2000-2004 MBSS, each crew must maintain an ongoing voucher collection checklist of herpetofauna specimens/photographs for each species taken or photographed (cumulatively during any of the 5 sampling years) in each 6 digit basin (ATTACHMENT 13). After 24-96 hours in formalin solution, herpetofauna specimens should be transferred to a **40%** ethanol solution for permanent storage. For MBSS 2000-2004, no larval salamanders or tadpoles need be retained.

[Formaldehyde is an extremely caustic agent and may cause severe irritation on contact of vapors or solution with skin, eyes, or mucus membranes. It is also a potential carcinogen. Always use in well ventilated area and in case of contact with skin or eyes, rinse immediately with copious amounts of fresh water.]

12) When the entire 75 m segment has been electrofished, turn off the unit and record the timer reading for each unit on the Fish Data Sheet (ATTACHMENT 11).

13) Transport fish captured during the first pass to an area downstream of the sample segment and return to the downstream block net with as little disturbance as possible. **Check the downstream blocknet for fish.**

[If water clarity in the sampling segment is reduced because of substrate disturbance during the first pass, second pass electrofishing must be delayed up to 1 hour until visibility improves to the point that capture efficiency is similar to that achieved during the first pass. If 2nd pass visibility is poorer that 1st pass visibility, it should be noted on the Fish Data Sheet (ATTACHMENT 11)].

14) When the electrofishing crew is ready to commence the second pass, fill out the second pass information on the Fish Data Sheet (ATTACHMENT 11), verify the timer reading on each unit and turn each unit on.

15) Commence second pass electrofishing as with the first pass.

[It is important to use the same effort on the second pass as was expended for the first pass (i.e., cover all habitat equally on both passes). Therefore, the entire segment should be electrofished on the second pass, and if two electrofishing units were used on the first pass, two units should be used on the second pass.]

16) After the second pass has been completed, turn off each unit and record the timer reading on the data sheet. **Check the downstream blocknet for fish.**

17) Place all fish captured on the second pass into the livecar labeled "second pass".

18) After removing debris, crayfish, etc., from the sample, weigh in aggregate (nearest 10 g) the biomass of all fish captured on the first pass. Return fish to the livecar and record 1st pass total weight on the Fish Data Sheet (ATTACHMENT 11). Repeat the weighing procedure for the 2nd pass.

[If using spring scales, ensure that the tare feature of the scale is used to minimize the possibility of math errors on weights]

19) Identify and enumerate all first and second pass fish, retaining in labeled jars **all** individuals not clearly identifiable to species for laboratory analysis. Record the numbers of each fish species on the Fish Data Sheet (ATTACHMENT 11) noting the number of unknown individuals under "Species A", "Species B", etc. For each species or unknown, the number of individuals retained should be indicated on the data sheet. **RETENTION OF ALL SPECIMENS WHICH CANNOT BE POSITIVELY IDENTIFIED IS MANDATORY.** Specimens for preservation should be promptly placed into plastic jars filled with a 10% buffered formalin solution (later transferrable to 70% EtOH solution). Individuals >160mm should be slit on the lower abdomen of the RIGHT side. Label all specimen jars with inside labels specifying the date, segment number, and name of collector (ATTACHMENT 12).The MBSS fish key should be used as needed for positive verification during field identifications.

[Formaldehyde is an extremely caustic agent and may cause severe irritation on contact of vapors or solution with skin, eyes, or mucus membranes. It is also a potential carcinogen. Always use in well ventilated area and in case of contact with skin or eyes, rinse immediately with copious amounts of fresh water.]

20) During the 2000-2004 MBSS, each crew must maintain an ongoing voucher collection checklist of fish for each species taken or photographed (cumulatively during any of the 5 sampling years) in each 6 digit basin (ATTACHMENT 13). Compare the list of species taken at the

segment with the checklist of species currently retained for the basin being sampled. If new species have been taken, retain 8-10 individuals of each new species (include a range of sizes if possible) in labeled plastic jars filled with buffered 10% formalin solution. For rare/uncommon species or gamefish (especially stocked fish), fewer specimens may be retained, at the discretion of the Crew Leader. Note on the Fish Data Sheet (ATTACHMENT 11) species for which voucher specimens have been retained or photographed. For specimens too large to be preserved in available jars, or those Federally listed as threatened or endangered **and positively identifiable in the field**, photographs are acceptable, with labeling as shown in ATTACHMENT 12. Each species photograph should include a label with the date and site identification.

21) During counting and identification of the fish sample for each pass, measure to the nearest mm (total length) and record on the Gamefish Lengths Data Sheet (ATTACHMENT 14) all individuals of each gamefish species captured (bass, walleye, trout, or esocids). During measurement, if visual observations suggest that some individuals may be stocked fish (based on fin wear, fin size, etc.), indicate so in the comments section for that species on the Fish Data Sheet (ATTACHMENT 11).

    In addition, observe and record on the Fish Data Sheet (ATTACHMENT 11) any unusual occurrence of anomalies for any of the species examined. Potential types of anomalies to note include excessive black spot or black spot on an atypical species, multiple skeletal deformities, lesions, or tumors, etc. **All fish with skeletal deformities should be labeled, preserved and forwarded to the Project Officer.**

22) Release all fish not retained as voucher specimens or for laboratory examination.

23) After fish sampling has been completed, record on the Summer Index Period Data Sheet (ATTACHMENT 5) the relative abundance of aquatic plants and presence/condition of mussels present within the sampling segment. At the crew leader's discretion, vouchers of shell from rare species may be retained for identification by DNR Heritage Division or outside mussel experts.

24) **After or during the time period when field sampling is conducted in a basin, additional qualitative electrofishing may be conducted at the discretion of the Project Officer or Crew Leader. At each site, all representative habitat should be surveyed, and a checklist of species captured and the latitude and longitude should be recorded on the MBSS Qualitative Electrofishing Data Sheet (ATTACHMENT 15). Elapsed time, elapsed distance, instream habitat and pool quality scores should also be recorded on the data sheet. As with quantitative sampling, any species not yet retained from previous segments should be retained as part of the voucher collection for that basin, and any species not positively identifiable in the field should be retained for laboratory examination.**

5.3.5 Physical Habitat

5.3.5.1 Introduction

In streams and rivers, physical habitat is often one of the primary factors affecting the abundance and diversity of aquatic biota. To provide a means to assess the importance of physical habitat to biological integrity and fishability of flowing waters in Maryland, habitat assessments will be conducted at all stream segments sampled as part of the MBSS. Habitat assessments will be based on a combination of metrics modified and adapted from USEPA's Rapid Bioassessment Protocols (RBP) and Ohio EPA's Qualitative Habitat Evaluation Index (QHEI). Several important quantitative habitat measurements are also made to further describe the physical characteristics at each segment.

Although EPA's RBP habitat assessment protocols differentiate between riffle-run and pool-glide stream types, all metrics selected for the MBSS are scored at all MBSS sample segments to allow direct comparisons across physiographic regions and summaries of conditions on a statewide basis.

5.3.5.2 Sampling Period

MBSS habitat assessments will be conducted during the summer index period to provide a characterization of habitat during summer low flow conditions. Habitat availability during this time period is commonly thought to be a primary factor limiting standing stocks of fish in streams.

5.3.5.3 Sample Site Boundary for Habitat Assessments

Instream habitat evaluations at a sample segment will be based only on the designated 75 m length of the stream. Adjacent landuse characterization will be based on features observable from the segment being sampled. However, any notable natural or anthropogenic features observed outside of the immediate zone of evaluation must also be noted on the data sheet in the comments section. Examples of such features include: beaver dams, water falls, recent logging, new construction, or point sources of pollution.

5.3.5.4 Habitat Evaluation Protocols

Habitat assessments during the summer visit should generally begin after electrofishing has been completed; however assessments may be done prior to electrofishing if the assessment can be done without reducing visibility for electrofishing. In general, the only time that habitat assessments should precede electrofishing is when it is likely that turbidity from the electrofishing crew will remain elevated for a long time after the first pass. Only crew members approved by the MBSS Training Officer should conduct the evaluation.

1) Evaluate and record on the Summer Habitat Data Sheet (ATTACHMENT 16) the linear extent (in meters), severity, and approximate areal extent (in square meters) of bank erosion on the right and left banks. Note that the areal extent is recorded X10.

2) Evaluate and record on the Summer Habitat Data Sheet (ATTACHMENT 16) the extent and composition of bar formation within the sample segment.

3) Evaluate and record on the Summer Habitat Data Sheet (ATTACHMENT 16) the relative abundance of nuisance exotic plants within 5 meters of the stream on either bank.

4) Count and record on the Summer Habitat Data Sheet (ATTACHMENT 16) the number of Large Woody Debris (LWD) (>10cm diameter and >1.5m long) located within the wetted portion of the segment. Do the same for LWD located above the wetted portion of the segment.

5) Count and record on the Summer Habitat Data Sheet (ATTACHMENT 16) the number of rootwads with trunk diameter (at chest height) >15cm that are functional habitat within the wetted portion of the stream. Also count and record the number of rootwads (>15cm diameter) which form part of the stream bank but are not functional aquatic habitat within the wetted portion of the stream.

6) Using the MBSS Habitat Assessment Guidance Sheet (ATTACHMENT 9), assign a score or percentage for each of the habitat metrics listed on the Summer Habitat Data Sheet

(ATTACHMENT 16).**The evaluator should refer to the Guidance Sheet each time a metric is scored; scoring based on memory is unacceptable**. During the assessment, the entire 75 m segment should be walked. Because of the probability of substrate disturbance during electrofishing, embeddedness should be evaluated within the thalweg of a riffle (preferred) or run during the first pass of electrofishing. If evaluation is unintentionally omitted during the 1st pass, the stream area immediately upstream of the sample segment should be evaluated and a notation made in the comments portion of the data sheet.

7) Classify the stream characteristics of the 75 m segment being sampled by checking one or more of the stream characterization choices shown on the Summer Habitat Data Sheet (ATTACHMENT 16). Include only those features which appear to be functionally important within the segment.

8) Measure and record maximum depth in the segment to the nearest centimeter.

9) Measure and record the wetted width to the nearest 0.1 m and the thalweg depth (deepest portion of the lateral transect) and velocity at the 0, 25, 50, and 75 meter points of the sample segment and record on the data sheet. All width measurements must be made perpendicular to the direction of streamflow by stretching a meter tape across the entire distance in which water is found, including large exposed boulders and islands with permanent vegetation. Subtractions should then be made for islands or other non-wetted areas such as large boulders that are deterred under most conditions, but no subtractions should be made for exposed substrates that are submerged at higher baseflows.

10) After ensuring that the flowmeter is functional and within calibration limits, select a transect suitable for flow measurements (glides with "u" shaped channels are best--try to avoid cross sections with boulders or other irregularities that create backflows and cross flows) and make a series of 10 to 20 velocity measurements at regular intervals across the stream. Start on the left side facing downstream. Measure velocity to the nearest 0.1 m/s at a point 0.6 of the distance from the water surface to the bottom (measured from the surface), making sure to orient the sensor to face upstream and taking care to stand well downstream to avoid deflection of flows. At the same locations where velocity measurements are taken, measure depths with the staff gauge of the flowmeter to the nearest 1 cm (depth and velocity measurements should be made at the selected point on the transect even if the point has no water).

    [When using an electromagnetic current meter, use the lowest time constant scale setting on the meter that provides stable readings.]

    [In some cases, it may be advantageous to temporarily constrict the flow patterns in the stream so that steady, laminar flows with adequate depths exist. **If flows are so low that they can not be measured with a flow meter, constrict flow as much as possible in a 1 meter section of uniform width and use the speed of a floated object as a substitute for velocity measured with the flow meter. Record on the data sheet the depth, width, and time (3 trials) for a floated object to move 1 m.]**

11) **After electrofishing, water quality measurements, and habitat assessments are complete, the Crew Leader and another person should carefully review and initial all data sheets for the segment BEFORE LEAVING THE SITE.**

5.3.6 Temperature Logger Retrieval

Temperature loggers can be retrieved after 15 August, and must be retrieved prior to 15 September. After reviewing photographs and deployment location descriptions, temperature loggers should be removed from every site. After the logger is removed from the site and before traveling to the next site, verify that the serial number is the same as the number entered on the Temperature Logger Deployment/Recovery Log Sheet (ATTACHMENT 18). Enter the time and date of retrieval.

ATTACHMENT 1

Spring Index Period Equipment List	
MBSS Sampling Manual	G.P.S. Unit, battery packs, chargers
Road Maps, Itinerary	G.P.S. instruction book, spare batteries, NiCad charger
Site List/Maps	Coolers, Ice, Ziplock Bags, Chain-of-Custody forms
QC Sample List	Bubble Wrap, Packing Material, Tape
Spring Index Period Data Sheets	Fed-X Forms
No. 1 Pencils, Permanent Markers	Label Tape (clear, 2" wide)
Crew Leader Field Notebook, Quad Map	Chest Waders (1 pair/person)
Pre-printed Adhesive Outside Labels, Inside Labels	First Aid Kit
Taxonomic Keys--Reptiles and Amphibians	Water Quality Sample Bottles- 1 liter
Pruning Tool	Water Quality Sample Bottles- 500 mL
Digital Camera, Extra Batteries, & Accessories	Syringes and valves
Mace	Tripod, Level, Stadia
Rangefinder	
Flagging, Spray Paint	
100 m Tape	
600 micron Mesh D-net	
Spare Net Bag for D-net	
EtOH (2 liters per site)	
Foul Weather Gear	Reserve Equipment (to be kept in sampling vehicle)
Pack Basket/ Backpack/ small cooler	Data sheets, Markers, Pencils
1 Liter Squirt Bottle	DI Water for blanks
	Spare Squirt Bottle, Funnel
	Spare Sample Bottles, Syringes
	Spare D-net, silocone for net repairs
	Spare Sample Jars, EtOH
	Wader Repair Kit

ATTACHMENT 2

Summer Index Period Equipment List	
MBSS Sampling Manual	Flowmeter/Staff Gauge/extra batteries/Meter Stick
Road Maps, Itinerary	Spring or Electronic Scale
Site List and Site Maps	DO, temp.,pH, conductivity meter (Hydrolab or equivalent)
Summer Index Period Data Sheets	1 liter Buffered Formalin/site
Fish Data Sheets	Backpack Electrofishing Unit(s) (site dependent)
Summer Habitat Data Sheets	Anode Ring Probe(s) (site dependent, fitted with 3/16" mesh);
Gamefish Length Data Sheets	"Y" connection and extra probe
Qualitative Electrofishing Sheets	Cathode Tail (1 per electrofishing unit)
Habitat Guidance Sheet- Laminated	Gasoline for Electrofishing
No. 1 Pencils, Permanent Markers	Dipnets, 3/16" mesh
Crew Leader Field Notebook, Quad Maps	Blocknets (2)- 2m, 6 m, 15 m & 40 m sizes
Pre-printed Voucher Labels; Sample Jars; ziplocks	Labeled Livecars
Taxonomic Keys--Reptiles and Amphibians; Fish, Freshwater Mussels	Livecar Net (1)
Voucher List for Each Drainage Basin	25 liter buckets; floating live car
Mace	Electrofishing Gloves (1pr/person)
Rangefinder, 100m tape	Wader Repair Kit
Flagging	
Digital Camera, Extra Batteries, & Accessories	Reserve Equipment
G.P.S. Unit and Spare, Battery Packs, NiCad Charger G.P.S. instruction book, Spare Batteries	Spare Generator(s)/Electrofishing Batteries
Compass	Spare Gas and Oil for Generators
Turbidimeter, extra batteries	Tool Box
Turbidity Standards	Spare Netting/Cable Ties for Anode Ring Nets
Disinfectant Lotion	Spare Voucher Jars and Formalin
Freshwater for Crew Consumption	Spare Data Sheets/Markers/Pencils/Labels
First Aid Kit	Extra Blocknets
Foul Weather Gear	Spare WQ Instruments/Flowmeter/Scale
Wader Repair Kit	Calibration Kits, Spare DO Membrane Kit
Pruning Tool	Waders
Machete	Calibration Weights
Measuring Board	
Pack Baskets/Backpacks	
Portable Cellular Phone	

ATTACHMENT 3

MBSS SPRING HABITAT DATA SHEET

Page ☐ Of ☐

SITE Watershed Code ☐☐☐☐ Segment ☐☐☐ Type ☐ Year ☐☐☐☐

DATE Year ☐☐ Month ☐☐ Day ☐☐

Reviewed By: _____

2nd Reviewer: _____

☐☐☐☐ **Distance from Nearest Road to Site (m)**

☐☐ **Trash Rating 0 - 20**

RIPARIAN VEGETATION

(facing upstream)

LEFT BANK	RIGHT BANK	
☐☐	☐☐	Width (50m max)
☐☐	☐☐	Adjacent Land Cover (see back)
☐☐☐☐	☐☐☐☐	Vegetation Type (see back)
☐	☐	Buffer Breaks (Y/N)

Buffer Break Types
(**M** = minor; **S** = severe)

☐	Storm Drain
☐	Tile Drain
☐	Impervious Drainage
☐	Gully
☐	Orchard
☐	Crop
☐	Pasture
☐	New Construction
☐	Dirt Road
☐	Gravel Road
☐	Raw Sewage
☐	Railroad

LANDUSE (Y/N)

- ☐ Old Field
- ☐ Deciduous Forest
- ☐ Coniferous Forest
- ☐ Wetland
- ☐ Surface Mine
- ☐ Landfill
- ☐ Residential
- ☐ Commercial/Industrial
- ☐ Cropland
- ☐ Pasture
- ☐ Orchard/Vineyard/Nursery
- ☐ Golf Course

STREAM GRADIENT

Reading	Location (m)	Height (m)
1	☐☐	☐☐.☐
	☐☐	☐☐.☐
2	☐☐	☐☐.☐
	☐☐	☐☐.☐
3	☐☐	☐☐.☐
	☐☐	☐☐.☐

STRAIGHT LINE DIST.

(m) ☐☐

CHANNELIZATION

☐ **Evidence of Channel Straightening or Dredging (Y/N)**

TYPE	EXTENT (m)		
	LEFT BANK	BOTTOM	RIGHT BANK
Concrete	☐☐	☐☐	☐☐
Gabion	☐☐	☐☐	☐☐
Rip-Rap	☐☐	☐☐	☐☐
Earthen Berm	☐☐	☐☐	☐☐
Dredge Spoil Off Channel	☐☐	☐☐	☐☐
Pipe Culvert	☐☐	☐☐	☐☐

Actual Coordinates
(If >30m distance between original coordinates and stream)

	deg	min	sec
	☐☐	☐☐	☐☐.☐
	☐☐	☐☐	☐☐.☐

Stream Block Ht. (m) ☐☐.☐

Stream Block Type ☐☐

	deg	min	sec
Lat	☐☐	☐☐	☐☐.☐
Lon	☐☐	☐☐	☐☐.☐

MBSS Drainage Basin Codes

YG = Youghiogheny River
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LP = Lower Potomac River
PX = Patuxent River
WC = West Chesapeake
PP = Patapsco River
BU = Bush River
GU = Gunpowder River
SQ = Lower Susquehanna River
EL = Elk River
CR = Chester River
CK = Choptank River
NW = Nanticoke-Wicomico Rivers
PC = Pocomoke River
OC = Ocean Coastal

Watershed	Abbreviation
Aberdeen Proving Ground	ABPG
Anacostia River	ANAC
Antietam Creek	ANTI
Assawoman Bay	ASSA
Atkisson Reservoir	ATKI
Atlantic Ocean	ATLA
Back River	BACK
Back Creek	BACR
Baltimore Harbor	BALT
Big Annemessex River	BANN
Big Elk Creek	BELK
Bird River	BIRD
Bodkin Creek	BODK
Bohemia River	BOHE
Breton Bay	BRET
Brighton Dam	BRIG
Broad Creek	BROA
Bush River	BUSH
Bynum Run	BYNU
Cabin John Creek	CABJ
Casselman River	CASS
Catoctin Creek	CATO
Conowingo Dam Susquehanna R	CDAM
Chincoteague Bay	CHIN
Christina River	CHRI
Conewago Creek	COCR
Conococheague	CONO
Corsica River	CORS
Deep Creek Lake	DCRL
Deer Creek	DEER
Dividing Creek	DIVI
Double Pipe Creek	DOUB
Eastern Bay	EAST
Evitts Creek	EVIT
Fifteen Mile Creek	FIMI
Fishing Bay	FISH
Furnace Bay	FURN
Georges Creek	GEOR
Gilbert Swamp	GILB
Gunpowder River	GUNP
Gwynns Falls	GWYN
Honga River	HONG
Isle of Wight Bay	ISLE
Jones Falls	JONE
Kent Island Bay	KEIS
Kent Narrows	KENA
Langford Creek	LANG
Little Conococheague	LCON
Liberty Reservoir	LIBE
Little Choptank	LICK
Little Elk Creek	LIEL
Little Gunpowder Falls	LIGU
Licking Creek	LIKG
Lower Monocacy River	LMON
Loch Raven Reservoir	LOCH
Lower Choptank	LOCK
Lower Chester River	LOCR
Lower Elk River	LOEL
Lower Gunpowder Falls	LOGU
Lower Pocomoke River	LOPC
Lower Wicomico	LOWI
Little Patuxent River	LPAX
Lower Susquehanna	LSUS
Little Tonoloway	LTON
Lower Chesapeake Bay	LWCH
Lower Winters Run	LWINT
Little Youghiogheny	LYOU
Magothy River	MAGO
Manokin River	MANO
Marsh Run	MARS
Marshyhope Creek	MACK
Mattawoman Creek	MATT
Middle Chesapeake Bay	MDCH
Middle Chester River	MICR
Middle River-Browns	MIDD
Miles River	MILE
Monie Bay	MONI
Middle Patuxent River	MPAX
Nanjemoy Creek	NANJ
Nanticoke River	NANT
Nassawango Creek	NASS
Northeast River	NEAS
Newport Bay	NEWP
Octoraro Creek	OCTO
Oxon Creek	OXON
Patapsco River Lower North Br	PATL
Patuxent River Lower	PAXL
Patuxent River Middle	PAXM
Patuxent River Upper	PAXU
Pocomoke Sound	PCSO
Piscataway Creek	PISC
Potomac AL Co	PRAL
Prettyboy Reservoir	PRET
Potomac River FR Co	PRFR
Potomac River Lower North Br	PRLN
Potomac Lower Tidal	PRLT
Potomac River MO Co	PRMO
Potomac River Middle Tidal	PRMT
Potomac River Upper North Br	PRUN
Potomac Upper Tidal	PRUT
Potomac WA Co	PRWA
Port Tobacco River	PTOB
Rocky Gorge Dam	RKGR
Rock Creek	ROCK
Sassafras River	SASS
Savage River	SAVA
South Branch Patapsco	SBPA
Southeast Creek	SEAS
Seneca Creek	SENE
Severn River	SEVE
Sideling Hill Creek	SIDE
Sinepuxent Bay	SINE
South River	SOUT
St. Clement Bay	STCL
Stillpond-Fairlee	STILL
St. Mary's River	STMA
Swan Creek	SWAN
Tangier Sound	TANG
Tonoloway	TONO
Town Creek	TOWN
Transquaking River	TRAN
Tuckahoe Creek	TUCK
Upper Elk River	UELK
Upper Monocacy River	UMON
Upper Chesapeake Bay	UPCH
Upper Choptank	UPCK
Upper Chester River	UPCR
Upper Pocomoke River	UPPC
West Chesapeake Bay	WCHE
Western Branch	WEBR
West River	WEST
Wicomico River	WICO
Wicomico Creek	WICR
Wills Creek	WILL
Wicomico River Head	WIRH
Wye River	WYER
Youghiogheny River	YOUG
Zekiah Swamp	ZEKI

VEGETATION TYPES

G= Grasses /Forbes
R= Regen Deciduous /Shrubs (<4"DBH)
Y= Young Deciduous (4-12" DBH)
M= Mature Deciduous (12-24" DBH)
O= Old Deciduous (>24" DBH)
A= Regen Coniferous (<4" DBH)
B= Young Coniferous (4-12" DBH)
C= Mature Coniferous (12-24" DBH)
D= Old Coniferous (>24" DBH)
L= Lawn

Riparian Buffer Zone/ Adjacent Land Cover Types

FR = Forest
OF = Old Field
EM = Emergent Vegetation
LN = Mowed Lawn
TG = Tall Grass
LO = Logged Area
SL = Bare Soil
RR = Railroad
PV = Paved Road
PK = Parking Lot/ Industrial/ Commercial
GR = Gravel Road
DI = Dirt Road
PA = Pasture
OR = Orchard
CP = Cropland
HO = Housing

Site Type

R = Random
T = Targeted
S = Sentinel

INSTREAM BLOCKAGE CODES

DM = Dam
PC = Pipe Culvert
F = Fishway
GW =Gaging Station Weir
G = Gabion
PX = Pipeline Crossing
AC = Arch Culvert
BC = Box Culvert
TG = Tide Gate

(Note: Height is measured in meters from stream surface to water surface above structure)

Sampleability Codes

s = Sampleable
1 = Dry Stream bed
2 = Too Deep
3 = Marsh, no defined channel
4 = Excessive Riparian Vegetation
5 = Impoundment
6 = Tidally Influenced
7 = Permission Denied
8 = Unsafe (Describe in Comments)
9 = Beaver
10 = Other _____

ATTACHMENT 4

MBSS SPRING INDEX PERIOD DATA SHEET

Page ____ Of ____

SITE Watershed Code ____ Segment ____ Type ____ Year ____

BASIN ____ (see back for codes)

DATE Year ____ Month ____ Day ____

TIME ____ (Military)

Reviewed By: _____

2nd Reviewer: _____

CREW: _____

STREAM: _____

COMMENTS: _____

SAMPLEABILITY

- ☐ Benthos
- ☐ Habitat Assessment
- ☐ Water Quality

TEMP. LOGGER (Y/N) ☐ **LOGGER NUM.** ____

LOCATION _____

ROAD CULVERT

Present in Segment? (Y/N) ☐

Sampleable? (Y/N) ☐

Width of Culvert? (m) ____

Length of Culvert? (m) ____

PHOTODOCUMENTATION

(Optional if Sampleable)

Time	Number	Title
____	____	_____
____	____	_____
____	____	_____

SITE ACCESS ROUTE _____

SAMPLE LABELS

1L Bottle Label Verified by: _____

500 mL Bottle Label Verified by: _____

Syringe Label Verified by: _____

Benthos Label Verified by: _____

QC LABEL

Watershed Code ____ Segment ____ (Letters only) Type ____ Year ____

1L Bottle Label Verified by: _____

500 mL Bottle Label Verified by: _____

Syringe Label Verified by: _____

Benthos Label Verified by: _____

Duplicate (D) or Blank (B): ☐

BENTHIC HABITAT SAMPLED

(Square feet; Total = 20 square feet)

- ____ Riffle
- ____ Rootwad/Woody Debris
- ____ Leaf Pack
- ____ Macrophytes
- ____ Undercut Banks
- ____ Other (specify) _____

STREAM WIDTH (m)

0 m ____

75 m ____

SAMPLING CONSID.: (☐ NUM. ANODES) _____

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Watershed Abbreviation

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Back Creek	BACR	
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Bodkin Creek		BODK
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Breton Bay	BRET	
Brighton Dam		BRIG
Broad Creek		BROA
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Bynum Run	BYNU	
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Conococheague		CONO
Corsica River		CORS
Deep Creek Lake		DCRL
Deer Creek	DEER	
Dividing Creek		DIVI
Double Pipe Creek		DOUB
Eastern Bay	EAST	
Evitts Creek	EVIT	
Fifteen Mile Creek		FIMI
Fishing Bay	FISH	
Furnace Bay	FURN	
Georges Creek		GEOR
Gilbert Swamp		GILB
Gunpowder River		GUNP
Gwynns Falls		GWYN
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Isle of Wight Bay		ISLE
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Lower Gunpowder Falls	LOGU	
Lower Pocomoke River	LOPC	
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Patuxent River Lower		PAXL
Patuxent River Middle		PAXM
Patuxent River Upper		PAXU
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Potomac River Lower North Branch		PRLN
Potomac Lower Tidal		PRLT
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Potomac Upper Tidal		PRUT
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Seneca Creek		SENE
Severn River		SEVE
Sideling Hill Creek		SIDE
Sinepuxent Bay		SINE
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Wicomico Creek		WICR
Wills Creek	WILL	
Wicomico River Head		WIRH
Wye River		WYER
Youghiogheny River		YOUG
Zekiah Swamp		ZEKI

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OR = Orchard
CP = Cropland
HO = Housing

Site Type

R = Random
T = Targeted
S = Sentinel

ATTACHMENT 5

MBSS SUMMER INDEX PERIOD DATA SHEET

Page ____ Of ____

SITE Watershed Code ____ Segment ____ Type ____ Year ____

BASIN ____ (see back for codes)

DATE Year ____ Month ____ Day ____

TIME ____ (Military)

Reviewed By: _____

2nd Reviewer: _____

CREW: _____

COMMENTS: _____

SAMPLEABILITY

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5 = Impoundment
6 = Tidally Influenced
7 = Permission Denied
8 = Unsafe (describe in comments)
9 = Beaver
10 = Other _____

- ☐ Electrofishing
- ☐ Habitat Assessment
- ☐ Water Quality
- ☐ Herpetofauna
- ☐ Mussels
- ☐ Aquatic Plants

AQUATIC PLANTS

(A, P, or E)

Submerged Aquatic Vegetation ☐

Emergent Aquatic Vegetation ☐

Floating Aquatic Vegetation ☐

(Absent, Present, Extensive)

HERPETOFAUNA

Taxa Observed	Number retained or Photo
_____	☐
_____	☐
_____	☐
_____	☐
_____	☐
_____	☐
_____	☐
_____	☐

MUSSELS

Taxa Observed	(N,O,R, or L)	Retained? (Y/N)
Unionids	☐	☐
Corbicula	☐	☐

None, Old Shell, Recent Shell, Live

WATER QUALITY

Temp (C) ____.____

DO (ppm) ____.____

pH ____.____

Cond (umho/cm) ____.____

Turbidity (NTU) ____.____

Meter Calibrations by: _____

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Back Creek		BACR
Baltimore Harbor		BALT
Big Annemessex River		BANN
Big Elk Creek	BELK	
Bird River		BIRD
Bodkin Creek	BODK	
Bohemia River		BOHE
Breton Bay		BRET
Brighton Dam	BRIG	
Broad Creek		BROA
Bush River		BUSH
Bynum Run		BYNU
Cabin John Creek		CABJ
Casselman River		CASS
Catoctin Creek		CATO
Conowingo Dam		CDAM
Chincoteague Bay		CHIN
Christina River		CHRI
Conewago Creek		COCR
Conococheague		CONO
Corsica River	CORS	
Deep Creek Lake		DCRL
Deer Creek		DEER
Dividing Creek		DIVI
Double Pipe Creek		DOUB
Eastern Bay		EAST
Evitts Creek		EVIT
Fifteen Mile Creek		FIMI
Fishing Bay		FISH
Furnace Bay		FURN
Georges Creek		GEOR
Gilbert Swamp		GILB
Gunpowder River		GUNP
Gwynns Falls	GWYN	
Honga River		HONG
Isle of Wight Bay		ISLE
Jones Falls		JONE
Kent Island Bay		KEIS
Kent Narrows		KENA
Langford Creek		LANG
Little Conococheague		LCON
Liberty Reservoir		LIBE
Little Choptank		LICK
Little Elk Creek		LIEL
Little Gunpowder Falls		LIGU
Licking Creek	LIKG	
Lower Monocacy R		LMON
Loch Raven Reservoir		LOCH
Lower Choptank		LOCK
Lower Chester River		LOCR
Lower Elk River		LOEL
Lower Gunpowder Falls		LOGU
Lower Pocomoke R		LOPC
Lower Wicomico		LOWI
Little Patuxent River		LPAX
Lower Susquehanna		LSUS
Little Tonoloway		LTON
Lower Ches. Bay		LWCH
Lower Winters Run		LWINT
Little Youghiogheny		LYOU
Magothy River		MAGO
Manokin River		MANO
Marsh Run		MARS
Marshyhope Creek		MACK
Mattawoman Creek		MATT
Middle Ches. Bay		MDCH
Middle Chester River		MICR
Middle River-Browns		MIDD
Miles River		MILE
Monie Bay		MONI
Middle Patuxent River		MPAX
Nanjemoy Creek		NANJ
Nanticoke River		NANT
Nassawango Creek		NASS
Northeast River		NEAS
Newport Bay	NEWP	
Octoraro Creek		OCTO
Oxon Creek		OXON
Patapsco River Lower North Br		PATL
Patuxent River Lower		PAXL
Patuxent River Middle		PAXM
Patuxent River Upper		PAXU
Pocomoke Sound		PCSO
Piscataway Creek		PISC
Potomac AL Co		PRAL
Prettyboy Reservoir		PRET
Potomac River FR Co		PRFR
Potomac River Lower North Br		PRLN
Potomac Lower Tidal		PRLT
Potomac River MO Co		PRMO
Potomac River Middle Tidal	PRMT	
Potomac River Upper North B		PRUN
Potomac Upper Tidal		PRUT
Potomac WA Co		PRWA
Port Tobacco River		PTOB
Rocky Gorge Dam		RKGR
Rock Creek		ROCK
Sassafras River		SASS
Savage River	SAVA	
South Br Patapsco		SBPA
Southeast Creek		SEAS
Seneca Creek	SENE	
Severn River	SEVE	
Sideling Hill Creek		SIDE
Sinepuxent Bay		SINE
South River		SOUT
St. Clement Bay		STCL
Stillpond-Fairlee		STILL
St. Mary's River		STMA
Swan Creek		SWAN
Tangier Sound		TANG
Tonoloway		TONO
Town Creek		TOWN
Transquaking River		TRAN
Tuckahoe Creek		TUCK
Upper Elk River		UELK
Upper Monocacy R		UMON
Upper Chesapeake Bay		UPCH
Upper Choptank		UPCK
Upper Chester River		UPCR
Upper Pocomoke River		UPPC
West Chesapeake Bay		WCHE
Western Branch		WEBR
West River		WEST
Wicomico River		WICO
Wicomico Creek		WICR
Wills Creek		WILL
Wicomico River Head		WIRH
Wye River		WYER
Youghiogheny River		YOUG
Zekiah Swamp		ZEKI

Common Names of Herpetofauna

SALAMANDERS:
Eastern Mud Salamander
Eastern Tiger Salamander(E)
Eastern Hellbender(E)
Four-Toed Salamander
Green Salamander(E)
Jefferson Salamander (W)
Long Tailed Salamander
Marbled Salamander
Mountain Dusky Salamander Mudpuppy(E)
Northern Dusky Salamander
Northern Two-Lined Salamander
Northern Slimy Salamander
Northern Spring Salamander
Red Spotted Newt
Red Salamander
Redback Salamander
Salamander (unknown)
Seal Salamander
Spotted Salamander
Valley and Ridge Salamander
Wehrle's Salamander(I)

TOADS:
American Toad
Eastern Narrowmouth Toad(E)
Eastern Spadefoot Toad
Fowler's Toad
Toad (unknown)

LIZARDS:
Broadhead Skink
Coal Skink(E)
Five-Lined Skink
Ground Skink
Northern Fence Lizard
Six-Lined Racerunner
Southeastern Five-Lined Skink

TURTLES:
Bog Turtle(E)
Common Musk Turtle
Common Snapping Turtle
Common Map Turtle(I)
Eastern Box Turtle
Eastern Painted Turtle
Eastern Mud Turtle
Eastern River Cooter
Eastern Spiny Softshell Turtle
Midland Painted Turtle
Northern Diamondback Terrapin
Red Belly Turtle
Red-Eared Slider
Spotted Turtle
Wood Turtle

FROGS:
Barking Treefrog(E)
Bullfrog
Carpenter Frog(I)
Frog (unknown)
Gray Treefrog
Green Treefrog
Green Frog
Hylid Frog (unknown)
Mountain Chorus Frog(I)
New Jersey Chorus Frog
Northern Spring Peeper
Northern Leopard Frog
Northern Cricket Frog
Pickerel Frog
Ranid Frog (unknown)
Southern Leopard Frog
Upland Chorus Frog
Wood Frog

SNAKES:
Black Rat Snake
Corn Snake
Eastern Garter Snake
Eastern Hognose Snake
Eastern Kingsnake
Eastern Milk Snake
Eastern Ribbon Snake
Eastern Smooth Earth Snake Eastern Worm Snake
Mole Kingsnake
Mountain Smooth Earth Snake(E) Northern Scarlet Snake(W)
Northern Black Racer
Northern Brown Snake
Northern Copperhead
Northern Pine Snake
Northern Redbelly Snake Northern Ringneck Snake Northern
Water Snake
Queen Snake
Rainbow Snake(E)
Red Bellied Water Snake
Rough Green Snake
Scarlet Kingsnake
Smooth Green Snake
Timber Rattlesnake

STATUS KEY
(E) =endangered
(I) = in need of conservation
(W) = watchlist

ATTACHMENT 6

SPRING INDEX PERIOD SAMPLE LABEL

_ _ _ _- _ _ _ - _ - _ _ _ _	BASIN:_ _
DATE: _ _ / _ _ / _ _ _ _	TIME: _ _ : _ _
SAMPLER: _____	MBSS

Explanation:

Watershed Code - Segment - Type - Year Basin: (use codes)

Date: Day/ Month/ Year Time: (military)

Sampler: MBSS

ATTACHMENT 7
Analytical methods used for water chemistry samples collected during the spring index period.

Analyte (units)	**Method**	**Instrument**	**Detection Limit**	**Holding Time (days)**
pH (standard units)	EPA (1987) Method 19	Orion pH meter	0.01	7
Acid neutralizing capacity (μeq/l)	EPA (1987) Method 5	Brinkmann Automated Titration System equipped with customized software	0.01	14
Sulfate (mg/l)*	EPA (1987) Method 11	Dionex DX-500 Ion Chromatograph (AS-9 HC column)	0.03	14
Nitrite nitrogen* (mg/l)	EPA (1999) Method 354.1	Lachat QuikChem Automated Flow Injection Analysis System	0.0005	28 (frozen)
Nitrate nitrogen* (mg/l)	EPA (1987) Method 11	Dionex DX-500 Ion Chromatograph (AS-9 HC column)	0.01	14
Ammonia (mg/l)*	EPA (1999) Method 350.1	Lachat QuikChem Automated Flow Injection Analysis System	0.003	28 (frozen)
Total dissolved nitrogen (mg/l)*	APHA (1998) 4500-N (B)	Lachat QuikChem Automated Flow Injection Analysis System w/In-line Digestion Module	0.050	28 (frozen)
Total particulate nitrogen (mg/l)	D'Elia et al. 1997	CE Elantech N/C Analyzer	0.0103	28
Orthophosphate (mg/l)*	APHA (1998) 4500-P (G)	Lachat QuikChem Automated Flow Injection Analysis System	0.0010	28 (frozen)

Total dissolved phosphorus* (mg/l)	APHA (1998) 4500-P (I)	Lachat QuikChem Automated Flow Injection Analysis System w/In-line Digestion Module	0.0013	28 (frozen)
Total particulate phosphorus (mg/l)	Aspila et al. 1976	Lachat QuikChem Automated Flow Injection Analysis System	0.0011	28
Chloride (mg/l)*	EPA (1987) Method 11	Dionex DX-500 Ion Chromatograph (AS-9 HC column)	0.02	14
Specific conductance (mg/l)	EPA (1987) Method 23	YSI Conductance Meter w/Cell	0.1	7
Dissolved organic carbon (mg/l)*	EPA (1987) Method 14	Dohrmann Phoenix 8000 Organic Carbon Analyzer	0.14	28
Particulate carbon (mg/l)	D'Elia et al. 1997	CE Elantech N/C Analyzer	0.0595	

* Indicates analyses that require filtration within 48 hours.

Literature Cited

APHA. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, Washington, DC.

Aspila, I., H. Agemian, and A.S.Y. Chau. 1976. A semi-automated method for the determination of inorganic, organic, and total phosphate in sediments. Analyst 101:187-197.

D'Elia, C. F., E.E Connor, N.L. Kaumeyer, C.W. Keefe, K.V. Wood, C.F. Zimmerman. 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures, Technical Report Series No. 158-97. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD.

EPA. 1987. Handbook of Methods for Acid Deposition Studies: Laboratory Analyses for Surface Water Chemistry. Office of Acid Deposition, Environmental Monitoring and Quality Assurance, U.S. Environmental Protection Agency, Washington, DC.

EPA. 1999. Methods and Guidance for Analysis of Water. EPA 821-C-99-004. Office of Water, U.S. Environmental Protection Agency, Washington, DC.

UMCES - Appalachian Laboratory
301 Braddock Road
Frostburg, MD 21532

Chain of Custody Record
Maryland Biological Stream Survey
Spring Index Period

Date of Shipment

YYMMDD

_____

Cooler Temperature on Receipt

_____ °C

Analyze For:

1-L Grab: DOC, TDP, TDN, Cl, NO_2, NO_3, PO_4, SO_4, NH3, PP, PN
0.5-L Grab: Specific conductance, ANC

Sample Identification

Site ID	Date YYMMDD	Time Military	Site ID	Date YYMMDD	Time Military

Field Comments:

Cooler Contents
Total Number of:

Syringes _____
1-L Bottles _____
0.5-L Bottles _____

Cooler relinquished by: _____
(print name)

_____
(signature)

Cooler received by: _____
(print name)

_____
(signature)

Date and Time of Receipt at Laboratory:

YYMMDD Time (24hr)

_____ _____

Lab Comments:

Page ____ of ____

ATTACHMENT 9

Guidance for MBSS Benthic Macroinvertebrate Sample Chain-of-Custody Sheet

General

This sheet provides a means of tracking the transfer of benthic macroinvertebrate samples between field collecting crews and DNR field office personnel responsible for processing the samples. If multiple sample containers are delivered for a single site, enter each container on a separate row. If entries are repeated down a row, it is not necessary to enter the information in each cell. Simply use an arrow or quote marks to indicate the information is repeated down the row. Please write as legibly as possible following the guidelines below. The entry of a printed name indicates responsibility of the individual for relinquishing or receiving each sample.

1. ***Site ID*** Enter the site ID just as it appears on the field data form.

2. ***Collector (print)*** Print the name of the person who collected the benthic sample.

3. ***Collection Date*** Enter the date the sample was collected (using DD/MM/YY format) just as it appears on the field data form.

4. ***Date Delivered to Field Office*** Enter the date the sample was delivered to the field office using DD/MM/YY format.

5. ***Relinquished By (print)*** Enter the printed name of the person relinquishing the sample to the appropriate field office staff member.

7. ***Received By (print)*** Enter the printed name of the person receiving the sample at the field office.

8. ***Field Office Log-In Number*** (Done by field office personnel) Enter the Benthic Sample Log-in number.

9. ***Comments*** Place any pertinent comments regarding the delivered samples, including unusual circumstances, here. Examples include “label for sample from site HA-P-056-312 fell off - see label in container” or “some of sample for site HA-P-056-312 spilled while in transport”.

If you have questions regarding the use of this sheet or the benthic sample chain-of-custody procedure, call Dan Boward at 410-974-3767.

ATTACHMENT 9
Maryland Department of Natural Resources
Monitoring and Non-Tidal Assessment Division
580 Taylor Avenue
Annapolis, MD 21401

MBSS Benthic Macroinvertebrate Sample Chain-of-Custody Sheet

Site ID	Collector (print)	Collection Date (DD/MM/YY)	Date Delivered to Field Office (DD/MM/YY)	Relinquished By (print)	Received by (print)	Field Office Log Number

Comments _____

ATTACHMENT 10

MBSS Stream Habitat Assessment Guidance Sheet

Habitat Parameter	Optimal 16-20	Sub-Optimal 11-15	Marginal 6-10	Poor 0-5
1. Instream Habitat[a]	Greater than 50% of a variety of cobble, boulder, submerged logs, undercut banks, snags, rootwads, aquatic plants, or other stable habitat	30-50% of stable habitat. Adequate habitat	10-30% mix of stable habitat. Habitat availability less than desirable	Less than 10% stable habitat. Lack of habitat is obvious
2. Epifaunal Substrate[b]	Preferred substrate abundant, stable, and at full colonization potential (riffles well developed and dominated by cobble; and/or woody debris prevalent, not new, and not transient)	Abund. of cobble with gravel &/or boulders common; or woody debris, aquatic veg., undercut banks, or other productive surfaces common but not prevalent /suited for full colonization	Large boulders and/or bedrock prevalent; cobble, woody debris, or other preferred surfaces uncommon	Stable substrate lacking; or particles are over 75% surrounded by fine sediment or flocculent material
3. Velocity/Depth Diversity[c]	Slow (<0.3 m/s), deep (>0.5 m); slow, shallow (<0.5 m); fast (>0.3 m/s), deep; fast, shallow habitats all present	Only 3 of the 4 habitat categories present	Only 2 of the 4 habitat categories present	Dominated by 1 velocity/depth category (usually pools)
4. Pool/Glide/Eddy Quality[d]	Complex cover/&/or depth > 1.5 m; both deep (> .5 m)/shallows (< .2 m) present	Deep (>0.5 m) areas present; but only moderate cover	Shallows (<0.2 m) prevalent in pool/glide/eddy habitat; little cover	Max depth <0.2 m in pool/glide/eddy habitat; or absent completely
5. Riffle/Run Quality[e]	Riffle/run depth generally >10 cm, with maximum depth greater than 50 cm (maximum score); substrate stable (e.g. cobble, boulder) & variety of current velocities	Riffle/run depth generally 5-10 cm, variety of current velocities	Riffle/run depth generally 1-5 cm; primarily a single current velocity	Riffle/run depth < 1 cm; or riffle/run substrates concreted
6. Embeddedness[f]	Percentage that gravel, cobble, and boulder particles are surrounded by line sediment or flocculent material.			
7. Shading[g]	Percentage of segment that is shaded (duration is considered in scoring). 0% = fully exposed to sunlight all day in summer; 100% = fully and densely shaded all day in summer			
8. Trash Rating[h]	Little or no human refuse visible from stream channel or riparian zone	Refuse present in minor amounts	Refuse present in moderate amounts	Refuse abundant and unsightly

a) Instream Habitat Rated based on perceived value of habitat to the fish community. Within each category, higher scores should be assigned to sites with a variety of habitat types and particle sizes. In addition, higher scores should be assigned to sites with a high degree of hypsographic complexity (uneven bottom). In streams where ferric hydroxide is present, instream habitat scores are not lowered unless the precipitate has changed the gross physical nature of the substrate. In streams where substrate types are favorable but flows are so low that fish are essentially precluded from using the habitat, low scores are assigned. If none of the habitat within a segment is useable by fish, a score of zero is assigned.

b) Epifaunal Substrate Rated based on the amount and variety of hard, stable substrates usable by benthic macroinvertebrates. Because they inhibit colonization, floculent materials or fine sediments surrounding otherwise good substrates are assigned low scores. Scores are also reduced when substrates are less stable.

c) Velocity/Depth Diversity Rated based on the variety of velocity/depth regimes present at a site (slow-shallow, slow-deep, fast-shallow, and fast-deep). As with embeddedness, this metric may result in lower scores in low-gradient streams but will provide a statewide information on the physical habitat found in Maryland streams.

d) Pool/Glide/Eddy Quality Rated based on the variety and spatial complexity of slow- or still-water habitat within the sample segment. It should be noted that even in high-gradient segments, functionally important slow-water habitat may exist in the form of larger eddies. Within a category, higher scores are assigned to segments which have undercut banks, woody debris or other types of cover for fish.

e) Riffle/Run Quality Rated based on the depth, complexity, and functional importance of riffle/run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/run areas, stable substrates, and a variety of current velocities.

f) Embeddedness Rated as a percentage based on the fraction of surface area of larger particles that is surrounded by fine sediments on the stream bottom. In low gradient streams with substantial natural deposition, the correlation between embeddedness and fishability or ecological health may be weak or non-existent, but this metric is rated in all streams to provide similar information from all sites statewide.

g) Shading Rated based on estimates of the degree and duration of shading at a site during summer, including any effects of shading caused by landforms.

h) Trash Rating The scoring of this metric is based on the amount of human refuse in the stream and along the banks of the sample segment.

MBSS FISH DATA SHEET

Page ___ Of ___

SITE Watershed Code ____ Segment ___ Type _ Year ____

Reviewed By: ____________

DATE Y Y M M D D

2nd Reviewer: ____________

	(Y/N)
Fish Move. During Net Install.?	
Bottom Visible in all Areas of Seg.?	
Same Water Clarity - 2nd Pass?	
Volt. ____ Waveform	
Len. of Seg. Actually Samp. (m)	

	Unit ___	Unit ___	Unit ___	Unit ___	Unit ___
Anodes/Unit					
Time (sec) Begin 1st p.					
Time (sec) Begin 2nd p.					
Time (sec) End 2nd p.					

Fish Captured? (Y/N)

SPECIES (See Back for Name Spelling)	Number Retained? or Photo	1st Pass Catch (Total)	2nd Pass Catch (Total)	Unusual Anomalies (Y/N)	Comments

Aggregate Fish Biomass _____ _____ (g)

COMMON NAMES OF FISH SPECIES

NON-GAME FISH

LAMPREYS:
American brook lamprey
Least brook lamprey
Sea lamprey
lamprey (unknown)

HERRINGS:
Alewife
American shad
Blueback herring
Gizzard shad
Hickory shad
Threadfin shad

CATFISHES:
Black bullhead
Blue catfish
Brown bullhead
Channel catfish
Margined madtom
Stonecat (r)
Tadpole madtom
White catfish
Yellow bullhead

SUCKERS:
Black redhorse
Creek chubsucker
Golden redhorse
Longnose sucker (E)
Northern hogsucker
Shorthead redhorse
Quillback
White sucker

KILLIFISH:
Banded killifish
Mummichog
Rainwater killifish
Sheepshead minnow
Striped killifish

STICKLEBACKS:
Fourspine stickleback
Threespine stickleback

MINNOWS:
Blacknose dace
Bluntnose minnow
Bridle shiner
Bullhead minnow
Central stoneroller
Cheat minnow (E)
Common carp
Common shiner
Comely shiner
Creek chub
Cutlips minnow
Eastern silvery minnow
Emerald shiner
Fallfish
Fathead minnow
Goldfish
Golden shiner
Grass carp
Ironcolor shiner
Longnose dace
Pearl dace
Redside dace (R)
River chub
Rosyface shiner
Rosyside dace
Satinfin shiner
Silver shiner
Silverjaw minnow
Spotfin shiner
Spottail shiner
Striped shiner
Swallowtail shiner
Tench
Cyprinella sp.

SCULPINS:
Checkered sculpin
Mottled sculpin
Potomac sculpin
Slimy sculpin (T)
Sculpin (unknown)

PERCHES:
Banded darter
Blackside darter
Fantail darter
Glassy darter(E)
Greenside darter
Johnny darter
Maryland darter(E)
Logperch (R)
Rainbow darter
Shield darter
Stripeback darter(E)
Swamp darter
Tessellated darter
Variegate darter
Yellow perch

SUNFISHES:
Banded sunfish
Black crappie
Blackbanded sunfish(I)
Bluespotted sunfish
Bluegill
Flier (U)
Green sunfish
Mud sunfish (R)
Pumpkinseed
Redbreast sunfish
Redear sunfish
Rock bass
Longear sunfish
Warmouth
White crappie
Lepomis hybrid
Sunfish (unknown)

Miscellaneous:
Longnose gar
Mosquitofish
Pirate Perch
American eel
Trout-perch (E)
Rainbow smelt
Bowfin
Eastern mudminnow
Inland silverside
White perch
Atlantic menhaden
Spot

GAME FISH

TROUTS:
Brook trout
Brown trout
Cutthroat trout
Lake trout
Rainbow trout

PIKES:
Chain pickerel
Muskellunge
Northern pike
Redfin pickerel

BASS:
Striped bass
Smallmouth bass
Largemouth bass
Walleye

STATUS KEY:
(R)= RARE
(U)= UNKNOWN
(I) = IN NEED OF CONSERVATION
(E) = ENDANGERED
(T) = THREATENED

ATTACHMENT 12

MBSS VOUCHER SPECIMEN LABELS

Maryland Biological Stream Survey

SITE ID_____
Cat. No._____ Family:_____
Species:_____
Basin: _____ Date: _____
State: _____ County:_____
Locality: _____
Lat: _____ Lon:_____
Col. By: _____
Det. By: _____No.Specimens:_____

ATTACHMENT 13
DRAINAGE BASIN _____VOUCHER COLLECTION LIST

BASIN _____ **CREW _____**

SPECIES	DATE	SITE ID

ATTACHMENT 14

MBSS GAME FISH LENGTH DATA SHEET

Page ____ Of ____

SITE Watershed Code ____ Segment ____ Type ____ Year ____

DATE Y Y M M D D ____

Reviewed By: _____

2nd Reviewer: _____

SPECIES	LENGTH (TL; mm)	SPECIES	LENGTH (TL; mm)
1.		31.	
2.		32.	
3.		33.	
4.		34.	
5.		35.	
6.		36.	
7.		37.	
8.		38.	
9.		39.	
10.		40.	
11.		41.	
12.		42.	
13.		43.	
14.		44.	
15.		45.	
16.		46.	
17.		47.	
18.		48.	
19.		49.	
20.		50.	
21.		51.	
22.		52.	
23.		53.	
24.		54.	
25.		55.	
26.		56.	
27.		57.	
28.		58.	
29.		59.	
30.		60.	

ATTACHMENT 15

MBSS QUALITATIVE ELECTROFISHING DATA SHEET

Page ____ Of ____

SITE Watershed Code ____ Segment ____ Type ____ Year ____

BASIN ____ (see back for codes)

DATE Year ____ Month ____ Day ____

TIME ____ (Military)

Reviewed By: _____

2nd Reviewer: _____

CREW: _____

STREAM: _____

	Fish Species	Time	Dist.	Ret. or Photo	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

ATTACHMENT 16

MBSS SUMMER HABITAT DATA SHEET

Page ☐ Of ☐

SITE Watershed Code ☐☐☐☐ Segment ☐☐☐ Type ☐ Year ☐☐☐☐

BASIN ☐☐ (see back for codes)

DATE Year ☐☐ Month ☐☐ Day ☐☐

TIME ☐☐☐☐ (Military)

Reviewed By: ____________

2nd Reviewer: ____________

CREW: ____________________________

____

BANK EROSION

	Left Bank	Right Bank
Extent (m)	☐☐	☐☐
Severity (1=min, 2=mod, 3=severe)	☐	☐
Eroded Area (m^2) x 10	☐☐☐	☐☐☐

BAR FORMATION & SUBSTRATE

☐ None ☐ Cobble
☐ Minor ☐ Gravel
☐ Moderate ☐ Sand
☐ Extensive ☐ Silt/Clay

EXOTIC PLANTS Relative Abundance

(A, P, E)

☐ Multiflora Rose
☐ Mile-a-Minute
☐ Japanese Honeysuckle
☐ Phragmites
☐ Thistle
☐ Japanese Stilt Grass
☐ ____________

☐☐ No. of Instream Woody Debris
☐☐ No. of Dewatered Woody Debris
☐☐ No. of Instream Rootwads
☐☐ No. of Dewatered Rootwads

HABITAT ASSESSMENT

1. Instream Habitat (0-20) ---------------- ☐☐
2. Epifaunal Substrate (0-20) ------------ ☐☐
3. Velocity/Depth Diversity (0-20) .... ☐☐
4. Pool/Glide/Eddy Quality (0-20) .... ☐☐
   Extent (m)................................ ☐☐
5. Riffle/Run Quality (0-20) .... ☐☐
   Extent (m) .... ☐☐
6. Embeddedness (%) .... ☐☐☐
7. Shading (%) .... ☐☐☐

STREAM CHARACTER

☐ Braided ☐ Gravel
☐ Riffle ☐ Sand
☐ Run/Glide ☐ Silt/Clay
☐ Deep Pool(>= .5m) ☐ Undercut Bank
☐ Shallow Pool(< .5m) ☐ Overhead Cover
☐ Boulder >2m ☐ Beaver Pond
☐ Boulder <2m
☐ Cobble
☐ Bedrock

A = Absent
P = Present
E = Extensive

Maximum Depth (cm) ☐☐☐

	Wetted Width (m)	Thalweg Depth (cm)	Thalweg Velocity (m/s)
0 m	☐☐.☐	☐☐☐	☐.☐☐
25 m	☐☐.☐	☐☐☐	☐.☐☐
50 m	☐☐.☐	☐☐☐	☐.☐☐
75 m	☐☐.☐	☐☐☐	☐.☐☐

FLOW

Lat Loc (m)	Depth (cm)	Velocity (m/s)
0 0 . 0 0	0 0 . 0	0 . 0 0

Alternative Flow Measurements

Distance

Depth (cm) ☐

Width (cm) ☐☐

Time (sec) **1.** ☐☐☐
2. ☐☐☐
3. ☐☐☐

COMMENTS ____________________________

____

FISH CRIB SHEET

Page ____ Of ____

SITE Watershed Code ____ Segment ____ Type ____ Year ____

DATE Y Y M M D D

____ PASS			____ PASS		
Species	Tally	Anomalies	Species	Tally	Anomalies

ATTACHMENT 18
MBSS Temperature Logger Field Sheet

Deployment Crew _____

Serial Number	Site #	Date/Time Deployed	Date/Time Retrieved	Photo #	Temperature Logger Location

TURBIDITY (Taken in large part from Bain and Stevenson 1999)

Turbidity is a measure of the extent that light penetration is reduced from suspended solids, and, to a lesser extent, pollution-derived color, optically active dissolved material, organic matter/detritus, and plankton/other microscopic organisms. Therefore, data interpretation should factor in these other sources of light reduction. For the MBSS, turbidity is measured with a field nephelometric turbidity meter as NTU, or nephelometric turbidity units. Light transmission is measured by passing a beam of light through sample cuvettes containing sample material and recording the amount of light that reaches the other side. Calibration is easily accomplished using cuvettes with standards of known turbidity. The state water quality criterion for turbidity is 50 NTU monthly average or 150 NTU instantaneous. Readings for most streams during baseflow will be well below 5 NTU.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is a term used to describe the concentration of the element oxygen in water. DO enters the water from one of two ways– photosynthesis of plants and directly from the atmosphere via diffusion or mechanical aeration (e.g., waves, waterfalls). DO it vital to respiration of both plants and animals. Because its importance to biota, DO is frequently used as an indicator of water quality. DO in surface waters varies with temperature because the saturation level for DO decreases as temperature rises. In rocky, high gradient streams, mechanical aeration is often great enough that even streams with highly elevated oxygen demand are at or near saturation levels. In low gradient coastal plain systems, even moderate oxygen demand (referred to as BOD, or biochemical oxygen demand) can result in DO levels that are low enough to harm aquatic biota.

DO is measured with a probe outfitted with a thin plastic membrane stretched over a platinum or gold cathode. When a current is passed between the indicating electrode and a reference electrode (usually silver chloride), the oxygen in the solution being measured diffuses through the membrane and is reduced at the cathode. The measured current flow corresponds to a given oxygen concentration for the temperature of the sample. Calibration is performed by exposing the probe to a known concentration (usually water saturated air).

In streams, DO varies during the course of a day. In organically enriched streams, DO is often lowest just before sunrise because plants have not been photosynthesizing and only respiration has been occurring. Conversely, DO increases after sunrise until the sun's angle of incidence is greatest because the rate of photosynthesis is dependent on sunlight. In less enriched streams this pattern may be less apparent or absent because stream temperatures are lower at night and thus can contain more dissolved oxygen.

pH

In Webster's, pH is described as being derived from the French phrase *pouvoir hydrogene*, or 'hydrogen power' and is defined as a'symbol for the degree of acidity or alkalinity of a solution'. More specifically, ph is a measure of the number of hydrogen ions in a given solution that are available to react. The more ions available for reaction, the lower the pH. The concentration of these ions is measured on a log scale, so each pH unit change represents a 10X change in hydrogen ion concentration. Pure water has a pH of

7 (neutral), which means that it is equally able to accept or donate hydrogen ions. At pH < 7, hydrogen ions are more readily donated.

pH is measured with a voltmeter attached electrically to a glass electrode– an electrode converts the voltage from a solution to a current which is amplified, read, and converted to a pH for that temperature. For samples with pH <7, hydrogen ions migrate from the solution being measured to the electrode, creating a measured positive charge (a negative charge is created when measuring a high pH sample). Calibration is accomplished using two, highly stable buffer solutions of known concentration. All samples must fall between the range of the buffer solutions being used (pH= 4 and 7 or pH = 7 and 10). The accuracy of a field pH meter is about 0.1 pH units.

CONDUCTIVITY

Conductivity or specific conductance is a measure of the ability of water to conduct an electric current. Electric current is carried by dissolved inorganic solids such as chloride, carbonate, nitrate, sulfate and phosphate anions (negatively charged particles), as well as sodium, calcium, magnesium, potassium, iron and aluminum cations (positively charged particles). Organic materials such as oils, phenols, alcohols and sugars do not carry electric current.

Specific conductance is measured in units of micro siemens per centimeter (μS/cm) at 25°C using a probe employing from two to six electrodes to generate a voltage potential in a cell and measure the electric current that passes through the water sample in the cell. The higher the current, the higher the conductivity of the water. Calibration is accomplished by setting the zero point in air (or de-ionized water @ 1μS/cm) and setting the upper range slope using a solution of a known value. Usually the calibration standard is near, but above, the range expected to be seen in the waters sampled.

In Maryland, stream conductivity ranges from less than 50 μS/cm in Western Maryland streams known to be affected by acid deposition ... to almost 4000 μS/cm in Gwynns Falls, an urban stream affected by point source discharges, urban runoff, and raw sewage. Other human influences on conductivity in streams include agriculture (primarily from the liming of fields) and acid mine drainage (AMD) in coal-bearing regions. AMD streams may exceed 1200 μS/cm because of high concentrations of sulfates, aluminum, iron, and manganese. In general, the Southern Coastal Plain has the lowest conductance waters, averaging less than 200 μS/cm, and the Valley and Ridge physiographic province has the highest average conductivities at about 400 μS/cm. In a given stream, conductivity usually increases in the downstream direction, but this pattern may be altered by the addition of acid deposition influenced tributaries. An example might be a coastal plain stream which originates in a series of limed farm fields and then receives water from a forested watershed.