Maryland Department of Natural Resources

Subject: Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland

Policy Number: 2015:01

Effective Date: June 8, 2015

Approved:  **Date:** 3 June 2015

I. Purpose

The policy shall guide the Department of Natural Resources' review, support, funding, and/or construction of stream restoration projects in Maryland.

II. Scope

The policy applies to all proposals for stream restoration that are supported or funded by the Maryland Department of Natural Resources, or are subject to review by the Department in association with established permitting processes.

The language associated with "stream restoration" carries many definitions for "manipulative" actions, ranging from localized engineering activities to more holistic, ecosystem-based approaches. As used in this policy and the associated "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects" (Protocols), manipulative actions categorized and defined in the Protocols, include "stream restoration", stream rehabilitation", "stream engineering", "stream reclamation", "stream stabilization", and "stream enhancement".

III. Policy

It is the Policy of the Department to protect the ecological integrity and function of Maryland's streams. To that end:

A. The Department developed a series of "Guiding Principles" as part of a river/stream management strategy which shall be utilized to guide our strategies, actions, and recommendations pertaining to the management of Maryland's rivers and streams.

B. The Department also developed and will utilize the "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices" designed to assure that future investments in stream restoration are well matched to the particular circumstances and conditions they are intended to address. These protocols and criteria describe how the Department will review proposed projects designed to accomplish stream restoration

objectives, or otherwise enhance the structure and/or function of stream systems in Maryland. Such projects shall include but are not limited to those submitted:

1. For review by units or divisions within DNR;
2. For review subject to the requirements of the State Non-tidal Wetlands and Waterways permit program;
3. For review by Federal agencies in accordance with the National Environmental Policy Act;
4. By local governments and/or private organizations subject to review through the interagency Joint Evaluation meeting process; or
5. For review by local governments, private organizations, or state agencies not subject to review processes identified in 1 thru 4 above.

C. The "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices" shall also be used to guide the Department's actions to support, fund, and/or construct stream restoration projects.

D. The Department, in collaboration with other agencies and partners, will modify the "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices" and "Guiding Principles" as the best available science related to stream restoration becomes available.

IV. Procedure

DNR units proposing or engaged in any actions to support, fund, and/or construct stream restoration projects shall utilize the "Guiding Principles" and "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices" as a basis for developing any stream management strategy or evaluating the advisability of any actions to support or fund stream restoration projects.

The Department will also utilize the "Guiding Principles" and "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices" in the review of all other stream restoration proposals that are submitted to DNR for review and comment through State and Federal permitting agencies and processes to insure consistency in the treatment of such proposals.

The procedure for review is fully described in the "Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices".

Maryland Department of Natural Resources

Protocols and Criteria for Review and Evaluation of Stream Restoration Projects and Practices

In support of Policy Number: 2015:01

Effective Date: June 8, 2015

PREAMBLE:

"If there is magic on this planet, it is contained in water."
Loren Eiseley, 1957

Due to the uncertainty of outcomes associated with stream restoration actions, the Department of Natural Resources (DNR) developed the following criteria to guide DNR's actions to review, support, fund, and/or construct stream restoration projects. These criteria will be used to evaluate the merits of proposed stream restoration actions using the best available science to support recommendations from the Department's review of proposals and projects.

Rivers, streams, and their watersheds are complex ecological systems defined by components of geology, hydrology, hydraulics, geomorphology, physicochemistry, water quality, biology, and floodplain connectivity. These aquatic systems have been altered in Maryland by land use changes, climate change, channel and riparian zone alterations, and loss of connectivity. Degraded stream systems are contributing to water quality and habitat problems in the Chesapeake Bay and its tributaries. Interest and public investment in stream corridor restoration projects in Maryland have increased sharply over the last two decades. Current Federal requirements for state agencies and local governments to achieve targeted total maximum daily loads (TMDL's) and develop watershed implementation plans (WIP's) to achieve these targets assure that interest in stream corridor restoration will continue to grow and perhaps accelerate in the future.

Efforts to restore degraded stream systems, while usually well-intentioned, are sometimes inappropriate or ineffective because they fail to address the underlying processes that support and maintain stream system structure and functions. Many conventional stream restoration projects are highly engineered efforts to stabilize stream channels that in some cases may be detrimental to in-stream and riparian biota and system stability (Karr and Chu 1999). Such projects may have been hampered by unclear or limited objectives (Kondolf 2006) or simply failed to consider and integrate systemic inter-relationships in the project design. Stream restoration success depends upon correctly diagnosing the problem(s) causing degradation, embracing a holistic restoration philosophy embedded in an adaptive management framework, eliminating or significantly reducing the major system stressors and implementing appropriate techniques that can restore structure, function, and resilience to some previous ecological state or trajectory that is self sustaining (SER 2004).

One approach to planning, designing, implementing, and monitoring the performance of stream restoration projects currently receiving attention in the Chesapeake Bay community is

the Function-based Stream Restoration Project Process. This approach is built on the Stream Function Pyramid Framework developed by Harman et al. (2012). The Framework offers a step-wise process for describing the health of the watershed in which a prospective restoration site is embedded: setting clear, realistic project goals and objectives; identifying key stressors and constraints; selecting assessment parameters and parameter measurement methods; identifying performance standards; establishing restoration potential (i.e., What is achievable?); and evaluating how much functional lift (e.g., improvement in biological diversity) can be achieved by the project.

The study of restoration ecology, aquatic and terrestrial, has become a relatively robust and independent scientific discipline only during the last two decades (Young 2000, Young et al. 2005). Consequently, research results coming from stream corridor restoration efforts may offer less than clear direction to resource managers and can often be confusing. Furthermore, the language associated with "stream restoration" carries many definitions for various "manipulative" efforts, ranging from localized engineering activities to more holistic, ecosystem-based approaches. Stream ecosystems are not amenable to rigorous experimental designs because they are governed by a host of dependent and independent variables that are heterogeneous in space and time. An added complicating factor is that system response times to restoration project manipulations are often too long to ascertain measurable short-term results, and post-project monitoring efforts rarely extend beyond 3-5 years. Kondolf (2006) and others have stated that post-restoration monitoring should continue for at least a decade, and also include several years of pre-project, baseline data----another monitoring component not always included in stream restoration projects. A properly-planned restoration project should be based on clearly-stated goals and objectives that can be evaluated with performance standards that are incorporated into the project design before it starts (SER 2004). These issues, individually or collectively, if not adequately addressed, can lead to poorly controlled or even uncontrolled restoration "experiments", with outcomes that are often not reproducible and/or quantifiable, and consequently, may not achieve their intended goals.

In essence, the art and science of stream restoration is a work in progress with much uncertainty and unpredictability concerning project results (Hildebrand et al. 2005). These concerns underscore the need for a policy document that defines criteria and describes the process the Maryland Department of Natural Resources (DNR) intends to use to guide DNR's stream restoration efforts and to review and comment on proposed stream restoration projects. This policy document is intended to provide the rationale for how DNR will evaluate the merits of proposed stream restoration projects and develop recommendations for approval or disapproval of particular projects. DNR hopes that this document will also provide direction to other MD state agencies, local governments, organizations and landowners who may want to undertake stream restoration projects.

The following review protocols and criteria are designed to assure that future investments in stream restoration are well matched to the particular circumstances and conditions they are intended to address. These criteria describe how DNR will review proposals for projects with objectives to restore, rehabilitate, reclaim, stabilize, mitigate impacts, or enhance the structure and/or function of stream systems in Maryland. Given the complexity associated with a host of variables that must be considered when evaluating stream restoration projects, it is incumbent upon DNR to develop and implement the review protocols and criteria now,

to minimize the likelihood that future stream restoration projects result in unintended consequences and/or waste valuable resources.

The underlying philosophy for this document is DNR's Vision for Managing Maryland's Rivers and Streams plus several Guiding Principles that include not only restoration but also protection/preservation (see Appendices A and B). Through the implementation of these protocols and criteria, DNR will guide its own actions and attempt to lead by example, while encouraging our sister agencies and local government partners to also embrace these protocols and criteria in the design, evaluation, and permitting of stream restoration projects.

I. PURPOSE

The purpose of these stream restoration review protocols and criteria are to:

A. Provide guidance and procedures for the review of proposals to conduct projects that may be identified alternatively as "stream restoration", "stream rehabilitation", "stream engineering", "stream reclamation", "stream stabilization" or "stream enhancement" that are submitted for review and evaluation by DNR's Project Review Division. (See definitions)

B Encourage and promote uniformity among various units within DNR and other state agencies regarding criteria and standards for evaluating activities proposed and described as stream restoration, rehabilitation, reclamation, stabilization, and engineering projects.

C. Provide guidance to state agencies, local governments, organizations and landowners engaged in stream restoration and their consultants in understanding the basis for DNR's determinations and recommendations regarding the range, nature and/or degree of restoration actions or activities that DNR considers to be most appropriate or responsive to achieve desired stream improvement objectives.

D. Guide DNR in making determinations for design efficacy and providing recommendations concerning stream restoration, rehabilitation, reclamation, engineering, ~~or~~ stabilization or enhancement projects which may be proposed to achieve TMDL targets by state agencies and local governments.

E. Guide DNR in determining whether or not all applicable State and Federal statutes, regulations, and relevant policies are being recognized and followed accordingly.

II. SCOPE

Maryland DNR divisions and units, as well as any other state agencies and local government partners that may adopt or utilize these criteria.

III. DEFINITIONS

Adaptive Management –	Natural resource management in which decisions are made iteratively as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices. Because adaptive management is based on a learning process, it can improve long–term management outcomes.
Afforestation –	The conversion of bare or cultivated land into forest.
Alluvial –	Pertaining to or composed of alluvium, or deposited by a stream or running water.
Assisted Recovery –	Refers to the removal of a perturbation or disturbance (e.g., excluding grazing livestock from a riparian zone) and allowing natural processes (e.g., re-growth of vegetation, fluvial processes) to operate, leading to recovery of ecosystem function.
Backwater –	Process whereby water is backed up in its course by an obstruction, an opposing current, or the tide.
Best Management Practices (BMPs)	Individual methods, techniques, design elements, and also broader approaches in project design plans and construction that have consistently shown results superior to those achieved with other means, and that are often used as a benchmark for optimally conducting projects in the field and which can evolve to become better. In this document, the term refers to practices having optimal performance, sustainability, and reliability for a variety of activities occurring within streams, floodplains, and riparian zones, including, but not limited to: access, construction, sediment and erosion control, flow conveyance, runoff management, site stabilization and restoration, vegetation management, and overall natural resource protection.
Biota –	The animal or plant life of a region.
Channel –	The physical confine of a stream, river, or slough consisting of a bed and banks and created by erosion

and/or deposition of sediment.

Conservation – The careful management and utilization of a natural resource in order to prevent depletion.

Control Site – A place or location that possesses similar environmental conditions to the site (or sites) where restoration activities are proposed. However, the control site is isolated (though in close proximity) from all restoration activities and allows for a direct comparison to test if the goals and objectives of the restoration activities were achieved.

Degradation – Changes that reduce water quality, habitat conditions, ecological integrity and stream health.

Ecological Integrity – The condition of an ecosystem that is supporting and maintaining a balanced and adaptive community of organisms with a species composition, diversity, and organization comparable to that of the natural habitats within its region.

Ecological Restoration – Process of assisting the recovery of a stream or ecosystem that has been degraded, damaged, or destroyed, with the goal of returning the stream or ecosystem to its intended trajectory and restoring natural/historic functions.

Ecosystem – Consists of the biota (plants, animals, micro-organisms) within a given area, the environment that sustains them, and their interactions.

Engineering – The application of scientific principles to design or develop structures, apparatus, or management processes with consideration of economics of operation and safety to life and property. The manipulation of natural materials, living organisms and physical or chemical environment to achieve specific human goals or solve technical problems.

Ephemeral Stream – A stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table (COMAR 26.20.01.02).

Eutrophication – The process by which a water body acquires a high concentration of nutrients, especially nitrogen and phosphorus, that typically promotes excessive growth of algae that can, in turn, deplete dissolved oxygen levels

when they die and decompose.

Floodplain – The portion of the river valley adjacent to the active channel that is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stages.

Forest – A biological community dominated by trees and other woody plants covering an area of 10,000 square feet or greater. Forest includes:
1) Areas with a tree cover ratio of 100 trees per acre with at least 50% of these trees being at least 2 inches in diameter at a height of 4.5 feet above ground; or
2) Areas with mature trees that provide a contiguous canopy over unimproved land; and
3) Areas meeting the criteria above that have been cut but not cleared.
Forest does not include orchards, tree nurseries, Christmas tree farms or other types of forest crops.

Geomorphology – The scientific study of landforms and the processes that shape them. Geomorphological functions within streams include the transport of wood and sediment to create more diverse bed-forms and a dynamic equilibrium.

Habitat – The dwelling place in which the life needs of a plant or animal are fully or partially supplied.

Hill Slope – Portions of the landscape consisting of curved, sloping surfaces shaped by mass wasting of materials, degradation from chemical weathering, and dissection by focused mechanical erosion associated with gully channels.

Hydraulics – The description of fluid flow in an open or closed channel.

Hydrology – The science dealing with water, its properties, circulation, and distribution on and under the earth's surface and in the atmosphere.

Indigenous – Originating or occurring naturally in a particular place; native plants and animals.

Invasive – A plant or animal species that is non-native (non-indigenous) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental damage or harm to the ecosystem or human health. Not all non-native species become invasive.

Intermittent Stream –	A stream that does not have flowing surface water during dry periods of the year, but may have groundwater-based surface flow at other times (COMAR 26.08.01.01).
Measurement –	A set of observations having the objective of determining the magnitude of a quantity which are accompanied by a quantitative statement of its uncertainty.
Mitigation –	An action or activity intended to compensate for or alleviate environmental damage. Mitigation may occur at the damaged site or elsewhere. It may involve site rehabilitation to an acceptable condition, but not necessarily to a natural condition. Mitigation is typically a permit requirement for some non-restoration type of action.
Nutrients –	The elements required to support the bodily structure and metabolism of biological organisms. These elements include nitrogen and phosphorus, which are considered pollutants if present in excessive quantities or result in the generation of adverse secondary effects, such as eutrophication and reduced water quality in slow moving or standing water.
Perennial Stream –	A stream or part of a stream that flows continuously during all of the calendar year as a result of groundwater discharge or surface runoff (COMAR 26.20.01.02).
Practicable –	Feasible or capable of being done with means at hand and circumstances as they exist.
Preservation –	Actions taken to maintain a natural resource in its existing condition, minimize the rate of change, and protect it from future functional damage or losses.
Reference Site or Ecosystem–	A place or written description or both, of a minimally disturbed area, that can be used as a model for planning a restoration project and then evaluating the post-manipulation product to determine if the project goals and objectives were achieved.
Riparian Area –	Lands adjacent to streams, rivers, lakes and estuarine shorelines that provide a variety of ecological functions and services and help improve or maintain water quality (Harman et al. 2012).
Sediment –	Mineral or organic material which makes up the active

channel of a stream or river. There are many commonly used size categories of stream sediments, from silt/clay (smallest), to bedrock (largest).

SER – Society for Ecological Restoration; International Science and Policy Working Group, 2004. The SER International Primer on Ecological Restoration; www.ser.org & Tuscon: Society for Ecological Restoration International.

Stability – The characterization of the constancy or persistence of a physical feature or ecosystem in terms of a position or form.

Storm Water Management – Environmental Site Design (ESD) practices, BMPs, and any other structural or nonstructural measures through which stormwater is detained, filtered, or infiltrated prior to discharge from a site. *Source: Maryland Model Stormwater Management Ordinance, April 2010, MD Dept. of Environment*

Stream (Tidal/Non-tidal) – A confined flowing body of water with a current.

Stream Engineering – Structural treatments for infrastructure or public safety or to protect infrastructure investments. Such structures are typically engineered and constructed to serve a human purpose related to hydraulic conveyance, safety, aesthetics, recreation or pollution control, but may not contribute to ecological restoration.

Stream Enhancement – Subjective term for actions undertaken to improve either the existing aesthetic (scenic) or environmental qualities. Stream enhancements may introduce individual stream corridor elements or in-stream habitat features through direct manipulation (e.g., placement of structures in a stream to attract fish and other aquatic biota). Stream enhancements are not designed to address hydrologic or hydraulic functions within the stream system.

Stream Practices – Various techniques that can restore structure, function, and resilience of streams. Practices can include, but are not limited to, use of imbricated rip-rap, root-wad revetment, Boulder revetments, Rock weirs, Rock cross vanes, Step pools, Log vanes, Rock vane/J-rock vane, Cut-off sills and Vegetative practices including use of Coir fiber log, Live fascine, or other plantings.

Stream Reclamation – Actions intended to return a stream to a state that existed prior to a disturbance event or activity, but not necessarily repair or replace all ecosystem functions. Reclamation can

be considered rehabilitation if an ecosystem function is restored or ecological restoration if biological integrity is restored.

Stream Rehabilitation – Recovery of individual ecosystem components related to functions and processes through isolated manipulation of individual elements, but not completely re-establishing conditions existing prior to alterations caused by direct or indirect human disturbances. Rehabilitation typically provides for partial recovery of ecosystem functions and processes. Rehabilitation projects include structural measures and "assisted recovery". Rehabilitation does not necessarily re-establish pre-disturbance structure, but does involve establishing geologically and hydrologically-stable landscapes that support the natural ecosystem mosaic.

Stream Restoration – The holistic process of attempting to return an ecosystem to pre-disturbance conditions or historic trajectory, structure and function, thereby re-establishing the dynamic and self-sustaining behavior of the ecosystem. Return of a stream ecosystem to its original, undisturbed state (e.g., pre-European settlement or prior to a major disturbance event). Ecosystems are dynamic and near-perfect replication of a previous condition is impossible. In some cases, the historic trajectory of a severely impacted stream may be difficult or impossible to determine with accuracy. Therefore, for purposes of these review guidelines, restoration shall also be defined as re-establishment of the structure and function and dynamic, self-sustaining behavior of the stream ecosystem. Restoration is a holistic process not achieved through the isolated manipulation of individual elements. (FISRWG, 1998)

Source: FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.

Note: See Appendix E for attributes of restored ecosystems (SER, 2004)

Stream Stabilization – A vegetative, structural or combination treatment of streams typically designed to stabilize the stream and/or stream bank to reduce erosion. Stream stabilization measures may be used to provide treatment when a stream is unable to transport its sediment load (i.e., sediments deposited

within the channel), leading to the condition referred to as aggradation. More often stabilization measures are applied when the ability of the stream to transport sediment exceeds the availability of sediments within the incoming flow, and stability thresholds for the material forming the boundary of the channel are exceeded and erosion occurs. Stream stabilization projects may or may not include bank stabilization.

Water Quality Load – The quantity of a constituent such as nitrogen, phosphorus, or sediment moving through a river section in a given time interval and typically reported as a mass flux.

Watershed – The geographic area or region where all the water that is under it or drains off of it goes into the same stream or river or other water body.

IV. APPLICABILITY

The following criteria shall be used to guide DNR's actions to support, fund or construct stream restoration projects, and to review all projects that are identified as "stream restoration", "stream rehabilitation", "stream reclamation", "stream stabilization", "stream enhancement", "stream engineering", or other projects or practices that are proposed to alter any portion of a stream system that are submitted for review to DNR's Project Review Division (PRD) or to any other unit within DNR. Such projects shall include but are not limited to those submitted:

A. For review by the units or divisions within DNR,
B. For review subject to the requirements of the State Non-tidal Wetlands and Waterways permit program;
C. For review by Federal agencies in accordance with the National Environmental Policy Act;
D. By local governments and/or private organizations subject to review through the interagency Joint Evaluation meeting process; or
E. For review by local governments, private organizations and/or state agencies not subject to review processes identified in IV A thru D above.

V. CONSISTENCY REQUIREMENT AND CLASSIFICATION OF STREAM PROJECTS

A. Consistency with Other State Regulatory and Non-regulatory Programs

All stream projects subject to review by DNR shall be determined to be consistent with the State's Coastal Zone Management Program; state water quality regulations established by COMAR; regulations and guidelines associated with the State Wetlands and Waterways Program administered by the Maryland Department of Environment (MDE); the Critical Area Law and

the regulations adopted by the Critical Area Commission; and all DNR programs, regulations and statutes. All "stream restoration" activities or other stream manipulation project proposals must be consistent with the spirit and intent of those regulations and guidelines before being recommended for approval or support by DNR.

B. Classification of Stream Projects to be Reviewed

1. All stream projects subject to review by DNR as **stream restoration** projects must be consistent with the definition of "stream restoration" in Section III to be approved by DNR and recommended for approval.

2. Stream activities subject to review that are not consistent with the complete definition of "stream restoration" may be recommended for approval as **stream rehabilitation,** provided such activities are consistent with the definition of "stream rehabilitation" and provided that individual stream corridor elements or attributes associated with instream and riparian biota, stability, hydrology, hydraulics, morphology, substrate, or water quality will be enhanced while no elements are significantly adversely impacted unless the project is expected to provide long term net benefits as a trade-off for any impacts expected.

3. Stream activities subject to review that are not consistent with the complete definitions of either "stream restoration" or "stream rehabilitation" may be recommended for approval or supported as **stream reclamation** provided one or more individual stream corridor elements or attributes associated with instream and riparian biota, stability, hydrology, hydraulics, morphology, substrate, or water quality will be enhanced. Such projects may be designed to return an area to a habitat state that existed prior to a disturbance event, but not necessarily repair or replace all ecosystem functions. Such projects shall be designed to address only the condition caused by the disturbance and the project shall utilize the least number of structural changes necessary to return the stream system to its pre-disturbance condition to achieve reclamation objectives.

4. Stream activities subject to review that are characterized as **stream stabilization** measures shall demonstrate consistency with the definition of "stream stabilization", and may be recommended for approval when the nature and scope of the work is limited to addressing a documented need for stabilization and may not include additional measures that would characterize the project as a stream restoration, rehabilitation, or reclamation project.

5. Stream activities characterized as **stream enhancement** include activities whose primary goal is to enhance the appearance or aesthetic qualities of a stream. Such projects may be recommended for approval

when the objectives, nature and scope of the project will enhance the scenic or aesthetic qualities or improve the view to or from the stream. Stream enhancements may introduce individual stream corridor elements or in-stream habitat features through direct manipulation (e.g., placement of structures in a stream to attract fish and other aquatic biota). Stream enhancements are not designed to address hydrologic or hydraulic functions, but may affect such functions within the stream system.

6. Stream projects that are limited to providing structural treatments for infrastructure or public safety or to protect infrastructure investments shall be characterized as **stream engineering**. Such structures are typically engineered and constructed to serve a human purpose related to hydraulic conveyance, safety, pollution control or protection of public investments in infrastructure unrelated to stream function. Stream engineering projects may be recommended for approval when the nature and scope of the work is limited to addressing a documented need for public safety or infrastructure protection and do not include additional measures that would characterize the project as a stream restoration, rehabilitation, or reclamation project.

7. When projects meet more than one of the classifications described in 5.B 1 through 6, they may be characterized as "crossover" projects. Such projects will be reviewed based on the mix of classifications that are determined most appropriate or best fit the nature of the project as determined by DNR.

VI. APPLICATION SUBMISSION ELEMENTS

A. Plans for proposed stream projects should include the following elements as may be determined to be applicable to the particular proposed project:

1. A clear rationale why the project is needed,
2. Characterization of the stream activities as meeting one or more of the classifications identified in Section V.B,
3. An ecological description of the site(s) and an assessment that clearly describes the current functional condition of the stream where the project is located,
4. The watershed conditions upstream and downstream of the proposed project area,
5. A brief description of the highest level of restoration that can be achieved, given the watershed conditions, constraints and the function-based assessment, (Harman et al, 2012)
6. A statement of the goals and objectives of the project,
7. A designation and description of the reference site or sites (see definitions),
8. Identification of alternative treatments considered and rationale for selecting the proposed approach to the project,

9. An explanation of how the proposed project will integrate with the landscape,
10. Explicit plans, schedules and budgets for site preparation, installation and post-installation activities, including a strategy for making prompt mid-course corrections,
11. A clear plan that illustrates the access route and project construction/staging area(s) for the proposed project,
12. Well-developed and explicitly-stated performance standards, with monitoring protocols by which the project can be evaluated, to determine, (a) if the project was implemented as proposed, and (b), if it achieved the desired or planned effect (e.g., physical, chemical or biological improvements), and
13. Strategies for long-term protection and maintenance of the site(s) or ecosystem.

B. All stream projects shall be designed to provide treatments to eliminate invasive species (terrestrial and aquatic) where they may exist in the area proposed for stream practices. Proposed projects should not propose use of invasive species or take actions that will or could allow invasive species to become established. Applicants shall identify BMP's proposed to eliminate the introduction or spread of invasive species.

VII. REVIEW CRITERIA

A. Stream Restoration Project Review Criteria

1. Stream restoration projects shall demonstrate that the proposed activities have been targeted with the most appropriate consideration of the physiographic setting, watershed condition, drainage network location, long-term restoration feasibility and cost.

2. Proposed restoration treatments should be geologically, hydraulically, geomorphically, and biologically appropriate to the project location.

3. Stream restoration treatments should demonstrate that they can be expected to result in self-regulating stream systems that are integrated with current ecological landscapes and land use and that eventually require minimal human intervention to sustain their function.

4. Stream restoration treatments shall demonstrate that they have no adverse impacts to rare, threatened and endangered species or their habitats.

5. Activities that are **not** supported by DNR as **"stream restoration"** include those that are intended to geotechnically stabilize a stream corridor for the purpose of protecting human created infrastructure or

enhancing public safety, or those that require perpetual maintenance. Activities that are designed to manage the quantity or quality of stormwater runoff from urban or agricultural hillslope areas, trap sediment and/or debris, or provide defense against floods will also not be supported when such activities are determined to exceed the natural capacity of the stream to accommodate them.

Stream activities that do not meet all of the elements that define "stream restoration" may be reclassified and reviewed as "stream rehabilitation", "stream reclamation" or some other classification as deemed appropriate by DNR, and

6. Proposed projects shall demonstrate that the long term benefits expected from the project will outweigh any impacts anticipated from short term disturbances.

B. Stream Rehabilitation Project Review Criteria

1. The rehabilitation of stream corridor attributes and physical elements may be recommended for approval by DNR for the purpose of enhancing water quality, habitat, or instream and/or riparian biota.

2. Rehabilitation activities within stream corridors may be determined appropriate to mitigate for unavoidable stream engineering activities.

3. Adaptive management strategies recommended for approval or supported by DNR may establish preferences for rehabilitation over the restoration of historic stream corridor conditions in some cases where holistic restoration is not feasible due to requirements for multi-objective uses including public uses not directly associated with habitat and ecosystem functions, engineering constraints, watershed land use constraints, and/or poorly defined historic characteristics.

4. Proposed stream rehabilitation projects shall demonstrate that the expected long term benefits expected from the project will outweigh any impacts anticipated from short term disturbances, and

5. Stream rehabilitation treatments shall demonstrate that they have no adverse impacts to rare, threatened and endangered species or their habitats.

C. Stream Engineering Review Criteria

1. Projects proposing structural treatments for protection of infrastructure or public safety may be recommended for approval by DNR as "**stream engineering**" projects, provided all engineering structures and design

elements demonstrate that impacts to existing stream corridor resources, including the channel, floodplain, hydrology, vegetation and biological community, are avoided to the greatest extent practicable.

2. Stream engineering projects that cannot demonstrate avoidance of impacts to stream corridor resources including the channel, floodplain, hydrology, vegetation and/or biological community shall demonstrate that any impacts will be minimized to the maximum extent practicable. All unavoidable impacts should be mitigated through appropriate stream rehabilitation activities recommended for approval by DNR.

3. Stream engineering treatments shall demonstrate that the long term benefits expected from the project will outweigh any impacts anticipated from short term disturbances, and

4. Projects shall demonstrate that the disturbances required to protect infrastructure or insure public safety are the minimum necessary to accomplish the project's objective.

5. Stream engineering treatments shall demonstrate that they have no adverse impacts to rare, threatened and endangered species or their habitats.

D. Stream Stabilization Project Review Criteria

Projects proposing direct or indirect stability improvements may be recommended for approval by DNR provided the application for such measures is accompanied by the following supporting information:

1. Demonstration of the cause and effect of a stability problem,

2. Clarification of a vertical or lateral (horizontal) stability problem,

3. Demonstration of the effect of proposed stability enhancement activities, including channel changes and structural stability considerations,

4. Demonstration of avoidance and minimization of impacts to stream corridor biota, riparian tree cover, habitat resources, and rare, threatened and endangered species,

5. Documentation of efforts to utilize vegetative measures and materials over structural measures as the preferred method of treatment. When structural measures are proposed, such documentation shall indicate why they are required over vegetative measures, and

6. Stream stabilization projects shall demonstrate that the long term benefits expected from the project will outweigh the impacts

anticipated from short term disturbances.

7. Stream stabilization treatments shall demonstrate that they have no adverse impacts to rare, threatened and endangered species or their habitats.

E. Stream Enhancement Project Review Criteria

1. Stream enhancement projects should not result in changes that are geologically, hydraulically, geomorphically, and biologically inappropriate to the project location.

2. Enhancement projects shall demonstrate that impacts to existing stream corridor resources, including the channel, floodplain, hydrology or instream and riparian biota, are limited to those necessary to accommodate the enhancement that is proposed.

3. Enhancement projects shall demonstrate that they will not result in adverse impacts to stream stability, sediment transport capacity, nutrient processing capabilities, existing hydraulic characteristics or cause greater channel migration than would be expected without the introduction of the proposed enhancement.

4. Documentation shall be provided concerning efforts to utilize vegetative measures and materials over structural measures as the preferred method of treatment. When structural measures are proposed, such documentation shall indicate why they are required over vegetative measures.

5. Proposed stream enhancement projects shall demonstrate that the long term benefits expected from the project will outweigh the impacts anticipated from short term disturbances.

6. Stream enhancement treatments shall demonstrate that they have no adverse impacts to rare, threatened and endangered species or their habitats.

7. Stream enhancement projects will provide environmental, in addition to aesthetic, benefits to the extent practicable.

F. Stream Reclamation Project Review Criteria

1. Stream Reclamation projects should not result in changes that are not geologically, hydraulically, geomorphically, and biologically appropriate to the project location.

2. Proposed stream reclamation projects shall demonstrate that the long term benefits expected from the project will outweigh the impacts anticipated from short term disturbances.

3. Projects proposed as stream reclamation projects shall identify the disturbance or event that caused the need for the project and identifies the project as consistent with the definition of stream reclamation.

4. Projects shall identify in so far as possible the pre-disturbance or pre-event conditions of the stream and the rationale for improvements or activities proposed to accomplish the reclamation objectives.

5. Stream reclamation treatments shall demonstrate that they have no adverse impacts to rare, threatened and endangered species or their habitats.

VIII. ADDITIONAL POLICIES AND REVIEW CRITERIA

A. Stormwater Management

1. Stormwater management facilities within stream corridors, including floodplains, will not be recommended for approval by DNR unless the applicant first demonstrates an effort to optimize use of environmentally sensitive design practices and then demonstrate that no practicable alternatives exist for a facility outside the stream corridor for non-point source runoff treatment or management.

2. Stormwater management measures, which are required for new development, may not occur in perennial and intermittent stream channels.

3. Stormwater management within or adjacent to stream channels, in the form of retrofits to address impacts of existing development, particularly development that pre-dates state and local requirements for stormwater management, may be recommended for approval when adequate documentation through watershed alternatives analysis of water quantity or quality management alternatives accompanies such proposals. Such proposals should meet state-of-the-art design and management strategy criteria.

4. Where stormwater management measures are proposed as a component of a stream project, the design should minimize demand for ongoing maintenance activities. When maintenance activities associated with project elements intended to provide non-point source water quality treatment are required, the nature and expected frequency of such activities and parties responsible for maintenance

shall be identified in the project proposal for the benefit and use by reviewers and regulators.

B. Water Quality

1. Stream restoration, rehabilitation, stabilization, reclamation, enhancement or engineering activities proposed to address water quality problems at the downstream end of a project reach may be recommended for approval by DNR only if appropriate alternatives analyses and documentation of cause and effect in the context of reach contributions to measured watershed nutrient and sediment loadings are provided. Appropriate documentation must include:

   a. Water quality loading evaluations associated with the project reach that have been reviewed and approved by the appropriate State or Federal agencies, and

   b. Demonstration of net measurable water quality benefit that exceeds the uncertainty of the related water quality loading evaluations identified in a. above, and

   c. Demonstration of cost effectiveness relative to other watershed non-point source pollution reduction alternatives.

2. Stream activities that do not demonstrate net measurable water quality benefits or cost effectiveness relative to other watershed non-point source pollution reduction alternatives may be recommended for approval when the project objectives and activities proposed are not limited to achieving nutrient or sediment reductions and are designed to address additional stream restoration, rehabilitation, reclamation, stabilization or enhancement objectives.

3. In-stream water temperature increases associated with backwatering, pooling, reductions in forest canopy, or the placement of rocks or other structures conducive to thermal increases by solar radiation will not be supported by DNR unless documented to be unavoidable elements of a project that would otherwise be recommended for approval. Such projects shall be designed to minimize thermal impacts and in no case will projects be supported that violate State water quality standards for temperature.

C. Riparian Forests and Vegetation

1. It is the overarching policy of DNR to protect riparian forests and tree cover and avoid tree clearing associated with stream restoration or other proposed stream "improvement" activities.

2. Riparian tree cover protection and stream corridor vegetation management considerations associated with all stream projects must conform to the spirit and intent of Maryland's Forest Conservation Act, the Maryland Chesapeake and Atlantic Coastal Bays Critical Area Criteria, the Chesapeake Bay Agreement, and DNR's initiatives related to riparian and watershed afforestation.

3. Impacts to existing forest cover or trees must be avoided or minimized to the maximum extent possible with ample justification in order for a stream restoration, rehabilitation, stabilization, reclamation, enhancement or engineering project to be supported by DNR.

4. All unavoidable impacts to riparian corridor forests or tree cover must be compensated for/mitigated through afforestation when on-site reforestation is not an option. DNR's suggestions for where to locate afforestation efforts and the kind of afforestation efforts that should be accomplished appear in Appendix C.

D. Monitoring

To advance the science of stream restoration, projects conducted in Maryland should have clear goals and/or objectives and build upon sound baseline data (to quantify annual background variations in stream conditions). Proposed projects should also include a description of restoration potential and explicitly stated performance standards that can be evaluated with appropriate monitoring protocols to determine, (a) if the project was implemented as proposed, and (b), if it achieved the desired or planned effect. Proposed projects should be well designed and embedded in an adaptive management context. Such projects should commit to pre and post-implementation monitoring (DNR recommends the use of a BACI [Before-After, Control-Impact] sampling framework – see Appendix D) to document project performance, so the results (successes and failures) can be used to enhance stream restoration science and design better projects in the future. The scope of project-related monitoring should at least document the quality of the system manipulations carried out and the effectiveness of the design in achieving project objectives and performance standards. Specific monitoring efforts beyond these minima should be appropriate for the particular stream project objectives.

Not all stream restoration projects will require the same level of pre- and post-implementation monitoring. A water quality monitoring strategy prepared by staff at the University of Maryland, Maryland Department of Natural Resources, and Maryland Department of the Environment (found here: http://www.dnr.maryland.gov/ccs/funding/pdfs/Monitoring_Strategy.pdf), to provide guidance for 2010 Trust Fund projects, offers suggestions on monitoring approaches for stream restoration projects aimed at reducing nutrient and sediment loads. Other DNR suggestions for monitoring protocols (including flow, biological communities, and geomorphology) associated with stream restoration projects appear in Appendix D.

E. Measures of Performance or Performance Indicators

1. Measures of performance to be used shall be based on post-construction site inspections and monitoring information gathered. Measures of performance shall be documented to guide future decisions and recommendations for project approvals based on the experience gained from findings based on their use.
2. Measures of performance will be dependent on the stated project objectives related to stability, habitat, instream and riparian biota, and water quality, and the scope and intent of the proposed stream activities and practices established in each project application.
3. Measures of performance or performance indicators may include:

    a. Restoration: re-establishment of specified indigenous stream conditions confirmed by DNR,

    b. Rehabilitation: establishment of specified stream attributes supported by DNR,

    c. Stability: documentation of the integrity of placed structures and constructed channel configuration through photos and/or other monitoring results,

    d. Substrate: documentation of target bed substrate composition through mapping and grain size distribution analysis, where appropriate,

    e. Water quality: measured changes in specified parameters in excess of measurement uncertainty, including reductions in nutrients, sediment or water temperature,

    f. Habitat: measured increases in instream habitat quality, as reflected in relevant geomorphic and flow measurements plus at least calculated indices of biological integrity for benthic macroinvertebrate and fish assemblages, using Maryland Biological Stream Survey protocols. (http:www.dnr.state.md.us/streams/publications.asp), and

    g. Riparian forest, tree, and vegetative cover: results equal to or greater than the pre-project conditions that were present prior to forest cover or vegetation disturbances.

F. Tracking

Selected stream restoration and rehabilitation projects shall be tracked by DNR, including project specifications, monitoring results and Project Review Division determinations. Tracking results will be used to guide decisions on other proposed projects based on habitat, water quality and cost considerations.

IX. PROCEDURE FOR IMPLEMENTATION OF REVIEW CRITERIA

A. Reviews of proposed stream restoration projects will be conducted through the interagency review processes established in conjunction with DNR's Environmental Review Policy (#94:06), (http://intranet/policy/environmentalreview.html).

B. Determinations of whether a proposed project meets the definitions of stream restoration, rehabilitation, stabilization, reclamation, enhancement or engineering will be made by the Project Review Division.

C. Conformance of stream restoration and other stream projects with the DNR policies, guiding principles and review criteria related to avoidance and minimization of impacts to stream corridor resources, mitigation, monitoring and measures of performance will be determined by DNR.

D. When considered appropriate, proposals that describe the kind of monitoring activities that will occur to measure the performance of stream projects shall be submitted by the applicant to the Project Review Division. Monitoring proposals associated with proposed projects will be evaluated by the Project Review Division. Monitoring proposals should be developed to measure performance in achieving the goals, objectives, scope and purpose of the project. To that end, the Review Division may recommend alternative monitoring measures considered more appropriate to a particular stream project than those proposed by the applicant.

E. Recommendations for approval or denial of a proposed stream project will be made by the Review Division and communicated to applicants and/or to funding/permitting agencies consistent with coordination protocols established through the Interagency Joint Evaluation process, MDE permit review procedures, or coordinated with NEPA and MEPA as determined by the Review Division to be most appropriate.

VIII. REFERENCES

- Shields, F. Douglas, Cooper Jr., CM, Knight, Scott S., and Moore, M.T., 2003. Stream corridor restoration research: a long and winding road. Geological Engineering 20:441
- FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.
- Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. *A Function-Based Framework for Stream Assessment and Restoration Projects.* US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006
- Hilderbrand, R.H., A.C. Watts, and A.M. Randle. 2005. The myths of restoration ecology. Ecology and Society 10(1): 19 [online].
- Holling, C.S. (ed.). 1978. Adaptive Environmental Assessment and Management. New York: John Wiley and Sons.
- Karr, J.R. and E.W Chu. 1999. Restoring life in running waters: better biological monitoring. Island Press, Washington, DC. 206 pages.
- Kondolf, G.M. 2006. Five elements for effective evaluation of stream restoration. Restoration Ecology 3(2):133-136.
- Lee, K.N. 1993. Compass and Gyroscope: Integrating Science and Politics for the Environment. Island Press: Washington, D.C
- MD Dept. of Environment Maryland Model Stormwater Management Ordinance, April 2010,
- Osterkamp, W. R., and Hedman, E. R., 1982, Perennial-streamflow characteristics related to channel geometry and sediment in Missouri River basin: U. S. Geological Survey Professional Paper 1242, 37 p.
- Palmer, M.A., H.L. Menninger, and E. Bernhardt. 2010. River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice? Freshwater Biology 55:205-222
- Smith, S., plus 12 co-authors, 2009, Maryland Streams: Take a Closer Look, Maryland Department of Natural Resources.
- SER (Society for Ecological Restoration International Science and Policy Working Group). 2004 The SER International Primer on Ecological Restoration www.ser.org and Tuscon: Society for Ecological Restoration International
- Stranko, S.A., R.H. Hilderbrand, and M.A. Palmer. 2011. Comparing the fish and benthic macroinvertebrate diversity of restored urban streams to reference streams. Restoration Ecology (in press).
- Tullos, D.D., D.L. Penrose, G.D. Jennings, and W.G. Cope. 2009. Analysis of functional traits in reconfigured channels: Implications for the bioassessment and disturbance of river restoration. Journal of the North American Benthological Society 28:1-80.

- USDA, Natural Resources Conservation Service. 2007. Basic Principles of Channel Design., Part 654 Stream Restoration Design National Engineering Handbook
- USDA, Agricultural Research Service; Stream corridor restoration research: a long and winding road, Shields, F. Douglas, Cooper Jr., CM, Knight, Scott S., Moore, M.T.
- Yetman, K. 2000. Stream corridor assessment survey protocols._Maryland Department of Natural Resources
- Young, T.P., D.A. Petersen, and J.J. Clary. 2005. The ecology of restoration: historical links, emerging issues and unexplained realms. Ecology Letters 8:662-673.
- Young, T.P. 2000. Restoration ecology and conservation biology. Biological Conservation 92:73-83.

APPENDICES

A. A Vision for Managing Maryland Rivers and Streams

B. Guiding Principles for River/Stream Management in Maryland

C. Mitigation Recommendations

D. Monitoring Recommendations

E. Attributes of Restored Ecosystems (SER 2004)

F. Prioritizing Streams for Protection and Restoration Based on a Triage System

APPENDIX A
A Vision for Managing Maryland Rivers and Streams

Marylanders are connected to nature through their stewardship of healthy rivers and streams that sustain ecological functions, support native aquatic species, provide high quality waters, clean drinking water supplies, and abundant outdoor recreation opportunities to ensure that these functions and qualities are available to future generations.

APPENDIX B
MARYLAND DEPARTMENT OF NATURAL RESOURCES
River/Stream Management Strategy

Guiding Principles
(November, 2012; Updated July, 2014)

The following "Guiding Principles" embrace those concepts and values that the Maryland Department of Natural Resources (DNR) "believes in" and will apply to the development of policies and strategies to guide our actions and recommendations pertaining to the management of Maryland's rivers and streams. These Guiding Principles provide a science-based perspective on rivers and streams intended to help DNR's Environmental Review Unit effectively evaluate and consistently formulate sound recommendations on proposed projects that could adversely impact these important aquatic resources. These Guiding Principles convey a set of values that all DNR units will embrace in making management recommendations and decisions that affect the State's rivers and streams.

These principles also recognize that recreational fishing is an important benefit of our rivers and streams, and DNR is charged with promoting and protecting these opportunities. In return, recreational fishing raises public awareness and fosters a strengthened sense of environmental stewardship and support for programs designed to protect these fishery resources and their aquatic habitats.

The word "streams" in the following list of Guiding Principles refers to all flowing waters of the State from headwater tributaries to the head-of-tide in Coastal Plain rivers. The term "stream restoration" is a broadly-used and often undefined label for an array of actions. These actions include not only projects that can legitimately be labeled "restoration" in a holistic, ecological context; but also other projects that should more accurately be defined as "rehabilitation" or "stabilization" or "reclamation" or "enhancement" or "engineering", each action and associated projects having different goals and objectives. Therefore, this list of Guiding Principles uses the more generic umbrella term "Aquatic Habitat Management" to encompass this array of actions called "stream restoration". Although the following Principles are grouped under a series of distinct headings, DNR recognizes many of these principles cannot be easily categorized and may be applicable to more than one subject heading. Moreover, certain principles may be more applicable, or of greater import than others, when applied to the review of a specific aquatic habitat management proposal. As such, some discretion or leeway in their interpretation or use as applied to specific stream projects is expected, particularly when their application must be balanced against other valid

public concerns for environmental justice, economic impact, public recreation and impact to landowners. These principles provide general guidance to support more specific "Environmental Review Guidelines for Stream Restoration Projects" and other management decisions associated with Rivers and Streams.

I. Protect Streams and Aquatic Habitat Resources

A. The biological, physical, and chemical condition of streams (and, by inclusion, watersheds) should be protected and not allowed to degrade.

B. High quality streams serve as biodiversity strongholds and models of high ecological integrity and should receive special protection consideration.

C. The level of protection (e.g., minimum riparian buffer width, storm water controls, impervious surface limitations) afforded to a stream for the maintenance of ecological integrity should be based on the best possible scientific information available. In the absence of adequate information and if the potential for risks is not certain but could be high, the most protective measures available should be carefully considered.

D. Preservation or protection of aquatic habitat is often more economically cost-effective and more ecologically beneficial and efficient than trying to restore the habitat after it is degraded. This is especially true for sensitive species and rare habitats that can never be fully restored once degraded.

E. Aquatic Habitat Management projects should strive to eliminate or minimize the sources (causes) of the degradation and not just deal with the symptoms.

F. Whenever possible and practical, a prioritization strategy should be used to decide when, where, and how limited dollars will be spent to achieve maximum benefits from stream protection or restoration projects. One possible strategy is the triage approach described in Appendix F.

II. Protect Rare and Sensitive Species

A. Aquatic Habitat Management projects should not put any imperiled species or their habitats at risk.

B. The current biological diversity of Maryland's streams should be protected. This includes protection and maintenance of all RTE species and other species of greatest conservation need (GCN).

C. Where possible, improving habitat, re-establishing extirpated stream species, and expanding the distribution of rare species into historical habitats should be explored.

D. Freshwater fisheries management and/or regulations and game fish stocking will continue to be pursued and should utilize an adaptive management approach and never put a RTE species at risk of decline or extirpation, prevent their population recoveries, and to the maximum extent possible, never compromise the ecological integrity of stream ecosystems. Management may include native,

naturalized or possibly non-native species. This shall be done in a way that will not preclude the restoration, maintenance or rehabilitation of targeted native, GCN or RTE species.

III. Promote Healthy Stream Corridors

A. The integrity of established riparian forests should not be compromised to re-configure stream channels, reconnect stream channels with their flood plains, or to remove legacy sediments, without ample justification and approval as an integral component of a holistic, whole-watershed management action.

B. Aquatic Habitat Management projects should consider how practices can be modified to enhance the resiliency of stream corridors to land use and/or climate change. Some elements of this resiliency would include: (1) wide riparian corridors to reduce the impacts of high flows on in-stream species, (2) high diversity of native vegetation to resist the impacts of invasive species, pests, and fire, and (3) diverse habitat features such as deep pools, complex woody debris presence, and strong connections with the hyporheic zone.

C. Aquatic Habitat Management projects should accommodate animal migration corridors, and redundant habitats should be created for those species most vulnerable to climate change, as identified by DNR.

D. Riparian vegetation plantings should use native species and be incorporated into all Aquatic Habitat Management projects wherever it is justified and feasible.

IV. Promote Healthy Aquatic Habitats

A. Aquatic Habitat Management projects should strive to achieve the chemical, physical, and biological integrity goals of the Federal Clean Water Act and also the nutrient and sediment reduction goals of the Chesapeake Bay Program

B. Aquatic Habitat Management projects should not degrade aquatic or terrestrial plant or animal communities in the pursuit of water chemistry or hydro-geomorphic goals.

C. Stream connectivity should be maintained to allow aquatic species to complete those activities necessary for their particular life cycles and to protect the genetic integrity and longevity of their populations in the face of changing environmental conditions.

D. Spawning migrations and other movements of fishes and other stream biota should not be blocked by human actions, unless justified and approved for resource management reasons.

E. Removal of dams and other obstructions in streams should not inadvertently facilitate the spread of invasive species; however, removal projects may be appropriate where the projected ecological benefits outweigh the risk of invasive species spread.

F. Stocking of streams intended to replace, restore, mitigate for, or enhance biological diversity should use species native to or naturalized in the focal watersheds.

V. Enhance Stream Resilience to Change

A. Because rivers and streams are by nature dynamic and expected to display changes over time, Aquatic Habitat Management projects should allow for variations in channel morphology and position. Projects should also account for unexpected increases in the intensity and frequency of 100-year floods and projections for sea level rise.

B. Enhanced stream connectivity and the maintenance thereof should be considered in the context of a changing climate and the need for freshwater, temperature-sensitive aquatic animals to migrate to more favorable habitats, often further upstream, as temperatures warm and sea level rises.

C. Aquatic Habitat Management projects should identify and protect those aquatic habitats most sensitive to climate change, particularly those that are naturally variable (e.g., vernal pools; intermittent, ephemeral, and perennial headwater streams).

D. Minimum flow requirements in Maryland streams should be adequate to protect aquatic species and ecological integrity in areas located downstream from dams, water diversions, and points of water withdrawals. Modeling efforts to assess these minimum flows should take into account climate change impacts and variations in water levels associated with lower summer base flows and higher fall-winter flows, current hydrologic trends, and future changes in hydrological dynamics.

VI. Employ a Systems Approach for Aquatic Habitat Management

A. Aquatic Habitat Management projects should take advantage of the natural resiliency of streams, recognize their ability to repair themselves, and decide when doing little or nothing to moderately-degraded streams may be most prudent. Repair of severely-degraded streams that possess almost no ability to recover should be justified by a comprehensive analysis or avoided.

B. Aquatic Habitat Management projects should have clearly defined goals that can be effectively assessed with data collected during the pre- and post-manipulation phases. This Guiding Principle recognizes that some individual projects/management actions are implemented with no or only a limited ability to have a measurable short term benefit, (due to lag times between implementation and response) yet the incremental and cumulative habitat improvements realized by several such projects/management actions may still be considered worthwhile toward achieving long term goals.

C. Aquatic Habitat Management projects should utilize an Adaptive Management approach and complete a full cycle of actions, from generating hypotheses about how the ecosystem will respond to interventions, through monitoring/evaluating and learning from the measured responses, and to applying the knowledge gained to future management actions in the subject system and in other systems.

D. Aquatic Habitat Management projects should ideally include several years of pre-manipulation monitoring to characterize the seasonal and annual variability of baseline conditions and several years of post-manipulation monitoring to evaluate project effectiveness against the backdrop of system variability. This Guiding Principle recognizes that to adequately evaluate the effectiveness of riparian vegetation plantings will usually require decades, not years, of post-manipulation monitoring. For some projects, monitoring should reach beyond the baseline parameters and assess ecosystem function, rather than just ecosystem structure. In other cases, commonly accepted principles, existing data, or a similar project scope or conditions may preclude the need for extensive monitoring.

E. Review of Aquatic Habitat Management projects proposed as "compensatory mitigation" to offset permitted instream and riparian area impacts should recognize that such "mitigation" will often still result in a net loss of habitat, and not complete "remediation" to pre-impact conditions or "replacement" of the ecological services provided by the lost habitat.

F. Aquatic Habitat Management projects should be designed to minimize the need for future human intervention for maintenance.

APPENDIX C
Mitigation Recommendations

1. Mitigation for unavoidable stream engineering disturbances and/or structures can be provided through "stream rehabilitation" activities. The following hierarchy of locations should generally be utilized to identify places to do mitigation:

    a. the impacted stream reach,
    b. an adjacent stream reach,
    c. a reach that is the same stream type (hillslope or alluvial) in the same order drainage network of the same physiographic district,
    d. a reach that is the same stream type (hillslope or alluvial) in the same 8-digit watershed of the same physiographic district,
    e. a reach that is the same stream type (hillslope or alluvial) in the same physiographic province.

    Measures proposed for stream mitigation may also include consideration of potentially beneficial out-of-kind opportunities (e.g. land conservation, stormwater management or outfall retrofits, stream buffer enhancements, etc.), where the resource benefits derived are determined to be equal or greater than the benefits that could be expected from in-kind mitigation provided in locations a. through e. above.

2. Mitigation for removal of riparian forest and tree cover for stream restoration purposes should be targeted toward restoring and improving canopy cover and subsequent stream shading, as well as soil stabilization. Standards should be

focused on Buffer restoration and enhancement, rather than a specific mitigation ratio. Mitigation should be provided as follows:

a. All areas disturbed (graded, cleared, etc.), including access routes, shall be re-established in multi-layered forest vegetation (canopy, understory, shrub and herbaceous layers) such that habitat, soil stabilization and water quality functions of the riparian buffer are restored as soon as feasible after construction. Species composition shall be native and based on nearby reference sites. This "restoration" shall occur on a square footage basis for the entire limit of disturbance.

b. In addition to the required restoration in (a) above, further buffer restoration and enhancement is required for the loss of tree canopy within 50 feet of a stream channel (loss of shading). This shall be provided on a square footage basis and calculated based on the actual canopy trees that are being removed for a project. This mitigation can either be additional planting of buffers in nearby stream reaches (where canopy currently does not exist) or can consist of enhancement or restoration work such as invasive species control or adding complexity to existing Buffers (e.g., adding a shrub layer where one may not currently exist).

c. When these provisions are less restrictive than the requirements of the Forest Conservation Act of 1991 or the Critical Area Law and Regulations, the provisions of said laws shall apply.

APPENDIX D
Monitoring Recommendations

Monitoring of stream projects recommended for approval by DNR or another state agency may be required depending on the scope and intent of the proposed activities to document project performance. The focus on monitoring may be only (or mostly) on the quality of the actual work performed and/or on the reliability of the overall project design. Additional monitoring measures carried out should be those most appropriate to ascertain the degree to which project objectives and performance standards are achieved.

1. **Duration:** The duration of the recommended monitoring plan will be dependent on the type and magnitude of change detection being pursued.
   a. Project completion – 1 year following construction to confirm target dimensions, configuration, substrate, and features,
   b. Stability – 5 years following construction for engineering integrity of structure and channel stability,
   c. Water quality – 6 years (minimum) for nutrients, sediment, and temperature, spanning from at least 2 (preferably 3) years prior to project implementation (i.e., baseline) to 4 years following completion of construction,
   d. Habitat – 6 years commencing 2 years following completion of construction, in addition to at least 2 (preferably 3) years prior to construction,
   e. Biota – 6 years commencing 2 years following completion of construction, in addition to at least 2 (preferably 3) years prior to construction,

f. Forest or tree cover – 10 years after construction by an expert (e.g., forester, arborist or botanist) or in conformance with the 1991 Forest Conservation Act.
g. Monitoring is also is recommended during construction activity for c, d and e above.

2. **Data collection:** DNR recommends that project performance monitoring should be conducted by third parties not associated with the construction of stream restoration, rehabilitation, or engineering installations in the State, including one of the following organizations:

   a. Federal and state agencies with established stream monitoring programs (USGS, EPA, MDE, DNR),
   b. Universities with water monitoring expertise, or
   c. Private companies specializing in stream monitoring efforts associated with restoration projects.

3. The proposed duration of monitoring, parameters to be monitored, organization that will conduct the monitoring, estimated costs and means of satisfying the need for monitoring shall be identified by the applicant prior to issuance of any recommendation for project approval by DNR.

4. Depending on the nature of the stream work proposed, project design should be based on an assessment of the results of pre-project (i.e., baseline) monitoring. In such cases, baseline monitoring should occur for a period of at least 2 (preferably 3) years prior to design/implementation of the project to capture and quantify the full range of annual, background variations in stream conditions.

5. To ascertain the degree to which project objectives and performance standards are achieved, DNR recommends the use of a BACI (Before-After, Control-Impact) sampling design. The sampling design should measure conditions at the proposed stream restoration site before restoration activities are performed, and then compare the findings to those conditions measured in the same location after the restoration activity occurs. This approach elucidates how the restoration activities changed the site from pre-construction conditions. The BACI design also includes measurements of stream conditions in a control stream reach that will not be affected (but is in close proximity) by restoration activities, and then compares these data with measurements of stream conditions at the restoration site. This approach allows the effects of the restoration activities to be differentiated from other factors (e.g., natural variability in stream conditions and impacts from stochastic events (e.g., floods)). If there is at least a 100 m long section of water course immediately upstream from the restoration site, the control reach can be located there and monitored before, during, and after construction occurs. If no such suitable section of stream is available, a control reach should be selected in a nearby stream that is similar in condition to the stream being restored and monitored. In addition, a reference site should be selected in one or more minimally-disturbed streams for monitoring before, during, and after construction. Reference sites should be located as close as possible to the stream being restored----ideally within the same 8-digit watershed, or at least within the same 6-digit basin, as long as the reference site is contained within the same

physiographic province as the restoration site. Reference site conditions describe what the restoration site conditions should be striving to achieve, if not soon after restoration at least ultimately. One or more minimally-disturbed Sentinel Sites sampled annually by the Maryland Biological Stream Survey (MBSS) within the same 8-digit or 6-digit basin as the restoration site could serve as the project's reference site(s)."

6. Personnel engaged in project monitoring that includes sampling the benthic macroinvertebrate and fish assemblages shall be certified by DNR staff affiliated with the Maryland Biological Stream Survey (MBSS).

   For more information on the MBSS program, please see here:
   http://www.dnr.state.md.us/streams/MBSS.asp

   For details on MBSS sampling protocols, see here:
   http://www.dnr.state.md.us/irc/docs/00014977.pdf

7. Personnel engaged in project monitoring that includes measurements of discharge (i.e., flow), geomorphology, and/or nutrient and sediment concentration/loads should consider adopting the monitoring protocols developed for Chesapeake and Coastal Bays Trust Fund Projects described at the following links:

   Discharge Protocols
   http://www.dnr.state.md.us/streams/pdfs/TFStreamDischarge.pdf

   Geomorphic Protocols http://www.dnr.maryland.gov/streams/pdfs/TFGeomorph.pdf

   Nutrient and Sediment Protocols
   http://www.dnr.state.md.us/streams/pdfs/TFWQ2014.pdf

APPENDIX E

Attributes of Restored Ecosystems

(as described by the Society for Ecological Restoration [SER] 2004)

The nine attributes listed below offer a basis for determining when "restoration" has been accomplished. Full expression of all nine attributes may not be needed to demonstrate restoration. But these attributes should demonstrate an appropriate trajectory of ecosystem improvement towards the project goals and objectives. Some of these attributes can be measured, but others must be indirectly assessed.

1. The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.

2. The restored ecosystem consists of indigenous species to the greatest practicable extent.

3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonize by natural means.

4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.

5. The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.

6. The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.

7. Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.

8. The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the system.

9. The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions.

APPENDIX F

Prioritizing Streams for Protection and Restoration Based on a Triage System

(Ronald Klauda and Patrick Graves, Maryland Department of Natural Resources, Annapolis, MD)

Background

Although Maryland is a small state (9,974 square miles), it has a dense drainage network of at least 10,000 miles of perennial streams and rivers. The human population in 2010 was 5,773,552 (an increase of 9.0% since 2000), making Maryland the seventh most densely-populated state in the U.S. (595 people per square mile). Urbanization and other land use changes are major stressors on the State's waters.

Protecting healthy and restoring degraded streams are goals of local, state, and federal agencies in Maryland. Protecting streams before they become degraded is especially important because protection is less costly than trying to restore them after they decline. But with so many miles of streams to deal with and agency budgets being cut and stretched to the limit, there are far more miles of streams to be restored than there are available dollars to allocate.

A prioritization strategy is needed to decide when, where, and how limited dollars should be spent to achieve maximum benefit. The prioritization strategy should embrace the fact that the benefits per restoration dollar spent (the costs) will be highest for slightly-degraded streams and lowest for severely and critically-degraded streams impacted by many stressors and having a very low probability of recovery.

This situation is analogous to a hospital emergency room, a battle field, or the site of a natural disaster---all places where the number of sick, injured, or wounded people often exceeds the available medical staff and/or supplies needed to threat them all in a timely manner. To prioritize patients' treatments based on the severity of their injuries and their chances of recovery, a sorting process or system called "triage" is performed (Kennedy et al. 1966; Rutherford 1989).

Triage comes from the French word "trier", meaning to sort, separate, select, choose, or cull. Triage was first used by Dominique Jean Larrey, a surgeon in Napoleon's army. Larrey used a triage system to ration limited medical resources for optimal benefit and achieve the greatest good for the largest number of sick, injured, and wounded soldiers.

Triage has been used in species protection and biodiversity conservation for many years (e.g., Bennett 1986; Hobbs and Kristjanson 2003; Wilson et al. 2006; Turner and List 2007; McDonald-Madden et al. 2008, Hilderbrand et al. 2010, Schneider et al. 2012). This approach has been much less frequently used to prioritize habitat restoration projects (e.g., Holt and Vinney 2001; Bottrill et al. 2008).

Methods for Using a Triage System to Sort and Group Maryland Streams

Between 2000 and 2009, the Maryland Department of Natural Resources (DNR) sampled 1,370 randomly-selected, 1st through 4th order, non-tidal stream sites statewide with the Maryland Biological Stream Survey (MBSS). Data from this survey were used to calculate multi-metric biological indicators of stream condition. These indicators, called indices of biotic integrity (IBI), were calculated for benthic macroinvertebrate and fish assemblages.

Stream Ecological Condition categories needed for development of a triage system were calculated by averaging the benthic and fish IBI scores for each sampled site, expressed as a Combined Biotic Integrity (CBI) score, that ranged from 1.0 (worst) to 5.0 (best). CBI scores from the 1,370 stream sites sampled by the MBSS between 2000 and 2009 were used to estimate the total miles of streams, statewide, that fall into each of the five Stream Ecological Condition (SEC) categories (see Appendix table).

For the triage system approach, we viewed these SEC categories as being analogous to five medical condition triage categories. This system was used to sort Maryland streams into five priority groups (1 through 5) that were also color-coded for mapping purposes. For each SEC category, we suggested appropriate management actions for streams that ranged from Protect to Do Nothing.

Application of a Triage System to the Mattawoman Creek Watershed

Data from 23 stream sites that were sampled by DNR's MBSS in this watershed between 2000 and 2009 were used to calculate a CBI for each site. Each CBI score was assigned to a SEC category, color-coded for the relevant Triage Group, and mapped (see Appendix map). Four of the 23 sampled stream sites are Priority 1 (red) streams that are moderately degraded and should be restored soon, then protected. Seven stream sites are Priority 2 (yellow) and only slightly-degraded. If these yellow sites are protected and the threats are minimized, it's likely they will be able to heal themselves with no further management actions. The even more encouraging observation is that over half (11) of the 23 sampled stream sites appear to be mostly healthy (Priority 3, green) and should be protected to prevent them from degrading. Only one of the 23 stream sites that have been sampled by the MBSS in the Mattawoman Creek watershed had a SEC score in the severely-degraded (Priority 4, blue) category, where stabilization rather than extensive/expensive restoration attempts are recommended. Fortunately, no sampled stream sites were critically-degraded and in the Priority 5 (do nothing) category.

Conclusions

The triage system described above is a suggested first step in targeting stream protection and restoration actions. Triage can sort out those streams with still mostly intact ecological integrity (i.e., mostly healthy or only slightly-degraded) that do not require restoration actions, but deserve protection/preservation actions that should be taken. Triage can also sort out those streams that are moderately-degraded and whose ecological integrity should be restored with modest management actions, if the key stressors are first removed and appropriate actions taken fairly soon. And, perhaps most importantly, a triage system can sort out those streams whose ecological integrity is severely compromised or irretrievably lost and restoration is not possible, even if much money and other resources are expended in the attempt. The most effective strategy for these streams is to implement the minimal necessary management actions to improve their appearance and ensure they do not endanger human health and safety. Allocating public resources to stream restoration actions should consider the value of the degraded system, the benefits if restoration is successful, the probability of success, and the total costs.

References

Bennett, D.H. 1986. Triage as a species preservation strategy. Environmental Ethics 8:47-58.

Botrill, M.C. and 13 co-authors. 2008. Is conservation triage just smart decision making. Trends in Ecology and Evolution 23(12):649-654.

Hilderbrand, R.H., R.M. Utz, S.A. Stranko, and R.L Raesly. 2010. Applying thresholds to forecast potential biodiversity loss from human development. Journal of the North American Benthological Society 29(3):1009-1016.

Hobbs, R.J. and L.T. Kristjanson. 2003. Triage: How do we prioritize health care for landscapes? Ecological Management and Restoration 4:39-45.

Holt, D. and H. Vinney. 2001. Targeting environmental improvements through ecological triage. Eco-management and Auditing 8:154-164.

Kennedy, K. R.V. Aghabagian, L. Gans, and C.P. Lewis. 1996. Triage techniques and applications in decision making. Annals of Emergency Medicine 28:136-144.

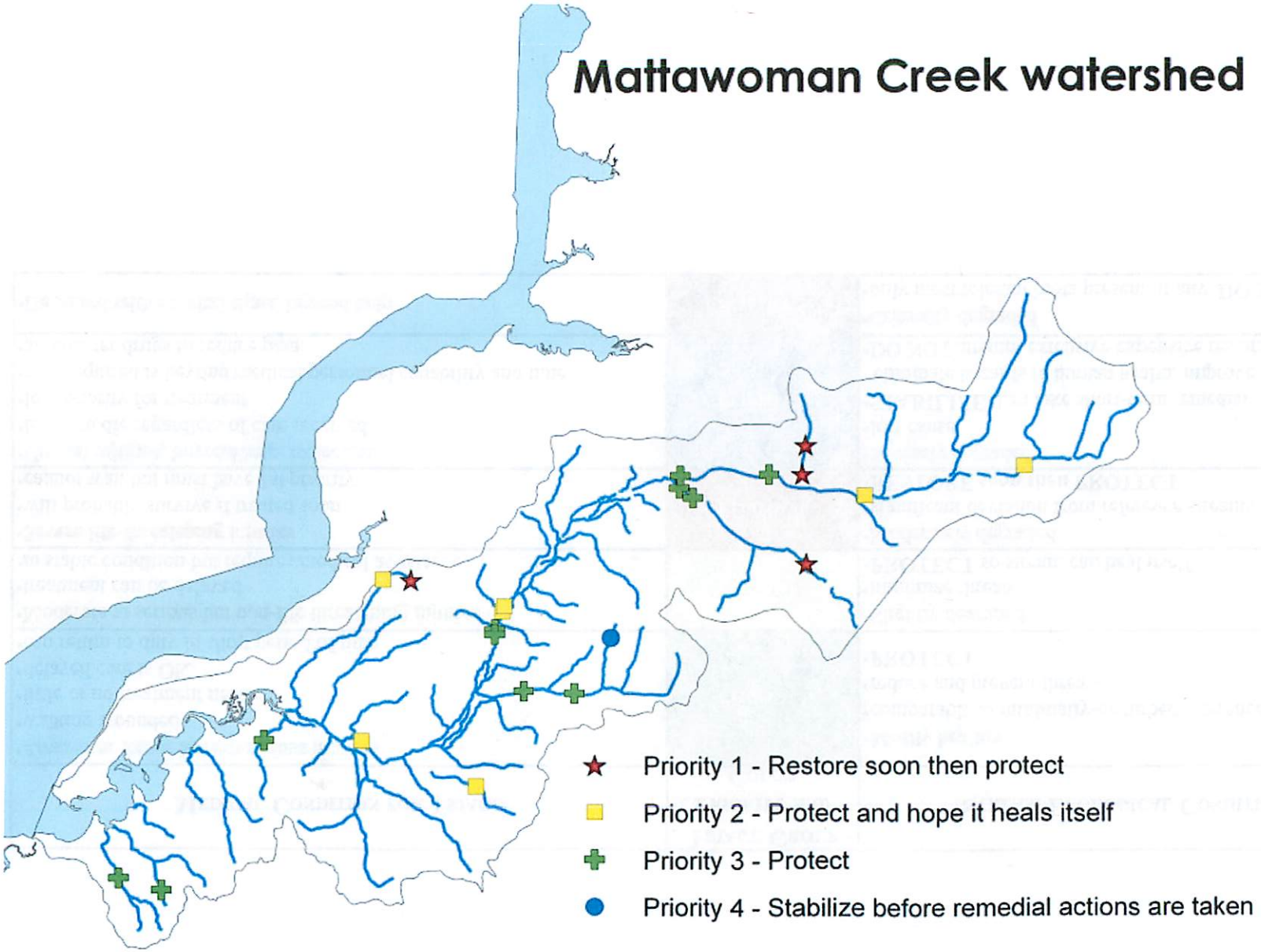
McDonald-Madden, E., P.W.J. Baxter, and H.P. Possingham. 2008. Subpopulation triage: How to allocate conservation effort among populations. Conservation Biology 22(3):656-665.

Schneider, R.R., G. Hauer, W.L. Adamowicz, and S. Boutin. 2010. Triage for conserving populations of threatened species: The case of woodland caribou in Alberta. Biological Conservation 143(7):1603-1611.

Turner, D.S. and M.D. List. 2007. Habitat mapping and conservation analysis to identify critical streams for Arizona's native fish. Aquatic Conservation: Marine and Freshwater Ecosystems 17:737-748.

Wilson, K.A., M.F. McBride, M. Bode et al. 2006. Prioritizing global conservation efforts. Nature 440:337-340.

Medical Condition for Triage	Triage Group Priority and Color	Stream Ecological Condition	Range of CBI Scores* (Total Miles)
•Routine or minor but not serious injuries •walking wounded •little or no treatment needed •delayed care is OK •can return to duty in short period of time	Priority 3	•Mostly healthy •comparable to minimally-disturbed reference stream •reduce and prevent threats •PROTECT	4.0 to 5.0 (1804)
•Moderate to serious but non-life threatening injuries •treatment can be delayed •in stable condition but requires medical assistance	Priority 2	•Slightly degraded •minimize threats •PROTECT so stream can heal itself	3.0 to < 4.0 (3263)
•Severe life-threatening injuries •will probably survive if treated soon •cannot wait but must have 1st priority	Priority 1	•Moderately degraded •significant deviation from reference streams •RESTORE soon then PROTECT	2.3 to < 3.0 (1759)
•Critical injuries, beyond help, expectant •likely to die regardless of care received •low priority for treatment •care required is beyond medical personnel capability and time •administer drugs to reduce pain	Priority 4	•Severely degraded •lost cause •STABILIZE then take short-term remedial actions to eliminate hazards to human health, improve aesthetics •DO NOT attempt extensive/expensive restoration	1.6 to < 2.3 (1562)
•Deceased with no vital signs, beyond help	Priority 5	•Critically degraded •only most tolerant biota present, if any; DO NOTHING	1.0 < 1.6 (807)


Mattawoman Creek watershed
Priority 1 - Restore soon then protect
Priority 2 - Protect and hope it heals itself
Priority 3 - Protect
Priority 4 - Stabilize before remedial actions are taken