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Restoration Research RFP Questions

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RFP Questions from FY 15

Effectiveness at accomplishing water quality and habitat goals

Differences among restoration techniques

1. What is the impact on nutrient and sediment loads (flow and concentration) of different stream restoration techniques (e.g., regenerative stormwater conveyance, natural channel design, valley restoration/legacy removal, other), keeping site conditions constant?
2. What is the impact on habitat and biological factors of different stream restoration techniques (e.g., regenerative stormwater conveyance, natural channel design, valley restoration/legacy removal, other), keeping site conditions constant?
3. Considering impacts on nutrients, sediment, habitat, hydrology, and biological resources of both short-term construction activities and long-term project function: Do different design types result in a net ecological benefit relative to pre-project conditions? To answer this question, trade-offs (reductions in function vs. increases in functions) would be considered.

Effects of site condition on outcomes of a restoration technique(s):

4. What is the impact of land use on the nutrient, sediment, habitat, and/or biological impacts of a restoration practice of a particular type (e.g., regenerative stormwater conveyance, natural channel design, stream valley restoration/legacy removal, other)? How does site condition, such as the land use, watershed condition, and/or valley type, determine water quality, habitat, and/or biological benefit?
5. What are the water quality, habitat, and/or biological impacts of a particular project type (regenerative stormwater conveyance, natural channel design, valley restoration/legacy removal), installed in the watershed headwaters versus downstream near the receiving waters?

Construction techniques

6. What is the difference in effects on water quality (turbidity), riparian habitat, and other biological effects between stream restoration work “in the wet” (construction without diverting the stream) vs. work “in the dry” (construction accomplished through diversion of the water flow)? You will be required to articulate potential covariates, such as project duration, sediment type, slope, stream size, gradient, stream flow, restoration type, drainage area, and other factors.

7. Iron can occur naturally in the soil and the groundwater. What restoration techniques are associated with increases in iron concentration in the surface water or sediment and for how long do any increases persist? What is the impact of the iron on biological resources? Does the iron originate from the materials brought on site for restoration or does the iron originate from natural sources (e.g., materials brought to the site for restoration may add to the natural background levels, may exacerbate the iron concentrations that occur naturally, may oxidize the iron during construction activity, and/or other factors)?

Stability

8. What design and construction factors, such as construction material type, material size, and/or extent of keying a structure into the bank, are correlated with structural instability for certain site conditions, such as soil type, hydrology, slope, flow, vegetation, and/or contributing drainage area? <u>*Note*</u>: This question acknowledges that there is debate in the community about the definition of the term “stability” and acceptable levels of movement of stream materials.

RFP Questions from FY 16

Effectiveness at accomplishing water quality and habitat goals – <u>Watershed/catchment-scale effects of restoration practices</u>

1. Watershed Restoration Assessment: What are the cumulative effects of watershed restoration activities within a watershed? Of interest in the restoration community is whether, given the high temporal and spatial variability of nutrient concentrations and flows, a signal from the restoration activities even in a highly targeted, small watershed can be measured relative to a control site (before vs. after restoration activities). A related question: What percentage of the impervious surface in a watershed must be treated with best management practices (BMPs) before a difference can be measured at the outfall? Does BMP type (e.g., stream restoration, environmental site design (ESD) practices, and stormwater wetlands) influence that percentage?
2. Stormwater Management Assessment: What is the effectiveness of stormwater management practices (implemented, for example, at a level required under the latest stormwater management regulations) on stream channel protection? What percentage of a catchment needs to be treated with ESD practices to reduce water flow enough to protect stream channels? Does location of ESD practices within the catchment make a difference in protecting the stream banks?
3. Monitoring is expensive and money spent on monitoring is by definition not spent on pollution reduction implementation. What degree of representative sampling is required to determine levels of pollutant discharge at a county scale? What sample size is needed to capture variability? What is the cost of such a monitoring program? Can a reduced monitoring regime, either in terms of number of sampling stations or parameters measured at a station or a factor such as % impervious surface treated in the region be used as a proxy?

Effectiveness at accomplishing water quality and habitat goals – <u>Differences among stream restoration techniques</u>

4. What is the impact on nutrient and sediment loads (flow and concentration) and/or habitat and biological factors of different stream restoration approaches that aim for different function (e.g., floodplain reconnection, frequency of inundation, bank stabilization, etc.) or that use different techniques (e.g., regenerative stormwater conveyance (RSC), natural channel design (NCD), stream valley restoration/legacy sediment removal), keeping site conditions constant?

Effectiveness at accomplishing water quality and habitat goals – <u>Trade-offs and creating net ecological uplift</u>

5. Trade-offs – Do different design approaches result in a net ecological benefit considering all resources potentially impacted (nutrients, sediment, habitat, hydrology, and biological resources) relative to pre-project

conditions? To answer this question, trade-offs (reductions in functions vs. increases in functions) would be considered. Are we maximizing certain benefits at the expense of other benefits?

Effectiveness at accomplishing water quality and habitat goals – Effects of site condition on outcomes of stream restoration technique(s):

6. What is the impact of site condition (such as land use, % impervious cover, watershed condition, existing habitat, and/or valley type) and/or watershed position (headwaters vs. downstream near the receiving waters) on the nutrient, sediment, habitat, and/or biological impacts of stream restoration approaches that aim for different function (e.g., floodplain reconnection, frequency of inundation, bank stabilization, etc.) or that use different techniques (e.g., RSC, NCD, stream valley restoration/legacy sediment removal)?

Iron precipitation

7. Iron can occur naturally in the soil and the groundwater. Some hypothesize that restoration practices can lead to precipitation of iron compounds. What stream restoration techniques are associated with increases in iron concentration in the surface water or sediment and how long do any increases persist? What is the impact of the iron on biological resources? Does the iron originate from the materials brought on site for stream restoration or does the iron originate from natural sources?

Stability of stream restoration practices and elements of practices

8. How well can various modelling approaches predict the structural "success" or "failure" for the various stream restoration techniques and structures? What variables must be included in the models to make accurate predictions for stream restoration "success" or "failure" at the site?
9. What are the flow conditions under which different in-stream channel structures (e.g., vanes, step pools, constructed riffles, large woody debris) or approaches (e.g., RSC, NCD, stream valley restoration/legacy sediment removal) function and remain stable? What are the energy tolerances beyond which the structures or approaches begin to fail?

RFP Questions from FY 17

Effectiveness of restoration programs at the watershed/catchment-scale

1. Watershed restoration assessment: What are the cumulative effects of watershed restoration activities within a watershed? Of interest in the restoration community is whether, given the high temporal and spatial variability of nutrient concentrations and flows, a signal from the restoration activities even in a highly targeted, small watershed can be measured relative to a control site (before vs. after restoration activities). A related question: What percentage of the impervious surface in a watershed must be treated with best management practices (BMPs) before a difference can be measured at the outfall? Does BMP type (e.g., stream restoration, environmental site design (ESD) practices, and stormwater wetlands) influence that percentage? We recognize that this question is extensive and reviewers will accept proposals that address a component of this research question.
2. Stormwater management assessment: What is the effectiveness of stormwater management practices (implemented, for example, at a level required under the latest stormwater management regulations) on stream channel protection? What percentage of a catchment needs to be treated with ESD practices to reduce water flow enough to protect stream channels? Does location of ESD practices within the catchment make a difference in protecting the stream banks?
3. Level of monitoring effort: Monitoring is expensive and money spent on monitoring is by definition not spent on pollution reduction implementation. What degree of representative sampling is required to determine levels of pollutant discharge at a county scale? What sample size is needed to capture variability? What is the cost of such a monitoring program? Can a reduced monitoring regime, either in terms of number of sampling stations or parameters measured at a station, or a factor such as % impervious surface treated in the region be used as a proxy?

4. ESD research for plant ground cover versus mulch and for compost amendments versus soil replacement: Local governments aim to implement ESD practices that require low maintenance and provide high water quality treatment. However, there are often high maintenance requirements for ESD practices. To reduce this maintenance burden for ESD practices: 1) Can plant ground cover be used in place of traditional mulch and achieve the desired water quality benefits (e.g., remove TN, TP, TSS, sediment, toxics and/or trap pollution)? and 2) For soils that infiltrate: a) Can compost amendments be used instead of soil replacement?; b) What is the optimal compost amount to use?; and c) What are the decision factors based on *in situ* soils?

Effectiveness of restoration practices at the project scale

5. Comparisons of water quality benefit across restoration technique or site condition. While many studies present data on a single restoration technique in a single set of conditions, few studies compare restoration effectiveness across restoration approaches or across a range of site conditions. Here we ask: How does water quality benefit (defined here as reduction in nutrient and sediment loads) compare across restoration approaches of different types and/or (depending on ability to replicate) across site conditions? The types of restoration approaches in which we are interested are those that aim for different function (e.g., floodplain reconnection, frequency of inundation, bank stabilization, etc.) or that use different techniques (e.g., regenerative stormwater conveyance (RSC), natural channel design (NCD), stream valley restoration/legacy sediment removal). The site condition factors in which we are interested include differences in land use, % impervious cover, watershed condition, valley type, and/or watershed position (headwaters vs. downstream near the receiving waters).
6. Stability of restoration practices. Research is needed to better understand why and when stream restoration practices “fail” in order to reduce “failures” and increase “successes.” (We recognize that there is no standard definition of “failure,” definition of “stability,” or agreed upon tolerance for movement of stream materials within or from a project.) What are the flow conditions under which different in-stream channel structures that are currently used in Maryland stream restoration projects (e.g., vanes, step pools, constructed riffles, large woody debris) or approaches (e.g., RSCs, NCDs, stream valley restorations/legacy sediment removal, or a combination of those techniques that aim for the same degree of floodplain reconnection) function and remain stable? What are the energy tolerances beyond which the structures or approaches begin to fail?
7. Water quality of an urban tree: Although there are several guidance documents and recommendations for urban tree benefits, the empirical data to determine the stormwater benefits of urban trees of a variety of species are needed in the Mid-Atlantic region. Projects will be expected to fully quantify the stormwater treatment value (volume, TN, TP, and TSS) for an urban tree or stand of trees, with tree species, tree size, tree age, and soil volume as factors. The stormwater treatment value derived from empirical data will be compared to modeled stormwater treatment value (e.g., iTree, Maryland Assessment Scenario Tool, etc.). This study can be a combination of literature review, empirical data collection, and models.

Trade-offs in resource improvements incurred by restoration practices and creating net ecological uplift

8. Resource trade-offs in different types of restoration projects. The decision to install a restoration project at any given site by definition implies that an existing condition at that site will be modified, replaced, and/or improved. The hypothesis of the restoration practitioner is that the net condition will be *improved.* However, a value judgment is placed on the existing condition, deeming the existing condition to be inferior to the desired “restored” condition that is often not based on quantification. In addition, there is an accompanying value judgment on the proposed resulting condition which may not take into account reductions of certain functions. Therefore, resource protection "officials," many of whom find themselves "stove piped" or in aquatic resource "silos" as to their particular responsibilities, find themselves having to make value judgments about the existing condition and what is in need of improvement.

   The goal of this question is to encourage quantification of the resources present prior to the activity compared to quantification of the resources available after an “intervention” or activity, calculating net ecological impact after evaluation of individual functional components. With certain kinds of restoration projects or practices, are we maximizing certain benefits (nutrients, sediment, habitat, hydrology, and biological resources) at the expense of other benefits in an unacceptable way? This research should allow restoration practitioners to more accurately calculate the resource's functional uplift at a particular site in order to optimize system functions in their decision making.

a) Tree trade-offs in stream restoration projects: Certain stream restoration practices by necessity can result in removal of trees: 1) trees may need to be removed on a short-term basis for construction site access; 2) trees may be removed for various methods of stream restoration in nontidal forested wetlands; 3) trees may be removed to accomplish legacy sediment removal in which the stream banks are forested; and 4) trees, even when remaining after restoration, may experience mortality due to changes in hydrology leading to higher water levels/inundation. What is the water quality and habitat cost of tree removal of certain practices compared to the benefit of the other elements of the restoration practice?

b) Wetland trade-offs in stream restoration projects: Certain stream restoration practices can impact type and function of existing wetlands. Impacts can include changes to the wetland's hydrology and plant community extent and distribution. What are the wetland impact losses compared to the benefits of stream restoration?

c) Submerged Aquatic Vegetation (SAV) trade-offs in living shoreline projects: Living shoreline projects, by definition, require more cross-shore space than shoreline armor projects, given that the creation of a platform for intertidal wetland vegetation and potentially an associated sill, must extend either into the subtidal zone or into the riparian zone. Such extension means that existing condition in either neighboring zone will be replaced with emergent wetland. With the resurgence of SAV in the Chesapeake, more living shoreline locations will have SAV habitat. How does impacting SAV compare to the benefit of creating intertidal wetland? Under what conditions (e.g., SAV coverage in an embayment) is an SAV impact tolerable? In addition, research shows that the sill can indirectly cause SAV loss to a nearby bed due to the sediment dropping out channelward of the sill and covering the SAV. How can indirect impacts of the sill on SAV loss be better predicted?

RFP Questions from FY 18

Effectiveness of restoration programs at the watershed/catchment-scale

1. <u>Watershed restoration assessment</u>: What are the cumulative effects of watershed restoration activities within a watershed? Of interest in the restoration community is whether, given the high temporal and spatial variability of nutrient concentrations and flows, a signal from the restoration activities even in a highly targeted, small watershed can be measured relative to a control site (before vs. after restoration activities). A related question: What percentage of the impervious surface in a watershed must be treated with best management practices (BMPs) before a difference can be measured at the outfall? Does BMP type (e.g., stream restoration, environmental site design (ESD) practices, and stormwater wetlands) influence that percentage? We recognize that this question is extensive and reviewers will accept proposals that address a component of this research question.
2. <u>Stormwater management assessment</u>: What is the effectiveness of stormwater management practices (implemented, for example, at a level required under the latest stormwater management regulations) on stream channel protection? What percentage of a catchment needs to be treated with environmental site design (ESD) practices to reduce water flow enough to protect stream channels? Does the location of ESD practices within the catchment make a difference in protecting the stream banks?
3. <u>Level of monitoring effort</u>: Monitoring is expensive and money spent on monitoring is by definition not spent on pollution reduction implementation. What degree of representative sampling is required to determine levels of pollutant discharge at a county scale? What sample size is needed to capture variability? What is the cost of

such a monitoring program? Can a reduced monitoring regime, either in terms of number of sampling stations or parameters measured at a station, or a factor such as % impervious surface treated in the region be used as a proxy?

Effectiveness of restoration practices at the project scale

4. Comparisons of water quality benefit among restoration techniques, approaches (functions sought to be restored), or site conditions. While many studies present data on a single restoration technique in a single set of conditions, few studies compare restoration effectiveness across restoration approaches, across different restoration techniques, or across a range of site conditions. Here we ask: How does water quality benefit (defined here as reduction in nutrient and sediment loads) compare among different restoration approaches or techniques and/or (depending on ability to replicate) across site conditions? The types of restoration approaches in which we are interested are those that aim for different function (e.g., degree of floodplain reconnection, frequency of inundation, bank stabilization, etc.). Those approaches can be accomplished with several techniques or a mixture of multiple techniques, including regenerative stormwater conveyance (RSC), natural channel design (NCD), and stream valley restoration/legacy sediment removal). The site condition factors in which we are interested include differences in land use, % impervious cover, watershed condition, valley type, and/or watershed position (headwaters vs. downstream near the receiving waters).
5. Stability of restoration practices. Research is needed to better understand why and when stream restoration practices "fail" in order to reduce "failures" and increase "successes." We recognize that there is no standard definition of "failure," definition of "stability," or agreed upon tolerance for stream material movement within or from a project. The investigator will have to define those for the purposes of his/her study approach. In addition, we recognize that sometimes designs intentionally do not promote fixed banks, which can be either "good" or "bad." Sometimes, features are designed to aggrade sediment, but rapid aggradation can prevent vegetation establishment and reduce "success" from a biological perspective, if not a physical one.
   a. What are the flow conditions under which different in-stream channel structures that are currently used in stream restoration projects (e.g., vanes, step pools, constructed riffles, large woody debris) or approaches (e.g., RSCs, NCDs, stream valley restorations/legacy sediment removal, or a combination of those techniques that aim for the same degree of floodplain reconnection) function and remain stable? What are the energy tolerances beyond which the structures or approaches begin to fail? Even if structures or approaches remain stable within the restoration project area, do they have negative impact (lead to degradation) on other reaches?
   b. How well can various modelling approaches (1D vs 2D) predict the structural "success" or "failure" for the various stream restoration techniques and structures? What variables must be included in the models to make accurate predictions for stream restoration "success" or "failure" at the site?

Construction Techniques

6. What is the difference in effects on water quality (turbidity), total sediment load delivered downstream, riparian habitat, and other biological effects between stream restoration work "in the wet" (construction without diverting the stream) vs. work "in the dry" (construction accomplished through diversion of the water flow)? All aspects of work in the wet vs work in the dry that affect sediment input must be considered, including:
   a) Installing a diversion when working in the dry, which may release sediment for some period of time at some high concentration (e.g., > than the water quality standard of 150 NTU) during the installation.
   b) Removing the diversion, which may also release sediment
   c) Duration of construction (hypothesized to be shorter for work in the wet)

Trade-offs in resource improvements incurred by restoration practices and creating net ecological uplift

7. Resource trade-offs in different types of restoration projects. The decision to install a restoration project at any given site by definition implies that an existing condition at that site will be modified, replaced, and/or

improved. The hypothesis of the restoration practitioner is that the net condition will be *improved.* However, a value judgment is placed on the existing condition, deeming the existing condition to be inferior to the desired "restored" condition that is often not based on quantification. In addition, there is an accompanying value judgment on the proposed resulting condition that may not take into account reductions of certain functions.

The goal of this question is to encourage quantification of the resources present prior to the activity compared to quantification of the resources available after an "intervention" or activity, calculating net ecological impact after evaluation of individual functional components. With certain kinds of restoration projects or practices, are we maximizing certain benefits (nutrients, sediment, habitat, hydrology, and biological resources) at the expense of other benefits in an unacceptable way? This research should allow restoration practitioners to more accurately calculate the resource's functional uplift at a particular site in order to optimize system functions in their decision making.

a) Wetland trade-offs in stream restoration projects: Certain stream restoration practices can impact type and function of existing wetlands. Impacts can include changes to the wetland's hydrology and plant community extent and distribution.
b) Tree trade-offs in stream restoration projects: Certain stream restoration practices by necessity can result in removal of trees: 1) trees may need to be removed on a short-term basis for construction site access; 2) trees may be removed for various methods of stream restoration in nontidal forested wetlands; 3) trees may be removed to accomplish legacy sediment removal in which the stream banks are forested; and 4) trees, even when remaining after restoration, may experience mortality due to changes in hydrology leading to higher water levels/inundation.

RFP Questions from FY 19

Effectiveness of stormwater and stream restoration programs at the watershed/catchment scale

1. <u>Watershed restoration assessment</u>: What are the cumulative effects of watershed restoration activities within a watershed? Of interest in the restoration community is whether, given the high temporal and spatial variability of nutrient concentrations and flows, a signal from the restoration activities even in a highly targeted, small watershed can be measured relative to a control site (before vs. after restoration activities). A related question: What percentage of the impervious surface in a watershed must be treated with best management practices (BMPs) before a difference can be measured at the outfall? Does BMP type (e.g., stream restoration, environmental site design (ESD) practices, and stormwater wetlands) influence that percentage? We recognize that this question is extensive and reviewers will accept proposals that address just one component of this research question.
2. <u>Stormwater management assessment</u>: What is the effectiveness of stormwater management practices (implemented, for example, at a level required under the latest stormwater management regulations) on stream channel protection? What percentage of a catchment needs to be treated with ESD practices to reduce water flow enough to protect stream channels? Does the location of ESD practices within the catchment make a difference in protecting the stream banks?
3. <u>Level of monitoring effort</u>: Monitoring can be costly and money spent on monitoring is by definition not spent on pollution reduction implementation. What degree of representative sampling is required to determine levels of pollutant discharge at a county scale? What sample size is needed to capture variability? What is the cost of such a monitoring program? Can a reduced monitoring regime, either in terms of number of sampling stations or parameters measured at a station, or a factor such as % impervious surface treated in the region be used as a proxy?

Effectiveness of restoration practices at the project scale

4. <u>Comparisons of water quality impact among stream restoration techniques, approaches (functions sought to be restored), or site conditions</u>. While many studies present data on a single restoration technique in a single set of conditions, few studies compare restoration effectiveness across restoration approaches, across different

restoration techniques, or across a range of site conditions. Here we ask: How does water quality impact (defined here as change in nutrient and sediment loads) compare among different restoration approaches or techniques and/or (depending on ability to replicate) across site conditions? The types of restoration approaches in which we are interested are those that aim for different function (e.g., degree of floodplain reconnection, frequency of inundation, bank stabilization, etc.). Those approaches can be accomplished with several techniques or a mixture of multiple techniques, including regenerative stormwater conveyance (RSC), natural channel design (NCD), and stream valley restoration/legacy sediment removal). The site condition factors in which we are interested include differences in land use, % impervious cover, watershed condition, soil type, valley type, and/or watershed position (headwaters vs. downstream near the receiving waters).

5. Climate impacts to restoration practice: Climate change models predict that frequency and intensity of rain events will increase, that growing season will lengthen, and that other processes related to the Chesapeake community's approved set of BMPs will change. As a result, some suggest that standards for stormwater practices, stream restoration, and other BMPs should change (e.g., plan to treat a two-inch rain event versus a one-inch rain event; design stream restoration practices for more frequent storms).

6. Emerging Pollutants: Temperature and salt have been identified as "emerging pollutants" of concern by the restoration community, beyond the "traditional" pollutants of nitrogen, phosphorus, and sediment that have been the focus of much of the restoration community to date. Questions within this area are:
   a. Thermal – What best management practice design and siting methods will reduce thermal impacts to streams in Maryland's Use III and IV watersheds (see the Maryland Stormwater Design Manual Section 4.1)?

   b. Salt – Which techniques of salt application to roadways will result in less loading to streams? Which BMPs can be used to reduce salt loading to streams?

7. Invasive species: The act of restoration, in ecological terms, can be considered a disturbance. Colonization by invasive species following any disturbance is common, and restoration practices are no different. In addition, managing invasives can be a costly component of post-project maintenance regimes. As a result, many in the practitioner community are looking for ways to implement restoration projects that result in less colonization by invasive species and if an "acceptable" threshold for invasive species could be quantified and used as a management tool. Specifically, funders are looking for research comparing the value of different techniques in reducing invasive colonization in stream restoration and tree planting projects.

Impact of construction activities on natural resources

8. Minimizing Short- and Long-term Impacts of Stream Restoration Construction: Some in the community are concerned that the act of project construction can have negative consequences on the resource(s). For example, construction equipment can compact soils, reducing infiltration and therefore water quality benefit. Certain alternative construction mechanisms may be available, or adding a step of countering the soil compaction may help. Researchers choosing to address this question will be responsible for identifying or proposing alternative methods, then either modeling their effect on TN, TP, and TSS load reduction and/or habitat characteristics, or testing them empirically. In the alternative construction methods used to address this question, consider how the construction methods impact the construction time, restoration materials used, and cost.
9. Work in the wet vs work in the dry for stream restoration: When permitting stream restoration, most regulatory agencies require practitioners to divert water around the stream section to be restored. Such diversion can be costly and can prolong the projects and therefore construction disturbance, leaving some to hypothesize that the net sediment impact of diverting is no "better" than that of a quicker project done with the stream flowing. Funders seek to ask: What is the difference in effects on water quality (turbidity) and total sediment load delivered downstream between stream restoration work "in the wet" (construction without diverting the

stream) vs. work "in the dry" (construction accomplished through diversion of the water flow) for streams that are larger than 1st order (e.g., streams that will use at least a 6 inch pump, estimated for base flow of 5.1 ft^3 per second)? All aspects of work in the wet vs work in the dry that affect sediment input must be considered, including:

a) Installation of a diversion when working in the dry, which may release sediment for some period of time at some high concentration (e.g., greater than the water quality standard of 150 NTU) during the installation;
b) Removal of the diversion, which may also release sediment; and
c) Duration of construction (hypothesized to be shorter for work in the wet).

This work will build on a previous study of this question in smaller-scale streams funded through this program. Preliminary results can be found here. The management and regulatory communities have reason to hypothesize that larger streams may present different scenarios than smaller streams.

You will be required to articulate potential covariates, such as restoration type, restoration size, project duration, sediment type, substrate type, slope, stream size, stream flow, land use, drainage area, area disturbed, and other factors. Your experimental design must include the replication needed for scientifically defensible results, and you must justify the number of replicates chosen. You are encouraged to perform a power analysis to ensure that your sample size is large enough to detect the hypothesized difference. Reviewers will be sensitive to the degree of replication proposed.

Trade-offs in resource improvements incurred by restoration practices and the resulting net ecological change as measured by a common "currency"

10. Resource trade-offs in different types of restoration projects. The decision to install a restoration project at any given site by definition implies that an existing condition at that site will be modified, replaced, and/or improved. The hypothesis of the restoration practitioner is that the net condition will be *improved.* However, a value judgment is placed on the existing condition, (e.g., deeming the existing condition to be inferior to the desired "restored" condition) that is often not based on quantification. In addition, there is an accompanying value judgment on the proposed resulting condition that may not take into account reductions of certain functions (e.g., removing trees to create a wetland). One difficulty is that the units of the resource negatively affected is often not the same as the units measured to report the restoration work (often pounds of nitrogen reduced).

    The goal of this question is to encourage quantification, in some comparable metric, of the resources present prior to the activity compared to the resources available after restoration project installation, calculating net ecological impact after evaluation of individual functional components. Your project should explore the "positive" and "negative" impact for at least two resources using common metric(s) (e.g., vegetation biomass, pounds of pollutant reduced, a habitat metric) to determine the net change.

    Research Question: With certain kinds of restoration projects or practices, do the net benefits (nutrients, sediment, habitat, hydrology, biological resources) outweigh the net impacts (persistent and excessive iron floc mats, tree loss and resulting habitat loss, etc.)?

    Include at least two resources for consideration, such as, but not limited to the following:

    - Wetland trade-offs in stream restoration projects: Certain stream restoration practices can impact type and function of existing wetlands. Impacts can include changes to the wetland's hydrology and plant community extent and distribution.
        - What are the changes to the wetland community and does this result in a loss of wetland function compared to the benefit of the other elements of the restoration practice?
    - Tree trade-offs in stream restoration projects: Certain stream restoration practices by necessity can result in removal of trees: 1) trees may need to be removed on a short-term basis for construction site

access; 2) trees may be removed for various methods of stream restoration in nontidal forested wetlands; 3) trees may be removed to accomplish legacy sediment removal in which the stream banks are forested; and 4) trees, even when remaining after restoration, may experience mortality due to changes in hydrology leading to higher water levels/inundation.

  - What is the water quality and habitat cost of tree removal of certain practices compared to the benefit of the other elements of the restoration practice?

- Iron presence in stream restoration projects: Iron can occur naturally in the soil and the groundwater. Some hypothesize that stream restoration practices can lead to precipitation of iron compounds. Iron can precipitate in the presence of oxygen which can be introduced when a stream restoration practice is installed where hydrology reconnection is accomplished. Ironstone, carbon, and other materials could be used in stream restoration projects and could add iron to the system and/or change the form of iron leading to impacts in the system. Iron flocculate or mats can reduce macroinvertebrates. Iron in streams could also have additional negative impacts such as impacts to percolation, heavy metal, aesthetics, etc.
  - What stream restoration techniques are associated with increases in iron concentration in the surface water, groundwater, and/or sediment and what are the impacts of this increased iron?

This research should allow restoration practitioners and permitters to more accurately calculate the resource's functional uplift at a particular site in order to optimize system functions in decision making.

RFP Questions from FY 20

Effectiveness of stormwater and stream restoration programs at the watershed/catchment scale

1. Keep - Watershed restoration assessment: What are the cumulative effects of watershed restoration activities within a watershed? Of interest in the restoration community is whether, given the high temporal and spatial variability of nutrient concentrations and flows, a signal from the restoration activities even in a highly targeted, small watershed can be measured relative to a control site (before vs. after restoration activities). The following are related questions: What percentage of the impervious surface in a watershed must be treated with stormwater best management practices (BMPs) before a difference can be measured at the outfall? Does BMP type (e.g., stream restoration, environmental site design (ESD) practices, stormwater wetlands) influence that percentage?
2. Keep - Stormwater management assessment: What is the effectiveness of stormwater management practices (implemented, for example, at a level required under the latest stormwater management regulations) on stream channel protection? What percentage of a catchment needs to be treated with ESD practices to reduce water flow enough to protect stream channels? Does the location of ESD practices within the catchment make a difference in protecting the stream banks?

Effectiveness of restoration practices at the project scale

3. Take off - Comparisons of water quality impact among stream restoration techniques, approaches (functions sought to be restored), or site conditions. While many studies present data on a single restoration technique in a single set of conditions, and sometimes at a single site without the replication needed to identify trends, fewer studies compare restoration effectiveness across restoration approaches, across different restoration techniques, or across a range of site conditions. Here we ask: How does water quality impact (defined here as change in nutrient and sediment loads) compare among different restoration approaches or techniques and/or (depending on ability to replicate) across site conditions? The types of restoration approaches in which we are interested are those that aim for different function (e.g., degree of floodplain reconnection, frequency of inundation, bank stabilization, etc.). Those approaches can be accomplished with several techniques or a mixture of multiple techniques, including regenerative stormwater conveyance (RSC), natural channel design (NCD), and stream valley restoration/legacy sediment removal. The site condition factors in which we are

interested include differences in land use, % impervious cover, watershed condition, soil type, valley type, and/or watershed position (headwaters vs. downstream near the receiving waters).

4. Keep - Biological Community Restoration: Recent research has shown that in many situations, especially in watersheds with relatively high impervious cover, stream restoration may result in improved physical habitats but not restored biological communities (macroinvertebrates, fishes, etc.). The reasons are not yet clear, but two hypotheses are the lack of source populations and chemical habitat barriers (e.g., conductivity, temperature). We seek a research team to test the hypothesis that individual/species/community seeding/transplantation in urban/suburban restored streams (in which physical habitat conditions would predict them to occur) will result in benthic communities that are more similar to reference streams compared to control restored sites in which individuals/species/communities were not transplanted. As part of this effort, researchers may also choose to test the chemical habitat hypothesis.

5. Keep – refine based on TT results - Climate change impacts to restoration practice: Climate change models predict that frequency and intensity of rain events will increase, growing season will lengthen, and other processes related to the Chesapeake community's approved set of BMPs will change. As a result, some suggest that standards for stormwater practices, stream restoration, and other BMPs should change (e.g., need to evaluate high intensity storms of varied frequencies (vs 24 hour event) to determine the design storm event that will be most effective for future climate change impacts such as flooding, increased pollution loading rates, and conveyance limitations).

   Funders are looking for investigators to compare the modeled or measured outcomes of varied storm frequency and duration (and associated flood impacts, loading rates, and % loads reduced for TN, TP, TSS, etc.) of current stormwater BMPs to those of a new set of stormwater BMP standards (e.g., larger practices, different siting of the same practices (moving them upstream or downstream)). The ultimate use of this information would be to evaluate design criteria of these BMPs for more effective practices using an updated design storm.

   In addition, for stream restoration practices funders are looking for investigators to compare modeled or measured outcomes (e.g., criteria for site selection, design approach for stability, design approach for habitat, or construction technique) of stream restoration practices under current conditions vs a new set of conditions (e.g., design element(s) to improve stability and/or improve habitat) to reduce the impacts of future climate change such as changing intensity duration frequency curves, frequency of storms, and/or periods of drought. Finally, a literature review that provides a synthesis of stream restoration siting criteria, design conditions, construction techniques/sequences, and/or other factors to manage for future climate impacts will be considered. The findings will support current stream restoration maintenance/upgrades and future stream restoration siting, designs, and/or construction practices.

6. Keep-Pollutants of Emerging Concern: Temperature; chloride; toxics, particularly polychlorinated biphenyls (PCBs); and fecal coliform bacteria, have been identified as "emerging pollutants" of concern by the restoration community, beyond the "traditional" pollutants of nitrogen, phosphorus, and sediment that have been the focus of much of the restoration community to date. Questions within this area are:

   a. Keep & refine-Thermal – What best management practice design and siting methods will reduce thermal impacts to Maryland's Use III and IV streams (see the Maryland Stormwater Design Manual Section 4.1)?
   b. Ongoing research covers this one and perhaps cycle back on when we get the results- Chloride (Salt) – Which techniques of salt application to roadways will result in less loading to streams? What source reduction practice(s) can be used to reduce salt loading to streams?
   c. Keep & refine-PCBs – Many regional water bodies have PCB impairments. Some of these impairments result from *in situ* legacy sources and may naturally attenuate over time, while in other cases active sources of PCBs have been identified. The specific sources of PCBs are often unknown as are whether practices used to reduce nutrient loads can also reduce PCB loads.

i. Are there significant differences in PCB loadings across different land use types, industry types, and eras of development?

Toxics (specifically PCBs) and bacteria – Both "traditional" (e.g., Maryland Stormwater Design Manual Chapter 3 and 5 practices: https://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Pages/storm water_design.aspx), and innovative stormwater management techniques may reduce delivery of pollutants such as PCBs, other toxins, and bacteria to receiving waters.

ii. What are the removal capabilities of different stormwater management designs on reducing toxic contaminant loads? We seek proposals that address either a) comparisons of traditional and innovative stormwater practices in this area (e.g., bioretention with traditional media vs. filters with variable media designs) or b) comparisons of effectiveness of different innovative techniques at reducing PCBs, other toxics, and/or bacteria loads. The project could be focused at the larger "receiving waters" scale or the individual practice scale, and researchers should consider storm flows and base flows.

7. Add to #10 - Invasive species: The act of restoration, in ecological terms, can be considered a disturbance. Colonization by invasive species following any disturbance is common and restoration practices are no different. In addition, managing invasives can be a costly component of post-project maintenance regimes. As a result, many in the practitioner community are looking for ways to implement restoration projects that result in less colonization by invasive species and to articulate whether an “acceptable” threshold for invasive species could be quantified and used as a management tool. Specifically, funders are looking for research comparing the value of different techniques in reducing invasive colonization in stream restoration and tree planting projects. Researchers choosing to address this question will be responsible for identifying or proposing one or more alternative methods, then testing them ideally with a paired BACI design (i.e., a suite of restoration projects in which traditional methods are used compared to a suite of restoration projects in which a new method to reduce invasive colonization is tested).

Impact of construction activities on natural resources

8. Add to #10 - Minimizing Short- and Long-term Impacts of Stream Restoration Construction: Some in the community are concerned that the act of project construction can have negative consequences on the resource(s). For example, construction equipment can compact soils, reducing infiltration and therefore water quality benefit. Certain alternative construction mechanisms may be available, or adding a step of countering the soil compaction may help. Researchers choosing to address this question will be responsible for identifying or proposing alternative methods, then either modeling their effect on TN, TP, and TSS load reduction and/or habitat characteristics, or testing them empirically. In the alternative construction methods used to address this question, consider how the construction methods impact the construction time, restoration materials used, and cost.

9. Keep - Work in the wet vs work in the dry for stream restoration: When permitting stream restoration, most regulatory agencies require practitioners to divert water around the stream section to be restored. Such diversion can be costly and can prolong the projects and therefore construction disturbance, leaving some to hypothesize that the net sediment impact of diverting is no “better” than that of a quicker project done with the stream flowing.

   Funders seek to ask: What is the difference in effects on water quality (turbidity) and total sediment load delivered downstream between stream restoration work “in the wet” (construction without diverting the stream) vs work “in the dry” (construction accomplished through diversion of the water flow) for streams that are larger than 1st order (e.g., streams that will use at least a 6 inch pump, estimated for base flow of 5.1 ft^3 per second)? All aspects of work in the wet vs work in the dry that affect sediment input must be considered, including:

a) Installation of a diversion when working in the dry, which may release sediment for some period of time at some high concentration (e.g., greater than the water quality standard of 150 NTU) during the installation;
b) Removal of the diversion, which may also release sediment; and
c) Duration of construction (hypothesized to be shorter for work in the wet).

Trade-offs in resource improvements incurred by restoration practices and the resulting net ecological change as measured by a common "currency"

10. Keep and make specific for stream restoration function - Resource trade-offs in different types of restoration projects. The decision to install a restoration project at any given site by definition implies that an existing condition at that site will be modified, replaced, and/or improved. The hypothesis of the restoration practitioner is that the net condition will be *improved.* However, a value judgment is placed on the existing condition, (e.g., deeming the existing condition to be inferior to the desired "restored" condition) that is often not based on quantification. In addition, there is an accompanying value judgment on the proposed resulting condition that may not take into account reductions of certain functions (e.g., removing trees to create a wetland). One difficulty is that the units of the resource negatively affected is often not the same as the units measured to report the restoration work (often pounds of nitrogen reduced).

With certain kinds of restoration projects or practices, do the net benefits (nutrients, sediment, habitat, hydrology, biological resources) outweigh the net impacts (tree loss and resulting habitat loss, etc.)?

Include at least two resources for consideration, such as, but not limited to the following:

- Wetland trade-offs in stream restoration projects: Certain stream restoration practices can impact type and function of existing wetlands. Impacts can include changes to the wetland's hydrology and plant community extent and distribution. What are the changes to the wetland community and does this result in a loss of wetland function compared to the benefit of the other elements of the restoration practice?

- Tree trade-offs in stream restoration projects: Certain stream restoration practices by necessity can result in removal of trees: 1) trees may need to be removed on a short-term basis for construction site access; 2) trees may be removed for various methods of stream restoration in nontidal forested wetlands; 3) trees may be removed to accomplish legacy sediment removal in which the stream banks are forested; and 4) trees, even when remaining after restoration, may experience mortality due to changes in hydrology leading to higher water levels/inundation. What is the water quality and habitat cost of tree removal of certain practices compared to the benefit of the other elements of the restoration practice? Your effort should build on/compliment but not duplicate two projects on this topic funded in 2017; see past projects funded at www.cbtrust.org/restorationresearch.