Factors Influencing the Headwaters, Nontidal, Tidal, and Mainstem Fish Habitat Function in the Chesapeake Bay Watershed: Application to Restoration and Management Decisions

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About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. Since its creation in December 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay Watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical workshops, and (5) interaction between STAC members and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Watershed. For additional information about STAC, please visit the STAC website at http://www.chesapeake.org/stac.

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Executive Summary

In support of the Chesapeake Bay Program's (CBP) Fish Habitat Outcome 2-Year Work Plan (2018-19), the Sustainable Fisheries and Vital Habitat Goal Implementation Teams (GITs) obtained funding from the Scientific and Technical Advisory Committee (STAC) to conduct a workshop to develop a Fish Habitat Assessment Framework for the Chesapeake Bay and its watershed (hereafter referred to as "the Watershed"). The workshop's objective was to identify the necessary information and analytical approaches needed to assess the condition and vulnerability of fish habitat in the Watershed. Such an assessment could identify the condition and primary drivers of fish habitat change, better guide conservation and restoration planning and investments, develop specific habitat management objectives to support the productivity of fish stocks, and evaluate the effectiveness of efforts to conserve and restore fish habitat.

The workshop included a CBP partnership agency-driven process to understand the scientific information and decision support needs of policymakers responsible for conserving fish and fish habitat throughout the Watershed. Input on the support and informational needs for such an assessment was obtained from state and federal fishery managers and scientists, state, local and federal land use planners and managers, and non-governmental organizations interested in the conservation of fish and habitat services in the Watershed.

The workshop was designed to 1) examine existing habitat assessment tools at the regional and national level, 2) identify opportunities to improve upon and integrate with existing assessments, 3) determine criteria for the selection and ranking of fish habitat condition and stressor variables, 4) identify and prioritize which of these variables have the greatest influence on habitat condition and vulnerability, 5) identify research gaps and priorities and 6) recommend a framework for developing such an assessment, if supported by partnership agencies and stakeholders. Guiding principles for developing this assessment framework included the following: 1) the scale must support planning and management decisions, 2) the tool must be based on best available science, data and analytical approaches, and 3) the tool must be designed to integrate and/or complement other available tools.

The workshop confirmed that there exists strong interest among Chesapeake Bay watershed managers, academia, and stakeholders for developing a fish habitat assessment for the Watershed. The impact that this assessment will have on conserving and restoring fish and their habitat in the watershed, in balance with societal needs, will be dependent upon the ability to develop the framework at a fine spatial scale (1:24,000 or finer), integrate the richness of data available in the Watershed, design a tool tailored to user needs, and provide the required level of maintenance, as well as outreach and training to potential users to achieve a high use-rate in decision-making.

Critical recommendations from this workshop supporting a regional Chesapeake Bay Watershed Assessment were as follows:

1) **Data gathering**: Identify lead agencies to build upon existing monitoring efforts. The efforts should support sustaining key existing data streams, and gathering, organizing, and assessing the availability, accessibility, and applicability of new biological and stressor data needed to support the development of a fish habitat assessment the Chesapeake Bay watershed at a fine spatial scale (1:24:000 or finer).
2) **Pilot assessment**: Conduct a pilot level assessment in a representative waterway(s) as a proof of concept.

3) **Assessment metrics**: Fish habitat assessment metrics should target conditions supporting the life history needs of species assemblages. Develop select metrics for representative species to help communicate the condition and stressor of fish habitat by habitat type.
4) **Outreach and training to assessment users**: Develop a communication framework. Design outreach and training modules accommodating diverse users interested in applying a regional fish habitat assessment tool to ensure that its content meets user needs.
5) **Research**: Communicate prioritized research needs to science providers in the Watershed. Encourage scientists to focus available resources on better understanding of fish habitat stressors that workshop participants identified as being high in severity and low in scientific certainty.

Considering the discussions at the workshop, the workshop steering committee recommends these additional efforts:

1) **Community of practice**: Establish a Community of Practice (i.e., a group of people who share a concern for something and learn how to do it better as they interact regularly) among those utilizing fish habitat assessment tools to facilitate the transfer of knowledge on lessons learned.
2) **Assessment coordinator**: Identify a person to lead the above recommendations and build upon the collaborations from this workshop established among Bay watershed management and science agencies at the local, state and federal level, academic institutions, environmental organizations and stakeholders. Without a dedicated person to lead, coordinate, organize, and motivate the number and diversity of involved parties, implementation of workshop recommendations and their expected benefits towards achieving Bay restoration goals pertaining to fish habitat will be limited. The Chesapeake Bay Fish Habitat Assessment planning, data collection, and product development should be coordinated with and contribute to the Northeast Regional Fish Habitat Assessment being led by the Mid Atlantic Fishery Management Council (MAFMC).

1.0 Introduction and Workshop Objectives

To those who live and visit the Chesapeake Bay watershed – which spans six states and the District of Columbia – fish are among the most tangible symbols. Sport and commercial fisheries are a multi-billion dollar industry in the region. Fish and shellfish further provide important ecosystem services such as trophic connectivity and water filtering. However, the ability for fishery managers to sustain fish populations and their associated socio-economic benefits in the Chesapeake Bay watershed has been increasingly challenged by changes to the landscape. The human population in the Bay's watershed has doubled since 1950[1] and has resulted in a negative impact on the quality and quantity of fish habitat.

Landscape-level decisions which impact fish habitat are typically the responsibility of state and/or local government agencies. In the absence of scientific information and decision support tools regarding the condition and vulnerability of fish habitat and populations, the conservation and restoration of fisheries and their associated socio-economic benefits in the Bay watershed are at risk. This workshop was designed to support that pursuit and build a framework from which to base a regional fish habitat assessment.

The main workshop **objective** was to identify the necessary information and analytical approaches to assess the condition and vulnerability of fish habitat in the Chesapeake Bay Watershed.

Guiding Principles of the assessment:

- Assessment scale must support planning and management decisions
- Assessment must be based on the best current available science, data, and analytical approaches
- Assessment must be designed to integrate with or complement other tools

A significant amount of work and data gathering was needed to develop a workplan and prepare for this workshop. A review of the 2015 National Fish Habitat Partnership (NFHP) Assessment (Crawford et al. 2015)[2], the Gulf Coast, and the Pacific Coast regional assessments was completed to determine methodology, use, and available data variables. Based on this review, the workshop steering committee was challenged to identify variables that influence fish habitat in the Chesapeake region to determine if data were available to evaluate known and expected stressors and to assess the scale of applicability of that available data. The USGS Chesapeake Bay Program and Leetown Science Center, along with the NOAA Oxford Laboratory, offered their time and expertise to the steering committee. The USGS/NOAA team assembled the data and the result was a comprehensive database of 15 factors, 441 stressor variables influencing fish habitat, and the rejuvenation of a collaborative and productive relationship between the agencies.

With the understanding that many land use decisions (i.e., planning, restoration, and conservation) are exercised at the local level (counties and municipalities), it was important to gain an understanding of the need and use of fish habitat information and tools from local planners and project leaders. A questionnaire was developed by the workshop steering committee and distributed to all jurisdictions in the watershed. Fishery managers were included in the questionnaire distribution to gain an understanding of their needs for fish management decisions and

[1] Source: https://www.chesapeakebay.net/issues/population_growth

[2] Crawford, S., G. Whelan, D.M. Infante, K. Blackhart, W.M. Daniel, P.L. Fuller, T. Birdsong, D.J. Wieferich, R. McClees-Funinan, S.M. Stedman, K. Herreman, and P. Ruhl. 2016. Through a Fish's Eye: The Status of Fish Habitats in the United States 2015. National Fish Habitat Partnership. Accessed on 20 June 2018, at http://assessment.fishhabitat.org/.

planning; however, they were a much smaller portion of the respondents. The Regional Fish Habitat Assessment User Needs Report is available as Appendix 8.8 and discussed in the *Potential Users Application of Tool* section of this report.

The **framework** is a series of fundamental questions developed for the workshop to guide discussion and serve as the basis for a future regional fish habitat assessment:

- Identify scale needed to drive action at relevant management levels.
- Determine criteria for selection and ranking of variables.
- Identify and prioritize the variables (stressors and conditions) most influencing habitat condition and vulnerability.
- Why was the variable selected? Describe impacts on habitat function and ecosystem services.
- Identify information gaps and scientific needs.

2.0 Potential Users Application of Tool

2.1 Potential Users Needs and Guidance

The Regional Fish Habitat Assessment User Needs Questionnaire (Appendix 8.8) was created to determine the utility of a regional fish habitat assessment for local decision makers and fisheries managers. In summary, the questionnaire collected responses from all jurisdictions; a majority (70%) of respondents said they would use a regional fish habitat assessment. However, some respondents noted that they already have a lot of spatial tools to use. The questionnaire queried their familiarity with other ecological service and assessment tools. There were some popular tools (higher response rate) that may be a complement to a fish habitat assessment tool. While there were responses from fish managers in the questionnaire, additional responses were also received from fishery managers at the June 19, 2018 Joint meeting of the Sustainable Fisheries and Habitat GITs. Participants at that meeting were asked if they would use a regional fish habitat assessment. Responses from this meeting are provided after the User Needs Questionnaire report in Appendix 8.8. Based on responses at the Joint meeting and the questionnaire, the conclusion is that a regional assessment would not be the primary tool for choosing a project area; but decision makers will use it in other ways. Many local managers welcome the opportunity to have this information to understand habitat in their area, focus the extent and type of projects, and see direct efforts beyond water quality. However, they really need information at a finer scale (1:24K) than the scale of the National Fish Habitat Assessment (1:100K), and more Chesapeake Bay relevant datasets than in the National Fish Habitat Assessment to be useful.

2.2 Uses of Habitat Assessment

The loss and degradation of aquatic habitats threatens the health and productivity of many commercially, recreationally, and ecologically important fish species and their food resources. Few efforts to date have focused on measuring the extent of fish habitat change. The rapid changes in habitat observed over the last few decades have emphasized the need to increase our understanding of stressor impacts to habitat quality and quantity, and elevated the focus on the importance of habitat availability. Habitat assessments that map habitat distributions, characterize the quality and quantity of habitats, and provide coincident spatial and temporal data on habitat stressors are critical to identifying appropriate conservation and restoration strategies. Habitat assessment tools

serve to connect fishery managers, who traditionally focus on managing harvest, with managers who influence and/or make decisions that affect habitats and stressors impacting natural mortality of fish stocks.

Habitat assessment tools are useful to communicate the status of fish habitats with accompanying visualizations of easy to understand metrics depicting habitat condition. These products help initiate and facilitate conversations on management options available to conserve, restore, and maintain a variety of habitat functions.

- **Restoration**

  Habitat assessments can show where stressors such as urban land use, agriculture, dams, culverts, pollution, and other human development have reduced habitat viability. These areas can be then be evaluated to determine what type of mitigation can be applied to restore habitat. In areas where degraded habitat exists, restoration can help address the sources of degradation through siting and design of best management practices (BMPs). Conservation and restoration targeting options can also be introduced into land use planning, and engage landowners, businesses, and local communities in support of habitat rehabilitation efforts.

  Understanding where habitats are degraded and the sources of that degradation also allow for decision support in prioritizing the use of limited resources to focus on places where projects can be most effective. The results from a habitat assessment can be built into grant and other funding opportunities to solicit projects more likely to improve current habitat condition in critical locations. For example, habitat assessment tools could be incorporated into National Fish and Wildlife Foundation (NFWF) business plans and priorities.

- **Conservation**

  Habitat assessments can also delineate high quality habitats that continue to support viable fisheries. These areas can be targeted for conservation, and management policies can be implemented to protect them from future degradation and enhance recreational use. Quantifying how much habitat remains in good condition provides a starting point for setting spatially and numerically specific conservation goals among multiple partners.

- **Fishery Management**

  Fishery managers have traditionally focused management actions on addressing harvest controls. Increasingly, more emphasis is being placed on addressing factors affecting natural mortality such as habitat condition. Habitat assessments can help develop specific habitat management objectives aimed at conserving and/or rehabilitating habitat to help recover fish populations or improve productivity of stocks. Magnuson-Stevens Fishery Conservation and Management Act authorizes habitat conservation through Essential Fish Habitat and Habitat Areas of Particular Concern (HAPC). Habitat assessment tools and products can help inform the essential fish habitat consultation process and establish HAPCs.

- **Communication**

  Habitat assessment tools evaluate the current condition of fish habitat and can provide a spatial depiction of the stressors that potentially limit successful fisheries management. These tools can be used to engage decision and policy makers at multiple governance levels from congress to local officials, as well as large multi-state and cross sector ecosystem partnerships such as the Chesapeake Bay Program.

3.0 Process

3.1 Assembling an inventory of stressor, condition and biological variables

A successful assessment of fish habitat in the Chesapeake Bay requires an agreed upon definition of habitats, then the availability and assembly of sufficient stressor (e.g., urban land cover), condition (e.g., bedrock) and biological (e.g., fish community and fish health) data. A team of USGS and NOAA scientists determined the availability of most of these data for the Chesapeake Bay watershed and compiled the relevant metadata (e.g., generator, provider, timeframe, extent, summary scale, and web link) prior to the workshop. The main objective was to identify data specific to the Chesapeake Bay watershed that were either not used in the 2015 NFHP Assessment (Crawford et al. 2015), or that were newly available at a finer spatial scale. During this process, numerous studies that have previously generated, assembled, and/or summarized such data for a variety of purposes were identified (Table 1, Appendix 8.7). The current data compilation effort started by examining and comparing each of these previous studies to identify overlap or differences in data, variables analyzed, study objectives, and data availability. Additional variables identified during this process that were not included in the previous studies were added. All data sources for which there were data within the Chesapeake Bay watershed were included in the compilation effort. Data that did not extend into the watershed were not included, but data that covered only part of the watershed (e.g., mines in Virginia or unconventional oil and gas operations in Pennsylvania) were included. A Microsoft Excel spreadsheet file was created to compile the results. The file of 441 variable records was used to facilitate presentation, analysis, and summary of the data compilation effort during the workshop.

For previous habitat assessment studies, source information for the data (i.e., - who collected, managed, or has the data) was documented, including web links where data or information can be found, purpose of the study, and, if available, the scale at which the study summarized the variables. Each variable in these studies was then examined to identify the original data source, spatial extent at which it was generated and year or years of data availability. Extent refers to the spatial coverage of the data and was grouped into categories based on relevance for particular habitats and areas of the Chesapeake Bay watershed (Table 2, Appendix 8.7). A coding system was used (Table 3, Appendix 8.7) to identify how the data had been summarized in each of the previous studies. Some studies summarized the data in multiple ways, while other studies did not summarize the data or such information was not found. For new variables that were not already included in a previous study/summary, similar information was collated and recorded except that no summary code was assigned to these variables.

An important component of the compilation effort was to identify the present status and availability of each data set. For the current effort, a variable was considered "currently available" if the identified link listed in the source was active, the data were available for download, or data were available based on personal communications with provided contacts. Variables determined to be not currently available were included in the hopes that if identified as being important by stakeholders, future efforts could focus on identifying a data source.

Each variable was categorized as a stressor, condition, or both. A variable was classified as a *stressor* if it indicated changes to environmental drivers that affect habitat quality and the species that occupy those habitats. Variables were classified as a *condition* if they represent the state of the habitat in a specific area for a specified time suitable for fish occupancy, which may include survival, growth, and reproduction. Some variables were classified as "both" because they could be a stressor for some species and a condition for others. For example, dams could inhibit spawning efforts for some species, but could create habitat structure for other species.

Variables were separated into 15 groups in the file with a separate spreadsheet for each group (Table 4). Initial groups were derived from the 2015 NFHP Inland Assessment (Crawford et al. 2015); however, the large amount of data available for the Chesapeake Bay region resulted in more group categories. For example, a 'Biological' group was added given the complexity of variables in this group being stressors (e.g., invasives), conditions (e.g., food base) or response endpoints (taxa richness). A 'Miscellaneous' group was also added to capture several variables that did not directly fit in the other 14 groups. In each tab, variables were sorted from largest to smallest spatial extent.

An initial attempt to highlight the relevance of each variable to each broad habitat type (i.e., Headwaters, Large Nontidal Rivers, Tidal Freshwater, and Tidal Saltwater) was also provided. For example, a variable that has dissolved oxygen information with a Bay-wide extent will likely not be useful in modeling fish habitat in the Headwaters habitat, but may be useful in the Tidal Freshwater and Estuary habitats. The indication of which variables can be used for which habitat types should not be considered final and this information was included to serve as a guideline when identifying missing data or gaps for each habitat type.

In total, 441 variables were identified that potentially can be used in a Chesapeake Bay region fish habitat assessment (Table 5). This is a much larger number of variables than was used in the 2015 NFHP Inland or Estuarine Assessments (Crawford et al. 2015). A caveat with the current compilation effort is that there is redundancy in the variables given the overlap among different data sources, thus the actual number of independent variables is lower than 441. For example, there are four different data sources for Dam Density; this inventory made no effort to select the most optimal version because this would be better handled through stakeholder input and/or during the modeling portion of a future assessment.

Although the primary emphasis of this compilation focused on stressor and condition variables, an initial attempt to synthesize fish data across the watershed from survey and monitoring programs has been conducted. Data on fish has been inventoried from 11 different (primarily non-tidal freshwater) sources totaling 15,732 sites with collection dates ranging from 1982 to 2018 (Table 6). During this synthesis of fish data, four previous compilation efforts have been found with data having sampling dates ranging from 1952 to 2017. From the 2015 NFHP Inland Assessment database 7,759 sites were identified within the states of the watershed (Table 7). The current compilation of fish data includes all available data from each source and therefore data have not been subset to Chesapeake Bay watershed specifically.

Table 4. List of the 15 grouping factors that each variable was assigned to along with a brief description and example.

Factors	Description/ Examples
Watershed	Layers and information used to delineate watershed boundaries, salinity zones, drainage or catchment areas, stream order
Pollution	Toxic Release Inventory, nitrate deposition, NPDES major sites, pesticide applied
Dams	Number of dams, type, habitat fragmentation due to dams
Mines	Mine density and type, abandoned areas, unconventional/conventional wells, pipelines
Water Use	Water withdrawal information
Human	Population density information
Urban	Road length/crossing density, urban areas, impervious surface cover, landfills
Ag	Percent hay/agriculture, pesticide use, confined animal feeding operation information
Natural	Elevation, slope, habitat, runoff, soil information, geology, stream density, ecoregions
Nutrient	Nitrogen and Phosphorus amounts, 303(d)
Water Quality	Salinity, water temperature, dissolved oxygen
Climate	Precipitation, temperature, sea level rise, number of wet days
Habitat	Bathymetry, wetlands, tidal marsh vegetation
Biological (Response and Predictor)	Fish abundance, stream IBI, biological condition
Miscellaneous	Shoreline Structure/erosion, dredging

Table 5. A summary of 441 variables identified from the pre-workshop compilation effort that potentially can be used in a Chesapeake Bay region fish habitat assessment, as compared to the National Fish Habitat Partnership Assessments (Crawford et al. 2015) separated by grouping factors (listed in Table 4).

Factors	# Variables	# Variables NFHP Inland	# Variables NFHP Estuary
Watershed	18	0	0
Pollution	38	3	1
Dams	12	2	1
Mines	53	4	1
Water Use	7	5	1
Human	5	1	1
Urban	34	6	7
Ag	26	2	2
Natural	86	3	13
Nutrient	29	3	0
Water Quality	19	0	1
Climate	20	2	0
Habitat	38	0	0
Biological (Response and Predictor)	46	11*	0
Miscellaneous	10	0	0
Total = 15	**441**	**31**	**28**

Table 6. Identified available fish data sources, primarily for non-tidal areas of the Chesapeake Bay region. Extent indicates the spatial coverage of data. * indicates Eastern Brook Trout Joint Venture (EBTJV) data set only includes data on trout.

Raw Data Sources			
Source	**Extent**	**Year(s)**	**Number of Sites**
VA DEQ	VA	2004-2017	791
MD DNR	MD	1995-2013	3216
MD DNR	MD	1995-2014	221
NY DEC	NY	1982-2011	9493
WV DEP	WV	2006-2018	323
PA DEP	PA	2008-2017	259
SRBC	PA, NY	2008-2017	466
USGS BioData	DE, MD, NY, PA, VA, WV	1993-2017	133
EPA EMAP	DE, MD, PA, VA, WV	1993-1996	311
EPA EMAP	DE, MD, NY, PA, VA, WV	1997-1998	297
EPA NRSA	DE, MD, NY, PA, VA, WV	2008-2009	222

Previous Compilation Databases			
Source	**Extent**	**Year(s)**	**Number of Sites**
Water Quality Portal	DE, MD, NY, PA, VA, WV	1977-2017	1255
AppLCC	DE, MD, NY, PA, VA, WV	1976-2012	20714
MARIS	MD, VA, WV, PA	1974-2013	20517
EBTJV*	MD, NY, PA, VA, WV	1952-2015	113360

Table 7. Summary of fish survey data used in the 2015 National Fish Habitat Partnership Inland Assessment.

Extent	**Year(s)**	**Number of Sites**
DE	1998	1
VA	1993-2008	128
MD	1993-1998	31
NY	1991-2008	7315
WV	1993-2008	109
PA	1993-2008	175

3.2 Scoring Criteria and Guidance

As a collective group, workshop participants were asked to determine criteria to score and rank the stressor variables. The participants decided to use three criteria for this exercise: severity, mitigation potential, and certainty. The definition and traits of each are described below and summarized in Table 8.

Severity was the first ranking trait. Severity scoring considered the spatial extent of impact a stressor exacted on the habitat or species (i.e., local or widespread), the temporal duration of impact (sporadic to intermittent to persistent) and magnitude (minor to major) of impacts affecting habitat health. Severity was scored "low" if the stressor tended to produce localized impacts and marginally influenced habitat function. Severity was scored "medium" if the habitat function was considered moderately impaired and the spatial extent was more than localized but not watershed-wide. A stressor scored "high" for severity if it was recognized across the watershed as producing significant impairments to habitat function and species populations.

Mitigation potential was the second ranking trait. Mitigation was scored low, medium, or high to reflect the collective understanding about known management methods for reducing the impact of a stressor on fish and habitat health and function. The issue of political will and motivation to apply an approach that may be unpopular was excluded from influencing the scores. Rather, scoring focused on what is known about options for remediation methods and their effectiveness to remove the impact of the stressor.

Certainty was the final scoring trait. Certainty scoring provided insight into how well scientific research supports our understanding of the linkage between stressor effects and impacts on fish health and habitat quality. Certainty was scored low if there was little more than anecdotal knowledge regarding impacts to fish or habitat health. Certainty

was high if there was substantial published research on impacts of the stressor on fish health and habitat condition and functions. Medium scores were applied when scientific support was identified but limited.

Table 8. Definitions of ranking criteria for fish habitat stressor variables, as determined by workshop participants.

Stressor Criteria	Ranking guidance
Severity	What is the importance of the stressor to impacting habitat degradation or a species population status? Consider: **Habitat function –** How would one characterize the overall changes in habitat processes (little/none, moderate, substantial)? **Spatial Extent** – What proportion of the habitat is impacted or likely to be impacted (10-30 year time horizon)?
Mitigation Potential	What is the feasibility of mitigating and/or preventing impacts from the stressor?
Certainty	What is the state of the science regarding the known linkage of impact of the stressor on fish and habitat health?

3.3 Break-out Group Exercises - Prioritizing Potential Fish and Habitat Stressors

Workshop participants were divided into break-out groups of four habitat types (Headwaters, Large Nontidal Rivers, Tidal Freshwater and Tidal Saltwater) based on their expertise. As described above, USGS and NOAA inventoried stressor variable data containing over 400 data sets for potential stressors of fish habitat that might be used for building the region-specific Chesapeake Bay Watershed Fish Habitat Assessment Framework. The data sets were then organized under 15 impact groups (or factors) representing classes of stressor variables influencing fish and their habitats (Table 4). Each break-out group considered the list of factors and variables and highlighted the themes relevant and limiting to their respective habitat type. The dataset used by the groups had some redundancies when the variable was provided in different data sources or measured differently in multiple sources. Therefore, the break-out groups had to group the variables into categories of their own design or arrangement. Groups further considered the relevance of each theme and lumped, split, or eliminated certain themes. While workgroup participants were familiar with many of the stressors and their potential to impair fish health or alter habitat, the awareness regarding stressor impacts specific to one type of habitat was a challenge for some groups.

In the second exercise, participants in each habitat group used their collective best professional judgement to go back through the identified stressor categories and select a score according to the selected criteria: severity, mitigation potential, and certainty. The groups worked systematically through each stressor category and assigned a score (low=2, medium=4, high=6) to rank the identified stressors. Some stressors were further grouped together under a broader stressor label (for example, herbicides and pesticides were grouped as toxicants). In some cases, where

stressors were included under several factors, the group duplicated the ranking from a previous factor. Comments regarding specific concerns or data needs were recorded in the process.

4.0 Results

From the list of 441 variables provided in the inventory, 87 variables were identified from the combined habitat groups as likely to have a significant impact on fish habitat in the Chesapeake Bay watershed (determined as a severity and certainty score of 6). Some of these variables overlap across habitat type and across factor. Further refining the list to remove any redundancy provides **54 unique variables identified as having a significant impact on fish habitat.** A list of these variables is provided in Appendix 8.5. Table 9 provides the total number of variables selected by each habitat type, and the number of variables identified with a high severity and a high certainty.

Table 9. Number of Variables Selected by each Habitat Type

Habitat Type	Total Number of Selected Variables	Number of Unique Variables Identified with High Severity and Certainty
Headwaters	23*	7*
Large Nontidal Rivers	108	15
Tidal Freshwater	83	31
Tidal Saltwater	66	34

** Selected broader factor level category. Not variable level.*

4.1 Severity Scoring Results by Habitat Type

Scoring tables for all four habitat types and ranking are available in Appendix 8.4. The factors that ranked highest for severity of impact are described in this section by habitat type. Table 10 summarizes the variables and factors that were identified as a severe impact to **multiple** habitat types.

Note that this exercise represents agreement based on the best professional judgment of species and habitat experts in attendance at the workshop. By nature of this approach, some stressors may be overlooked simply because they have not been studied extensively or experts in the workgroup were not aware of studies documenting stressor impacts.

Table 10. Variables and factors that were identified by multiple habitat types as priority impact stressors

Factor	Variables	Habitat
4 Habitats		
Agriculture, Nutrients	Nutrients	Large Nontidal Rivers, Tidal Saltwater, Headwaters, Tidal Freshwater
Urban, Human	Impervious Surface	Large Nontidal Rivers, Tidal Saltwater, Headwaters, Tidal Freshwater
3 Habitats		
Climate, Habitat, Pollution, Water Quality	Water Temperature	Tidal Saltwater, Tidal Freshwater, Headwaters
Agriculture, Urban, Pollution	Sedimentation	Large Nontidal Rivers, Tidal Saltwater, Headwaters
Urban, Human	Stormwater discharge/runoff	Large Nontidal Rivers, Tidal Saltwater, Headwaters
Agriculture, Human	Land use	Tidal Saltwater, Tidal Freshwater, Headwaters
Agriculture, Habitat	Erosion	Large Nontidal Rivers, Tidal Fresh, Headwaters
Human	population density/change	Large Nontidal Rivers, Tidal Freshwater, Headwaters
2 Habitats		
Habitat	Submerged Aquatic Vegetation Loss	Tidal Saltwater, Tidal Freshwater
Biological	Invasive species	Tidal Saltwater, Tidal Freshwater
Urban, Human	Habitat loss	Tidal Saltwater, Tidal Freshwater
Urban, Natural	Wetlands loss	Tidal Saltwater, Tidal Freshwater

Headwaters:

This break-out group decided to score most of the variables by group (factor). The two exceptions are Mining and Pollution where finer resolution scoring assessments were provided.

The factors that ranked highest for severity of impact on headwaters and high certainty about quantifying those impacts were:

- Sediment pollution
- Water temperature (climate effect)
- Dams (blockages)
- Overall Agriculture
- Overall Habitat

Sediment pollution affects physical instream habitat that can impact spawning and nursery habitat, as well as alter food web dynamics. Understanding the source-sink dynamics of a watershed in its interaction with the stream is critical to managing sediment in the headwater streams and sediment delivery to downstream habitats.

Space-time distributions of water temperature are important to survival, growth, and reproduction of cold water species which have physiological tolerances limiting species distributions and population success at local to global scales. With severe declines in brook trout (*Salvelinus fontinalis*) distribution over the last century associated with warming climates throughout the mid-Atlantic region, understanding present and predicting future temperature refugia for sustaining, or managing for expanding cold water habitats, has high value and relatively high uncertainty on patterns and trends in water temperature at critical management scales.

Habitat access and population isolation due to dams and culverts that create fragmented habitats and affect movement of both individuals and populations are long recognized challenges affecting the plumbing of the watershed. Habitat connectivity is key to allowing seasonal to interannual movements of species in support of a dynamic equilibrium that sustains persistent range and densities of cold water species such as brook trout.

Agriculture presents significant impacts from mixed effects due to physical and chemical impacts in streams and from agricultural management of adjacent habitats or watershed effects at larger scales of land cover/land use. Severity of impact of agriculture activities on cold water habitats is considered high certainty based on quantifying impacts with a broad range of BMPs, suggesting there is good mitigation potential.

Overall habitat recognizes structure, function, and interconnectedness of habitats that support the habitat integrity, and promote ecosystem health, resilience, and sustainability. Many BMPs are familiar to managers regarding instream and watershed management options (e.g., riffle:pool:run ratio targets, shoreline plantings, reforestation, sediment removals to reconnect floodplains, wetland restoration, etc.). Management potential is a high value target for cold water habitats.

Two other factors are recognized for their high severity and certainty of effects are:

- Overall human impact
- Overall urban impact

In each case, the group recognized their overall importance as having a diverse suite of potential impacts, however, the consensus suggested that mitigation potential was presently low. Among the 7 factors identified with high severity risk, the recognition for high certainty about impacts and moderate mitigation potential suggest these factors

rate as a priority for targeting research and understanding focused on mitigation associated with headwaters habitat and health management.

Factors considered of moderate scale for severity risk to cold water habitats included diverse chemistry impacts, land use effects, water availability and biologically mediated concerns. The diverse factors of pH/acidity, ionic chemistry, metallic mining, overall water use and overall biology were considered to have lower mitigation potential at this time than toxics and dissolved oxygen. Road salt, nutrients, pesticide (and related) compounds, polycyclic aromatic hydrocarbons (PAHs) and unconventional oil and gas (UOG) activity all ranked as moderate certainty in our understanding of impacts and interactions but having only moderate mitigation potential at this time. Overall climate was recognized for moderate certainty in our understanding about risks and impacts to cold water habitats but due to the scale of climate issues, relatively low mitigation potential exists at the regional management scales. This suite of factors and variables represents important targets for improving our understanding of their effects on fish habitat and opportunities to elevate our ability to manage and mitigate their impacts. The top two ranked factors here, toxics and dissolved oxygen, ranked for high certainty of impact understanding and represent factors with high mitigation potential. Their rankings suggest they are perhaps the lowest in importance for research and management activities relative to the needs in understanding effects and mitigation opportunities of other factors and variables influencing fish habitat at this time.

The final set of factors considered by the group as low severity included metals, oxygen demand, wind and solar, endocrine disrupting chemicals (EDCs) and non-metallic mining. Mitigation potential and certainty in our understanding were highly varied. While severity ranked low, certainty of impacts also ranked low especially for EDCs and non-metallic mining. Therefore, their priority could be considered important to target for additional research and improving management understanding for mitigating their effects.

Overall nutrients and Overall Water Quality were considered redundant with other rankings. The break-out group consolidated results and did not conduct separate rankings for these two factors. Overall Natural was not considered as a factor and was not ranked.

Large Nontidal Rivers:

This break-out group reviewed and scored a total of 108 stressor variables by each factor. The overall distribution for severity was 24% high, 52% medium, and 28% low. Twenty-six stressors were ranked high for severity and fifteen stressor variables were also ranked high for certainty. A summary for the factors with the largest number of severe ratings are as follows:

- Urban
- Human
- Pollution
- Agriculture
- Human

Urban: The largest numbers of severe stressor variables were identified in the Urban factor. These were stormwater runoff, sediment, impervious surfaces, toxics, flow alteration, and loss of riparian vegetation. All of these were ranked as having low to medium mitigation potential. Certainty was high for stormwater runoff, sediment, and impervious surfaces as their effects on aquatic systems have been well studied. Further work on the remaining three stressor variables would help identify specific aspects of their impacts and were rated as having medium certainty.

Human: This factor contained the second largest number of severe stressor variables and included stormwater runoff, fragmentation/deforestation, impervious surfaces, population density and housing density. Two of these were also ranked with the Urban factor. All had high certainty given the well-known impacts on fish and aquatic habitats. Population and housing density were considered to have no mitigation potential as there was little expectation of reducing population or tearing down houses. Mitigation potential for the remaining stressor variables was low to medium.

Pollution: Four stressor variables under this factor were ranked as severe. These were sedimentation/siltation, toxics (urban), heavy metals, and toxics (agricultural). The group thought it important to treat urban and agricultural toxics separately as they represent different classes of toxic chemicals and will likely have different mitigation approaches. They were also distinguished with different certainty scores: medium for urban and low for agriculture. All stressor variables were rated as having medium mitigation potential.

Agriculture: Sediments, nutrients and pesticides were listed as severe under this factor. Certainty was high and mitigation potential medium for sediments and nutrients. Pesticides were ranked with medium certainty and low mitigation potential.

Seven additional stressor variables under various factors were identified as severe: forest loss, river flow variability, eutrophication, species shifts, drought, flow alteration, and bank erosion. All were ranked as having low to medium mitigation potential.

Only two stressor variables were ranked as having high severity and low certainty: species shifts and toxics (agricultural). Nine additional stressor variables with medium severity were identified as having low certainty: hormones/pharmaceuticals, shifts in groundwater levels, invasive species, disease/pathogens, acid rain, pH shifts, endocrine disrupting compounds (EDC), trash, and groundwater withdrawals.

Across all factors, the number of high (30%) and low (29%) ranked stressor variables for certainty were nearly equal with most ranked as medium (41%). Only two percent of the stressor variables were rated with high mitigation potential; the majority (56%) were rated as having low mitigation potential.

Tidal Freshwater:

The group identified and ranked a total of 92 stressors for the 13 factors listed. Thirty-eight stressors were ranked high for severity. Of these, 31 were also ranked high for certainty, indicating the group was confident that these stressors would impair tidal fresh fish habitat. The most important factors that had the highest ranked stressors for severity and certainty were:

- Agriculture
- Biological
- Climate
- Habitat
- Human and Urban
- Natural
- Nutrients
- Pollution
- Water Quality
- Water Use

A summary of these stressors is included below under each factor heading.

Agriculture: Four stressors under the Agriculture factor were rated high for severity and certainty. These included erosion, nutrients, toxicants, and water use. The group concluded that established peer-reviewed literature for these stressors supported a better understanding of how they impaired water quality and fish health. The group also noted that of the four stressors, the stress owed to erosion required additional research to examine specific impacts to tidal fresh habitat.

With the exception of water use, mitigation potential was rated as moderate for these stressors because the influence of the stressor may persist in the environment years after mitigation. Mitigation potential of the water use stressor was ranked high because it can be directly and readily eliminated by restricting use.

Only one stressor that ranked high in severity was not ranked high in certainty. An agricultural practices stressor was defined by the group as environmental stress caused by tilling practices related to row cropping, nutrient loading from animal feed lots and fertilizer use, and polluting from land treatments of sludge. As the group was familiar with multiple studies related to impacts from various agricultural practices on water quality and fish habitat, they rated severity of agriculture as high. Certainty was ranked as moderate because there was general agreement among group members that more research was needed to better understand how independent agricultural practices (e.g., animal feed lots versus fertilizer use) limit fish habitat.

Biological: Under the Biological factor, fishing activities and invasive species were considered impacts with a high severity and certainty. These stressors can alter community composition and food webs. The group agreed that peer-reviewed, published research supports their conclusions, but that conclusions for some specific biological stressors are more robust than others. Mitigation potential to address these stressors varied. It was very low for invasive species because once an invasive species becomes established in the ecosystem, it can be difficult to eradicate. However, the population size of an invasive species can be managed through hunting, fishing, and agency-led harvest pressure. Mitigation potential to manage stress owed to fishing activity was high because such stress can be directly managed with regulations and laws.

Three biological stressors were ranked as having a highly severe impact, but with moderate certainty because of the need for more conclusive research. The stressors are declines in production and changing species dominance of benthic and forage fish communities as well as species that act as habitat engineers. The cause(s) of these stressors were not well described by the group. The group identified a number of possible consequences of these stressors including poor body condition of predators, a mismatch in predator-prey interactions and reduction in important habitat. Participants agreed that more data and research were needed to increase understanding and certainty of these consequences. Mitigation potential for preventing simplification of benthic and forage fish communities and loss of species' engineered habitat were rated as moderate based on the group's limited understanding of the cause(s) of the stress.

Climate: Only one stressor, water temperature, was ranked high for severity and certainty under the Climate factor. This determination was based on participants' knowledge of studies that have shown fluctuations in spring water temperature increase mortality of larval fishes. This mortality can result in poor recruitment. Since research demonstrates an increasing trend in surface water temperatures, and because of a decline in production related to temperature increases, participants rated water temperature stress high for certainty. Mitigation potential for stress owed to water temperature was low because the causes are diffuse and global, and in some cases the stressors are irreversible.

The group also identified hypervariable stream conditions as a highly severe stress that the group was moderately certain affected fish habitat. This stressor is described by episodic stream flooding events, intense and frequent drought, and periodic high stream flow. Due to the need for more research on the consequences of this stressor in tidal freshwater fish habitat, participants assigned a moderate certainty to this stressor.

Habitat: There were six stressors of the Habitat factor that ranked high in severity and certainty. These stressors included changes in: bottom substrate, channelization/dredging, invasive species, submerged aquatic vegetation (SAV), water temperature, and woody structure.

Changes in bottom substrate were ranked high in severity and certainty based on observations and anecdotal reports of loss in spawning habitat quality. Participants specifically discussed how sedimentation has covered gravel bottoms and filled shallow spawning areas, both of which reduce spawning habitat area and quality. The group noted a need for more research on how sedimentation affects the extent of change in bottom substrate. Other causes of changing bottom substrate include algal growth, SAV growth, streambed scouring, and boating or fishing activities.

Channelization and dredging are known to immediately and drastically change habitat by deepening channels and damaging benthic communities and riparian habitat. These known and documented impacts prompted the high severity and certainty ranking.

Invasive species can alter community composition, as well as directly alter fish habitat quality and function. Participants cited the effect of *Phragmites* in elevating marshes and dense canopy forming SAV species that promote localized hypoxia. These examples prompted the group to assign a high certainty and severity to this stress.

Loss of SAV was cited as a severe and a highly certain stressor on fish habitat quality because like dredging, it represents a structural shift in habitat that can impact distribution and survival of fish species that are dependent on SAV for refugia from predators, reproduction, and forage.

Changes in water temperature were included for the Habitat factor for similar reasons as when included for the Climate factor. The rating was repeated based on the evidence previously discussed.

Loss of woody structure was considered severe and a highly certain stressor of habitat quality. Shoreline and waterway management has often promoted removal of woody debris after large storm events. Though large flows of woody debris can cause navigational hazards and impact shoreline recreation, studies have shown it plays an important ecological role from headwaters to the oceans. Removal of woody debris from streams or impairing its source via destruction of riparian forests has reduced supply and altered habitat quality by limiting refugia from predators for young fish and crabs in tidal freshwater habitats. Based on the extensive work that has been conducted to study impacts of woody debris removal, the group rated this stressor as highly severe and certain.

Mitigation potential for habitat stressors was considered low for invasive species and water temperature as previously mentioned in the biological and climate sections respectively. Mitigation potential was ranked moderate for the remaining stressors generally because there would be a lag in natural recovery even after the stressor was alleviated.

Human and Urban: Although other workgroup participants ranked Urban and Human factors independently, the tidal freshwater habitat group suggested they be combined under one single factor because they were closely related. There were fourteen stressors evaluated under these two factors with twelve of these receiving a high severity and high certainty ranking.

The Human and Urban Factor had three stressors related to the human population, including population density, change (increases) in population size over time and change in the spatial distribution of population density. The group agreed that all population stressors were severe and highly certain based on growth projections in the region over the next two decades. Land use change was a fourth stressor closely related to increased population size as more people need housing and associated infrastructure. Increased urban development will lead to increased intensity of stress, including more impervious surfaces, greater number of road crossings, riparian habitat loss, wetland loss, shoreline change, and stream channelization. All of these stressors are known to reduce aquatic habitat function and quality. Though studies of the impacts of development on tidal fresh habitats are fairly limited, the group agreed that the present understanding of impacts in nontidal freshwater habitat can be confidently translated to tidal freshwater habitats because tidal freshwater habitats occur downstream.

In addition to land use change, increased fishing and boating activity were considered stressors under the Human Factor. The group voiced concern about increased harvest pressure and habitat impacts from boating activities including erosion from wakes and propeller scarring in SAV beds and other shallow habitats. The group felt these stressors would surely increase the detriment of fish habitat as the human population expands, leading to development of roads and homes, and rated these stressors as high for severity and certainty.

Mitigation potential of population stressors impervious surfaces, road crossings, and wetland losses were ranked low because regulation of these stressors is not the purview of natural resources managers. While the group ranked mitigation potential low for tidal fresh marsh habitat, there have been successful restoration projects in areas where drainage was a limiting factor. Mitigation potential of land use change was rated as moderate because there has been some limited success in working with local planning agencies to consider conservation measures that can reduce impacts of land use change and promote conservation of key habitats. Likewise, mitigation potential to address stressors related to riparian habitat loss, shoreline change, and stream channelization were considered moderate because of the limited success in addressing some losses either through abatement of stress or recovering some ecological functions through restoring habitats to more naturalized conditions. Mitigation potential for fishing and boating stress was ranked high because there are management and regulatory avenues through which resource managers can directly limit these stresses.

Natural: Stressors under the Natural Factor were not ranked. Participants noted that natural variation is intrinsic to ecosystems and therefore should not be ranked, but should be accounted for in any model development. While participants discussed the role of natural variation in SAV when characterizing fish habitat, that stressor is also ranked under the Habitat factor (see above).

Nutrient: The group identified three stressors to consider under nutrients: eutrophication, excessive nitrogen, and excessive phosphorus. As there is a wealth of documentation of impacts of excessive nitrogen and phosphorus enrichment that leads to eutrophication of tidal freshwater, participants ranked these three stressors as high for both severity and certainty. Yet, there was also discussion about the need for more studies to understand how fish species respond to different thresholds of enrichment. To accomplish this, participants agreed that research should be conducted at a finer scale to understand how eutrophication is specifically impairing tidal fresh habitat and attendant species. One participant suggested that the same discussion could be directed to other stressors if they were monitored as intensively as nutrients.

Pollution: The group identified suspended sediments as the only stressor that could be ranked high for certainty and severity under the Pollution factor. This ranking was designated based on discussion of data documenting sediment

loads throughout the Bay watershed and the impact on fish habitat (see discussion on changes in bottom substrate under the Habitat factor for specific examples).

The potential to mitigate sediment loading was deemed low because many of the sources of sediment are from legacy practices. Therefore, the sediment will persist in the environment beyond management practices that reduce sediment loads, even if implemented today.

The group also generated a list of 14 other stressors to consider under the Pollution Factor. They included: toxicants, endocrine disruptors, debris pollution, nutrients, harmful algal blooms (HAB's), thermal, road salt, pesticides, oil and gas, atmospheric deposition, coal ash, septic leaks, waste water overflows, and marina discharges. These stressors were not ranked high for severity and/or certainty.

Water Quality: The group identified one stressor as high for severity and certainty in the Water Quality factor. While other water quality stressors affect other habitat types, the only stressor that the group could definitely relate to tidal fresh habitat was water temperature. This stressor was rated high for severity and certainty for reasons previously presented (see above).

Mitigation potential for water temperature was rated as low, because sources of stress extend beyond the purview of fish habitat managers. Other habitat groups that considered mitigation potential in the context of a broader range of decision makers ranked the mitigation potential higher.

Five additional water quality stressors that are influenced, and therefore potentially mitigated by humans, were identified by the group, but not as highly severe and/or highly certain to affect fish habitat. These included: pH, dissolved oxygen, salinity, chlorophyll, and water quantity/flow.

Water Use: Two closely related stressors were ranked as high for certainty and severity under the Water Use factor. These were surface water withdrawal and water withdrawal. These stressors were addressed collectively as water use under the Agriculture factor (see above).

Tidal Saltwater:

Thirty-three stressors were ranked high for severity of impact on tidal salt habitats and high certainty under the following factors. Some stressors in the tidal salt habitat stressors list are listed more than once, primarily due to the fact that a stressor may be linked to multiple factors, each resulting in expression of the stressor.

- Nutrient
- Pollution
- Human
- Urban
- Agriculture
- Natural
- Water Quality
- Biological
- Climate

The stressors that ranked highest for severity of impact are summarized below, and discussed based on the group's expert opinion of how certain they were about the information on impact and mitigation potential:

- Nitrogen was the only stressor that was scored as a 6 (i.e., 'high') for all three criteria.

- Accounting for redundancy, a group of 24 stressors scored as high severity of impact (6), medium mitigation potential (4), and high certainty of information (6). This group of stressors included nutrients (as a group), land use development, shoreline armoring, impervious surfaces and storm-water discharges.
- A suite of stressors resulting from climate change, including increased water temperatures, sea level rise, trophic effects and movement of invasive species, were scored as having high severity of impact (6), but scored low (2) in mitigation potential.

The primary factors contributing to the highest scored stressors were linked to human uses of the coastal zone, such as urban development, agriculture, and resultant water quality from both point and non-point sources.

The final set of factors considered by the group were rated having low severity of impact (2) and high mitigation potential (6) included water withdrawals, changes in water temperatures due to discharges, and aquaculture.

4.2 Mitigation Potential

The scoring in each of the criteria was based on the best professional judgment of the species and habitat experts present at the workshop. However, it should be noted that most workshop participants do not work directly on mitigation or restoration projects.

Table 11 includes the variables that ranked high for mitigation potential of the identified variables in each habitat group. The severity ranking is included in the table because the mitigation discussion in the group often included the severity of the stressor. Generally, groups were characterized by their own priorities, which were often distinct from other groups. Therefore, the discussion of mitigation potential unique to each of the habitat types is included in the Severity Scoring Results in section 4.1 of this report.

Some common factors in the habitat groups that were ranked high for mitigation potential include: Pollution, Mines, Urban, and Human. More specifically, the following variables were scored with a high mitigation potential by multiple habitat groups: mining, fishing activities, toxics, thermal discharge, and wastewater treatment discharge. Additional research or review are needed for some variables to increase the understanding and degree of habitat improvement for mitigation practices.

Table 11. Variables Ranked High for Mitigation Potential by Habitat Type

Headwaters			
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Factor***
Toxics	4	6	Pollution
Dissolved oxygen	4	6	Pollution
Oxygen demand	2	6	Pollution
Non-metallic mining (gravel, sand)	2	6	Mines

Large Nontidal Rivers			
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Factor***
Wastewater treatment plants discharge	4	6	Urban
Acid Mine Drainage	2	6	Mines

Tidal Freshwater			
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Factor***
Water withdrawal	6	6	Water Use
Surface water withdrawal	6	6	Water Use
Fishing / boating activities	6	6	Human
Water use	6	6	Agriculture
Fishing activities	6	6	Biological
Dredging	4	6	Mines
Artificial structures	4	6	Habitat

Coal ash	4	6	Pollution
Culverts	4	6	Dams
Debris pollution	4	6	Pollution
Wastewater overflows	4	6	Pollution
Wastewater treatment	4	6	Water Use
Golf courses (number, size)	4	6	Urban
Sewage facilities	4	6	Urban
Thermal	2	6	Pollution
Dams	2	6	Dams
Gravel/sand mining	2	6	Mines
Septic leaks	2	6	Pollution
Marina discharges	2	6	Pollution

Tidal Saltwater			
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Factor***
Nitrogen	6	6	Nutrient
Toxics	4	6	Pollution
Fishing activities	4	6	Human
Deforestation	4	6	Agriculture
Toxics	4	6	Agriculture
Water withdrawal	2	6	Water Use
Discharge temp change	2	6	Water Use
flow effects	2	6	Water Use
Aquaculture	2	6	Human

4.3 Bowl Questions

Throughout the two-day workshop participants were periodically asked to answer a question and place their anonymous responses in a bowl at the center of the table. The responses to this informal survey are provided in Appendix 8.6. The questions and their purpose are listed below:

1. Would you use a regional fish habitat assessment for fisheries management (Yes/No)? How would you use it? Most, if not all, of the workshop participants were not included in the Regional Fish Habitat Assessment User Needs questionnaire responses. This question as used to determine the utility of the assessment from a different type of potential assessment user.
2. Have you had success marketing a spatial tool? There are many spatial tools available, but many of them are not well known. If any of the participants have had success in marketing a tool, these lessons would be useful for marketing a potential regional assessment tool. This question is further discussed in Section 6.0 of this report.
3. Identify one word that describes fish habitat. The responses to this question were used to generate the word cloud (fish) on the cover of this report. The size of each word indicates its frequency.
4. Identify one factor that should be in a fish habitat assessment. The responses to this question were used to generate the word cloud (fish) on the cover of this report. The size of each word indicates its frequency.

5.0 Certainty/ Data Gaps/ Research Needs

Certainty

The habitat break-out groups evaluated the certainty of scientific understanding of the identified stressor variable and its habitat impacts. These scores per habitat type are listed in Appendix 8.4. A low certainty score (2) indicates an area where more research is needed. The workshop participants recommend that priority areas for research are variables with minimum certainty and maximum severity scores.

Data and Research Gap Questions

Each habitat group was asked to answer four questions related to data and research gaps. The habitat groups brainstormed on the types of data that would be useful in a Chesapeake Bay watershed fish habitat assessment, but were missing in the data inventory compiled by USGS and NOAA. The remaining questions focused on areas of additional study that are needed, and the implications on not having this information in the regional assessment. The responses to these questions, by habitat group, are provided below:

Headwaters:

1. **What variables are we missing or underrepresented with data per habitat type (gaps)?**
    a. Improved groundwater monitoring network (strategically planned) and influence layer. Monitoring stream thermal regimes pre and post restoration projects to connect with flood plains and hyporheic soils (groundwater).
    b. Road salt
    c. Wetland change
    d. Geomorphology
    e. Historical land use
    f. Partner continuous monitoring data
    g. Isolation and fragmented habitat

2. **What additional stressors should we recommend need study/monitoring?**
    a. Cross check where there is low certainty (2) and high severity (6) in the table
    b. Where we need science to inform management and decision making. Pre and post temperature monitoring of restoration and stormwater management projects to identify BMPs to protect coldwater resources, and prevent projects that raise thermal stress.
    c. Multi stressor analyses and experiments to understand interactions and feedback loops
    d. Synthesize existing water temperature data
    e. Climate change impacts and using improved climate change scenarios

3. **What are the implications on the assessment tool of not having the information?**
    a. Likely none of the information gaps are a barrier to moving forward with the tool. But the gaps will make the tool less useful. For instance, large scale implementation of stormwater retrofits and TMDL restoration projects without thermal consideration will jeopardize populations of coldwater resources (i.e., brook trout, coldwater obligate macroinvertebrates)
    b. Need to appropriately qualify results based on this
    c. Scale size considerations (1:100,000 is likely not sufficient and is a missed opportunity, while 1: 24,000 too few data)

4. **Research recommendations?**
    a. Literature search on what is out there/effects of stressors
    b. Evaluate different scales on performance/what they both give you from a management or science perspective.

Large Nontidal Rivers:

1. **What variables are we missing or underrepresented with data per habitat type (gaps)?**
    a. Streambank condition, e.g., miles of stream banks that are eroded / vulnerable to erosion
    b. Reach scale habitat condition / meso-habitat
    c. Fine-scale land use and disturbance mapping (1m)
    d. River segment predicted waste water contributions for additional EDC
    e. Improved land use data (i.e., specific ag practices, % of crops…) including change over time
    f. Predictive Water Budget
        - Comprehensive withdrawal info for groundwater
        - Evapotranspiration
        - Base flow index
        - Select ecological flow metrics
    g. Substrate composition
    h. Distribution and severity of blue-green algal blooms

2. **What additional stressors should we recommend need study/monitoring?**
    a. Efficacy of restoration BMPs (including biological / fish benefits)
    b. Efficacy of mitigation BMPs (including biological / fish benefits)
    c. Connection with upstream catchments (linkage between large rivers and upstream)

3. **What are the implications on the assessment tool of not having the information?**
    a. Inability to assess (reduce confidence) progress towards outcomes or predict outcomes based on individual stressors on fish and habitats

4. **Research recommendations?**
    a. Targeted cause and effect / driver stressor models
    b. Assessment tool to inform management decisions (at decision-relevant scale) and help focus conservation/restoration actions
    c. Business as usual scenarios to evaluate impact from no action / no restoration
    d. Outreach/education of land planners and decision makers about land use impacts / value of fish habitat preservation

Tidal Freshwater:

1. **What variables are we missing or underrepresented with data per habitat type (gaps)?**
    a. Data on marine pollution
    b. Data on road salt- impact conductivity
    c. Data on marine discharges
    d. Fishing and boating activities- use. Impacts of wakes, SAV
    e. Need population change data- projection
    f. Updated shoreline armoring data (particularly in MD)
    g. Do we have the data to model erosion
    h. What scale is the Agriculture data?
    i. Eutrophication- need finer spatial scale. Currently on value for Bay
    j. Need adequate coverage of flow data in tidal fresh
    k. All climate stressors are a data gap: scale, severity, and impact
    l. Don't have woody structure or updated bottom substrate data
    m. Scale of invasive species data
    n. Forage- zooplankton
    o. Data on endocrine disruptors

2. **What additional stressors should we recommend need study/monitoring?**
    a. Those stressors ranked moderate to high severity and low to moderate certainty
    b. Impact on road crossings

3. **What are the implications on the assessment tool of not having the information?**
    a. Implications are related to ranking criteria. For example, more important for stressors of high to moderate severity and low to moderate certainty.
    b. Forage data, shoreline armoring. Consider the severity rank on the stressor that is listed as missing data or research.

4. **Research recommendations?**
    a. Variables with high to moderate severity and low to moderate certainty should be a focus of future research
    b. Determine if data set is useful for determining impact of variable
    c. Scientific understanding of toxicants impacting fish.
    d. Potential carbon change impacts

Tidal Saltwater:

1. **What variables are we missing or underrepresented with data per habitat type (gaps)?**
    a. Benthic substrate – need better resolution for substrate type (better than %mud), especially in nearshore areas where different substrates are located (mud flat v. sand silt v. cobble)
    b. Additional high resolution benthic data needed in certain areas
    c. Ensure we have range maps for all species considered
    d. Need spatial association of specific species with specific habitats (i.e., where is spawning habitat for striped bass)? Need quantification.
    e. Forage availability, especially in shallow water
    f. Shallow water/nearshore characterization
    g. Physical habitat, benthic, and fish linkages

2. **What additional stressors should we recommend need study/monitoring?**
    a. Chemicals of emerging concern
    b. Microplastics (e.g., consumption in oysters; aquaculture)
    c. Acoustic impacts to fisheries (localized)
    d. Boat wake impacts; spatial maps of boating traffic patterns and activities
    e. Overboard disposal of dredge material

3. **What are the implications on the assessment tool of not having the information?**
    a. Depends on the type of tool and the audience (e.g., fishery managers vs. land managers)
    b. Assessment would have limited utility
    c. Need insight into benthic/shallow water environments (and links to specific species) to gain understanding into natural mortality
    d. More general tool ok for BMP effectiveness
    e. To prioritize any habitat for a particular use (forage, spawning, etc.) need more info on where fish are performing those functions
    f. A concerted monitoring effort is needed to make connections between the fish and the habitat
    g. Need info on contaminants to assess impacts to fisheries (i.e., effects on reproduction)

4. **Research recommendations?**
    a. Microplastics, endocrine disruptors, toxic contaminants
    b. Monitoring habitat affinities
    c. Sampling of forage and shallow water habitats
    d. Effects of quality of habitat (e.g., not all seagrass beds are created equal)
    e. Linking structure to function
    f. synergies among environmental factors
    g. Implications for restoration selection
    h. Metabolic metrics for different systems
    i. Respiration; net auto/heterotrophic
    j. Monitoring of BMP effectiveness; status

6.0 Marketing the Assessment Tool

A marketing plan is needed to ensure the Chesapeake Bay Regional Fish Habitat Assessment, if created, is used by its intended audience. This advice was provided by the Chesapeake Bay Program's Local Government Advisory Committee (LGAC), who served as an advisor for the workshop, as well as from several workshop attendees. The marketing plan should address several factors, including:

- Product Description, including information about how this tool differs from or improves upon existing tools such as the National Fish Habitat Assessment
- Intended Audience, including a detailed description of the audience and how each is expected to use the tool
- Anticipated benefits of using the tool, e.g., this tool will help the user prioritize conservation activities
- Access to the tool, including information about where to find the tool, what hardware or software is needed to use the tool, and any cost
- Training available to users and/or list of Technical Assistance providers who can provide one-on-one assistance with using the tool
- Contact for questions about using the tool

Several potential opportunities for marketing emerged throughout the process of planning and conducting the workshop. These include (but are not limited to):

- American Planning Association State Chapters – Many of these Chapters were useful in distributing the User Needs questionnaire to local planners. The APA's State Chapters offer training for planners, an intended user of the tool. Training on the Assessment tool that qualifies for Certification Maintenance credits is recommended.
- State environmental and natural resource agencies – State agencies could promote the tool to grant applicants in order to maximize corollary benefits of water quality improvements and help prioritize targeting conservation practices.
- VIMS Center for Coastal Resources Management – VIMS Center for Coastal Resources Management has a history of providing locality specific training and workshops (see responses to Bowl Questions in Appendix 8.6).
- NGO's – The Nature Conservancy, Trout Unlimited, Riverkeepers, etc.
- Chesapeake Bay Program

Additional resources will be needed to develop a marketing plan should the Regional Fish Habitat Assessment project go forward. If the project proceeds on a pilot basis, a marketing aspect should be built into the pilot project.

7.0 Recommendations

Recommendations from the Fish Habitat Workshop are listed as follows and described below:

- Develop Pilot Assessment,
- Incorporate Adaptability,
- Develop the Assessment at the finest scale possible,
- Prioritize Research Needs,
- Conduct data mining exercise to fill data gaps,
- Establish a Community of Practice, and
- Identify a person as an Assessment Coordinator

Develop Pilot Assessment

Each break-out group identified a suite of stressors from the available data that ranked high for severity and certainty. This led to a unified recommendation to pursue developing a pilot study to conduct an assessment on representative waterways. Such a project will require appointing a lead team to build upon the work that has been done in identifying and categorizing data. The next step will require this team to oversee gathering data sets on key stressors along with biological data and evaluating the scale of applicability. This exercise will also include testing various biological response metrics, where available and sufficiently robust, including assemblage measures and individual species metrics to determine which measures are most sensitive to stressors. Concurrent with this effort, participants recommended engaging target users in the development process to assure the tool would meet their needs and will work in concert with tools they presently use.

Incorporate Adaptability

All groups acknowledged there was limited information and science to directly link stressors with habitat impact to fish and agreed that any assessment developed should be built in such a way to incorporate additional stressors as science evolves to increase understanding of effects. Furthermore, research on studied stressors should continue in order to improve our understanding of how stressors impair habitat function in order to improve mitigation techniques.

Develop the Assessment at the finest scale possible

Participants agreed a fine spatial scale is the most appropriate for a fish habitat assessment for planning, management, restoration, or mitigation of stressors. That said, participants recognized that data resolution will vary among datasets and habitats and recommended considering a hierarchical approach paired with probabilistic modeling to develop the assessment.

Prioritize Research Needs

Break-out group participants also identified numerous research needs, as outlined above. All groups suggested researching stressors that were ranked as low certainty and expected high severity. Priority research areas to fill science gaps include but are not limited to:

Headwaters:

- Improved understanding of sediment sources and sinks in a watershed
- Modeling impacts of climate driven temperature changes
- Understanding mitigation potential of human and urban disturbances

- Evaluating effects of endocrine disrupting chemicals (EDC's) and non-metallic mining

Large Nontidal Rivers:

- Understanding cause and effect by developing driver/stressor models
- Modeling scenarios to assess impacts of not taking management/restoration action
- Evaluative assessment of fish habitat conservation for communication

Tidal Freshwater:

- Assessing data to determine if it is useful in assessing stressors
- Understanding impacts of toxicants, EDC's and emergent contaminants
- Understanding how changes in carbon upstream influence production downstream

Tidal Saltwater:

- Understanding fish habitat affinities
- Understanding stressors to forage assemblages and on forage dynamics
- Rating habitat quality by habitat type (e.g., not all seagrass beds are equal)
- Synergism among factors
- Understanding ecosystem dynamics (respiration, metabolism, etc.)

Conduct data mining exercise to fill data gaps

Groups also identified data gaps, but in some cases these gaps represent research needs. This stems from the fact that datasets were identified, but data were lacking for some habitat types. Therefore experts had to borrow from experiences in other habitat types to infer a stress on the habitat of focus. Additional data needs are numerous and listed under each habitat type. These needs should be reviewed during the data mining process to determine if data exists. Where data gaps do exist, research should be prioritized to determine if stressors are present and acting.

Based on discussions at the workshop, the workshop steering committee recommends these additional efforts:

Community of Practice

Establish a Community of Practice among those utilizing fish habitat assessment tools to facilitate the transfer of knowledge on lessons learned.

Assessment Coordinator

Identify a person to lead the above recommendations and build upon the new and enhanced collaborations from this workshop among Bay watershed management agencies at the local, state and federal level, academic institutions, environmental organizations and stakeholders. A coordinator would be instrumental in making the connections with this Chesapeake Bay habitat assessment effort and the larger Northeast habitat assessment in development by the Mid-Atlantic Fishery Management Council (MAFMC). Without a dedicated person to lead, coordinate, organize, and motivate the number and diversity of involved parties, implementation of workshop recommendations and their expected benefits towards achieving Bay restoration goals pertaining to fish habitat will be limited.

8.0 Appendices

8.1 STAC Workshop Proposal

Workshop Title: Factors Influencing Fish Habitat Function in the Chesapeake Bay Watershed: Application to Restoration and Management Decisions (Responsive)

Submitted by: Sustainable Fisheries Goal Implementation Team (SFGIT), Vital Habitats Goal Implementation Team (HGIT), Fish Habitat Action Team (FHAT), and Stream Health Workgroup (SHWG)
Endorsed by: Peyton Robertson (Chair, SFGIT) and Christine Conn (Co-Chair, HGIT)

Workshop Steering Committee:

Mark Monaco (STAC)	*Gina Hunt (FHAT)*	*Margaret McGinty (FHAT)*	*Tom O'Connell (USGS)*
Donna Bilkovic (STAC)	*Bruce Vogt (SFGIT)*	*Peter Tango (STAR)*	
Rich Starr (SHWG)	*Mary Gattis (LGAC)*	*Kara Skipper (SFGIT)*	

Workshop Description: Fish habitat is defined by the National Fish Habitat Action Plan as "any area on which an aquatic organism depends, directly or indirectly, to carry out the life processes of the organism, including, an area for spawning, incubation, nursery, rearing, growth to maturity, food supply, or migration…" Fish habitat is considered the core of ecosystem based fisheries management and although several efforts have identified important habitats for Chesapeake Bay fish species, there is still a great need to study these habitats under an ecosystem lens by identifying and assessing factors influencing these habitats.

The SFGIT, HGIT, FHAT, and SHWG propose a two-day workshop which will focus on identifying factors influencing (including projected climate change impacts) habitat function throughout the Chesapeake Bay Watershed. The Fish Habitat Management Strategy takes the first step in closing this information gap by identifying five habitat types and corresponding representative species within the Chesapeake Bay and providing a preliminary list of factors influencing these habitats. To build off these efforts, this workshop aims to expand upon existing information to create a comprehensive listing of factors influencing the five identified habitats.

Workshop participants will then develop criteria for analyzing the impact of factors influencing habitat, which will be utilized to evaluate the significance of these factors on habitat function as well as mitigation techniques.

Our current efforts towards achieving the Fish Habitat Outcome require the integration of these factors into management and restoration efforts to ensure a comprehensive and resilient ecosystem approach which will improve the effectiveness of current measures. This assessment will be crucial in improving adaptive management in habitat restoration and conservation efforts and drawing connections between habitat condition and response (i.e. fish kills, decreased reproductive success, and trophic disruption).

Management Need: This workshop is greatly needed as the initiation and continuation of several fish habitat workplan actions depend on this base knowledge to move forward. The workshop will produce several deliverables which will outline factors influencing fish habitat, provide a weighted significance of these factors on fish habitat, and analyze mitigation techniques to ultimately improve fish habitat restoration and conservation efforts. With limited funding capabilities for fish habitat restoration and conservation efforts, it is imperative that funded efforts are implemented in a manner which takes into account the effectiveness and longevity of proposed activities within the context of multiple fish species.

The workshop goals will be both timely and essential to fulfill the Fish Habitat Outcome in the Watershed Agreement to "Continually improve effectiveness of fish habitat conservation and restoration efforts by identifying and characterizing critical spawning, nursery and forage areas within the Bay and tributaries for

important fish and shellfish, and use existing and new tools to integrate information and conduct assessments to inform restoration and conservation efforts." Further, the products of this workshop will support ongoing efforts detailed in the 2016 – 2017 workplans. The proposed workshop outcomes of identifying factors influencing fish habitat, determining which factors are most limiting to fish habitat and community health and developing quantitative rating criteria for these factors will assist the SHWG in determining vital physical habitat functions. This proposal addresses the following actions from the Fish Habitat Workplan

"Continue to improve our understanding of specific habitat stressors, including temporal consideration to promote sound management strategies that can conserve and restore habitat for productive fisheries"

"Work with Chesapeake Bay Program (CBP) partners and Goal Implementation Teams to identify threats and understand how those threats are being addressed"

"Engage and communicate fish habitat needs with CBP partners and local communities"

And actions in the Stream Health Workplan:

"Identify practicable metrics consistent with BMP verification guidance to credit projects for N, P, and sediment load reductions and stream functional improvement for overall improvement in stream health, and incorporate these recommendations into BMP Verification Plans"

"Implement recommendations from the STAC workshop report to establish a joint SHWG and Urban Stream Workgroup to develop guidance to align the stream restoration BMP protocols for nutrient and sediment loads delivered downstream to optimize improvements in stream health and function"

Workshop Synthesis: Workshop discussions and outcomes will be documented in a final workshop report that will be distributed to the CBP and interested parties. The final report will be released within 90 days following the workshop. Products (detailed on page 3) will focus on the use of existing data and strategies and include recommendations to develop metrics where data are lacking. The final report will provide guidance on how identified factors can be addressed, and the significance these factors play in the evaluated habitat types and representative species. The Chesapeake Bay Local Government Advisory Committee (LGAC) coordinator is a member of the steering committee; this will help ensure the workshop products will be useful to local government and decision makers.

Pre-workshop Preparation: The Steering Committee will reach out to appropriate scientists and experts when designing the workshop to ensure necessary expertise is available and all relevant information, research, and data sets are identified, compiled, and sent to the workshop participants in advance of the workshop (preliminary habitat types and representative species are below).

Habitat Types	Representative Species*
Tidal saltwater sub-tidal (ex. oyster reefs, open water)	Bay anchovy, croaker, spot, summer flounder, striped bass
Tidal saltwater nearshore and intertidal (ex. marshes, SAV)	Juvenile Sciaenids, grass shrimp, bay anchovy
Headwaters	Smallmouth bass, trout
Large Nontidal Rivers	Black bass, American shad
Freshwater Tidal (ex. Emergent marshes)	Striped bass, largemouth bass, American shad, yellow perch

**Includes but is not limited to representative species selected from the Fish Habitat Management Strategy, Key Forage species from the 2014 STAC Forage Workshop Report, and species from the TetraTech Fish Habitat Literature Review. List may be modified as expert opinions are consulted.*

Steering committee will utilize existing reports and literature to inform workshop including but not limited to:

- National Fish Habitat Partnership's 2015 Status Report
- Atlantic States Marine Fisheries Commission Habitat Matrix
- TetraTech Fish Habitat Egg and Larval Matrix, Adult Matrix, and Literature Review

- North Atlantic Landscape Conservation Cooperative Aquatic Cores and Connectors
- Forage Workshop Report

Workshop Speakers and Attendees: The Steering Committee will identify and convene experts in tidal saltwater and freshwater habitat to address the workshop objectives and significantly contribute to the workshop products. In addition to Chesapeake Bay region experts, the Committee will invite experts from other regions to offer outside perspectives and knowledge to the workshop.

Questions to address:

- What factors limit and influence tidal and nontidal fish habitat?
- What quantitative rating criteria exist for these factors and how can criteria be applied to fill gaps?
- How can factors influencing be mitigated or restored?
- What is the process to mitigate these factors?
- How can monitoring, conservation, restoration and communications actions be implemented?

Workshop Products:

Fish Habitat Data Inventory - Inventory of relevant literature sources pertaining to fish habitat, identified factors influencing, and fish productivity and response to factors and mitigation techniques.

List of factors influencing fish habitat in tidal and nontidal systems - Steering Committee will build off the listing of factors influencing fish habitat in the Management Strategy, adjusting and adding additional considerations as necessary. This can be used to evaluate the condition of a habitat in the context of fish health.

Quantitative criteria to analyze significance of factors which limit fish habitat function - Quantitative criteria to evaluate the significance and interactions of factors influencing fish habitat.

List of mitigation techniques for each factor that optimize, restore or conserve fish habitat - This list will be essential to determine which factors pose the greatest risk to fish habitat and can inform how the Chesapeake Bay Watershed can more effectively target restoration and management techniques.

Communications products to deliver results to local government and broader Chesapeake Bay Watershed - This component will be useful in communicating information and actions that can mitigate factors influencing fish habitat to managers and local decision makers. Communications products will highlight the criteria developed by the workshop to better match action to opportunity.

Rationale: This workshop will bring together experts from across disciplines to assemble basic fish habitat information needed to progress actions in multiple workplans and to advance the outcomes of multiple goal teams. The information is the foundation required for fish habitat assessment and adaptive management.

Timeline: Steering Committee will begin bi-monthly meetings in June 2017 to plan the workshop, gather existing information and data, and identify experts. In November, participants and key partners will be invited to the workshop. The workshop will be conducted and the steering committee will have a follow up meeting in February 2018. The report will be submitted to STAC in May 2018.

Budget Justification and Logistics: The workshop will be held over two days between winter 2018 and spring 2018. Workshop participation will be by invitation only and target 30 participants. Estimated costs for venue, catering and travel are included below:

Venue - $4000	Catering - $3000	Travel for participants - $3000	**Total - $10,000**

Chesapeake Bay Program

January 31, 2017

Dear STAC Leadership,

On behalf of the Chesapeake Bay Pro gram's Habitat Goal Implementation Team (Habitat GIT), I am writing to express my strong support for the proposed workshop "Factors Influencing Fish Habitat Function in the Chesapeake Bay Watershed: Application to Restoration and Management Decisions." This workshop proposal is the joint effort of both the Habitat GIT and the Sustainable Fisheries Goal Implementation Team and is organized in such a way as to answer a number of specific management questions relevant to our shared Fish Habitat Outcome that have long needed to be addressed . The proposal requests a gathering of experts in fish habitat assessment for both tidal and non-tidal systems to identify these factors that prevent full productivity and diversity from being realized. Workshop attendees will evaluate mitigation measures to assess the relative impact to fish habitat and production. The workshop will result in criteria to assess the status of fish habitat related to these factors.

The proposed workshop outcomes and products would benefit progress toward our Stream Health and Fish Habitat Outcomes by allowing us to form a foundation from which we can develop a baseline of watershed wide fish habitat. The workshop is vital to making progress on our Fish Habitat Work Plan, several action items of which are dependent on the outcomes and products that will result from this proposed workshop. In particular, the workshop will consider our "understanding of specific habitat stressors" need by producing a list of factors influencing fish habitat in tidal and non-tidal systems and developing quantitative criteria to evaluate their impact on fish habitat. The workshop will also allow for progress to be made on our Stream Health Work plan, by determining the "best way to address impairments that are not associated with a pollutant TMDL".

The proposed workshop product s will provide fishery and habitat managers with tools with which to identify and ultimately address, factors influencing achievement of the Fish Habitat Outcome. I thank you for your consideration of our proposal.

Sincerely,

Christine Conn

Christine Conn
Maryland Department of Natural Resources
Co-Chair, Habitat Goal Implementation Team

Chesapeake Bay Program
Science.
Restoration.
Partnership.

410 Severn Avenue Suite 112 | Annapolis, MD 21403 | 410-267-5700

January 31, 2017

Dear STAC Leadership:

As Chair of the Sustainable Fisheries GIT, I am writing to endorse the proposed workshop titled "Factors Influencing Fish Habitat Function in the Chesapeake Bay Watershed: Applications to Restoration and Management Decisions". The proposed workshop was developed in coordination with the Sustainable Fisheries GIT, Habitat GIT, Stream Health Workgroup, and Fish Habitat Action Team and focuses on filling a prominent gap in fish habitat understanding in the Chesapeake Bay.

The Fish Habitat Outcome has a broad and expansive geographic scope, from the high salinity mouth of the Chesapeake Bay to the small cold freshwater streams in the headwaters of the watershed. The proposed workshop aims to identify factors influencing the condition of tidal and non-tidal fish habitats and develop criteria for assessing the significance of these factors on fish habitat. Workshop experts will assess these identified factors as well as mitigation methods and techniques to improve decision-making and application of fish habitat restoration and management throughout the Bay. The knowledge acquired from the proposed workshop can serve as a catalyst to develop more effective approaches for restoration and management of fish habitat that will provide the greatest benefit to the Bay's living resources.

Products resulting from this proposed workshop will fulfill information gaps identified in the Fish Habitat Management Strategy and will benefit actions under the Stream Health Workplan and Fish Habitat Workplan. The cross goal team benefits extend to local government involvement as well, as the proposal highlights a communication and coordination component with the Local Government Advisory Committee for applications in on-the-ground fish habitat efforts.

I fully support this proposal for a STAC workshop to advance the Fish Habitat Outcome and improve our understanding and decision-making process in restoring and managing fish habitat in the Chesapeake Bay.

Sincerely,

Peyton Richardson, Chair Sustainable Fisheries Goal Implementation Team

8.2 Workshop Agenda

Factors Influencing Fish Habitat Function in the Chesapeake Bay Watershed: Application to Restoration and Management Decisions

A Scientific and Technical Advisory Committee (STAC) Workshop

Dates: April 25-26, 2018
Location: Maymont Estate, 1700 Hampton Street, Richmond VA 23220
Garden Hall

Agenda, Materials, and Presentations (as available) are accessible on the workshop webpage

Objective: To identify the necessary information and analytical approaches to assess the condition and vulnerability of fish habitat in the Chesapeake Bay Watershed.

Workshop Goals and Products:
Over the course of two days, attendees will seek to:

- Identify the necessary information and relevant approaches needed in the development of a Chesapeake Watershed Regional Fish Habitat Assessment that supports planning and management decisions,
- Identify of the most significant variables (stressors and conditions) influencing habitat condition and vulnerability,
- Create criteria for analyzing the impact of factors influencing the identified habitats
- Rank the identified factors/variables and how they affect habitat function, and
- Develop a workshop report that will include the results of the above analysis, information gaps, recommendations, and next steps.

To prepare for the workshop, please review the following materials:

- Fish Habitat Workshop - Assessment Framework
- Final Report - Fish Habitat Assessment Questionnaire
- National Fish Habitat Inland and Estuary Assessment Methodology
- Definition of Terms
- Draft Variable/Stressor Identification and Ranking Criteria
- CBP Fish Habitat Outcome Management Strategy

Day 1 - April 25, 2018

9:00-9:30	Registration *Coffee and light breakfast will be provided for attendees*
9:30-10:00	Welcome and Workshop Overview – Gina Hunt (MD DNR), Sean Corson (NOAA) and David Whitehurst (VA DGIF)
10:00-11:00	Background Assessment, Reports, and Goals – Bruce Vogt (NOAA), Gina Hunt (MD DNR)
11:00-11:10	BREAK
11:10-12:10	Habitat Assessment Data and Scale (Part 1) – Kelly Maloney (USGS, Leetown Science Center), Suzanne Skelley (NOAA)
12:10-1:10	LUNCH (*Provided*)
1:10-1:50	Habitat Assessment Data and Scale (Part 2) – John Young (USGS, Leetown Science Center); Facilitated Discussion
1:50-2:30	Data Table Presentation – Lacey Williamson (USGS) Criteria Discussion for Variable/Stressor Activity – Gina Hunt (MD DNR)
2:30-2:40	BREAK
2:40-4:15	Selection of Variables/Stressors – Breakout Groups
4:15-4:30	Wrap up and Adjourn

Day 2 - April 26, 2018

9:00-9:30	Registration *Coffee and light breakfast will be provided for attendees*
9:30-10:00	Welcome, and Day 1 Framework Overview, and Breakout Group Report Out
10:00-12:00	Ranking Variables/Stressors Activity – Breakout Groups
12:00-1:00	LUNCH (*Provided*)
1:00-2:00	Additional Variables/Stressors and Gaps – Breakout Groups
2:00-2:45	Next Steps and Recommendations – Bruce Vogt (NOAA)
2:45-3:00	Wrap up and Expectations – Rachel Dixon (CRC, STAC Coordinator)
3:00-4:00	Steering Committee Strategy Meeting

8.3 Definition of Terms

Fish Habitat Workshop Definition of Terms: What do you mean by that?

Aggregation- The data summary unit (county, catchment, reach, etc.)

Extent- The area covered by the data.

- Global = Covering at least North America
- Nationwide = Covering at least the contiguous United States
- US Coastal = Covering at least the coastal United States
- Watershed = Covering at least the entire Chesapeake Bay Watershed (inland)
- Baywide = Covering at least the entire Chesapeake Bay coastal area and estuary
- BT range = Covering the eastern range of Brook Trout, but not the entire Chesapeake Bay Watershed
- State = Covering the state(s) listed

Factor- A broad category of variables that include stressors influencing fish habitat and conditions that are a measure of habitat quality.

Fish Habitat- Any area on which an aquatic organism depends, directly or indirectly, to carry out the life processes of the organism, including an area used by the organism for spawning, incubation, nursery, rearing, growth to maturity, food supply, or migration, including an area adjacent to the aquatic environment if the adjacent area: (1) Contributes an element, such as the input of detrital material or the promotion of a planktonic or insect population providing food, that makes fish life possible; (2) Affects the quality and quantity of water sources; (3) Provides public access for the use of fishery resources; or (4) Serves as a buffer protecting the aquatic environment. [definition is adopted from the National Fish Habitat Partnership (NFHP) Action Plan 2nd edition]

Habitat Condition- State of the habitat in a specific area for a specified time that could produce fish occupancy, which may include survival and reproduction.

Habitat Function- The biological, geochemical and physical processes and components that take place or occur within an ecosystem and support fish habitat.

Habitat Types (used at the workshop) -

a. Headwaters - these may include but not exclusive, 3rd order and lower streams and cold and upstream waters)

b. Large Nontidal Rivers - these may include but not exclusive, 4th order and larger streams and warm water streams

c. Tidal Estuarine
    i. Tidal saltwater nearshore and intertidal (e.g., marshes, SAV)
    ii. Saltwater sub-tidal (e.g., oyster reefs, open water)

d. Tidal freshwater (e.g., tidally influenced rivers below head of tides, emergent wetlands)

Habitat Quality - the ability of the environment to provide conditions appropriate for individual and fish population persistence. "Quality should be based on the demographics of the population and not necessarily numbers alone. Quality is an outcome (e.g., survival and productivity) and is not a user-defined inherent property of a location. For example, Hall et al. (1997) suggested low habitat quality represents the resources available for survival, medium habitat quality represents resources available for survival and reproduction, and high-quality habitat includes resources available for population persistence. These are critical distinctions because a geographic location (e.g., study area) could fluctuate from year-to-year in some critical resource (e.g., berry or insect production) yet retain the same basic vegetation composition and structure. Thus, habitat quality could vary from year to year." [derived in part from (Krausman & Morrison, 2016.)]

Habitat Vulnerability - A measure of future threats (some may not exist currently), transitions to future states, and the likelihood/probability of the future conditions occurring.

National Fish Habitat Assessment - Provided through the National Fish Habitat Partnership (NFHP), it is a nationwide assessment of human effects on fish habitat in the rivers and estuaries of the United States. The assessment assigns a risk of current habitat degradation scores for watersheds and estuaries across the nation and within 14 sub-regions. The results also identify some of the major sources of habitat degradation."
http://assessment.fishhabitat.org/#578a9a43e4b0c1aacab89763/578a99f4e4b0c1aacab89699

Scale - The resolution of data. The question of interest in regards to scale is: What are the smallest features that are captured?

Stressor - Changes to environmental drivers that affect habitat quality and the species that occupy those habitats.

Variable - category that includes both stressors to fish habitat and measures of condition

How are these terms related in the data file?

Factor (The data available at the workshop is provided under 15 factors).

- Variable
  - Stressor
  - Condition

Factors	# Variables	# Variables NFHP Inland	# Variables NFHP Estuary	Description/ Examples
Watershed	17	0	1	Layers and information used to delineate watershed boundaries, salinity zones, drainage or catchment areas, stream order
Pollution	38	2	3	Toxic Release Inventory, nitrate deposition, NPDES major sites, pesticide applied
Dams	11	1	1	Number of dams, type, habitat fragmentation due to dams
Mines	53	6	1	pipelines
Water_Use	7	5	1	Water withdrawal information
Human	4	1	1	Population density information
Urban	32	6	4	Road length/crossing density, urban areas, impervious surface cover, landfills
Ag	26	4	1	Percent hay/agriculture, pesticide use, confined animal feeding operation information
Natural	87	5	6	Elevation, slope, habitat, runoff, soil information, geology, stream density, ecoregions
Nutrient	29	4	4	Nitrogen and Phosphorus amounts, 303(d)
Water_Quality	19	0	2	Salinity, water temperature, dissolved oxygen
Climate	20	2	0	Precipitation, temperature, sea level rise, number of wet days
Habitat	13	0	0	Bathymetry, wetlands, tidal marsh vegetation
Biological	50	0	0	Fish abundance, stream IBI, % priority watersheds
Miscellaneous	9	0	0	Shoreline Structure/erosion, dredging
Total = 15	**415**	**31**	**28**	

8.4 Habitat Scoring Tables

Habitat Type: Headwaters
NOTE: This Break-out Group decided to score most of the variables by FACTOR (variable group). The two exceptions are variables for Pollution and Mines, which were scored individually.

Representative Species: Brook Trout, trout (general)

Habitat Function: Spawning, Recruitment, Survival, Growth, Shelter

List aggregate variable/stressors for each factor	*Criteria 1: Severity*	*Criteria 2: Mitigation Potential*	*Criteria 3: Certainty*	*Factor*	*Notes*
Sediment	6	4	6	Pollution	
Water Temp (effects of climate, point sources discharge, reservoir releases)	6	4	6	Pollution	
Overall DAMS	6	4	6	Dams	Includes Number, Density, Position, Size, Retention Time, Release Type, Flow Regime (hydropower, etc.), Culverts, Thermal Pollution
Overall Human	6	2	6	Human	Includes Population Density, Housing Density, Septic System Density, Sanitary Sewer Age and Density, Population Growth Rate, Commercial Employment Density, Socio-economic Components, Land Use, Pharmaceutical Use, WWTP Type, Fishing Pressure

Overall Urban	6	2	6	Urban	Mitigation Score is Given Current Technology; Includes Land Use, Land Use Change, Imperviousness, Stream Canopy Cover, Channelization, Roadways/Road Density, Road Crossings, Geomoprhic Characteristics, Urban Age, Stormwater Management, BMP Implementation, Altered Hydrology, Sedimentation, Green Infrastructure, Coal Tar Sealants (PAHs), Distance to Stream
Overall AG	6	4	6	Ag	Includes Sedimentation, Density of Ag Activities, Animal Agriculture (type, density, manure handling), Manure Management Practices, Nutrient Management, Overland Erosion and Streambank Erosion, Legacy Issues (sedimentation and other constituents), Lack of BMP Activities, Drain Tiling, Altered Hydrology?, Ditching, Lack of Riparian Buffers, Temperature Effects, Nutrients and Enrichment, Agrichemicals (pesticides, EDCs, hormones)
Overall Habitat	6	4	6	Habitat	Both Response and Stressor; Includes Variables with Available Data (Wetland Loss, RBP Data Sets (all states and agencies), USGS NWIS (habitat assessment data), EPA RBS (relative bed stability)), and Variables With No Data Currently Available (Hydraulic Geometry, Sediment Erosion and Delivery Info, Channel Scour and Fill)

Toxics	4	6	6	Pollution	
dissolved oxygen	4	6	6	Pollution	
pH/acidity	4	4	6	Pollution	
Ionic chemistry	4	4	6	Pollution	
metallic mining	4	4	6	Mines and other energy issues	
Overall Water Use	4	4	6	Water Use	Includes Water Withdrawals in All Forms (Domestic, Industrial, Ag), Water Diversions
Overall Biological	4	4	6		ONLY STRESSOR VARIABLES; Includes Invasive Species, Species Competition (rainbow trout, brown trout, stocked brook trout), Disease, Food Availability (food web), Loss of Key Woody Species (hemlock, ash), Food Quality, Predation
Road Salt	4	4	4	Pollution	
Nutrient	4	4	4	Pollution	
pesticides/ herbicides/ fungicides	4	4	4	Pollution	
Poly-aromatic hydrocarbons	4	4	4	Pollution	
Unconventional Oil and Gas	4	4	4	Mines and other	

				energy issues	
Overall Climate	4	2	4	Climate	This is a major stress for the future; Includes Air Temp and Water Temp, Duration and Changing Rainfall, Temperature Extremes and Distributions, Sea-level Rise (eastern shore area), Salinization, Snowfall and Cover, Wildfires, Changing Hydrology (peaks, low flows, statistics)
metals	2	4	6	Pollution	
Oxygen demand	2	6	6	Pollution	
wind and solar	2	4	4	Mines and other energy issues	
Endocrine disrupting compounds	2	2	2	Pollution	
Non-metallic mining (gravel, sand)	2	6	2	Mines and other energy issues	

Habitat Type: Large Nontidal Rivers					
Representative Species: Freshwater Mussels, Black bass, American Shad, American Eel, River Herring					
Habitat Function: Spawning, Recruitment, Survival, Growth, Shelter					
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Criteria 3: Certainty***	***Factor***	***Notes***
sediment/siltation	6	4	6	Pollution	
stormwater runoff	6	4	6	Human	
stormwater runoff	6	4	6	Urban	
Sediment	6	4	6	Urban	
Sediments	6	4	6	Agriculture	
Nutrients	6	4	6	Agriculture	
forest loss	6	4	6	Natural	
eutrophication	6	4	6	Nutrient	
bank erosion	6	4	6	Habitat	
flow alteration	6	2	6	Dams	
fragmentation / deforestation	6	2	6	Human	
impervious surface	6	2	6	Human	
impervious surfaces	6	2	6	Urban	

population density	6	0	6	Human	
housing density	6	0	6	Human	
toxics (urban)	6	4	4	Pollution	
heavy metals	6	4	4	Pollution	
Toxics	6	4	4	Urban	
flow alteration	6	2	4	Water Use	
flow alteration	6	2	4	Urban	
loss of riparian vegetation	6	2	4	Urban	
Pesticides	6	2	4	Agriculture	
river flow variability	6	2	4	Natural	
Drought	6	2	4	Climate	
toxics (ag)	6	4	2	Pollution	
species shifts	6	2	2	Biological	
waste water treatment plants discharge	4	6	6	Urban	
Nutrients	4	4	6	Pollution	
fish passage	4	4	6	Dams	
loss of habitat / fragmentation	4	4	6	Dams	

sediment regime	4	4	6	Dams	
DO alteration	4	4	6	Dams	
contaminant spills	4	4	6	Human	
Nutrients	4	4	6	Urban	
lack of riparian	4	4	6	Agriculture	
algal blooms	4	4	6	Nutrient	
specific conductivity	4	4	4	Pollution	
Unconventional Oil and Gas	4	4	4	Mines	
coal ash / tailing / gob piles	4	4	4	Mines	
combined sewer overflows	4	4	4	Urban	
wetland loss	4	4	4	Urban	
wetland loss	4	4	4	Agriculture	
total dissolved solids	4	4	4	Water Quality	
Turbidity	4	4	4	Water Quality	
Dredging	4	4	4	Habitat	
shoreline development	4	4	4	Habitat	
Pathogens	4	2	4	Pollution	

resource extraction (sand/gravel)	4	2	4	Mines	
water withdrawal	4	2	4	Mines	
loss of allochothonous inputs	4	2	4	Mines	
velocity changes	4	2	4	Water Use	
water withdrawal	4	2	4	Water Use	
road crossings	4	2	4	Urban	
channel alteration / morphology	4	2	4	Urban	
septic system discharge	4	2	4	Urban	
thermal impacts	4	2	4	Urban	
Salinity	4	2	4	Urban	
Toxics	4	2	4	Agriculture	
bank / channel alteration	4	2	4	Agriculture	
increased pathogens	4	2	4	Nutrient	
Temp	4	2	4	Climate	
Flow	4	2	4	Climate	
extreme events (floods, storms)	4	2	4	Climate	
precipitation	4	2	4	Climate	

algal blooms	4	2	4	Climate	
legacy sediments	4	2	4	Habitat	
EDC	4	4	2	Pollution	
Trash	4	4	2	Urban	
groundwater withdrawal	4	2	2	Water Use	
invasive species	4	2	2	Human	
hormones / pharmaceuticals	4	2	2	Agriculture	
groundwater level shifts	4	2	2	Agriculture	
invasive species	4	2	2	Natural	
Ph shifts	4	2	2	Nutrient	
invasive species	4	2	2	Climate	
disease / pathogen	4	2	2	Climate	
acid rain	4	2	2	Climate	
invasive species	4	2	2	Biological	
Acid Mine Drainage	2	6	6	Mines	
thermal shifts	2	4	6	Dams	
hydroelectric turbine	2	4	6	Dams	
Hypoxia	2	4	6	Nutrient	

thermal pollution	2	2	6	Pollution	
toxic metals	2	2	6	Mines	
pH	2	2	6	Mines	
"produce water" impacts	2	4	4	Mines	
over harvesting	2	4	4	Human	
Landfill	2	4	4	Urban	
working waterfronts	2	2	4	Human	
saltwater intrusion	2	2	4	Climate	
Groundwater salt intrusion	2	2	4	Climate	
gene flow isolation	2	4	2	Dams	
chlorophyll	2	4	2	Water Quality	
thermal shifts	2	2	2	Mines	
gold mining	2	2	2	Mines	
thermal shifts	2	2	2	Water Use	
aquaculture	2	2	2	Human	emerging
thermal alteraion	2	2	2	Agriculture	
salinity	2	2	2	Agriculture	
pathogens	2	2	2	Agriculture	

biosolids	2	2	2	Nutrient	
ammonia toxicity	2	2	2	Nutrient	
human population shifts	2	2	2	Climate	
terrestrial species composition	2	2	2	Climate	
UVB radiation	2	2	2	Climate	
nitrogen deposition	2	2	2	Climate	
shifts in ET	2	2	2	Climate	
geology	2	0	2	Natural	

Habitat Type: Tidal Freshwater					
Representative Species: Striped bass, Atlantic Sturgeon, American Shad, American Eel, River Herring, White Perch, Yellow Perch					
Habitat Function: Spawning, Recruitment, Survival, Growth, Shelter					
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Criteria 3: Certainty***	**Factor**	***Notes***
Water withdrawal	6	6	6	Water Use	Ag, industrial, municipality
Surface water withdrawal	6	6	6	Water Use	
Fishing / boating activities	6	6	6	Human	harvest, habitat impacts (boat wakes, SAV scarring/loss)
Water use	6	6	6	Agriculture	
Fishing activities	6	6	6	Biological	
Land use change (shoreline, etc.)	6	4	6	Human	
Riparian habitat loss	6	4	6	Urban	
Shoreline change / armoring	6	4	6	Urban	
Stream channelization / ditching	6	4	6	Urban	
Erosion	6	4	6	Agriculture	Need data / model

Nutrients	6	4	6	Agriculture	
Toxicants	6	4	6	Agriculture	
Submerged Aquatic Vegetation	6	4	6	Natural	
Woody structure	6	4	6	Habitat	
Submerged Aquatic Vegetation	6	4	6	Habitat	
Bottom substrate	6	4	6	Habitat	Data needs to be updated
Channelization / dredging	6	4	6	Habitat	
Nitrogen	6	4	6	Nutrient	
Phosphorous	6	4	6	Nutrient	
Eutrophication	6	4	6	Nutrient	Examine data for finer spatial scale
Population density	6	2	6	Human	
Population change/spatial shift	6	2	6	Human	
Population change/over time	6	2	6	Human	
Impervious surface	6	2	6	Urban	
Wetland loss	6	2	6	Urban	
Road crossings	6	2	6	Urban	

Temperature	6	2	6	Water Quality	
Temperature	6	2	6	Climate	
Invasive species	6	2	6	Habitat	Spp that disrupt habitat, including SAV spp
Water temperature	6	2	6	Habitat	
Invasive species	6	2	6	Biological	Data better for some but not others
Agricultural practices	6	4	4	Agriculture	Crop, animal, land treatment (sludge, fertilizer, etc)
Benthic inverts	6	4	4	Biological	lack of, shifts in spp
Predator-prey interactions	6	4	4	Biological	
Forage (quality, availability, shifts, Zooplankton)	6	4	4	Biological	
Sediment	6	2	4	Pollution	
Episodic events	6	2	4	Climate	
Drought / Eco Flows	6	2	4	Climate	
Dredging	4	6	6	Mines	ACOE / Permitting agencies data
Artificial structures	4	6	6	Habitat	loss or addition

Nutrients	4	4	6	Pollution	may fall under WQ
Harmful algal Blooms	4	4	6	Pollution	
Endocrine Disruptors	4	2	6	Pollution	
Dissolved oxygen	4	2	6	Water Quality	
Coal ash	4	6	4	Pollution	
Culverts	4	6	4	Dams	
Other barriers	4	4	4	Dams	
Wetland loss	4	4	4	Climate	
Tidal freshwater marsh	4	4	4	Habitat	loss of
Spp that are habitat engineers	4	4	4	Biological	Mussels, beavers
Saltwater intrusion	4	2	4	Water Use	
Groundwater withdrawal	4	2	4	Water Use	
Well withdrawal	4	2	4	Water Use	
Salinity	4	2	4	Water Quality	
Precipitation	4	2	4	Climate	too much or too little
Sea level rise	4	2	4	Climate	

Debris pollution	4	6	2	Pollution	tires, micropastics
Waste water overflows	4	6	2	Pollution	
Waste water treatment	4	6	2	Water Use	
Golf courses (number, size)	4	6	2	Urban	
Sewage facilities	4	6	2	Urban	
Toxicants	4	4	2	Pollution	several subgroup toxicants noted
Pesticides	4	4	2	Pollution	
Fragmentation	4	4	2	Dams	
Flows	4	4	2	Dams	
Connectivity	4	4	2	Habitat	
Quantity / Flow	4	2	2	Water Quality	May not have adequate coverage
Chlorophyll	4	2	2	Water Quality	optimal level (too much or too little)
Stratification	4	2	2	Climate	
Phenology change	4	2	2	Climate	
Natural chemical process changes (e.g. carbon)	4	2	2	Habitat	

Thermal	2	6	6	Pollution	
Dams	2	6	6	Dams	
Gravel/sand mining	2	6	6	Mines	
Septic leaks	2	6	2	Pollution	
Marina discharges	2	6	2	Pollution	boats, marinas
Brine discharge	2	4	2	Water Use	
Road salt	2	2	2	Pollution	
Oil and gas	2	2	2	Pollution	Pipelines
Atmospheric deposition	2	2	2	Pollution	
Pipelines	2	2	2	Mines	
pH	2	2	2	Water Quality	
Acidification	2	2	2	Climate	

Habitat Type: Tidal Saltwater					
Representative Species: Bay Anchovy, Atlantic Sturgeon, Blue Crab, Oyster, Spot, Croaker, Summer Flounder, Striped bass, Forage Species					
Habitat Function: Spawning, Recruitment, Survival, Growth, Shelter					
List aggregate variable/stressors for each factor	***Criteria 1: Severity***	***Criteria 2: Mitigation Potential***	***Criteria 3: Certainty***	***Factor***	***Notes***
Nitrogen	6	6	6	Nutrient	
Nutrients	6	4	6	Pollution	
Development	6	4	6	Human	
shoreline armoring	6	4	6	Human	
impervious surface	6	4	6	Human	
habitat loss	6	4	6	Human	structural habitat loss
Agriculture	6	4	6	Human	
impervious surface	6	4	6	Urban	
Septic	6	4	6	Urban	
stormwater discharge	6	4	6	Urban	
Wastewater Treatment Plants	6	4	6	Urban	
habitat loss	6	4	6	Urban	
Development	6	4	6	Urban	

shoreline hardening	6	4	6	Urban	
Nutrients	6	4	6	Agriculture	
Runoff	6	4	6	Agriculture	
Sedimentation	6	4	6	Agriculture	
Land use	6	4	6	Agriculture	
Wetlands loss	6	4	6	Natural	
SAV loss	6	4	6	Natural	
oyster reef loss	6	4	6	Natural	
Phosphorus	6	4	6	Nutrient	
Dissolved Oxygen	6	4	6	Water Quality	
turbidity /light	6	4	6	Water Quality	
chl-a/phytoplankton	6	4	6	Water Quality	
loss of feeding habitat	6	4	6	Biological	
loss of forage	6	4	6	Biological	
Harmful algal blooms	6	4	6	Biological	
climate change	6	2	6	Natural	
water temp	6	2	6	Water Quality	

Water temp	6	2	6	Climate	
Sea level rise	6	2	6	Climate	
trophic effects	6	2	6	Biological	
invasive species	6	2	6	Biological	
Sediments	6	4	4	Pollution	
Habitat fragmentation	6	4	4	Natural	
increased mortality	6	2	4	Biological	
range shift	6	2	4	Biological	
Toxics	4	6	6	Pollution	
Fishing	4	6	6	Human	impacts, overfishing, effort
gear type	4	6	6	Human	
Deforestation	4	6	6	Agriculture	
Toxics	4	6	6	Agriculture	
Dredging	4	4	6	Human	temporally constrained
Boating	4	4	6	Human	
Marinas	4	4	6	Human	
Dredging	4	4	6	Urban	
Riparian forest removal	4	4	6	Natural	

shoreline erosion	4	4	6	Natural	
Endocrine disruptors	4	2	6	Pollution	
road density	4	2	6	Urban	
Disease	4	2	6	Biological	
discharge (ex Conowingo)	4	4	4	Water Use	
Salinity intrusion	4	2	4	Climate	
pH	4	2	2	Water Quality	
Precipitation	4	2	2	Climate	
Storm intensity/frequency	4	2	2	Climate	
road crossings	2	2	6	Urban	
Salinity	2	2	6	Water Quality	
Water withdrawal	2	6	4	Water Use	
Discharge temp change	2	6	4	Water Use	
flow effects	2	6	4	Water Use	
Aquaculture	2	6	4	Human	
Marine debris	2	4	2	Pollution	
pH	2	2	2	Climate	

8.5 List of unique variables identified as high severity and certainty for stressor impact to fish habitat.

*54 variables total, listed alphabetically

Agricultural practices	Oyster reef loss
Benthic inverts	Pesticides
Bottom substrate	Phosphorus
Channelization/ditching/dredging	Population change/spatial shift
Chl-A/phytoplankton	Population density
Climate change	Predator-prey interactions
Development	Range shift
Dissolved Oxygen	River flow variability
Episodic events (ie. droughts, flooding)	Road crossings
Erosion	Runoff
Eutrophication	Sea Level Rise
Fishing / boating activities	Sedimentation
Flow alteration	Septic
Forage (quality, availability, shifts, Zooplankton)	Shoreline change / armoring
Forest loss	Species shifts
Habitat loss	Stormwater runoff
Harmful Algal Blooms	Submerged Aquatic Vegetation
Heavy metals	Surface water withdrawal
Housing density	Temperature
Impervious surface	Toxicants
Increased mortality	Trophic effects
Invasive species	Turbidity /light
Land use	Wastewater treatment plants
Loss of feeding habitat	Water temperature
Loss of riparian vegetation	Water use (including withdrawal)
Nitrogen	Wetland loss
Nutrients	Woody structure

8.6 Bowl Question Responses

Q1. Would you use a regional fish habitat assessment for fisheries management (Yes/No)? How would you use it?	Q2. Have you had success marketing a spatial tool?	Q3. Identify one word that describes fish habitat	Q4. Identify one factor that should be in a fish habitat assessment.
A regional habitat assessment would identify both healthy and degraded systems that would drive restoration and/or conservation efforts. The tool could be used to identify where greater collaboration with land use planners should be initiated. Or whether the collaboration should focus on conservation in currently healthy areas, and perhaps most importantly, why.	VIMS Center for Coastal Resource Management: yes by providing locality specific training and workshops exploring the tool	essential	Agriculture land Use; stressor sedimentation, increased temp
1) to target restoration locations; 2) understand gaps in our science to guide additional research activities, particularly where habitat and populations are disconnected	yes - we developed the NOAA BioMapper tool to view and integrate natural and social science data to support MPA design and locator	vital	land use

Regional habitat assessment would help me decide where to study fish community population dynamics. It could also help me advise state water resource permit agencies to regulate water withdrawals and discharges. It would help me advise local county government on land use management and development.	NOAA's involvement in the CBP fish passage workgroup's development in the Fish Passage Tool (Mary Andrews w/ NOAA)	vital	land cover
could be used to target research areas	The Chesapeake Bay Fish Passage Prioritization tool. Also there is the North East FP Prioritization tool and a South East Tool. These tools do get used by a variety of people working on FP and other projects such as eDNA	critical	land use
as a guide for local government, soil conservation and planning groups to guide limited funds to priority areas	Limited success promoting NFHP Coastal Assessment and TNC salt marks/seagrass productivity tool	essential	land use change
depends on the level of resolution of the data, needs to be very local.	Yes - EBTJV and TU's Brook Trout conservation portfolio	essential	land use change

1) better link conservation/restoration actions with habitat quality/quantity; 2) prioritize locations/types of conservation activities; 3) support settling habitat objectives for fisheries management	somewhat: modeling tools, not necessarily spatial mapping	essential	water quality (including sediment, nutrients, endocrine disruptors, pharmaceuticals, metals, toxics…etc.)
develop habitat conservation goals and objectives that can be used to manage fisheries	USGS has the results of "SPARROW" N, P, S models used to focus water-quality projects by EPA, NRCS and several states	water	shoreline condition (hard, natural, etc.)
prioritize areas for preservation, conservation and restoration; understand effect on fish populations (natural, migratory etc.) - important next step but this tool has to lead to fish connection	no - I've observed development of tools without a clear audience or business case	water	biological; fish abundance is indicative of healthy habitat; biological communities can tell a lot about habitat conditions.
As a fisheries science agency, I would use this assessment to prioritize research to address info gaps and areas of high certainty	We've had broad range of experiences. I'd say 1/3 failed, 1/3 were moderately used and only 1/3 were successful. The key is to explore why some failed, or were only moderately successful.	multidimensional	impervious surface

A regional assessment would be used to help inform (along with other key data) conservation / restoration priorities for CBP. Determine which data can also help inform general watershed health and vulnerability - serve multiple outcomes.	yes - our VA-WV water science center is developing geospatial tools to identify drought predictions, water monitoring sites and waste water exposure risk in streams: www.usgs.gov/centers/va-wv-water/DataandToolsmenu	wet	geomorphology
could serve as a model for doing other regional / finer scale habitat assessments on other parts of the country	We are currently in the process of doing so with a wild trout tool for local, planning, project review. So far, so good.	multi-scalar	sedimentation / substrate
to target overall management actions (conservation)	Various (TMDL tools, biological condition gradient tools); R shiny server apps	all encompassing	change in water temperature due to climate change
help target conservation efforts	Yes - MD DNR freshwater fisheries has developed a Coldwater Resource Mapping Tool, an esri online based tool that shows the presence of trout and coldwater obligate macroinvertebrates including basic survey data at the 12 digit watershed scale.	necessary	dissolved Oxygen

input for ecosystem modeling	No but been involved in data gathering / verifying for the Long Island Sound Blue Plan (a marine spatial planning effort). Identification and dissemination of data/tool involved many stakeholder interviews and public meetings to share product and solicit feedback. Product was "inventory" of natural resources and human uses (with associated data gaps) and was emailed to all process participants for feedback. Generally, lots of skepticism from user groups about its usefulness.	bioenergetics	forage availability
research applications; develop hypotheses; identify science and data gaps needed to inform fish/aquatic habitat conservation and restoration	We have deep sea coral data portal that has very broad user audience (cross-sector, international). There are existing comprehensive list-serves and mechanisms to reach the community so the marketing/roll out wasn't too difficult	varied	water quality

I am a researcher so my primary use would be in selecting sites for future research projects	No - have not attempted	home	wastewater percent and concentrations of hormones in stream segments throughout the streams in the bay
Marine fisheries managers could use a regional tool to assess which habitats need fishing pressure relief or which ones could handle more. We really need a tool to aid in determining how our regulations affect habitat use and the needs of recreational fisherman.	Partly - tool was used initially but not maintained so customer base dropped off	niche	% impervious surface
My organization would use the tool to inform us where to focus for habitat restoration / protection investment.	Moderate success with EcoSheds tool	high water quality	water temperature
for identifying priority habitats for conservation or mitigation	Our agency has had limited marketing efforts in marketing a spatial tool. I have been involved in the development and marketing of spatial tools at the regional level with greater success - but nothing that has been overwhelming.	wet	measure of aquatic connectivity (is there access to spawning habitat and is there connection for all aquatics)

Regional assessment would allow NOAA-HCD to prioritize project review/engagement to ensure our high valued fisheries habitats (SAV, oyster reefs, ANAP fish spawning, cobble etc.) are protected through the regulatory permitting process. Spatial data at finest scale available.	The CBP has several successful tools, primarily CAST. The CBP has also a number of unsuccessful tools.	water	stormwater
vulnerability or risk forecasting from a science framework	our offices worked closely on building and/or promoting several spatial tools such as: 1) TNC habitat tool, 2) envision the Choptank atlas, 3) promoted the Choptank EP 4) oyster data tool 5) eastern shore flow paths analysis	integrity	loss of forest canopy (riparian and watershed wide)
identifying vulnerable areas or species that restoration can improve	Yes - NCCOS has been effective at marketing assessments and effectiveness is correlated to degree of investments and end users. So if end uses define requirements of the assessment, it is easier to deliver an	health	miles of eroded or unstable stream bank

	assessment that meets their needs.		
to track progress towards the 2014 ches bay watershed agreement. To inform work of other CBP GITs.	no	difficult	fish / shellfish distribution and abundance / density
support the development of a habitat health status and tracking change indicator for the Chesapeake bay watershed	no	velocity	I think we need fish community data as a response to know how well the habitat model works. opt for instream data as much as possible not just GIS created predictions

My organization would use a regional habitat assessment produced by this group if it provided a new way to look at Data that is different than existing tools in my project area. We use existing tools to prioritize our conservation efforts and where to put in resources for protection, restoration / reintroduction and reconnection.	yes	functionality	benthic structure
using FHA with other tools (water quality models) to help focus restoration efforts to get some benefits to multiple CBP outcomes	yes	variable	management relevant variables
Identify indicators to: 1) track stream health, 2)advance stream restoration projects to target specific species 3) SHWG looking to develop other metrics to stream health in addition to BIBI identified in workshop April5-6	yes	structure	disease: bacteria, parasites (eg. Challenges we have seen with the intro of MSX and DERMO with oysters)

to improve knowledge about essential fish habitat requirements of federally managed species that use the Chesapeake Watershed. This could also improve state assessments of these species and lead to better understanding of inshore-offshore connectivity and influence of Chesapeake habitats on offshore fisheries populations	yes	interconnected	biological response data
1)indicator of fish habitat outcome; 2) communication tool with public	yes	happy fish	Services: ecosystem services of a fish habitat might improve otherwise degraded habitats. These services could include genetic sources of diversity, marina or businesses use, angler opportunities via fishing piers and boat launches
to inform research questions; to provide guidance to localities and property owners	yes	threatened	

identifying tidal habitat in MD and VA that are important to one or two commercially or recreationally important species and that would benefit from restoration or protection. My office would look across states to _____ this habitat.		complicated	
Use regional habitat assessment to contribute to advancing ecosystem-based science and management. Integrate with social and economic information		niche	
would use it to influence land-use decisions by responsible parties; would use it to focus departments conservation programs to important areas		key	
it would be helpful to have a mapper that includes important species habitat ranges that could be overlayed with Atlantic Coastal Bays Trust Fund sites.		natural	

inventory of existing fish habitat tools, the purpose of each and what data they include		prolific	
use underlying model to assess change			
recommendations on how to minimize negative impacts from BMPs (major ones)			
to advise VMRC unrelation to permitting process to minimize impacts on aquatic resources			
VDGIF Fish Passage Project: I would use a fish habitat assessment tool as an additional source of information in conjunction with our Fish Passage Prioritization tool (updated in 2018). The FP Tool uses ecological metrics and is "customizable" - knowing more detail about the fish habitat that would be made accessible by a fish passage project would be useful in further prioritizing projects.			

Regional assessment would be use to 1) locate where to focus resources and data collection - areas that score low need a better understanding as to why 2) identify where local outreach is needed to the planners and other decision makers			
public outreach, assessing diversity of habitat types, and communicate expectations of fish productivity for different areas			
would like to integrate fish habitat indicator into healthy watershed assessments (i.e. assessments of watershed condition and vulnerability) and trends if possible			

8.7 Additional Tables

Table 1. The assessments, studies, and summaries used for identifying data sources that have been used for monitoring, identifying, or describing fish habitat, the surrounding environment, or variables thought to influence fish.

Study Acronym	Source	Source Link
NFHP	National Fish Habitat Partnership	http://assessment.fishhabitat.org/#578a9a43e4b0c1aacab89763/578a99f4e4b0c1aacab89699
Tetratech	Fish Habitat Tetratech Stressor and Threat Analysis	https://www.chesapeakebay.net/what/publications/species_habitat_matrix
SHEDS	Spatial Hydro-Ecological Decision System	www.ecosheds.org
StreamCat	StreamCat, USEPA	https://www.epa.gov/national-aquatic-resource-surveys/streamcat
EDC	Endocrine Disrupting Chemicals, USGS	https://www.sciencebase.gov/catalog/item/59e537d6e4b05fe04cd1bc90
TU	Trout Unlimited	https://tu.org/ebt-portfolio-rwa
DS	Downstream Strategies	http://northatlanticlcc.org/projects/downstream-strategies-project/chesapeake-bay-watershed-brook-trout-habitat-and-climate-change-vulnerability-assessment/index_html
EBTJV	Eastern Brook Trout Joint Venture	http://easternbrooktrout.org/assessment-data
NAWQA	National Water-Quality Assessment	https://www.sciencebase.gov/catalog/item/5669a79ee4b08895842a1d47
FHMS	Fish Habitat Management Strategy	https://www.chesapeakebay.net/documents/22036/1c_fish_habitat_ms_6-24-15_ff_formatted.pdf
BLUE	Blue Infrastructure MD and VA	http://data.imap.maryland.gov/datasets/e96524e952a342b5936ed1c0ee3a7901_0 http://cmap2.vims.edu/BlueInfraStructure/BlueInfraStructure.html
TNCH	Nature Conservancy Habitat Prioritization Tool	http://maps.tnc.org/chesapeakehabitat/
TNCAH7	The Nature Conservancy Aquatic Habitat 7 Class	https://www.sciencebase.gov/catalog/item/522e3caee4b03aca2bea0d14
UOG	Unconventional Oil and Gas	https://www.sciencedirect.com/science/article/pii/S0048969717319654?via%3Dihub
FPPT	Chesapeake Fish Passage Prioritization Tool	http://maps.tnc.org/EROF_ChesapeakeFPP/

Table 2. Definitions of extent applied to the available data in the USGS/NOAA data inventory.

Extent	Definition (Covering at least the…)
Global	North America
Nationwide	Contiguous United States
US Coastal	Coastal United States
Watershed	Entire Chesapeake Bay watershed
Baywide	Mouth of the Chesapeake Bay to head-of-tide
BT Range	Eastern range of the brook trout, but not the entire Chesapeake Bay watershed
State	State listed
Specifics	Area specified (i.e. – Susquehanna = covering the Susquehanna watershed

Table 3. The summary codes for how the data had been summarized in previous assessments, studies, and summaries.

Code	Source and Summary Unit
1	National Fish Habitat Partnership Inland summarized by upstream/local catchment/buffers (90m)
1a	Regional fish Habitat Assessment
2	National Fish Habitat Partnership Estuary summarized by Watershed
2a	National Fish Habitat Partnership Estuary summarized by Shoreline and Estuarine Drainage Area
2b	National Fish Habitat Partnership Estuary summarized by Estuary Drainage Area
2c	National Fish Habitat Partnership Estuary summarized by Estuary
3	StreamCat summarized by upstream/local catchment
3a	StreamCat summarized by local/upstream catchment and 100/600m riparian buffer
3b	StreamCat summarized by local/upstream catchment and 100m riparian buffer
3c	StreamCat summarized by local/upstream catchment and 600m riparian buffer
4	TetraTech
5	Trout Unlimited summarized by subwatershed and BT patch
5a	Trout Unlimited summarized by floodplain
6	Eastern Brook Trout Joint Venture summarized by subwatershed and watershed
7	National Water-Quality Assessment summarized by local/upstream catchment
7a	National Water-Quality Assessment summarized by local/upstream catchment and 50m riparian buffer
8	Spatial Hydro-Ecological Decision System summarized by catchment
9	Endocrine Disrupting Chemicals summarized by local catchment
10	Downstream Strategies summarized by local/upstream catchment
10a	Downstream Strategies summarized by local catchment
10b	Data available from https://nalcc.databasin.org/datasets/
11	Fish Habitat Management Strategy
12a	Blue Infrastructure Maryland
12b	Blue Infrastructure Virginia
13	The Nature Conservancy Aquatic Habitat 7 Class
14	The Nature Conservancy Habitat Prioritization Tool
15a	Unconventional Oil and Gas Merriam et al. 2018 summarized by local and upstream catchments
15b	Unconventional Oil and Gas Maloney et al. 2018 summarized by local and upstream catchments
16	Chesapeake Fish Habitat Prioritization summarized by total upstream catchment, local upstream watershed, and local downstream watershed (in relation to dams)

8.8 Regional Fish Habitat Assessment User Needs Report

Regional Fish Habitat Assessment User Needs Report

What is the utility of a regional Chesapeake Bay watershed fish habitat assessment?

What do you need to improve the watershed?

Habitat scientists from around the Chesapeake Bay watershed are looking to **better understand your information needs** for project and land-use planning. The goal of this effort is to compile data and resources that habitat and land-use project designers, planners, and implementers can easily access and utilize to improve and increase the effectiveness of their work.

How can we help you?

With your input, compiled resources and data would be made available in a regional habitat assessment that would include the Chesapeake Bay Watershed (District of Columbia, Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia). The habitat assessment would focus on factors that impact the quality and quantity of fish habitat in your specified region, the species that utilize that habitat, and identify the factors/stressors influencing fish habitat.

How can you share your needs?

To help ensure this assessment is relevant and beneficial to you, **please complete this online survey by March 16, 2018**. In **less than 10 minutes** you can answer 20 questions related to your experience and project or planning needs. Keep in mind that many land-use plans and habitat projects that you may work on have an impact on fish habitat even if that is not the primary focus. We request that you please participate even if fish habitat is not a primary project goal of your work.

Where will your response go?

A summary of the responses will be provided at a workshop on fish habitat stressors and assessment needs in April 2018. Your collective responses will be used to guide decisions and discussions for a future regional habitat assessment and the potential development of other resources.

Thank you for your valuable input!

If you have any concerns or questions about this survey, please contact Gina Hunt at (410) 948-9836.

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I. Introduction

A workshop will be held on April 25-26 2018 to focus on identifying and ranking factors and stressors influencing fish habitat function throughout the Chesapeake Bay Watershed. This workshop will build on the initial listing from the Chesapeake Bay Program Fish Habitat Team's Management Strategy and the approach in the National Fish Habitat Assessment. The workshop will focus on building a framework for a regional Chesapeake Bay watershed fish habitat assessment.

It was recognized early in the workshop planning process that the utility of a regional assessment was unknown. Who would use the assessment and what did they need it to include? A guiding principal for the assessment framework is that it should support planning and management decisions. Therefore, a user-needs questionnaire was developed to determine what land use and restoration planners, and habitat and fish managers need in a fish habitat assessment. The results are compiled in this report to serve as guidance at the fish habitat workshop. With the end in mind, workshop participants will be better informed to build a framework for a regional fish habitat assessment.

II. Summary of Key Findings

Responses were received from one-hundred-forty-eight (148) individuals throughout the Chesapeake Bay watershed. The questionnaire was designed to inform the development of a regional Chesapeake Bay fish habitat assessment. The majority of respondents (70%) stated they would use a regional assessment. However, they also acknowledged that it needs to complement the tools or prioritization methods they are already using.

All spatial tools listed in the questionnaire were recognized by some respondents. The tools in which respondents had the most familiarity are listed below. However, it is unclear if the top tools are the most frequently used because of utility or marketing.

- Chesapeake Bay United States Geological Survey Data
- Water Quality Standards Attainment (Clean Water Act 303d lists)
- United States Geological Survey Tool
- The Nature Conservancy Tools
- Eastern Brook Trout Joint Venture

Respondents indicated the most important information to be included in the assessment is:

- Water quality degradation – nutrient, sediment, and emerging contaminants
- Development/urban land use
- Impervious surface – patterns of growth and impervious surface percentage
- Wetland distribution and type
- Agricultural land use
- Invasive species distribution and abundance (e.g., zebra mussels, rock snot, hydrilla)

The majority of respondents requested the smallest scale for the assessment, *less than 1:24,000*, but some mentioned that the scale should be based on the available data in the area. There were no suggestions for utility or requirements specific to fishery management. However, there was some preference toward information, including economic impact, of recreational fish species.

III. Methodology

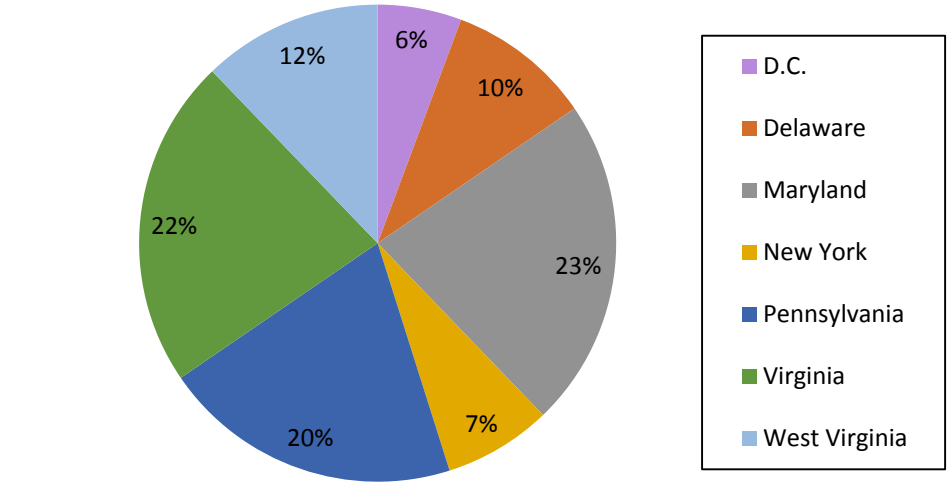
The questionnaire, developed by the workshop steering committee, consisted of 19 questions. While the invitation was clear that the questionnaire was inquiring about the utility of a fish habitat assessment, many questions purposefully omitted the specificity of "fish habitat" in the question. Because the audience was not

necessarily familiar with this term, the questions were more vague and referred to a "habitat" assessment. The questionnaire was available online through Survey Monkey from February 22, 2018 through March 16, 2018. It was distributed directly to **767** people by email and it was sent in newsletters from several state planning associations and the Chesapeake Stormwater Network. The open rate to the direct emails was forty percent.

II. Detailed Findings

Respondents: A total of 148 individuals responded to the questionnaire. The majority of responses (65%) were received from people that received the questionnaire with direct contact through survey monkey. The total responses on each question may not be 148 because individuals were not required to answer all questions. There was response from each jurisdiction in the Chesapeake Bay watershed as illustrated in Chart 1.

Chart 1.



More respondents (41%) work in local government than any other sector. This could have an influence on the overall response to certain questions. For example, this may explain the significant number of respondents (74 of 148) who work with Watershed Implementation Plans (WIP). These plans are detailed strategies for how to meet pollutant reduction goals. They are generally implemented on the local level. Though Maryland, Virginia, and Delaware comprise a majority of the responses and have both tidal and non-tidal waters, a majority of respondents (64%) work in freshwater (cold or warm water streams) systems. This response could be a reflection of the high number of local government respondents.

Chart 2.

Most respondents work in restoration, but there was broad experience in other areas. The activities of the respondent's organization or agency are reported in Chart 2. In addition, 64% of respondents are actively involved in planning or implementing habitat conservation or restoration projects. One of the expected uses of the potential assessment is planning for land conservation and restoration projects. The experience and organizational activity represented indicates we received responses from the appropriate potential user group. It is not possible to tell if research and monitoring responses are from fishery managers. Therefore, this is one intended audience from which we may be lacking input.

Tools/Data Sets:
The questionnaire asked the respondent's familiarity with twenty-seven spatial tools. With such a long list, it was surprising that all tools received some response. However, twenty-six respondents indicated they were not familiar with any of the spatial tools listed. AdaptVA, Virginia Blue Infrastructure, and National Fish Habitat Partnership Data System all received the least with three responses each. The top quartile of tools selected is provided in Table 1.

Table. 1. Top Quartile of Tools

The Nature Conservancy Habitat Prioritization Tool	21
Climate Change predictors	23
Eastern Brook Trout Joint Venture	31
The Nature Conservancy Tools	33
United States Geological Survey Tool	37
Water Quality Standards Attainment (Clean Water Act 303d lists)	40
Chesapeake Bay United States Geological Survey Data	45

While respondents stated they were familiar with many spatial tools, very few mentioned a tool when asked how they identify or select sites for restoration or conservation work. A complete list of responses is provided in the Appendix I. In addition to the tools or prioritization responses, there were some common themes. Many responses fell into a theme of client/landowner interest, funding, or citizen complaints, and often a combination of these reasons are used in selecting sites.

Utility of an Assessment:
Seventy percent of respondents indicated that they would use a regional habitat assessment to prioritize potential sites for restoration/conservation. Some additional responses, provided below, indicated potential utility, but it would need to complement their current process or tools.

- Maybe - I would need to see how it interfaces with current program
- Maybe but would need more information first on how it would like with our ongoing tools
- Only if it also evaluates human habitat needs and waterfront recreational access
- Potentially - depending on the nature of the developed product I could see it being a component feeding into our process
- Not sure; there are so many different mapping tools already available!
- This could be used in conjunction with other tools or prioritization methods. If all other things were equal, habitat needs could rank one site above another.
- We already have a couple regional habitat assessments available. The recently developed Watershed Resources Registry (statewide) and the Nature Conservancy's tool (for much of the state).
- Yes, however we use Trout Unlimited's Eastern Brook Trout Conservation Portfolio combined with funding priorities and mapping/business plans developed by the National Fish and Wildlife Foundation and partners.

Data in:
The questionnaire asked preference for the types of data that should be included in the assessment to be useful. Eighteen types of data were provided. Respondent's choices were unlimited and they were able to suggest other data not listed. The responses are ranked in Table 2 from highest (most popular) to lowest.

Table 2. Data Needed in the Assessment.

Water quality degradation – nutrient, sediment, and emerging contaminants	77
Development/urban land use	66
Impervious surface – patterns of growth and impervious surface percentage	65
Wetland distribution and type	60
Agricultural land use	59
Invasive species distribution and abundance (e.g., zebra mussels, rock snot, hydrilla)	58
Fish species distributions and abundance	57
Fragmentation by dams and culverts/barriers to fish migration	55
Shoreline armoring/hardened shoreline	43
Climate change – annual and seasonal patterns and trends	43
Dissolved oxygen	41
Fishing activities (recreational or commercial)	35
Submerged aquatic vegetation (underwater grasses) distribution and trends	34
Water withdrawals	33
Conductivity	30
Salinity	29
Climate change – sea level rise, at risk shorelines	28
Mines	23

The respondents were asked an open-ended question regarding the species that are important to their management efforts. There were 89 responses, but only a few answers appeared with enough frequency to enumerate. Trout, alone and with other species, was the most often mentioned of any fish resource. Ten responses stated "all aquatic species" and 28 respondents stated they were not sure. By association, game fish species (recreational) including brook trout and black bass were the most common responses.

Information Out-

In addition to selecting data to be included in the assessment, respondents had the opportunity to select the types of information they would want from the assessment tool. An objective of the workshop is to identify the necessary information and analytical approaches to assess the condition and vulnerability of fish habitat in the Chesapeake Bay Watershed. Both "habitat condition" and "habitat vulnerability" scored very high for information needs. There was no significant difference in the frequency of the responses; however, "potential mitigation measures" was also frequently requested.

In an open-ended question, respondents were asked what other information they needed beyond that listed in the questionnaire. The responses were varied, but some noteworthy comments are listed below.

Table 3. Additional Information

Accurate ranges and abundances
Actual species locations
Any updated data is beneficial.
assessment of current habitat conditions
CEC data, pharmaceuticals, microplastics
Class A wild trout shapefile, naturally reproducing trout shapefile.
completed project sites
DO data, recent Bay bottom type survey data

Easily accessible and discernible historic fish species data for all waters.
Economic values
fish passage improvement opportunities that would achieve the most impact on habitat
High resolution land use/cover data including impervious cover (something better than NLCD; likely specific to all of PA)
Horseshoe crabs, SAV distribution
identification/mapping of natural stream barriers, greater resolution of hydrography (eg better than NHD+)
Location of existing restoration projects
Long-term temperature forecasting within headwater streams
Macro invertebrate surveys Bacterial Microbiomes Pathogen (bacterial and viral) assessments Farm-level agricultural practices including animal densities
Maps of areas currently inhabited by each invasive plant species
Priority preservation / habitat restoration sites based on sea level rise inundation.
success measures for different habitat practices
temperature, invasive species mapping and distribution
temporal data on anadromous and semi-anadromous species.
Trends and helpful restoration efforts to improve the ecosystem even with development
We don't have staff or money for monitoring, and we don't have local experts on animal species (only plants), so at this point just about any data would be helpful for us.

Scale:
The scale of an assessment is often determined by data availability, but it is also important to determine the end users need. The questionnaire offered three scale options (with examples and illustrations). The majority (45) of respondents requested the smallest scale offered, *less than 1:24,000*. Other suggestions included the HUC 12 scale or smaller and the ability to switch from a Google Earth to Topo map scale. This suggests a hierarchical assessment based on the scale of the available data in an area. Most respondents (24 and 28 respectively) also requested the data be aggregated at the county or reach (a continuous stretch of stream or river) level. This aggregate question only received 80 total answers and may not have been well understood by respondents.

Sources of Information:
If a regional assessment is developed it will be important to know how to reach the intended users to inform or market the tool. The questionnaire sought to identify the respondent's go-to source for information of this type. There were 79 respondents, but most people listed more than one trusted source. Some respondents listed individual people that they contact for information, but most often a state agency was listed. The water quality agencies (MD Department of Environment, PA Department of Environmental Protection, VA Department of Environmental Quality) received the most responses. The state natural resource agencies were also mentioned frequently. There were significantly fewer responses that mentioned planning commissions or conservation districts.

The respondents also provided contacts that they thought should be contacted regarding the utility of an assessment. There were a myriad of responses with no general theme. But these are contacts that may be used post-workshop for additional information.

Recommendations:
The respondents were clear that they could use a regional assessment; however, they already have many tools available to them. Generally, conservation and restoration projects are opportunistic. They have a willing landowner, concerned citizens, funding available or a combination of these reasons to pursue a project in a certain area. For most, tools are secondary in their selection process.

In order to make a fish habitat assessment tool meaningful to respondents, it will need to work well with their existing tools and processes. It will need to provide resolution at a local scale and provide information that has been otherwise unavailable or scattered in its availability. As one respondent suggested, "varying degrees of resolution are going to be important to the different stakeholder. Being able to adjust to those different resolutions is going to be crucial to the efficacy of the tool in the end."

Once developed, marketing the tool through the trusted sources that the respondent's already use will be critical. These were identified as the state water quality and natural resource agencies.

In their own words, below are some recommendations for the assessment from the respondents:

- More education of local technical staff is needed to show how useful it could be.
- …don't forget about the smaller, highly urbanized communities. While our existing habitats may not be as pristine as the more suburban counties, we still need help, and because we're smaller we don't have the resources on staff or the money to pay consultants for those resources, so something like a regional habitat assessment would be very useful to us. But it would need to include information on the urban areas.
- Success measures for different habitat practices
- Information that is readily available and understandable to the general public - what are the public benefits of habitat restoration…
- It needs to be in a form that local decision makers can understand and relate to... impacts on the economy, tourism, taxes...

There are some areas and requests that warrant consideration for additional research, but are beyond the scope of the workshop and the assessment. There is a desire by respondents to have economic impact information on fish resources and habitat projects. While the tourism impacts of recreational fishing to an area can be identified, it is more difficult to quantify the economic benefits of a project that benefits fish habitat. In addition, respondents would like an assessment to provide information on fish habitat condition and vulnerability, and identify the associated mitigation measures. The workshop will identify and prioritize factors and stressors, but it will stop short of identifying the best mitigation measures for the prioritized factors and stressors.

It is unclear if fisheries managers had significant participation in the questionnaire. Therefore, it is recommended that information would need to be gathered from the managers to determine the utility of an assessment to that sector.

Appendix I: Survey Questionnaire with Response Totals

1. **Name?**

2. **Multiple Choice: Who do you work for?**

Academic	7
Consulting	10
Federal	7
Interstate (e.g., SRBC, ICPRB)	1
Local	60
Non profit	23
Other (please specify)	11
State	25
Grand Total	**143**

OTHER:
1. Conservation District
2. Conservation District
3. Contractor
4. Volunteer Donegal Chapter TU
5. I'm a Pa Master Naturalist volunteer
6. Planning District Commission
7. Regional Government
8. retired
9. retired land owner
10. Utility Cooperative
11. Volunteer

3. **Checkboxes: What jurisdiction(s) does your organization work in? Check all that apply.**

D.C.	14
Delaware	24
Maryland	55
New York	18
Pennsylvania	50
Virginia	55
West Virginia	30
None of the above	2

4. **Checkboxes: What nearby aquatic habitat could be affected by your projects or land use planning? Check all that apply.**

Tidal saltwater nearshore and intertidal	52
Freshwater non-tidal (cold and upstream waters)	100
Freshwater non-tidal (warm)	85
Freshwater tidal	54
Don't know	6
None of the above (provide answer below)	4

NONE OF THE ABOVE:
1. Wetland
2. While my agency does, I do not perform projects in my current role, nor do I directly participate in land use planning. I do, however, lead and participate in conservation design planning, which impacts all of the habitats listed here.
3. North east River, Brackish
4. Wetland

5. Checkboxes - What activities is your organization involved with? Check all that apply.

Advocacy	36
Legislation	35
Conservation planning	76
On-the-ground conservation (implementation)	81
Restoration planning	91
On-the-ground restoration (implementation)	92
Communication	72
Education	84
Public access	55
Research and monitoring	71
None of the above	2
Other (please specify)	17

OTHER:
1. Chesapeake Bay Critical Area
2. Creating local land use policy based on local data.
3. enforcement of CBPA and MS4 permit
4. Highways
5. QDMA and Crep.
6. land use planning
7. Land Use Planning
8. Land use planning/zoning; comprehensive planning; floodplain management; subdivision ordinance implementation; enforcement of environmental regulations
9. Landscape Management
10. Local government land use
11. Municipal Planning
12. Planning & Zoning
13. Planning and Zoning related functions-site plan review, Critical Area monitoring.
14. regional planning
15. Regional Planning, i.e. Water Supply and Hazard Mitigation Planning
16. regulatory
17. Town & Green Team within Town

6. Multiple Choice: Are you actively involved in planning or implementing habitat conservation or restoration projects?

Yes	80
No	31
Other (provided below)	14

OTHER:
1. As much as I am allowed

2. As related to permit issuance for construction
3. Do stream or wetland restorations count?
4. Formulating Comprehensive Plan
5. I evaluate projects
6. Indirectly through CREP
7. Living Shoreline Project
8. Occasionally, but not currently
9. Raingardens
10. We are currently rehabbing a trail project that runs through sensitive marsh areas.
11. We direct local folks to places that can do habitat conservation/restoration
12. We work with developers to conserve nontidal wetlands through the use of open space developments and the maintenance of the Resource Protection Area.
13. Where required IAW state and federal regulation
14. Writing manuscript based on completed project

7. Are your efforts associated with Watershed Implementation Plans?
(Watershed Implementation Plans are detailed strategies developed by jurisdictions in the Chesapeake Bay to help determine how the jurisdictions will meet their nitrogen, phosphorus, or sediment reduction goals.)

Yes	74
No	37
Not sure	13

8. Select all tools/datasets you're familiar with or have used for previous projects. Check all that apply.

AdaptVA	3
Virginia Blue Infrastructure	3
Chesapeake Bay Fish Passage Prioritization Tool	17
Chesapeake Bay United States Geological Survey Data	45
Climate Change predictors	23
Virginia Comprehensive Coastal Resource Management Portal	9
Eastern Brook Trout Joint Venture	31
FishStats	6
Landscope	5
Maryland Greenprint	12
Maryland Coastal Atlas	9
Maryland iMAP: Biota	14
Maryland Water Monitoring Site Mapper	11
North Atlantic Landscape Conservation Cooperative	9
National Fish Habitat Partnership Fish Habitat Assessments	10
National Fish Habitat Partnership Data System	3
North Atlantic Aquatic Connectivity Collective	11
North Atlantic Landscape Conservation Cooperation	9
The Nature Conservancy Tools	33
The Nature Conservancy Habitat Prioritization Tool	21
Shoreline Managers Assessment Mapper	5
Virginia Coast Geospatial and Educational Mapping System (GEMS)	14
Virginia DCR Conservation Lands Database	18
Virginia Department of Environmental Quality GIS Database	16

Virginia Department of Game and Inland Fisheries Database	16
United States Geological Survey Tool	37
Water Quality Standards Attainment (Clean Water Act 303d lists)	40
None of the Above	26
Other (provide answer(s))	15

OTHER:

1. Census Data; VA Dept of Health Shoreline Sanitation Data; Natural Heritage Database; VA Dept. of Historic Resources Data
2. Have tried to educate myself on tools but not sure what I have used.
3. I have used these tools for past planning projects.
4. In-house restoration project database
5. Locally created current land use geodatabase with stream buffers.
6. MD Critical Area, shoreline protection monitoring and enforcement.
7. National Wetlands Inventory, Ches Bay Sustainable Landscape Maintenance Manual
8. NJDEP imap
9. Not certain all the tools they are using.
10. Pa DCNR, 18 acres in crep
11. STEPL other project models related to Section 319
12. Trout Unlimited Eastern Brook Trout Conservation Portfolio
13. USGS National Water Information System (NWIS) USGS BioData USEPA Chesapeake Assessment Scenario Tool (CAST) Chester County Stream Conditions Program USEPA Enforcement and Compliance History Online (ECHO) eMapPA
14. VIMS Shoreline inventory
15. Watershed Resources Registry www.watershedresourcesregistry.org

9. How do you identify or select sites for restoration or conservation?

1. Connectivity analysis via NAACC 2. landscape connectivity prioritization via TNC Barrier Prioritization Tool 3. 303d lists, Priority Waterbody Lists 4. local groups identifying stream corridor deficiencies
1. We focus efforts on marginal brook trout habitat within close proximity to intact brook trout habitat 2. We heavily focus efforts in karst systems to ensure long-term temperature resiliency under varying climate scenarios
Accessibility (i.e. land owner interest/willingness), erosion issues
As an NRCS employee, assistance is provided through voluntary methods, using conservation technical assistance and or farm bill programs.
As an outcome of mapping storm water conveyance for MS4 compliance.
As part of the comprehensive planning process, which takes in account multiple, integrated ecological, topographical and economical issues.
as related to the Chesapeake Bay Critical Area Law
As the landowner I have enrolled in stream CREP and completed an in stream habitat restoration funded by NRCS.
based on interests of participants in our group of colleges and universities
Based on local data and ownership
Based on mitigation needs and location/watershed
Based on need of cooperating agencies and national mission.
Based on relative contribution to larger scale, deliberately aligned watershed planning and conservation design conventions (e.g. Cross-GIT priorities which align closely with Nature's Network outputs.

based on remediation sites
Based on water quality impairments.
Based on what we can get funding for with grants or what Green team can address ourselves.
Biological data, logic and an intimate knowledge of my resource.
By erosion complaints from citizens, by investigating priority watersheds, and prioritizing based on degree of erosion and potential for uplift.
CITIZEN CONCERN/COMPLAINTS PROBLEMS IN CITY FROM AREA CONCERN FOR PRESERVATION
Client interest
Cold or potentially coldwater,willing landowner,wild trout
Community needs, IPs, funding, partner needs
concerned citizens approaching us and elected officials bringing concerns
Conservation through GreenPrint Targeted Ecological Areas Restoration through Chesapeake Bay Trust Fund priority maps - projects selected based on nutrient reduction efficiencies..and secondarily based on habitat benefits
Conservation would just include education about issues and increase in local zoning restrictions - we use GIS to analyze local parcel, land use, soils, floodplain, wetland, infrastructure location, building/development location, local knowledge of current problems areas, etc.
Cooperatively with the state agency responsible for fish
Dependent on project type, client, and goals.
description of model
development request
DNR
Done by partner organizations
Either through 319 Watershed Based Plan for specific pollutants, or by consideration by Trib Team of projects proposed to us by Chesapeake Bay stakeholders
Environmental Ranking
For some sites, we are asked to provide assistance to other organizations/agencies, and for other sites, we have used existing watershed restoration plans and available funding opportunities to help guide project selection.
Generally landowners bring areas of concern to our attention and we prioritize them as we see fit.
GIS
GIS, site visits
I work with Lancaster County Conservancy, TU, the Conservation District, and the Alliance for the Chesapeake Bay.
Identified by partner organizations, areas that are pre-permitted, areas part of large-scale restoration
In conjunction with proposed projects
In Rockville, stream restoration projects are prioritized for high erosive sediment loads from streambanks, threat to infrastructure or private property, and (lesser) ease of access and limited forest/wetlands impacts

It depends a lot on the project. A lot of times I get contacted by interested parties about sites. Other times it can be where funders identify. If I'm selecting a site I look to see where the project would have the most benefit.
Landowner requests.
local government desk top resources
Location in the watershed. Risk of acute and chronic impacts to the surrounding community and hydrologic systems. Response and remedial action to incidents or wstorm events
Look for sites that are in poor condition and try to turn them around then begin management...
Looking for sites or series of sites that bring the highest return and connect to previous projects.
Municipal property with sensitive areas.
My group's involvement is via TMDL development and that schedule is developed according to our Watershed Framework, a 5 year rotating basin approach, and the schedule defined by addressing impaired waters in an efficient manner.
needs of landowner
Non buildable areas and buffers
observation
On the ground and GIS analysis of potential project sites that will sufficiently offset stream and wetland impacts associated with Section 404 CWA permits.
others identify sites I evaluate them
PA Fish and Boat Commission has created a prioritization process using our fisheries survey data as the main data input. We needed a prioritization process to cover the entire commonwealth. Our process currently allows us to prioritize within any geographic region or watershed across the commonwealth.
Poquoson has established Resource Protection Areas and requires wetlands delineation on development projects. Plum Tree Island National Wildlife Refuge makes up a significant part of the city's land mass and about half of our tidal wetlands. We participate as much as we can with the USFWS and the Corps on restoration/planning efforts for this resource.
Position not at forefront of site selection
Primarily impairments (i.e. TMDL, 303(d) list), local stakeholder involvement.
Primarily voluntary donations from citizens for FEMA acquisition projects (the current Board had chosen to no continue the acquisition program)
Prioritization
Prioritized sites based on partnerships, land ownership (conservation easements), fish habitat, and water quality improvement opportunities.
Priority sites are typically identified through Hazard Mitigation and Source Water Protection Plans for our Drinking Water Utilities.
Priority watersheds and sub watersheds, funding requirements, willing landowner.
Project-specific
Proximity to water resources, amount of pollution reductions, ownership
Ranking sheet, conservation plans, public demand, environmental need
recommend prioritized sites based on gamefish surveys

Restoration Areas are selected based upon periodic maintenance schedule of Cooperative Infrastructure needs.
rfp. GIS. GIS combined with on the ground research.
Sampling, familiarization of resources within my district, quantification or visual assessment of habitat, species dependent evaluation and management of habitat
Select impaired waters have been chosen. Based on willing partners, sites are chosen and implemented annually over the past 10 years.
Site identification and selection vary across BMPs. Here is a process that is generally used across all the BMPs we implement: 1. Set strategy for compliance with TMDLs, MS4 permit requirements, and federal/state/local regulations. This includes identifying regions where specific outcomes are required (e.g. watersheds or land use planning areas), measuring the gaps between the required outcome and current status, and establishing milestones and deadlines for closing each gap in each region. 2. Referring to existing site inventories (from e.g. small watershed action plans and TMDL implementation plans), set BMP specific implementation targets to meet the milestones and deadlines from step 1. If the milestones and deadlines cannot be met with BMPs identified in existing inventories, plan additional site identification processes. Site identification may begin ASAP, or may be scheduled in the future to support future milestones and deadlines, as appropriate for the situation and BMP. Site identification begins with office based site screening, utilizing existing GIS and remote sensing data, monitoring data, citizen and staff reports, and engineering plans. Site identification may include new field based evaluations, such as SWAP upland and stream corridor assessments. Note that for many BMPs, site inventories have a shelf life due to changes to conditions in the field, restoration science, and regulatory requirements. Therefore, the greatest emphasis is on BMP targets for the next milestone (e.g. targets may be porfolios of specific sites), and targets for future milestones may lack details (e.g. targets may be a quantity of BMP implementation without specific sites identified.) 3. Use BMP portfolios from step 2 to request funds, staff, equipment, contracts, and other resources necessary for BMP implementation. 4. Prioritize and select sites. Prioritization is based on proximity to deadlines for required outcomes, benefits of each site towards required outcomes (e.g. nitrogen load reduction), benefits outside required outcomes (e.g. habitat improvements, building community support), and cost. Selection follows the prioritized list, and is constrained by resources available (see 3 above) and operational realities (e.g. mobilization costs of staff, contractors and equipment can make it inefficient to jump large distances between sites). Initial prioritization and selections are usually revised based on conditions found in the field.
Site Plan driven or on City owned property.
Site review after area identified by team member
Sites initially identified primarily via watershed management plans, stakeholder and intra-agency inquiries and requests. Sites are then desktop screened. Qualifying sites are field scoped with developed semi quantitative protocol in part based on parameters from BANCS, Pfankuch, EPA rapid habitat
Sometimes prioritized geospatially but mostly ad-hoc. If there's a non-forested stream, that property is a target
Through complaints, watershed surveys, WIPs, assessments
Through county WIP priorities
Through inspections and referrals.
Through park planning, environmental assessments, and money earmarked for specific activities.
Through partners or listening to counties (Maryland)
Through Regional Planning which includes local government, state agencies and non-proffitt organizations
Through watershed management planning - to reduce sediment transport in streams
TNC prioritization tool and focus watersheds

Use ranking sheets to determine sites of greatest need. Sites are usually brought to our attention from landowners.
Usually based on proximity to perennial streams
usually identified by clients-County, NGO
Variable, typically they are identified based on a combination of feasibility and cost-effectiveness for sediment and nutrient reduction. Which is typically derived from some sort of stream assessment.
Visual observation; referrals; government and ngo referrals
Watershed Assessments
We are a local government. The town council and committees work on planning. Garrett Park is an arboretum and on the National Trust for Historic Preservation.
We bid on permitted projects only
we don't actively seek; we direct local folks (that come to us that have a concern or issue) to companies that can assist them in evaluation or restoration projects
We focus on priority (local, state, and federal) watersheds looking at comprehensive watershed implementation (i.e. effects from ag. operations, streambank erosion, and dirt and gravel roads). We also focus efforts based on active watershed organizations and willing landowners.
We had a stream assessment conducted by a consultant several years ago and have been using that as our starting point. We are conducting a new stream assessment for certain streams now. Currently, we consider only streams that we can get credit for the Chesapeake Bay TMDL in our restoration efforts.
We work in cooperation with PA Department of Environmental Protection to identify streams to target for monitoring of sediment movement during storm flow as well as pesticide cycling through the hydrologic system.
When a mitigation site is needed, we look for locations, preferably within or near WVDOH right-of-way, that could use some improvement.
when issues need to be resolved
Where it is deemed in the public interest, and where local gov't can get the necessary permissions & easements of right-of-way from private property owners.
Willing land owner & funding availability
WIP
work with conservation districts and watershed groups
Would likely be first noted based on institutional/professional knowledge of someone working on or near the project.

10. Could you see yourself using a regional Habitat Assessment to prioritize potential sites for restoration/conservation?

Yes	80
No	15
Not applicable	11
Other (Specified below if could use it for another purpose)	19

OTHER:

1. Another department in my agency might - I don't directly to that type of work
2. Better question for others in the organization.
3. I don't think this can be effectively done with coarse-scale modeling. I'm more interested in techniques that would include side-scan sonar. Actual quantification of instream habitat. As far as riparian issues, concentrations of agriculture, wasting Ag lands, and missing riparian zones are easy

to identify for someone that is familiar with their management district.
4. I would like to see if it has application to the Pocomoke City, MD.
5. I'm a private 70 acre landowner
6. maybe - I would need to see how it interfaces with current program
7. Maybe but would need more information first on how it would like with our ongoing tools
8. No. We have already prioritized sites and land uses.
9. Not certain
10. Not sure.
11. Only if it also evaluates human habitat needs and waterfront recreational access
12. Perhaps, if the data was accurate and detailed enough.
13. Possibly
14. Potentially - depending on the nature of the developed product I could see it being a component feeding into our process
15. Rockville is fairly urban and our streams don't show much variation in habitat quality.
16. This could be used in conjunction with other tools or prioritization methods. If all other things were equal, habitat needs could rank one site above another.
17. useful when evaluating potential development near critical areas
18. We already have a couple regional habitat assessment available. The recently developed Watershed Resources Registry (statewide) and the Nature Conservancy's tool (for much of the state).
19. Yes, however we use Trout Unlimited's Eastern Brook Trout Conservation Portfolio combined with funding priorities and mapping/business plans developed by the National Fish and Wildlife Foundation and partners.

11. If yes, what data should be included for the assessment to be useful? Check all that apply.

Water quality degradation – nutrient, sediment, and emerging contaminants	77
Fragmentation by dams and culverts/barriers to fish migration	55
Shoreline armoring/hardened shoreline	43
Mines	23
Water withdrawals	33
Development/urban land use	66
Agricultural land use	59
Impervious surface – patterns of growth and impervious surface percentage	65
Fishing activities (recreational or commercial)	35
Salinity	29
Conductivity	30
Dissolved oxygen	41
Submerged aquatic vegetation (underwater grasses) distribution and trends	34
Climate change – annual and seasonal patterns and trends	43
Climate change – sea level rise, at risk shorelines	28
Fish species distributions and abundance	57
Invasive species distribution and abundance (e.g., zebra mussels, rock snot, hydrilla)	58
Wetland distribution and type	60
Not applicable	2
Other (specify below)	8

OTHER:
1. Geomorphic conditions (e.g. stream erosion) . Additional biotic indicators of stream health (e.g. macroinvertebrates). Additional sources of temperature impairments (e.g. wet ponds)
2. Better question for applicable departments than me.
3. Existing/failed conservation/restoration efforts, especially upstream, major upstream dischargers (NPDES permit holders)

4. Fine sediments. Riparian land use! Pesticide presence. Cyanobacteria metrics, such as phycocyanin levels, biomass, recent concerning cyanotoxin presence, nitrogen and phoshporus concentrations + vegetative biomass (total nutrients in the system), ESTROGENICITY! STEAM WIDTH TO DEPTH PROFILES - and how that is changing rapidly and what is expected in the future.
5. If available, all data should be evaluated as effective predictors for conservation prioritization (let data decide which is best)
6. Most of this info is available if you know where to look
7. Subsidence rates
8. SWCD/NRCS Best management practice project sites, riparian buffer acreage, existing restoration sites.
9. Vegetative invasive species - vines, trees, shrubs

12. If yes, Select the types of information you would want a habitat assessment tool to provide for your region. Check all that apply.

Habitat vulnerability/risk to degradation	76
Condition of fish habitat	68
Fish species utilization	52
Driving factors influencing habitat change	61
Potential mitigation measures (e.g., planting riparian vegetation	72
Not applicable	2
Other (specify below)	6

OTHER:
1. Ability to also evaluate/use variables that predict condition
2. adaptive species and zones near urban land use areas
3. best opportunities for culvert improvements and dam projects for fish passage
4. Better question for applicable departments than me.
5. public lands (easier implementation)
6. wildlife management

13. If yes, what map scale is most appropriate so you could use a regional Habitat Assessment to improve your work?

<1:24,000 e.g., Google Earth image	45
1:100,000 eg State Atlas, Gazatteer	5
1:24000 e.g., USGS Topomap	17
Don't know	18
Other (please specify below)	7

OTHER:
1. HUC 12 or less as well as the above
2. Scale based on data
3. It would be great if you could switch from a Google Earth to Topo map.
4. Local GIS Mapping
5. perhaps something like HUC 12, which is often the scale of a 319 watershed based plan and the area a watershed group might cover
6. There is so much good local data that it would seem that a regional assessment would only be an information resource. Local data is almost always preferable when it comes to actually targeting land for specific uses.
7. Watershed - tributary level! Fine scale.
8. 1:2400. Scale relevant to urban BMP site identification and selection.

14. If yes, How would you want the data grouped (aggregated) in the map tool?

County	24
Don't know	11
Entire Bay watershed	1
In Bay – major tributary	3
In Bay – subestuary	2
Not applicable	1
Reach (a continuous stretch of stream or river)	28
River	9
State	2
Stream order (grouped by the number of stream branches from that segment of stream)	11

15. If yes, what species are important to your management efforts?
This was an open-ended question therefore the answers are not enumerated.

All
All
all
All
All
All native aquatic organisms
all salt water and fresh creatures, birds and bats
All species that affect a construction timeline. Different species will close the construction schedule for a period of time which is predetermined on each pan set.
All trees and wildlife.
aquatic species (in streams), riparian species
bass, crappie, perch, blue crab
Bobwhite Quail
brook trout
Brook Trout
Brook Trout
brook trout
brook trout
brook trout clupeids- herrings and shad moronids- striped bass and white perch yellow perch American eel American brook lamprey
Brook Trout Madison Cave Isopod
brook trout smallmouth bass associated coldwater fishes
Brook Trout, Brown Trout, Rainbow Trout and American Eel.
brook trout, eel passage, smallmouth bass, fish that host mussels to repopulate mussel communities
brook trout/small mouth bass
Brown and rainbow trout, smallmouth bass, sunfish
Clupeids, Yellow Perch, Striped Bass
cold water fisheries, macroinvertebrates

Cold water sport fish (especially native trout). Fish species indicative of healthy streams, as specified in the MBSS fish IBI metrics relevant to our area (coastal plain and eastern piedmont): *Benthic fish species *Intolerant fish species *Lithophilic spawning species *Round-bodied sucker species *Top predator fish species *Invertivore fish species *Algivore fish species *Herbivore fish species *Filter feeder fish species
Coldwater fluvial fish and exotic/invasive species
Deer, rabbits, raccoons
depends on the site
Don't know
Don't know
don't know
Eastern brook trout
Eastern brook trout, alosines, American eel, migratory gamefish (striped bass), freshwater mussels, sturgeon
Eastern Brook Trout, American Eel, Native mussel spp.
Eel
Fish health in relation to all fish species and those species that they rely on to achieve a healthy ecosystem. However, as an employee working for the WV DNR, there is a high priority placed on sport fish. Many of my stream fisheries have been burdened by altered riparian zones, sedimentation, high levels of nutrient influx, and channels that are getting wider and shallower, dramatically reducing the amount of habitat for larger, sport fish and, thus, poorer diversity, evenness, and sport fishing/recreational opportunities. This also increases the impacts to stream bottom organisms due to rising and falling stream levels (impervious surfaces as well) and the quantity of harmful algal blooms that we have (no shading from riparian, excessive nutrients, sunlight bombarding the shallow substrate. The same can be said for our state managed lakes, which are receiving the same harmful impacts.
Freshwater streams
hellbender, trout
I am not active in management efforts.
Invasive species, trout streams
James spiny mussel
Native cold and warm water species.
native species, wildlife and plantings
None currently identified.
None directly, but we mainly focus on created habitat for macroinvertebrates.
Our scope is not species specific.
Oysters
Oysters; menhaden, striped bass, SAV, blue crabs, hard clams, razor clams, soft shell clams, shad, river herring
People - access to nature, recreation, sea level rise adaptation
Perch, catfish, mussel, crab,
Primarily game fish species including Brook Trout (cold water) and black basses and other centrarchids (warmwater)
Really all of them, but prioritize species most utilized in aquaculture, i.e. oysters, clams, crabs, menhaden
Recreational fish species
RTE species Commercial and recreational importance - economic value
Shad, eel, Eastern Elliptio mussel, hellbender, brookies, smallmouth Bass
small mouth bass,red eye bass, some trout,very limited,sunfish
Spartina alterniflora spartina patens ammophila breviligulata crassostrea virginica

Threatened and Endangered Species.
Trout
Trout
Trout
Trout
Trout
Trout
trout (esp brook trout), freshwater mussels, threatened and endangered listed species (eg hellbenders), state species of greatest conservation needs
Trout and other cold water species. Aquatic and non-aquatic insects that are necessary for coldwater restoration. Native trees, shrubs, plants
Trout, baitfish
Typically we don't focus on an individual species. In the past small mouth bass have been of importance.
varies by project
vegetation
We don't know what species are or should be important to us. We need help.
We think the bay program already does a great job of identifying important species.
Wetland species; endangered and threatened; general habitat protection for quality of life impacts
whatever keeps the fishing tournaments - bass
Wild Trout

16. What other data would be helpful for you to have that you currently do not have access to?

Accurate ranges and abundances
Actual species locations
All State collected data.
Any updated data is beneficial.
As a volunteer , beyond my scope
assessment of current habitat conditions
Canvasing water depths throughout the Potomac drainages, stream widths, better access to compiled and analyzed trends in water quality for our streams.
CEC data, pharmaceuticals, microplastics
central location to share data sets
Chesapeake Conservancy style GIS
Class A wild trout shapefile, naturally reproducing trout shapefile.
Climate change temperature modeling. Tree stand data.
completed project sites
Current available data sources have been sufficient for the purposes of managing habitat issues
data transparency rather than simplified indices
DO data, recent Bay bottom type survey data
Easily accessible and discernible historic fish species data for all waters.
Economic values
elevation data (LiDAR DEM) aggregated per county economic viability of conservation efforts
Endangered species in area, none currently known.

Expanded information on dangers of invasive species, animal and botanical. Economic value of conservation activities/services/activities in Lancaster County
external agency habitat priorities to identify overlap for leveraging
fish passage improvement opportunities that would achieve the most impact on habitat
High resolution land use/cover data including impervious cover (something better than NLCD; likely specific to all of PA)
Historical aerial imagery
Horseshoe crabs, SAV distribution
How do I know what I don't have access to?
Hyperlocal assessment of habitat, species, risks
I do not need additional data. Chesapeake Conservancy is providing stream monitoring for temperature, sediment, nutrient load, and electro-shocking for fish counts.
identification/mapping of natural stream barriers, greater resolution of hydrography (eg better than NHD+)
Information that is readily available and understandable to the general public - what are the public benefits of habitat restoration; cost benefit analyses; impacts of poor decision making and lack of regulatory compliance on habitats and resulting impacts on the economy (tourism; recreational and commercial fishing; beach closures, etc.)
Land areas where runoff is a particular concern to aquatic species.
land owner contact info
Landowner data base
Location of Cultural resources
Location of existing restoration projects
Long-term temperature forecasting within headwater streams
Macro invertebrate surveys Bacterial Microbiomes Pathogen (bacterial and viral) assessments Farm-level agricultural practices including animal densities
Maps of areas currently inhabited by each invasive plant species
Mitigation banking districts
Nitrogen levels of water being discharged from spring and seeps in Karst areas.
northern long ear bat
Not sure. Most of what I need or use is readily available.
Not sure. Perhaps relative capacity of local conservation and restoration partners to perform work, and measures of community/landowner willingness to support or allow work by sub-watershed.
Not sure; there are so many different mapping tools already available!
Nothing on fish.
nutrient, turbidity, dissolved oxygen, grasses
Parcel data information. What BMP's have been completed on each parcel.
parcel data to overlay with high-resolution land cover
Priority preservation / habitat restoration sites based on sea level rise inundation.
run-off data
Same as data I checked before - anything animal/habit or climate/sea level change
State, Independent studies, Historical
stream reach and small drainage areas that are ranked for their conservation and restoration value to fish habitat.
success measures for different habitat practices
temperature, invasive species mapping and distribution
temporal data on anadromous and semi-anadromous species.
Trends and helpful restoration efforts to improve the ecosystem even with development

We don't have staff or money for monitoring, and we don't have local experts on animal species (only plants), so at this point just about any data would be helpful for us.
Widespread data on aquatic populations (fish and macros). We certainly only have spot data on this from MBSS.
Wild Brook Trout streams

17. Who is your primary contact(s) to obtain information (tools / data) for your organization? (Example: State Agency, Planning Association.) Please specify.

WVDEP
Anne Arundel County, MD DNR
Bill Merrey Baltimore County
Cecil County GIS, Chesapeake Bay Critical Area
Chad Thompson: Water Resources Registry. John Wirts: DEP water quality data. Chesapeake Bay Program workgroups: other various tools.
Chesapeake Bay Foundation, Chesapeake Conservancy, US Fish and Wildlife, Penns Valley Conservation Association, PA Fish and Boat Commission
Conservation District,USFW
David Thorne (WVDNR) for fish community and water quality data.
DEP, PFBC, county planning office
Department of Natural Resources, Critical Area Commission
DEQ, DCR, FEMA, EPA, ACOE, SWCD GWRC
DNR
DNR, MDE.
First State Data (Delaware GIS Consortium)
Frederick County, MDE, MDP
Hampton Roads Planning District Commission
I tend to contact the Conservation Districts because they are local and tend to know the issues in their Counties.
Internet sources
Internet; state agencies; VIMS
It varies by information need.
Joe Petroski (GIS)
Land and Resource Management
Local trout unlimited chapter. Donegal Chapter
Lower Eastern Shore Regional Office of Planning
Maryland coastal bay's program
Maryland Dept of Environment
Maryland Dept. of Natural Resources, Maryland Fish & Wildlife Conservation Office
Maryland iMap, County agencies, MDP PropertyView
MD DNR
MD DNR
MD DNR iMap database
MDE and MD DNR
MDE, VDEQ, DOEE and other local jurisdictions for the construction regulations, specifications and guidelines and the compliance regulations.
MDP

Multiple. Depends on project. County level through national.
n/a, we use publicly available geodata
national and federal maps
Natural Resources Conservation Service, Department of Conservation and Recreation, local county government.
North Atlantic and Appalachian Landscape Conservation Cooperatives
NYSDEC - GIS
Other state agencies
PA DEP
PA DEP, PAFBC, USGS
Pa Fish & Boat Comm.
PA Fish and Boat Commission
PaDEP
PADEP, PA fish and Boat , DCNR, US Fish and wildlife, SRBC
Penn State Extension. Strouds. PA Fish and Game. Lancaster County Conservation District. Chesapeake Bay Alliance.
PFBC, Div of Habitat Mgmt and Div of Fish Mgmt; County Conservation Districts, DEP
PGC Harrisburg
Planning & Zoning Director
Potter County Planning Dept., PASDA
President, Donegal TU
Rob Pierce, Planning & Development Director
State Agency - MD DNR
State agency- Fisheries
state agency staff - fisheries service
state agency, WVDNR, BTJV
State, Local, Consultants
the Hampton Roads Planning District Commission; VA DCR; VA DEQ
trout unlimited (Maryland)
USGS, PA-DEP, PA Fish and Boat Commission, PA Game Commission, PA Department of Conservation and Natural Resources
VA DCR, USFW, VA DGIF, VMRC, VIMS,
VA DEQ, DGIF
VADEQ, USACE
Va-DEQ, USGS, Va-DMME
varies based on site
VIMS, VITA, MPPDC
Virginia DEQ
VMRC; VIMS; word of mouth
Watershed associations and local government (also get background data from national and state sources such as USGS, PA-DEP, etc.)
We obtain information from several state agencies (DEQ, DCR), non-profit organizations (FOR, Wetlands Watch) and educational institutions (VIMS).
WV NRCS State Wildlife Biologist
WV TAGIS, WVCA
WVDNR
WVDNR, USFWS, TU Science Team

18. What other organizations or contacts should we connect with to determine whether a regional Habitat Assessment would be useful to local organizations and government agencies? Please provide their contact info below:

Central Shenandoah Planning District Commission, Trout Unlimited
Clearwater Conservancy of Central PA, Inc; Regional Trout Unlimited Offices, Western Pennsylvania Conservancy, NFWF
County Farmland Protection Boards Drinking Water Utilities
County Soil Conservation Districts, Riverkeepers Network, County and municipal public works agencies
Delaware Dept. of Natural Resources, sister jurisdictions.
DNR, Chesapeake Bay Critical Area
DNREC - Div. of Watershed Stewardship
DRBC, SRBC, Three Rivers Quest
Federal
Kent County Planning, Queen Anne's Council Planning, Kent County Soil Conservation, Queen Anne's County Soil Conservation
Lanc. Conservation District
Lancaster County Conservation District. lancasterconservation.org/ Penn State Extension https://extension.psu.edu/lancaster-county
Local Watershed Assessments and Local NPDES MS4 managers (DPW or Planning & Zoning)
Lower Shore Conservancy
Maryland Critical Area Commission, Maryland Department of the Environment
Maryland Department of Planning - Chuck Boyd Local watershed groups, land trusts, river keepers Local government planning offices - MACO and MML
Maryland department of planning to incorporate statewide development plan information.
Maybe the Hampton Roads Planning District Commission.
Middle Peninsula Planning District - Public Access Authorities - www.mppdc.com
Montgomery County
MSRA and contracting and development organizations (AGC, USGBC, NAHB) They need to know how and why habitat assessments are needed and the results of the assessments.
Northern Virginia Regional Commission, Northern Virginia Soil and Water Conservation District (but please don't forget about us smaller, urban areas in NOVA when you contact these larger groups)
Pa Tu
Suzy Campbell, Danielle Watson, and Andrea Walker
South River Federation
Too early in my involvement to give knowledgeable reply
Trout Unlimited
Trout Unlimited Pennsylvania Fish and Boat Commission
Trout Unlimited - Phil Thomas
USFWS NOAA
usgs nawqa data, epa habitat assessment data
WVDEP, WVDNR,

19. Is there anything else you think we should know about the utility of a regional Habitat Assessment?

Agricultural landscapes are not degraded habitats. Water quality baseline improvement plans should not ignore local land use plans. Habitat assessment needs to be in context with active resource management not based on an undisturbed wilderness ideal.
An ArcGIS Online map with downloadable data is always helpful. GIS feature service data also helpful.

For organizations responsible for compliance with TMDLs and NPDES permits, the utility of tools like a regional habitat assessment is a function of how much the tool assists the organization on the following tasks, listed in order of highest to lowest potential utility: 1. Compliance with existing permit and TMDL requirements. 2. Elimination of impairments for which TMDLs have been issued. 3. Elimination of impairments for which TMDLs have yet to be issued. 4. Helps the organization obtain or increase support (monetary or political) for their program. 5. Anything else the tool helps with.
How intermediate scale regional assessment is connected and inter-operable with both sub-scale and larger scale similar assessments.
I think most importantly is the fact that most people who would benefit from such a tool in WV have just undertaken a year plus effort to develop a regional watershed planning tool (WRR)
If a regional assessment of habitat is done, it should be coupled with regional water quality/chemistry assessments, and data should be made broadly publicly available.
In Northern Virginia there is a tendency to focus on the larger counties (Fairfax, Loudoun, etc.) and to forget about the smaller, highly urbanized communities. While our existing habitats may not be as pristine as the more suburban counties, we still need help, and because we're smaller we don't have the resources on staff or the money to pay consultants for those resources, so something like a regional habitat assessment would be very useful to us. But it would need to include information on the urban areas.
Is the Maryland National Capital Area Park and Planning Commission involved?
It needs to be in a form that local decision makers can understand and relate to... impacts on the economy, tourism, taxes...
Many regions of PA need to prioritize stream stability before traditional habitat structures can be incorporated, especially glaciated regions.
more education of local technical staff is needed to show how useful it could be
Our work is driven by water quality requirements under the Clean Water Act - we do not generally plan for habitat but use tools that should provide collateral benefits
Please, Please, Please, help the public make the connection of how certain species habitat conditions impacts human health and economics.
Public Awareness is critical for connecting the residents with their local waterways.
Suggest checking out CAPS program (http://www.umasscaps.org/)
The application of such assessments are much more valuable when specific projects or sites for improvement are identified. Even more so, relating habitat impairments and improvements to community goals, such as flooding resiliency and nutrient management, engenders much greater interest toward planning efforts.
The results should be accessible to environmental contractors and the developers, contractors and organizations we serve.
There are a lot of redundant efforts going on at a regional scale. It would be helpful if various groups would work together and communicate better.
There are already a lot of mapping tools available.
This town is entirely within the Delaware Bay watershed (Smyrna & Leipsic Rivers) - not a part of the Chesapeake Bay watershed
Unless we can regulate the problematic land use in this region, the rest is useless. I could sum up 95% of my problems that revolve around the way our streams and their directly adjacent landscapes are treated. We can model our landscape and our surface waters until we've exhausted all of our funding, which is diminishing at the time. We need to regulate agriculture to prevent impacts to aquatic health and habitat. If we can't do that, we need to buy land and restore it.
Varying degrees of resolution are going to be important to the different stakeholder. Being able to adjust to those different resolutions is going to be crucial to the efficacy of the tool in the end.

Potential Users Feedback from June 19, 2018 Joint meeting of the Sustainable Fisheries and Habitat GITs

What about you? Could you use a regional fish habitat assessment?

- Using info to communicate conservation values to partners, point to specific species with commercial/rec value (i.e., Brook trout)
- Stormwater and temperature information, impervious surface is no longer working, I want a more specific mechanism.
- From the Mid-Atlantic Fishery Management Council and federal side- we are currently working on NE regional fish habitat assessment
    - Info from national assess wasn't appropriate in coastal areas, all looking to scale things down and then pilot and replicate to scale up
    - Info on quantity and quality of habitat for ecosystem component species
    - Ocean planning and offshore aquaculture initiatives, energy development
        - Need to point out what is important
    - Metrics associated with water quality may be more useful for conservation
    - We would use it!
- Can we put a finer point on critical habitat areas? How do we make decisions based on 1 project? Is there a way to prioritize?
    - Tier 3 assessment: can you quantify value from energetic standpoint? How valuable is marsh for a specific species? And specific time of year?
    - NOAA is moving towards ecosystem-based management but we only have tools to talk about things in single species context
- We need to work on developing habitat objectives - how much habitat do we need to support a specific stock? Let's come up with specific number or area that we need to conserve/protect to maintain healthy stocks
    - Fisheries management has only really looked at harvest
    - More specific data can allow us to apply habitat objectives, set clear targets
- Will this assessment address climate change/sea level rise in the future?
    - Climate is one of the factors, shows up under every habitat type
- Essential Fish Habitat consultations - we can't review every project! Something to help prioritize our energy would be helpful

Name	Affilitation	Contact (Email)
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Weaver, Alan	VA Dept of Game and Inland Fisheries	alan.weaver@dgif.virginia.gov
Whitehurst, David	VA Dept of Game and Inland Fisheries	David.whitehurst@dgif.virginia.gov
Williamson, Lacey	USGS Contractor	lwilliamson@contractor.usgs.gov
Woodland, Ryan	UMCES	woodland@umces.edu
Young, John	USGS	jyoung@usgs.gov

Tidal Salt nearshore/intertidal	Tidal Fresh	Headwaters 3rd order and lower	Nontidal 4th order plus
Tom Ihde (MSU/STAC)	Margaret McGinty (MD DNR)	Kelly Maloney (USGS)	Jennifer Rapp (USGS)
Donna Bilkovic (VIMS/STAC)	Tom O'Connell (USGS)	Ken Hyer (USGS)	Steve Faulkner (USGS)
Mark Monaco (NOAA/STAC)	Joe Love (MD DNR)	Matt Sell (MD DNR)	John Young (USGS)
Ryan Woodland (UMCES)	Troy Tuckey (VIMS)	Renee Thompson (USGS/CBPO)	Scott Phillips (USGS/CBPO)
Lisa Kellogg (VIMS)	Albert Spells (USFWS)	Jason Hill (VADEQ)	Nancy Roth (Tetra Tech)
Sydney Alhale (VMRC)	Kara Skipper (MD DNR)	Neely Law (CWP)	David Whitehurst (VA DGIF)
Sean Corson (NOAA)	Marek Topolski (MD DNR)	Gary Shenk (USGS/CBPO)	Scott Stranko (MD DNR)
Kara Meckley (NOAA)	Bruce Vogt (NOAA)	Matthew Cashman (USGS)	John Mullican (MD DNR)
David O'Brian (NOAA)	Alan Weaver (VA DGIF)	Peter Tango (USGS/CBPO)	Vicki Blazer (USGS)
Tony Marshak (NOAA)	Laura Drescher (EPA/CBPO)	Lacey Williamson (USGS)	John Clune (USGS)
Emily Farr (NOAA)		Seth Coffman (Trout Unlimited)	
David Bruce (NOAA)			
Suzanne Skelley (NOAA)			
Rachel Dixon (CRC/STAC Coordinator)	Gina Hunt (MD DNR)	Katherine Wares (CRC)	Margot Cumming (CRC)
	Facilitators		
Steering Comm Member	April Croxton, NOAA		
Staff/Notes	Jennifer Lechuga, NOAA		