Scope of Work: Development of Spatially-explicit Models and Decision Support Tools for Assessing and Prioritizing Conservation Actions for Aquatic Habitats of the North Atlantic LCC

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ABSTRACT

Downstream Strategies (DS) and its partners will create and implement a flexible and dynamic aquatic assessment process with the North Atlantic Landscape Conservation Cooperative (NALCC) and its partners. This approach has been widely accepted by aquatic and fish experts across the country and the NALCC will be the next organization to take advantage of this unique process. DS will assemble data and analyze conditions to understand fish distribution, habitat, and threats to aquatic species across the NALCC region. We will engage stakeholders throughout all stages of the project to ensure compatibly of results with the specific goals of the NALCC. The central focus of this project will revolve around a flexible modeling process that has been highly refined from similar on-going and completed projects across the country. Multiple models of different species or species groups will be performed and result in expected species distribution maps, as well as identification and quantification of threats and stressors to the species modeled. The DS project team will utilize the spatially-explicit model results to populate a multi-criteria decision support tool (DST) that will integrate the components of each model developed. The DST will provide a highly functional and user-friendly mechanism for resource managers to visualize, rank, and manipulate inputs to prioritize areas for conservation action.

A 2012 online presentation given by Maureen Gallagher and Steven Krentz of the United States Fish and Wildlife Service (USFWS) describes this process in detail can be found here: “Fishing for Answers” http://www.youtube.com/watch?v=izLCcXBaAiY&feature=youtu.be

1. INTRODUCTION

1.1 Goal and objectives

Downstream Strategies, LLC (DS) has prepared this scope of work to outline the requirements, timeline, schedule, and budget for the development of spatially-explicit models and decision support tools for assessing and prioritizing conservation actions for aquatic habitats of the North Atlantic Landscape Conservation Cooperative (NALCC).

Our goal is to assemble data and analyze conditions to understand fish distribution, habitat, and threats to aquatic species. DS will reach this goal by implementing, improving, and customizing our assessment methodology specific to NALCC. Additionally, DS will leverage our existing datasets and novel decision support tool composition with the wealth of scientific works available to enable NALCC stakeholders to prioritize conservation and management efforts for inland, estuarine, and coastal aquatic species.

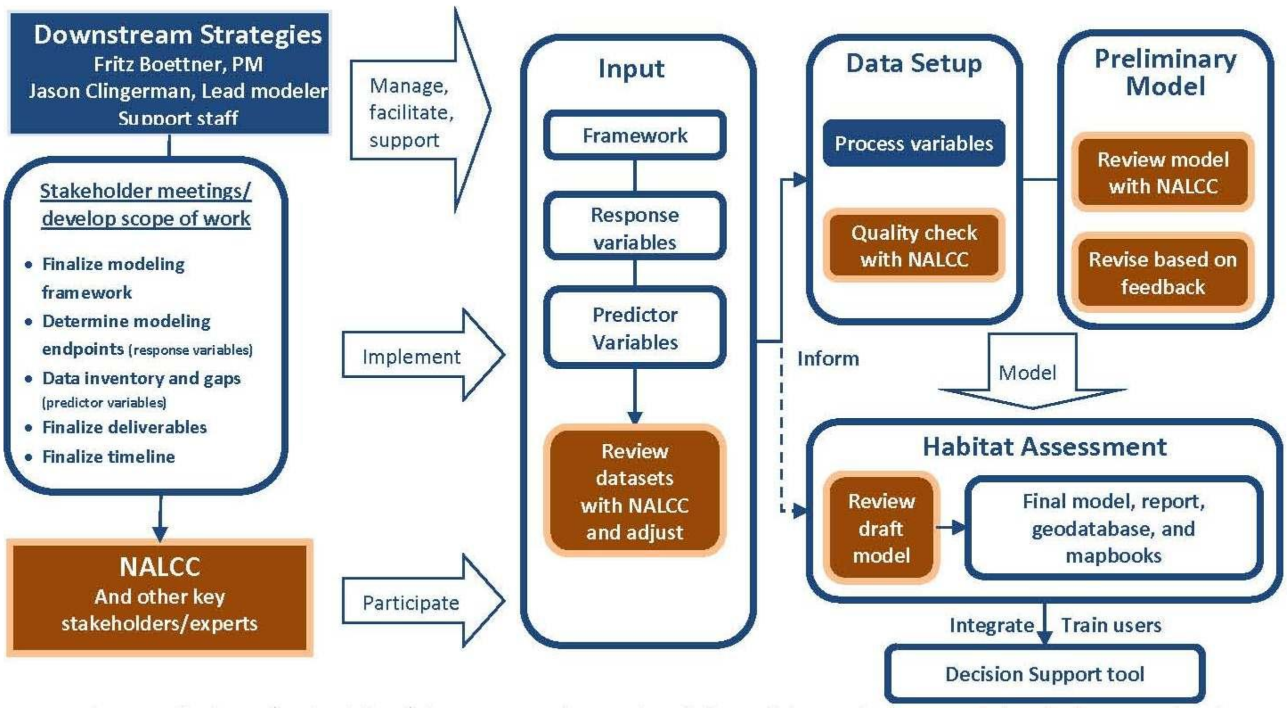
Our objectives will function around a stakeholder process to compile, analyze, and model data determined to be most useful to resource managers during conservation efforts. The process will include a detailed review and augmentation of existing datasets, developing spatially explicit models, and delivering a readily accessible geospatial decision support tool that will empower NALCC stakeholders during evaluation of conservation approaches.

2. METHODOLOGY

2.1 Stakeholder process

The development and implementation of the modeling framework is designed as an inclusive process. Lessons learned thorough recent project experiences have resulted in DS implementing an enhanced role for stakeholder involvement to optimize project outcomes. To begin, DS will lead several "face-to-face" meetings with key stakeholders and aquatic experts in the region. The Atlantic Coast Fish Habitat Partnership (ACFHP) and the NALCC will work with the DS team to identify and bring together stakeholders who are relevant to the project process. DS will then prepare a detailed methodology and submit for stakeholder comment, questions, and suggestions. Utilizing the input from stakeholders, DS will customize the modeling methodology to best meet the needs of the NALCC. We will continue to solicit review and feedback from stakeholders throughout the entire modeling process. We understand the importance of continued involvement, and have specifically built time into the anticipated project schedule to both obtain and incorporate stakeholder input. This approach ensures that the NALCC stakeholders understand the inputs and approve the outputs, creating an inclusive and participatory process, shown in Figure 1.

Figure 1: Stakeholder process and project workflow



2.2 Geographic scope of project

Our modeling effort will be based on the National Hydrology Dataset (NHDv2[1]) tools and data developed by the United States Environmental Protection Agency (USEPA) and the United States Geological Survey (USGS). We utilize "medium resolution" NHD data where catchments are delineated from individual stream segments at the 1:100,000 scale. Within the NALCC, there are approximately 140,000 catchments where there is NHD data coverage. This includes all of the land area of the NALCC within the United States, and a small area of Canada where flow enters the United States. Catchments in Canada contain a much larger drainage area than in the US, see Figure 2 An additional number of headwater catchments will also be included in analyses where watersheds

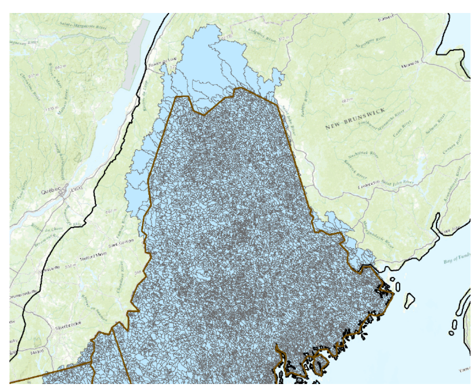


Figure 2: Canadian border example

[1] It is DS's assumption that the NHDv2 is the preferred dataset to use for this modeling process. However, the NHDv1 catchments were used for the Midwest and Great Plains assessments and could prevent a seamless integration with those models, this decision can be made as part of the a process.

begin in adjacent LCCs.

In addition to the modeling for inland streams, there are 64 distinct estuaries defined by the National Fish Habitat Partnership (NFHP) Estuary Assessment that fall within the NALCC boundary, which will be considered for use by the NALCC. By considering use of this spatial framework, predictor variables compiled, by the NFHP Estuary Assessment and response variables collected from available sources, we will model the aquatic habitats for each of these distinct estuaries. In addition, coastal area data and assessment methods will be explored and utilized to understand the NALCC coastal conditions. For both the coastal and estuarine habitats, DS will reach out to existing experts that can provide guidance and support for modeling these distinct habitats.

2.3 Data compilation and preparation

To begin modeling, DS will need to acquire, process, and format both response and predictor variables. DS will work with the NALCC stakeholders to assemble a list of the predictor variables useful for documenting current conditions and assessing threats to the aquatic habitats of interest.

DS will work the National Fish Habitat Partnership (Science & Data Committee) to ensure data products and tools meet the requirements necessary for integration into the existing FHP framework (refer to footnote [1]). As part of the data development process, DS will submit a data management plan to the NALCC for approval. This plan (template provided by the NALCC) will guide the project team and NALCC through the duration of the project. A data dictionary will accompany all data products and the proper metadata will be associated with each dataset. All data will be provided to the NALCC for their distribution to their network(s) and partners.

In past modeling efforts, DS found that land cover, climatological factors, geology, and human disturbance variables were most important, but selected variables will be refined to meet the needs of the NALCC stakeholders. Once the predictor variables are established, DS will utilize the tools available within the NHDv2 (or NHDv1) Plus to provide a measure of the local and the cumulative upstream effect of each individual variable. The spatially-explicit geodatabase of predictor variables will be one of the deliverables DS will provide to the NALCC. This data will be compiled at the NHD “catchment” level, but can be scaled up to HUC-8, HUC-12, region, state, or other useful scale as necessary.

For the methodology, we plan to capitalize on the existing scientific analysis and data compilation efforts already completed for the NALCC study area cited in the RFP. A preliminary review of existing works specifically relevant to this project indicates significant effort has been directed toward identifying threats and stressors. These likely threats can be easily incorporated into the methodology by including them as predictor variables. Other efforts have analyzed stream type, flow, and temperature, and these outputs can also be easily incorporated into the DS approach as potential predictor variables for modeling aquatic responses.

We will create five to ten separate stream/river models for all inland waters, and the response variables may include any measure of aquatic habitat condition. In past efforts, DS has found that presence-absence models of important species have generally provided the most accurate models, but our approach will be to actively engage NALCC stakeholders to determine the most appropriate combinations of response variables for the NALCC’s conservation needs. An example for five separate endpoints could be the following: brook trout presence-absence, lithophilic spawning species richness, sensitive mussel presence-absence, sensitive anadromous species presence-absence, and American eel abundance. Once the response variables are determined, DS will work with the NALCC and appropriate agencies (generally state fisheries agencies) to compile and input survey data to create the response variables.

We will also create five to ten distinct models for estuaries. The predictor dataset for the estuaries compiled by the NFHP Estuarine Assessment will be considered with input from NALCC stakeholders to identify any data gaps in the available predictor dataset, to define response variables for estuarine environments, and to collect the data necessary to create a full predictor and response dataset. An example of the potential estuarine responses could include: presence-absence of oyster beds, reproductive success of an estuarine-spawning fish, striped bass abundance, presence-absence of spiny dogfish, and abundance of menhaden.

DS will assemble and synthesize spatial data specific to coastal habitats. While the coastal data does not align with the NHD datasets, DS will inventory and assess data relevant to coastal habitats by examining existing resources, such as the National Oceanic and Atmospheric Administration (NOAA) Essential Fish Habitat Mapper. DS is committed to working with stakeholders and NALCC coastal and estuarine experts to develop a methodology that will meet the requirements of this project. All data and results (inland, estuarine, and coastal) developed during this project will be integrated into the decision support tool, described in Section 2.5. Again, DS will work closely the Science & Data Committee to ensure that the final data and tool products adhere to the standards and expectations of the NALCC and the NFHP.

2.4 Modeling methodology

Using the combination of predictor and response variables derived from the stakeholder process, DS will build a distinct model for each of the multiple species or species groups selected utilizing boosted regression trees (BRT). BRT models combine decision trees (i.e. classification and regression trees [CART]) and boosting methodologies, which result in better cross-validated models than other methods (Elith et al., 2006), including CART. Decision trees are advantageous because (1) they can incorporate any type of predictor data (binary, numeric, categorical); (2) model outcomes are unaffected by differing scales of predictors; (3) irrelevant predictors are rarely selected; (4) they are insensitive to outliers and non-normalized data; (5) they can accommodate missing predictor data; and (6) they can automatically handle interactions between predictors (Elith et al. 2008). The boosting algorithm used by BRT improves upon the accuracy of basic CART approach by following the idea that averaging many rough models offers efficiency over finding a single prediction rule that is highly accurate (Elith et al., 2008).

Once each model is constructed using the available data, it will be possible to extrapolate predictions to each unsampled catchment or estuary within the NALCC boundary. These current conditions are useful for assessments of suitable habitats and mapping the expected range of species. In addition to the expected current conditions, we will utilize the model results to create an index of anthropogenic stress. The identification of these spatially-explicit threats indicated through the modeling process will provide a powerful tool to NALCC stakeholders for prioritization of conservation actions.

For each model, a detailed description of methodology and report of the inputs, responses, model prediction accuracy, stressor influence, and maps (including mapbooks) will be delivered to the NALCC. To complement the reports, a geodatabase of all spatially explicit results will be included in accordance with all appropriate metadata standards.

2.5 Decision support tool

The DS project team will utilize the spatially-explicit model results to populate a multi-criteria decision support tool (DST), which will integrate the components of each habitat assessment. The DST will provide a highly functional and user-friendly mechanism for resource managers to visualize, rank, and manipulate inputs to prioritize areas for conservation action. The NALCC project will realize significant efficiencies from complementary works and tools that DS has already completed as part of an existing contract with Plains and Prairie Potholes Landscape Conservation Cooperative (PPPLCC) and the Midwest Fish Habitat Partnership. Furthering the efficiency benefit to the NALCC, DS has refined a unique tool development process during the PPPLCC project that generated an ArcMap 10 desktop DST. This desktop version—with data and models integrated—will be provided to the NALCC at the end of the modeling process. Additionally, it is noted that if a web-based DST is developed through other efforts, it is the preference of the NALCC that the platform be applied to this project. If available, the web-based toolset will be identical to the desktop version, but available through a web interface.

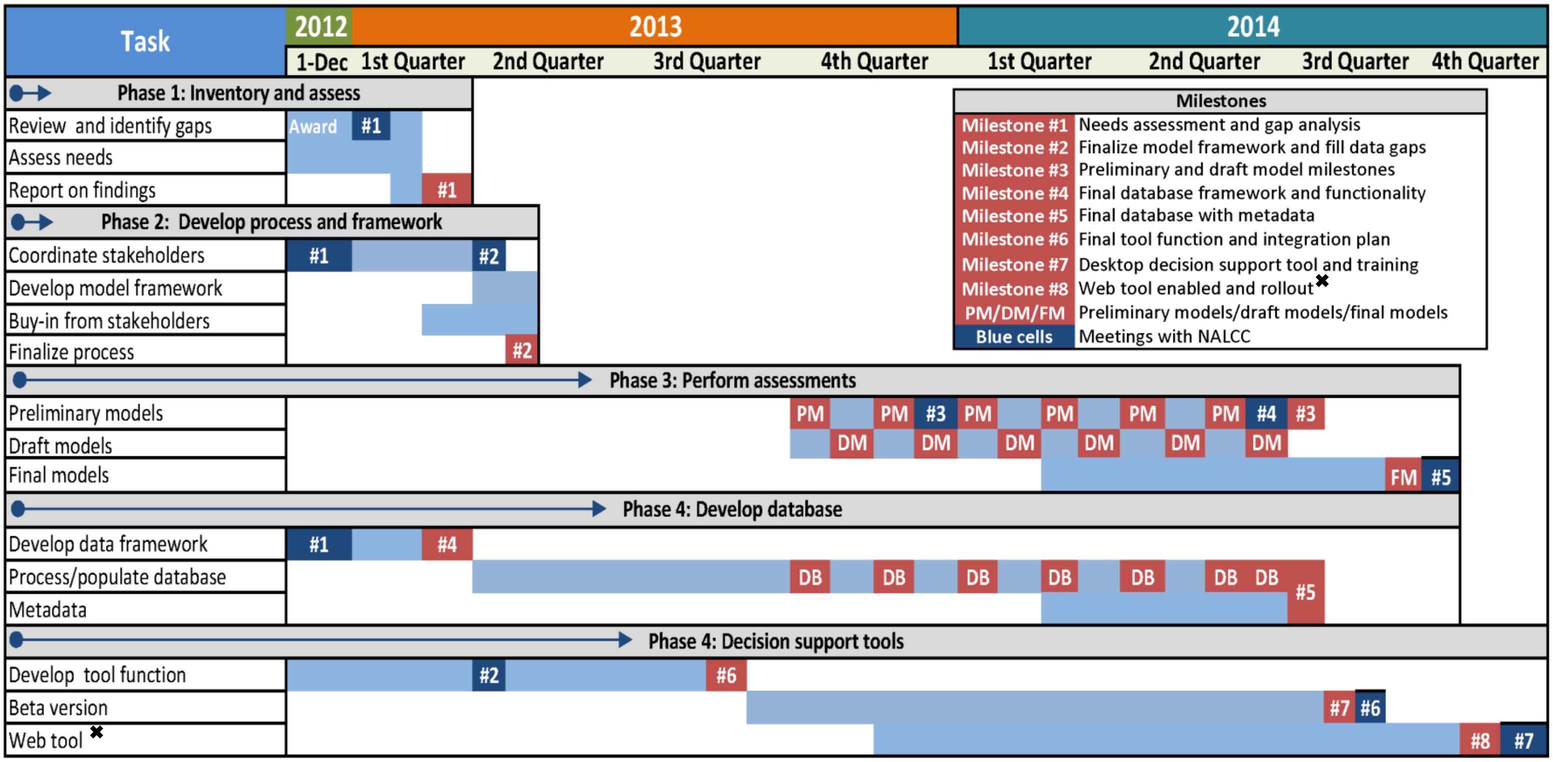
The DST will provide three key functions: visualization, ranking support, and futuring:

- **Visualization:** The visualization tool allows easy and intuitive exploration of all data compiled or created during modeling. This tool can be customized to zoom to and display results at varying spatial scales of interest to the NALCC.
- **Ranking support:** This tool ranks catchments within a selected HUC8 watershed (or other relevant region) based on user-defined criteria and weighting of catchment-level variables. These variables will include modeling results and predictor variables, and could also include additional socioeconomic or other variables of interest.
- **Futuring**: The futuring tool predicts changes in the stress index for a selected catchment based on the user modifying existing stressor conditions. Additionally, changes in stressor indices within the selected catchment can then be propagated downstream with new stressor indices calculated for all downstream catchments.

3. TIMELINE

Timeline for the project is two years.

Figure 3: Project timeline



✖ If funding is made available outside of this project

4. BUDGET

A categorized budget is presented below in Table 1. The total cost is $250,000, inclusive of all professional labor, materials, equipment and expenses anticipated to be responsive to the stated goals of the NALCC Priority Science Program**.** DS will invoice on a monthly basis and include work completed, expenses, and contract labor for each invoice. It is preferred that DS receive a retainer of $10,000 at the start of the project.

Table 1: Project budget

Category	Description	Cost
Personnel service	Total hours at established professional rates	$146,400
Fringe benefits	Accounted in above item as function of rates for salaried professional staff	N/A*
Indirect overhead	5% of total (15% indirect expenses , 10% subcontractor expenses)	$12,555
Supplies and materials	Hardware, software, printing, reproduction	$7,045
Travel	Stakeholder meetings, conferences, presentations or other project related events	$15,000
Contractual service	Decision support tool integration. Aquatic species, habitat, and GIS expertise support	$69,000
Total		**$250,000**

Although no direct cash match funding is available, DS incorporates value addition through an established and thoroughly critiqued methodology for performing landscape-scale modeling where significant stakeholder interaction is required. Both the pre-existing datasets we have accumulated and application of our tested methodology will provide efficiency to the NALCC Priority Science Program project. The modeling and decision support tool framework were built using project funds from various partners across the United States. This project aims to build on existing methodologies and efficiencies to develop more robust models and useful decision support tools.

5. QUALIFICATIONS

5.1 Downstream Strategies and its partners

DS has worked on several large-scale, federally funded, GIS-intensive modeling projects since 2009, including work for the Appalachian Regional Commission. DS has been engaged with the United States Fish and Wildlife Service (USFWS), Midwest and Great Plains Fish Habitat Partnerships, and the Plains and Prairie Potholes Landscape Conservation Cooperative since 2010 to develop fish habitat condition assessments for multiple species for the Midwest and Great Plains regions. This multi-year project covers much of the United States with total contracts exceeding $400,000. Working with the Scientific Advisory Network, DS created a modeling framework and produced powerful modeling results at the catchment level that are already in use for projects in the Midwest and Great Plains. The framework for the NALCC project mirrors those developed by DS for the USFWS project. These methods have undergone an intensive stakeholder process, resulting in a highly successful modeling framework. Our client, Maureen Gallagher, USFWS Region 3 Coordinator of the National Fish Habitat Action Plan, can provide a statement of support letter for DS performance with these contracts. This project experience makes DS and its subcontractors uniquely qualified to perform the modeling work requested in the NALCC RFP.

Fritz Boettner, Principal Investigator, Downstream Strategies. Mr. Boettner will serve as ***project manager and coordinator*** and will be responsible for all budget, timeline compliance, and milestone attainment aspects. He has ten years of professional experience and is the project manager for the USFWS fish habitat assessment projects.

Jason Clingerman, Aquatic Ecologist, Downstream Strategies. Mr. Clingerman will be the ***lead modeler*** and will oversee all modeling aspects of this project working directly with stakeholders to finalize methods, data, and results. He is experienced in natural resources science and management, specifically in aquatic and watershed ecology and is the lead modeler for the USFWS project.

Todd Petty, Associate Professor, West Virginia University. Dr. Petty will serve as the ***scientific advisor*** and ***lead the technical review team***. Dr. Petty is an Associate Professor of Wildlife and Fisheries in the WVU Division of Forestry and Natural Resources and has 15 years of research experience in Appalachian watersheds.

Michael Strager, *Assistant Professor, West Virginia University.* Dr. Strager will be part of the ***tool development and review team***. Dr. Strager is an Assistant Professor of Spatial Analysis in the Division of Resource Management at WVU with expertise in multi-criteria analysis and development of decision support tools. Over the past 20 years he has worked in watershed management, wildlife modeling, land conservation, landscape ecology, sustainable forestry, and optimization modeling.

Evan Hansen, Chief Scientist and Analyst, Downstream Strategies. Mr. Hansen will serve as ***Chief Scientist*** and will lead the ***quality assurance review team***.

Frank Orr, *Project Manager, Critigen*. Mr. Orr will serve as ***technical task manager*** for this effort providing coordination and task management of software development efforts. Mr. Orr has over 15 years of extensive, project-based experience in assessing needs and developing requirements, designing spatial databases, planning and designing GIS enterprise architectures, and implementing custom, integrated GIS enterprise solutions. He has managed large-scale programs and projects including GIS application development, GIS needs assessments, enterprise GIS implementations, sustainability and carbon-management application development, solar site assessments, and solar feasibility studies. *Stefan Orehovec, Lead Programmer, Critigen*. As ***lead programmer*** for this effort, Mr. Orehovec will develop the new versions of the ArcGIS extensions, ensuring functionality is maintained and capabilities are enhanced. With more than 15 years of experience, Mr. Orehovec is adept at developing software applications for viewing and editing geographic and tabular data. These applications range from simple scripts for evaluating data to complex forms which interact with a user. In addition, Mr. Orehovec has produced web sites that allow the public to view and explore geographic data.