Attachment C

PROPOSAL COVER SHEET
Required from all respondents

Please complete and submit this Cover Sheet with your grant The completed Cover Sheet can be scanned and emailed to Thomas.anderson@mass.gov Responses can also be sent in by regular mail to Executive Office of Energy & Environmental Affairs, Division of Conservation Services, 100 Cambridge St., 10th Floor, Boston MA 02114.

Organization information to be used for the contract:

Organization Name: BSC Group, Inc.

Mailing address: 803 Summer Street

Boston, MA 02127

Phone: 617-896-4300

Email: gdavies@bscgroup.com

Website: _____

Commonwealth of Massachusetts, Vendor Code:
VC6000173026
(if our organization has one)

CHIEF EXECUTIVE or authorized signatory:

_____

PRIMARY CONTACT FOR THIS GRANT REQUEST AND POSITION (provide name, phone, e-mail and address if different from above):

Gillian T. Davies

_____

Authorized Signature

Gillian Davies
Print Name

Senior Ecologist / Natural Climate Solutions Specialist
Title

FY 25 GRANT PROJECT INFORMATION

GRANT AMOUNT REQUESTED:

Total $ 99,961

TOTAL PROJECT BUDGET (from all sources, including grant.)

$ 111,283

Total project match

$ 11,322

Project name: Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis

SUMMARY OF GRANT PROJECT (limit to 75 words) (Please also forward this summary of project electronically to thomas.anderson@mass.gov so we can easily cut and paste it in summary reports :

The Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis Project aims to collect and analyze baseline soil and biomass carbon data from upland and wetland forests in Massachusetts, and contribute such data to a future comprehensive Massachusetts Soil Carbon Database to support carbon-smart policy and management practices. The project involves establishing six upland and wetland forest carbon field data sampling sites, with data collection including soil and vegetation sampling.

BSC GROUP

Challenge Grants Implementing the Commonwealth's Healthy Soils Action Plan / NOVEMBER 19, 2024

Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis

Submitted to the Massachusetts Executive Office of Energy and Environmental Affairs

Prepared by BSC Group in partnership with Regenerative Design Group, Woodwell Climate Research Center, Dr. Matthew Duveneck, and Scouter Design

BSC GROUP
BUILD | SUPPORT | CONNECT

Engineers
Environmental Scientists
Software Developers
Landscape Architects
Planners
Surveyors

www.bscgroup.com

November 19, 2024

Tom Anderson
Division of Conservation Services
Executive Office of Energy & Environmental Affairs
100 Cambridge Street
Boston, MA 02114

Dear Mr. Anderson:

The Massachusetts Healthy Soils Action Plan (HSAP) Challange Grant presents an exciting opportunity to implement the HSAP's recommended action steps to improve the current state of soil health in Massachusetts, including for wetlands. In response to this opportunity, BSC Group, together with Woodwell Climate Research Center, Dr. Matthew Duveneck, Regenerative Design Group, and Scouter Design, who collectively have extensive experience in soil, forest, and wetland carbon research and practice and graphic design, has developed a proposal for a "Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis Project" for your consideration.

Soil carbon is crucial for mitigating climate change and delivering ecosystem services, with significant carbon storage potential in forests, both wetland and upland. Massachusetts upland and wetland forests store substantial amounts of soil organic carbon, with wetlands having more than double the per-acre carbon stocks of upland forests. Projected forest development by 2050 could lead to significant carbon dioxide emissions due to the loss of soil organic carbon, particularly highlighting the need for smart growth measures and best management practices to reduce wetland forest conversion.

The Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis Project aims to collect and analyze baseline soil and biomass carbon data from upland and wetland forests in Massachusetts, and contribute such data to a future comprehensive Massachusetts Soil Carbon Database, which would be available to support carbon-smart policy and management practices. The project involves establishing six upland and wetland forest carbon field data sampling sites, with data collection including soil and vegetation sampling. The data would be analyzed at the Woodwell Environmental Chemistry Laboratory, with results integrated into a future MA Soil Carbon Database and published on the MA Healthy Soils Website.

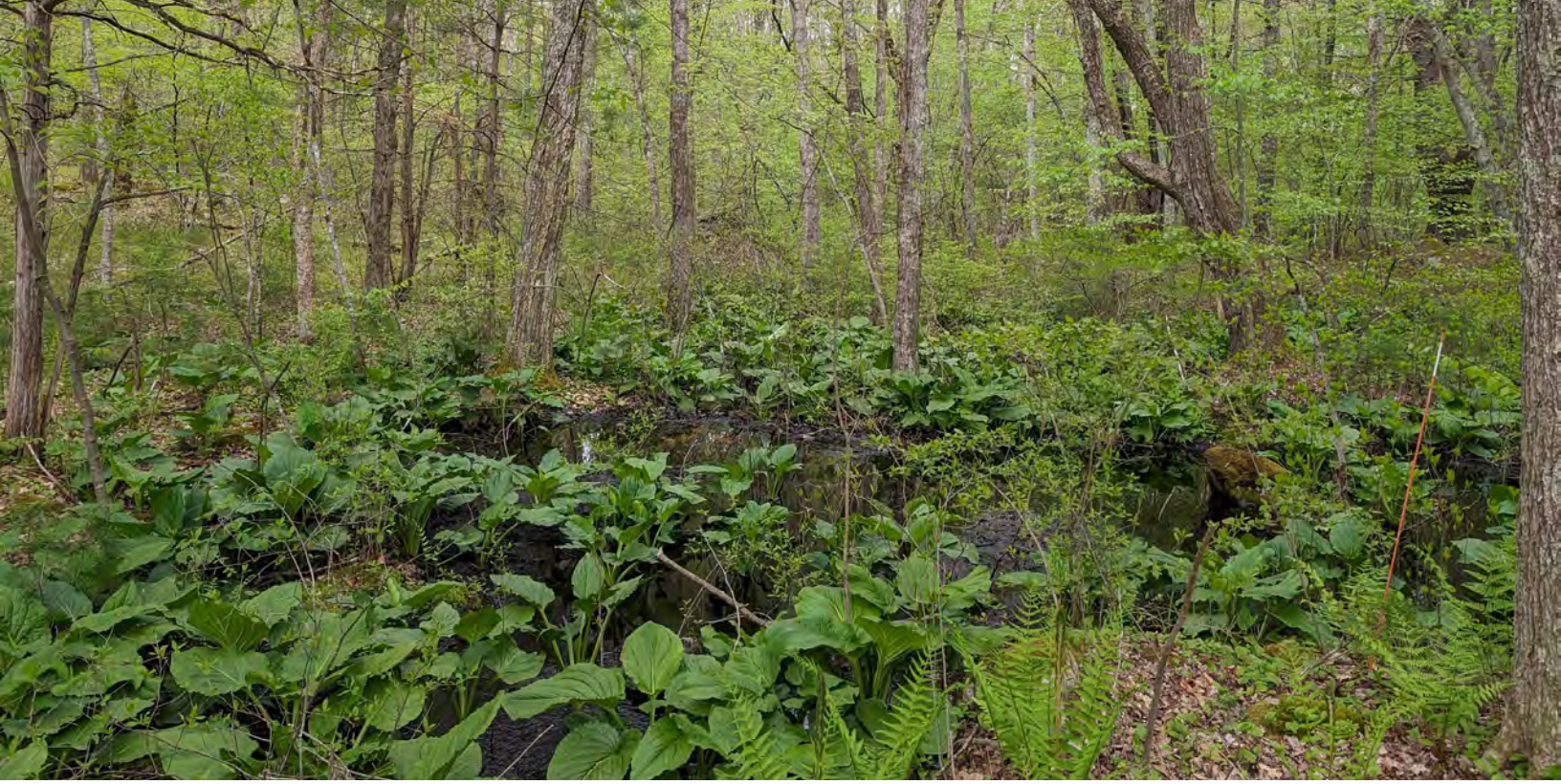
We believe our project team is uniquely qualified to provide this practical and effective option for assisting with implementation of the HSAP and its goals based on our unparalleled depth in wetland, forest, and soil science research & practice, ecosystem carbon modelling, and GIS. Thank you for your consideration and please feel free to contact me with any questions about our proposal or require additional information.

Sincerely,

BSC Group

Gillian T. Davies

Gillian Davies, PWS, RSS, NHCWS, CESSWI
Senior Ecologist / Natural Climate Solutions Specialist
803 Summer Street / Boston, MA 02127 / 617-896-4300



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Project Description

INTRODUCTION

"Soil carbon comprises 9% of the mitigation potential of forests, 72% for wetlands, and 47% for agriculture and grasslands. Soil carbon is important to land-based efforts to prevent carbon emissions, remove atmospheric carbon dioxide and deliver ecosystem services in addition to climate mitigation." [1]

The 2023 Healthy Soils Action Plan (HSAP):

- States that "Massachusetts' forest capture over 1-million tons of carbon dioxide in their soils alone and help maintain healthy watersheds by filtering over 1.6 trillion gallons of water annually (Losing Ground, 2020).
- Estimates that tree-covered soils (~3 million acres statewide) store approximately 156 million tons of soil organic carbon, the equivalent of 574 million tons of carbon dioxide, the second largest soil carbon pool after wetlands.
- Estimates that the state's forested, scrub/shrub and emergent herbaceous wetlands cover approximately 590,565 acres (~14% of Massachusetts land area), and store approximately 190 million tons of Soil Organic Carbon (SOC), the equivalent of 698 million tons of carbon dioxide.
- In Massachusetts wetlands, per-acre SOC stocks average more than double the stocks found in upland forests. The HSAP reports that the vast majority of wetlands are freshwater forested wetlands, which occupy approximately 407,578 acres, or 69% of total Massachusetts wetland area.

The HSAP predicts:

- That close to 133,000 acres of forest could transition to developed land by 2050 (based on Harvard Forest's New England Land Futures scenarios), with an anticipated emission of 14.4 million tons of carbon dioxide due to cumulative loss of SOC.
- That Business-as-Usual rates of wetland conversion to development will result in 84,000 more metric tons of carbon emitted per year than if smart growth measures are implemented that result in a 50% reduction in wetland conversion (see HSAP page 58).

The HSAP makes dozens of evidence-based recommendations to assist in reducing upland and wetland forest carbon emissions caused by human activities. Implementing these soil-smart changes in upland and wetland forest management will require Massachusetts-specific carbon data on upland and wetland forests, and the SOC stock differences between the two forest types.

[1] Bossio DA, Cook-Patton SC, Ellis PW, Fargione J, Sanderman J, Smith P, Wood S, Zomer RJ, von Unver M, Emmer IM, & Griscom BW. 2020. The role of soil carbon in natural climate solutions. Nature Sustainability 3, 391-398.

This level of detail to guide management recommendations is currently not available.

This project specifically furthers the following HSAP recommendations by generating much needed baseline carbon data for Massachusetts forests and the SOC stock differences between upland and wetland forests. The database generated by this project would help guide and support the following HSAP recommended actions by providing important baseline data that is specific to Massachusetts forests (wetland & upland):

From the HSAP Forests Section (pages 45 – 46):

F2 - *Consider maintaining or increasing incentives that keep forests soils healthy and in forest land cover.*

- **a.** *Look for ways across existing forest programs to incentivize management practices that enhance soil and ecosystem health.*

F5 - *Account for forest-based carbon emissions and sequestration in climate change policies and actions.*

- **a.** *Policy: Account for the sequestration and emission of carbon from forests in state greenhouse gas tracking. Include live below ground biomass and soil organic carbon.*

F7 - *Increase support for research into the effects of forest management practices on soil health.*

- **a.** *Long-term effects of different management patterns and harvest intensities on soil organic carbon storage and sequestration*
- **b.** *The extent, intensity, and durability of soil compaction from harvesting and other management*
- **c.** *Effects of soil decompaction, remineralization, and other fertilization on forest regeneration and composition*

F2 - *Increase monitoring + research of ongoing changes to forest soils from climate change.*

From the HSAP Wetlands Section (pages 62 – 63)

W2 - *Review and propose updates to regulations that protect the structure and function of wetland soils and the ecosystems they support.*

- **e.** *Provide resources to expand municipal adoption of effective performance standards that protect existing wetland soils and their ecosystem services (including carbon stocks and sequestration capacity) and contributing upland areas. Approaches could include grants for technical assistance to develop local ordinances.*

W4 - *Account for wetland-based emissions in all climate change policies and action.*

W7 - *Seek to revise management activities in wetlands including vegetation management, filling, dredging, or other modifications to hydrology so they account for the impacts to soil health such as additional carbon emissions, reduced sequestration, or increased sediment transport.*

- **b.** *Promote invasive species management that does not damage wetland soil health.*
  - **i.** *Research the effects of chemical and mechanical disturbance on soil health.*
  - **ii.** *Develop soil-smart BMP's for invasives management.*

Although the Wetlands Protection Act regulations *(310 CMR 10.00 et al.)* offer some protection for Massachusetts wetlands, they do not yet recognize the carbon-related benefits/ ecosystem services of wetland soils and their ability to offset carbon emissions. However, the regulations do allow impacts to wetland soils without requiring mitigation specifically for carbon impacts.

Data on the carbon differences between upland and wetland forests in Massachusetts is sparse, and this project would contribute to filling this critical gap, thus providing data and science to support carbon-smart policy and management practices for both upland and wetland forests. The preliminary and general data that does exist regarding carbon differences between upland and wetland forests indicates that wetland forests typically hold more than twice the carbon of upland forests, and most of that carbon is in the soil, thus indicating that impacts to wetland forests and especially to wetland forest soil have the potential to release greater amounts of carbon to the atmosphere than impacts to upland forests and upland forest soil. Greater understanding of these carbon dynamics, including understanding differences between different types of upland and wetland forests, will support more informed policy-making.

More specifically, the purpose of this project is to:

- Collect and analyze (including laboratory analysis) baseline SOC and aboveground biomass carbon data for comparison between upland and wetland forests in Massachusetts using sampling/collection protocol and processes developed by this same Project Team under the **HSAP Ecosystem Carbon Sampling Protocols & Planning Project**, which is also being proposed during this grant round. The timelines for the two projects have been coordinated to ensure efficient and coordinated completion of both projects prior to June 30, 2026.
- The purpose of proposing this project and also proposing the separate HSAP Ecosystem Carbon Sampling Protocols & Planning Project (Ecosystem Protocols Project) is to leverage the protocols developed from one with the intensive field and lab analysis from the other, thus allowing sampling from a larger number of sites, enhancing the reliability of the data gathered, and allowing sampling on a wider variety of Massachusetts forest soil types. We choose to separate the proposals in order to maximize the benefits gained from each. The value of the Ecosystem Protocols Project will be greatly enhanced by pairing it with a robust field sampling and laboratory analysis project, which allows for testing and refinement of the protocols developed in the Ecosystem Protocols Project. This hands-on, field and laboratory-focused project benefits greatly by accessing well-developed sampling and laboratory protocols and processes. The combined efforts of the two projects are anticipated to be an efficient and cost-effective investment for the Commonwealth.
- This project would collect high quality baseline upland and wetland forest soil and biomass carbon data in specific areas of Massachusetts at six (6) forest carbon field data sampling/monitoring sites. Ideally, the property owners would commit to establishing the sites as long-term upland and wetland forest carbon field data sampling/monitoring sites, in addition to allowing data collection for this project. The sites would be split approximately evenly between wetland forest (e.g. red maple swamp; floodplain swamp; Atlantic white cedar swamp; black spruce swamp) and upland forest (e.g. spruce-fir-Northern hardwoods; Northern hardwoods- hemlock-white pine; transition hardwoods-white pine-hemlock; central hardwoods-hemlock-white pine; pitch pine-oak) sites and would represent some of the primary Massachusetts forest types in each category.

This project will contribute to the implementation of the above-mentioned HSAP Priority Actions, recommendations, and HSAP Challenge Grant RFR goals by generating baseline Massachusetts upland and wetland forest carbon data that is greatly needed, since little of this type of data exists. Once a better database has been compiled, analysis of the database is anticipated to provide a better understanding of how to implement the carbon-smart upland and wetland forest carbon policy and management practices that are referenced in some of the HSAP recommendations listed above.

This project will be conducted in four phases (or Tasks) over an 18-month period from January 2025 to June 2026 (see the Methodology and Timeline sections). Each of these phases will be implemented by our highly experienced and qualified Project Team (see Team), and led by BSC Group, a member of the HSAP Working Group, and lead consultant for the MassDEP No Net Loss of Wetland Carbon Project. The project upland and wetland forest carbon field data collection and analysis program is outlined in greater detail in the Methodology, Timeline, and Expected Outcomes + Deliverables sections. A final HSAP Massachusetts upland and wetland forest carbon project report (Final Project Report) will be published to the **MA Healthy Soils Website** and the forest carbon data gathered will be maintained by RDG in accordance with the protocols developed in the **HSAP Ecosystem Carbon Sampling Protocols & Planning Project** so that it can be integrated into a **future MA Soil Carbon Database**.

The Project Team is uniquely qualified to execute this scope of services. World class soil carbon researchers from Woodwell Climate Research Center (Woodwell) (based in Falmouth, MA) and forest ecologist Matthew Duveneck, an expert on above-ground Massachusetts forest carbon who conducts research at Harvard Forest, will be leading development of the upland and wetland forest carbon field observations & soil sampling protocols.

The Environmental Chemistry Laboratory at Woodwell Climate will be used to conduct soil sample analysis. Team members include the lead authors of the HSAP (RDG), a member of the HSAP Working Group (BSC Group (BSC)), and the consulting team from the Massachusetts Department of Environmental Protection (MassDEP) No Net Loss of Wetland Carbon Project (BSC, RDG, Woodwell Climate Research Center, and the Massachusetts Association of Conservation Commissions (MACC)).

The No Net Loss of Wetland Carbon Project conducted an extensive literature search on wetland carbon science, policy, and management; used machine learning to map Massachusetts wetland extent and carbon; developed preliminary software recommendations and mock-ups for a wetland carbon user interface; and provided MassDEP and the Massachusetts Executive Office of Energy & Environmental Affairs (EEA) with extensive policy, regulatory, and wetland carbon management recommendations. The final report for this project is currently under review by MassDEP. The Project Team's extensive background will allow them to draw on internal wetland healthy soil subject matter expertise and resources, while aligning with, and avoiding duplication of, prior efforts.
The Challenges:

GOALS + OBJECTIVES

This project meets all four primary objectives of these healthy soils Challenge Grants in the following ways:

1. **Promote Soil Health:** To support demonstration type projects that document, prioritize and implement practices aimed at improving soil health and fertility.
   - › *This project will promote soil health by documenting and quantifying soil organic carbon, as well as sampling of aboveground biomass carbon (large roots and representative understory sampling), in dominant Massachusetts forests types. Before practices can be prioritized, baseline Massachusetts forest carbon data that identifies carbon differences between upland and wetland forests, and between different forest types, needs to be developed and analyzed. This project would generate such data and analysis.*
2. **Sustainable Land Management:** To encourage innovative approaches to sustainable land management that minimizes environmental degradation, enhances biodiversity and/or restores degraded soil health.
   - › *This project will develop the baseline Massachusetts upland and wetland forest carbon data and analysis that will inform innovative approaches to sustainable land management, with sustainable approaches/practices integrating an understanding of the carbon differences between upland and wetland forests.*
3. **Community Engagement:** To foster community involvement and education in sustainable land practices and soil health improvement.
   - › *This project will develop the baseline Massachusetts upland and wetland forest carbon data and analysis (i.e. content) that can then be integrated into other HSAP projects that offer specific community outreach and education events.*
4. **Refine Tools for Municipal Soil Mapping, Assessment + Planning:** Update and distribute assessment and planning tools to enable municipalities, regional planning districts, and conservation organizations to visualize and integrate soil health into regular workflows.
   - › *The baseline Massachusetts upland and wetland forest carbon data and analysis that is generated by this project will be made available to municipalities, regional planning districts, and conservation organizations for their education and use as they work to integrate soil health into regular workflows, including making the Final Project Report available on the MA Healthy Soils Website.*

THE CHALLENGES

Projects in or near wetlands, and the carbon, soil, and ecosystem dynamics of wetlands themselves, are inherently complex. For instance, wetland disturbance typically results in increased carbon emissions from the disturbed wetland, particularly when wetland soils are disturbed or drained. Successful protection and restoration of wetland soil health and mitigation for impacts to soil health requires a sound understanding of the soil dynamics of the specific region under consideration, making Massachusetts upland and wetland forest carbon data sampling and analysis an essential component of full implementation of the HSAP.

Some of the challenges in implementing upland and wetland forest carbon data sampling & analysis, and our strategy for managing the challenges, are outlined below:

- **Collection of upland and wetland forest carbon data requires landowner permission.** To minimize difficulties with obtaining landowner permission, the Project Team proposes working with EEA and other state agencies and non-profits such as land trusts to identify data collection/research sites on state or non-profit-owned lands. If possible, these sites could be used for data collection in future years, should funding become available. This would allow tracking of forest carbon over time.
- **This data collection & analysis project is intended to utilize ecosystem carbon sampling protocols developed under the HSAP Ecosystem Carbon Sampling Protocols & Planning Proposal and is dependent upon the HSAP Ecosystem Carbon Sampling Protocols & Planning Proposal being funded.** The decision as to whether or not to go forward with both the HSAP Ecosystem Carbon Sampling Protocols & Planning Project Proposal and this one rests with EEA, and thus EEA will determine whether this proposal goes forward, just as it would if this proposed project were not dependent upon the HSAP Ecosystem Carbon Sampling Protocols & Planning Proposal. Should EEA decide to fund this project but not the HSAP Ecosystem Carbon Sampling Protocols & Planning Project, this scope of services could be adjusted to include forest carbon sampling protocols and processes, with a commensurate reduction in the number of sites that could be sampled and analyzed.

As noted above, the purpose of proposing two separate projects rather than one is to allow sampling from a larger number of sites, thus enhancing the reliability of the data gathered, and allowing sampling on a wider variety of Massachusetts forest soil types. If the two projects were combined, the reduced budget would allow for only limited data collection. The value of the Ecosystem Carbon Sampling Protocols & Planning Project will be greatly enhanced by pairing it with a robust field sampling and laboratory analysis project, which allows for testing and refinement of the protocols developed in the Ecosystem Carbon Sampling Protocols & Planning Project.

This hands-on, field and laboratory-focused project benefits greatly by accessing well-developed sampling and laboratory protocols and processes. The combined efforts of the two projects are anticipated to be an efficient and cost-effective investment for the Commonwealth.

- **This project would run simultaneously with the HSAP Ecosystem Carbon Sampling Protocols & Planning Project.** The timelines for the two projects have been coordinated closely, and the Project Teams for the two projects involve many of the same team members, including the project managers for both projects. These team members, including the project managers for both projects, have worked together successfully before on complex, multi-phase, Massachusetts EEA and MassDEP projects. The Project Team organizations have deep benches and can pull in additional staff should tasks take

longer than anticipated, to keep both projects on track in a coordinated way. Project Team members have strong and tested organizational and communication skills and enjoy working together. This team is passionate about healthy soils, wetlands, forests, and addressing the climate change challenge, with high standards for the quality and timeliness of work products.

- **Quality vs. quantity tradeoffs.** This project must be completed within the stipulated budget limit of $100,000 and within the timeframe of January 2025 – June 30, 2026, thereby necessitating decisions about maximizing quality while collecting and analyzing as much data as possible. This Project Team has discussed this issue, and is proposing 6 study sites, each of which will include 3 – 6 data plots/soil pits, as discussed above and in the Methodology section. While it would be beneficial to conduct additional studies, doing so would compromise the thoroughness and quality of the data sampling & analysis process in order to stay within budget and on the timeline. It is well known amongst soil scientists that more can be learned about a site by doing fewer well-documented and deeper soil pits rather than a plethora of superficial, shallow pit or augur assessments

METHODOLOGY

The Project Team has the experience, expertise, depth of staffing, facilities, and commitment to meet our goals + objectives while addressing the above challenges.

Phase 1 - Project Management, Coordination & Communication

Good communication, coordination, and project management is essential for any project. At the start of the project, the BSC Project Manager (Gillian Davies) will be available for a Zoom Kickoff meeting with EEA to review the project scope and budget and discuss any questions or requests.

Throughout all of the Phases, the Project Team will communicate actively with EEA staff via email and quarterly project status summaries. Additionally, the Project Team will communicate actively and coordinate internally with all team members to ensure the project is accomplishing project milestones in accordance with the project timeline, stays on budget, the actions of all team members are well coordinated, and the project is well-coordinated with the HSAP Ecosystem Carbon Sampling Protocols & Planning Project. As project manager, BSC will lead project coordination and communications and will compile and submit quarterly project status summaries. BSC is highly experienced in managing projects of this size and scope, and that involve multiple consulting groups and complex client goals and concerns.

Because this same Project Team is staffing the proposed HSAP Ecosystem Carbon Sampling Protocols & Planning Project, coordination between the two projects will be relatively straightforward. The consulting team has years of experience working together on multiple projects and will plan and execute timely and effective coordination between these two projects, including regular check-in calls between the project managers of the two projects.

Phase 2 – Field Data Sampling Site Identification, Landowner Permissions, & Scheduling

The initial phase of this project will be focused on identifying potential upland and wetland forest carbon field data sampling sites that reflect some of the main forest types in different regions of the state, as noted in the Figure above, and obtaining landowner permission to conduct carbon studies at the sites. During this phase, a field visit schedule will be developed. As mentioned above, this project assumes that the HSAP Ecosystem Carbon Sampling Protocols & Planning Project is being implemented simultaneously with this project.

Field visit scheduling will be coordinated to coincide with finalization of upland and wetland forest carbon sampling protocols in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project.

Phase 3 – Field Data Documentation/ Sampling

Once field data documentation/sampling sites have been identified and site access permissions have been obtained, and once the upland and wetland forest carbon sampling protocols have been developed, field data documentation and sampling crews made up of BSC staff will be deployed. These crews will attend a full-day training led by Woodwell (soils) and Matthew Duveneck (vegetation) to ensure that they are trained in the specific upland and wetland forest carbon sampling protocols designed for this project. The crews will then conduct upland and wetland forest carbon data collection at the identified study sites during the 2025 growing season and will send soil and vegetation samples to the Woodwell Climate Research Center Environmental Chemistry Laboratory for analysis.

Soil and Vegetation Documentation & Sampling

Soil sampling will include sampling each horizon in test pits, as well as documentation of the soil profile. Vegetative samples will include large roots, and representative understory vegetation sampling from each site.

Each of six sites would be split approximately evenly between wetland forests (e.g. red maple swamp; floodplain swamp; Atlantic white cedar swamp; black spruce swamp) and upland forests (e.g. spruce-fir-Northern hardwoods; Northern hardwoods- hemlock-white pine; transition hardwoods-white pine-hemlock; central hardwoods-hemlock-white pine; pitch pine-oak) and would represent some of the primary Massachusetts forest types in each (as shown in the Figure above).

The goal of this project will be to produce very high-quality forest carbon data for each site, with between 3 and 6 data plots/soil pits. At each wetland site, up to 3 upland data plots/ soil pits will be documented in addition to the 3 wetland data plots/soil pits, so that the transition from wetland to upland forest carbon can be better understood. When an upland forest site is assessed, if there is a wetland in the vicinity, the same process will occur in reverse – at least 2 or 3 wetland data plots/soil pits will be documented. However, there may be some upland data plots that are located a significant distance away from a wetland, making such a transect infeasible.

Example outline of field and lab methodology:

- A representative sampling transect will be implemented along an upland to wetland (center) forest gradient.
- In the upland, transitional, and wetland forest sections of transect, we will follow established US Forest Service Forest Inventory and Analysis (FIA) sampling protocols for their phase 2 plots, slightly modified for this application to only include one 58.9-foot radius plot for field sampling. Within this plot, we will measure the diameter at breast height (DBH), species, and height of all trees. This information will be used to quantify above and belowground tree biomass using established allometric equations.
- Within the upland, transitional, and wetland forest plots we will provide species identification of forest floor vegetation within two 3x3 ft square quadrat plots. For these plots (if the landowner grants permission), we will clip and remove biomass and litter for lab carbon assessments.
- Soil sampling will occur at up to 3 pits within upland portions of the transect, with approximately 2 pits within the transitional zone, and 2-3 pits within the wetland. At each pit, soils will be field profiled using US NRCS, Soil Society of America, and USACE

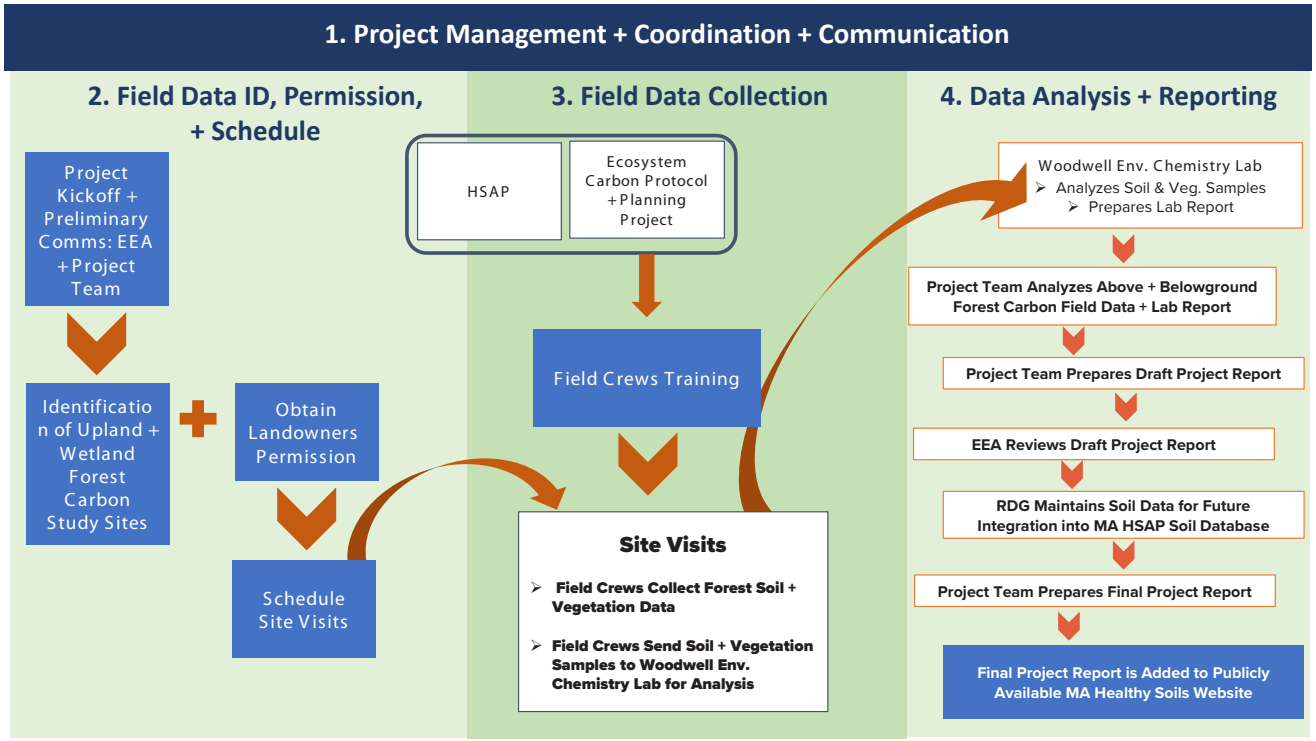
soil classification guidelines and photographed. Soil cores will be extracted from each pit/sample site using ~ 7 cm diameter corers in upland/transitional/wetland zones (down to 1 m depth except for deep wetland locations where the cores may be extracted up to 2 m depth).

- At soil sample locations, pH, soil temperature, and soil moisture data will also be recorded.
- Collected vegetation and soil samples will be processed in the Woodwell Environmental Chemistry Laboratory. For vegetation, we will obtain data on total organic carbon and nitrogen (gC/g and mgN/g per sample). For soils, we will obtain soil texture (%clay, sand, silt); bulk density; total carbon and nitrogen concentrations (using Elementar Variomax Cube CN analyzer) , and pH per sample, with samples from approximately five soil horizons per pit/location.

Phase 4 – Data Analysis + Reporting

In Phase 4, the soil and vegetation samples will be analyzed at the Woodwell Environmental Chemistry Laboratory, where a laboratory report will be produced. Both upland and wetland forest carbon field and laboratory data from Phase 3 will be analyzed. The forest carbon data will be maintained by RDG in accordance with the protocols developed in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project so that it can be integrated into a future MA Soil Carbon Database. The Project Team will prepare Draft and Final Project Reports documenting the project site locations, methods, data analysis, and findings. Once approved by EEA, the Final Project Report will be added to the MA Healthy Soils Website

METHODOLOGY FOR FIELD DATA DOCUMENTATION/SAMPLING, ANALYSIS + REPORTING



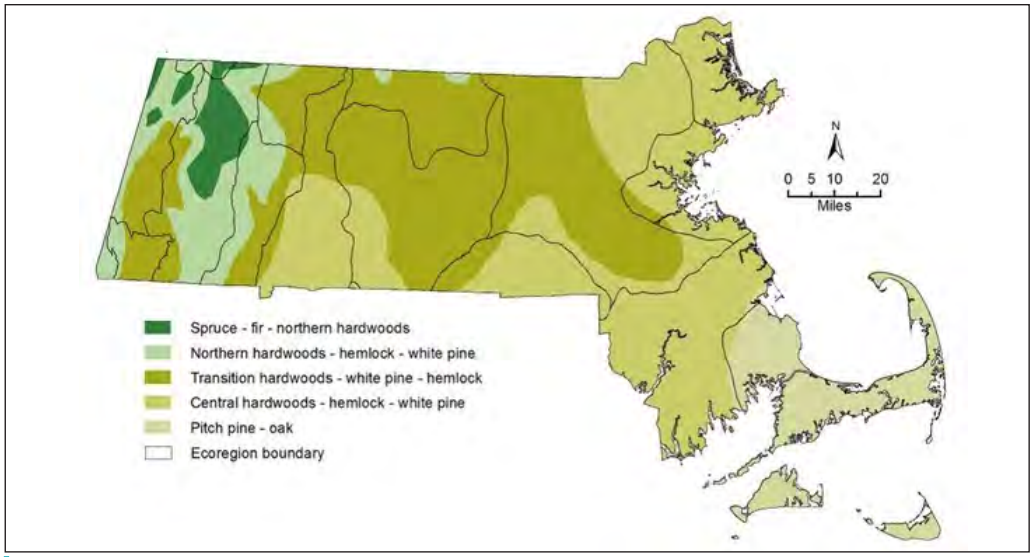


Figure: **Massachusetts Forest types**
Source: https://www.mass.gov/guides/forestry-in-massachusetts

EXPECTED OUTCOMES + DELIVERABLES

The primary deliverables from this project will be:

- Establishment of 6 forest carbon field data documentation/sampling sites, for completion of this project. Ideally and in addition, the property owners would commit to establishing the sites as long-term upland and wetland forest carbon field data documentation/sampling sites. The sites would be split approximately evenly between wetland forest (e.g. red maple swamp; floodplain swamp; Atlantic white cedar swamp; black spruce swamp) and upland forest (e.g. spruce-fir-Northern hardwoods; Northern hardwoods- hemlock-white pine; transition hardwoods-white pine-hemlock; central hardwoods hemlock-white pine; pitch pine-oak) sites and would represent some of the primary Massachusetts forest types (see Figure above).
- Field and laboratory data pertaining to upland and wetland forest carbon and the differences between the two, for a range of Massachusetts forest types in different Massachusetts ecological regions will be provided, as noted above. As noted above, the goal of this project will be to produce very high-quality forest carbon data for each site, with at least 3 data plots/soil pits in each study site, and up to 6 data plots/soil pits wherever possible. At each wetland site, up to 3 upland data plots/soil pits will be documented as well, so that the transition from wetland to upland forest carbon can be better understood. When an upland forest site is assessed, if there is a wetland in the vicinity, the same process will occur in reverse – at least 2 or 3 wetland data plots/soil pits will be documented. However, there may be some upland data plots that are located a significant distance away from a wetland, making such a transect infeasible.
- The **Woodwell Environmental Chemistry Laboratory** will provide a Laboratory Report summarizing laboratory analysis of soil and vegetation samples.
- Upland and wetland forest carbon datasets that will be maintained by RDG in accordance with the protocols developed in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project so that they can be integrated into a future MA Soil Carbon Database.
- Upland and forest carbon data and project results, as reported in the Final Project Report, will be added to the MA Healthy Soils Website, so as to share more broadly and further develop these resources.
- Draft and Final Project Reports documenting project site locations, methods, data analysis, and findings.

We are confident this project will fulfill the following key outcomes:

1. Identify upland and wetland forest carbon field data collection/monitoring sites for this project, and ideally as long-term data collection/monitoring sites.
2. Utilize upland and wetland forest carbon field data documentation/sampling and laboratory protocols developed in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project.
3. Develop data that can be integrated into a future MA Soil Carbon Database, thus improving accuracy and reliability of Massachusetts ecosystem carbon data.
4. Contribute project data, results, as reported in the Final Project Report, to the MA Healthy Soils Website to share knowledge more broadly.
5. Provide a project report that shares project methodology and new knowledge about Massachusetts upland and wetland forest carbon more broadly.

The final deliverables for this project will be:

1. Establishment of upland and wetland forest field data collection/monitoring sites located in the primary Massachusetts upland and wetland forest cover types and in various ecological regions of the state, as noted above.
2. Massachusetts upland and forest carbon data sets will be maintained by RDG in accordance with the protocols developed in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project so that they can be integrated into a future MA Soil Carbon Database.
3. Provision of Massachusetts upland and forest data and reporting for the MA Healthy Soils Website.
4. Draft and Final Project Reports.

PROJECT IN-KIND MATCH

This project includes match contributions including the following:

- Woodwell's Jenny Watts will lead the field crew training day at no charge (1 day) and will lead the soils portion of the first field documentation/sampling (located at the Woodwell site in Falmouth) at no charge (1 day). BSC Group's project manager and field crew will attend the field crew training day at no charge (5 people x 1 day). BSC Group's project manager will only charge a half day for the first field documentation/sampling day (located at the Woodwell site in Falmouth).
- BSC's project manager will donate some initial project management, coordination + communication time during the initiation of the project in Phase 1.
- BSC and Woodwell office space and Woodwell's laboratory and forest study site will be available for in-person meetings and the field crew training and first field documentation sampling day at no cost.
- After project completion, Project Team members are available to give presentations about the project and results at professional conferences and non-profit annual meetings on a *pro bono* basis and will help promote such presentations.
- Depending on project results and time available, Project Team members may be able to write an article about the project and project results for an academic journal.

This proposal document serves as the written commitment of the Project Team to provide the specified match services noted above.

Budget

On the following page we have provided our proposed budget for the Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis.

BUDGET

Project Phase	*Subtask*	Grant Monies	In-Kind Match Contributions
Phase 1: Project Kickoff + Communications	1.1 Project Kickoff + Communications + Coordination	$ 186	$ 372
	1.2 Quarterly Project Status Summaries	$ 745	$ -
Phase 1: Project Kickoff + Communications Total		**$ 932**	**$ 372**
Phase 2: Site ID, Landowner Permissions, Site Visit Scheduling	2.1 Identify Upland + Wetland Forest Carbon Study Sites	$ 2,802	$ -
	2.2 Obtain Landowner Permission	$ 3,164	$ -
	2.3 Schedule Site Visits	$ 2,000	$ -
Phase 2: Site ID, Landowner Permission, Site Visit Scheduling Total		**$ 7,965**	**$ -**
Phase 3: Field Data Documentation + Sampling	3.1 Field Crew Establishment + Training @ Woodwell Offices + 1st Site Visit	$ 12,811	$ 10,950
	3.2 Field Crew Site Visits	$ 29,603	$ -
	3.3 Soil & Vegetation Samples Transported to Woodwell Env. Chem. Lab	$ 1,200	$ -
Phase 3: Field Data Documentation + Sampling Total		**$ 43,615**	**$ -**
Phase 4: Data Analysis + Reporting	4.1 Woodwell Lab Soil + Veg Sample Analysis + Lab Report	$ 9,293	$ -
	4.2 Maintenance - Upland & Wetland Forest Carbon Data	$ 1,327	$ -
	4.3 Draft Project Report	$ 22,415	$ -
	4.4 Final Project Report	$ 13,683	$ -
	4.5 Final Report Posted on MA Healthy Soils Website	$ 1,032	$ -
Phase 4: Data Analysis + Reporting Total		**$ 47,449**	**$ -**
Grand Total		**$ 99,961**	$ 11,322

Note: In-Kind value for services include donated use of space for meetings and the field crew training from Woodwell and BSC, supporting labor from Woodwell and BSC, some initial project management time labor from BSC, donated labor to staff presentations at conferences where project methods and results can be shared with the larger upland and wetland forest communities, and associated promotional support from the Project Team. However, in the table above, only the in-kind labor costs incurred during the project time period are included, as the in-kind cost for use of space during the project and time/costs contributed for presentations after project completion are imprecise.

BSC GROUP

Organizational Capacity

The BSC Project Team for the Healthy Soils Action Plan Upland and Wetland Forest Carbon Data Collection & Analysis Project is comprised of leading organizations who are heavily involved in major climate resilience planning efforts in Massachusetts.

ABOUT BSC

BSC Group (BSC), founded in 1965, is a full-service planning and engineering consulting firm with a staff of 185 personnel and offices in Boston, Worcester, Andover and West Yarmouth, Massachusetts, as well as Glastonbury, Connecticut, and Manchester, New Hampshire. BSC has provided interdisciplinary ecological, permitting, design, planning, GIS, and construction phase services for municipal, state, and private sector clients throughout the northeast for nearly six decades. BSC's ecological team includes over 50 scientists, subject matter experts, former regulators, and advisory panel members who routinely apply their expertise to challenging projects, offering key insights and strategic benefits.

BSC PROJECT TEAM

BSC will serve as prime consultant for this proposed project and has joined forces with members of other leading Massachusetts firms, including Regenerative Design Group, Woodwell Climate Research Center, and Scouter Design to conduct the Upland and Wetland Forest Carbon Data Collection & Analysis Project. Dr. Matthew Duveneck, a forest ecologist with Massachusetts forest carbon expertise, will also join the team. Each of these leaders has unique expertise and together provide unparalleled depth in wetland, forest, and soil science research & practice, GIS, and ecosystem carbon modelling.

The firms and individuals represented in this Project Team have a proven track record of implementing successful projects of this scale. Individually, each of the firms and key team members have been at the forefront of climate resilience, Nature-based and Natural Climate Solutions, ecosystem, upland and wetland forest carbon, and wetland research, practice, and policy work in their respective fields. Regenerative Design Group (along with Linnean Solutions) led the production of the Healthy Soils Action Plan and was a member of the MassDEP No Net Loss of Wetland Carbon Project consulting team.

BSC Group served on the HSAP Working Group and led the MassDEP No Net Loss of Wetland Carbon Project. Woodwell Climate Research Center was a member of the MassDEP No Net Loss of Wetland Carbon Project consulting team and is an award-winning world class ecosystem climate research center with a substantial focus on the carbon dynamics of wetlands and forests (including wetland forests).

Additionally, these firms have gone on to collaborate on four MVP Program projects that operationalized the insights and recommendations from the HSAP for municipalities. Matthew Duveneck's work has specialized in Massachusetts forest ecology and forest carbon dynamics, with much of his work conducted as a researcher at Harvard Forest.

KEY PERSONNEL

Gillian Davies PWS, RSS, NHCWS, CESSWI; Ethan Sneesby, RSS; Evan Fox, Marleigh Sullivan; Maribelle Tucci [BSC Group]

- **Project management + field data collection site selection + forest carbon field crews + technical review/report preparation + production lead.** BSC will serve as the project Prime with Gillian Davies as Project Manager. BSC will collaborate on selection of field data collection sites; staff the forest carbon field crews; provide technical review and contribute to report preparation; and present results at conferences if EEA desires this outreach.

Bas Gutwein, Rafter Ferguson PhD, Von Harvey [Regenerative Design Group]

- Field data collection site selection + MA **Healthy Soils Website coordination + technical review + production support + integrate field data & analysis into a future MA Soil Carbon Database.** RDG will collaborate on selection of field data collection sites; coordinate integration of forest carbon data & analysis from field work into MA Healthy Soils Website; provide technical review and contribute to report preparation; support production of final deliverable documents; and present results at conferences if EEA desires this outreach, as well as integrate final data and data analysis into a future MA Soil Carbon Database.

Jennifer Watts PhD, Taniya Roychowdhury PhD [Woodwell Climate Research Center]

- **Field data collection site selection + technical review/report preparation + develop & lead field crew training (soils) + laboratory analysis of field data.** Woodwell will collaborate on selection of field data collection sites; provide technical review; develop & lead the soils portion of field crew training conduct laboratory analysis of field data; and provide analysis and report preparation pertaining to below-ground forest carbon.

Matthew Duveneck, PhD

- **Develop & lead field crew training (vegetation) + technical review/report preparation.** Matthew Duveneck will develop & lead the vegetation portion of field crew training and will provide analysis and report preparation pertaining to above-ground forest carbon.

Terri Courtemarche, [Scouter Design]

- **Graphic Design, Report formatting.** Scouter Design will prepare graphics and format & layout Draft and Final Project Reports.

On the following page, we have provided an organization chart demonstrating the responsibilities of the organizations on our team. Team member profiles and project descriptions can be found in Appendix A and professional resumes for all proposed team members can be found in Appendix B.

PROJECT TEAM

EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS

DIVISION OF CONSERVATION SERVICES

PROJECT MANAGER

Gillian Davies, PWS, SSSSNE, NHCWS, CESSWI

PHASE 1

PROJECT KICKOFF + COMMUNICATIONS

BSC Group - Lead

QUARTERLY PROJECT STATUS SUMMARIES

BSC Group - Lead

PHASE 2

ID FOREST STUDY SITES

BSC Group - Contribute

Regenerative Design Group - Contribute

Woodwell Climate Research Center - Contribute

LANDOWNER PERMISSION + SITE VISIT SCHEDULING

BSC Group - Lead

SCHEDULE SITE VISITS

BSC Group - Lead

PHASE 3

FIELD CREW TRAINING

Woodwell Climate Research Center - Soils Lead

Matthew Duveneck - Vegetation Lead

BSC Group - Participants

UPLAND + WETLAND FIELD DATA DOCUMENTATION + SAMPLING

Woodwell Climate Research Center + **Matthew Duveneck** - Leads

BSC Group Field Crew - Participants

LAB ANALYSIS + REPORT

Woodwell Climate Research Center - Lead

PHASE 4

DRAFT + FINAL PROJECT REPORTS

BSC Group - Lead

Woodwell Climate Research Center - Contribute

Matthew Duvenek - Contribute

Regenerative Design Group - Contribute

Scouter Design - Graphic Design

DATA MAINTENANCE FOR FUTURE MA HSAP SOIL DATABASE

Regenerative Design Group - Lead

FINAL PROJECT REPORT ADDED TO MA HEALTHY SOILS WEBSITE

Regenerative Design Group - Lead

Project Timeline

PROPOSED TIMELINE

This project will be conducted in three phases between January 1, 2025 and June 30, 2026.

1. Project Management + Coordination + Communication

January, 2025 through June 30, 2026

1.1. **Project Kickoff + Communications:** A 1-hour project kickoff meeting will be held via Zoom or Teams with EEA and the Project Manager to review project goals, tasks, protocols, reporting, and budget/billing, and answer questions. As needed, other communications will occur throughout the project, such as via email, to ensure that the project launch and implementation is efficient, effective, and meets EEA expectations. Internal Team coordination will occur as needed throughout the project.

1.2. **Quarterly Project Status Summaries:** Brief project status summaries shall be provided to EEA on a quarterly basis.

PHASE 1 MILESTONES:

- Project Kickoff (EEA + Project Manager).
- Quarterly Project Status Summaries.

2. Field Data Study Site Identification + Landowner Permissions + Site Visit Scheduling

January, 2025 to June 2025

2.1. **Identify Upland + Wetland Forest Carbon Study Sites:** Sites will be chosen to represent some of the major upland + wetland forest cover types a nd the different ecological regions in Massachusetts, as noted in the Methodology and Expected Outcomes + Deliverables sections.

2.2. **Obtain Landowner Permission:** Goal will be to choose study sites on properties owned by the Commonwealth or by non-profits, potentially raising the likelihood that permission will be granted for sites to be used for long-term studies, should additional funding become available in the future.

2.3. **Schedule Site Visits:** Once sites have been identified and landowner permission granted, a schedule for site visits will be created. Site visits will occur during the 2025 growing season.

Phase 2 Milestones:

- Upland + Wetland Forest Carbon Study Sites Are Identified.
- Landowner Permissions Have Been Obtained.
- Site Visit Schedule Has Been Created.

3. Field Data Documentation/Sampling

May 2025 through October 2025

3.1. **Field Crew Establishment + Training:** Woodwell + Matthew Duveneck will lead training for BSC Ecologists, Soil Scientists, and Botanists who will comprise the Field Crews. The Field Crew Training will ensure that crew members are trained in the specific above + below ground upland and wetland forest carbon sampling protocols designed for this project in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project.

3.2. **Field Crew Site Visits:** Using protocols referenced in 3.1, field crews will conduct upland and wetland forest carbon data documentation/sampling at the study sites identified during project Phase 2.

3.3. **Soil and Vegetation samples sent to Woodwell Environmental Chemistry Laboratory:** Field crews will send soil and vegetation samples from each site to the Woodwell Environmental Chemistry Laboratory for analysis.

Phase 3 Milestones

- Field Crews are Established.
- Field Crew Training Has Occurred.
- Site Visits Have Occurred and Data Has Been Collected.
- Soil and Vegetation Samples Have Been Sent to Woodwell Environmental Chemistry Laboratory.

4. Data Analysis + Reporting

June 2025 through June 2026

4.1. **Woodwell Environmental Chemistry Laboratory Soil + Vegetation Sample Analysis + Laboratory Report:** Soil and vegetation samples from upland and wetland forest study sites will be analyzed in accordance with laboratory protocols and a laboratory report will be prepared.

4.2. **Maintenance of Upland and Wetland Forest Carbon Data:** In accordance with the protocols developed in the HSAP Ecosystem Carbon Sampling Protocols & Planning Project, RDG will maintain project upland and wetland forest carbon data so that it can be integrated into a future MA Soil Carbon Database.

4.3. **Draft Project Report:** Project Team will prepare a Draft Project Report documenting the project site locations, methods, data analysis, and findings.

4.4. **Final Project Report:** Project Team will prepare a Final Project Report documenting the project site locations, methods, data analysis, and findings.

4.5. **MA Healthy Soils Website:** Final Report will be added to the MA Healthy Soils Website.

Phase 4 Milestones

- Woodwell Environmental Chemistry Laboratory Soil + Vegetation Analysis Report Submitted to EEA by January 31, 2026.
- RDG Provides Documentation of Long-Term Upland + Wetland Forest Carbon Data Maintenance + Management to EEA by March 1, 2026.
- Draft Project Report Submitted to EEA by March 1, 2026.
- Final Project Report Submitted to EEA by June 1, 2026.
- Final Project Report Added to MA Healthy Soils Website by June 30, 2026.

Project Evaluation and Monitoring

PERFORMANCE METRICS

(see Expected Outcomes + Deliverables for more detail)

- Six (6) forest carbon field data collection/ monitoring sites will be established, with sites split approximately evenly between wetland forests and upland forests and representing some of the primary Massachusetts forest types in each category.
- At least three (3) data plots/soil pits will be documented at each study site. All wetland study sites will include up to three (3) additional upland data plots/soil pits to document the wetland-upland carbon transition. When upland study sites are within a couple of hundred feet of a wetland, at least two (2) or three (3) wetland data plots/soil pits will also be documented for the same purpose.
- The Woodwell Environmental Chemistry Laboratory will provide a Laboratory Report summarizing laboratory analysis of soil and vegetation samples.
- Upland and wetland forest carbon datasets will be maintained by RDG so that they can be integrated into a future MA Soil Carbon Database, and EEA will be provided with documentation of this data maintenance.
- Upland and forest carbon data and project results, as presented in the Final Project Report, will be added to the MA Healthy Soils Website.
- Draft and Final Project Reports documenting project site locations, methods, data analysis, and findings will be provided.

REPORTING

Project progress summaries of project activities and accomplishments will be submitted on a quarterly basis. The progress summaries will include supplemental materials. Relevant documents from the prior quarter will be submitted as a batch each quarter. The Final Project Report will be uploaded to the MA Healthy Soils Website and submitted as PDF's to the EEA on or before June 30, 2026.

Sustainability Plan

POST-GRANT PROJECT SUSTAINABILITY ASSESSMENT

This project represents the continuation of a partnership established between the Regenerative Design Group and BSC Group that was established during the production of the Healthy Soils Action Plan.

Since completing the majority of the work in 2021, these firms have gone on to collaborate on four MVP Program projects that operationalized the insights and recommendations from the HSAP for municipalities. It also represents a continuation of the partnership between BSC Group, Regenerative Design Group, Woodwell Climate Research Center, and the Massachusetts Association of Conservation Commissions that formed as the consulting team for the MassDEP No Net Loss of Wetland Carbon Project, a project that provides not just a collaborative team foundation, but also a shared knowledge base about wetland soil and biomass carbon; wetland and soil health; and the extent and carbon content of Massachusetts wetlands.

These firms are joined by Matthew Duveneck, who will add outstanding expertise as a forest ecologist who has conducted extensive research in Massachusetts, much of which has been done at Harvard Forest.

Regenerative Design Group has already committed to hosting and maintaining the overall MA Healthy Soils Website for up to 5 years after the completion of their 2024/2025 Development Guide HSAP Challenge Grant project, to which this upland and wetland forest carbon project's Final Project Report will be added. During the 5-year period, an alternate website host may be determined, provided they have the commitment and resources to continue the curation of the material.

Following completion of this project, the Project Team intends to continue this work through partnerships with leading researchers, industry actors, and professional associations. As the attached firm profiles demonstrate, each of the Project Team members already has a track record of being an industry leader in generating new knowledge and bringing healthy soils, wetland carbon, forest carbon, climate science, and the importance of protecting and restoring healthy soils, to professionals, volunteers, and the general public.

Potential future related projects could include periodic (such as every 5 years) upland and wetland forest carbon studies at the study sites established for this project, and/or could include establishing and periodically monitoring additional upland and wetland forest carbon study sites to expand the database.

For a future HSAP Challenge Grant RFR, this project team plans on proposing a study similar to this one, only for upland shrub, wetland shrub/scrub, and upland and wetland herbaceous cover types. It is anticipated that the approach for that future project would be similar to the approach undertaken for this project.

We anticipate that the work described in this proposal will reveal additional needs and pathways to promote healthy soils and climate resilience/carbon storage in upland and wetland forest soils. The team assembled for this project is committed to using the findings from this project to address these gaps through continuing and expanding collaboration.

BSC GROUP

Risk Assessment for Project, Partners, + Timeline

The members of this team and our partners have an excellent track record of delivering high-quality experiences and work products on-time and on-budget.

The attached resumes and project qualification sheets provide documentation of these work products and the high degree of qualification we bring to this project, including numerous professional certifications, advanced degrees, and decades of professional experience.

It is notable to mention that two of the larger projects, Heathly Soils Action Plan and the Apple Country Natural Climate Solutions project, spanned the beginning of the COVID pandemic. This required a hard pivot to remote or distanced options in outreach, education, and field-based events. The success of these projects gives us confidence that we can navigate unforeseen challenges.

We have identified the following risks and mitigation strategies for the completion of the Guide:

- Landowners do not wish to allow access to their properties
  - The Project Team will seek to establish study sites on land owned by the Commonwealth and/or by non-profits. Existing relationships between Project Team members and staff from non-profits will help facilitate discussions.
- Project budget shortfalls for the ambitious HSAP Upland & Wetland Forest Carbon Project scope of services
  - The Project Team has developed a scope of services that is commensurate with the required budget cap of $100,000 and the required timeline with all work products due by June 30, 2026. Given the experience and staffing capacities of the Project Team and their organizations, we have high confidence that we will be able to perform the scope of services and deliver all work products on time and within the budget.

- Staffing changes/disruptions
  - Each project team firm has a deep bench of staff that could step in should unexpected disruptions require a change of project staffing. In anticipation of this potential, the Project Team will hold regular project meetings internally with understudies and construct a resilient file sharing system accessible to all members of each firm.
- Tasks take longer than expected
  - As mentioned, each firm on the project team has a deep bench. Should tasks take longer than expected, we have the capacity to pull in additional staff to ensure that key deadlines are met, as well as a solid track record of delivering high-caliber work products.
- COVID Resurgence / Other Pandemic
  - Meetings will be scheduled as Zoom or Teams meetings, and thus are resilient to a COVID resurgence or other pandemic emergence. Risk of infection is low in outdoor, open-air environments, making field work feasible even if COVID or another disease is being transmitted through the larger population. Project Team members have been conducting field work successfully throughout the various highs and lows of COVID over the past few years.

The proposed scope of services is solidly within the wheelhouse of Project Team expertise. In summary, we put forward this proposal as a low-risk investment due to the subject matter expertise and institutional capacity of the partners, the ability to deliver this scope of work within this budget and without requiring additional third-party funds for completion, and success is not contingent upon other third-party institutional endorsements.

This project will establish six (6) forest carbon study sites where soil and vegetation data and samples will be documented and collected. The sites will be approximately evenly split between wetland and upland sites that represent many of the primary Massachusetts upland and wetland forest cover types, and will be spread across different Massachusetts ecoregions. The data and samples gathered will be analyzed at the Woodwell Environmental Chemistry Laboratory in Falmouth, MA, and a Laboratory Report will be prepared. The Project Team will analyze the Laboratory Report and field study results. Draft and Final Project Reports will be prepared, with the Final Project Report posted on the MA Healthy Soils Website. RDG will maintain the project data so that they can be integrated into a future MA Soil Carbon Database, and EEA will be provided with documentation of this data maintenance.

Appendix A

Firm Profiles and Project Experience

BSC Group

Firm Profile and Project Experience

BSC GROUP

WWW.BSCGROUP.COM

AT A glance

OFFICE LOCATIONS

HEADQUARTERS

Boston, MA

Andover, MA

West Yarmouth, MA

Worcester, MA

Glastonbury, CT

Manchester, NH

1965
BSC FOUNDED

200
TEAM MEMBERS

CORE SERVICES

Ecological Science

Permitting & Regulatory Compliance

Climate Resilience

Flood Risk Information & Modeling

Environmental Engineering

Land Surveying, GIS, Mapping & Analysis

Custom Software & Spatial Data Integration

FIRM OVERVIEW

At BSC, we partner with our clients to deliver creative and practical transportation, land development, and environmental solutions. We also help them find climate-resilient solutions. Clients trust BSC to work with them to expertly guide siting, strategically navigate regulatory processes, and holistically design infrastructure to help achieve their vision.

BSC's engineers, planners, and scientists take pride in their ability to respond nimbly to move projects forward.

We solve complex challenges by applying expertise across disciplines, sharing ideas and perspectives to see a project from every side.

The purpose of our work is to improve the quality of life in and around our communities using our skills and experience to promote balance between the built and natural environment.

Proudly employee-owned, our people are the heart of our company.

AREAS OF EXPERTISE

- Wetland and Soil Science
- Wetland Delineation
- Wetland Permitting
- Floodplain Management
- Water Quality/Water Resources Ecology
- Marine, Aquatic and Terrestrial Biology
- Botanical Surveys
- Wildlife Surveys
- Rare and Threatened Species Surveys
- Threatened and Endangered Species Permitting
- Ecological Restoration
- GIS Mapping and Assessment
- Drone-based Field Survey
- GIS Hazard and Natural Resources Mapping
- Stormwater Management and Flood Protection
- Construction Oversight and Monitoring

REPRESENTATIVE CLIENTS

MASSACHUSETTS DEPARTMENT OF CONSERVATION AND RECREATION

MASSACHUSETTS BAY TRANSIT AUTHORITY (MBTA)

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION (MASSDOT)

NATIONAL GRID

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (MASSDEP)

EVERSOURCE

BORREGO SOLAR

GREAT RIVER HYDRO

MASSDEP NO NET LOSS OF WETLAND CARBON

CLIENT

Massachusetts Department of Environmental Protection (MassDEP)

SERVICES

Development of Innovative Wetland Carbon Protection and Restoration Strategy, Policy, and Regulations

Software Development

Wetland Carbon Accounting Science

Wetland Extent and Wetland Carbon Data Set + Mapping + Machine Learning

Leading a consulting team, BSC is working with MassDEP to identify innovative strategies, approaches, concepts, and regulatory recommendations to achieve No Net Loss of Wetland Carbon in Massachusetts and to meet wetlands-related climate goals outlined in the *Massachusetts Clean Energy and Climate Plan for 2025 and 2030, Chapter 8: Protecting Our Natural and Working Lands*. Our project team includes BSC, Regenerative Design Group, the Massachusetts Association of Conservation Commissions (MACC), and the Woodwell Climate Research Center.

BSC researched wetland carbon policies, regulations, and projects in all 50 states as well as in other countries, researched wetland carbon bylaws and regulatory provisions in Massachusetts municipalities, and led the project team in developing innovative wetland carbon protection and restoration strategies, approaches, and regulatory recommendations, including collaborating with MACC as they updated their local wetland bylaw database.

Project team member Woodwell Climate Research Center developed Massachusetts-relevant science-based wetland carbon accounting approaches, consistent with best available wetland carbon science.

Project team member Regenerative Design Group developed a cutting-edge wetland mapping approach based on machine learning that identifies previously cryptic wetlands, such as forested wetlands, which traditional mapping methods often have difficulty detecting.

The project final report is now being reviewed by MassDEP.

GUIDE FOR IMPLEMENTING THE HEALTHY SOILS ACTION PLAN IN DESIGN AND CONSTRUCTION

CLIENT

Massachusetts Executive office of Energy and Environmental Affairs

SERVICES

Ecological Services

Landscape Architecture

Civil Engineering

Climate Resilience

Transportation Engineering

Environmental Engineering

The Healthy Soils Action Plan (HSAP) released by the Massachusetts Executive office of Energy and Environmental Affairs provides an assessment of the condition of our soils and a blueprint for how we can effectively conserve and protect, restore, and properly manage our soils to improve the vitality of nature around us, resilience to climate change, and the health and quality of life of our residents. However, many of the recommendations either lack a clear path to implementation or are in conflict with typical practices of the development and construction industries.

BSC is working with Regenerative Design Group and others in the development of an implementation guide for the HSAP. The guide will serve as a roadmap towards engaging a cross-section of professionals in construction, development, engineering, and design in a series of coordinated events to promote general awareness of the HSAP, distill industry input and additional research and make recommendations for improving typical soil management practices and standards, and address problems. BSC's role on the project includes serving as liason to MassDOT to coordinate conversations, solicit participation and materials, and sharing insights and experience, and:

- Participating in and hosting industry work groups
- Providing technical review and production support
- Case study collection
- Reviewing of soil specifications and MassDOT specifications
- Contributing to current & recommended best practices
- Identification of existing challenges to achieving better soil health
- Supporting the development of presentation and website materials

APPLE COUNTRY ECOLOGICAL CLIMATE RESILIENCY AND CARBON PLANNING AND ASSESSMENT

BOLTON, MA

CLIENT

Towns of Bolton and Harvard and the Devens Regional Enterprise Zone

SERVICES

Climate Resilience Planning

Climate Vulnerability Assessment

Community Stakeholder Engagement

Development of Educational Resources

Ecological Carbon Assessment

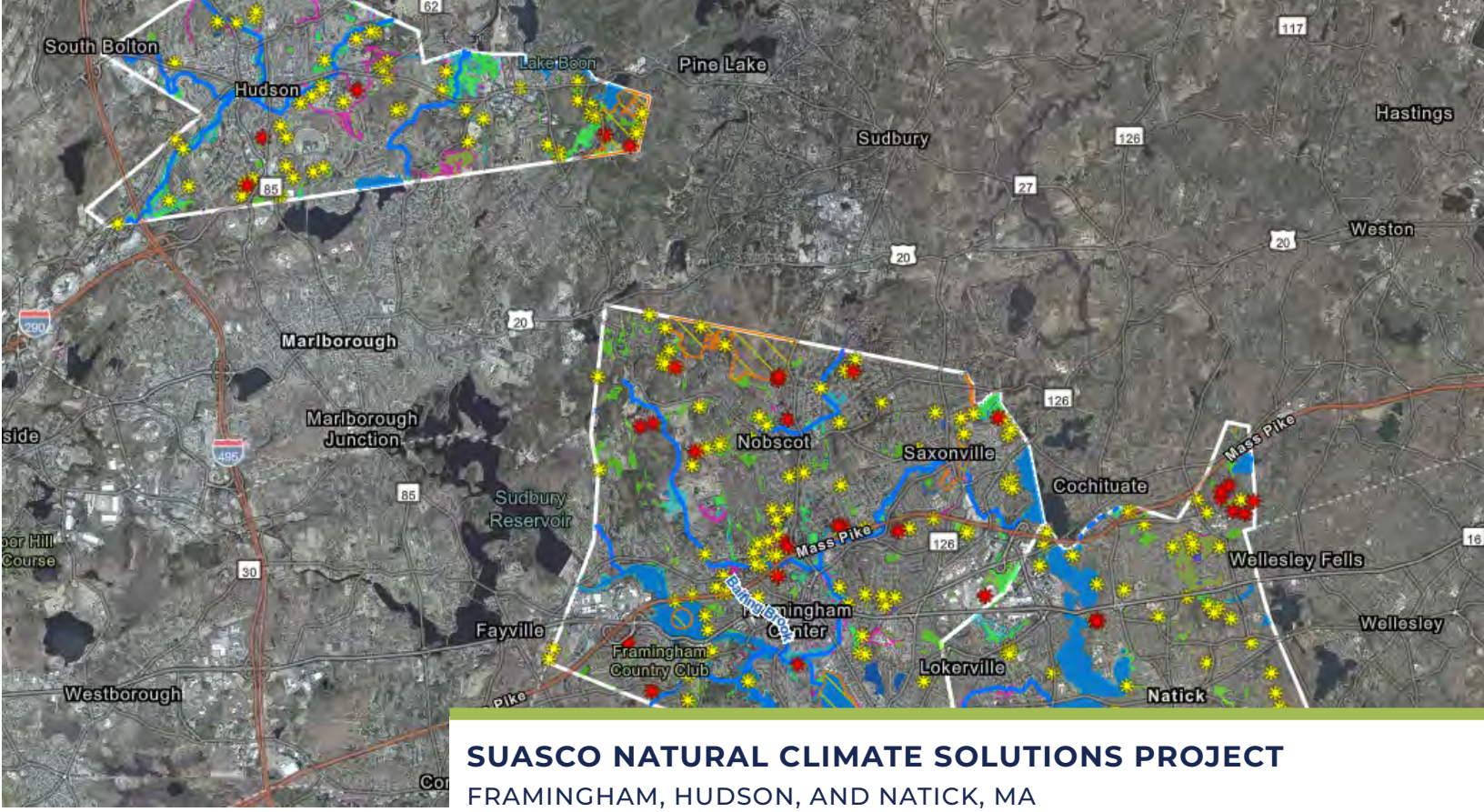
Grant Proposal Preparation

Identification of Nature-based Solutions

As part of a regional approach to climate resilience planning, BSC worked with the Towns of Bolton and Harvard and the Devens Regional Enterprise Zone (Devens) and led a multi-disciplinary consulting team that included healthy soils experts (Linnean Solutions and Regenerative Design Group) and a forest ecologist and forest carbon expert (Woodwell Climate Research Center) to provide climate resiliency and carbon planning assessment services. The project was funded by an MVP Action Grant awarded to the communities following a BSC-supported application process.

Apple Country's vast landscape of forests, farmland, wetlands, and active floodplains is essential in the area's ecological functioning, carbon functioning, and regional community and environmental resiliency. BSC's team of ecologists, landscape architects, climate resilience specialists, designers, engineers, and GIS specialists analyzed local ecological resources, conducted community outreach and engagement, and developed GIS mapping to produce predicative climate-focused documents and maps that identify and prioritize Nature-based Solutions (NbS) and best management practices and policies.

The project report highlighted opportunities for resilience and protection of wetland and forest carbon using NbS and implemented climate-smart best management practices and policies. The resulting report provided a regional perspective, analysis, and recommendations, as well as town-specific assessment and recommendations.



SUASCO NATURAL CLIMATE SOLUTIONS PROJECT

FRAMINGHAM, HUDSON, AND NATICK, MA

CLIENT

City of Framingham and the Towns of Hudson and Natick

SERVICES

Climate Resilience

Ecology

Environmental Justice

Forest Carbon and Climate Mitigation

GIS

Nature-based Solutions

Public Outreach

The SuAsCo Natural Climate Solutions Project was a collaborative effort between municipalities in the Sudbury-Assabet-Concord (SuAsCo) watershed (Hudson, Framingham, and Natick) to identify opportunities for Nature-based Solutions (NbS) that prioritize the needs and well-being of both residents and ecosystems, especially people who live in Environmental Justice and Climate Vulnerable communities within the towns while providing essential ecosystem services to the whole community.

BSC led a team of consultants to collaborate with the communities to identify opportunities for wetlands, floodplains, forests, and other ecosystems to support broader resilience planning efforts and expand communities' capacity to protect, restore, and enhance carbon sequestration and other ecosystem services through community-driven assessment of NbS, providing recommendations to improve regulations; and developing and providing educational materials and opportunities.

BSC's public engagement included coordinating core team meetings, a site walk, and NbS trainings for community members, stakeholders, and municipal staff. We developed education and outreach materials and activities, including a project website with data viewer, ecological climate resilience and carbon storage infographics, and a StoryMap. Self-guided tours are being installed in each town with signage, including QR codes linking to the StoryMap, to provide durable, accessible, and educational opportunities about climate resilience, ecosystems, and NbS.

NATIONAL GRID I135/J136 UTILITY ROAD PROJECT

WINCHENDON, MA

CLIENT

National Grid

SERVICES

Climate Resilience

Wetland Carbon Conservation

Wetland Restoration

Wetland Creation

Wetland Delineation

Permitting

GIS Mapping

GPS Survey

As part of our on-call licensing and permitting contract with National Grid, BSC provided ecological services for the design and construction of a permanent utility-grade road along the I135N and J136N transmission lines in Winchendon, MA. During the field investigation phase, BSC completed wetland delineation and GPS survey, GIS mapping of wetlands and environmental constraints, and local, state, and federal permit plans.

BSC guided and oversaw wetland restoration and creation activities and provided an innovative approach to wetland replication that fostered the conservation of soil carbon (climate mitigation) and enhanced drought survival (climate resilience).

This innovative approach led to:

1. An acceleration of establishing the wetland vegetative cover as well as preserving soil carbon, structure, and function by transferring intact soil profile and surface vegetation from impact area to restoration and mitigation area.
2. A reduction of both environmental impacts and financial costs: reduced area of exposed soil, eliminated need to stockpile soils, reduced work hours required to construct wetland, and reduced number of plants and supplemental soil to be purchased and the carbon emissions associated with their transport.

Woodwell Climate Research Center

Firm Profile and Project Experience

Woodwell Climate Research Center

CLIMATE SCIENCE FOR CHANGE

We face the greatest challenge of our time: restoring a safe and stable climate, while adapting to inevitable impacts. Science is the core of our success. Woodwell Climate Research Center is dedicated to climate science pursued in partnership with stakeholders and decision-makers to produce maximum societal benefit. Our renowned researchers investigate how human activities are affecting the flow of carbon and water—key climate factors—through the world's most critical ecosystems, from the Arctic to the tropics. Together with our global network of partners, we generate breakthrough insights into the risks we face, and the just, effective solutions we can develop.

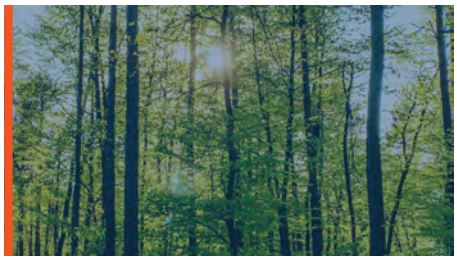
CREATING BREAKTHROUGH INSIGHTS

Our scientists are experts in combining field data with large-scale satellite monitoring and computer modeling to generate insights that scale from local to global. Woodwell Climate experts are:

Making climate risk actionable Decision-makers need trustworthy, relevant, and detailed information about the risks we face now and in the next few decades. We work with partners to advance understanding of climate hazards, like extreme weather and fire, and their socioeconomic and geopolitical impacts, from water and food scarcity, to labor impacts, conflict, and migration.

Filling gaps in carbon accounting Thawing of Arctic permafrost could release enough greenhouse gases to threaten our climate targets, but these emissions aren't in models and budgets. Burning trees for energy emits more carbon than fossil fuels, but is often incentivized as carbon neutral. We bring rigorous, independent science to the table to ensure realistic goals and effective policies.

Realizing the potential of natural climate solutions Forests, wetlands, and soils provide our best hope for cooling the planet. We integrate ecological and social science to develop equitable, cost-effective, and evidence-based strategies ranging from finance for forest conservation, to soil carbon monitoring, wetland restoration, and agricultural land management.



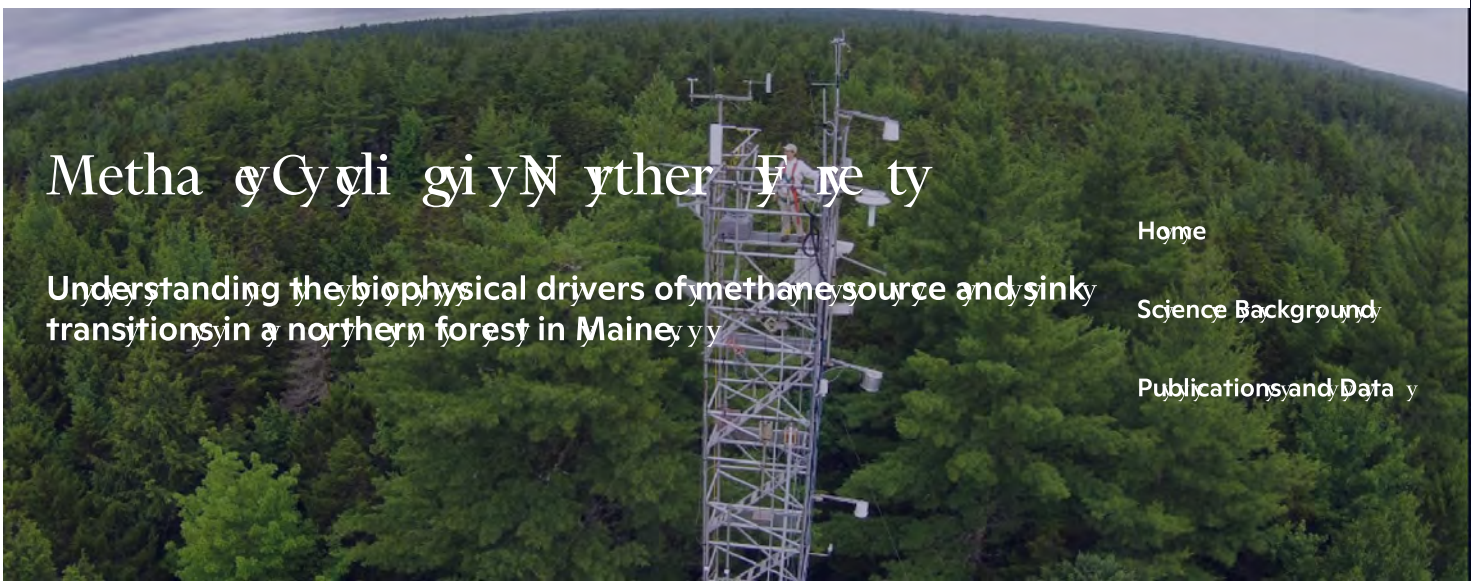
WORKING IN CONCERT FOR OUTSIZED IMPACT

We work with partners, stakeholders, and government officials in more than 20 countries across six continents—from the Arctic to the Amazon, and D.C. to D.R.C. We engage throughout the research process to ensure that our insights can be integrated into real-world decision-making. This approach has delivered outsized impact for over 35 years. Woodwell Climate researchers have:

- Helped shape the UN Framework Convention on Climate Change
- Provided Congressional testimony or briefed Hill staffers dozens of times in the past five years
- Shaped the first guidelines for corporate disclosure of physical climate risk
- Informed critical Brazilian legislation to protect 30 million acres of Amazon forest
- Contributed to more than a dozen reports by McKinsey & Company on climate risk and net zero pathways

BY THE NUMBERS

PRINCIPAL INVESTIGATORS	18
TOTAL STAFF	120+
CORE PARTNERS	30+
SCIENTIFIC PUBLICATIONS	120+/yr
MEDIA MENTIONS	6,500+/yr



Methane Cycling in Northern Forests

Understanding the biophysical drivers of methane source and sink transitions in a northern forest in Maine

Home
Science Background
Publications and Data

Research area

Arctic | Carbon

Methane is second only to carbon dioxide (CO_2) in its contribution to human-induced climate change, thanks to its global warming potential—34x greater than CO_2.

However, we understand very little about methane flux in forests, the processes and feedbacks that drive it, and how methane emissions or uptake will evolve with a changing climate.

Our Work

At the Howland Research Forest, ME, we are taking on this priority for biological research and improving methane flux models. Our innovative, multi-scale, and cross-disciplinary study is identifying the conditions and mechanisms driving methane sink/source activity across soil moisture gradients in northern forests.

Led by Woodwell Climate Research Center, in collaboration with the University of Maine, Emory University, Arizona State University, San Diego State University, and the USDA Forest Service, this research uses new DNA sequencing techniques that allow us to study microbial traits. Measuring these traits across different environmental conditions ultimately helps us learn how microbes sequestration of methane in sub-boreal forests may be offsetting methane emitters globally, and how this may change under future climate conditions. The Howland Research Forest serves as a case study to identify drivers and functional relationships across wet to dry soils, and from soils to canopy.

Team

Assistant Scientist

Senior Research Associate

Research Assistant

Collaborators

Associate Professor of Forest Ecology, University of Maine

Assistant Professor, Emory University

Associate Professor, Arizona State University

Associate Professor of Ecology, San Diego State University

Research Plant Physiologist, USDA Forest Service

Ecologist, USDA Forest Service

No Net Loss of
CARBON IN WETLANDS

No Net Loss of Wetland Carbon in Massachusetts Project Final Report

July 2024

PREPARED FOR

Massachusetts Department of Environmental Protection (MassDEP)
100 Cambridge Street, Suite 900
Boston, MA 02114

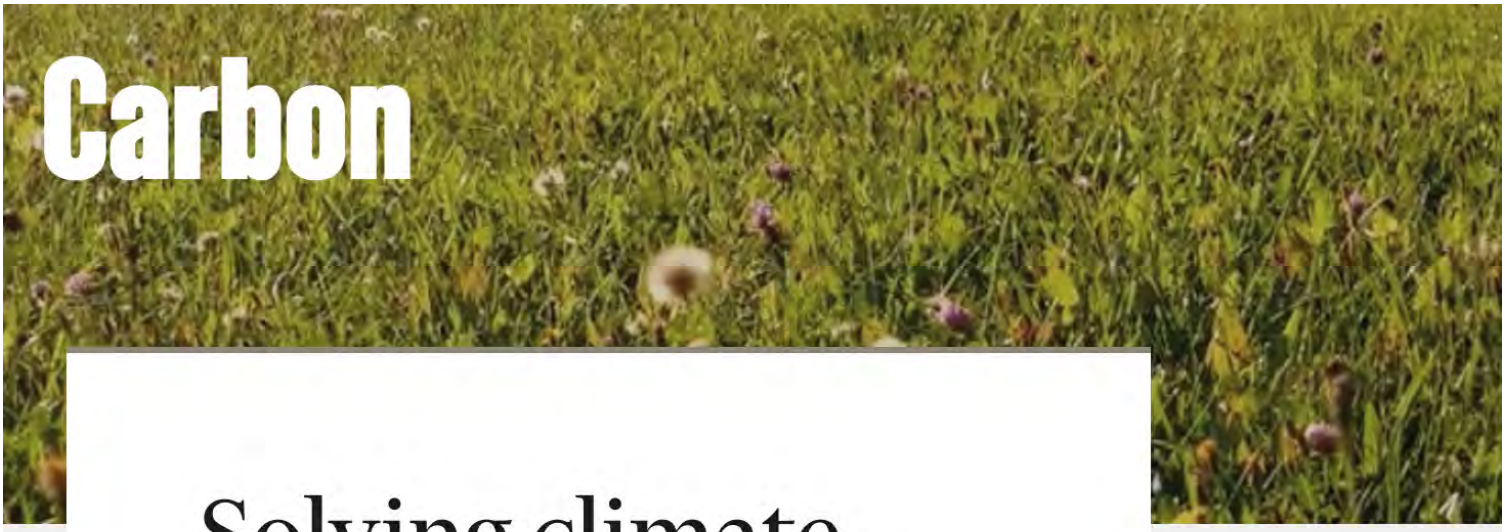
PREPARED BY

BSC Group, Inc.
1 Mercantile Street, Suite 610
Worcester, MA 01608

PROJECT TEAM & REPORT CO-AUTHORS

BSC Group, Inc.
Massachusetts Association of Conservatic Commissions
Regenerative Design Group

This report has been prepared by the No Net Loss of Wetland Carbon in Massachusetts Project Consulting Team: BSC Group, Inc., the Massachusetts Association of Conservation Commissions, Regenerative Design Group, Scouter Design, and Woodwell Climate Research Center. The specific recommendations developed by the Project Consulting Team for achieving No Net Loss of Wetland Carbon in Massachusetts have been discussed with staff from the Massachusetts Department of Environmental Protection (MassDEP) and the Massachusetts Executive Office of Energy and Environmental Affairs (EEA), who have provided valuable information and insights. However, the recommendations presented in this report do not represent policy or regulatory decisions or commitments from MassDEP or EEA. The report is intended to provide useful information for these government agencies as they develop approaches that work towards achieving No Net Loss of Wetland Carbon in Massachusetts.



Carbon

Solving climate change means reducing global carbon emissions.

Climate change is driven by the increase in concentrations of CO_2 and other greenhouse gases in the atmosphere, primarily due to fossil fuel combustion. Fortunately, the Earth's forests, soils, and natural systems can be a powerful tool to slow this dangerous build-up—if they are properly conserved and managed.

Woodwell Climate scientists work across continents and fields of study to find comprehensive strategies to promote natural climate solutions for reducing carbon in the atmosphere.

Experts

Jonathan Sanderman
Carbon Program Director

Richard A. Birdsey
Senior Scientist

Brendan M. Rogers
Associate Scientist

Christopher R. Schwalm
Risk Program Director

Wayne S. Walker
Chief Scientific Officer

Elchin Jafarov
Senior Research Scientist

Susan M. Natali
Senior Scientist

Ludmila Rattis
Assistant Scientist, Tanguro Field Station General Coordinator

Jennifer D. Watts
Arctic Program Director, Associate Scientist

All Carbon Experts

Regenerative Design Group

Firm Profile and Project Experience

resilient communities. productive landscapes. nature-based solutions.

OUR FIRM

Regenerative Design Group is a worker-owned ecological design practice dedicated to creating productive landscapes and resilient communities. We work across scales, offering innovative, practical, and flexible solutions for individuals, institutions, and communities.

Our capacity for interdisciplinary thinking is informed by our backgrounds in ecology, agriculture, conservation, architecture, and education. Grounded in the principles of permaculture design, our team weaves the elements of any project into a high-functioning whole system.

COOPERATIVELY OWNED AND RUN

Founded in 2009, Worker-Owned since 2021

Founding Board of Directors, 2021

OUR WORK

Research

We support clients and their communities in articulating their vision and goals, and bringing rigorous ecological analysis and long-term climate projections to the table.

Master Planning & Campus Design

We develop designs for campuses that combine food production and learning, guiding the transition from high-input management to diverse educational landscapes.

Regenerative Agriculture & Farm Design

We work with communities and farm owners to develop diverse farming and agroforestry systems that support the farm's social, environmental, and economic goals.

Productive Habitats & Ecosystem Regeneration

We work to restore and enhance existing natural systems that provide fresh air, clean water, food, fuel, fiber, wildlife, shelter, and wild forage.

Residential Design & Integrated Homesteads

We help homeowners envision and create beautiful, efficient homes and landscapes that invite engagement through the production of food and integration of natural systems.

Regenerative DesignGroup COOPERATIVE

www.regenerativedesigngroup.com

Massachusetts Healthy Soils Action Plan

CLIENT

Massachusetts Executive Office of
Energy + Environmental Affairs, 2019-2023

SERVICES + ACCOMPLISHMENTS

Analysis and modelling of Soil Organic Carbon (SOC) stock, segmented by land cover type

Projection of 2050 SOC flux, based on land cover change

Soil-smart planning and management priorities

Stakeholder engagement

Management of 40 person working group

PROJECT OVERVIEW

The Massachusetts Healthy Soils Action Plan (HSAP) is the nation's first effort to understand, protect, and revitalize soil function in all land uses statewide. This Plan, commissioned by Massachusetts Executive Office of Energy and Environmental Affairs, reveals the tremendous impact land use and management has on the soils of the Commonwealth and sets forth strategies and actions to increase soil health as a way to improve food security, ecosystem function, and climate resilience across the region.

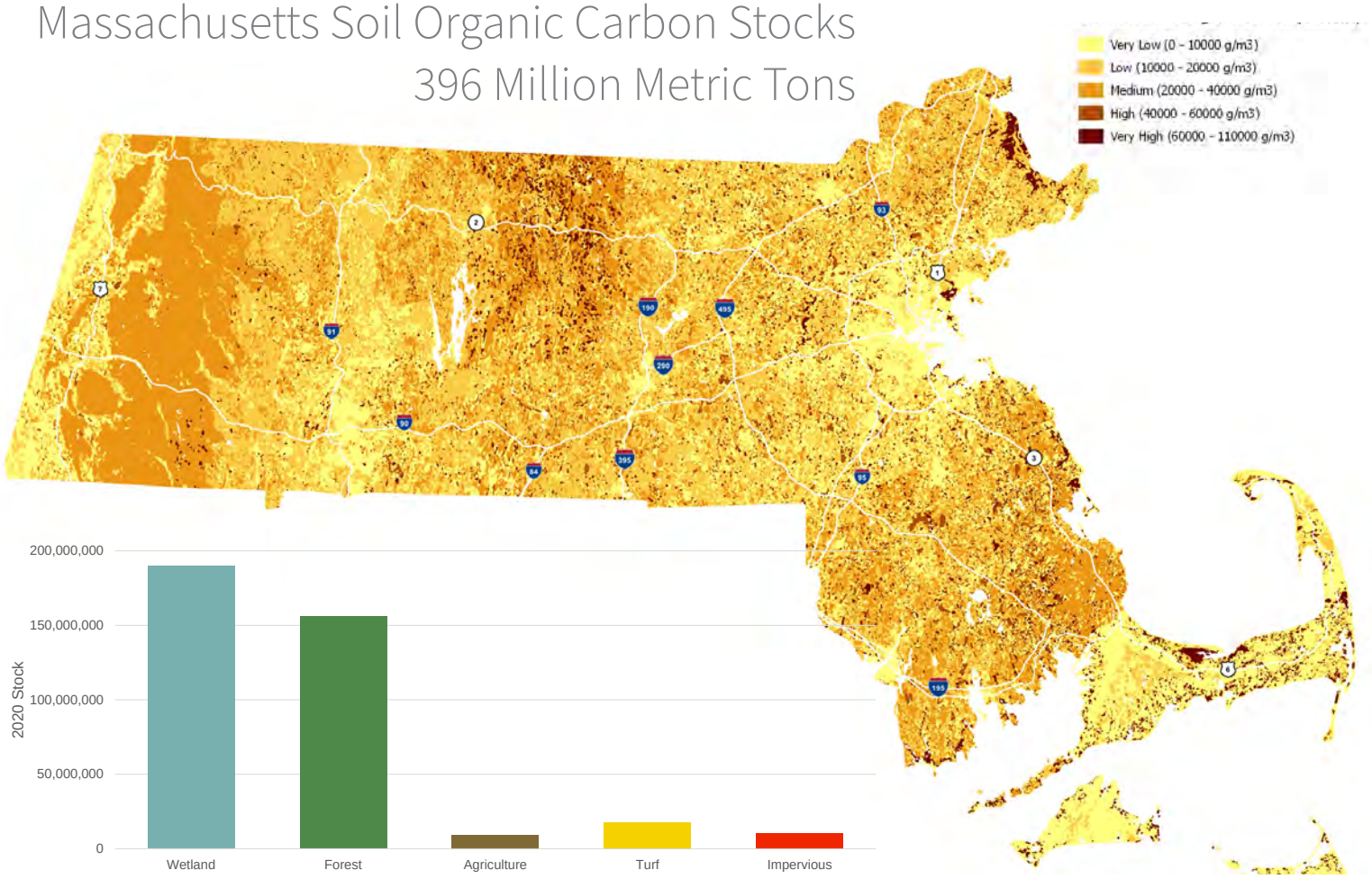
Through an 18-month process the consultant team, led by Regenerative Design Group, conducted a detailed literature review and geospatial analysis to understand the key factors and dynamics that shape soil health. This included the development of a novel method for quantifying soil organic carbon (SOC) based on land cover and drainage classification.

With guidance and review of a 40-member Working Group, representing state and federal agencies, conservation organizations, scientific advisors, and community stakeholders, RDG developed a series of evidence-based strategies and actions aimed at transforming the impact of soil management on climate from a negative to a positive.

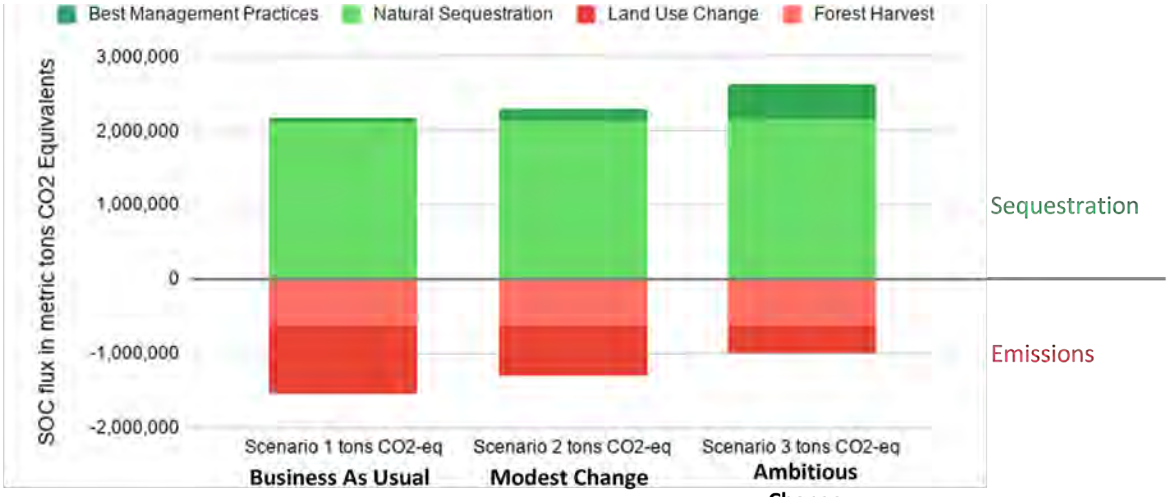
The result is a roadmap for policymakers, land managers, and soil health advocates to understand the interconnected nature of the Commonwealth's landscapes and the role they play in soil carbon sequestration and climate resilience.

Regenerative DesignGroup

Massachusetts Soil Organic Carbon Stocks
396 Million Metric Tons



2050 Comparison of Annual Soil Organic Carbon Fluxes



Deerfield Soil Health Plan

CLIENT

Town of Deerfield
Municipal Vulnerability Preparedness Program, 2022

SERVICES + ACCOMPLISHMENTS

Analysis and modelling of Soil Organic Carbon (SOC) stock, segmented by land cover type

Soil-smart planning and management priorities

Intensive stakeholder engagement

Sample bylaws aimed at protecting and improving soil resources

Soil sampling across a variety of land types providing the basis for future soil health tracking

Design and execution of a “soil health field day” for 120 high school students

Awarded by the Massachusetts chapter of the American Planning Association for excellence in Sustainability & Resilience planning

PROJECT OVERVIEW

The Deerfield Healthy Soils Project is based on the premise that protecting and improving soil function across land uses is an essential component of climate-resilient planning. The overall goal of this project was to identify the most impactful actions and strategies that the community of Deerfield, Massachusetts can implement to steward its soils in ways that support the myriad of co-benefits and beneficial functions of healthy ecosystems including enhanced carbon sequestration and storage, greater fertility, and improved water dynamics.

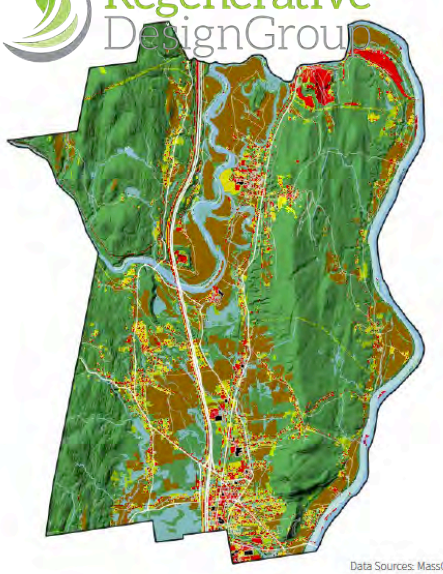
Over the course of a year, Regenerative Design Group led a process that included high resolution modeling of Deerfield’s current healthy soil resources; presentations, workshops, and conversations with stakeholders with a special focus on farmers considering the town’s large agricultural community; soil sampling across a variety of land types providing the basis for future soil health tracking; a “soil health field day” for 120 high school students; and the development of several recommendations for potential bylaw improvements aimed at protecting and improving soil resources.

This project was completed in 2022 as part of a larger Municipal Vulnerability Preparedness action in the town of Deerfield, MA. Regenerative Design Group (RDG) worked closely with Chris Curtis (Conservation Works) who was the lead planner for the larger MVP project and who was the lead author of the sample bylaws included in our report. The consultants reported directly to Deerfield’s Climate Change and Energy Committee in carrying out the work of the project. The project was recognized in 2022 by the Massachusetts chapter of the American Planning Association with it’s Sustainability & Resilience Award.

Regenerative DesignGroup

Land cover + Soil Organic Carbon Stocks in Deerfield, MA

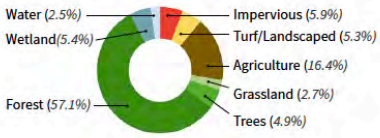
Regenerative DesignGroup



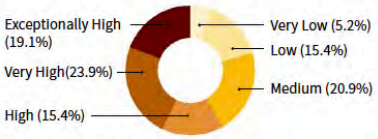
Data Sources: MassGIS 2016 Landcover

Data Sources: Soils SSURGO-Certified NRCS, NRCS Rapid Carbon Assessment, MassGIS 2016 Landcover

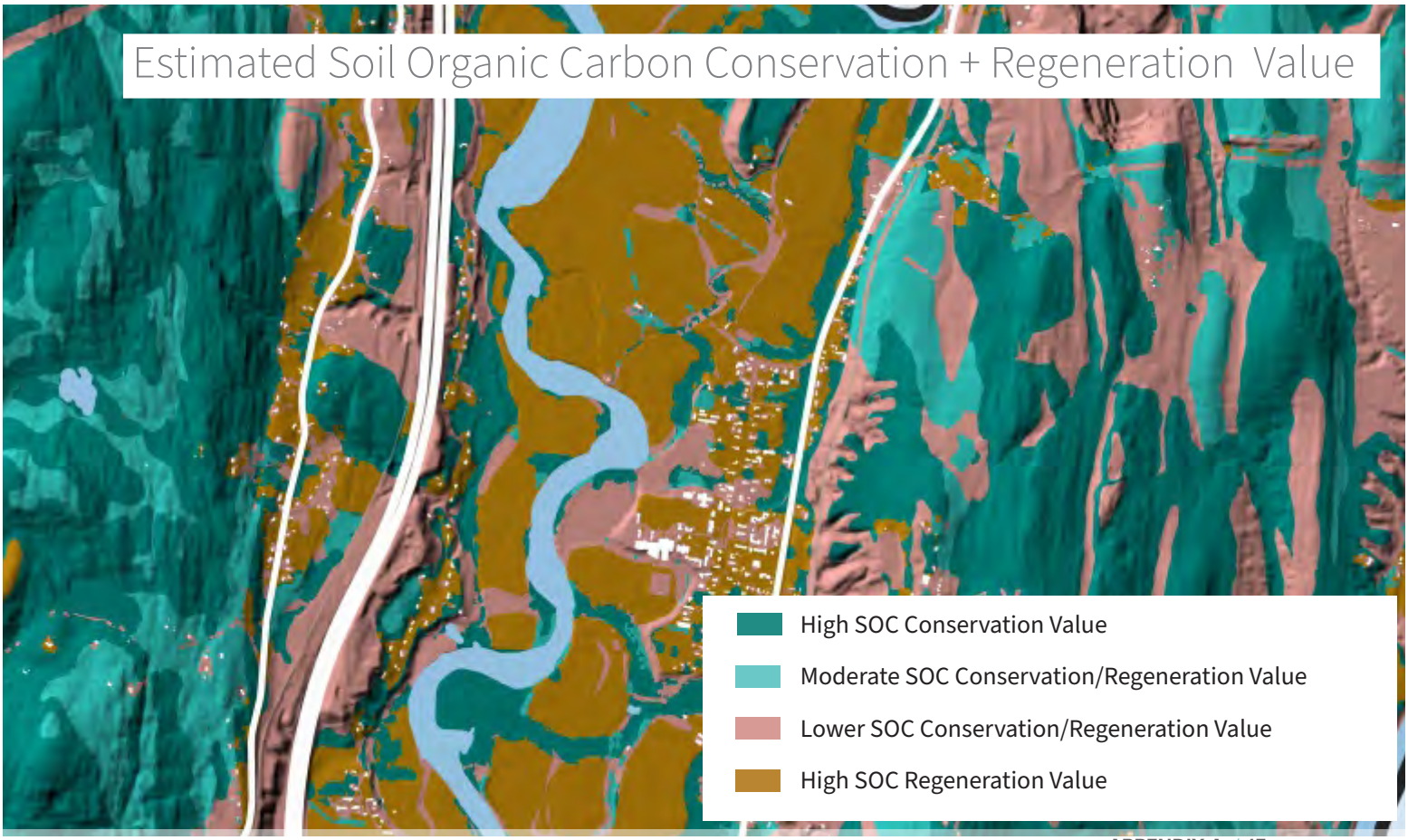
Forest	12,525 ac
Agriculture	3,506 ac
Wetland	1,160 ac
Turf & Landscaped Areas	1,123 ac
Trees	1,041 ac
Impervious	965 ac
Grassland or Shrub	571 ac
Open Water	527 ac

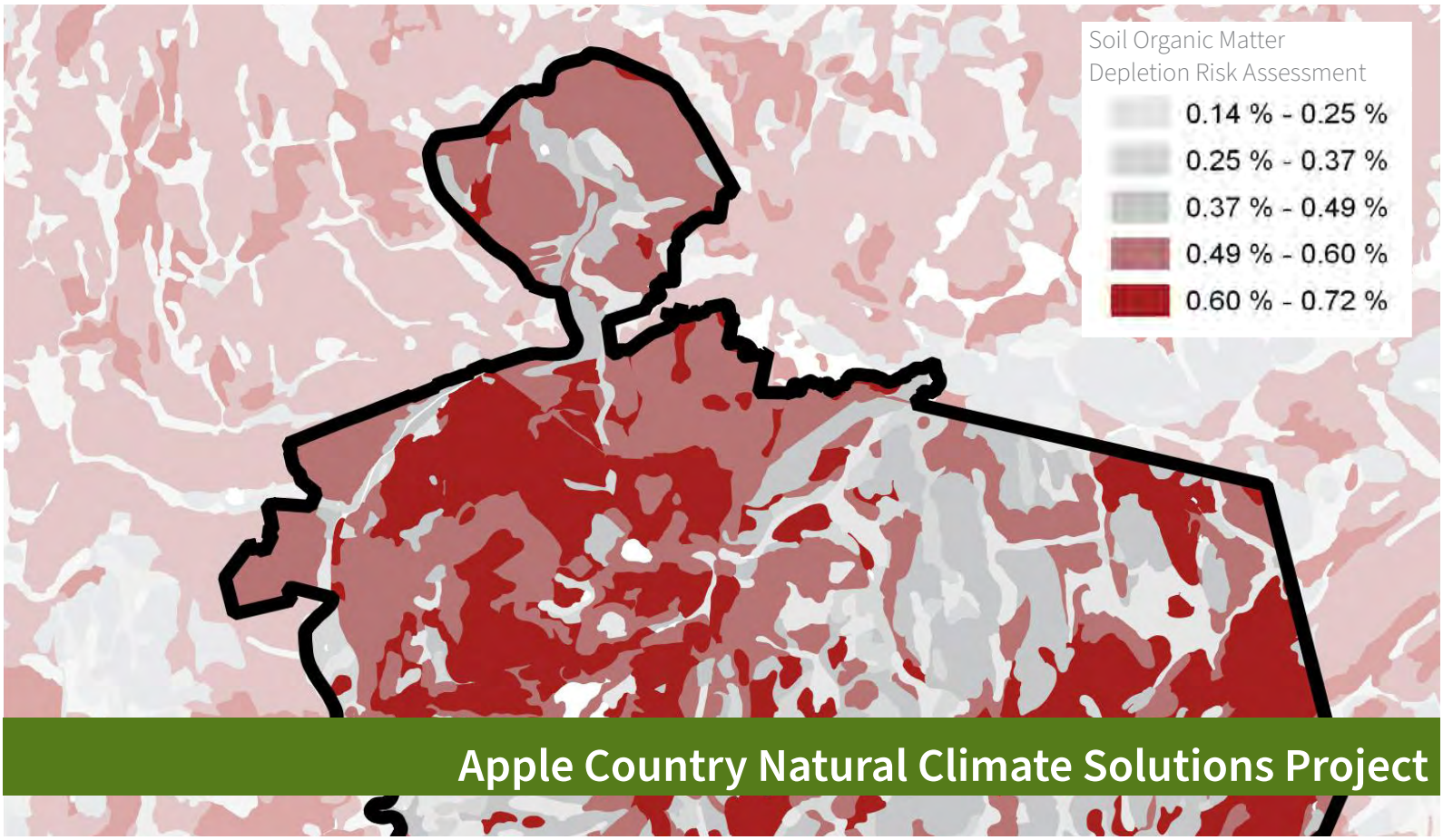


Very Low (0-20 tons/acre)	1,120 ac
Low (20-40 tons/acre)	3,299 ac
Medium (40-60 tons/acre)	4,481 ac
High (60-80 tons/acre)	3,306 ac
Very High (80-100 tons/acre)	5,107 ac
Exceptionally High (100+)	4,097 ac



Estimated Soil Organic Carbon Conservation + Regeneration Value





Apple Country Natural Climate Solutions Project

CLIENT

Towns of Bolton + Harvard with Devens Regional Enterprise Zone. Massachusetts Municipal Vulnerability Preparedness Program, 2019

SERVICES + ACCOMPLISHMENTS

Refined method for modeling soil organic carbon using land cover

Analysis and modelling of soil organic carbon stocks, segmented by land cover type

Projection of annual soil organic carbon fluxes for 2050 based on land use change predictions

Development of soil-smart planning and management BMPs

PROJECT OVERVIEW

In a regional effort to address the challenges of climate change, biodiversity loss, and regional development pressures, Bolton, Harvard, and Devens engaged BSC Group, Linnean Solutions, Woodwell Climate Research Center, and Regenerative Design Group to identify regional vulnerabilities and recommend nature-based climate solutions (NbS) that will increase the resiliency of their communities and ecosystems.

Nature-based Solutions provide cost-effective climate resilience by providing multiple co-benefits, including reduction of greenhouse gas emissions, improved water quality and water supply, reduced flooding, improved air quality, cooler local temperatures, fish and wildlife habitat and support for biodiversity, recreational and aesthetic opportunities, and improved physical and mental public health.

Regenerative Design Group led the mapping and analysis of soil carbon components of this project and contributed to the identification of NbS to increase regional climate resilience. To assist the communities to understand the impact of land use on health of their soils and contributions to climate resilience, RDG remapped NRCS soil carbon based on land cover (top right) and created an infographic of projected soil organic carbon fluxes in 2050 (bottom right).

Regenerative DesignGroup

Land Cover Adjusted Soil Organic Carbon

When adjusted for land cover, the total stock of SOC in Apple Country increased from 2.2 million metric tons (SSURGO) to 2.8 million metric tons, a difference of 400,000 tons.

This work suggests that the amount of carbon stored in the soils of this region is underestimated. This underestimation diminishes the significance of conserving and regenerating forests and wetlands.

ORIGINAL SSURGO SOC

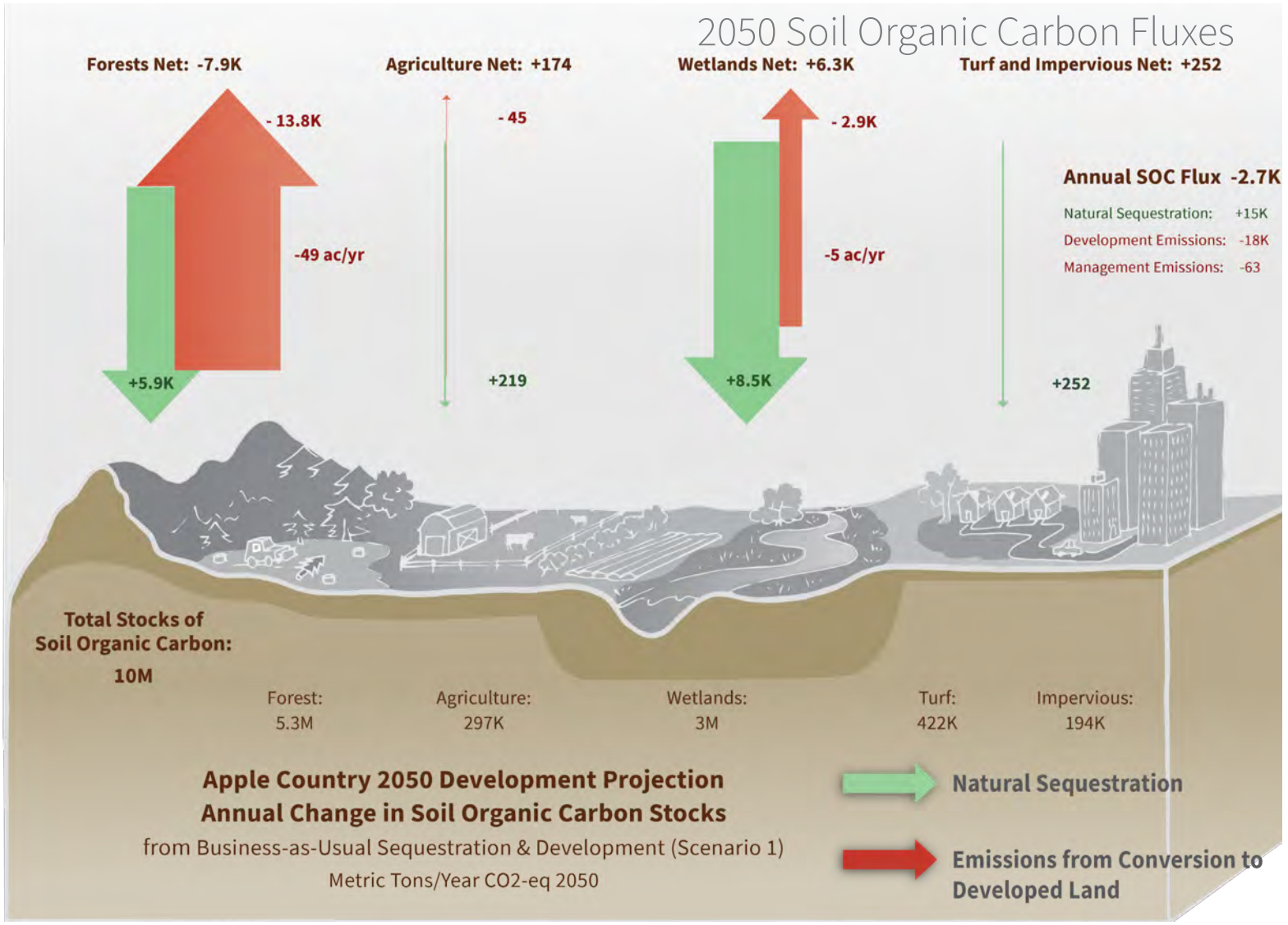
2.2 Million Metric Tons

FOREST PEDON NORMALIZED SOC

3.2 Million Metric Tons

LAND COVER ADJUSTED SOC

2.8 Million Metric Tons



SuAsCo Nature Based Solutions Project

CLIENT

Towns of Hudson, Framingham, and Natick, Municipal Vulnerability Preparedness Program, 2022-2024

SERVICES + ACCOMPLISHMENTS

Analysis and modelling of Soil Organic Carbon (SOC) stock, segmented by land cover type

Projection of 2050 SOC flux, based on land cover change

Soil-smart planning and management priorities

Selection of and recommendations for high-impact locations for nature based solutions

Focus on environmental justice and climate vulnerable populations using an analysis of a range of human health hazard data to guide project priorities

PROJECT OVERVIEW

Launched in the fall of 2022, the SuAsCo Natural Climate Solutions project is a joint effort by stakeholders in the towns of Hudson, Framingham, and Natick with consultant partners from Regenerative Design Group, Linnean Solutions, and BSC Group to identify high impact sites for nature based interventions that will support the towns' climate resilience.

With the understanding that soil health is foundational to the function of all terrestrial ecosystems, Regenerative Design Group lead an initial phase of the project aimed at establishing a baseline estimation of current soil health in the towns and analyzing the effects existing land cover and management practices have on these resources. These were summarized in a series of maps entitled Soil Functions for Resilience (top right).

From this baseline, the team completed an analysis that combines RDG's refined soil carbon predictions with other ecological data to map ecological planning priorities. The result is a map of planning districts (bottom right) with different priorities (e.g. restore and transform or plan an manage for resilience). Appropriate recommended actions for each district and an analysis of ideal candidate sites are major products of this project. Proposed sites for nature based solutions will receive a multi-stage assessment of vegetative health by drone monitoring.

This project also has a strong focus on environmental justice and improving conditions for climate vulnerable populations. Demographic data was overlaid with other data on known ecological hazards to create a human health and vulnerability map that contribute to developing project priorities.

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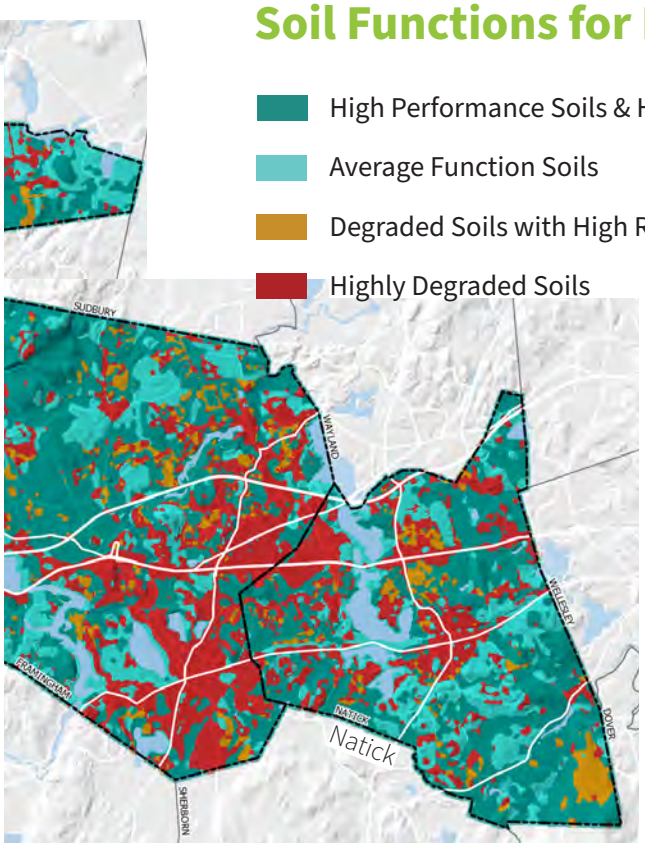
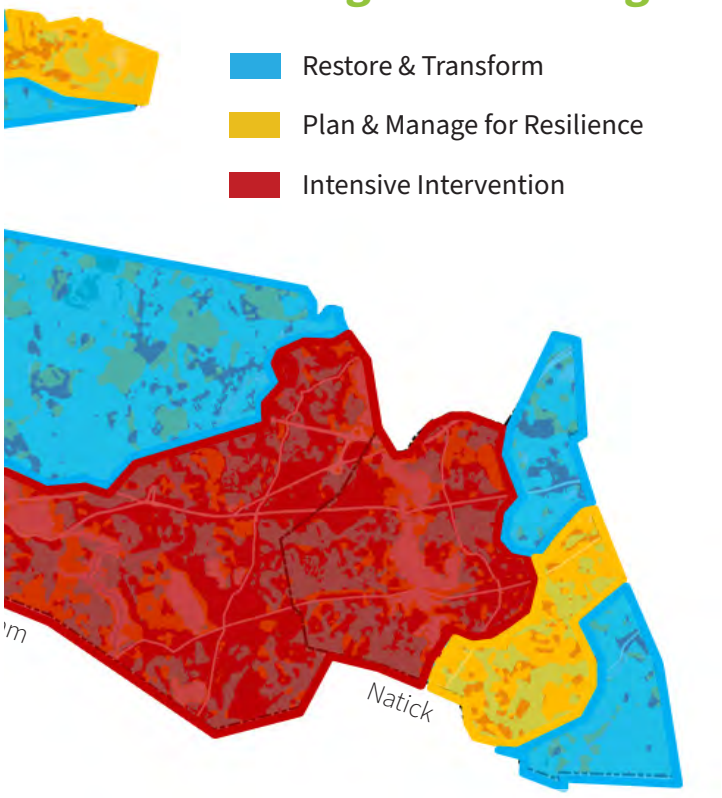
Soil Functions for Resilience



Ecological Planning Priorities



Spruces Park Landscape Resource Plan

CLIENT

Williamstown, MA

SERVICES

Site Assessments

Design + Management of a Project Website

Community Survey Creation + Synthesis

Concept Development

PROJECT OVERVIEW

Spruces Park is a low-lying, mostly flat 50-acre open space park that sits in the floodplain of the Hoosic River. It was formerly the site of the Spruces Mobile Home Community, which operated for 57 years before massive flooding from Hurricane Irene in 2011 set in motion the development's closure and resettling of over 300 residents.

The park, which was purchased by Williamstown through a FEMA Hazard Mitigation Grant and is subject to FEMA regulations, has since been used for passive recreation. Our team was charged with developing a landscape resource plan that further defined ways in which the community was already using the open space, enhanced the floodplain function of the site, and integrated new uses that fit within regulatory constraints.

Organizing principles for the landscape resource plan included:

Maintain + Enhance Ecosystem Services

» Keep encroachments South of the floodway to minimize regulatory, cost and timeline constraints
» Expand and enhance floodplain plant communities

Increase Whole-Site Legibility

» Prioritize a clear hierarchy of access roads, gravel lanes, and pathways that allow for a variety of experiences; retire some of the current lanes from use
» Use "feature" trees, existing shade, congregation spots, river access, etc. to guide movement through the site

Expand Opportunities for Recreation and Gathering

» Explore a variety of configurations for mixed-use playing fields and other community field uses in the available 16 acres south of the floodway

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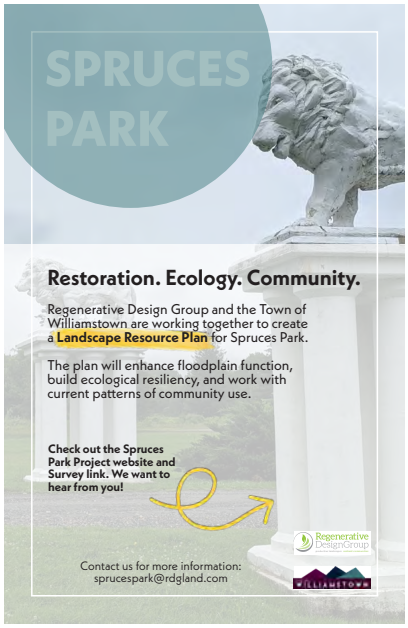
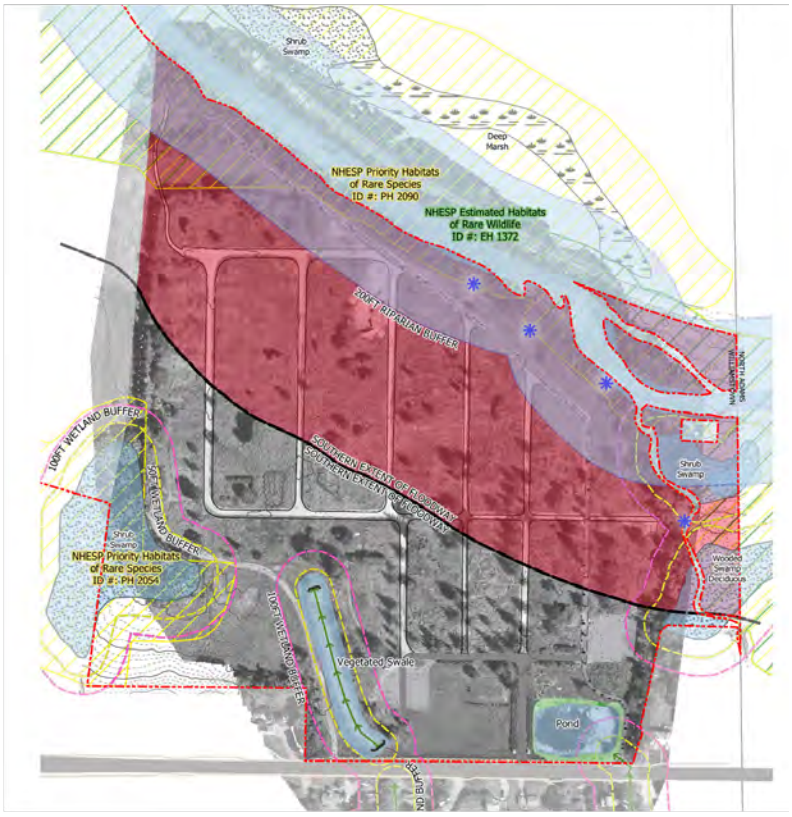
Water Resources + Regulatory





SPRUCES NORTH

Summary of Plan Goals

1. Find a balance between wilder open space and managed community uses within the park's regulatory constraints.

2. Increase whole site legibility.

3. Expand opportunities for low imapact recreation.

Leash Laws

Williamstown leash laws require dog owners and keepers to restrain their dogs physically by leash or by voice control when they are not on the owner's property. It is recommended that park rules require on-leash on the bikepath and all areas in Spruces South. Dogs should be able to be off-leash, under voice command, in most parts of Spruces North.

1 Floodplain Forest Grove

Although extensive underground utilities limit floodplain forest restoration, there are opportunities to establish plant communities typical of floodplain forests for this region. A floodplain grove is sited at the northwest entrance to Spruces and extends along the route of the river and bike path, totalling about 6 acres, and providing a counterpoint to the open meadows that define much of the park. Recommended trees include local genotypes of Silver Maple *(Acer saccharinum)*, Cottonwood *(Populus deltoides)*, Tulip Poplar *(Liriodendron tulipifera)*, Hackberry *(Celtis occidentalis)* with an herbaceous layer of Ostrich Fern *(Matteuccia struthiopteris)* and Wood Nettle *(Laportea canadensis)*.

2 The Spruces Meadow

The Spruces Meadow is currently the dominant typology at the park. Although, in landscape terms, this zone is more akin to a savannah, or mixed woodland-grassland, it is widely referred to as a meadow. Proposed changes to this roughly 14-acre zone include retiring 4 internal N-S gravel lanes, the addition of shade trees along reamining gravel lanes, and a more comprehensive network of mown meadow paths. One annual mowing in late winter/early spring to deter woodies and optimize pollinator habitat is recommended.

SPRUCES SOUTH

3 Wet Meadow

This zone unites the existing daylighted intermittent stream with the wetland to the west to create a 6.10 acre ***pollinator-supporting*** scrub-shrub wet meadow. A circuit path with boardwalk sections protects sensitive wet areas. The existing farm road still traverses this zone, but is rerouted out of the 50' buffer.

Recommended plants for this zone include Buttonbush *(Cephalanthus occidentalis)*, Sweet Pepperbush *(Clethra alnifolia)*, Red-osier Dogwood *(Cornus sericea)*, Common Spicebush *(Lindera benzoin)*, Fox Sedge *(Carex vulpinoidea)*, Blue Vervain *(Verbena hastata)*, and Spotted Joe Pye Weed *(Eupatorium maculatum)*

4 Maple Lawn

The 0.70 Maple Lawn remains as a picnic zone, but with greater connectivity to other uses. In the context of surrounding changes, this area becomes more significant as a central gathering spot.

5 Nature Play

A 0.60 acre field nestled between the East Parking Lot, Wet Meadow, and Maple Lawn caters to children, families, and school groups that may not venture north into the larger open space. A playground of natural materials, sensory garden, and small fruit foraging create a unique spot within the the park.

6 Sports Field

Two interior lanes are retired, to allow for a U12-sized soccer field (80 yards x 55 yards). Alternatively, a regulation tournament field could fit here, albeit with some encroachment into the floodway (shown below).

7 Community Lawn

A 1.75 acre open space used for community events, movie nights, informal sports, and lawn picnics. Border tree and shrub plantings help to define the space and soften the edges between Route 2, parking and access lanes. A small covered platform with volunteer-maintained, ***pollinator-supporting*** gardens is sited close to the parking lot.

8 Spruces Pond Field

A 1.70 acre field that centers around Spruces Pond, this area is largely unchanged except for the addition of a fishing dock and diversifying the pond edge with wet-tolerant plants like Sweetflag *(Acorus americana)*, Water Plantain *(Alisma plantago-aquatica)*, Swamp Milkweed *(Asclepias incarnata)*, and Marsh Marigold *(Caltha palustris)*.

9 Entrance + Parking

Existing low juniper hedge is replaced with native flowering and shade trees to create a more welcoming arrival. Vehicle access is limited to the east and west parking lots. The west lot, as currently configured, can park 40 cars if spots are appropriately indicated. (*Finished layout of east parking lot is unclear based on Bike Path construction documents.)

Estimating land cover-based soil organic carbon to support decarbonization and climate resilience planning in Massachusetts

CLIENT

Journal of Soil Security, 2022

SERVICES + ACCOMPLISHMENTS

Meta-analysis of scientific literature on soil organic carbon in various land cover types

Development of land cover SOC averages

Estimation of total SOC statewide SOC stocks for Massachusetts

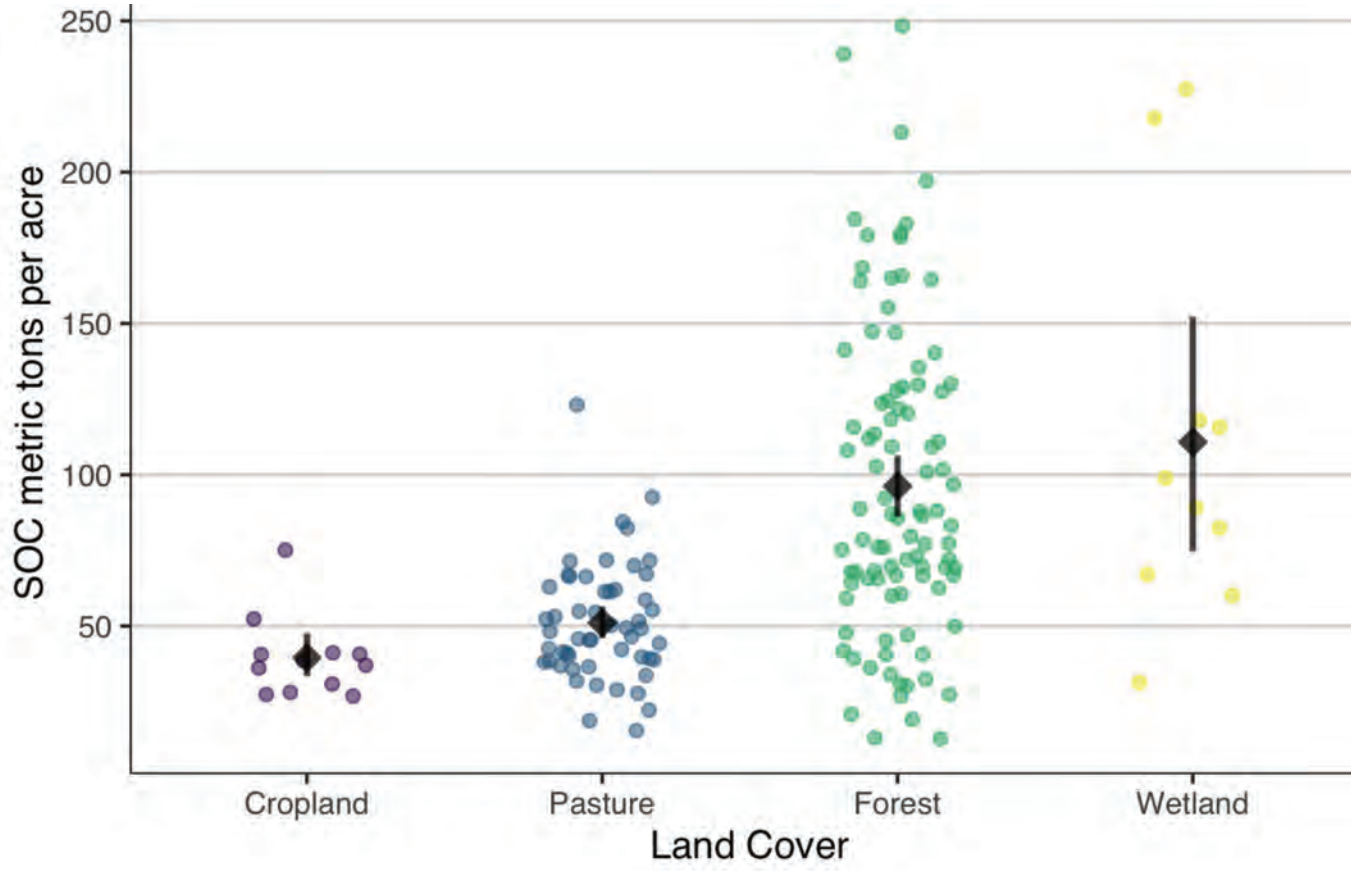
ABSTRACT

Land management and land cover change exert a strong influence on soil organic carbon (SOC) storage. As scientific, political, and business communities increase their awareness of the essential roles SOC plays in climate regulation and ecosystem functions, efforts to quantify the impacts of land use and management on SOC have increased rapidly. Existing methods of estimating SOC stocks from widely available data do not account for land cover, and are therefore of limited usefulness in understanding the impacts of past and future land use change.

This project explores a method of linking land cover to SOC, using data from public data sets and the scientific literature, to provide an SOC Inventory for Massachusetts and compares the results to those derived from a common baseline approach. Our method derives average land cover SOC values by combining data from the USDA-NRCS Rapid Carbon Assessment and the National Cooperative Soil Characterization Database with values from a meta-analysis of scientific literature. These are applied to the total area of the 20 most abundant landcover classes of Massachusetts. We compare this land cover-based approach with a baseline using SOC values found in the Soil Survey Geographic Database (SSURGO), applied to each soil map unit found within Massachusetts.

Our approach produced an estimated stock of 481 million metric tons of SOC, 29% and 109 million metric tons greater than the SSURGO baseline. We use these estimates to explore the use of the land cover based SOC values to project the impacts of likely land cover change by 2050.

Regenerative DesignGroup



CONTEXT + KEY FINDINGS

After the completion of the Massachusetts Healthy Soils Action Plan, members of RDG's consulting team published an article on the novel approach to estimating soil organic carbon at the state or larger regional scale.

Figure 3 (above) graphs the SOC mt/ha to a 1 meter depth for 172 samples tested by the National Resource Conservation Service from within 100 miles of the Massachusetts border. Cropland

An excerpt from Table 1 (right) contains the average SOC values for each major land cover type found in Massachusetts.

2016 High Resolution Land Cover Class	Average Soil Organic Carbon MT ha 1m depth	Source of SOC Value
Impervious (2)	54	Meta-analysis/ SSURGO
Developed or Open Space (5)	99	Meta-analysis/ SSURGO
Cultivated Crops (6)	81	RaCA/SCDB
Pasture or Hay (7)	126	RaCA/SCDB
Grassland or Herbaceous (8)	113	RaCA/SCDB
Deciduous Trees- non forest (9)	54	Meta-analysis/ SSURGO
Evergreen Trees- non forest (10)	54	Meta-analysis/ SSURGO
Forest (11)	214	RaCA/SCDB
Scrub/Shrub (12)	121	Meta-analysis/ SSURGO
Palustrine Forested Wetland (13)	825	RaCA/SCDB
Palustrine Scrub/Shrub Wetland (14)	825	RaCA/SCDB
Palustrine Emergent Wetland (Persistent) (15)	825	RaCA/SCDB
Estuarine Forested Wetland (16)	398	Meta-analysis/ SSURGO
Estuarine Scrub/Shrub Wetland (17)	398	Meta-analysis/ SSURGO
Estuarine Emergent Wetland (18)	398	Meta-analysis/ SSURGO

Ayer-Devens Pocket Forest Pilot Project

CLIENT

Town of Ayer
Municipal Vulnerability Preparedness Program, 2022

SERVICES + ACCOMPLISHMENTS

Stakeholder engagement

Pocket forest design

Soil testing and enhancement reccomendations

Print + digital educational materials

Town-wide analysis of ecological and social implications

Organization of a community planting day

PROJECT OVERVIEW

The aim of the Ayer/Devens Pocket Forest Project was to find the most suitable and impactful sites for planting small, dense, and diverse forests that will store and filter stormwater, cool and clean the air, increase habitat connectivity for wildlife, act as a seedbank for diverse tree species, and enhance human habitation in the Town of Ayer and the Devens Enterprise Commission.

After a robust community engagement, planning, and design process, we joined with the people of Ayer and Devens in April of this year to install one of the first pocket forests in the Northeastern US. More than 50 community members helped us prepare the soil and plant a diverse collection of trees and shrubs near downtown Ayer.

Ayer and Devens will be carrying on the momentum of this pilot project to install four more pocket forests next year (two in each town). Sites were selected based on a number of criteria that considered ecological and social factors to point towards high impact locations. We collaborated closely with BSC Group and Linnean Solutions as a consultant team to carry out this project.

Regenerative DesignGroup COOPERATIVE

Scouter Design

Firm Profile and Project Experience

SCOUTER DESIGN

SMART DESIGN THAT CONNECTS YOUR STORY TO YOUR AUDIENCE.

A little about us.

Transforming ideas into visual stories that resonate with your target audience is our passion and the hallmark of our work. Our collaborative approach along with listening and communicating throughout the process allows us to create the most effective solution for your project, while creating a positive experience for all.

At Scouter Design, we work with clients to create new brands and refresh existing ones. This may include a logo or creating or expanding a business's system of products such as templates, brand guides, stationery, corporate overviews, and annual reports. We make our templates functional for our clients to help streamline their process and believe that training is an integral part of that deliverable.

We want our clients to enjoy working with us as much as they enjoy the products that we deliver. Our philosophy revolves around these three concepts.

Explore. Create. Connect.

EXPLORE
Through research and exploration, we seek to uncover and understand what your audience cares about.

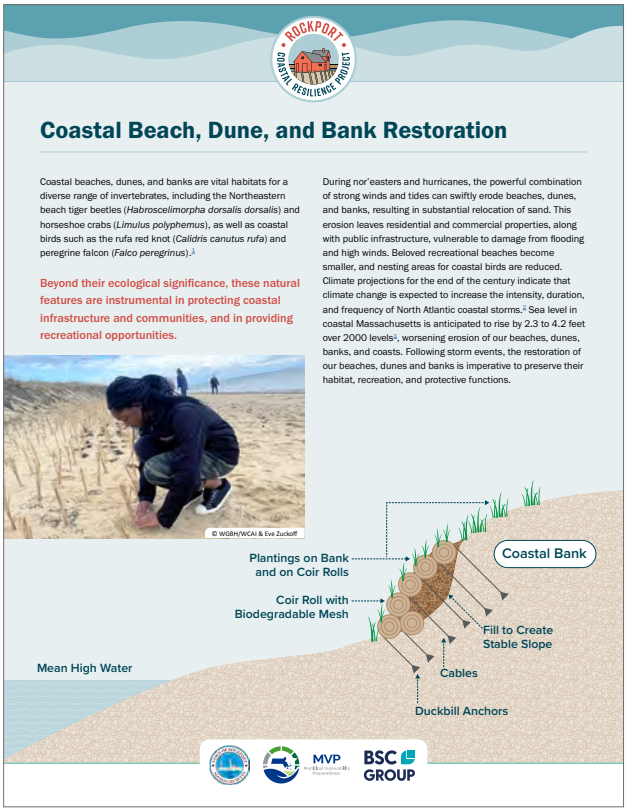
CREATE
We develop smart concepts and deliver custom solutions that support your vision and relate to your audience.

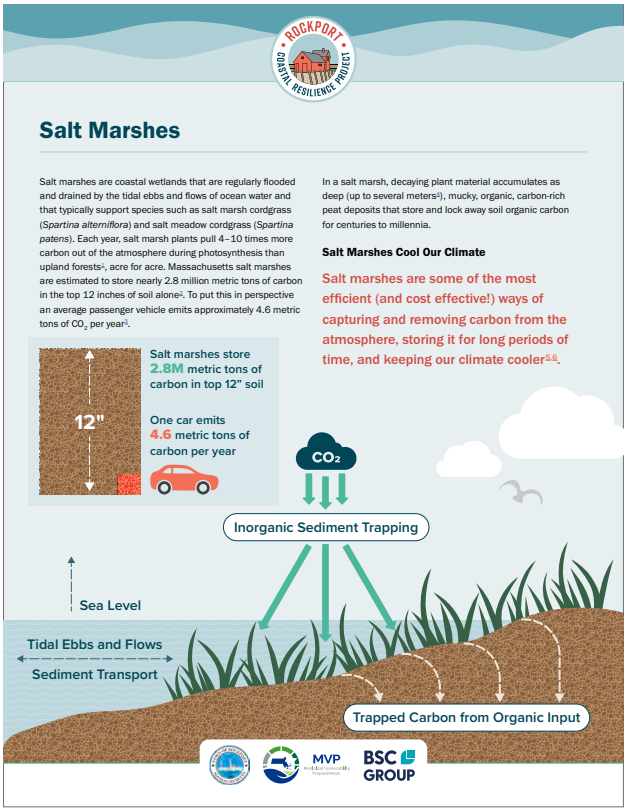
CONNECT
Our clear and compelling designs visually highlight your story that will engage your audience.

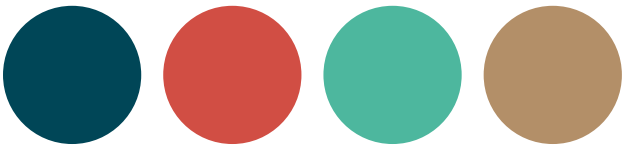
Terri Courtemarche
Principal, Graphic Designer

Terri brings over 25 years of graphic design experience creating logos, brand identities, templates, and report design to her clients. Her prior experience leading an in-house team of designers at an engineering firm exposed her to a range of clients that included state transportation agencies, municipalities, airports, and federal agencies. Currently, she works with engineering firms and environmental planners focusing on branding and climate action plans. Using her design skills to benefit others, Terri also volunteers with non-profit organizations to help them promote their work.

ROCKPORT COASTAL RESILIENCE PROJECT TOOLKIT / MASSACHUSETTS







CLIENT'S MISSION.

BSC worked with the Town of Rockport to find solutions to mitigate climate challenges along their coastline. To inform stakeholders and community, we designed a toolkit of outreach materials that BSC and Rockport could use to promote this effort.

EXPLORING IDEAS.

Creating a strong brand around an initiative helps build community engagement and interest. This toolkit included infographics, templates, and a project logo. To customize the project's brand, we drew on the character of the coastal town for inspiration for all of the brand components.

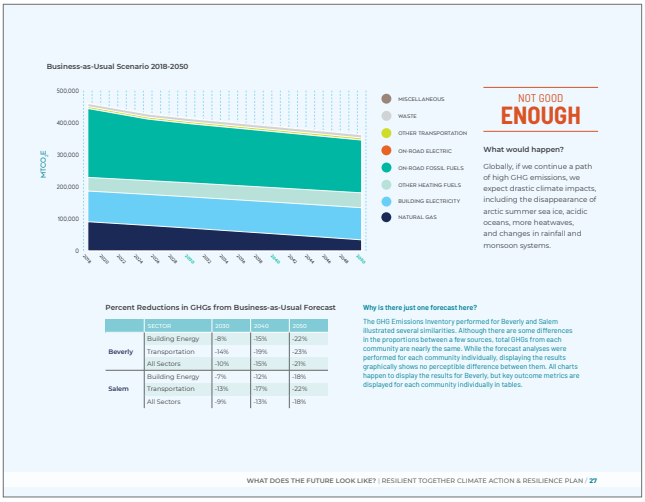
CREATING SOLUTIONS.

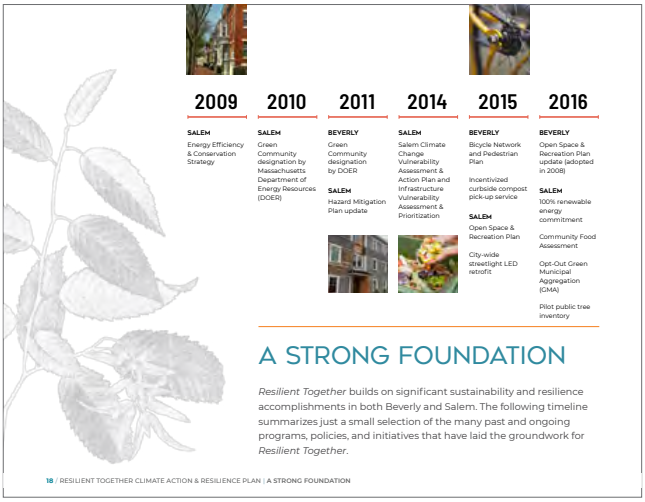
Illustrations and graphics are the best way to convey information that is complex. We created a series of infographics for the public that visually show the issues and supporting data for each topic. The graphics can be repurposed for social media and presentations.

CONNECTING PEOPLE.

Our communities are diverse. That means we can expand our reach and our message by creating the infographics in other languages depending on the languages being spoken within our community.

BEVERLY & SALEM CLIMATE ACTION & RESILIENCY PLAN / MASSACHUSETTS





BACKGROUND

Beverly and Salem worked with KLA to assess climate change within their communities and create a plan and target goals that they can achieve to address climate change.

EXPLORE

The clients wanted to highlight the inclusive process that they used to hear from and inform their communities. For this reason, it was important to show how they achieved that by using various methods such as social media, surveys, and focus groups.

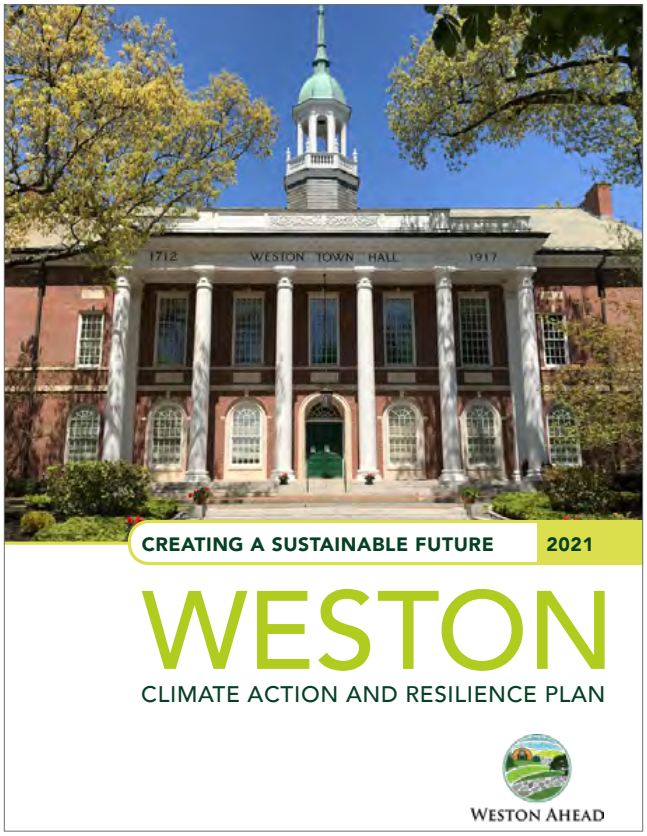
CREATE

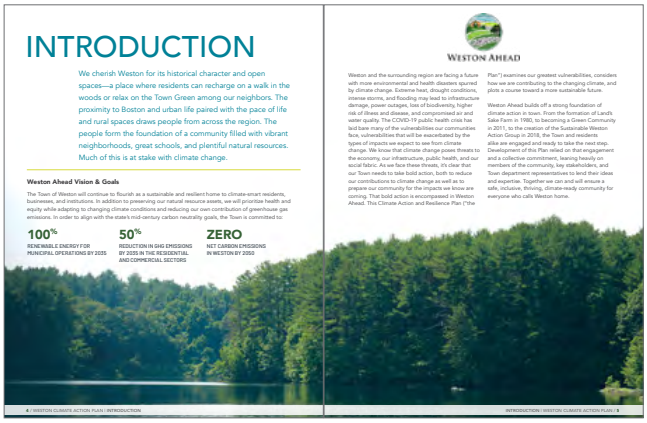
We chose to support the story by using public engagement infographics, quotes, local community stories, and photos of the community working to protect our environment.

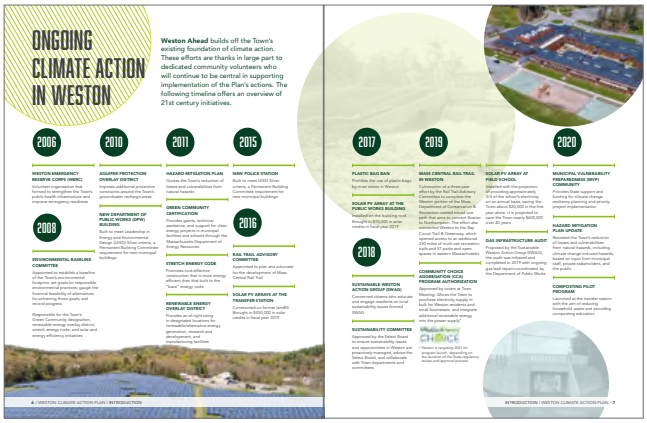
CONNECT

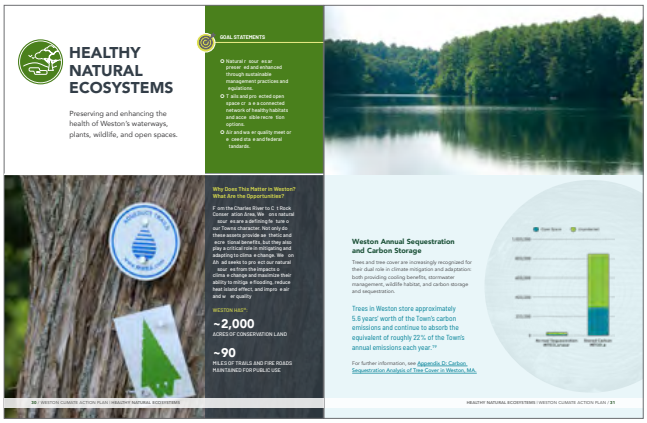
The interactive report was posted online for the community to review. It was also made ADA compliant so it was accessible to everyone.

WESTON CLIMATE ACTION & RESILIENCY PLAN / MASSACHUSETTS









BACKGROUND

The Town of Weston underwent the process of defining their goals for addressing climate change within their community with KLA. This report is the result of their findings.

EXPLORE

We explored different ways to tell their story in a visual way while also using their brand and logo. Creating smaller pieces of information helped make complex and technical information understandable for all readers.

CREATE

Each section used call out boxes to highlight important aspects of the plan; charts and infographics to easily grasp complex data; and imagery to add visual interest. These attributes helped deliver the overall goals of the plan in a visual and legible way.

CONNECT

This interactive report was posted on-line for the community to read and included attributes such as hyperlinks and bookmarks to make it easy to navigate and read.

BEVERLY & SALEM CAP SKILL SHEETS / MASSACHUSETTS

BACKGROUND

In conjunction with the Climate Action Plan, Beverly and Salem used skill sheets early in the process to inform the community about the different areas that most affect climate change and our environment.

EXPLORE

The information needed to be concise and easy to understand. Under these topics, the clients were able to create an awareness as to how our every day habits can impact our environment as well as how we can help.

CREATE

Local examples of where climate change was being addressed, whether large or small, were incorporated. Infographics and imagery made a compelling visual narrative and the brand created a consistent and cohesive message.

CONNECT

The skill sheets were designed in multiple languages because of the diversity in the communities. They were also ADA compliant so that the information was accessible to all readers.

Appendix B

Team Member Resumes

BSC GROUP

Gillian
Davies, PWS, RSS, NHCWS, CESSWI

Senior Ecologist/Natural Climate Solutions Specialist
Senior Associate

YEARS OF EXPERIENCE

33

EDUCATION

MES, Ecosystem Ecology
Yale University School of the Environment

BA, Psychology
Williams College

Certificate of Completion in the New England Regional Soil Science Certificate Program
University of Massachusetts

AFFILIATIONS

Global Development and Environment Institute, Tufts University, Visiting Scholar (2018-present)

Society of Wetland Scientists -Chair WOTUS ad hoc Committee, Co-Lead Climate Change & Wetlands Initiative; 2016-2017 President, Past President, President Elect

MEET GILLIAN

Gillian provides expertise and innovative solutions encompassing peer review for Conservation Commissions, ecosystem-based climate change resiliency and mitigation assessment and planning, state and federal permitting, wetland delineation, impact analysis, wetland restoration/mitigation planning, design and monitoring, expert witness testimony, and environmental construction/post construction inspection.

A well respected leader in the field of wetland sciences, Gillian holds many prestigious titles at industry organizations dedicated to promoting the understanding, conservation, protection, restoration, science based management, and sustainability of wetlands. She currently serves as Chair of the SWS WOTUS ad hoc Committee and Co Lead of the SWS Climate Change and Wetlands Initiative. She is also a Visiting Scholar at the Tufts University Global Development and Environment Institute. In the past she has held such titles as Society of Wetland Scientists (SWS) President, SWS Professional Certification Program President, SWS New England Chapter President, and Association of Massachusetts Wetlands Scientists President.

Gillian has worked extensively with Massachusetts Conservation Commissions as a peer-reviewer and previously as an education/outreach specialist for the MassDEP. She has provided numerous workshops and presentations to Conservation Commissions and other members of the wetland's professional community in Massachusetts and internationally.

AFFILIATIONS (CONT.)

Society of Wetland Scientists Professional Certification Program, 2021-2022 President; President Elect

Society of Wetland Scientists New England Chapter; 2014-2015 President, Vice President

INTECOL (International Association for Ecology) Wetlands Working Group, Member (2021-present)

Association of Massachusetts Wetlands Scientists; 2002-2003 President, Vice President

REGISTRATIONS

Registered Soil Scientist, Society of Soil Scientists of Southern New England

CERTIFICATIONS

Professional Wetland Scientist, Society of Wetland Scientists #2181 (2011)

Certified Wetland Scientist – NH #071 (1999)

Certified Erosion, Sediment, and Storm Water Inspector, Envirocert International, Inc.

Certified Municipal Vulnerabilities Preparedness Provider – MA

GOVERNMENT SERVICE

MA Executive Office of Energy and Environmental Affairs & Commission for Conservation of Soil, Water & Related Resources Healthy Soils Action Plan Work Group (2019–2020)

GOVERNMENT SERVICE (CONT.)

MA Department of Transportation Wetland Mitigation Banking Group (2018)

MA Executive Office of Energy and Environmental Affairs Natural Resources and Habitat Subcommittee to the Climate Change Adaptation Advisory Committee (2009)

MA DEP Wetlands & Waterways Circuit Rider (1999-2003)

OTHER VOLUNTEER

National Academy of Sciences, Engineering, and Medicine Transportation Research Board Panelist (2018–2022)

PROJECT EXPERIENCE HIGHLIGHTS

MassDEP No Net Loss of Carbon in Wetlands in Massachusetts Project: Statewide

Project Manager & Senior Ecologist

Led multidisciplinary team to develop strategies and methodologies for No Net Loss of Wetland Carbon in Massachusetts policies and regulations. Consulting team developed innovative wetland soil carbon mapping using machine learning and researching and developing concepts and preliminary design for an interactive carbon accounting tool for both Teal Carbon (inland freshwater) wetlands and Blue Carbon (coastal saltwater) wetlands.

SuAsCo Natural Climate Solutions Project: Hudson, Framingham, and Natick

Project Manager & Natural Climate Solutions Specialist

Coordinated consulting team and 3 urban/suburban communities with Environmental Justice communities to identify Nature-based Solutions (NbS) to climate change and biodiversity loss. Project identified opportunities for wetlands, floodplains, forests, and other ecosystems to support broader resilience planning efforts, and expanded communities' capacity to protect, restore and enhance carbon sequestration and other ecosystem services through community driven assessment of NbS; and developed educational materials and opportunities.

Ayer-Devens Main Streets Pocket Forest Pilot Project, MA

Project Manager & Natural Climate Solutions Specialist

Coordinated consulting team and 2 communities with Environmental Justice communities to improve community health and resilience through: the design and planting of a pilot pocket forest; community driven selection of, and permitting assessment for, four additional pocket forest sites; development of a project website and pocket forest educational materials; and a variety of community events including a community planting day at the pilot pocket forest.

MassDEP Coastal Floodplain Outreach

Senior Ecologist

Advised project team on coastal floodplain ecological features and functions, and effectiveness of visual and text communications to inform development of a public education outreach campaign focused on the climate resilience benefits provided to coastal communities by the coastal floodplain. The campaign included development of a coastal floodplain video, pamphlet, and StoryMap.

Apple Country Natural Climate Solutions Project: Bolton, Harvard, and Devens Regional Enterprise Zone

Project Manager & Senior Ecologist

Coordinated team of consultants and 3 communities to identify Nature-based Solutions (NbS) to climate change and biodiversity loss. Project identified opportunities for wetlands, floodplains, forests, and other ecosystems to support broader resilience planning efforts, and expanded communities' capacity to protect, restore and enhance carbon storage and sequestration and other ecosystem services by providing a model for community driven assessment of NbS; providing recommendations to improve regulations; and developing and providing educational materials and opportunities.

Rockport Coastal Resilience Project, Rockport, MA

Project Manager & Natural Climate Solutions Specialist

Led interdisciplinary team to identify coastal Nature based Solutions. Project identified opportunities for coastal NbS to support broader climate resilience planning efforts, and expanded communities' capacity to achieve greater resilience to sea level rise and coastal storms through community driven assessment of NbS; and developed educational materials and opportunities, including a website, StoryMap, and infographics.

Massachusetts Department of Transportation, Route 2, Lincoln and Concord, MA

Senior Wetland & Soil Scientist; & Certified Erosion, Sediment & Storm Water Inspector

Provided environmental monitoring services for complex highway improvements project (construction of new interchange, road widening, safety improvements), including monitoring of two large wetland replication areas (totaling 77,963 s.f.), with relocated streambeds. During monitoring of wetland mitigation areas, responsible for implementing innovative approach (IRIS tubes) to assessing hydric status of soils. The project area encompassed approximately 60 acres, is 2,751 meters long, and included multiple work areas operating simultaneously. Environmental Monitoring included responsibility for monitoring project compliance with MA Wetlands Protection Act Variance and Stormwater Pollution Prevention Plan conditions, preparing numerous reports, developing solutions to emerging issues, and coordinating with state and federal regulatory agencies, as well as MassDOT and the project contractor.

Massachusetts Department of Transportation, Route 18, Weymouth, Abington, Southfield, MA

Senior Wetland & Soil Scientist; & Certified Erosion, Sediment & Storm Water Inspector

Provided environmental monitoring services for complex highway widening projects (road widening, bridge replacement, safety improvements), including monitoring construction of wetland replication area (totaling 42,210 s.f.) and wetland restoration areas. The project area was 4.1 miles long and included multiple work areas operating simultaneously. Environmental Monitoring included responsibility for monitoring project compliance with MA Wetlands Protection Act and Water Quality Certification Variance and Stormwater Pollution Prevention Plan conditions, preparing numerous reports, developing solutions to emerging issues, and coordinating with state and federal regulatory agencies, as well as MassDOT and the project contractor.

Nashua River Communities Resilient Lands Management Project

Natural Climate Solutions Specialist & Senior Ecologist

Collaborating with the Massachusetts Association of Conservation Commissions, Gillian led development of wetland climate change by-laws and regulations for Massachusetts municipalities and tailored those bylaws and regulations to the specific needs of the Towns of Bolton and Clinton. This project aimed to improve community climate resilience and ecosystem carbon mitigation by protecting and restoring ecosystem services through the development and adoption of better land management practices and articulated through the writing of forest management and lawns and landscaping management guides.

Nashua River Watershed Natural Climate Solutions Project, Ashburnham, Fitchburg, Groton, Leominster, Pepperell, MA

Senior Ecologist

Advised consulting team for 5 urban/suburban communities with Environmental Justice communities on project to identify Nature-based Solutions to climate change and biodiversity loss. Project identified opportunities for wetlands, floodplains, forests, and other ecosystems to support broader resilience planning efforts, and expanded communities' capacity to protect, restore and enhance carbon sequestration and other ecosystem services through community driven assessment of NbS.

Route 44 Relocation Project Wetland Mitigation Monitoring, Carver/Kingston, MA

Senior Wetland & Soil Scientist

Responsible for monitoring inland wetland replication/restoration areas associated with construction of relocated Route 44, for assessing invasive species, as well as report preparation. A total of 16.58 acres of wetland replication was constructed for this project, with an additional 0.4 acres of wetland restoration.

Municipal Vulnerability Preparedness Planning Projects: Amesbury, Bolton, Georgetown, MA

Project Manager & Senior Ecologist

Responsible for projects in each municipality to work with municipal staff, stakeholders, and community members to identify existing climate vulnerabilities and community strengths, future opportunities for building community climate resilience, and prioritization of those opportunities. This work provided the communities with the basis for specific, action oriented projects to improve infrastructure, social and environmental community climate resilience, and prioritization of actions. The Georgetown MVP Planning Project included integration of the Georgetown Hazard Mitigation Plan Update.

Massachusetts Association of Conservation Commissions Wetland Buffer Zone Guidebook Project, Belmont, MA

Project Manager & Lead Author

Responsible for project to research and write comprehensive guidebook on the science and regulation of wetland resource area buffer zones and Riverfront Areas under the Massachusetts Wetlands Protection Act and local bylaws and ordinances. Preparation of guidebook includes supervision of junior staff and coordination with Massachusetts Association of Conservation Commission Buffer Zone Guidebook review team, scientific literature search, and development of recommendations for science-based review of projects under existing state regulations and local bylaws/ordinances, as well as how to develop local bylaws and ordinances supported by current scientific findings. The guidebook provides a discussion of wetland, buffer zone and Riverfront Area regulation in the context of climate change, outlining how buffer zones contribute to protection of carbon in wetlands, support climate adaptation and climate resiliency ecosystem services that wetlands provide, and protect wetlands from the impacts of climate change.

BSC GROUP

Ethan
Sneesby, RSS

Wetland Scientist

Associate

YEARS OF EXPERIENCE
5

EDUCATION
MS, Crop and Soil Environmental Science
Virginia Tech University

BS, Environmental Science and Management
University of Rhode Island

CERTIFICATIONS
- 40-Hour OSHA

REGISTRATIONS
Registered Soil Scientist, Society of Soil Scientists of Southern New England (SSSSNE)

MEET ETHAN
Ethan is experienced with various methods of soil and wastewater sampling and analysis as well as GPS and GIS related to utility projects and open water bathymetric and soil mapping. Ethan has his master's degree in crop and soil environmental science from Virginia Tech. As a graduate assistant, he worked on the evaluation of wetland water budget modeling software as well as on the construction of a library of target hydroperiods for common wetland types in Virginia, Maryland, and North Carolina. Ethan has extensively studied wetlands, soil morphology, soil conservation and their impact on environmental quality.

Ethan's advanced skillsets are put to use supporting BSC's peer review efforts, working on National Grid and Eversource projects, and assisting the firm's environmental engineering group. Ethan has a strong background in soils and wetland hydrology which serve as a boon when performing review of disturbed or complicated wetland systems where vegetation cannot be relied upon to protect our resources adequately.

PROJECT EXPERIENCE HIGHLIGHTS

Melink Solar Development, 179 Greenwich Road, Ware Conservation Commission, Ware, MA
Wetland Scientist & Soil Scientist

Responsible for wetland delineation peer review including Riverfront Area and review of two Notices of Intent on two parcels (37 acres and 38 acres). Ethan reviewed the project for compliance with Ware Conservation Commission Wetland Protection Bylaw (Chapter 30 3) and the Massachusetts Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and associated regulations (310 CMR 10.00 et al.). Additionally, BSC provided findings and comments relative to the project's compliance with MassDEP Wetlands Program Policy 17 1: Photovoltaic System Solar Array Review 225 CMR 20.00: Solar Massachusetts Renewable Target (Smart) Program.

Spencer Conservation Commission, 10 Meadow Road, Notice of Intent, Spencer, MA
Wetland Scientist

Responsible for the wetland delineation peer review including BVW and associated Buffer Zone, and 200 foot Riverfront Area. Reviewed the project for compliance with the Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and associated regulations (310 CMR 10.00 et al.).

Amesbury Conservation Commission, Notice of Intent for 9, 14, and 15 Estes Street and Estes Street Improvements. Amesbury, MA
Wetland Scientist

Responsible for Wetland Delineation peer review regarding the Notice of Intent (NOI) for a site identified as Overlook at Estes, Amesbury, MA comprising 9 Estes Street, Map 63, Parcel 22, 14 Estes Street, Map 63, Parcel 21, 15 Estes Street #R, Map 63, Parcel 19, and Estes Street Improvements. Reviewed the project for compliance with the Amesbury wetland regulations, and Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and associated regulations (310 CMR 10.00 et al.).

Robbins Road over Robbins Brook Bridge Replacement, Winchendon, MA
Wetland Scientist

Performed wetland delineation services in support of the Town of Winchendon's replacement of the Robbins Road over Robbins Brook Bridge. Prior to BSC's design of the bridge's replacement, Ethan demarcated the boundaries of jurisdictional wetland resources (e.g., inland bank and bordering vegetated wetland), which contributed to the preparation of a Bordering Vegetated Wetland Field Data Form for inclusion with the Notice of Intent Application (NOI).

Bellingham Conservation Commission, Peer Review of Abbreviated Notice of Resource Area Delineation 180 Paine Street, Bellingham, MA,
Wetland Scientist

Responsible for the wetland delineation peer review including BVW and associated Buffer Zone, Isolated Vegetated Wetland (IVW), Bank to a Pond, Inland Bank to Streams (intermittent and perennial) and associated Buffer Zone, Bordering Land Subject to Flooding (FEMA Flood Zone AE), and 200 foot Riverfront Area. Reviewed the project for compliance with the Bellingham wetlands protection by law, and Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and associated regulations (310 CMR 10.00 et al.).

Amesbury Conservation Commission, Peer Review of Abbreviated Notice of intent, 91 Macy Street, Amesbury, MA
Wetland Scientist

Responsible for the wetland delineation peer review Including Riverfront area. Reviewed the project for compliance with the Amesbury wetland regulations, and Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and associated regulations (310 CMR 10.00 et al.).

National Grid, Wetland Delineation and GIS Mapping Services for E5F6 Transmission Line Insulator Replacement Project, Shelburne to Millbury, MA
Wetland Scientist

Responsible for providing National Grid with wetland delineation and GIS mapping support services for the proposed Transmission Line Insulator Replacement Project (IRP). Ethan performed wetland delineation mapping services, including data collection of dominant plant species, characterization of soils, and general hydrological field indicators within the project right of way. Data collection also included all major features (e.g., wetlands, beaver dams, crushed culverts, culvert crossings, stone walls, pipelines, and fences), which were geotagged with photographs using Trimble units/ESRI's collector. Collected features were stored in an online geodatabase, allowing the photographs and data to be intuitively viewed within an ESRI web application.

Eversource Energy, F132 Line Structure Replacement Project, Pittsfield and Lanesborough, MA
Wetland Scientist

Responsible for providing environmental consulting services for a Line Structure Replacement project from Pittsfield to Lanesborough, MA. for BSC's contract with Eversource Energy. Ethan performed field identifications of wetlands within the limits of the project right of way and prepared federal wetland field data forms to document the delineation of federal wetlands at locations where wetland impacts were likely to occur. This data collection also included obtaining stream and access road widths for construction planning purposes.

BSC GROUP

Evan
Fox

Field Oversight Technician
Wetland Scientist

YEARS OF EXPERIENCE

6

EDUCATION

MNRS, Natural Resources Stewardship
Colorado State University

BS, Environmental Design
University of Massachusetts

CERTIFICATIONS

- OSHA 10 Hour
- Wilderness First Aid
- S130/S190 Wildland Firefighting
- S212 Chainsaw
- Pesticide Applicator- Colorado
- CGP Site Inspector Certificate

AFFILIATIONS

- Town of Gill Conservation Commission - Member
- Society of Ecological Restoration- Member
- Native Plant Trust – Member
- Association of Massachusetts Wetland Scientists – Member
- Massachusetts Association of Conservation Commissions – Member

MEET EVAN

Evan is a Field Oversight Technician and Wetland Scientist with experience in habitat management and ecological restoration, herbicide application to manage invasives and various natural resource assessments. He performs wetland delineations and construction monitoring and reporting. He's also on the Wetland Subject Matter Expert (SME) team and is responsible for continuing to modernize data collection efforts within the Ecology Team.

PROJECT EXPERIENCE HIGHLIGHTS

National Grid, E5/F6 ACR, Western MA
Wetland Delineator

Responsible for accurate delineation, flagging and GPS recording of wetland boundaries in accordance with USACE standards.

National Grid, I135/J136 Tower Painting, Southern NH
Wetland Delineator

Responsible for accurate delineation, flagging and GPS recording of wetland boundaries in accordance with USACE standards.

Eversource, CT-26 Vegetation Management, Central CT
Wetland Delineator

Responsible for accurate delineation, flagging and GPS recording of wetland boundaries in accordance with USACE standards.

National Grid, E5/F6 ACR Project, Various Towns, MA
Wetland Delineator

Conducted wildlife habitat evaluations in multiple towns along the transmission line, using the Massachusetts Department of Environmental Protection Wildlife Habitat Protection Guidance.

Stamford City Parks Invasive Species Plan, Stamford, CT Invasive Species Survey Design, Implementation, & Management Plan Development
Ecological Scientist

Responsible for identifying and mapping floral invasive species as well as developing a treatment and adaptive management plan for the City of Stamford, CT parks.

National Grid, K137/L138 OPGW, Ayer, MA
Replication Specialist

Responsible for the planning and coordination of a wetland replication. This task included selecting appropriate plants and soils, consulting and supervising a construction crew in the creation of additional wetland based on design standards approved by our in-house landscape architects.

Everett STEM Class Field Event, Everett, MA
Educator
Helped lead a volunteer day with 30 middle school students in making trail and habitat improvements in Rivergreen Park. Sharing knowledge about invasive species, wildlife habitat, and practicing safety guidelines with hand tools.

PRIOR TO JOINING BSC, EVAN CONTRIBUTED TO THE FOLLOWING PROJECTS:

Highlands Ranch Metro District, Dad Clark Gulch River Restoration, Highlands Ranch, CO
Project Manager
Oversaw the soil stabilization and revegetation efforts of a .5 mile stretch of perennial stream and over 6 acres of riparian and upland areas. Supervised a crew of 12 employees and personally operated machinery including skid-steers, excavators, and trucks hauling said equipment on trailers. Coordinated with clients, engineers, ecologists, and suppliers, and reported progress with weekly production logs. Performed follow up vegetation management with mechanical and chemical applications.

Kankakee Sands Prairie Restoration, Newton County, IN
Restoration Technician
Managed invasive species using herbicides and machinery such as brush cutters and chainsaws and mimicked natural processes by using prescribed burns and assisting with rotational grazing to lay the groundwork for eventual introduction of Bison. Collected and processed native seed for ongoing restoration plantings.

Colorado Natural Heritage Program, Wetland and Riparian Assessment, Inventory, and Monitoring, Various Locations CO and WY
Crew Lead
Performed vegetation sampling, soil profile characterization, water quality sampling, and evaluation of land use stressors utilizing Line Point Intercept and other standardized methods to develop a baseline inventory of wetlands on Bureau of Land Management parcels across the Intermountain West. Was responsible for the planning and oversight of a 3 person teams efforts to visit 30 wetlands each field season for 2 summers, traveling hundreds of miles on 7-day long trips in remote country.

BSC GROUP

Marleigh Sullivan

Ecological Scientist

Associate

YEARS OF EXPERIENCE

12

EDUCATION

MS, Soil and Water Resources Management
University of New Hampshire

BS, Environmental Conservation
University of New Hampshire

AFFILIATIONS

- NH Association of Natural Resource Scientists Board of Directors, Treasurer

MEET MARLEIGH

Marleigh is an ecological scientist with expertise in soil science, hydrology, water biogeochemistry, plant biology, and ecology. She is experienced with wetland delineation methodology conforming to the USACE Wetland Delineation Manual. Specifically, Marleigh is experienced with hydric soil indicators and soil profile descriptions; plant taxonomy and field identifications in both upland and wetland environments; and her background in hydrology and water chemistry is particularly valuable for identifying indicators of hydrology. She also performs vegetation surveys for restoration projects and performs rare plant surveys in NH, MA, RI, and CT. Marleigh is also familiar with stormwater, surface water, and groundwater hydrology beneficial in managing construction sediment/erosion controls.

PROJECT EXPERIENCE HIGHLIGHTS

1421/1512 Line Uprate, Eversource Energy, Lee, Becket, Otis, Blandford, and Russell, MA
Compliance Inspector

Performed environmental compliance monitoring for Eversource's Line Uprate Project of the 1421/1512 transmission lines extending from Lee to Granville, MA. Marleigh was responsible for all construction-phase field monitoring for the project to ensure compliance with applicable local, state, and federal environmental regulations and permits and company best management practices (BMPs). This includes overseeing construction on a weekly basis; reviewing sediment/erosion controls and other BMPs; reviewing construction restoration and mitigation efforts; providing contamination spill response; identifying environmental concerns and proposing responsive actions through coordination with the construction crews and comprehensive reporting.

Storm Hardening Initiative, Eversource Energy, Various Locations, CT
Wetland Delineation Specialist

Performed wetland delineation for the Storm Hardening Initiative projects in Connecticut and Massachusetts. Marleigh was responsible for field wetland delineations and field location of wetland flags; evaluating permit requirements; preparing and filing required permit applications including Category 1 Notifications in accordance with the Connecticut General Permit and individual 401 Water Quality Certification application in Massachusetts.

MA Department of Conservation and Recreation (DCR) Invasive Species Management Plan, Various Locations, MA
Compliance Inspector

Developed a survey protocol for mapping invasive plants throughout approximately 60 DCR owned and managed parks throughout Massachusetts. Led a team of ecological scientists to collect data on foot in the most efficient and useful manner possible within a tight budget. The collected data was used to develop an invasive species management plan to help DCR prioritize locations and species to target, as well as proposed methods and means of performing management (e.g. hand pulling, mowing, herbicide, etc.).

Massachusetts Division of Fisheries and Wildlife (MDFW) Hockomock Swamp, West Bridgewater, Easton, and Raynham, MA
Compliance Inspector

Developed and protocol and performed survey and mapping of Common Reed (*Phragmites australis*) and other incidentally observed invasive plant species within the 5,000 acres of MDFW owned and managed portions of Hockomock Swamp in West Bridgewater, Raynham, and Easton, MA. Field surveys were used to supplement BSC collected aerial drone photography and ultimately used to develop an invasive species management plan.

Cabot Taps Separation Project, National Grid, Greenfield and Montague, MA
Compliance Inspector & Permitting Specialist

Provided Inspection and permitting services for the Cabot Taps Separation Project for National Grid, which involved investigatory soil borings used to design structure foundations, followed by the relocation of existing double circuit lines onto of new pairs of single circuit structures. Marleigh played a key role in field assessments, permitting, and monitoring for both phases of the project. The project included a variety of environmental permitting hurdles including rare species, vernal pools, and wetland resource areas. Marleigh was responsible for ensuring compliance with applicable regulations and permits through coordination with work crews and comprehensive environmental reporting. In particular, she led full time and weekly compliance monitoring for both phases of the project, lead coordination and communication with construction personnel, and communication with permitting agencies. She continues to perform biannual wetland restoration monitoring for the project.

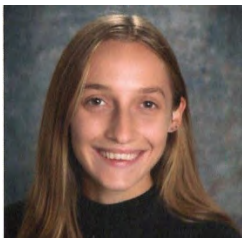
Interstate Reliability Project (IRP), National Grid, Millbury, Sutton, Northbridge, Uxbridge, Millville, MA
Compliance Inspector

Responsible for performing compliance inspections for the 15.4 mile long Massachusetts portion of the Interstate Reliability Project that extends from Millbury, MA to North Smithfield, RI. This project includes a new 345 kV line and major improvements to an existing line including the expansion of the ROW, removal of existing 69 kV structures, and installation of new 345kV structures. Marleigh is part of a team of wetland professionals who provide full time monitoring for the project. She performs inspections and reporting necessary to ensure compliance with applicable regulations and permits, and to ensure strict adherence to approved drawings and specifications, which include monitoring, tree clearing operations, removal of lead-contaminated structures, road construction, drilling operations, dewatering and structure installation, sediment and erosion controls, mitigation practices, rare species monitoring, and to provide guidance to construction personnel.

1361/1242 Line Pole Replacement and Reconductoring Project, Eversource Energy, Greenfield and Deerfield, MA
Compliance Inspector

Performing environmental compliance monitoring for the pole replacement and reconductoring of Eversource's 1361 and 1242 double-circuit lines in Greenfield and Deerfield, MA. Marleigh is currently responsible for ensuring environmental compliance with applicable local, state, and federal regulations and permits and company best management practices (BMPs) for all construction activities including investigatory soil borings, road and construction pad building, swamp mat placement, reconductoring of the lines, and the implementation of BMPs. Marleigh oversees construction on a weekly basis to assess erosion/sediment controls and other BMPs; identify environmental concerns and to provide insight on appropriate prevention or mitigation measures; coordinating with construction crews to facilitate environmental compliance; and provide comprehensive reporting.

BSC GROUP



Marabelle Tucci

Wetland Scientist

YEARS OF EXPERIENCE

1

EDUCATION

BS, Environmental Science (Soils and Land Use) and Horticulture, Delaware Valley University

3-year Horticulture Program, Berks Career and Technology Center

CERTIFICATIONS

- APSS (in progress)
- OSHA 10HR #06941221
- CGP Site Inspector Certificate
- National Occupational Competency Testing Institute (NOCTI)
- Pesticide Sprayer Cleanup (Penn State Online Course)

AFFILIATIONS

- Delaware Valley University Soil Judging Team

MEET MARABELLE

Marabelle is an Ecologist in the Ecological Services Department of BSC's Glastonbury office. She assists with various natural resource assessments such as wetland delineations, vernal pool surveys, and invasive and rare plant surveys. In addition, she performs construction monitoring and assists with project reporting and permitting. Marabelle is experienced with various methods of soil and wastewater sampling, and processing and interpreting data. Her technical skills include R (Statistical Computing) and SAS (Statistical Analysis Software), ArcGIS, and ArcMap.

Marabelle has a strong background in soils, land use, and plant science. She is highly skilled in conducting research and collecting and interpreting data.

PROJECT EXPERIENCE HIGHLIGHTS

38A1 Distribution Line Rebuild Project, Conway, MA

Assisted in wetland and stream delineations along 38A1 distribution line.

Woonasquatucket River Gas Line Bridge Crossing Project, Providence, RI

Assisted in wetland investigations and stream delineations along the Woonasquatucket River.

1773 Line ACR & OPGW Installation Project, Rocky Hill, CT

Assisted in wetland delineation and US Army Corps of Engineers Wetland Determination Data Form.

315 Transmission Line Asset Condition Refurbishment Project, Woonsocket, Cumberland and North Smithfield, RI

Provided environmental compliance inspections and reporting (including monthly reporting to RIDEM) for an eight (8) mile transmission line rebuild project in northern Rhode Island.

JENNIFER D. WATTS

CURRICULUM VITAE

October 2024

Woodwell Climate Research Center

149 Woods Hole Road, Falmouth, MA 02540 1644 USA

C: (406) 581 8449 | E mail: jwatts@woodwellclimate.org

Woodwellclimate.org/staff/Jennifer-watts

Researchgate.net/profile/Jennifer Watts 7

EDUCATION

2017	Ph.D., Systems Ecology (*Remote Sensing and Ecosystem Modeling*); College of Forestry and Conservation, University of Montana, Missoula. Dissertation: Potential contrasts in CO_2 and CH_4 flux response under changing climate conditions: a satellite remote sensing driven analysis of net ecosystem carbon budget for arctic and boreal.
2008	M.S., Land Resources Management (*Land Rehabilitation*); Department of Land Resources & Environmental Sciences, Montana State University, Bozeman. Thesis: Monitoring of cropland practices for carbon sequestration purposes.
2006	B.S., Land Resources Management (*Soils and Geospatial Technology*); Department of Land Resources & Environmental Sciences, Montana State University,

PROFESSIONAL EXPERIENCE

July 2024	Associate Scientist & Program Director, Woodwell Climate, Falmouth, MA.
July 2019	Assistant Scientist, Woodwell Climate Research Center, Falmouth, MA.
Sep 2017	Affiliate Professor of Remote Sensing, Montana State University, Bozeman, MT.
2017 2019	Postdoctoral Researcher, Woodwell Climate Research Center, Falmouth, MA.
2016 2017	Postdoctoral Researcher, NTSG, University of Montana, Missoula, MT.
2010 2016	Research Assistant, NTSG, University of Montana, Missoula, MT.
2009 2010	Research Assistant, Spatial Science Center, Bozeman, MT.
2008 2009	USGS Northern Rocky Mountain Science Center, Bozeman, MT.

PEER-REVIEWED JOURNAL ARTICLES (SELECTED)

1) Xia, Y, J Sanderman, JD Watts, et al. (2024) Coupling remote sensing with a process model for the simulation of rangeland carbon dynamics. *J. Advances Modeling Earth Systems*. In Press.
2) Virkkala, A, B Rogers, **JD Watts**, KA Arndt, S Potter, et al. (2024) An increasing arctic boreal CO_2 sink offset by wildfires and source regions. *Nature Climate Change*. In Press.
3) Xia, Y, J Sanderman, **JD Watts**, MB Machmuller, S Ewing, C Rivard (2024) Leveraging legacy data with targeted field sampling for low cost mapping of soil organic carbon stocks on extensive rangeland properties. *Geoderma*, 448. https://doi.org/10.1016/j-geoderma.2025.116952.
4) **Watts, JD**, M Farina, JS Kimball, L Schiferl, Z Liu, K Arndt, D Zona, et al. (2023) Carbon uptake in Eurasian boreal forests dominates the high-latitude net ecosystem carbon budget. *Global Change Biol.*, https://doi.org/10.1111/gcb.16553

5) Mullen, AL, **JD Watts,** BM Rogers, ML Carroll, CD Elder, J Noomah, Z Williams, JA Caraballo Vega, et al. (2023) Using high-resolution satellite imagery and deep learning to track dynamic seasonality in small water bodies. *Geophysical Res. Lett*., https://doi.org/10.1029/2022GL102327.

6) Du, J, J Kimball, R Bindlish, JP Walker, **JD Watts** (2022) Local scale (3 m) soil moisture mapping using SMAP and Planet SuperDove. *Remote Sensing*, 14, 3812. https://doi.org/10.3390/rs14153812.

7) Miller SM, MA Taylor, **JD Watts** (2018) Understanding high latitude methane in a warming climate. *Earth & Space Science News*, https://doi.org/10.1029/2018EO091947

8) ***Watts JD***, JS Kimball, A Bartsch, KC McDonald (2014) Surface water inundation in the boreal Arctic: impacts on regional methane emissions. *Environmental Res. Lett*, 9, https://doi.org/10.1088/1748-9326/9/7/075001

PROFESSIONAL REPORTS (SELECTED)

1) Pan Arctic Methane: Current monitoring, capabilities, approaches for improvement, and implications for global mitigation targets. https://www.wilsoncenter.org/publication/pan arctic methane current monitoring capabilities approaches improvement and
2) Carbon Monitoring Plan for Northern Great Plains Grazing Lands. Woodwell Climate. Prepared for the National Fish and Wildlife Foundation. In Press.
3) MA – No Net Loss of Carbon in Wetlands scoping study. BSC Group. Prepared for MA DEP and EEA.

PROFESSIONAL ACTIVITIES AND SERVICE (SELECTED)

Workshop/Meeting Organizing Committees (Recent, External):

2024-present: NASA Earth Science Advisory Committee member
2024-present: Meridian Group NRCS Carbon working group Chair
2023-present: National Fish & Wildlife Foundation carbon MMRV co lead
2019-present: Woodwell Rangeland Carbon science co lead
2022-present: Woodwell Wetland CH_4 emission mapping lead
2023: WMO International GHG Symposium, Observations & Models Session Chair
2023: 103rd AMS High latitude Water and Carbon Cycles in a Warming World Session Co-chair
2022: Woodwell/Turner/Montana State Rangeland Carbon Workshop, Co-Lead Organizer
2020: Woodwell High Latitude CO_2 and CH_4 Flux Workshop Co-organizer
2019: NASA ABoVE Data and Model Synthesis Group Co-chair

Journal Reviewer

Science; *Nature*; *Global Change Biology*; *Geophysical Research Letters*; *Remote Sensing of Environment*; *Remote Sensing*; *Biogeosciences*; *Wetlands Ecology & Management*; *Environmental Research Letters*

Taniya RoyChowdhury, Ph.D.

RESEARCH SCIENTIST
Woodwell Climate Research Center
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Falmouth, MA 02540, USA

Email: troychowdhury@woodwellclimate.org
Phone: (614) 619 2131
Google Scholar Citation
ORCID id: 0000 0002-4028 7996

A. Education and Training

Pacific Northwest National Laboratory	Microbiology	Post doc	2017
Oak Ridge National Laboratory	Biogeochemistry	Post doc	2015
The Ohio State University, USA	Soil Science	Ph.D.	2012
University of Calcutta, India	Agricultural Chemistry & Soil Science	M.S.	2005
University of Calcutta, India	Chemistry (Honors)	B.S.	2003

B. Professional Experience

2022-Present	Research Scientist II, Woodwell Climate Research Center, Falmouth, MA
2020-2022	Research Soil Scientist, USDA ARS, Davis, California
2018-2020	Principal Faculty Specialist, Environmental Science & Technology Department, University of Maryland, College Park
2008-2011	Graduate Teaching Associate, Soil Science, The Ohio State University
2007-2008	University Fellow, Soil Science, The Ohio State University
2005-2006	Post Masters Research Fellow, Microbiology, University of Calcutta, Kolkata, India

C. Research Emphasis: Soil Microbial Ecology, Biogeochemistry, Carbon Cycle, Global Change

D. Selected Projects

1. **Shallow or Deep: Can cover crops make soil carbon stick**? The emerging complexities of soil microbial carbon cycling, stabilization and destabilization mechanisms must inform cover crop management to more accurately predict climate benefits of cover cropping, yet are almost completely ignored in the current discussion on climate smart agriculture. Here we interrogate the impacts of mixed species cover crops on microbially mediated carbon dynamics along soil depth increments up to 60 cm that is expected to represent a gradient of cover crop root density.
2. ***represent a gradient of cover crop root density*** **Pathways of carbon metabolism under cover crops.** Soil carbon sequestration has a high potential to mitigate climate change, but our predictive understanding of soil organic carbon stabilization mechanisms remains uncertain due to over simplistic accounting of microbial properties in biogeochemical models used to evaluate outcomes of agronomic management. Using a cutting edge highly resolved data science approach to quantification of the chemically diverse carbon substrates available for microbial uptake, this project will determine the impacts of carbon chemical diversity on soil carbon and nutrient cycling.
3. **Impact of cover crops on full soil profile carbon.** This project seeks to understand the impact of cover crops on soil carbon properties down to one meter depth by sampling at a number of replicated cover crop trials on commercial farms.
4. **Leading indicators of soil carbon change.** Change in soil carbon often takes many years to a decade to detect. This project seeks to understand if other measurements of forms of organic matter and microbial functions can be good predictors for longer term soil carbon change.

E. Professional Service

1. Guest Editor: Frontiers in Microbiology, 2022; Frontiers in Agronomy & JoVE, 2023
2. *Ad hoc* reviews for scientific journals: Applied & Environmental Microbiology, Ecological Engineering, Environmental Microbiology, Environmental Science & Technology, Journal of Geophysical Research Biogeosciences, PLoS One, mBio, Microbial Ecology, mSystems, Soil Biology & Biochemistry, Soil Systems, Microorganisms, Global Change Biology, mSphere, Microorganisms
3. *Ad hoc* proposal review panelist for the Department of Energy, National Science Foundation, USDA NIFA

F. Synergistic Activities

1. Advisory Board Member of Applied Microbiology International
2. Professional Memberships: International Society of Microbial Ecology; American Society of Microbiology, American Geophysical Union; Soil Science Society of America (Tri Societies).
3. Conference Session Convener and Chair: American Geophysical Union Fall Meetings (2023, 2016); Soil Science Society of America: Division of Soil Biology & Biogeochemistry (2016)

G. Honors and Awards

2023	Recipient of Christiana Figueres Prize at Applied Microbiology International. The prize is awarded to a scientist who uses microbiology to help further our understanding of climate change or directly in solutions thereof.
2023	Travel Award Agricultural Microbiomes Thinkathon: A community based Interactive Workshop organized by the American Phytopathological Society
2014	American Society of Microbiology Science Teaching Fellowship
2011	Edward J. Ray Travel Award for Scholarship and Service, Council of Graduate Students, The Ohio State University
2011	Young Scientist Travel Award, International conference on "Enzymes in the Environment", Bad Nauheim, Germany
2010	Rhonda and Paul Sipp Wetland Research Award, The Ohio State University
2007	University Fellowship, The Ohio State University
2005	First in First Class, Gold Medalist, University of Calcutta, India

H. Relevant Publications (2019 - 2024)

1. **RoyChowdhury, T.,** Rubin, R., ***Jacques, M., Mullen, A., Martin, A., Caroll, M., Oldfield, E., Sanderman, J. Cover crops and full profile soil carbon stocks: Observations from commercial trials. *Environmental Research Letters*. In prep.
2. Hamovit, N., **RoyChowdhury, T.**, Akob, D.M., Zhang, X., McCarty, G., Yarwood, S.A. Comparative assessment of a restored and natural wetland using ^{13}C DNA SIP reveals a higher potential for methane production in the restored wetland. *Applied Environmental Microbiology*.
3. Li, Y., Xue, Y., **RoyChowdhury, T.**, Graham, D.E., Tringe, S.E., Jansson, J.K., Tas, Neslihan. Genomic insights into redox driven microbial processes for carbon decomposition in thawing Arctic soils and permafrost (2024). *mSphere*, e00259 24.
4. Oldfield, E.E., Lavallee, J.M., and others. Greenhouse gas mitigation on croplands: clarifying the debate on knowns, unknowns and risks to move forward with effective management interventions (2024). *Carbon Management*, 15(1), 2365896.
5. **RoyChowdhury, T.,** Bramer, L., Brown, J., Kim, Y. M., Metz, T. O., Hoyt, D., McCue, L.A., Diefenderfer, H.L., Bailey, V.L. Soil metabolomics predict microbial taxa as biomarkers of moisture status in soils from a tidal wetland (2022).

Microorganisms, Special Issue: Advances in Soil Microbiome, 10 (8), 1653. https://doi.org/10.3390/microorganisms10081653

6. Shaffer Nothias Thompson et al. and the Earth Microbiome Project (500) Consortium. Standardized multi omics of Earth's microbiomes reveals microbial and metabolite diversity. *Nature Microbiology, 7, 2128 2150.*
7. Patel, K.F., Fansler, S., Campbell, T., Bond Lamberty, B., Smith, P.A., **RoyChowdhury, T.**, McCue, L.A., Bailey, V.L. Soil texture and environmental conditions influence the biogeochemical responses of soils to drought and flooding (2021). *Communications Earth & Environment*, **2 (1),** 127.https://doi.org/10.1038/s43247-021-00198-4
8. Metz, T., Xu, C., Couvillion, S., Sontag, R., Isern, N., Maezato, Y., Lindemann, S., **RoyChowdhury, T.,** Zhao, R., Morton, B., Moore, R., Jansson, J., Bailey, V., Mouser, P.J., Romine,M., Frederickson, J. (2021). MetFish: A metabolomics pipeline for studying microbial communities in chemically extreme environments. *mSystems.*
9. **RoyChowdhury, T.,** Berns, E.C., Moon, Ji Won, Gu, B., Liang, L., Wullschleger, S.D, Graham, D.E. Temporal, Spatial and Temperature controls on methanogenesis and organic carbon mineralization in Arctic soils from high centered polygons (2020). *Frontiers in Microbiology. Special issue on the Microbial Communities of Polar and Alpine Soils,* 11. https://doi.org/10.3389/fmicb.2020.616518
10. McClure, R., Lee, J. Y., **RoyChowdhury, T.**, Bottos, E.M., White III, R.A., Kim, Y. M, Nicora, C.D., Metz, T.O., Hofmockel, K.S., Jansson, J.K., Song, H. S. Integrated network modeling approach defines key metabolic responses of soil microbiomes to perturbations (2020). *Scientific Reports*, 10(1), 10882 https://doi.org/10.1038/s41598-020-67878-7
11. **RoyChowdhury, T.**, Lee, J. Y., Bottos, E.M., White III, R.A., Bramer, L., Brown, J., Zucker, J., Kim, Young Mo, Brislawm, C.J., Fansler, S.J., Metz, T.O., McCue, L.A., Callister, S.J., Song, H. S., Jansson, J.K. Metaphenomic responses of a native prairie soil microbiome to moisture perturbations (2019). *mSystems*, 4(4) https://doi.org/10.1128/msystems.00061 19
12. Vera Gargallo, B., **RoyChowdhury, T.**, Brown, J., Fansler, S.J., Duran Viseras, A., Sanchez Porro, Bailey, V.L., Ventosa, A., Jansson, J.K., Ventosa, A. Spatial distribution of prokaryotic communities in hypersaline soils (2019). *Scientific Reports*, 9:1769. https://doi.org/10.1038/s41598 018 38339 z

Keith Zaltzberg-Drezdahl

Managing Director, Head of Planning, Worker-Owner

Keith is a founding partner of Regenerative Design Group where he leads planning initiatives focused on ecological resilience and community well-being. With a background rooted in resilience planning, urban agriculture, and permaculture design, Keith combines rigorous analysis with a strong social justice mission to shape landscapes rooted in place and community. His approach to planning is grounded in understanding the ecological and social potential of place, rigorous analysis, and systematic assessment. His work includes leadership roles in projects such as the Massachusetts Healthy Soils Action Plan, where he played a pivotal role in understanding the impact of land use on soil health and carbon sequestration. His strategic insights have also guided regional climate resilience initiatives, contributing to the development of nature-based solutions that enhance environmental quality and community resilience. He shares his expertise as a lecturer and instructor at The Conway School and Smith College, focusing on sustainable design principles and environmental stewardship, and holds a BS in Environmental Design from UMass-Amherst.

FOCUS AREAS

- Landscape Carbon Accounting & Planning
- Resilience Planning & Adaptive Design
- Soil Resource Planning
- Regenerative Agriculture & Urban Farm Design
- Project Management

TECHNICAL SKILLS

- GIS Mapping and Analysis
- AutoCAD
- Adobe Creative Suite

LECTURES + WORKSHOPS

- Soil Organic Carbon Estimation, Soil Science Society of America.
- Developing Healthy and Resilient Communities: A Case Study, Architecture Boston Expo
- Regenerative Design for Change Makers, Omega Institute

SELECTED PROJECTS

MA No Net Loss of Carbon in Wetlands | MassDEP

Development of a wetland mapping approach based on machine learning that identifies previously ambiguous wetlands. This project aims to identify innovative strategies, approaches, concepts, and regulatory recommendations to achieve No Net Loss of Carbon in Wetlands in Massachusetts. Project team includes BSC Group, the Massachusetts Association of Conservation Commissions (MACC), and the Woodwell Climate Research Center.

Nashua River Watershed-Wide Nature Based Solutions | Fitchburg, Leminster, Ashburnham, Pepperell, and Groton, MA

MVP Project. Produce a multi-layered analysis of soil health challenges and opportunities for the 454 square mile Massachusetts portion of the Nashua River Watershed. Part of a larger MVP project to determine priority sites for nature-based solutions in the five project communities.

Hudson-SuAsCo Nature Based Solutions Project| Hudson, Framingham, and Natick, MA

MVP Project. Use a robust process of remote data analysis and community engagement to identify high impact sites for nature-based olutions that will support the towns' climate resilience. Focus on soil-carbon and landcover mapping and analysis to guide priority sites.

Nashua River Resilient Lands Management | Clinton and Bolton, MA

MVP Project. Development of management and stewardship guides and identification of leverage points for town bylaws changes to increase the resilience and functioning of important landscapes and ecosystems in Clinton and Bolton.

Soil Health Assessment | Deerfield, MA

MVP Project. Analysis of exisiting soil function by land cover and assessment of vulnerabilities and opportunities for soil health. Scope included healthy soils workshops and outreach events. *2022 Sustainability + Resiliency Award from the American Planning Association - Massachusetts Chapter*

Soil Health Productivity Assessment & Planning | Trustees of Reservations

Collaborated with American Farmland Trust to assess field-specific soil health and whole-site ecological health of seven Trustees farm properties. Designed and facilitated three workshops for Trustees staff and land managers. Final report included recommendations for soil health management, agroecological interventions and a discussion of trade-offs.

Climate Resiliency and Carbon Planning | Apple Country, MA

MVP Project. Collaborated with BSC Group and Linnean Solutions to assess and analyze ecological resources, and provide recommendations for nature-based solutions in the Towns of Bolton and Harvard and the Devens Regional Enterprise Zone. Extensive mapping, community outreach, site walks, and soil health assessments.

Soil Resource Assessment & Planning | Massachusetts Healthy Soil Action Plan

Project lead for a 10-person project team and 50-person working group in GIS-analysis, scientific literature review, expert interviews, and broad stakeholder engagement to develop a comprehensive Healthy Soils Action Plan for all major land uses in Massachusetts. *2023 Special Recognition Award for Significant Value to Landscape Architecture from the Boston Society of Landscape Architects*

Greenhouse Gas Environmental Impact Assessment | Massachusetts Environmental Policy Act Office

Provided QAQC and technical team support in the development of a model to estimate greenhouse gas emissions and carbon sequestration loss from tree clearing associated with proposed expansion of a utility right of way.

Regenerative Land Use Experiment | Major Northeast Utility Company

Assessment of potential for additional carbon sequestration through innovative land and vegetation management practices on ROW lands across three state for a major utility. Led in-depth study of current land cover, carbon stocks, and management practices to develop high level toolkits for land management teams.

SELECTED PUBLICATIONS

Gutwein, S., Zaltzberg-Drezdahl, K., Toensmeier, E., & Ferguson, R. S. (2022). Estimating land cover-based soil organic carbon to support decarbonization and climate resilience planning in Massachusetts. Soil Security, 9, 100076. https://doi.org/10.1016/j.soisec.2022.100076

Regenerative DesignGroup

Von Harvey

Communications Specialist

Von is a communicator and designer who applies user experience (UX), web, graphic, and marketing design to tell stories and engage with people and communities. She believes technology should have a positive impact on humanity, which includes being equitable and sustainable. Von holds a BA from Hampshire College and has professional certifications in UX design, graphic design, and digital marketing.

FOCUS AREAS

» Web and digital user experience (UX) and accessibility design
» Digital Marketing + Content Strategy

TECHNICAL SKILLS

» WordPress, Drupal, Squarespace, and Webflow CMS platforms
» MailChimp Email Marketing
» Google Analytics
» Adobe Creative Cloud

SELECTED PROJECTS

Massachusetts Healthy Soil Guide | Greenfield, MA

Created WordPress-based website for the Massachusetts Healthy Soil Guide for Construction and Development, making soil health practices and resources accessible and actionable for site construction and landscaping professionals.

PREVIOUS POSITIONS

Center for New Americans | Northampton, MA | 2023–present

Communications Specialist

- Manage WordPress CMS-based website, including content, usability, and layout updates
- Provide content and marketing strategy for social posts, blog content, and print materials

Vinka Design | Florence, MA | 2012–present

Prinicipal

- Design and implement digital marketing and advertising, content strategy, UX, and Websites for clients with a focus on artists and authors; examples include betsyhartmann.com and onematchfilms.com

UMass Amherst College of Engineering | Amherst, MA | 2021-2022

Associate Director of Communications and Digital Media

- Coordinated with team and senior leadership to ensure all digital content, including a 5,000-page website and 3 social channels, was accurate, strategic, and reflective of the user journey for various audiences
- Designed print and digital marketing materials and collateral for various offices and departments, including significant development campaigns

Regenerative DesignGroup

Sebastian Gutwein

Managing Director, GIS Specialist, Worker-Owner

Sebastian is a living systems designer whose extensive experience draws from the arts, ecology, politics and place. His extensive experience allows him to integrate diverse disciplines into comprehensive planning strategies that address complex challenges such as water conveyance, agricultural programming, and intricate GIS analysis. Since 2015, Sebastian has been the Land Surveying and Digital Design Instructor at The Conway School. He continues to expand his expertise in leveraging geospatial technology for innovative landscape planning and management solutions.

FOCUS AREAS

- Resilience Planning & Site Design
- Whole Systems Integration
- Landscape Analysis & Assessment
- Food Systems Evaluation & Design
- Implementation, Construction & Project Management
- Solar Site Design & Housing Layout

TECHNICAL SKILLS

- Digital Rendering
- GIS Analysis + Assessment
- Document Production & Design
- Land Surveying

SELECTED PROJECTS

MA No Net Loss of Carbon in Wetlands | MassDEP

Lead data and GIS analyst for a wetland mapping approach based on machine learning that identifies previously ambiguous wetlands. This project aims to identify innovative strategies, approaches, concepts, and regulatory recommendations to achieve No Net Loss of Carbon in Wetlands in Massachusetts. Project team includes BSC Group, the Massachusetts Association of Conservation Commissions (MACC), and the Woodwell Climate Research Center.

Soil Resource Assessment & Planning | Commonwealth of Massachusetts

Lead data and GIS analyst. Developed novel, data-driven model to quantify statewide soil organic carbon stocks and assess impact of land cover change on soil carbon.

Municipal Vulnerability Preparedness Projects: Soil Resilience Planning | Various Municipalities, MA

Lead data and GIS analyst. Development of unique and comprehensive models that combine soil and other ecological data with social and cultural information to identify high impact locations for nature based solutions for climate resilience. Mapping and research support for community engagement workshops and outreach events.

Greenhouse Gas Environmental Impact Assessment | Massachusetts Environmental Policy Act Office

Land use and carbon analyst. Directed development of environmental impact assessment model for greenhouse gas emissions and carbon sequestration loss from tree clearing associated with proposed expansion of a utility right of way.

Regenerative Land Use Experiment | Major Northeast Utility Company

Land use and carbon analyst. Assessed potential for additional carbon sequestration through innovative land and vegetation management practices on ROW lands across three state for a major utility. Conducted in-depth study of current land cover, carbon stocks, and management practices to develop high level toolkits for land management teams.

SELECTED PUBLICATIONS

Gutwein, S., Zaltzberg-Drezdahl, K., Toensmeier, E., & Ferguson, R. S. (2022). Estimating land cover-based soil organic carbon to support decarbonization and climate resilience planning in Massachusetts. Soil Security, 9, 100076. https://doi.org/10.1016/j.soisec.2022.100076

Regenerative DesignGroup

Rachel Wyatt Lindsay

Head of Site Design, Senior Designer, Worker-Owner

As Head of Site Design at Regenerative Design Group, Rachel works principally with organizations and homeowners to create productive, resilient landscapes. She draws from her experiences in organic farming, Latin-American sustainable development, and art to approach design with cultural sensitivity and environmental integrity. Rachel approaches projects of all scales through a soil, carbon, and water conservation lens, looking for opportunities to reduce the environmental impact of design installation while meeting the client's goals and aesthetic preferences. Her projects encourage people to engage deeply with their local ecosystems and apply holistic and low-stress approaches toward gardening and landscaping. A worker-owner at RDG, Rachel was a member of the steering committee that led the ownership transition process and has been the Treasurer of the Board of Directors since its establishment in 2022.

FOCUS AREAS

- Low Impact Site Design
- Soil Smart Design & Practices
- Productive & Edible Landscape Design
- Regenerative Small-Scale Agriculture & Gardening
- Ecosystem Integration with Native Plants
- Pollinator Habitat
- Project Management

Technical Skills

- Project Management
- Construction Support
- Site Analysis
- Detailed Site Design
- Hand + Digital Rendering
- Auto CAD, Adobe, + GIS
- Document Production

SELECTED PROJECTS

Healthy Soils Guide for Site Design + Construction | Commonwealth of Massachusetts

Project manager and outreach coordinator of a multi-firm collaboration to develop guidelines for the implementation of the Healthy Soils Action Plan in site design and development projects.

Estate Garden | Concord, MA

Lead designer and project manager for 2,000 sq. ft. of terraced production gardens with surrounding orchard, greenhouse, and small livestock managment area.

Soil Resource Assessment & Planning | Commonwealth of Massachusetts

Research assistant, coauthor, and document production manager for the Healthy Soils Action Plan for all major land uses in Massachusetts. *2023 Special Recognition Award for Significant Value to Landscape Architecture from the Boston Society of Landscape Architects.*

Low Impact Forest Residence | Hurley, NY

Site design and construction support for a new home in a pine, oak, and hickory forest, with a rapid rate of re-establishment due to strict limitation on soil disturbance, rigid soil amendment specifications, and native plant designs.

Ecologically Sensitive Residence | Wayland, MA

Landscape design for a pre-existing home surrounded by ecologically valuable wetlands and floodplain forest. Plans included the relocation of snapping turtle nests, minimal soil disturbance, and a native-forward plant palette.

Residential Site Grasslands Regeneration | Littleton, MA

Soil and ecosystem restoration for an 8-acre clear cut new home site, including

the establishment of edible landscaping, 4 acre native meadow, and successional restoration of an oak, red maple, and American chestnut forest.

The Gann Farm | Gann Academy, Waltham, MA

Supporting design services for an existing 3-acre student farm, including regenerative principles for no-till vegetable production, outdoor classroom, and a 1-acre food forest.

RiverMills Green Infrastructure Renovation | Chicopee, MA

Lead designer for site analysis, troubleshooting, vegetation inventory, and stormwater infiltration renovation plans for an existing green infrastructure system at the RiverMills Senior Center, a brownfield redevelopment project in the Riverfront Area of the Chicopee River.

Urban Pollinator Streetscape | Northampton, MA

Lead designer for the transformation of a lawn-dominated landscape into a fully perennial multi-season pollinator habitat garden with rainwater collection and infiltration.

Tropical Agroforestry Farm Assessment + Land-Use Master Plan | Gashora, Rwanda

Associate designer and document production management for the Rwanda Institute for Conservation Agriculture preliminary feasibility assessment.

EDUCATION + PROFESSIONAL DEVELOPMENT

- B.A. Anthropology + Studio Art, Wesleyan University, 2005
- M.S. Ecological Design, The Conway School of Landscape Design, 2015
- Massachusetts Association of Conservation Commissions Fundamentals Certificate, 2022
- Greenfield Conservation Commission, 2016-2018, Vice-Chair 2018-2022
- SosteNica: The Sustainble Development Fund of Nicaragua, Board Member 2012 - present
- Agroecology and Biointensive Agriculture, Las Cañadas, Cooperative, Huatusco Mexico, 2010
- Fullbright Scholar, Nicaragua 2009

LECTURES + WORKSHOPS

- *Unlocking the Carbon Potential of Soils (with Chris Hardy, Sasaki, and Gillian Davies, BSC Group) - American Society of Landscape Architecture 2024 Conference, Washington D.C.*
- *Healthy Soils at Home - Greening Greenfield, Greenfield MA*
- *Soils for High Functioning Landscapes - Ecological Landscape Alliance Season's End Summit*
- *Eco-Friendly Solutions for the Home Garden and Landscape* and *Regenerative Farming: Sustainable agriculture and its ties to global well-being* - Wesleyan University Institute of Lifelong Learning
- *Planning for Change: Design and Land Management in a Time of Climate Change* - Simsbury Land Trust
- *Rain Gardens: Why they are important, and how to make one that works* - Springfield Garden Club
- *Green Infrastructure Workshop Series* - City of Holyoke, MA + Pioneer Valley Planning Coalition
- *Designing Gardens for the Benefit of All* - Association of Professional Landscape Designers

Regenerative DesignGroup

Rafter Ferguson

Senior Researcher

Rafter specializes in research, education, and training focused on integrating agroecology, racial equity, and full-spectrum social justice into sustainable development practices. He applies participatory research and design methods, combining quantitative and qualitative data analysis with popular education approaches. His expertise spans agroforestry, climate change mitigation and adaptation, and grassroots farmer-centered development initiatives. Rafter is committed to fostering resilient communities through innovative planning strategies that prioritize environmental stewardship and social equity.

SKILLS

- Group facilitation + public speaking
- Multivariate statistics, data analysis, and visualization with R/RStudio (including dimension reduction, clustering, bootstrapping, and Bayesian and frequentist multilevel modeling)
- Software: Google Drive Suite, Microsoft Office Suite, iWork Suite

EDUCATION

- University of Illinois at Urbana-Champaign Ph.D., Crop Sciences, 2015
- University of Vermont M.S., Plant and Soil Science, 2011
- Bard College B.A., Anthropology, 2001

SELECTED PROJECTS

MA No Net Loss of Carbon in Wetlands | MassDEP

Data, GIS analysis, and technical writing for a wetland mapping approach based on machine learning that identifies previously ambiguous wetlands. This project aims to identify innovative strategies, approaches, concepts, and regulatory recommendations to achieve No Net Loss of Carbon in Wetlands in Massachusetts. Project team includes BSC Group, the Massachusetts Association of Conservation Commissions (MACC), and the Woodwell Climate Research Center.

Hudson-SuAsCo Nature Based Solutions Project| Hudson, Framingham, and Natick, MA

MVP Project. Research and integrate relevant data to create infographic and related materials that reveal a comprehensive picture of the effect of timber harvest on the above and below ground carbon storage in aging forests. Materials are used to make the case for town bylaws and planning strategies towards promoting proforestation where applicable.

PROFESSIONAL EXPERIENCE

Interlace Commons | 2022-Present

Justice, Equity, and Diversity Consultant

- Qualitative research with BIPOC farmers to address barriers to agroforestry adoption
- Co-author of report “From the Roots Up: Centering racial justice to build transformative agroforestry” (with Ruth Tyson)
- Co-author of curriculum for technical service providers “Working with People, Working Across Difference: Social Competencies to Grow Agroforestry” (with Ruth Tyson)

Union of Concerned Scientists Washington, DC | 2018-2021

Scientist, Food and Environment Program

- Research, communication, and advocacy bridging agroecology and sustainability with farmer-centered equity issues
- Build and manage relationships with grassroots coalition partners with a focus on BIPOC-led and -centered organizations

Haverford College Haverford, PA | 2016-2018

Mellon Postdoctoral Fellow and Visiting AP of Environmental Studies

- Developed and ran original courses on politics and science of sustainable agriculture, the climate crisis, and related issues
- Organized "Beyond the Grassroots," a 1-day symposium bringing together agroecology researchers, organizers, and farmer-activists

University of Lisbon Lisbon, Portugal | January-July 2016

Postdoctoral Research Fellow with EU project "Bottom-up Climate Adaptation Strategies Towards a Sustainable Europe"

- Designed, co-organized, and taught an international course on research design for research professionals, graduate students, and grassroots activists
- Facilitated visioning and strategy sessions for interdisciplinary research on bottom-up adaptation strategies with lab members in the Centre for Ecology, Evolution, and Environmental Change

SELECTED PUBLICATIONS

Gutwein, S., Zaltzberg-Drezdahl, K., Toensmeier, E., & Ferguson, R. S. (2022). Estimating land cover-based soil organic carbon to support decarbonization and climate resilience planning in Massachusetts. Soil Security, 9, 100076. https://doi.org/10.1016/j.soisec.2022.100076

Spangler, K., McCann, R. B., & Ferguson, R. S. (2021). (Re-)Defining Permaculture: Perspectives of Permaculture Teachers and Practitioners across the United States. Sustainability, 13(10), 5413. https://doi.org/10.3390/su13105413

Toensmeier, E., Ferguson, R., & Mehra, M. (2020). Perennial vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition. PLOS ONE, 15(7), e0234611. https://doi.org/10.1371/journal.pone.0234611

Ferguson, R. S., & Lovell, S. T. (2017). Diversification and labor productivity on US permaculture farms. Renewable Agriculture and Food Systems, 1–12. https://doi.org/10.1017/S1742170517000497

Ferguson, R. S., & Lovell, S. T. (2017). Livelihoods and production diversity on U.S. permaculture farms. Agroecology and Sustainable Food Systems, 41(6), 588–613. https://doi.org/10.1080/21683565.2017.1320349

Ferguson, R. S., & Lovell, S. T. (2015). Grassroots engagement with transition to sustainability: diversity and modes of participation in the international permaculture movement. Ecology and Society, 20(4), 39. https://doi.org/10.5751/ES-08048-200439

Ferguson, R. S., & Lovell, S. T. (2013). Permaculture for agroecology: design, movement, practice, and worldview. A review. Agronomy for Sustainable Development, 34(2), 251–274. https://doi.org/10.1007/s13593-013-0181-6

For other publications see: Complete publication list. Google Scholar. ResearchGate.

Regenerative DesignGroup

Eric Giordano

Assistant GIS Analyst, Worker-Owner

Eric is a designer, musician, and avid composter. He began his journey in ecological design in NYC, where he built rainwater harvesting systems, ran a composting hub, and consulted on several garden projects. He received a Permaculture Design Certification from the Center for Bioregional Living, a Master Composter Certification from the NYC Compost Project, a Certificate of Horticulture from the Brooklyn Botanic Garden, and a Masters of Science in Ecological Design from the Conway School. Eric is dedicated to rethinking the way we meet human needs in a way that honors and regenerates Earth's living systems.

FOCUS AREAS

- Resilience Planning & Site Design
- Landscape Analysis & Assessment
- Food Systems Evaluation & Design

TECHNICAL SKILLS

- Digital Rendering
- GIS Analysis + Assessment
- Document Production & Design
- Drone Surveying

SELECTED PROJECTS

Municipal Vulnerability Preparedness Projects: Soil Resilience Planning | Various Municipalities, MA

Mapping and production support to develop unique and comprehensive models that combine soil and other ecological data with social and cultural information to identify high impact locations for nature based solutions for climate resilience. Research and production for community engagement workshops and outreach events.

Nashua River Watershed-Wide Nature Based Solutions | Fitchburg, Leminster, Ashburnham, Pepperell, and Groton, MA

GIS analysis of soil health challenges and opportunities for the 454 square mile Massachusetts portion of the Nashua River Watershed. Produced 93 page report that clarified high level strategies for promoting soil health specific to each project community.

Hudson-SuAsCo Nature Based Solutions Project| Hudson, Framingham, and Natick, MA

Support remote data analysis and community engagement to identify high impact sites for Nature-based Solutions that will enhance the towns' climate resilience. Focus on soil-carbon and landcover mapping and analysis to guide priority intervention sites.

Deerfield Healthy Soils Project | Deerfield, MA

Mapping, research, graphics, and report production for a comprehensive guide to protect soil health in Deerfield, MA. Included recommended bylaw updates for protecting vulnerable soil resources. *2022 Sustainability + Resiliency Award from the American Planning Association - Massachusetts Chapter.*

Greenhouse Gas Environmental Impact Assessment | Massachusetts Environmental Policy Act Office

GIS analysis and development of environmental impact assessment model for greenhouse gas emissions and carbon sequestration loss from tree clearing associated with proposed expansion of a utility right of way.

MATTHEW J. DUVENECK

EDUCATION

- PhD, Environmental Science & Resources. Portland State University. 2014
- M.S., Forest Resources. University of Massachusetts 2005
- B.S., Resource Conservation. University of Montana 2000
- A.S., Fire Science. Southern Maine Technical College 1996

RESEARCH INTERESTS

Landscape ecology, forest management, fire ecology and behavior, simulation modeling, climate change, disturbance interactions, ecosystem resilience, geographic information science, remote sensing.

APPOINTMENTS

- *Liberal Arts Department Professor*
  2017 Present New England Conservatory

- *Research Associate*
  2017 Present Harvard Forest, Harvard University

- *Post Doctoral Fellow*
  2014 2017 Harvard Forest, Harvard University

- *Fire Science Department Chair Professor*
  2005 2010 Southern Maine Community College

- *Research Technician*
  2000 2002 USFS Fire Science Laboratory

- *Firefighter*
  1998-99 Helena Helitack/Arrowhead Hotshots

PUBLICATIONS

42). Herb W. R., K. Blann, L. Johnson, M. White, **M. J. Duveneck**, R. Garono, J. Jereczek. (*In review)*. Projecting the impacts of climate change and forest transition on streamflow in Lake Superior tributaries. Journal of Hydrology.

41). Zhou, Z., S. V. Ollinger, A. P. Ouimette, B. R. Miranda, E. J. Gustafson, **M. J. Duveneck**, J. R. Foster, D. R. Bronson, D. Laflower (*In review*). Integrating nitrogen and carbon cycling into LANDIS II/PnET Succession to improve forest landscape modeling: Methods and sensitivity analyses.

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40). Reese, G., C. Dymond, K. Quigley, **M. J. Duveneck,** M. Russell, E. Gustafson, R. Scheller, B. Miranda, and B. Sturtevant. (*2024*). Best practices for calibration of forest landscape models using fine scaled reference information. Canadian Journal of Forest Research. https://doi.org/10.1139/cjfr 2024-0085.

39) Gustafson, E., B. Miranda, B. Sturtevant, and **M. J. Duveneck**, (2024) Overcoming conceptual hurdles to accurately represent trees as cohorts in forest landscape models. Ecological Modeling. https://doi.org/10.1016/j.ecolmodel.2024.11065

38). Hof, A.R., J. Lundström, **M. J. Duveneck** (2023). Modeling the Impacts of Climate Change on Ecosystem Services in Boreal Forests. In: Girona, M.M., Morin, H., Gauthier, S., Bergeron, Y. (eds) Boreal Forests in the Face of Climate Change. Advances in Global Change Research, vol 74. Springer, Cham. https://doi.org/10.1007/978 3-031-15988 6_25.

37). Hassan, M. M., **M. J. Duveneck,** J. Southwork. 2023. Tracking forest cover change and fragmentation in Teknaf following a massive influx of Rohingya refugees. Ecological Informatics. https://doi.org/10.1016/j.ecoinf.2022.101966.

36). Liang, Y., E.J. Gustafson, H.S. He., J. Serra Diaz, **M. J. Duveneck,** J. R. Thompson. 2022. What is the role of disturbance in catalyzing spatial shifts in forest composition and tree species biomass under climate change? Global Change Biology. https://doi.org/10.1111/gcb.16517.

35). Lucash, M., S. Weiss, **M. J. Duveneck**, R. Scheller. 2022. Managing for red cockaded woodpeckers is more complicated under climate change. Journal of Wildlife Management. http://doi.org/10.1002/jwmg.22309.

34). Mina, M. Messier C., **M. J. Duveneck**, M Fortin, N. Aquilué. 2022. Managing for the unexpected: building resilient forest landscapes to cope with global change. Global Change Biology. https://doi.org/10.1111/gcb.16197.

33). Sirén, A, C. Sutherland, A.Karmalkar, **M. J. Duveneck**, & T. L. Morelli. Forecasting species distributions: Correlation does not equal causation. *2022*. Diversity and Distributions. https://doi.org/10.1111/ddi.13480.

32). Soucy, A., P.Rahimzadeh Bajgiran, S. De Urioste Stone,r A. Weiskittel, **M. J. Duveneck**, B. McGreavy. A Comprehensive and Spatially Explicit Regional Vulnerability Assessment of the Forest Industry to Climate Change. *2021*. Journal of Forestry. https://doi.org/10.1093/jofore/fvab057.

31). Sotnik, G. B.A. Cassell, **M. J. Duveneck**. R.M. Scheller. A new agent based model provides insight into deep uncertainty faced in simulated forest management. *2021*. Landscape Ecology. 1 19. https://doi.org/10.1007/s10980 021-01324-5.

30). **Duveneck, M. J.** (co lead author), MacLean, M. G. (co lead author), Plisinski, J., Morreale, L. L., Laflower, D., & Thompson, J. R. (*2021*). Forest carbon trajectories: Consequences of alternative land use scenarios in New England. Global Environmental Change, 69, 102310. https://doi.org/10.1016/j.gloenvcha.2021.102310.

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29). Fer, I., Gardella A., Shiklomanov A. N., Serbin, S. P., De Kauwe M. G., Raiho A., Johnston M. R., Desai A., Viskari, T., Quaife, T., LeBauer D. S., Cowdery E. M., Kooper R., Fisher J. B., Poulter B., **Duveneck M. J.**, Hoffman, F. M., Parton W., Mantooth J., Campbell E.E., Haynes, K. D., Schaefer K., Wilcox K. R, Dietze M. C. *2020*. Beyond Modeling: A Roadmap to Community Cyberinfrastructure for Ecological Data Model Integration. Global Change Biology. https://doi.org/10.1111/gcb.15409.

28). Pearman Gillman, S. B, **M. J. Duveneck**, J. D. Murdoch, and T. M. Donovan *2020*. Wildlife resilience and protection in a changing New England landscape PlosOne. E 15(9): e0239525 https://doi.org/10.1371/journal.pone.0239525.

27). Schrum, P., R. Scheller, M. Lucash, and **M. J. Duveneck**. *2020*. Base Hurricane: A new extension for the Landis II forest landscape model. Environmental Modelling & Software, 104833. https://doi.org/10.1016/j.envsoft.2020.104833.

26). De Jager, N. R., J. J. Rohweder, and **M. J. Duveneck**. *2020*. Climate Change Is Likely to Alter Future Wolf Moose Forest Interactions at Isle Royale National Park, United States Frontiers in Ecology and Evolution. 8. https://doi.org/10.3389/fevo.2020.543915.

25). Mina, M., C, Messier, **M. J. Duveneck**, M. Fortin, and N. Aquilué. *2020*. Network analysis can guide resilience based management in forest landscapes under global change. Ecological Applications. 30(7), 1 18. https://doi.org/10.1002/eap.2221.

24). Thompson J., J. Plisinski, K. Fallon Lambert, **M. J. Duveneck**, L. Morreale, M. McBride, M. G. MacLean, M. Weiss, and L. Lee. *2020*. Spatial Simulation of Co Designed Land Cover Change Scenarios in New England: Alternative Futures and Their Consequences for Conservation Priorities. Earth's Future. 8(7). https://doi.org/10.1029/2019EF001348.

23). Pearman Gillman, S. B., **M. J. Duveneck**, J. D. Muroch, and T. M. Donovan. 2020. Drivers and Consequences of Alternative Landscape Futures on Wildlife Distributions in New England, USA.. Frontiers in Ecology and Evolution, 8. https://doi.org/10.3389/fevo.2020.00164.

22). MacLean, M., J. Holt, M. Borsuk, M. Markowski Lindsay, B. Butler, D. B. Kittredge, **M. J. Duveneck,** D. Laflower, D. Orwig, D. Foster, and J. R. Thompson. 2020. Potential impacts of insect induced harvests in the mixed forests of New England. Forests. 11(5), 498. https://doi.org/10.3390/f11050498.

21). Markowski Lindsay, M., D. Kittredge, J. Holt, J. Thompson, D. Orwig, D. Laflower, B. Butler, M. Borsuk, **M. J. Duveneck**, and M. G. MacLean. 2020. Compounding the disturbance: Family forest owner reactions to invasive forest insects. Ecological Economics. *167*, 106461. https://doi.org/10.1016/j.ecolecon.2019.106461.

20). **Duveneck, M. J.,** and J. R. Thompson. 2019. Social and biophysical determinants of future forest conditions in New England: Effects of a modern land use regime. Global Environmental Change. 55 (2019): 115 129. https://doi.org/10.1016/j.gloenvcha.2019.01.009,

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19). McKenzie, P.F., **M. J Duveneck**, L. Morreale, and J. R. Thompson. *2019*. Local and global parameter sensitivity within an ecophysiologically based forest landscape model. Env. Software and Modeling. https://doi.org/10.1016/j.envsoft.2019.03.002.

18). McBride, M. F., **M. J. Duveneck**, K. Fallon Lambert, K.A. Theoharides, and J. R. Thompson. 2018. Perspectives of resource management professionals on the future of New England's landscape: Challenges, barriers, and opportunities. Landscape and Urban Planning. https://doi.org/10.1016/j.landurbplan.2018.10.019.

17). Janowiak, M. K., A. D'Amato, C. W. Swanston, L. Iverson, F. Thompson III, W. Dijak, S. Matthews, M. Peters, A. Prasad, J.S. Fraser, L.A. Brandt, P.R. Butler, S.D. Handler, P.D. Shannon, D. Burbank, J. Campbell, C. Cogbill, **M. J. Duveneck**, M. Emery, N. Fisichelli, J. Foster, J. Hushaw, L. Kenefic, A. Mahaffey, T.L. Morelli, N. Reo, P. Schaberg, K.R. Simmons, A. Weiskittel, S. Wilmot, D. Hollinger, E. Lane, L. Rustad, P. Templer. 2018. New England Forest ecosystem vulnerability assessment: a report from the New England Climate Change Response Framework. Gen. Tech. Rep. NRS 173. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 234 p. https://doi.org/10.2737/nrs gtr 173.

16). Thompson, J.R., J.S. Plisinski, P. Olofsson, C.E. Holden, **M. J. Duveneck**. 2017. Forest loss in New England: A projection of recent trends. *PloS one*. *12*(12). https://doi.org/10.1371/journal.pone.0189636.

15). **Duveneck, M. J.,** J. R. Thompson. 2017. Climate change imposes phenological tradeoffs on forest net primary productivity. Journal of Geophysical Research Biogeosciences. https://doi.org/10.1002/2017JG004025.

14). Liang, Y., **M. J. Duveneck,** E. J. Gustafson, J. Serra Diaz, J. R. Thompson. 2017. How disturbance, competition and dispersal interact to prevent tree range boundaries from keeping pace with climate change. Global Change Biology. https://doi.org/10.1111/gcb.13847.

13). **Duveneck, M. J.,** J. R. Thompson, E. J. Gustafson, Y. Liang, and A. M.G. de Bruijn. 2016. Recovery Dynamics and Climate Change Effects to Future New England Forests. Landscape Ecology. https://doi.org/10.1007/s10980 016-0415-5.

12). Mallampalli V. R., J. Thompson, **M. J. Duveneck**, S. Meyer, A. Ligmann Zielinska, C. G. Druschke, K. Hychka, M. A. Kenney, K. Kok, and M.E. Borsuk. 2016. Methods for Translating Narrative Scenarios into Quantitative Assessments of Land Use Change. Environmental Modeling and Software. 7-20. https://doi.org/10.1016/j.envsoft.2016.04.011.

11). **Duveneck, M. J.**, and R. M. Scheller. 2015. Measuring and managing resistance and resilience under climate change in northern Great Lake forests (USA). Landscape Ecology. https://doi.org/10.1007/s10980 015-0273 6.

10). **Duveneck, M. J.**, and R. M. Scheller. 2015. Climate change effects to productivity and functional diversity in northern Great Lake forests with climate suitable planting. Ecological Applications. 25 6. Pages 1653 1668. https://doi.org/10.1890/14 0738.1.

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9). Truitt, A., E. Granek, **M. J. Duveneck**, K. Goldsmith, M. Jordan, S. Copp, K. Yazzie. 2015. What's novel about novel ecosystems: Managing change in an ever changing world. Environmental Management. Pages 1-10. https://doi.org/10.1007/s00267 015 0465-5.

8). **Duveneck, M.J.**, Jonathan R. Thompson, and B. Tyler Wilson. 2015. Imputed Forest Composition Map for New England Screened by Species Range Boundaries. Forest Ecology and Management. 347-1. Pages 107 115. https://doi.org/10.1016/j.foreco.2015.03.016.

7). **Duveneck, M. J.**, R. M. Scheller, and M. White, A. 2014. Effects of alternative forest management strategies in the face of climate change in the northern Great Lake region. Canadian Journal of Forest Research. 44 700-710 (2014). https://doi.org/10.1139/cjfr 2013-0391.

6). **Duveneck, M. J**., R. M. Scheller, M. White, A, S. Handler, and C. Ravenscroft. 2014. Climate change effects to northeastern Minnesota and northern lower Michigan forests: A case for preserving diversity. Ecosphere. 5(2): art23. https://doi.org/10.1890/ES13 00370.1.

5). Handler, S., **M. J. Duveneck**, L. Iverson, E. Peters, R. M. Scheller, K. R. Wythers, L. Brandt, P. Butler, M. Janowiak, C. Swanston, K. Barrett, R. Kolka, C. McQuinston, B. Palik, P. B. Reich, C. Turner, M. A. White, C. Adams, A. W. D' Amato, S. Hagell, R. Johnson, P. Larson, M. Larson, S. Matthews, R. Montgomery, S. Olson, M. Peters, A. Prasad, J. Rajala, P. D. Shannon, J. Daley, M. Davenport, M. R. Emery, D. Fehringer, C. L. Hoving, G. Johnson, L. B. Johnson, D. Neitzel, A. Rissman, C. Rittenhouse, and R. Ziel. 2014. Minnesota Forest Ecosystem Vulnerability Assessment and Synthesis: A report from the Northwoods Climate Change Response Framework. Gen. Tech. Rep. NRS 133. Newtown Square, PA; U.S. Department of Agriculture, Forest Service, Northern Research Station. 228 p. https://doi.org/10.2737/NRS GTR 133.

4). Handler, S., **M. J. Duveneck**, L. Iverson, E. Peters, R. M. Scheller, K. R. Wythers, L. Brandt, P. Butler, M. Janowiak, C. Swanston, A. C. Eagle, J. G. Cohen, R. Corner, P. B. Reich, T. Baker, S. Chhin, E. Clark, D. Fehringer, J. Fosgitt, J. Gries, K. R. Hall, C. Hall, R. Heyd, C. L. Hoving, I. Ibanez, D. Kuhr, S. Matthews, H. Muladore, K. Nadelhoffer, D. Neumann, M. Peters, A. Prasad, M. Sands, R. Swaty, L. Wonch, J. Daley, M. Davenport, M. R. Emery, G. Johnson, L. B. Johnson, D. Neitzel, A. Rissman, C. Rittenhouse, and R. Zeil. 2014. Michigan Forest Ecosystem Vulnerability Assessment and Synthesis: A report from the Northwoods Climate Change Response Framework. Gen. Tech. Rep. NRS 129. Newtown Square, PA; U.S. Department of Agriculture, Forest Service, Northern Research Station. 229 p. https://doi.org/10.2737/NRS GTR 129.

3). Skowronski, N. S., K. L. Clark, **M. J. Duveneck**, and J. Hom. 2011. Three dimensional canopy fuel loading predicted using upward and downward sensing LiDAR systems. Remote Sensing of Environment. 115, 703-714. https://doi.org/10.1016/j.rse.2010.10.012.

2). Clark, K. L, N. Skowronski, J. Hom, **M. J. Duveneck**, Y. Pan, S. Van Tuyl, J. Cole, M. Patterson and S. Maurer. 2009. Decision support tools to improve the effectiveness of

hazardous fuel reduction treatments in the New Jersey pine barrens. International Journal of Wildland Fire. 18, 268 277. https://doi.org/10.1071/WF08080.

1). **Duveneck, M. J.** and William A. Patterson III. 2007. Characterizing Canopy Fuels to Predict Fire Behavior in Pitch Pine Stands. Northern Journal of Applied Forestry. 24 (1) 2007. https://doi.org/10.1093/njaf/24.1.65.

REPORTS AND THESES

- **Duveneck, M. J.**, W. Xi, and R. M. Scheller. Chapter 7: Understanding Model Outputs; and Scheller, R. M. and **M. J. Duveneck.** Chapter 13: Simulating Forest Management with the Base Harvest Extension. In Scheller, R.M. and MS Lucash. Editors. 2014. Forecasting Forested Landscapes: An Introduction to LANDIS II with Exercises. Self Published. ISBN: 9781722654924.

- **Duveneck, M. J.** 2013. Managing for Resistance and Resilience of Northern Great Lakes Forests to the Effects of Climate Change. Doctoral Dissertation. Portland State University, Portland, OR. https://doi.org/10.15760/etd.1550.

- Williams, B. J., B. Song, J. Hom, and **M. J. Duveneck**. 2008. Wildfire Visualization Using GIS and Forest Inventory Data. In Proceedings of the 6th Southern Forestry and Natural Resources GIS Conference (2008).

- Patterson, W.A. III, D. Crary Jr. and **M. J. Duveneck**. 2008. The impossible summer burn: Techniques for fuel reduction, habitat restoration and happy locals in northeastern pine barrens. Fire Science Brief. 13 (2008).

- **Duveneck, M. J.** 2005. Characterizing Canopy Fuels as They Affect Fire Behavior in Pitch Pine. Master's Thesis. University of Massachusetts. Amherst, MA.

- Patterson, William A. III and **M. J. Duveneck**. 2004. Fire Management Plan for The Maine Army National Guard Hollis Training Site. University of Massachusetts Forestry Program.

- Patterson, W. A. III, D. Crary Jr., and **M. J. Duveneck**. 2004. Managing pitch pine to Reduce Crown Fire Potential. In Managing fuels in northeast barrens: A field tour sponsored by the Joint Fires Sciences Program for northeastern fire managers. University of Massachusetts Forestry Program.

TEACHING EXPERIENCE

New England Conservatory

- Natural Disasters & Catastrophes (Fall 2017, Fall 2020, Fall 2023)
- Energy in the 21st Century (Fall 2017, Fall 2020, Fall 2023)
- Freshman Seminar: Complexities in Repairing the Environment (Fall 2017, Fall 2018, Fall 2019, Fall 2020, Fall 2021, Fall 2022, Fall 2023)
- Watershed Hydrology: Understanding Water in the Environment (Spring 2018, Spring 2021)
- Climate Change Adaptation (Spring 2018, Spring 2021, Spring 2024)

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- Social Dance (Spring 2018, Spring 2019, Spring 2020, Spring 2022, Spring 2023, Spring 2024)
- Mapematics: Introduction to Geographic Information Science (Fall 2018, Spring 2020, Spring 2022, Spring 2023)
- Forest Ecology (Fall 2018, Fall 2021, Fall 2024)
- Intro to Probability and Mathematical Modeling (Spring 2019, Fall 2021, Fall 2024)
- Our Cosmic Origins (Spring 2019, Spring 2022)
- Sustainable Societies (Fall 2019. Fall 2022)
- Evolution of Life on the Planet (Spring 2020, Spring 2023)
- Introduction to Physical Geography (Fall 2019, Fall 2022)
- Introduction to Botany and Plant Physiology (Spring 2021, Spring 2024)

University of Massachusetts Amherst

- Ecology, Economy, and Future of Maple Syrup (Guest lecturer, 2016)

Northeastern University

- Architecture and Land Use (Guest lecturer, 2016)

LANDIS II Forest Simulation Model Training

- Introduction to LANDIS II (Instructor, 2013 Portland, OR; 2014 Harvard Forest, MA, 2021 Remote)

Portland State University

- Landscape Ecology (Guest lecturer, 2013)
- Intro Environmental Management (Guest lecturer, 2013)
- Investigating Forest Ecosystems (Teaching Assistant, 2010)
- Old Growth Forest Ecology (Teaching Assistant, 2011)

Southern Maine Community College

- Fire Service Building Construction (Fall: 2005).
- Fire Service Hydraulics (Spring: 2006, 2007, 2008).
- Service Learning (Fall: 2005, 2006; Spring: 2007).
- Wildland Fire Management (Fall: 2008, 2009; Spring: 2009, 2010).
- Wildland Fire Behavior (Spring: 2008, 2009).
- Fire Inspector (Spring: 2006, 2007, 2008, 2009, 2010).
- Fire Protection Systems (Fall: 2005, 2006, 2007, 2008, 2009).

Peninsula School, Menlo Park, California

- 7th and 8th grade (Teaching Assistant, 2000-2001)

University of Montana

- Dendrology (Teaching Assistant, 1999-2000)
- Wood Identification (Teaching Assistant, 2000)

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Visiting social dance Instructor

- Pinewoods American Dance/Music Week, Plymouth, MA (2009, 2011, 2018).
- BACDS American & English Week, Mendocino, CA (2009, 2010, 2011).
- Winter Dance Week, Brasstown, NC (2007, 2008, 2009, 2010, 2012, 2013, 2014).
- Bates College Tango Club, Lewiston, ME (2007, 2008).
- Davis Elkins College/Augusta Dance Week, Elkins, WV (2007, 2008).
- Stanford University Waltz Week, Stanford, CA (2007).
- Timber Ridge Dance Week, High View, WV (2006, 2008).
- Chesapeake Dance Weeekend, MD (2010, 2011, 2015).
- Music City Masquerade, TN (2012)
- New England Conservatory, MA (2014, 2015, 2019, 2021)

SERVICE AND OUTREACH

- Executive Board (2022 Present), LANDIS II foundation.
- Academic Technology Committee (2022 present). New England Conservatory.
- Board of Directors, Nominating Committee, and Program Committee; Director. Harry F. Guggenheim Foundation. 2011 Present. Foundation sponsors scholarly research addressing problems of violence, aggression, and dominance.
- Undergraduate Curriculum Committee (2020 2022); Chair. 2021 2022. New England Conservatory.
- Advisory Board; Advisor. North Atlantic Fire Science Consortium. 2014 2019. Consortium provides link with fire science, management, and policy in the North Atlantic region.
- Search Committee Chair; Southern Maine Community College, Maine Fire Training Director. September 2009
- Search Committee Chair; Southern Maine Community College, Fire Science Professor. April 2009
- Co organized Symposium; "Simulating Forest Dynamics Using LANDIS II" for the International Association of Landscape Ecologist meeting in Portland, Oregon, July 2015.
- Reviewer; Ecological Economics (2017), Forest Ecology and Management (2017), Ecological Applications (2017), Canadian Journal of Forest Research (2016), Environmental Research Letters (2016), International Journal of Wildland Fire (2015), Landscape Ecology (2015, 2016, 2018), Environmental Modeling and Software (2015), Ecological Modeling (2014, 2016), Pearson Education (2006), International Journal of Remote Sensing (2019), Frontiers in Forests and Global Change (2022).
- Student Committee: Núria Aquilué Junyent (PhD, Université du Québec à Montréal 2018).

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GRANTS & CONTRACTS

- Messier, C. et al. (**Duveneck, M. J**, cooperator). 2024. Pan-Canadian NSERC Alliance. Simulating Forest Change Across Canadian Forests. $6 million (CAN).

- **Duveneck, M. J.** 2024. The Nature Conservancy Central Appalachians Program, LANDIS Modeling for USFS Region 8 Appalachians Climate Change Vulnerability Assessment. $57,000.

- **Duveneck, M. J.** 2022. Second Century Stewardship. Parameterization and simulation of Acadia National Park forests, Maine. Schoodic Institute. $20,000.

- **Duveneck, M. J.** 2018. Consulting and parameterization of forest simulation model in Fort Bragg, North Carolina. Portland State University. $1800.

- **Duveneck, M. J.** 2018. Modeling forest change in Northeast National Parks. University of Massachusetts. $5000.

- **Duveneck, M. J.** 2018/2019. Consulting and parameterization of forest simulation model in Quebec. Université du Québec à Montréal. $1000.

- **Duveneck, M. J.** 2016. Consulting and development of vegetation map in Pennsylvania to initialize forest simulation model. Pennsylvania State University. $8000

- Ayers, M. P., C.F. Aoki, K.L. Clark, R.M. Scheller, **M. J. Duveneck** (Cooperator). R. Billings. 2016 2017. Southern pine beetle range expansion: Forecasting SPB population dynamics and impacts of disturbance interactions on future forests of New York, New Jersey and New England. USDA Forest Service. Northeastern Area State & Private Forestry.

- Scheller, R. M., C. Swanston, S. Handler, M. White, **M. J. Duveneck**. (Assisted writing) 2011-2013. Scenarios for forest reserve and adaptive management under alternative climate change scenarios in the northern Great Lakes. Upper Midwest and Great Lakes Landscape Conservation Cooperative. $111,404.

- **Duveneck, M. J.** 2010. Development of operations manual and provide training for Mobile Fire Sprinkler & Alarm Simulator. Portland, Maine Area Metro Fire Departments. $6000.

- **Duveneck, M. J.** 2008. Characterizing canopy fuels with indirect upward looking LiDAR in Montana conifer forests. USFS Global Change Program. Northern Research Station. $4000.

- **Duveneck, M. J.** 2007. Parameterize crown fuels in New Jersey Pine Barrens with Upward LiDAR. USFS Global Change Program. Northern Research Station. $2000.

- **Duveneck, M. J.** 2007. SMCC Mini Grant. Curriculum Update for “Building Construction for the Fire Service”. $400.

- **Duveneck, M. J.** 2007. SMCC Mini Grant. Course development for: “Wildland Fire Ecology & Behavior”. $400.

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- **Duveneck, M. J.** 2006. FARSITE modeling for New Jersey Pine Barrens. USFS Global Change Program. Northern Research Station. $1000.

- **Duveneck, M. J.** 2006. SMCC Mini Grant. Course development for: "Introduction to Forest Fire Management". $400.

AWARDS

- Portland State University; Environmental Science & Management Bushby Graduate Scholarship. Portland, OR. June 2013. $4500.

- Portland State University; Academically Controlled Auxiliary Activities (AAA) Student Travel Award, Portland, OR. February 2013. $750.

- U.S. Regional Association of the International Association for Landscape Ecology; Student Travel Award. Austin, TX. April 2013. $500.

- Portland State University; Environmental Science & Management Bushby Graduate Travel Award. Portland, OR. June 2012. $475.

- Michigan State University NASA; Professional Enhancement Award. Annual Symposium of the U.S. Regional Association of the International Association for Landscape Ecology. Newport, RI. April 2012. $700.

- Portland State University; Dean's Award. Portland, OR. September 2010. $7500.

- National Institute for Staff and Organizational Development (NISOD); Teaching Excellence Award. International Conference on teaching & Leadership Excellence. Austin, TX. May 2008.

- University of Massachusetts Department of Natural Resources Conservation; Herschel G. Abbott Award; Amherst, MA. April 21, 2004. $700.

- University of Massachusetts Department of Natural Resources Conservation; Membership Xi Sigma Pi Forestry Honor Society; Amherst, MA. April 21, 2004.

- USFS Fire Sciences Lab; Fire/Fire Surrogate Research Burn Award. July 2002. $500.

PRESENTATIONS (Oral and Posters)

- **Duveneck, M. J**., M. MacLean, D. Laflower, and J. Thompson. Management response to insect outbreaks: Are the effects larger than insects themselves? (Invited Seminar). International Association of Landscape Ecologists. March 2023. Riverside, California.

- **Duveneck, M. J.** Stories from Schoodic Institute. (Invited Seminar). The Story Collider. June 2022. Schoodic Institute. Winter Harbor, Maine.

- **Duveneck, M. J**., M. MacLean, and J. Thompson. The effect of climate, the modern land use regime, and alternative future scenarios on forest carbon in New England, USA. (Invited

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Seminar). International Association of Landscape Ecologists. July 2019. Milan, Italy.

- Scheller, R.M., M.S. Lucash, **M.J. Duveneck**. Managing forests for change: Simulations suggest radical innovations in management will be necessary. (Seminar). Ecological Society of America 104th Annual Meeting. August 2019. Louisville, Kentucky.

- De Jager, N.R. **M.J. Duveneck**, and J.J. Rohweder. Interactive effects of wolf predation and climate change on moose forest interactions at Isle Royale National Park, USA (Seminar). International Association of Landscape Ecology Meeting. April 2019. Chicago, IL.

- **Duveneck, M. J.** Crown fuel and fire modeling in pitch pine (Field tour). North Atlantic Fire Science Exchange. Montague Plains Field Trip. August 2018. Montague, MA.

- MacLean, M. G., **M. J. Duveneck**, D. Laflower, A. Chmurzynski, J. Thompson. The importance of interacting global change drivers when modeling forest disturbance in New England (Seminar). Ecological Society of America Conference. August 2018. New Orleans, LA.

- Thompson, J., **M.J. Duveneck**, K. Fallon Lambert, J. Plisinski, L. Morreale. Land use regimes and the future of New England's forest carbon (Seminar). Ecological Society of America Conference. August 2018. New Orleans, LA.

- **Duveneck, M.J.** Artists are engaged by science (Seminar). Consortium for the Liberal Education of Artists Conference. April 2018. Baltimore, MD.

- **Duveneck, M.J.** Effects of the modern land use regime on future New England forests (Seminar). Ecological Society of America Conference. August 2017. Portland, OR.

- **Duveneck, M. J.** Interactions of climate and land use in New England: Simulating alternative scenarios of future forests (Seminar). Wildfire in the Northeast Conference. December 2016. Mystic, CT.

- **Duveneck, M. J.** Future forests, climate and land use in New England (Seminar). Visionary Meeting on Understanding and Forecasting the Impact of Climate Change on Maine's Forest. November 2016. Portland, ME.

- **Duveneck, M. J.** and J. Thompson. Tradeoffs between increased gross photosynthesis and increased respiration demand under climate change: Seasonal and spatial variability in New England (Seminar). International Association of Landscape Ecology Meeting. April 2016. Asheville, NC.

- **Duveneck, M. J**., and J. Thompson. Effects of seasonal phonological changes to future forest productivity (Invited Presentation). Harvard Forest Research Symposium. March 2016. Petersham, MA.

- Rapp, J.M., **M.J. Duveneck**, and J. R. Thompson. Expansion of the maple syrup industry in New England: projecting where the taps will be in a changing environment (Poster). Harvard Forest Research Symposium. March 2016. Petersham, MA.

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- **Duveneck, M. J**., J. Thompson, L. Morreale, and J. Plisinski. Future Effects to New England Forests: Scenarios of Harvest, Development, and Climate Change (Invited Presentation). International Association of Landscape Ecology Meeting. July 2015. Portland, OR.

- **Duveneck, M. J.** Measuring and Managing Resilience under Climate Change and Alternative Scenarios in Northern Great Lake Forests (Invited Presentation). US Forest Service NYC Urban Field Station. June 2015. Bayside, NY.

- **Duveneck, M. J.** Forest Management for Resilience under Climate Change: Case Studies of Alternative Silviculture in the Great Lakes Region (Invited Presentation). Northeastern Area Association of State Foresters Annual Meeting. Climate Change: Climate Preparedness for a Changing Forest. June 2015. Petersham, MA.

- **Duveneck, M. J.** Managing for Resilience in Multiple Dimensions under Climate Change: Informing Forest Managers in the Great Lake Region with Alternative Scenarios (Seminar). Harvard Forest Seminar Series. March 2015. Petersham, MA.

- **Duveneck, M. J.**, Jonathan R. Thompson, B. Tyler Wilson, Sofie McComb, and Luca Morreale Plot Level Forest Composition Data at a Regional Scale (Poster). October 2014. Scenarios to Solutions Harvard Forest Research Coordination Network Planning Workshop, South Casco, ME.

- **Duveneck, M. J.** Measuring and Managing Resilience Under Climate Change in Northern Great Lake Forests (Seminar). University of Vermont. Gund Institute Seminar Series. September 2014. Burlington, VT.

- **Duveneck, M. J.** Climate Change Effects to Northern Great Lakes Region Forests: Managing for Resistance and Resilience (Webinar). April 2014. The Nature Conservancy, Field Climate Forum.

- White, M., **Duveneck, M. J.**, Scheller, R. M. How Do We Manage Forests For Climate Change? Forest Restoration and Management in Changing Climate: Implications for Lake Superior Watersheds (Seminar). January 2014. Duluth, MN.

- **Duveneck, M. J.** How Do We Manage Forests For Climate Change? Assessing Resistance and Resilience of Northern Great Lake Forests. (Seminar). Portland State University, Dissertation Defense. November 2013. Portland, OR.

- **Duveneck, M. J.** Climate Change Vulnerability Assessment and Declining Resistance and Resilience in the Northern Great Lakes Region. (Seminar). Portland State University, Forest Ecology and Management Seminar Series. October 2013. Portland, OR.

- **Duveneck, M. J**. ,R. M. Scheller, and M. White. A Landscape Comparison of Potential Climate Futures in Minnesota and Michigan. (Prepared presentation for seminar). Ecological Society of America 98th Annual Meeting. August 2013. Minneapolis, MN.

- **Duveneck, M. J**. and R. M. Scheller. Climate Change in Northern Minnesota and Northern Lower Michigan Forests: Assessing the Effect of Latitude. (Seminar). International Association of Landscape Ecology Meeting. April 2013. Austin, TX.

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- Falkowski, M. J., A.T. Hudak, N. L. Crookston, R. M. Scheller, **M .J. Duveneck**, L. M. Nagel, and R. E. Froese. Enhancing Tools and Geospatial Data to Support Operational Forest Management and Regional Forest Planning in the Face of Climate Change. (Poster). NASA Land Use/Land Cover Change meeting. April 2013. Rockville, MD.

- Scheller, R. M., and **M. J. Duveneck**. Future forest scenarios under climate change in Northern Lower Michigan. (Seminar). Michigan Climate Change Response Framework Workshop. September 2012. Pellston, MI.

- **Duveneck, M.J**. and R.M. Scheller. Climate Change Adaptation: Forest Management Scenarios in Northern Minnesota. (Seminar). Purdue University/North Carolina State University Summer Field Tour. July 2012. Portland, OR.

- Scheller, R. M., **M. J. Duveneck**, M. White. Scenarios of alternative forest management under climate change scenarios in the northern Great Lakes. (Seminar). Minnesota Climate Change Response Framework Workshop. July 2012. Grand Rapids, MN.

- **Duveneck, M. J.,** R. M. Scheller, M. White, S. Handler, C. Swantson. Assisted Migration for Climate Change Adaptation: Forest Management Scenarios in Northern Minnesota. (Invited Presentation). International Association of Landscape Ecology Meeting. April 2012. Newport, RI.

- White, M., **M. J. Duveneck**, and R. M. Scheller. Forest Restoration and Biodiversity Conservation in a Changing Climate. (Prepared presentation for seminar). Adaptive Management In the Face of Climate Change Workshop. February 2012. Cloquet, MN.

- Scheller, R. M., **M. J. Duveneck**, M. White, S. Handler, C. Swanston. Scenarios of alternative forest management under climate change scenarios in the northern Great Lakes. (Webinar). Upper Midwest and Great Lakes Landscape Conservation Cooperative Project Sub topic Meeting. January 2012. East Lansing, MI.

- **Duveneck, M. J**. and R. M. Scheller. Assisted migration for climate change adaptation. (Poster). LANDIS II Conference. January 2012. Madison, WI.

- White, M., R. M. Scheller, **M. J. Duveneck**. Understanding Climate Change in Northeastern Minnesota. (Webinar). September 2011. Minnesota Science Team Meeting.

- Scheller, R. M. , J. Thompson, M. White, C. Ravenscroft, **M. J. Duveneck**, D. Mladenoff. Tree species migration in Wisconsin, Minnesota, and Massachusetts: A model comparison of potential limiting factors under climate change. (Prepared presentation for seminar) Ecological Society of America 96th Annual Meeting. August 2011. Austin, TX.

- Carr, T, **M. J Duveneck**, and L. West. Service learning as a tool for civic engagement. (Seminar). Maine Community College System Dirigo Institute. June 2006. New Harbor, ME.

- **Duveneck, M. J**. Characterizing canopy fuels as they affect fire behavior of pitch pine (*Pinus rigida*). (Seminar). Maine Forest Service Regional Forest Ranger Meeting. November 2005. Gray, ME.

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SCOUTER DESIGN

Terri Courtemarche

PRINCIPAL/GRAPHIC DESIGNER

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PORTFOLIO: www.scoutergraphicdesign.com

EDUCATION

BFA, University of North Florida / 1992

IDEO: Design for Change 2019 / Unlocking Creativity 2019 / From Superpowers to Great Teams 2018

EXPERIENCE

Scouter Design / Chelmsford, MA / Jan. 2020-present

Explore. Create. Connect.
Smart design that connects your story to your audience.

- Collaborate with clients to develop new brands or expand on existing ones
- Logo and visual identity development
- Design branded collateral and templates, training
- Report and infographic design
- Design 508 compliant accessible documents

VHB / Watertown, MA / Nov. 1993- Dec. 2019
Graphic Design Manager

- Art direct, mentor, train, and inspire an in-house team of designers
- Designed deliverables including project branding, branded collateral for public outreach efforts, report design, infographics, presentations, email marketing, and signage/interpretive panels
- Developed templates and provided training to colleagues
- Created 508c accessible documents
- Used brainstorming and conceptualizing exercises to push the boundaries of design

AIGA Mentorship Program / 2018

PRO BONO

Reach out and Read, MN / Infographic design
San Jose Library, CA / Infographic design
Tennessee Commission on Children & Youth, TN / Logo design
Nashoba Neighbors, MA / Logo design & Annual Report
St. Theresa School, MA / Logo design

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