



Charles River Watershed Association



The Charles River Natural Valley Storage Area (NVSA) Health Assessment

Understanding our Vital and Threatened Wetlands in the Charles River Watershed



NVSA Flooded in July 2021

Wetlands and streams throughout the region are facing pressures including invasive species growth, loss of biodiversity, reduced riparian habitat, low streamflow, and poor water quality. The NVSA wetlands are no exception to these issues, as the land surrounding them is rapidly developing, leading to the introduction of invasive species, increase in impervious surfaces and pollutant loads, and increased demand for groundwater withdrawal.

The purpose of this health assessment is to begin determining what pressures are affecting the NVSA wetlands by evaluating conditions at one critical area. Area N, at the confluence of Mine and Dix Brooks in Franklin, MA, is particularly vulnerable to these pressures. This area is adjacent to I-495, a train line, and corporate developments. Dix Brook is also a Coldwater Fish Resource (CFR) stream that supports cold water fish species, and is especially vulnerable to changes in temperature, surrounding land use, and water levels.

"The purpose of this health assessment is to determine what pressures are affecting the NVSA wetlands to protect and restore this vital natural resource for generations to come."

- Lisa Kumpf

River Science Program Manager

Stream Health

Fish survey in Dix Brook



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Dix Brook is one of only nine Coldwater Fish Resource (CFR) streams in the Charles River watershed. The brook has not been sampled since 2003, and was in need of an updated survey. On June 24, 2021 CRWA accompanied MassWildlife biologists to perform an electrofishing survey at Dix Brook, both upstream and downstream of Financial Park, the most downstream culvert before it flows into Mine Brook in NVSA Area N.



Electrofishing in Dix Brook



Redfin Pickerel

Upstream of the culvert only four fish were found, all redfin pickerel between 2 and 3 inches long. Downstream of the culvert, there were both larger redfin pickerel and sunfish. Based on these observations, Mass Wildlife speculated that the culvert underneath Financial Park may be considered 'perched', meaning that only smaller fish can pass through it to pass upstream. These results suggest that Dix Brook has low biodiversity and restricted fish passage.

CRWA and volunteers also assessed stream health by surveying Dix Brook's features to determine aquatic habitat quality. Using EPA's Habitat Rapid Bioassessment Protocols, three habitat assessments were completed on separate dates in 2020 and 2021. Overall, Dix Brook had a 'Suboptimal' habitat, scoring 67% of the maximum possible habitat score.



**CRWA Volunteers
Performing a
Habitat Assessment**

Results show that Dix Brook is a fairly unaltered stream habitat buffered by a variety of healthy forested wetland plants. However, the stream suffers from bank erosion and has too much sediment deposited on its bed, reducing the habitat quality and the long-term stability of the stream channel.

Average Scores of Habitat Quality Parameters (out of 20)

Sediment Deposition	6.3	Marginal
Channel Sinuosity	9.7	Marginal
Bank Stability	11.0	Suboptimal
Channel Flow	12.0	Suboptimal
Pool Bottom	13.3	Suboptimal
Bottom Cover	14.0	Suboptimal
Pool Variability	14.3	Suboptimal
Channel Alteration	16.0	Optimal
Bank Vegetation	17.7	Optimal
Riparian Zone	20.0	Optimal

These issues likely result from an industrial building that was built in 2018 near the Brook. Excess stormwater runoff from new roads and buildings is rerouted into Dix Brook, causing heavy flows through the small stream during rainstorms, which erode the banks, leading to more sediment on the stream bottom.



CRWA Volunteer Sampling River Bugs

Benthic macroinvertebrates, or river-bottom dwelling bugs, are an indicator of pollution in rivers and streams, as some species are more or less tolerant of pollution. The presence of these organisms is an indirect measure of the presence of pollution within their habitats. Typically, when water quality is poor, pollution sensitive organisms decrease in abundance, while pollution tolerant organisms dominate in variety and number.

CRWA and volunteers sampled benthic macroinvertebrates in Dix Brook twice in 2021. Once collected, bugs were identified and water quality was scored based on EPA's Rapid Bioassessment protocol with the scale: Poor (<20), Fair (20-40), Good (>40). Some of the bugs found included midge larvae, stonefly nymphs, mayfly nymphs, caddisfly larvae, aquatic worms, and scuds, which represent a range of pollution sensitive and pollution tolerant species. The average score for the two samples had a water quality score of 17.8, indicating poor water quality conditions overall.



Mayfly Nymph

Vegetative Health

Aerial imagery assessments



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In order to gain a broader picture of the health of the NVSA, assessing health of the vegetation in these areas, in addition to stream and habitat health, is critical to preserving these areas.

Trees and wetland plants act to store floodwaters, so if their health is compromised the NVSA may not be able to serve its original purpose as a natural flood storage system.

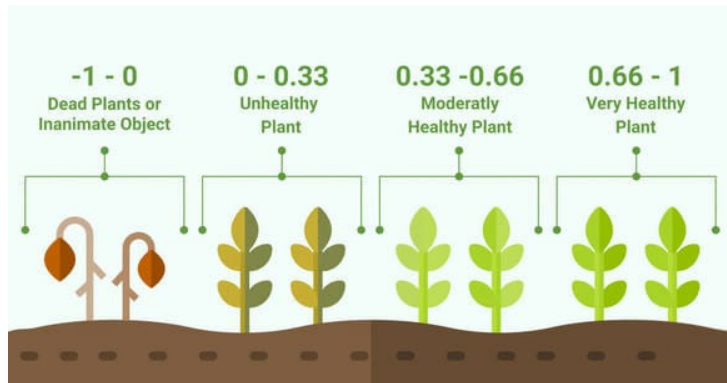
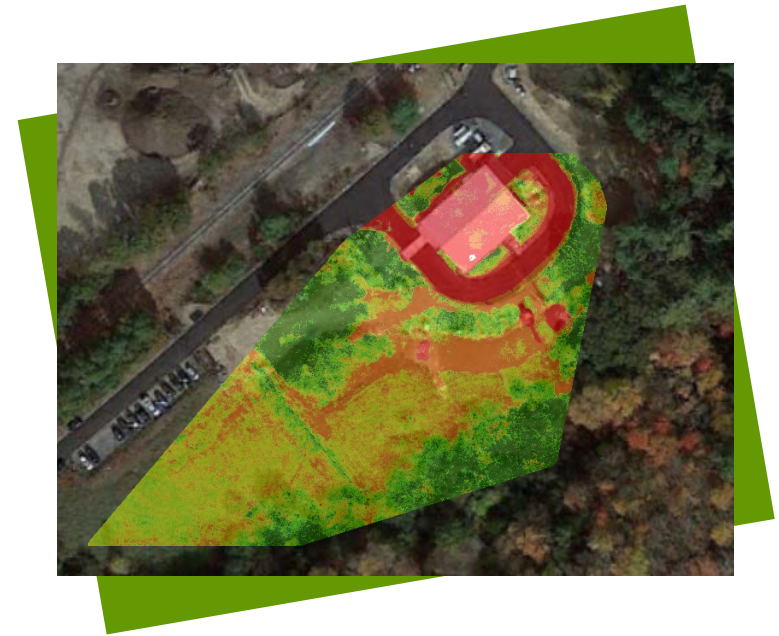


Diagram showing NDVI values as they relate to vegetative health. On maps, red indicates dead plants or inanimate objects and dark green indicates very healthy plants.

To assess the vegetative health of Area N, aerial imagery collected from a drone and from satellite images was used. The Normalized Difference Vegetation Index (NDVI) was calculated for each image using mapping software. In images, healthy plants reflect near-infrared light as part of photosynthesis, which is used as a measure of vegetation health.



A 5 acre portion of Area N with NDVI calculated from drone images.

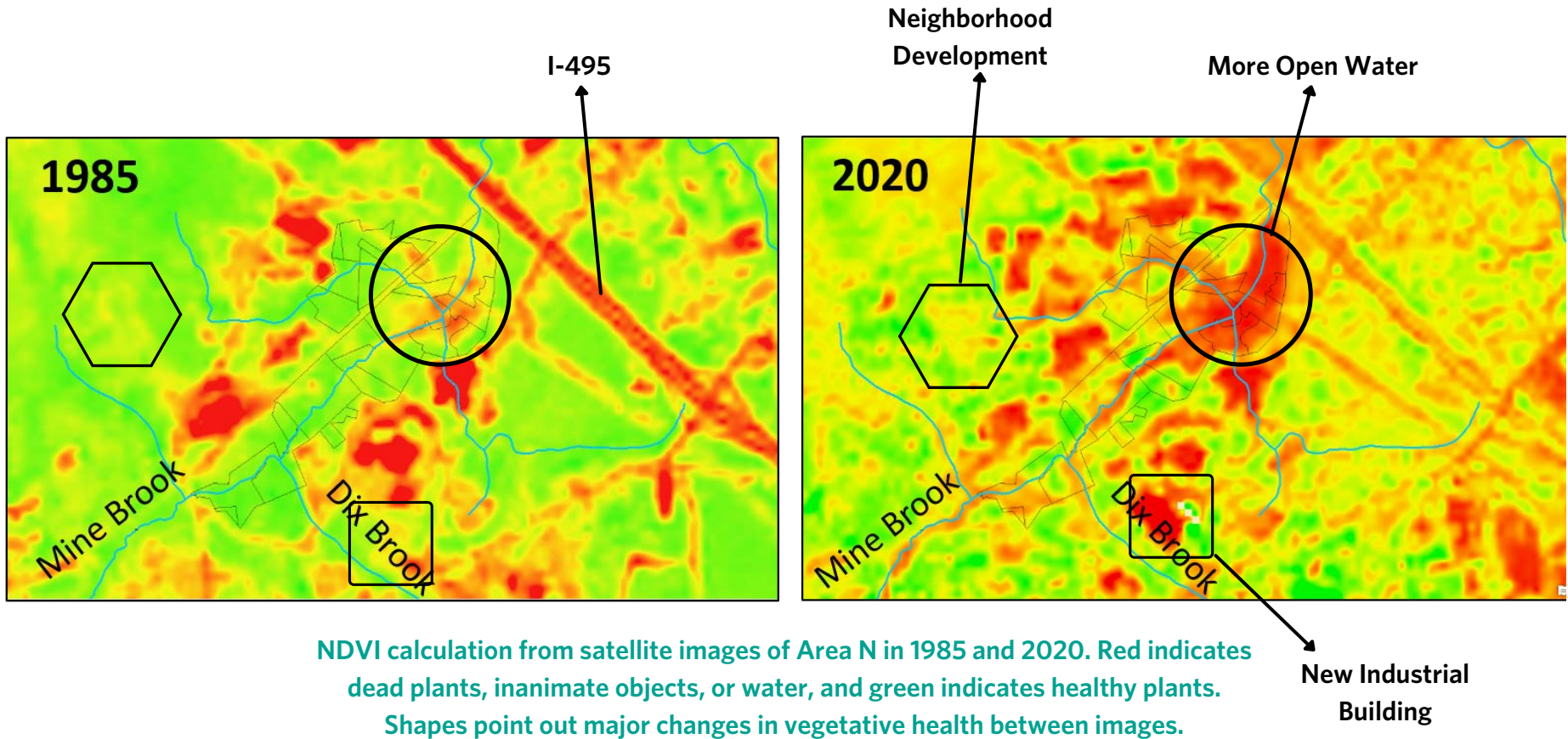
A drone survey was conducted over part of Area N during summer 2021, and satellite images were collected over the area from different time periods. After trial and error, CRWA found that using satellite images to calculate NDVI was favorable over using drone imagery, as it was not able to cover a large enough area with enough resolution to evaluate the >100 acre NVSA conservation areas. In addition, images have been taken regularly with Landsat satellites regularly since the 1980s, allowing evaluation of trends in vegetative health over time.

Vegetative Health

Aerial imagery assessments



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Satellite images from 1985 through 2020 show that Area N has gone through significant change in 35 years, and vegetative health has declined overall. Most of the decline in vegetative health has to do with pressures from surrounding development, including industry building and neighborhood development and expansion. Another change is in the size of open water areas within the wetlands, which may be increasing due to a need to hold more stormwater runoff from surrounding streets and buildings.

Vegetative Health

Invasive species encroachment



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Another major threat to vegetative health in the NVSA wooded wetlands is the introduction of invasive plant species. Invasive species are fast-growing non-native plants that quickly dominate ecosystems, killing native plants and reducing biodiversity. Bittersweet is an invasive vine that is particularly rampant in New England forests and wetlands. Over only months bittersweet can cover, shade, and outcompete other vegetation in the area, and can even uproot full-grown trees when left unchecked.



**Bittersweet Vines
in Area N**



Dead Tree with Bittersweet Vines

Invasive plant species observed during field surveys of NVSA Area N included bittersweet, multiflora rose, and garlic mustard. Bittersweet vines were observed taking over the canopies of fully grown native trees, especially on the edges of the conservation areas. As trees and wetland plants clean and store floodwaters, a decline in the health of native vegetation is likely beginning to decrease the flood reduction function of the NVSA wetlands.

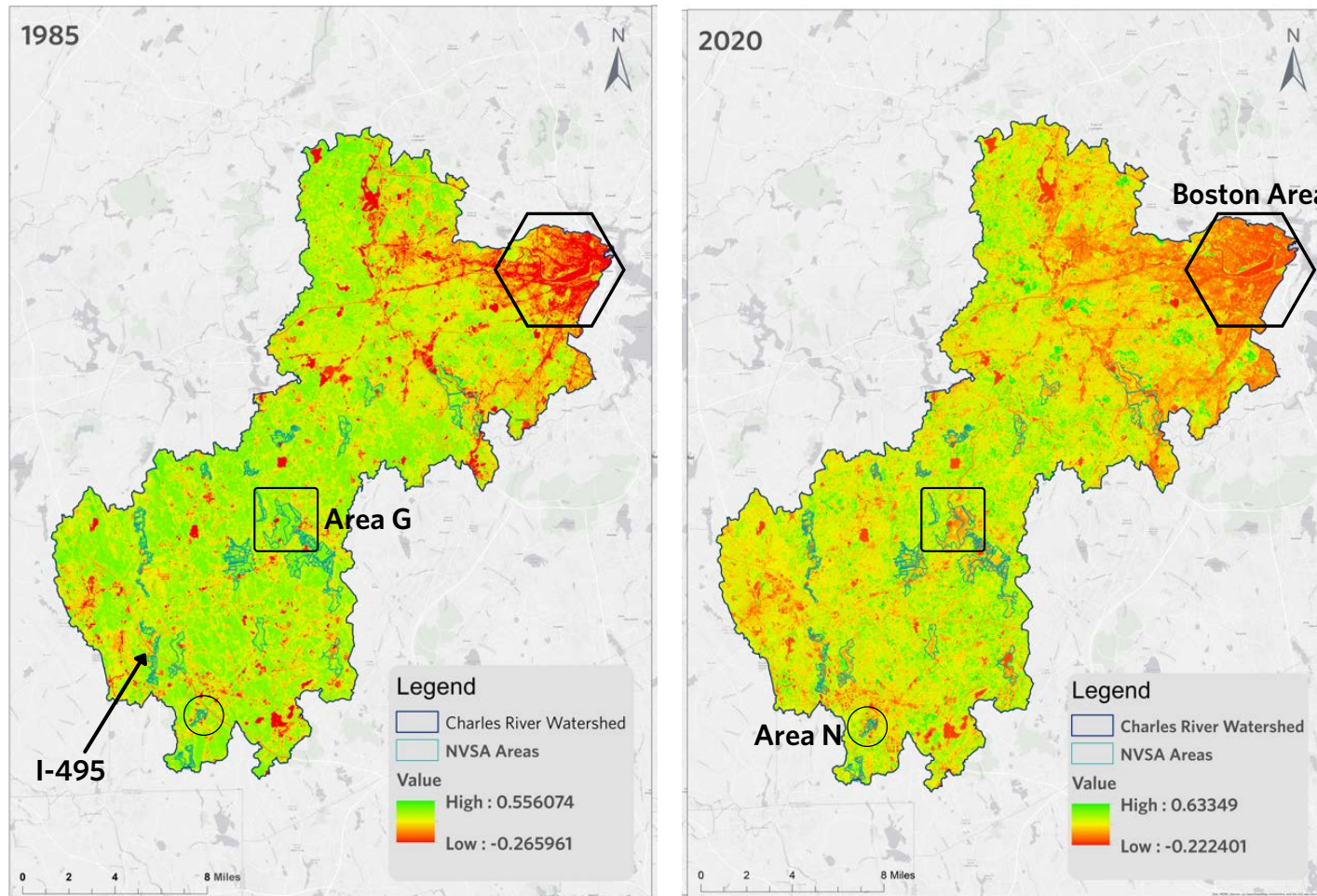
Watershed Wide Change

Trends over time in vegetative health



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This pilot study of vegetative health in Area N allowed CRWA to take a larger-scale view of change throughout the Charles River watershed. Results show that overall vegetative health has declined between 1985 and 2020. This trend is also evident within other NVSA wetland areas, especially Area G in Medfield and Millis, likely resulting from the same pressures facing Area N. Change was particularly evident along the I-495 corridor in the upper watershed, which is considered the fastest developing area in the Charles River watershed. A slight improvement in vegetative health was present in the Boston area, likely due to conservation efforts.



NDVI calculation from satellite images of Charles River watershed in 1985 and 2020. Red indicates dead plants, inanimate objects, or water, and green indicates healthy plants. Shapes point out major changes in vegetative health between images.

This pilot study allowed us to evaluate the health of NVSA wetland Area N, and begin thinking about the pressures facing this conserved land.

Conclusions

1. Dix Brook has a suboptimal habitat and poor water quality conditions for river bugs
2. Dix Brook has low fish populations, likely due to a perched culvert impeding passage
3. Dix Brook has bank erosion problems and excess sediment, likely due to surrounding increases in stormwater runoff, due to development
4. Area N's vegetative health has declined over the past decades mainly due to surrounding development pressures
5. Vegetation in Area N is threatened by invasive plant species, including bittersweet vines
6. These trends are likely present throughout the NVSA wetlands and the Charles River watershed, especially along the I-495 corridor

Next Steps:

- Work with the Town of Franklin to address the perched culvert at Dix Brook
- Advocate for continued land conservation and/or low-impact development
- Consult with land conservation groups to address encroachment from development on a watershed scale
- Engage volunteers in removal of invasive plants, including bittersweet vines



Sunrise Over the NVSA

Acknowledgements



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CRWA is grateful to all who made this project possible. We could not have done this without the support of our funders at the Massachusetts Environmental Trust. Mark Larson of the US Army Corps of Engineers provided historical context about the NVSA wetlands. Dr. Adam Kautza from the Massachusetts Division of Fisheries and Wildlife helped coordinate and conduct the Dix Brook fish survey. Sean McNamara volunteered his time to pilot the drone to collect aerial images. X-Cel Conservation Corps members and CRWA interns collected benthic macroinvertebrate and habitat assessment data in Dix Brook. Dr. Valerie Pasquarella and Aleksandra Ostojic consulted on processing NDVI images.



Drone Image of Dix Brook



Photos by:

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- Madison Wolters

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