WORKING DRAFT

Report of the GC3 Science and Technology Working Group

September 2020

Table of Contents

Executive summary

In late 2019, the "*World Scientists' Warning of a Climate Emergency*"[1] followed a devastating report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019),[2] the interim 1.5°C report of the Intergovernmental Panel on Climate Change (IPCC, 2018),[3] and a National Climate Assessment (2018).[4] These reports, and the just-released *Living Planet Report 2020,* [5] do not equivocate: *the scope and pace of destruction is far outpacing the natural systems and resources that support us*. Despite long-term, widespread, science-based recognition of the imbalance,[6] we lack ecoliteracy and system-wide solutions. The cultural cause(s) of climate change remain largely unaddressed,[7] and the scope and scale of health impacts is just coming to the fore.[8]

What is happening in Connecticut, and what is the path to our best future? Climate impacts are occurring in rural, suburban, and urban communities in Connecticut. Some future impacts are certain, some uncertain. We need nature to thrive, and survive, and must accelerate the implementation of adaptation strategies while urgently enacting polices to reduce greenhouse gas emissions. Local systems, local action and a core network of intact ecology benefit us now and are essential to our long-term resilience. At this junction, achieving a just and healthy future demands our full attention, and the good news is that cultural change can be rapid. Unbiased, interdisciplinary science and responsible leadership is required to achieve three connected and essential goals: support the well-being of our citizens, slow global climate change, and prevent further degradation of ecosystems.

Here we outline known impacts, future uncertainty, and a ***practical***, ***priority-based*** and ***precautionary*** approach: ***1)*** immediately, identify and plan for known impacts, and mobilize cost-effective actions with clear benefits; ***2)*** coordinate statewide data to prioritize funding and ensure equity and environmental justice; ***3)*** mobilize long-term research and public education relevant to climate change and climate science; ***4)*** facilitate and support local and cultural transitions that reconnect health, community and sustainability.

We note that impacts and recommendations outlined herein overlap with other Working Groups. Our Phase 1 draft is an initial interdisciplinary review of impacts, gaps and priorities.

---

[1] World Scientists' Warning of a Climate Emergency, *BioScience*, 2020 https://doi.org/10.1093/biosci/biz088
[2] https://ipbes.net/
[3] https://www.ipcc.ch/sr15/
[4] National Climate Assessment https://nca2018.globalchange.gov/
[5] https://www.worldwildlife.org/publications/living-planet-report-2020;
https://www.overshootday.org/newsroom/country-overshoot-days/
[6] https://securesustain.org/scientists-reporting/
[7] Capria, F. (2016) A Systems View on Life. Cambridge University Press
[8] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)32594-7/fulltext

Overview

"Science and everyday life cannot and should not be separated."
~ Rosalind Franklin, PhD (1920-1958)

There is clear scientific consensus on the interconnected and accelerating crises in climate, biodiversity and public health around the world.[9] In just two years there have been ~30 peer-reviewed "Scientists' Warnings".[10] It's urgent to identify clear and cost-effective solutions to mitigate and adapt to impacts that are known - and in some cases aligning with worst-case scenarios and reaching dangerous tipping points.[11] We need to address impacts of climate change in ways that provide long term benefits and prioritize essential building blocks and protect nature and people of all ages.

At this juncture, keeping Connecticut's citizens healthy and the State's communities and economies functioning requires working across disciplines and without conflicts of interest. Practical, evidence-based actions will put us on the best path. We have been and must continue to be a leader in the development and implementation of science-based policies.

Impacts are inevitable, and the cost of inaction will be high. Scientific knowledge and technical measurement capabilities are evolving rapidly, and local information is critical to detecting the impacts of global climate change on the wide range of communities in Connecticut.[12] To guide decisions and prioritize actions in an unbiased way, we must expand our capacity to make measurements across the State. Mitigating and adapting will demand a persistent focus on information along with equity, cooperation, and community-level resilience and decisions.

Impacts and risks are inequitable, and economically and environmentally devastating. We need to protect citizens and entire communities that are most vulnerable and least able to withstand stress or recover from additional challenges. Insufficient and incremental changes, and special interest/silo-based decisions, are reduced by multisolving,[13] outlined in more detail below. *Multisolving saves time and money by addressing multiple problems and forging win-win solutions.* It protects the climate alongside co-benefits such as creating local jobs, improving health, biodiversity, and disaster resilience, producing healthy food, and protecting clean water.

Impacts on natural systems and within communities are inevitable. The sea is rising, seasons are changing. Some invasive species will thrive, and some native species might also. Protecting intact natural ecosystems, healthy soil, and beneficial insects is essential and provides many co-benefits, including public health. A strategic balance of land conservation that protects nature where possible nature and supports programs for long-term research and responsible resource

[9] https://climate.nasa.gov/scientific-consensus/; https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)32594-7/fulltext
[10] https://scientistswarning.forestry.oregonstate.edu/journal-articles-related-scientists-warning
[11] https://www.nature.com/articles/d41586-019-03595-0
[12] https://www.ecolise.eu/
[13] https://www.climateinteractive.org/ci-topics/multisolving/what-is-multisolving/

use is the foundation of long-term statewide and local resilience. Our coastal and inland wetlands store high levels of carbon, and many of Connecticut's forests are carbon-dense and growing - offering long-term, low-cost mitigation and many other co-benefits.[14]

The interdisciplinary GC3 process positions Connecticut as a leader in a genuine dual commitment to science and equity. The Science and Technology Working Group is united in aligning with known science, admitting uncertainty, and forging policies that apply the principles of *1) harm reduction*: reducing negative climate impacts of existing activities and services; and ***2)*** *evidence-based medicine*: ongoing decision-making based on the intersection among public good, public values and the best science. Emerging technologies and ongoing research will help us measure changes, integrate knowledge, and plan and prioritize our ability to address expected (and unexpected) impacts and inequities.

What we do now makes the biggest difference, and we cannot afford wrong turns.

Goals, Principles and Scientific Consensus

The ***overarching goals*** of this initial draft report from the Science and Technology Working Group are to outline known impacts, the range of future impacts, and existing knowledge gaps. We address priorities in equity, ecology, public health and safety, commerce and jobs, and community lifelines. To this end, the Science and Technology Working Group focused on:

- current and emerging science on the impacts of climate change in Connecticut;
- adaptation guidelines that protect people, their infrastructure and the environment;
- urgent technology, research and monitoring needs;
- essentials and co-benefits for a just and healthy future in communities across the State.

The ***guiding principles*** of the Science and Technology Working Group are to include unbiased, interdisciplinary peer-reviewed science, examples of best practice and scientific consensus statements. Evaluating science and translating it into ***education*** and ***action*** in local communities is essential.

We need to act where impacts are known, continue to collect data, and admit the unknown. Long-term solutions require cultural changes that engage a range of disciplines. Honest assessments are fundamental to mobilizing change, aligning science and public policy, engendering public trust, and ensuring that public resources serve the public good.

Connecticut is a proven leader. The robust and interdisciplinary process of the GC3 can put Connecticut on a path to the best future and catalyze actions in other states and communities. An equitable translation of science into policy and public knowledge and action has the

[14] https://newildernesstrust.org/about/wild-works/; https://cteco.uconn.edu/projects/carbon/index.htm https://www.frontiersin.org/articles/10.3389/ffgc.2019.00027/full; https://www.pnas.org/content/115/14/3663

potential to address - simultaneously - climate change impacts, ecosystem impacts, community resilience, environmental justice, and public health. It will ensure that we protect natural, cultural, and historical resources throughout the state and therefore enjoy a high quality of life in rural, suburban and urban communities across Connecticut.

First, we outline key technical reports and science that must translate across sectors to ensure Connecticut is a climate-adapted state with reduced risk and resilient, equitable communities.

Impacts: Sea Level Rise, Temperature and Precipitation

Technical reports that review the state of the science and projections for Connecticut have been prepared through the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) for sea level rise (O'Donnell, 2018)[15] and temperature and precipitation (Seth et al., 2019).[16] The following impacts and recommendations are based on these reviews and a consensus within the GC3 Science and Technology Working Group. The full reports are on-line and provided as appendices.

1. There is high confidence in projected changes through mid-century. Projected changes after mid-century will depend on mitigation actions taken in Connecticut and globally. Since our understanding of the processes that determine climate is advancing rapidly, and data is being continuously collected, we recommend a comprehensive review of projections be undertaken by the State at five-year intervals as outlined below.

2. Mean sea level in Long Island Sound could be up to 20 inches above the National Tidal Datum Epoch (1983-2001) by 2050 (O'Donnell, 2018). This projection is not sensitive to future trends in CO2 emissions.

3. Changes in mean sea level will have a significant impact on the frequency and extent of flooding along the Connecticut coast. With 20 inches of sea level rise coastal flood risk could increase by a factor of 5 to 10 with no change in storm conditions. Extremely high water levels, like what occurred during Superstorm Sandy, would then be expected every 5 to 10 years.

4. Sea level rise will continue after 2050. Recent simulations indicate that mean sea level could by up to 80 inches higher by 2100 if CO2 emissions are not reduced soon.

---

[15] O'Donnell, J. (2019). Sea Level Rise in Connecticut. CIRCA Report. https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/10/Sea-Level-Rise-Connecticut-Final-Report-Feb-2019.pdf

[16] Seth, A., G. Wang, C. Kirchhoff, K. Lombardo, S. Stephenson, R. Anyahand J. Wu (2019). Connecticut Physical Climate Science Assessment Report (PCSAR): Observed trends and projections of temperature and precipitation. CIRCA Report. https://circa.uconn.edu/wp-content/uploads/sites/1618/2019/11/CTPCSAR-Aug2019.pdf

5. Average temperatures in Connecticut could increase by 5 ^{o}F (2.7 ^{o}C) by 2050. Connecticut's temperature has already risen more than the global average.

6. All indices of hot weather are expected to shift toward more frequent and higher temperature events. For example, by mid-century the number of days per year with temperatures above 90 ^{o}F (32 ^{o}C) could increase. Statewide, from 1970 to 1999 the average number of days was 5, and this is projected to increase to an average of 25 days between 2040-2069. (*Note that specific locations and specific years will show more days with extreme temperatures than statewide and long-term averages).* The number of days with frost could decrease from 124 to 85.

7. Temperature projections after mid-century are sensitive to policy choices on CO2 emissions. Coordinated mitigation now means it is more likely that the temperature will stabilize after 2050. If not, warming is likely to accelerate.

8. Drought risk is also expected to increase. The probability of unusual events (extremely low annual and summer water availability, and extremely high 1-day and 5-day precipitation) are projected to increase by a factor of between 2 and 4 by mid-century.

9. Though it is unclear whether the frequency or intensity of extratropical storms in Connecticut will change, they will likely bring more precipitation. There will be less snow and more rain, but high snowfall events will be more probable.

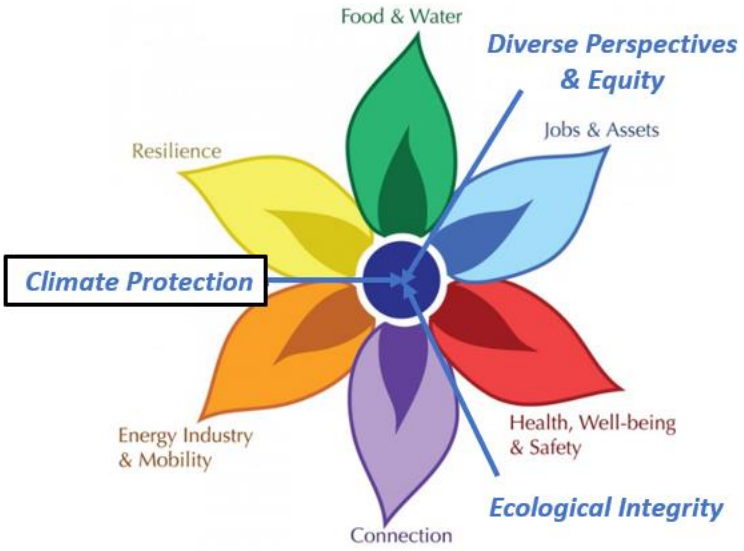
10. Projection of changes in the frequency of tropical cyclones in a warmer climate are uncertain. However, it is likely that they will have higher winds and lead to more precipitation. Since 1980 there has been an increase in the frequency of hurricanes in category 3 or greater.

The known and unknown impacts outlined above reflect the reality that climate change is here in Connecticut - and that natural systems are complex and dynamic. Connecticut is fortunate to have engaged citizens, businesses and policymakers. An analysis of multiple moral foundations by the Cornell National Social Survey (USA) found that fairness and compassion are positively associated with a willingness to take action on climate change.[17]

[17] https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0163852

In Connecticut we have an academic center to provide leadership and science support to towns, Connecticut Institute for Resilience & Climate Adaptation (CIRCA),[18] and a statewide community-based action network, Sustainable CT.[19] As of September 2020, Sustainable CT includes 112 registered and 48 certified towns, and its distributed success is leveraged by private money and non-profit, state and local initiatives. These efforts are essential, because evidence-based action requires local knowledge and can require analyses linking between "big-data" and "hyper-local" for cost-effective multisolving solutions.

The multisolving **F**ramework for **Lo**ng-term, **W**hole-system, **E**quity-based **R**eflection ("FLOWER") diagram below is adapted from Climate Interactive, an independent, not-for-profit think-tank that grew out of MIT Sloan and developed the En-ROADS simulator.[20] The schematic reveals the diverse impacts and is designed to identify co-benefits of climate solutions. It is adapted to reflect the consensus of the Science and Technology Working Group that ecological integrity and diverse perspectives are central - and that equity should be emphasized further based on the explicit goals of the GC3. These overarching issues, particularly the global crisis in ecological integrity, have come more fully to the fore since FLOWER was developed. A short video explaining multisolving and the climate co-benefits using the FLOWER analysis is available.[21]



Adapted **F**ramework for **Lo**ng-term, **W**hole-system, **E**quity-based **R**eflection (**FLOWER**)

[18] https://circa.uconn.edu/
[19] https://sustainablect.org/
[20] https://www.climateinteractive.org/
[21] https://www.climateinteractive.org/ci-topics/multisolving/flower/

In this Phase 1 draft report we focus on top-line, interdisciplinary, and immediate impacts and opportunities. We identify additional research needed to prioritize future actions, recommend a 5- year review, and outline some emerging recommendations in no particular order at this time. We acknowledge overlap with other working groups and existing efforts at many levels.

Based on the high interest in and public feedback throughout this process we celebrate the highly-engaged citizenry in Connecticut - a essential asset now and in the future. We invite all manner of public input and expert commentary on the content of this initial draft and welcome suggestions for additional content and topics for Phase 2 of the GC3 process.

Impacts: Infrastructure and Energy

Stewarding, managing and upgrading our natural and built environment and energy systems to reduce risk and increase resilience is a priority for planning and action. Impacts to state-wide and community-based lifelines of infrastructure (*ranging among water, food, transportation, communication, shelter, resource distribution, disaster resilience*) and energy (*i.e. reducing demand; clean, affordable options; distributed local energy*) demand a multisolving approach to identify gaps, priorities and opportunities. Jobs and economic opportunities should prioritize vulnerable communities facing an increased burden. Policies should not only seek the best science to address impacts to the environment, they should endeavor to use multisolving solutions to redress economic inequality in parallel with protecting and repairing the climate.

We need to incorporate the best available science *continuously* into planning and design. As one example (and noted in the Infrastructure and Land Use Working Group), this is essential to ensure transportation infrastructure durability and longevity. Planners and engineers have traditionally relied on historical estimates of precipitation, stream flow and sea level – which may no longer reasonably predict future conditions (non-stationarity). There is a knowledge gap regarding how to incorporate future climate scenario output predicted by global climate models into the design practices for transportation infrastructure.

Research is currently underway to fill this gap. It is sponsored by the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration (FHWA), and conducted in the National Cooperative Highway Research Program (NCHRP)**,** which is administered by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine. The objective of this coordinated, high level research is to develop a design guide of national scope to provide engineers with the tools needed to amend practice to account for climate change. Connecticut Department of Transportation is involved with this research (NCHRP Project Nos. 15-61, 20-44(23), 15-61A) and is anticipating incorporating the resulting guidance into its design manuals.

Efficient transportation, including public transportation, are key parts of the solution. These are also well-established opportunities for multisolving.[22] Climate change is impacting a range of factors that are causing major shifts in where people need or want to go and when. Transportation is a major source of greenhouse gas emissions, but it is also a community lifeline and a major source of economic development.[23] An increased focus on efficient transportation and effective public transportation offers mitigation, public health, equity and more. Public outreach, education and incentives can facilitate uptake and access. These actions, coupled with system-wide analyses, can ensure that routes and schedules maximize the ability of public transportation systems to serve the public good and support individual and community resilience. New data is needed to integrate emerging opportunities to maximize positive impacts, overcome barriers, and support community values.

Green infrastructure, broadly defined, is multisolving and is part of the solution. Climate impacts to the integrity and function of existing and future of green infrastructure are complex and dynamic. The Environmental Protection Agency (EPA) defines green infrastructure as "*a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits*."[24] Green infrastructure technologies include: rainwater harvesting, rain gardens, bioswales, green roofs, street trees[25] and much more. In some cases we need patience: natural systems have many co-benefits, and some can strengthen over time and/or be virtually self-sustaining while offering mitigation, adaptation, biodiversity and health.

Impacts and benefits of green infrastructure accrue at a range of temporal and spatial scales. A long-term, visionary and ongoing success is the Charles River Watershed in Massachusetts[26] - a decades-long effort, anchored by wetlands protection for flood prevention, transformed a trash-filled and polluted "*Dirty Charles*" into "*the cleanest urban river in America*."

Connecticut has many opportunities[27] and some are simple, low-cost and hyper-local: protecting and restoring wetlands and riparian corridors, reducing erosion, and reducing impervious surfaces by establishing biodiverse bioswales,[28] rain gardens and green roofs, retaining and planting trees, and depaving. As noted, climate change will increase the heat island effect and flooding frequency, two impacts that converge on urban areas, and urban forests provide many ecosystem services[29] – including free cooling.[30] *Unneeded impervious*

---

[22] https://www.climateinteractive.org/multisolving-in-action/examples-of-multisolving/efficient-transportation-cuts-carbon-and-reduces-poverty/
[23] https://journals.sagepub.com/doi/abs/10.1177/0042098013494426
[24] https://www.epa.gov/green-infrastructure/what-green-infrastructure
[25] https://www.sciencedirect.com/science/article/pii/S0169204617300464?via%3Dihub
[26] www.crwa.org
[27] https://portal.ct.gov/DEEP/Water/Watershed-Management/Low-Impact-Development-and-Green-Infrastructure-Municipal-Outreach
[28] https://www.mdpi.com/2412-3811/2/4/12
[29] https://pubmed.ncbi.nlm.nih.gov/26828167/
[30] https://www.sciencedirect.com/science/article/abs/pii/S0925857413000578

areas should be depaved and repurposed, for example to roadside bioswales, natural areas, food forests, community gardens, or co-located pollinator habitat and community-scale energy.

Impacts are reduced by leveraging *natural infrastructure*. Full protection of the ecosystem services of natural infrastructure (i.e. headwaters, wetlands, riparian zones, native biodiversity) has mitigation and adaptation co-benefits along the shoreline and throughout watersheds. Clean water is a bedrock priority, essential to life and wellbeing, and Connecticut General Statute §22a-15 declares that "there is a public trust in the air, water and other natural resources." Accordingly, water is held in the public trust, as is public land that protects it. Disturbing public natural areas protecting water should proceed with caution, grounded in the principles of harm reduction and evidence-based decision making.

Natural infrastructure represents low-cost multisolving: for example, protecting and/or restoring natural ecosystems and their vertebrate diversity reduces the vectors and the prevalence of Lyme disease,[31] a public health threat expected to worsen with climate change.[32] Allowing naturally-occurring beavers to be dam engineers where possible is a powerful approach to adaptation - reduces downstream flooding, creates successional habitat (at no ongoing cost), and benefits many species.[33]

Climate impacts to energy reliability are underscored by recurring and recent storm events. A pernicious cycle of power outages and recovery efforts (at all levels) risks serious economic and health impacts, lost mitigation, and cumulative impacts. Some factors:

- *Economic and health impacts - loss of food security, income, transportation, education, cooling/heating, childcare and more – are costly and an accelerating equity issue.*

- *Extensive vegetative management releases stored carbon and decreases ongoing mitigation, increases local temperatures, and fosters a network of invasive plants.*

- *A strategic plan to bury power lines and prioritize resilient, distributed, clean energy prevents impacts, protects health and solves multiple problems.*

- *Judicious evidence-based tree removal or pruning represents harm reduction: reducing negative impacts on mitigation, adaptation, equity, biodiversity and public health.*

- *Local infrastructure to support the best energy options and the best use of local resources creates jobs, lifelines and equity.*

Climate change impacts and advances in science and technology require and enable us to reduce energy demand and reassess our energy portfolio. There are many benefits of energy efficiency and energy audits: they pay for themselves, make people more comfortable and

[31] https://www.pnas.org/content/100/2/567
[32] https://www.sciencedirect.com/science/article/pii/S1877959X15000874
[33] https://www.exeter.ac.uk/creww/research/beavertrial/

healthy, and reduce energy demand and associated emissions.[34] This is a major opportunity to increase equity. Connecticut needs to stay on a strong path with lifecycle analyses, increase efforts to reduce energy demand, and increase efficient, clean, carbon-free, resilient, community-based energy - particularly in distressed and vulnerable communities.

Clean energy does not come out of a smokestack. Fossil fuels aside, most of the "renewables" powering our electrical grid (ISO New England[35]) are combustion-based – trash and wood. A cleaner power grid complements cleaner distributed energy, and we can practice *harm reduction* now by reassessing *existing subsidies* for these options. For example, biomass is legal, and burning wood is legal, but based on math and science biomass should no longer qualify as a Class I renewable (supported by ratepayers equal to solar) for mitigation and health:

1) Harvesting for bioenergy increases atmospheric carbon: even burning residues has a negative impact and slows accumulation of forest carbon,[36] at a time when growing forests (proforestation)[37] is recognized as a powerful and cost-effective mitigation and multisolving approach to climate change in New England.[38] Unfortunately, initial errors in carbon accounting propagated policies that subsidize making climate change worse. This "wrong turn," resulted in now-entrenched, damaging and accelerating subsidies have been difficult to undo, and have now resulted in a major scientific outcry.[39] There are better options for energy and for wood.

2) The acute and chronic effects of air pollution on all systems, including the brain,[40] and myriad health impacts of chronic wood smoke particulates in all ages, are clear.[41] HEPA filters can help individuals.[42] Air pollution is an ongoing environmental injustice. Less than 10 miles away is our neighbor of Springfield, MA - the asthma capital of the country.[43]

Impacts of climate change will spur economic development: private investments in risk reduction, energy efficiency, and distributed systems have co-benefits. Statewide benefits include local jobs, equity and community resilience. Prioritizing energy for on-site use, brownfields, dual-use, or within the built environment provides jobs and energy where needed (reducing transmission-based loss) and prevents losing land that may be needed for (or better suited for) other uses (food, housing, habitat, recreation). Energy policy should be updated based on harm reduction, new technologies, lifecycle analyses, and environmental justice.

---

[34] https://www.climateinteractive.org/multisolving/warm-up-new-zealand-is-multisolving-with-home-insulation/
[35] https://www.iso-ne.com/isoexpress/web/charts
[36] https://iopscience.iop.org/article/10.1088/1748-9326/aaa512/meta;
https://iopscience.iop.org/article/10.1088/1748-9326/aaac88
[37] https://www.frontiersin.org/articles/10.3389/ffgc.2019.00027/full
[38] https://www.europarl.europa.eu/doceo/document/ENVI-AM-650588_EN.pdf;
[39] https://sites.tufts.edu/gdae/files/2020/05/Forest-Letter-to-Congress.pdf
https://sites.tufts.edu/gdae/files/2020/05/EU-Forest-Letter-3.pdf
[40] https://www.pnas.org/content/117/25/13856
[41] https://woodsmokepollution.org/
[42] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3080954/
[43] https://www.aafa.org/asthma-capitals/

Climate impacts exacerbate the need for local resource partnerships for use and reuse. Practical polices are needed, and adaptive reuse of existing resources and infrastructure can preserve natural resources, reduce waste, support local decision-making, shorten supply chains, and increase community resilience. Regional co-ops or programs for municipal collaboration and equipment depots that partner farmers, arborists, and foresters and various types of contractors can support equipment overhead costs and provide local, circular systems (mitigation and adaptation) that reduce overhead, and provide equity for small and beginning operators. A previous mechanisms in Connecticut that could be leveraged for this purpose include the Intermunicipal Capital Equipment (ICE) program,[44] and there are examples of successful operations.[45] Public funding for technical assistance for establishing equipment co-ops, local adaptive reuse,[46] local supply chains, and resource reuse and recycling is needed.

Climate impacts risk numerous community lifelines. Impacts at multiple levels are outlined in other working groups, and we emphasize that a genuine dual lens of science and equity is an essential and exciting crossroads. This perspective, along with a coordinated set of actions, offers critical transitional opportunities for co-benefits of mitigation, adaptation, nature-based solutions, and improved public health, based on connecting with nature, self-care and mental health.[47] These building blocks, and knowing your state and your local community is planning and preparing, can reduce anxiety and depression - an escalating an widespread impact of climate change.[48] Local planning and action must proceed in a evidence-based way that educates and engages the public and engenders public trust. Adaptation should prioritize mitigation, conservation, efficiency, and self-sustaining systems wherever possible.

Despite the known and unknown impacts of climate change, Connecticut has a bright future. Some families have been here for many generations, many citizens are committed deeply to their local community, and everyone loves the natural beauty of our State. Pride of place is an asset in comprehensive efforts and public-private partnerships. Our "steady habits" can help prevent wrong turns. We have a chance to mobilize the fairness and compassion[49] and showcase enduring "Yankee" values of thrift and ingenuity. Ultimately new infrastructure and energy projects must meet known and projected impacts while protecting - or in some cases relocating - the natural, cultural and historical resources that make Connecticut special. If these resources are at risk, it's time to plan for their future. Throughout the state, infrastructure and energy impacts range in size and scope - and create a wide range of jobs and opportunities for environmentally beneficial and equitable outcomes.

---

[44] https://portal.ct.gov/OPM/IGPP-MAIN/Grants/Intertown-Capital-Equipment/Intertown-Capital-Equipment
[45] https://www.flamigearthproducts.com/; https://ilsr.org/baltimores-camp-small-zero-waste-initiative/
[46] https://www.thebalancesmb.com/introduction-to-reclaimed-lumber-2877753
[47] https://www.liebertpub.com/doi/full/10.1089/acm.2019.0421
[48] https://ecoamerica.org/wp-content/uploads/2014/06/eA_Beyond_Storms_and_Droughts_Psych_Impacts_of_Climate_Change.pdf
[49] https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0163852

Impacts: Ecosystems, Public Health, Community Resilience

The world is too dangerous for anything but truth and too small for anything but love."
— William Sloane Coffin, Jr. (1924-2006)

The benefits and risks of a global economy came sharply into focus in 2020 when pandemic- and storm-induced disruptions combined and heightened public awareness of global crises in climate and biodiversity - as well as gaps in health care, local supply chains, and disaster preparedness. Connecticut responded to this acute "stress test" with a calm assessment of facts, clear resolve and timely action. The impacts of climate change necessitate a sustained and similar response. ***Connecticut can lead by example with its public agencies, policies and resources, an unbiased interdisciplinary realignment, and a dual lens of science and equity.***

Ecosystems, public health and community resilience are connected. Natural systems benefited from the pandemic,[50] whereas a combination of international trade/travel and human interference in natural systems contributed to its occurrence (and to previous zoonotic events).[51] Protecting nature where possible, and within urban, suburban and rural communities, is a first principle in a resilient future.

Impacts are local, and community engagement and local action is essential. The wide-ranging European Network for Community-Led Initiatives on Climate Change and Sustainability (ECOLISE)[52] published their first status report in 2019 titled: "*Reshaping the Future: How local communities are catalyzing social, economic and ecological transformation in Europe*."[53] In a comprehensive review of dozens of grassroots and community-led initiatives across Europe, the report concluded that local, community-led action is essential and effective - and requires both technical and social innovation. Community-led initiatives can "*buffer risks rather than creating dependencies, systematically addressing gaps in provision of necessary goods and services in order to build resilient local-regional economies rooted in ethics of care for people and nature*." (pp 118). The impacts of climate change can be addressed creatively by the multisolving potential of community-based programs.

Climate change impacts are expected on community lifelines of food and water. Impacts include the availability and safety of the food we consume and the water we need to drink and recreate in (among many other uses). Adaptation is necessary, and a longer growing season and opportunities to increase carbon on farmland may bring new opportunities and incentives. To ensure vibrant local systems farms need to be supported in fulfilling their primary mission of growing food or providing resources. It's an essential investment in the future of the region, and recent global metanalysis showed that small farms grow proportionally more food, more

[50] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7139249/
[51] http://www.emro.who.int/about-who/rc61/zoonotic-diseases.html
[52] https://www.ecolise.eu/
[53] https://www.ecolise.eu/wp-content/uploads/2016/02/Status-Report-on-Community-led-Action-on-Sustainability-Climate-Change-in-Europe-2019.pdf

diverse crops, and waste less.[54] We suggest an expansion of the EBT/SNAP benefits offered at farmers markets to improve public health and equity and support community resilience.[55]

Climate change globally is expected to result in a significant increase in the risk to public health through its effects on bacteria, viruses, parasites, and chemicals and biotoxins linked to food and waterborne disease.[56] Connecticut is relatively fortunate, but changing rainfall patterns, extreme weather events, and increasing air and water temperatures affect the persistence and occurrence of bacteria, viruses, harmful algae and corresponding risk of food and waterborne disease.[57] See the GC3 Public Health and Safety Statement of Health Impacts – Water-related Illness for a discussion of these risks. *Increased long-term monitoring of and protection for healthy soil and natural systems is imperative.*

Dr. Rebecca Shaw, Chief Scientist at World Wildlife Fund (WWF), put a spotlight on the core issue: "*One of the things that science has told us in the last decade so clearly is that we depend on intact natural systems and intact natural ecosystems, in all its component parts, to deliver those things we count on every day: clean air, clean water, pollination, a stable climate, food, healthy soils to produce the foods we eat*" and "*that health is declining and declining fast*." The recent WWF report - Living Planet 2020[58] builds on previous reports and does not equivocate: "*Our relationship with nature is broken."*

Protecting and restoring "Right Relationships"[59] starts with protecting and restoring nature. Connecticut has outsized natural beauty and rich biodiversity for a small, densely populated state[60] - bordered by two other small and even-more densely populated states. We have critical corridors on the *Eastern Wildway*[61] - a network for species movement and migration that links eastern Canada to the Gulf of Mexico. Our environment is loved and appreciated by the citizens and our greatest strength in the face of climate impacts: a network of intact nature is an essential lifeline to clean water, food, health, resources, and resilient communities.

Climate change impacts and future risks necessitate a proactive and strategic balance. The Working and Natural Lands Reports affirm that we need responsible stewardship of all types of land in Connecticut, for many reasons, and our landscape must be anchored by clean water and a connected network of nature. Some research reports suggest making water the primary value of forests; forests and trees regulate the water, energy and carbon cycle.[62] Connecticut's

---

[54] https://www.sciencedirect.com/science/article/pii/S2211912417301293?fbclid=IwAR2pFFIi3aXzofpF9mDX2ps7TpAUibu7XDre6cTNCV13YdopBjaLvhr_VT4

[55] https://portal.ct.gov/DSS/SNAP/Farmers-Markets

[56] https://www.who.int/foodsafety/publications/all/Climate_Change_Document.pdf?ua=1

[57] https://www.who.int/publications/i/item/food-safety-climate-change-and-the-role-of-who

[58] https://www.worldwildlife.org/publications/living-planet-report-2020

[59] https://www.thechangingearth.net/

[60] https://www.statista.com/statistics/183588/population-density-in-the-federal-states-of-the-us/

[61] https://wildlandsnetwork.org/wildways/eastern/

[62] https://www.sciencedirect.com/science/article/pii/S0959378017300134#bib0515;

forests are carbon-dense, and New England's forests are recognized globally for their role in climate stabilization.[63] Technical assistance is needed in the emerging research area of increasing carbon on farmland, but simple solutions like compost add carbon and reduce our waste stream. Coordinated programs could facilitate this regionally. As noted above, keeping farms viable and keeping resources and jobs in local communities, is essential.

In parallel with land for resource production, prioritizing suitable land as natural areas as free as possible from unnecessary manipulation (similar to the stewardship of National Parks) is supported by diverse scientific evidence. Public natural areas provide intergenerational for people and are anchored on the essential need to protect a) the unknown and b) the ongoing process of evolution and natural selection. Protected and connected areas provide ecological integrity and the possibility that the full complement of species can migrate. Taking care of nature is a fundamental priority, and a healthy future for Connecticut depends on it.

Upcoming United Nations goals are expected to recommend protecting 30% of the land and sea by 2030.[64] Strongly protecting 30% is not realistic, but protecting 30% among natural areas, research areas and production areas might be. Connecticut has a strong public and private commitment to land conservation of all stripes and the Connecticut Land Conservation Council hosts the largest state-level land conservation conference in the country.[65] Connecticut's 2018 Green Plan recommended protecting 21% of Connecticut by 2023,[66] with 10% owned by DEEP and 11% by other public and private partners. We are still short of goal (at 75%). The biggest policy gap is that only ~1% of Connecticut has strong protection as a nature preserve, similar to a national park (a slightly higher percentage (~4%) is currently stewarded as an intact natural area). Strategically increasing the protection on suitable public and private areas ("protect the best, restore the rest" as outlined below) is urgent for climate, biodiversity and public health.

Proforestation (growing existing natural forests) has recently been identified as the most powerful, low cost, and immediate mitigation opportunity with multiple immediate co-benefits and proven long-term resilience.[67] It is one of three main strategies featured by the International Union for the Conservation of Nature[68] and included in Amendments 55, 73, and 125 from the Committee on the Environment, Public Health and Food Safety to the European Parliament.[69] This has been further affirmed by recent data showing that New England's forests are growing even more than we thought: older forests are best able to withstand (and young trees are more vulnerable to) the stresses of climate change.[70] New England's forests have been identified as part of the "Global Safety Net" needed to stabilize the climate.[71] Natural

[63] https://advances.sciencemag.org/content/6/36/eabb2824.full
[64] https://eos.org/articles/30-by-30-a-push-to-protect-u-s-land-and-water
[65] http://www.ctconservation.org/annualconference
[66] https://portal.ct.gov/DEEP/Open-Space/The-Green-Plan
[67] https://www.frontiersin.org/articles/10.3389/ffgc.2019.00027/full
[68] https://www.iucn.org/crossroads-blog/202003/primary-forests-a-priority-nature-based-solution
[69] https://www.europarl.europa.eu/doceo/document/ENVI-AM-650588_EN.pdf
[70] https://academic.oup.com/aobpla/article/10/1/ply003/4812670
[71] https://advances.sciencemag.org/content/6/36/eabb2824.full

areas provide the anchor for diverse farmland and well-managed production forests, and the control areas and baselines for long term research programs. As noted above, clean water and soil health are fundamental building blocks. Soil health and biodiversity need comprehensive, long-term monitoring.

Climate change impacts dictate that we "protect the best, restore the rest.[72]" Multiple global efforts have identified this simple approach - strategic planning of natural infrastructure centered on the principles of harm reduction and evidence-based decision-making. Protecting any old-growth forest and remnants with a buffer area is a priority. Natural stewardship with long-term monitoring[73] of areas that are intact, healthy and/or recovering should be the default approach (mitigation and adaptation) provides for spiritual renewal, science, education and evolution.[74] It will enable allocating of public resources for research programs and resource partnerships, advising private landowners, and restoring degraded areas across urban, suburban and rural areas of the State. Increasing the ecological integrity of the landscape can occur across the state and can dramatically increase the cumulative carbon stored on our land.[75] Comprehensive place-based effort can offer many co-benefits.[76]

Some impacts of climate change on nature are inevitable and part of evolution. Framing change in a dynamic system and within evolutionary history provides perspective while we try, as quickly as possible, to realign our relationship with nature and improve ecoliteracy. Natural systems are resilient and evolve more rapidly under stress: new research shows that tree species can adapt their germ line, ash trees are surviving the emerald ash borer, and even small wild places provide critical links. Much is unknown, and the public strongly supports strongly protecting public land. The importance of nature for self-care and personal resilience was in full view as people flocked to natural areas during the pandemic.

Long Island Sound is part of Connecticut's natural landscape, and one of our states' largest and most critical natural resources. Although not specific to any working group, many of our large-scale climate impacts are related to Long Island sound (sea level, precipitation, etc. noted above, as well as ocean acidification, water quality, biodiversity). Vulnerable built and natural communities near the shore include wastewater infrastructure, ecosystems, fisheries and aquaculture, and more. All have community and economic impacts, and one of multisolving's benefits is the entire system is engaged: conflicts of interest cannot dominate, and everyone is focused on solving multiple problems for multiple benefits. This common-sense approach maximizes private and public good: generating new ideas that reexamine silos and habits for new opportunities.

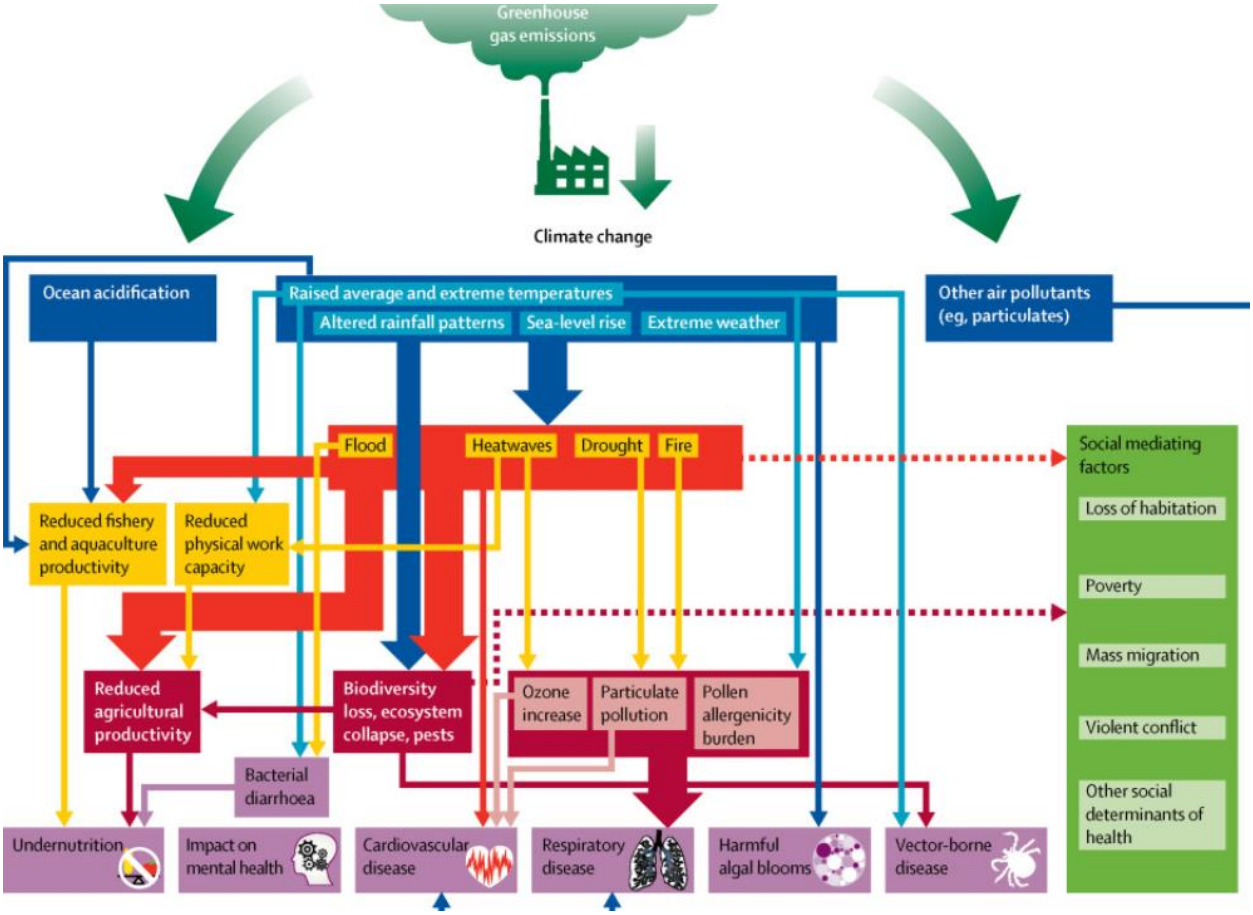
---

[72] https://www.nature.org/en-us/what-we-do/our-insights/perspectives/10-steps-new-deal-for-nature-biodiversity/#forests
[73] https://www.wildlandsandwoodlands.org/sites/default/files/W%26W%20Science%20update%202018.pdf
[74] https://onlinelibrary.wiley.com/doi/full/10.1002/evl3.121
[75] https://cteco.uconn.edu/projects/carbon/Tomasso_webinar_14_9_23.pdf
[76] https://www.parkwatershed.org/wp-content/uploads/2020/01/Park_EnvEd-report.pdf

Climate impacts on our health are seen and unseen. Evidence-based approaches are needed both for the natural world and for impacts to public health. These two actions are reinforcing, and both have acute and chronic components. A recent global consensus report outlined how climate actions that protect children have long-term co-benefits and help other vulnerable populations. A collaboration of 27 leading academic institutions, the United Nations, and intergovernmental agencies from every continent lighted the primary relationship between climate and health. Of particular note: the consensus report on climate and health broke down silos from its inception by including world experts in climate science, ecology, mathematics, geography, and engineering; energy, food, livestock, and transport experts; economists, and social and political scientists as well as the requisite public health professionals and doctors. Multisolving and interdisciplinary thinking is needed to address climate change impacts and realign priorities.

The schematic below (from the report) links climate impacts to ecological, physical and social wellbeing and is a snapshot of some of the interactions and complexities.[77] Many of these impacts are featured by other working groups or discussed briefly above. We emphasize that the links between climate change and health deserve a high priority for *harm reduction* and *evidence-based decision-making* based on the principles of *preventative medicine* - and with a perspective that considers long-term and cumulative impacts.

[77] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)32594-7/fulltext



We emphasize that diverse impacts of climate change on health can have cumulative *transgenerational* effects, and climate-induced stress limits or prevents recovery from any other acute and chronic stresses. We acknowledge the critical role of nutrition in all aspects of health, and, as noted above, we see opportunities to reduce climate-induced economic impacts on Connecticut's local farms while supporting community resilience and public health. Related to this, we highlight specifically the current impacts of a climate *crisis* on mental health and well-being – a cornerstone of good decision-making and long-term strategic planning.

Climate impacts on mental health and personal resilience is a major, escalating concern. It will affect our ability to take care of ourselves, take care of each other, and take appropriate action. Mental health is precious asset that can be compromised at any time by tragedy, injury, stress and anxiety, lack of sleep, chronic poor nutrition, social isolation, and more. Preexisting vulnerabilities and acute stress precipitate a range of devastating and costly problems like chronic mental illness, cognitive decline, drug addiction, relapse, domestic abuse, homelessness. While rates of mental illness (anxiety, depression, schizophrenia) are typically

higher in urban areas,[78] they increased more in rural areas during the pandemic.[79] Nevertheless, climate change-related anxiety is found across the landscape, across all demographics, and has been increasing – and depression, drug overdoses, and suicidal thoughts all increased during the pandemic (e.g., Hayes et al., 2018).[80]

In a study of nearly 2 million in the US, exposure to extreme weather, multiyear warming and tropical cyclones each were associated with increased mental health problems (stress, depression, and problems with emotions) (Obradovich et al., 2018).[81] Rates of negative psychological effects of climate change are particularly high among children and young people (Burke et al., 2018).[82] This should be a matter of grave concern, and a major impetus for positive messaging and community-based education and action, as there are direct measurable effects on short and long-term health and secondary effects seen in poor school performance (e.g., Sheffield & Landrigan, 2011).[83]

Immediate changes are possible and known to improve immune function and mental health, such as increased opportunity for time spent in natural outdoor environments (e.g., Vanaken & Danckaerts, 2018)[84] aligning with a general research agenda to explore the relationship between nature contact and health,[85] even in urban forests.[86] SHIFT (**S**haping **H**ow we **I**nvest **F**or **T**omorrow) is an organization dedicated to the advancement of nature as a social determinant of health. The 2019 conference was devoted to the business case for protecting nature. The SHIFT conference in 2020 is titled "*Healthy by Nature*.[87]

---

[78] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5374256/

[79] https://content.apa.org/fulltext/2020-38395-001.html

[80] Hayes, K., Blashki, G., Wiseman, J., Burke, S., & Reifels, L. (2018). Climate change and mental health: risks, impacts and priority actions. *International journal of mental health systems*, *12*, 28. https://doi.org/10.1186/s13033-018-0210-6

[81] Obradovich, N., Migliorini, R., Paulus, M. P., & Rahwan, I. (2018). Empirical evidence of mental health risks posed by climate change. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(43), 10953–10958. https://doi.org/10.1073/pnas.1801528115

[82] Burke, S., Sanson, A. V., & Van Hoorn, J. (2018). The Psychological Effects of Climate Change on Children. *Current psychiatry reports*, *20*(5), 35. https://doi.org/10.1007/s11920-018-0896-9

[83] Sheffield, P. E., & Landrigan, P. J. (2011). Global climate change and children's health: threats and strategies for prevention. *Environmental health perspectives*, *119*(3), 291–298. https://doi.org/10.1289/ehp.1002233

[84] Vanaken, G. J., & Danckaerts, M. (2018). Impact of Green Space Exposure on Children's and Adolescents' Mental Health: A Systematic Review. *International journal of environmental research and public health*, *15*(12), 2668. https://doi.org/10.3390/ijerph15122668

[85] https://ehp.niehs.nih.gov/doi/10.1289/EHP1663

[86] https://link.springer.com/article/10.1007/s11676-019-00916-x?utm_source=TrendMD

[87] https://shiftjh.org/the-2020-shift-summit/

Regular sleep and quality food are essential for mental health and personal resilience. Evidence-based resilience and prevention opportunities to support brain health and young people are a priority: the future is in their hands. For teens, later school start times to allow for adequate sleep have multiple co-benefits (Wahlstrom & Owens, 2017).[88] Long term interventions like healthy nutrition have many benefits and can help support our local farm-based economy (Adan et al., 2019).[89] The International Transformational Resilience Coalition is a professional consortium that has been raising awareness and gathering resources to be preventative and support personal resilience in the face of climate impacts.[90] In Connecticut a veteran-led organization has been focused on helping other veterans and first responders, but the training and skills apply to anyone.[91] A new partnership between DEEP and DMHAS recognizes the importance of mental health and the benefits of nature.[92]

Final Note: The Role of Continuous Public Education and Positive Change

The impacts of climate change require an acceleration of positive education and cultural change. Impacts are and will continue to be dynamic, and the good news is that humans are highly adaptable - education is life-long and takes many forms. Leveraging the intersection between a growth-based mindset and intrinsic motivation is needed.[93]

Multiple impacts of climate change risk being worsened by poor scientific literacy or by defending positions motivated by non-scientific concerns.[94] Scientific literacy is variable across communities, even as it more important than ever to translate science to public policy. A well-informed citizenry is best positioned to be proactive, practice self-care, and make good - sometimes difficult - decisions, in the face of impacts. Polarized views can occur most often among knowledgeable individuals whose scientific understanding is colored by conflicts or religious or political viewpoints.

---

[88] Wahlstrom, K. L., & Owens, J. A. (2017). School start time effects on adolescent learning and academic performance, emotional health and behaviour. *Current opinion in psychiatry*, *30*(6), 485–490. https://doi.org/10.1097/YCO.0000000000000368

[89] Adan, R., van der Beek, E. M., Buitelaar, J. K., Cryan, J. F., Hebebrand, J., Higgs, S., Schellekens, H., & Dickson, S. L. (2019). Nutritional psychiatry: Towards improving mental health by what you eat. *European neuropsychopharmacology : the journal of the European College of Neuropsychopharmacology*, *29*(12), 1321–1332. https://doi.org/10.1016/j.euroneuro.2019.10.011

[90] http://www.theresourceinnovationgroup.org/intl-tr-coalition/

[91] https://www.mindfulresponder.org/

[92] https://portal.ct.gov/DEEP/News-Releases/News-Releases---2020/DMHAS-and-DEEP-Announce-Series-of-Wellness-Activities-in-State-Parks

[93] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5836039/

[94] https://www.pnas.org/content/114/36/9587

A first step is emphasizing science and technology is not just for "experts." Science is everywhere and part of everything we do, and so is an ongoing process of facing the known vs. the unknown. Science and technology should not be intimidating: an informal but implicit scientific process is part of the trial (and error) of cooking, gardening, and fixing things. It is implicit in improving your health, care for a sick loved one, or raising a healthy child. It is implicit in the process of developing new tools, skills, habits or relationships, and in the ongoing innovation and adjustment found in many professions that are called "scientific" per se – artists, craftspeople, farmers, business owners, and educators of all stripes.

A building block of scientific literacy is understanding the natural world that sustains us. Currently, Next Generation Science Standards are not a "core" content area: there is no daily requirement in early grades. Confidence in scientific thinking should be established early with respect to our primary reality, i.e. personal health, ecosystems, and climate. Updated these standards, mobilizing more scientists for regular public outreach, updating public websites, and supporting a range of professionally-facilitated and organized citizen science projects can offer many co-benefits.

Research Recommendations and Top Priorities

A major goal of the Science and Technology working Group is "locally-scaled scientific information and analysis available to assess the consequences of climate change . . . in the context of the State's changing land use and demographics." ***This requires assembling the most comprehensive data possible, at appropriate temporal and spatial scales, and engage in an iterative assessment.*** Existing and emerging data identifies some immediate priorities and opportunities. A sampling of additional recommendations is provided at the end.

Climate Science for Connecticut

Establish Ongoing 5-Year Review of Climate Science and Downscaling of Climate Models

Climate science continues to evolve rapidly with new insights from observations and models used for projections, particularly for regional and local scales. As noted above, some changes are inevitable and must be addressed now. After 2050 the effects of the actions we take now to limit greenhouse gas emissions will have a substantial impact on the climate of the next century. A statutory requirement for a review of emission, trends in data, and projections of models is essential to sustaining the state's commitment to science-informed climate action. A 5-year update would also allow an assessment of the effectiveness of policies, provide a venue for new issues to be considered, and the opportunity to build new data and the results of improved models into the State's planning documents (e.g., Hazard Mitigation Plan). In a changing

climate, planning and action must be complemented by tracking data and science innovations if we are to protect the environment and ensure the health, prosperity, and equity of Connecticut's communities. These assessments should consider regional socioeconomic assessment models for Connecticut.

Assess Baselines and Interdisciplinary Climate Impact Data for Connecticut.
It is essential to establish consistent and persistent data that characterize the impacts of climate change on the environment and society, and collaborative means for analysis of projections at spatial and temporal scales relevant for ecosystems, public health, transportation, infrastructure, environmental justice, etc. A working group should be established to comprehensively survey what is being done, what needs to be done, and how data should be archived and distributed.

Examples of data essential to characterizing impacts might include: air quality, temperature, and humidity in places people live; water level in flood zones, stream flow rates, water temperature, salinity and pH in streams and estuaries; ground water levels and salinity; soil health and carbon storage and sequestration in natural systems; comprehensive biodiversity (including insects).

Characteristics of communities or hyperlocal areas that might be vulnerable to consequences of climate change, or mitigation and adaptation strategies, should also be tracked. These data are also recommended by other working groups and should include: access to food, water, transportation, energy, education, health care, recreation, parks and beaches. Epidemiological data should be able to be linked to information about local climatology and exposure to hazards (toxins).

General recommendations for ecoliteracy, environmental justice and community level action

Climate Science Communication for Public Engagement:

The public must feel empowered to respond to needed cultural and behavioral changes that will reduce negative impacts on their health, their environment, and the earth system. Education must occur at multiple levels, and must be accessible and relevant for rural, urban and suburban communities.

Messaging campaigns, citizen science and apps can focus on opportunities with co-benefits.

A training strategy for formal and informal educators to be effective communicators of climate change models, imagery, impacts and resilient actions will reach audiences from K-12 school systems, current and future teachers, municipal leaders and diverse community groups all needing to take collective action for improved outcomes.

Development of a certification and professional development process for formal and informal education professionals supports the growth of science education, educational professional development and elevates the profession of environmental science throughout Connecticut.

Nature and Associated Benefits for Distressed Communities:

Address environmental justice and the lack of open space and recreational opportunities in distressed communities while simultaneously prioritizing ecological integrity and ecosystem services.

Protect ecosystems wherever possible. Secure new open space for recreational opportunities for environmental justice communities for multiple mitigation, health and equity benefits. Restore existing open space as needed by planting site-appropriate trees and native plants if needed and/or protect existing tree cover to ensure ongoing carbon sequestration and protect carbon storage and biodiversity. This action provides mitigation and adaptation while also providing needed jobs, access to natural areas and recreational opportunities that offer many other co-benefits, such as improved physical and mental health.

Ensure access to natural, or "wild" areas across the State. Wilder areas are needed for climate migration and preventing extinction, and access to a natural area that people can count on offers outsized benefits for mental health, carbon and biodiversity,

Comprehensive Place-Based Implementation of Mitigation, Adaptation and Resilience

Select and establish pilot region(s) to quantify and demonstrate site-specific co-benefits of comprehensive climate resilience planning that is proactive and risk-based.

Making Connecticut's communities equitable and resilient to climate risk impacts and its challenges requires timely local actions and cultural shifts. Pilot regions anchored to urban/suburban watersheds will maximize co-benefits of climate mitigation and adaptation, ecosystem services, and equity and community resilience.

We recommend establish criteria for selecting pilot region(s) to showcase and quantify a comprehensive climate resilience plan with transferable benefits. Targeted pilot projects must incorporate science, equity and environmental justice, and the interdisciplinary goals of the GC3 and state planning documents at a pace, scale and cost that can inspire broader changes.

Pilots should be located in strategic ecoregions, with one or more in an urban-suburban watershed to demonstrate the full range of co-benefits with a range of stakeholders, costs, funding sources and timelines/implementation schedules.

This recommendation interfaces with all working groups and addresses mitigation and adaptation and resilience.

Initial Recommendations for Actions to Implement Adaptation and Resilience Strategies

From the Science and Technology Working Group (draft from, in no particular order)

Climate Change Communication for Public Engagement Develop professional certification program for unified messaging of Climate Change Impacts and Actions.	
• Recommended Implementation Action Description	To implement any climate change strategy an understanding of what is at stake is required. The public must feel empowered to respond to needed behavioral changes that improve climate conditions effecting their health, their environment and earth systems. A training strategy for formal and informal educators to be effective communicators of climate change models, imagery, impacts and resilient actions will reach audiences from K-12 school systems, current and future teachers, municipal leaders and diverse community groups all needing to take collective action for improved outcomes. Development of a certification and professional development process for formal and informal education professionals supports the growth of science education, educational professional development and elevates the profession of environmental science throughout Connecticut.
Completion Timeframe	A timed, tier strategy for development of training is required to meet the levels of necessary outreach: • Immediate financial support will continue the educational activities as specified in Public Act 18-181 Section D and currently conducted by DEEP and DOE with expansion to focus on diversification of professionals in the field of environmental and science education while providing knowledge and access to climate change educational materials. • Create certification program for informal application and educational professional credit through college system within 2 years. • Within 5 years, have an environmental education certification program for continuing education credit and high school career development through unified partnership of community and or private colleges. Leading to employment and higher education enrollment.
Implementation Entities	CT DEEP, Education Outreach, CT State Department of Education, CT State Department of Education, Higher Education Department, Coalition of Colleges and Universities, Connecticut Outdoor and Environmental Education Association, Connecticut Science Teachers Association, CT Green LEAF School Program
Climate challenges addressed	Education builds involvement in change. All actions suggested require public buy in and understanding. The ability to effect change and have an impact is learned. Public demand for improvements requires an understanding of what is at stake and what are our options. Education is not just for children. These same messages and concepts need to be taught to municipal and regional leaders, businesses, and advocates. Informal education centers serve the community and schools increasing environmental literacy that reflects the

	goals of our state and engages the public in taking action to alter behavior that reduces climate impacts. Successful messaging and education does not just happen. It requires a systematic plan to involve community, government, and educational systems working together as stated in the CT Environmental Literacy Plan. Unified messages of climate change education through public outreach education is the direct pipeline to public understanding of what is being asked of them and how they can engage in behavioral change that supports improvement in carbon levels, pollution reduction, land choices, community supported science, and personal action. Climate mitigation and adaptation actions are only considered when they are seen as possible and that comes with repeated and consistent messaging.
Protection of vulnerable communities	Public Act 18-181 section D identifies the support of climate change education in K-12 curriculum. Elementary educators, on average, provide only one hour of science education per week due to a variety of reasons. A common reason is lack of science training and security with the subject matter. Funding for educational support of teachers in underserved communities is a priority within the state education system. Access for science enrichment trainings has declined for all of Connecticut schools with the high-risk cities showing the greatest stress. Loss of grants and time constraints have squeezed school systems limiting access and opportunities. Increased educational training for formal and informal educators in urban and underserved communities, with a focus to increase diverse leaders in these fields, connects school to home and home to communities. Diversity is needed in science professions and in environmental sciences to effectively reach our diverse population. Developing a trained community of environmental professionals that reflect the demographics of our communities increases connections within communities. Underserved communities are at highest risk to climate impacts for health and safety. Targeting efforts in these already high priority areas will strengthen community growth and serve to increase environmental literacy of the communities through the community of schools.
References for action	*Classroom Teacher More Effective than Outside Presenter for Climate Change Education*. Journal of Environmental Education Research Vol. 18 2012 issue 5 *Teaching Climate Change: What educators should know and can do.* Danial Shephardson and Andrew Hirsh, American Educator VOL. 43 Number 4 Winter 2019-2020 Weather and Climate NGSS Concept Map;North American Association of Environmental Educators. https://naaee.org/sites/default/files/conference/session/naaee_research_symposium_2017.pptx

Advance Connecticut's Capacity for Water Quality Observations in Long Island Sound: Relevance to Food Safety and Security	
Recommended Implementation Action Description	Climate change has a profound impact on the availability and the safety of the food we consume and is expected to result in a significant increase in risk to public health through its effects on bacteria, viruses, parasites, and chemicals & toxins linked to foodborne diseases.[i] Changing rainfall patterns, increases in extreme weather events, and increasing air and water temperature affect the persistence and occurrence of bacteria, viruses, harmful algae and corresponding foodborne disease.[ii] See the GC3 Public Health and Safety Statement of Health Impacts – Water-related Illness for a discussion of these risks. A number of predictive models incorporating oceanographic, meteorologic and remote sensing data are available to assist resource managers in forecasting Harmful Algal Blooms (HABs), naturally occurring bacteria such as Vibrio spp., and waterborne pathogens (such as Norovirus) related to sewage contamination, all of which have the potential to impact food safety and human and animal health. In order to be reflective of local conditions, these predictive models must be informed by high quality baseline monitoring of environmental parameters and in-situ sampling of water, phytoplankton, and indicator organisms. Existing oceanographic models can be applied to multiple areas for forecasting, however significant in-situ monitoring gaps exist, notably continuous and/or real-time water quality observations in near-shore coastal areas of Long Island Sound. Recommendations: • Advance the State's capacity for real-time monitoring of water quality conditions through a robust in-situ observational network; • Support the creation of an advisory committee tasked with identifying partner agencies, conducting an inventory of existing in-situ observational platforms and relevant water quality data sources, and prioritization of needs for forecasting efforts; • Promote a comprehensive approach that builds upon existing monitoring efforts with guidance from the advisory committee; • Integrate monitoring of water quality conditions in Long Island Sound for application to forecasting food safety related hazards (HABs, pathogens, etc) via the NowCOAST system
Completion Timeframe	• Support the creation of a Water Quality Observations Advisory Committee comprised of state entities listed below with technical advisors from academia and federal agencies: • Inventory existing in-situ observational platforms and relevant water quality data sources, conduct risk analysis to identify gaps, and prioritizite needs for

	coordination with existing operation platforms and forecasting efforts through NOAA NowCOAST: 3 to 5 years • Implement recommendations of the advisory committee: Greater than 5 years
Implementation Entities	NOAA (NCCOS and NWS), NowCOAST, NERACOOS, LISCOS, EPA, USGS, Academic Institutions, DEEP, Department of Agriculture, Department of Public Health, municipalities, NGOs
Climate challenges addressed	Increasing climate-ocean impacts threaten marine species and ecosystems that are essential for sustaining jobs, supporting coastal economies, practicing cultural traditions and feeding billions of people around the world. These impacts will worsen in the future without urgent action. Climate change increases the frequency and severity of extreme weather events which impacts food security. Improved forecasting for unsafe conditions related to food will help managers prevent foodborne disease related to fisheries product safety and nutrition, as well as prevent economic losses related to disease outbreaks and recalls. **Related GC3 Focus Areas:** Equity and Environmental Justice Science and Technology Adaptation and Resilience • Working and Natural Lands • Public Health and Safety • Drinking Water • Recreational Waters • Vector-borne Disease • Mental Health, Nutrition, and Food Safety • Floods and Storms • Vulnerable Populations • Health Co-benefits of Climate Hazard Mitigation
Protection of vulnerable communities	Vulnerable communities protected include food insecure, low-income populations who practice sustainance harvesting of fish, shellfish and seaweeds from impacted coastal waters. Low-income and immigrant workers are employed in the fisheries industry and improved forecasting protects these communities from unemployment.
References for action	Food Safety, Climate Change, and the Role of World Health Organization https://www.who.int/foodsafety/publications/all/Climate_Change_Document.pdf?ua=1 NOAA Ecological Forecasting https://oceanservice.noaa.gov/facts/ecoforecasting.html Lake Erie Harmful Algal Bloom Forecast https://tidesandcurrents.noaa.gov/hab/lakeerie.html USGS NowCast Great Lakes https://ny.water.usgs.gov/maps/nowcast/ NOAA NowCoast https://nowcoast.noaa.gov/ NOAA NCCOS Vibrio Predictive Models https://products.coastalscience.noaa.gov/vibrioforecast/northeast/default.aspx#LI Long Island Sound Coastal Observatory (LISCOS)

	http://lisicos.uconn.edu/ NERACOOS http://neracoos.org/

Recommendations from the GC3 Science and Technology Workgroup for Actions to Implement Adaptation and Resilience Strategies

Recommended Implementation Action Title: Join the International Association to Combat Ocean Acidification (OA Alliance) and commit to furthering the five goals identified in the Alliance's Call to Action.	
Recommended Implementation Action Description	Carbon dioxide generated by human activity has increased the acidity of global oceans by approximately 30% since the Industrial Revolution. Essential marine species and ecosystems that sustain jobs, support economies in coastal communities, continue cultural traditions, and provide protein/food for millions are threatened by climate-ocean impacts including ocean acidification. The Ocean Acidification (OA) Alliance was formed following catastrophic losses of oysters at West Coast hatcheries in 2007 and 2008. The Alliance's Call to Action identifies five goals that members work together on to "highlight ocean acidification as an imminent threat to coastal economies and ocean ecosystems". 1) Advance Scientific Understanding 2) Reduce Causes of OA 3) Build Adaptation and Resiliency 4) Expand Public Awareness 5) Build Sustained International Support The OA Alliance members include national governments, US states, municipal governments, and indigenous nations. The States of Maine, New York, Washington, Oregon, California, and Hawaii are members of the OA Alliance. There are no costs to join the OA Alliance. The only requirement is to develop an OA Action Plan and work to implement it and advance the five goals listed above. Benefits to joining the Alliance include support from the organization and guidance from other members. Joining the OA Alliance complements and further supports the GC3's mid-term reduction target recommendation was adopted by the Connecticut General Assembly when it passed An Act Concerning Climate Change Planning and Resiliency (Public Act 18- 82).
Completion Timeframe	• Join the Alliance: Less than 1 year • Development and adoption of the Action Plan: 3 to 5 years

	• Implementation of Recommendations: Greater than 5 years
Implementation Entities	Join the Alliance: Governor, Commissioners of DEEP and Agriculture Development of Action Plan : Task Force with input from State and Federal Agencies, Municipalities, NGOs, Academic Institutions, Tribes Implementation: State and Federal Agencies, Municipalities, NGOs, Academic Institutions, Tribes
Climate challenges addressed	Increasing ocean acidification combined other climate-ocean impacts threaten marine species and ecosystems that are essential for sustaining jobs, supporting coastal economies, practicing cultural traditions and feeding billions of people around the world. These impacts will worsen in the future without urgent action.
Protection of vulnerable communities	Protecting shellfish, crustaceans, and fish communities from impacts of acidification protects minority communities that rely on these natural resources for sustenance as well indigenous people
References for action	International Alliance to Combat Ocean Acidification https://www.oaalliance.org/ Ocean Acidification Alliance Toolkit https://www.oaalliance.org/wp-content/uploads/2020/06/OAlliance_APToolkit_DOWNLOAD.pdf Northeast Coastal Acidification Network (NECAN) http://www.necan.org/references/ https://www.dec.ny.gov/lands/114877.html NY OA Task Force NY has agreed to assist CT with creation of the plan as it pertains to shared waters and resources. Many of the recommendations developed for the NY OA Action Plan are applicable and can be adapted to the CT waters of Long Island Sound. https://env.chem.uconn.edu/the-long-island-sound-lis-respire-program/# https://www.sciencedirect.com/science/article/pii/S0272771414001553

Recommendations from the GC3 Science and Technology Workgroup for Actions to Implement Adaptation and Resilience Strategies

Recommended Implementation Action Title: **Appoint a task force to develop an Action Plan to research, monitor, and address coastal acidification impacts to natural resources including shellfish, crustaceans, and fish**	
Recommended Implementation Action Description	Carbon dioxide generated by human activity has increased the acidity of global oceans by approximately 30% since the Industrial Revolution. Essential marine species and ecosystems that sustain jobs, support economies in coastal communities, continue cultural traditions, and provide protein/food for millions are threatened by climate-ocean impacts including ocean acidification. Many coastal states are developing Ocean Acidification Action Plans to address the challenges posed by ocean acidification. We recommend that Connecticut also take this step. Development of a Task Force and Action Plan complements and is supported by the GC3's mid-term reduction target recommendation was adopted by the Connecticut General Assembly when it passed An Act Concerning Climate Change Planning and Resiliency (Public Act 18- 82).
Completion Timeframe	• Creation of the Task Force: Less than 2 years • Development and adoption of the Action Plan: 3 to 5 years • Implementation of Recommendations: Greater than 5 years
Implementation Entities	Appointment of task force members: CGA Development of Action Plan: Task Force with input from State and Federal Agencies, Municipalities, NGOs, Academic Institutions, Tribes Implementation: State and Federal Agencies, Municipalities, NGOs, Academic Institutions, Tribes
Climate challenges addressed	Increasing ocean acidification combined other climate-ocean impacts threaten marine species and ecosystems that are essential for sustaining

	jobs, supporting coastal economies, practicing cultural traditions and feeding billions of people around the world. These impacts will worsen in the future without urgent action.
Protection of vulnerable communities	Complements Equity and Environmental Justice Concerns: Protecting shellfish, crustaceans, and fish communities from impacts of acidification protects minority communities and indigenous peoples that rely on these natural resources for sustenance.
References for action	International Alliance to Combat Ocean Acidification https://www.oaalliance.org/ Ocean Acidification Alliance Toolkit https://www.oaalliance.org/wp-content/uploads/2020/06/OAlliance_APToolkit_DOWNLOAD.pdf Northeast Coastal Acidification Network (NECAN) http://www.necan.org/references/ https://www.dec.ny.gov/lands/114877.html NY OA Task Force NY has agreed to assist CT with creation of the plan as it pertains to shared waters and resources. Many of the recommendations developed for the NY OA Action Plan are applicable and can be adapted to the CT waters of Long Island Sound. https://env.chem.uconn.edu/the-long-island-sound-lis-respire-program/# https://www.sciencedirect.com/science/article/pii/S0272771414001553

Recommendations for Actions to Implement Adaptation and Resilience Strategies

Recommended Implementation Action Title Support CT-based agriculture by 1) incentivizing regenerative and sustainable practices that improve soil health and increase soil carbon and 2) expanding year-round the benefits to local farms that are offered at farmers markets. Outcomes will be tracked based on farm survival, sustainability and revenues, as well as biodiversity and public health benefits and GHG mitigation.	
Recommended Implementation Action Description	Sustainable agriculture that increases land-based carbon, local food systems and local resource use can dramatically reduce GHG emission, increase community resilience, and improve health. We recommend that local whole foods from CT farms that are supported at $2 food/ $1 EBT transfer at farmers markets be expanded to CT supermarkets year-round. This improves health, supports community resilience and soil health, and increases land-based carbon.
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Less than 2 years • 3 to 5 years • Greater than 5 years This is a combination of new programs and incentives for farms and an expansion of an existing program.
Implementation Entities	Agencies, CGA, Municipalities, NGOs, Academic Institutions, etc. that may participate in the action.
Climate challenges addressed	This has the potential to reduce carbon emissions and improve soil health long term. Needs expertise in this area to ensure these actions. Less transportation of food decreases GHGs as does improved public health.
Protection of vulnerable communities	Expanding farmers markets benefits his is a direct benefit for vulnerable communities. Improving soil health is a benefit for everyone.
References for action	Provide links to plans, reports, academic papers, etc. that support the action or where the action was first proposed, as applicable.* WILL ADD

Recommended Implementation Action Title Address EJ lack of open space recreational opportunities in distressed communities while simultaneously prioritizing ecological integrity and ecosystem services.	
Recommended Implementation Action Description	**Secure new open space as recreational opportunities for EJ communities; restore open space by planting trees if needed; and/or protect existing tree cover to increase carbon sequestration and protect carbon storage.**
Completion Timeframe	These time frame categories are a guide to implementation of this action: **Less than 2 years**
Implementation Entities	CT DEEP, CGA, Municipalities, NGOs, Civic Groups may participate in the action.
Climate challenges addressed	**Action provides means to sequester and store carbon, while also providing needed recreational opportunities, which offer other co-benefits, such as improved physical and mental health.**
Protection of vulnerable communities	**Provide new open space recreation opportunities located within a municipality considered as Targeted Investment Community or Distressed Municipality (CGS section 32-9p CGS)**
References for action	**Draft Conservation and Development Policies: The Plan for Connecticut, 2018-2023**

Recommendations for Actions to Implement Adaptation and Resilience Strategies

From the Science and Technology Working Group

Recommended Implementation Action Title Protect mental health with preventative approaches	
Recommended Implementation Action Description	Prioritize ways to support mental health and prevent mental illness, particularly in young people and vulnerable communities
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Less than 2 years (immediately)
Implementation Entities	DEEP, DPH, DMHAS and others
Climate challenges addressed	Mental health problems are increasing, deplete collective resources and capacity to respond to climate change, and risk our ability to make decisions and participate in resilient communities. Some priorities that reduce anxiety include: Proactive planning as a public process to reduce anxiety Community lifelines of food, water, transportation, health care Access to natural areas Adequate sleep – suggest statewide change to school start times
Protection of vulnerable communities	Poor and urban areas suffer disproportionately from mental illness and are at increased risk due to climate change
References for action	See report.

Recommendations for Actions to Implement Adaptation and Resilience Strategies

From the Science and Technology Working Group

Recommended Implementation Action Title Remove Biomass Facilities from list of Class 1 Renewable Energy Sources in the CT Renewable Portfolio Standard (RPS)	
Recommended Implementation Action Description	Remove Biomass Facilities from list of Class 1 Renewable Energy Sources
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Less than 2 years (immediately)
Implementation Entities	DEEP, PURA
Climate challenges addressed	Biomass energy, particularly wood biomass, emits more CO2/Btu than coal, and most biomass fuels are not renewable on the time scales that matter for meeting the Paris Agreement goals. It is critical to prevent sources of CO2 emissions to limit global warming. Burning biomass fuel also releases toxins and particulates damaging to public health.
Protection of vulnerable communities	Biomass facilties are often located in close proximity to vulnerable populations and create inequities in public health due to particulate and toxic emissions. Reducing CO2 emissions and global warming will ameliorate impacts on vulnerable communities which are often first and most affected.
References for action	Sterman et al, ERL, 2018; Dvivedi et al., ERL 2019

Recommendations for Actions to Implement Adaptation and Resilience Strategies

From the Science and Technology Working Group

Recommended Implementation Action Title Prioritize proforestation on public land; ensure old-growth forest and remnants are protected.	
Recommended Implementation Action Description	Allow suitable existing natural public forests to grow to maximizes carbon accumulation and ecological complexity. Protect old-growth forests and remnants as they are essential to protecting the full range of native species, including species still-to-be-discovered.
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Less than 2 years (immediately)
Implementation Entities	DEEP
Climate challenges addressed	Least expensive, immediate and powerful approach to maximize negative emissions. Provides opportunities for long term monitoring, climate migration, natural selection. Maximizes natural resilience where possible – older forests most resilient and young areas more vulnerable to temperature and precipitation stress. Reduces loss of carbon from the land (mitigation) and enables prioritizing sufficient resources for monitoring and restoring habitats, maintaining existing young habitats where needed, restoring habitats that are not regenerating, etc. Opportunity for outreach and public education, mental health
Protection of vulnerable communities	Places for respite, cooling, recreation and science and education across the state.
References for action	See report

Water Inundation (PAGE 23) Encourage adaptation strategies that will ameliorate the effects of water inundation	
Recommended Implementation Action Description - Focus on precipitation intensity - Long island sound -	Precipitation intensity is expected to increase as a result of climate change. Existing natural habitats have the potential to become overwhelmed by an increase in flooding events and water quality is expected to be impacted by elevated levels of stormwater runoff. The functionality of natural habitats, which naturally filter and retain precipitation, should be bolstered by reducing existing stressors such as invasives and habitat fragmentation, and by increasing natural habitat conservation within and around developed areas. Practices should be implemented to reduce water runoff, combined sewer overflow and non-point source pollution. Guidelines for drinking water facilities should be updated to compensate for an increase in water contamination. (2011 report)
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Less than 2 years • 3 to 5 years • Greater than 5 years
Implementation Entities	DEEP, DOT, UConn, Yale, CIRCA, etc. - What schools have an environmental studies program in CT
Climate challenges addressed	- Flooding events - Sea level rise - Decrease in water quality
Protection of vulnerable communities	Vulnerable communities in Connecticut likely to be negatively impacted by water inundation. Most of the population in CT lives along or next to a waterbody. Cities are most likely to be impacted by combined sewer overflow
References for action	To be added

New construction and infrastructure will need to take into account and review current environmental policies regarding the impacts of climate change on water inundation in Connecticut. They should prioritize green infrastructure.

Vector-borne and Zoonotic Diseases Intensify monitoring for vectors and develop strategies for controlling arthropods and zoonotic pathogens that threaten public and veterinary health	
Recommended Implementation Action Description	Vector-borne and zoonotic diseases (VBZDs) threaten the health of humans, pets, wildlife, and livestock. Consistent monitoring using standardized methods to track new and emerging zoonotic pathogens and their hosts, as well as arthropod vector species and their associated pathogens, should be intensified. Evidence-based vector control strategies that use integrated pest management (IPM) to minimize pesticide resistance and reduce risk to pollinators and other non-target organisms should be developed and deployed in areas at high risk. Partnerships with regional vector control specialists, academic scientists focused on risk and prevention, and with veterinary and wildlife specialists for predicting risk, are crucial to mitigating the geographic spread of vector species and zoonotic disease agents. Sustainable, public education efforts that include science-based information on risk assessment source reduction, personal protection, habitat modification, and should be intensified.
Completion Timeframe	These time frame categories are a guide to implementation of this action: • 3 to 5 years • Greater than 5 years
Implementation Entities	CT: CAES, CT DPH, WCSU, UCONN, YALE SPH, YALE EIP, CT DEEP With consultation/partnership with NEVBD, USDA, CDC
Climate challenges addressed	- Rainfall effects, water inundation - Temperature change - Extreme weather events
Protection of vulnerable communities	Children and elderly adults are at particular risk for vector-borne diseases. Efforts to increase prevention education for these populations are needed, as well improved science communication regarding safe and judicious use of pesticides.
References for action	Hunter, P.R. 2003. Climate change and waterborne and vector-borne disease. Journal of Applied Microbiology. 94: 37-46S. Tabachnick, W.J., 2010. Challenges in predicting climate and environmental effects on vector-borne disease episystems in a changing world. Journal of Experimental Biology. 213: 946-954. Rocklov J., and Dubrow, R. 2020. Climate change: an enduring challenge for vector-borne disease prevention and control. Nature Immunology. 21: 479-483.

Establish a Program for Research, Planning, and Education of Climate Change Impacts on Health, Ecosystems, Biodiversity, Water, Food, and Soil.	
Recommended Implementation Action Description	Urgent recommendation, provides baseline for future measurement An inter-agency, inter-sector program should be developed to coordinate and synthesize important and complex adaptations to climate change. The focus would be on Health, Ecosystems, Biodiversity, Water, Food, and Soil. Research includes past and current monitor as well as projection to >2050 using modeling of climate change, topic-specific, and social-equity indexes. Topic-specific mapping tools should be designed for Connecticut to assist adaptation strategies. Education and engagement of citizens should harness the extensive environmental and health networks in Connecticut, but advances with digital technology tools, such a citizen-monitoring mobile apps and virtual-simulation of scenarios in the state. This program coordinates between counties, state, and Northeast Region. It can start with a coordinator in a state department, or hybrid institute like CIRCA, to build a program that serves as a hub for incremental expansion.
Completion Timeframe	Greater than 5 years
Implementation Entities	Connecticut Institute for Resilience and Climate Adaptation, Department of Energy and Environmental Protection, Department of Public Health, Department of Education, Green Bank, Sustainable CT, Connecticut Agricultural Experiment Station, Yale/University of Connecticut and higher education institutions, environmental-health NGOs and professional associations, Coalition of Northeastern Governors.
Climate challenges addressed	The primary changes projected for Connecticut will impact all six components of this program. The adaptation program centralizes and integrates with technological advancement to predict future risks and engages the citizens. Deeper awareness will move climate adaptation to public participation in mitigation.
Protection of vulnerable communities	Survey data indicates that the most vulnerable populations are most interested in climate change. This program uses social vulnerability index to predict the risks and provides accessible tools to empower their adaptation and mitigation of climate change exposures and risks. Critical to measure in communities
References for action	**IPCC, 2014**: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. **Shi L, et al. 2016.** Roadmap towards justice in urban climate adaptation research. Nature Climate Change 6: 131–137. **French, R. 2018.** Creating a Resilient Connecticut Coast: Constructing Infrastructure to Adapt to a Changing Climate. American Geophysical Union, Fall Meeting 2018, abstract #GC52A-04. **O'Donnell, J., et al. 2018.** Adapting to the Town-Scale Impacts of Climate Change in Connecticut. American Geophysical Union, Fall Meeting 2018, abstract #PA42B-10.

Research, Monitoring and Education Develop and educate about climate change and health impacts and adaptation to other sectors of state government, municipals, NGOs, and public schools.	
Recommended Implementation Action Description	The public health risks and adaptation from climate change should be educated across state and local government departments. The developing public health impact and adaptation should be disseminated to the public by communicating with health-environment institutions, NGOs and professional societies. One goal is to develop an educational platform, including mapping tools, vulnerability indexes, mobile applications to engage citizens in monitoring the causes and symptoms of climate-related diseases. Modernized educational curriculum and tools should be developed for distribution to public schools and colleges. Coordination with regional and national coalitions would connect resources and patterns of health risks at a larger scale. Efforts need to include policy makers and teach about climate *science*
Completion Timeframe	3 to 5 years
Implementation Entities	Department of Public Health, state and local government departments, Sustainable CT, Yale University, University of Connecticut, Connecticut State Universities and other private/public universities, state health-environmental NGOs and professional societies, state media network, Coalition of Northeastern Governors, regional and national alliances on climate change and health.
Climate challenges addressed	Projected changes in temperature and precipitation will produce a wide range of public health risks from heatwaves to flooding to escalation of infectious diseases. Public interests in personal health would engage and mobilize citizen efforts in climate mitigation and adaptation.
Protection of vulnerable communities	Educational programs will be coordinated with the development of equity index tool to target vulnerable populations in our state for each public health risk.
References for action	**Shaman J, Knowlton K. 2018.** The Need for Climate and Health Education. Am J Public Health 108:S66-S67. doi: 10.2105/AJPH.2017.304045 **Rohat, G., A. Monaghan, M. H. Hayden, S. J. Ryan, and O. Wilhelmi. 2020.** Intersecting vulnerabilities: Climatic and demographic contributions to future population exposure to Aedes-borne viruses in the United States. Environ. Res. Lett. (in press). doi: https://doi.org/10.1101/732644. **Semenza, J.C, David E. Hall, D.E, Daniel J. Wilson, D.J., Brian D. Bontempo, B.D. David J. Sailor, D.J., and George, L.A.** Public Perception of Climate Change: Voluntary Mitigation and Barriers to Behavior Change. Behavioral and Public Communication 35: 479-87.

Identify and Conserve Ecosystem Services (PAGE 26) Identify and conserve ecosystem services vulnerable to climate change	
Recommended Implementation Action Description	- Forests, marshes and other natural areas that are important for carbon sequestration, cumulative carbon, and emission reduction. - Natural areas that protect riparian zones (wetlands, rivers, etc.). - Wildlife corridors that protect wildlife and increase biodiversity. - Forests and other natural areas that provide ecosystem services necessary for maintaining public health, such as drinking water, control of insects that carry vector-borne diseases, mental health, clean air, heat stress, etc. -
Completion Timeframe	Greater than 5 years (identify soon, conserve over time)
Implementation Entities	DEEP, DOT, UConn, Yale, etc.
Climate challenges addressed	- Sea level rise and extreme weather events
Protection of vulnerable communities	Vulnerable communities are more prone to changes in infrastructure development that disturbs natural areas. These communities will also be more impacted by the public health aspect and will experience increased benefits from protecting ecosystem services.
References for action	To be added

Climate Change Research and Education (PAGE 25) Identify research needs and disseminate current climate change adaptation research and technical resources to the appropriate stakeholders, and encourage future efforts through state grants	
Recommended Implementation Action Description	- Research and technical assistance in the areas of Agricultural practices that maximize soil health, reduce erosion, and employ pest management practices that minimize risk on human health and ecosystems for farmers, potential new design standards for drinking water treatment facilities, or habitat management practices - Identify current climate change adaptation research and technical resources, such as academic institutions, government agencies and non-profits and connect them with appropriate stakeholders - Future research and technical assistance grant programs should prioritize the most vulnerable areas and promote collaboration between research/technical assistance entities. (2011 Report)
Completion Timeframe	Greater than 5 years
Implementation Entities	Agencies, CGA, Municipalities, NGOs, Academic Institutions, etc. that may participate in the action.
Climate challenges addressed	To be added
Protection of vulnerable communities	To be added
References for action	To be added

Support Ecosystem Services (PAGE 26) Encourage land stewardship behaviors that support ecosystem services	
Recommended Implementation Action Description	Incentivize and encourage: - the creation of storm buffers for communities near water bodies - the maximization of carbon storage and sequestration (i.e. the protection of carbons sinks such as old growth forests and salt marshes, etc.) - the reduction of habitat fragmentation and protection of vulnerable habitats, increase connectivity - the restoration of abandoned lands to natural ecosystem habitats Tax credits to incentivize landowners for ecosystem services. Invest in data and monitoring of carbon programs and research Promote private and public partnerships for data gathering and monitoring Incentivize restoration on abandoned lands . Increase ecological integrity overall Consider conversion of repetitive loss properties
Completion Timeframe	These time frame categories are a guide to implementation of this action: • Less than 2 years • 3 to 5 years • Greater than 5 years
Implementation Entities	DEEP, DOT, UConn, Yale, etc.
Climate challenges addressed	See report
Protection of vulnerable communities	Among other benefits, restoration of abandoned lands could benefit vulnerable communities
References for action	To be added

Comprehensive Place-Based Implementation of Mitigation, Adaptation and Resilience Select and establish pilot region(s) to quantify and demonstrate the benefits of implementing a comprehensive climate resilience plan that is risk-based. At least one region should be an urban/suburban watershed in order to take advantage of the co-benefits of climate mitigation and adaptation, ecosystem services, and equity and community resilience. Identify and mobilize actions with a range of costs and timelines and leverage diverse stakeholders and funding sources.	
Recommended Implementation Action Description	Making Connecticut's communities equitable and resilient to climate risk impacts and its challenges requires timely local actions and cultural shifts. We recommend establishing pilot region(s) to showcase and quantify benefits of a comprehensive climate resilience plan. Targeted pilot projects must incorporate science, interdisciplinary goals of the GC3 and the vision outlined in state planning documents at a pace, scale and cost that can inspire broader changes. Pilots should be in different ecoregions, with at least one in an urban-suburban watershed to express the full range of co-benefits with a range of stakeholders, costs and timelines. This recommendation interfaces with all working groups and addresses both mitigation and adaptation.
Completion Timeframe	This is a plan with multiple timelines with near-term and long-term benefits for health and climate. • Less than 2 years <u>Actions with immediate and long-term benefits – No cost:</u> Protect public natural assets; avoid degradation; identify key connections and areas for additional protection or restoration; identify partners for projects and identify funding; engage community; develop outreach, education, assessment. • 3 to 5 years <u>Actions w/ known benefits/ no downsides - A range of costs:</u> Targeted depaving, ecological restoration, and community-based food and energy; mobilize science and education; establish iterative process with outreach, education, assessment. • Greater than 5 years <u>Actions w/ coordinated planning, permitting and funding</u> More complex restoration and permitting, such as: stormwater projects, land acquisition, long term assessment and monitoring.
Implementation Entities	A wide range of Agencies, CGA, Municipalities, NGOs, Academic Institutions, etc. may participate in the action, as well as Sustainable CT.

[i] https://www.who.int/foodsafety/publications/all/Climate_Change_Document.pdf?ua=1
[ii] https://www.who.int/publications/i/item/food-safety-climate-change-and-the-role-of-who