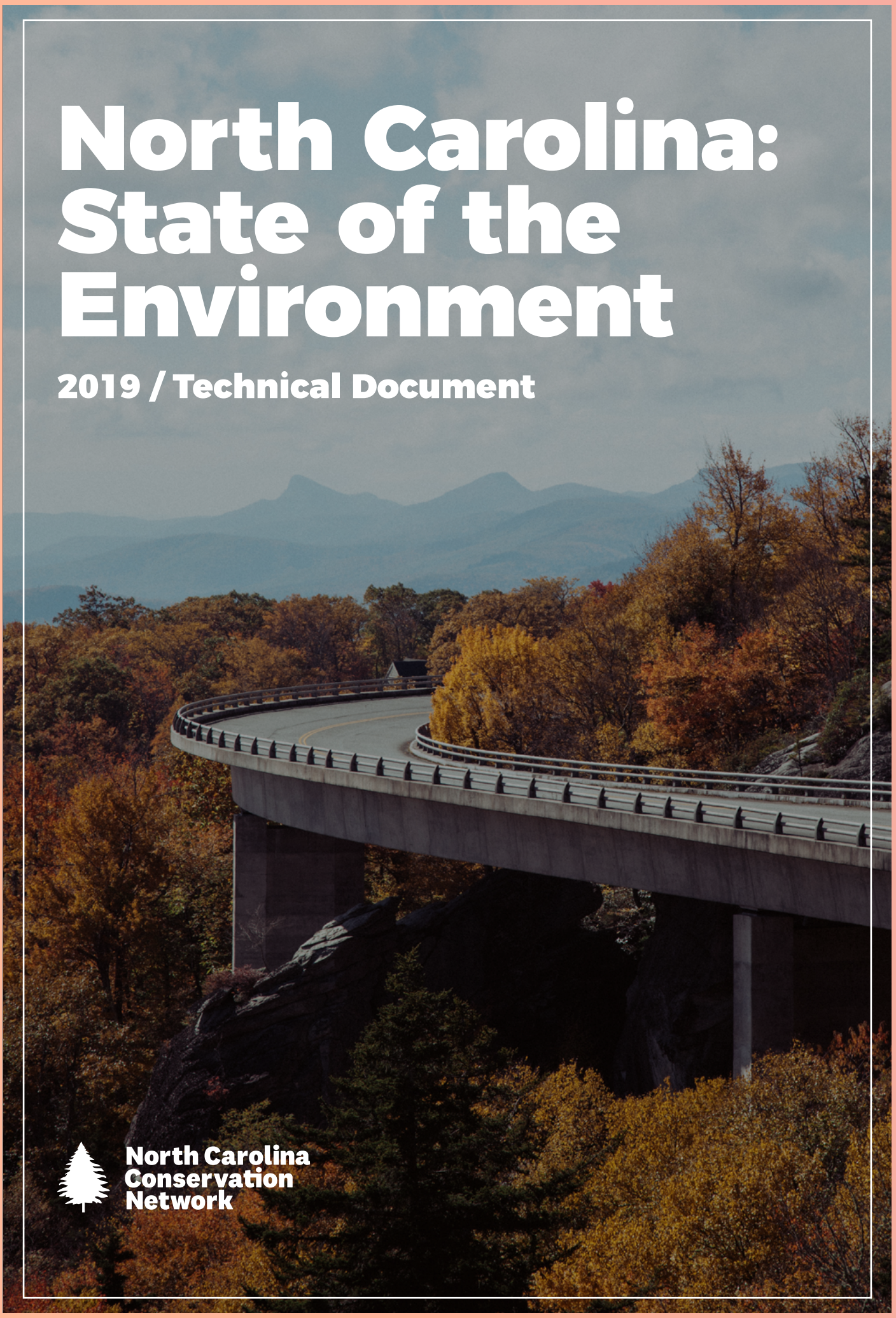
North Carolina: State of the Environment

2019 / Technical Document



North Carolina Conservation Network

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About

The 2019 State of the Environment report tracks 116 indicators that capture various dimensions of well-being for North Carolina's residents. The indicators reflect the view that having a healthy natural and human environment both sustains and depends on having a vibrant economy, strong civil institutions, and a healthy and well-educated populace. These 116 indicators add up to 55 distinct goals, expressed as vision statements, such as "all North Carolinians breathe healthful air" or "North Carolinians have access to affordable electricity."

The indicators and goals are policy-neutral. We believe that a great majority of North Carolinians across the ideological spectrum would agree that each of the goals is desirable, and would likely agree on the best direction for each indicator to trend. However, the goals and indicators leave aside the question of what policy interventions are needed to accelerate a trend or change its direction, or whether government has a role in addressing a trend at all.

What you are reading now is the technical document. It explains how each of the indicators relates to its goal, and discusses the choice of metrics and data sources for each indicator. The technical document cites recent studies and reports that provide greater insight into the challenges facing the state with respect to specific goals or indicators. The technical document contains the core of the analysis underpinning the summary report, and offers rich details for those interested in diving deeper on a specific goal or indicator. Where appropriate, the discussion of each goal in the technical document includes a short cross-reference to related policy solutions, listed in Appendix I.

Appendix I ("Solutions") is not at all policy-neutral. It outlines an array of policy interventions that, if adopted, will improve North Carolina's economy, environment, public health, and resilience. The solutions reflect an agenda for action from across North Carolina's conservation and environmental communities, not only (or even primarily) the priorities of the NC Conservation Network. We will welcome the opportunity to work with decision makers on other strategies as well.

Understanding the Indicators

Our indicators fall broadly into seven categories:

Changing climate baselines

Our land & water

Our people

Our civil society

Our economy

Our infrastructure

Flows of energy & waste

We have tried to choose indicators that meet several criteria:

- They track something that matters.
- They do not duplicate other indicators.
- They reflect accurate and reliable data that is or will be available on a regular basis.

This is the first edition of this report. We expect to publish future updates, and to improve and evolve the indicators we track to better measure what matters. We welcome suggestions of additional relevant sustainability indicators.

Special Themes: Climate Change, Resilience, Equity

This report collects a mass of information, but we make sense of information through the stories we tell, the themes that emerge across the data, and empathy for what those themes mean in the lives of North Carolinians. This year, our review highlights three themes.

Climate mitigation. Human behaviors are driving global climate change, and changes in human behaviors – to reduce excess emissions of heat-trapping gasses to the global atmosphere – are essential to curb it. Those changes require action far beyond North Carolina's borders, but we have to do our part, too. Key indicators of North Carolina's contribution to the global problem are our total greenhouse gas emissions, emissions from various sectors of the economy, and the extent to which we are successfully retaining carbon in our forests, wetlands, and soils. Solutions include boosting energy efficiency and deployment of solar and wind power; better forest, wetland, and soil management; and improving growth patterns and transportation investments to minimize the future emissions needed to move people and goods around our state.

Indicators and solutions related to climate mitigation occur throughout the report; the table below collects them in one place to summarize North Carolina's progress toward limiting emissions.

Curbing greenhouse gas emissions indicators

NUMBER	INDICATOR	TREND
	Global trends and NC's role	
1.1	Atmospheric CO_2 concentrations	RISING
17.1	NC total greenhouse gas emissions	WEAK
	Keeping carbon on the ground	
2.2	Extent of forest biomass	RISING

NUMBER	INDICATOR	TREND
2.5	Survival of wetlands	FALLING
	Transitioning to clean energy	
47.1	GHG emissions from energy consumption	MIXED
47.2	Energy efficiency of economy	DECLINING
48.1	Percentage electricity generation from renewables	WEAK
48.2	Grid modernization	GOOD
	Limiting GHG emissions from the built environment	
41.1	VMT per dollar of state GDP	BASELINE
41.2	GHG emissions from transportation	FALLING
44.1	Transportation mode funding split	BASELINE
44.2	Workers driving alone	NO TREND
44.3	Bike/pedestrian accident rates	MIXED
45.1	Spatial distribution of growth	WEAK
45.1	Percent of solo drivers with commutes > 30 minutes	RISING
	Limiting GHG emissions from all other sectors	
13.1	GHG emissions from agriculture	NO CHANGE
33.1	NC economic growth rate compared to nation	RISING
34.1	Growth in sustainable sectors as share of economy	NO METRIC
51.2	Diversion of wastes to composting	BASELINE

Resilience. As evidenced by increases in extreme weather in North Carolina and around the globe, climate change is happening. Even if the world could reach 'net zero' carbon emissions overnight, the lag time in the global carbon cycle guarantees that North Carolina would continue to experience the effects of climate change for decades to come. Many of those changes will impose pain, but we can partially reduce our losses by planning ahead, making our communities and our state economy more resilient.

All over the nation, communities are experimenting with planning for resilience, and with forecasting the threats and risks they will need to manage. While those efforts are important and necessary in North Carolina, the data sources underpinning them are still spotty and speculative. For purposes of this report, we take a pragmatic approach: most of our indicators of resilience track losses from extreme events. Here's our logic: the harms of climate change are manifesting first through disasters. More intense rain events and hurricanes cause flooding, stronger droughts cause forest fires, and warmer winters allow new diseases to become endemic. One measure of resilience is whether we learn from these events and act to prevent similar losses in the future. If our losses from disasters keep increasing, that is a sign that our thinking hasn't gotten far enough ahead of the threats to minimize the harms they cause. The downside of these metrics is that they can be incredibly volatile from one year to the

next, making it hard to spot a trend. We've tried to address that by averaging damages across five-year intervals, but even that may be too short. The ultimate costs of failing to adapt are in lost opportunities for growth and community stability; we do not have a metric for those.

Resilience solutions are multi-layered. The most basic involve building back wisely after disasters, and ensuring that infrastructure is built to avoid or withstand flooding and wildfires. A second layer involves proactively managing threats by buying out buildings in the floodplain, reconnecting floodplain wetlands, and retrofitting cities to capture rather than shed runoff. Perhaps the most ambitious but also important layer requires systems thinking: imagining a competitive economic future for North Carolina in the climate we are likely to have, and making infrastructure and educational investments to make that vibrant economy a reality.

Indicators and solutions related to resilience occur throughout the report; the table below collects them in one place for a sense of whether North Carolina's efforts at building resilience are working.

Resilience indicators

NUMBER	INDICATOR	TREND
	Drivers - the hand we've dealt ourselves	
1.1	Atmospheric CO_2 concentrations	RISING
1.2	Global average temperature increase	RISING
1.3	Rate of sea level rise	RISING
	Sea level rise	
5.2	Annual ratio of living shorelines to bulkheads	BETTER
5.3	Area of submerged aquatic vegetation	BASELINE
46.2	Rolling 5-year coastal damage (wind, storm surge)	NO TREND
	Water supply	
8.2	Statewide groundwater levels	UNCLEAR
7.3	Surface water flows	DATA GAP
	Infrastructure resilience in floodplains	
40.1	Percent of housing stock in 500-year floodplain	BASELINE
43.1	Rolling 5-year average damages to transportation system	BASELINE
46.1	Rolling 5-year average flood damage	RISING
9.2	Critical water and wastewater infrastructure in floodplains	UNCLEAR
50.1	Outages and reliability of the electric grid	BASELINE
	Other related indicators	
46.3	Rolling 5-year average structure loss to wildfire	FALLING
18.7	Numbers of vector-borne illnesses	RISING

NUMBER	INDICATOR	TREND
34.1	Sustainable sectors as a share of the state economy	NO METRIC

Equity. In its most basic, stripped-down sense, equity is fairness - fairness that assures inclusion and opportunity for all state residents. It does so not by pretending that equality before the law reflects equal access or impact on the ground. Instead, equity recognizes that historic and current distributions of wealth and power - distributions that track race, ethnicity, gender, and inherited social status - continue to deny many North Carolinians access to health, economic opportunity, and a clean environment. Equity seeks to restore that access.

This report focuses on racial equity. We recognize that in North Carolina people and communities of color – and especially Black, Latino, and Native people and communities – bear historic and current burdens beyond those carried by economically similar whites. These burdens have been confirmed time and again through peer reviewed research, and reflect institutionalized racism and intrinsic bias, even where overt prejudice has receded.[1]

We believe North Carolina is making progress over time, but the state cannot reach its potential so long as race and ethnicity still drive significant disparities in health, economic opportunity, and quality of life. For that reason, we weigh equity heavily in evaluating progress towards goals. If an indicator is getting better on average, but racial disparities are increasing, we are not getting closer to achieving the goal associated with that indicator, and our analysis notes that.

Indicators and solutions with equity dimensions are distributed throughout the report; the table below collects them in one place for a summary of how North Carolina is doing at narrowing or eliminating racial and ethnic disparities overall.

Racial equity and environmental justice indicators

NUMBER	INDICATOR	TREND
	Exposure to pollution	
18.5	Years of premature death per 100,000 residents	RISING
27.2	Spatial distribution of toxic releases	BASELINE
54.1	Proximity to waste management (TSD) facilities	BASELINE
16.1	Correlation between respiratory hazard and EJ census blocks	BASELINE
16.2	Correlation between heavy traffic and EJ census blocks	BASELINE
18.3	Rate of hospitalizations for asthma	NO TREND
13.2	Volume of swine waste sprayed	BASELINE

1 See, for example, David Williams et al, Racism and Health: Evidence and Needed Research, Annu. Rev. Public Health 2019.40:14.1–14.21, doi.org/10.1146/annurev-publhealth-040218-043750 (review article assessing contributions of structural racism, cultural racism, and individual-level discrimination to disparities in health outcomes); Sherman James, The strangest of all encounters: racial and ethnic discrimination in US health care, Cad. Saúde Pública 2017; 33 Sup 1:e00104416, doi: 10.1590/0102-311X00104416 (review article linking racial disparities in health outcomes in part to physician intrinsic bias); Raj Chetty et al, Race and Economic Opportunity in the United States: An Intergenerational Perspective, March 2018 (analysis of entire US population 1989-2015 finds that parental income and ongoing discrimination are the leading drivers of black-white income gaps).

NUMBER	INDICATOR	TREND
	Equitable children's health	
20.1	Rate of low birthweight	RISING
20.2	Percent of children in excellent or very good health	BASELINE
18.2	Incidence of obesity	RISING
21.1	Percent of households experiencing food insecurity	RISING
21.2	Percent of low income residents close to a grocery store	BASELINE
55.1	Unscreened chemicals in consumer products	BASELINE
15.1	Indoor air quality	DATA GAP
20.3	Children's toxic exposures	DATA GAP
	Cost of environmental services	
9.1	Number of non-viable water systems	BASELINE
10.1	Affordability of water	BASELINE
49.1	Affordability of energy	VOLATILE
	Other equity indicators	
18.4	Incidence of cancer	FALLING
18.6	Suicide rate	RISING
19.1	Percent of residents with health coverage	RISING
22.3	Percent completing high school in four years	BASELINE
22.4	Percent attending college, achieving advanced degrees	RISING
24.2	Rate of incarceration	FALLING
27.1	Residential segregation	BASELINE
27.3	Neighborhoods experiencing gentrification and displacement	NO METRIC
31.1	Legislative match to demographics of electorate	BASELINE
36.1	Median income of NC households	RISING
36.2	Percent of children and adults living in poverty	FALLING
38.2	Number of counties where median income> sufficiency income	BASELINE
39.1	Minimum wage jobs to afford a two bedroom apartment	BASELINE

What We Learned, 2019

The effort to abstract an overall trend in North Carolina's sustainability from the available data requires numerous judgment calls. The following image summarizes what we've learned and concluded this year.

The outer ring lays out the indicators in a clockwise circle, omitting the first three (global climate) indicators, since North Carolina has minimal control over them. Moving inward, the next ring shows the 55 goals. The third ring aggregates trends to the level of the subcategories: lands, coasts, water, agriculture, air, health, education, community, governance, economy, housing, transportation, land use patterns, energy, and waste. The final, inner ring shows the values we've assigned to the six main categories in 2019. In short form, they run as follows:

Land & Water: **mixed.** North Carolina's inland landscapes and the coast are threatened by development and climate change. Many populations of birds and fish are in slow decline. Water quality shows mixed trends. Row crop agriculture is conserving soil and water, but animal agriculture needs to be a better neighbor.

Our people: **inadequate.** Public health indicators show substantial racial and ethnic disparities, and key indicators are heading in the wrong direction. Children are at risk, and too many North Carolinians lack reliable access to healthy food. Trends in education are more mixed, but net, we see inadequate progress on health and education.

Our Social Fabric: **good.** North Carolinians benefit from a strong ethic of community, with thriving arts and public service sectors. Data on state and local governance is too limited for us to evaluate this year.

Our Economy: **good.** At the top of the business cycle, North Carolina's economy isn't working equally well for everyone, but most people are better off than they were a decade ago, in the heart of the Great Recession. We lack data on the answers to questions we'd most like to answer from a sustainability perspective: how big are sustainable business sectors as a part of the state economy, and how fast are they growing?

Infrastructure: **inadequate.** Affordable housing is in short supply across the state, not just in the booming Piedmont cities. Transportation shows mixed trends—but, too often, new construction is driving sprawl into greenfields, increasing costs, locking in future greenhouse gas emissions, and damaging commuters' health.

Energy & Waste: **mixed.** Grouped together because they deal with flows of energy and matter,

these goals and indicators signal looming problems. Renewable energy has enjoyed years of rapid growth from a low baseline. Yet, to avoid climate disruption, the transition to a clean energy economy needs to speed up in depth and breadth. Waste generation continues to grow, with heavy clouds on the horizon for recycling and materials management.

The process of aggregating trends requires judgment calls. This year, in particular, a large number of the indicators offer baseline information, not trends. We have shown most of those in gray; for a relative handful, their starting conditions are so promising or so bad that we've assigned them a positive or negative value. Next year, we hope to identify trends for a much larger share of the indicators.

For easier reading, all of the categories, goals, and indicators are laid out in chart form in Appendix II.

Gratitude

The overall structure and choice of many of the goals and indicators in this report are inspired and strongly influenced by Sustainable Jersey's Sustainable State of the State report, published annually since 2015[2]. We are grateful for the example provided and the high bar set by the New Jersey report.

A report of this scale takes many helping hands. The team at the NC Conservation Network is immensely grateful for the time and good advice of the following reviewers and issue experts: Kim Brand, Bridgette Burge, Calvin Cupini, Morgan Whitman Gramann, Will Hendrick, Ramona McGee, Daniel Parkhurst, Sam Perkins, Scot Quaranda, David Stephan, Whitney Tucker, Doug Wakeman, Lexia Weaver, Ben Zemonek, and Ana Zivanovic-Nenadovic.

In addition, several GIS experts produced illuminating maps specifically for this report. We are grateful to Andrew Pericak, Jovian Sackett, and Curtis Smalling. Credit for maps is attached to each image.

All the data we rely on is public. Some can be easily located and downloaded; in other cases, we are greatly indebted to state and federal employees who took time to answer our questions, helped us figure out what we were asking for, and then collected and shared the data with us: Joelle Burleson, DEQ; Ann Deaton, DEQ; Jeff DeBernardinis, DEQ; Dee Dee Fauser, USACE; Andy Haines, DEQ; Steve Hall, DEQ; Colleen Kiley, DPS; Tom Langan, DPS; Michael Pjetraj, DEQ; Michael Schafele, DNCR; Ronnie Smith, USACE; Lisa Tolley, DEQ; Nat Wilson, DEQ; and Reid Wilson, DNCR.

Misjudgments and errors are our own, and none of the people thanked in this section should be assumed necessarily to share the interpretations we offer in this report.

Changing Climate Baselines

North Carolina contributes to climate change and can contribute to its resolution, but we cannot reach the goal of stabilizing climate change and its impacts by ourselves. Nonetheless, because climate change affects nearly all the other goals and indicators, we're including three baseline climate indicators here.

Goal 1: Key drivers and effects of climate change in North Carolina slow or stabilize.

Trend: Weak

Climate change is driven by emissions around the world, and has built up significant momentum. And yet, North Carolina can have an outsized influence on our world's future. Our state economy,

2 See, for example, Sustainable Jersey, The 2018 New Jersey Sustainable State of the State Report, 2018, volume I: Summary Report; volume II, Technical Report.

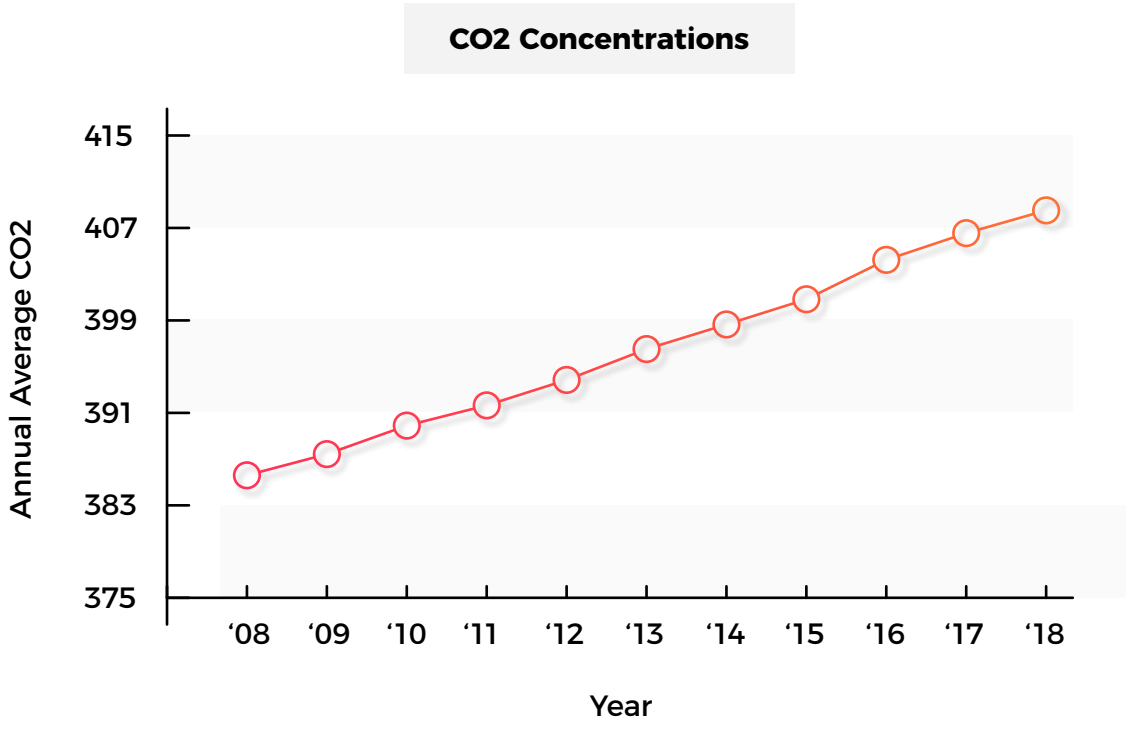
$540 billion dollars in 2017, is the 11th largest state economy in the United States.[3] Viewed as a separate country, North Carolina would have the 24th largest economy in the world, ahead of Argentina, Norway, Nigeria, and Malaysia.[4] More to the point, in 2017, North Carolina emitted just over 116 MMT of carbon dioxide equivalents (CO_2e),[5] or 11.3 tons CO_2e per resident. That is roughly equivalent to the per capita emissions rate for Germany or Belgium in 2012 (the most recent year with per capita global CO_2e data), and not quite double the world rate of 6.52 tons per year.[6] We have more emissions to trim, and more capacity to trim them, than most nations of the world.

We also start with this goal because climate change will shape North Carolina's sustainability for decades to come. Taking a long view, we look forward to the years when key climate indicators stabilize; not surprisingly, all three below - global CO_2 concentrations, global temperatures, and the rate of sea level rise - are currently pointed in the wrong direction.

Solutions: To reduce our greenhouse gas emissions, North Carolina should I1, adopt an overarching goal to reach carbon neutrality; J1, modernize the electric grid to support renewables; J2, expand renewable generation and storage; J3, expand energy efficiency; J5, curb wood pellet facilities; J7, avoiding investments in expanded natural gas pipelines; K4, integrate avoidance of induced sprawl into transportation planning; and G2, divert food from landfills to composting. In addition, A6, incentives for reforestation, offers a way to boost carbon sequestration.

Indicator 1.1: global average atmospheric CO_2 concentrations.

Trend: Rising, bad



Anthropogenic climate change is driven by emissions of a number of different gases, but excess carbon dioxide contributes by far the greatest share of warming. Because CO_2 belongs to a global atmospheric

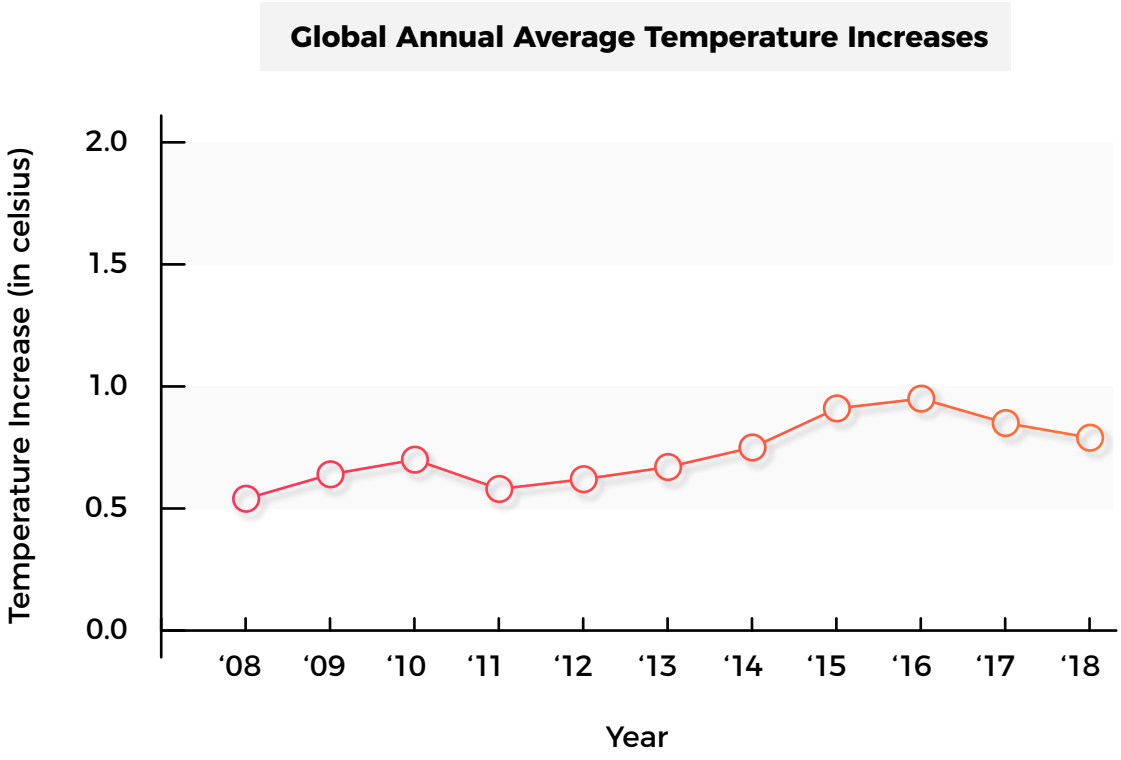
3 US Bureau of Economic Affairs, 2017 Gross Domestic Product by State (SAGDP2N), November 14, 2018.
4 International Monetary Fund, World Economic Outlook Database, October 1, 2018.
5 NCDEQ, North Carolina Greenhouse Gas Inventory (Final), January 2019, at 17.
6 European Commission, Emissions Database for Global Atmospheric Research (EDGAR), Fossil CO_2 and GHG emissions of all world countries, 2017.

pool, for this indicator we look to a data source outside of North Carolina: the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory, which tracks the global atmospheric average CO2 concentration.[7]

We hope that the nations of the world will take the decisive action needed for this indicator to level off sooner rather than later. In October 2018, the Intergovernmental Panel on Climate Change (IPCC) issued, yet again, an urgent call to action for nations to move towards net-zero emissions of carbon to reduce the chance of crossing various irreversible tipping points in the climate system.[8] For this year, this indicator is very much trending in the wrong direction.

Indicator 1.2: global annual average temperature increases.

Trend: Rising, bad



*Global annual average temperature increase from 20th century baseline.

One effect of climate change is warmer temperatures, as well as more extreme weather, hot and cold. Given the natural variability of the climate, it can be hard to see local trends on the kind of short time horizon – about a decade – used for most of the indicators in this report. But scientists do estimate the global annual average temperature each year, and the sheer breadth of the samples tends to offset the noise. That data shows that increased greenhouse gas concentrations are already translating into warmer average annual temperatures. Every year since 2000 has seen a global annual average temperature larger than the average for the last century (1901-2001), and the size of the anomaly has continued to increase, from 0.43 degrees Celsius in 2000 to 0.79 degrees Celsius in 2018.[9]

7 Dr. Pieter Tans, NOAA/ESRL and Dr. Ralph Keeling, Scripps Institution of Oceanography.
8 Intergovernmental Panel on Climate Change, Global Warming of 1.5° C, October 2018.
9 NOAA National Centers for Environmental information, Climate at a Glance: Global Time Series, published January 2019, retrieved on February 12, 2019 from https://www.ncdc.noaa.gov/cag/.

Indicator 1.3: rate of sea level rise.

Trend: Rising, bad

Different regions of North Carolina's coast have been subsiding gradually since the end of the last Ice Age. Thermal expansion of the oceans and melting of global ice reserves has substantially accelerated the rate at which mean sea level is rising relative to dry land. The rate is calculated on the basis of tide and water level data collected by NOAA at four gauges along North Carolina's coast every six minutes. In Wilmington, NC, for example, relative sea level is currently rising by 2.3 millimeters (0.09 inches) per year, and the rate of the rise is increasing.[10]

Looking to the future, scientists expect sea level to continue to rise much faster than it has historically – but how much faster is uncertain. A 2017 NOAA analysis considered a range of possible rates of sea level rise, and projected a roughly 13 inch global rise by 2050 on the intermediate path, with an outer range of 6 inches (low) to 25 inches (high).[11] The same analysis projects a rise of 39 inches by 2100, with an outer range of 12 inches (low) to 98 inches (high). Regional conditions – local subsidence and a slowing Gulf Stream current – could conceivably add up to another 39 inches of rise along the North Carolina coast by 2100.[12]

The website sealevelrise.org provides a particularly clear overview of the drivers of sea level rise on our coast – melting ice, local coastal subsidence, ocean expansion, and slowing of the Gulf Stream

Our Land & Water

From the Appalachians to the Atlantic Coast, North Carolina is blessed with great natural beauty. Our landscapes and the recreational opportunities they afford draw many new residents to the state and sustain the state's $23 billion tourism economy.[13] Beyond that, our landscapes support forestry and farming, and provide ecosystem services that keep our surface waters drinkable, recharge groundwater supplies, and sustain abundant fish and wildlife.

The 16 goals in this section include some indicators traditionally associated with conservation and others with pollution control: land cover, habitat, wildlife, water, agricultural land, and air quality. Overall, as detailed below, North Carolina has shown mixed progress towards sustainable management of our lands and water over the last year.

Land and Habitats

Three goals cover different aspects of lands and habitats: the quality of North Carolina's landscapes for human uses; the ecological integrity and diversity of habitats; and whether fish and wildlife populations are thriving.

Goal 2: North Carolina's landscapes continue to support our economy and quality of life.

Trend: Mixed

North Carolina's forests, fields, urban trees, and wetlands support our well being in a variety of ways,

10 See, NOAA, Wilmington, NC station, ID 8658120, available online at https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8658120

11 NOAA, Global and Regional Sea Level Rise Scenarios for the United States, NOAA Technical Report NOS CO-OPS 083, 2017, at 23.

12 Idem, at 25.

13 NC Economic Development Partnership, All 100 North Carolina Counties Saw Increased Visitor Spending in 2017, August 23, 2018.

cleaning the air, filtering water, recharging aquifers, and protecting us from flooding. The five indicators under this goal include loss of open space, biomass of living trees, tree canopy in urban areas, proximity of people to public lands, and survival of wetlands. Several of these indicators offer only baseline values this year; between a positive trend in biomass but continued loss of wetlands, we rate progress towards this goal as mixed this year.

Solutions: North Carolina can protect and conserve our landscapes for human uses by A1, restoring dedicated funding for the natural resource trust funds; A2, funding the Clean Water Management Trust Fund; A3, funding the Parks & Recreation Trust Fund; A4, funding the Agricultural Development & Farmland Preservation Trust Fund; A5, investing in floodplain restoration and reconnection; A6, establishing incentives for reforestation; J5, curbing wood pellet facilities; K4, avoiding induced sprawl in transportation planning; L2, encouraging farmland protection plans; and M6, establishing a Mountain Resilience Commission.

Indicator 2.1: Loss of open space

Trend: No trend

North Carolina retains much natural beauty, but in recent decades the population of the state has grown rapidly, and the area paved over for roads, neighborhoods, and commercial buildings has grown faster still. Our average individual footprint is increasing, even as there are more and more of us. While growth has many benefits, the loss of open space has direct and indirect costs. This indicator measures the rate of loss of open space. Unfortunately, the data for this analysis is increasingly obsolete. The US Geological Survey is slated to release the 2016 National Land Cover Dataset (NLCD) sometime in 2019; it will have layers for 2013 and 2016.[14] In the meantime, however, the most recent version is the 2011 NLCD, now at least eight years old. Moreover, 2006-2011, the period between the last two NLCD layers, covered the Great Recession, when new development slowed significantly across the state. Rather than present an obsolete and misleading figure, we are including this indicator as a placeholder this year but not evaluating it. We look forward to identifying a trend when this report is updated next year.

In the meantime, several teams of researchers have estimated growth patterns across North Carolina or specific regions for several decades, and projected them into the future. A 2014 analysis of the Southeast as a whole, using road network analysis to capture low-density sprawl that the NLCD tends to miss, predicts a dramatic increase in the developed landscape to 2060, with a continuous megalopolis forming across the Piedmont, mostly at the expense of farmland.[15] The paper projects less growth in the mountains, but - given the tighter topography - expects it to destroy up to a third of wetlands in the Blue Ridge. A 2014 paper calculates local growth patterns across North Carolina from 1992 to 2001, validated against 2006 land cover, and projects future trends to 2030. That approach misses the 2008 recession, and so the projections should perhaps be seen as an upper bound on growth, but they are sobering: 20% increase in developed land and 17% decrease in forest compared to 1992, 7% decrease in farmland compared to 2001.[16]

Various regional analyses echo these predictions of continued loss of open space. A 2010 analysis of growth in North Carolina's mountains anticipates that the 14 county region will reach a population of one million soon after 2030, with the conversion of 5% of the remaining private open space to developed uses.[17] A 2015 USGS analysis, also based on data through 2006, examines a 14 county region in Southeastern North Carolina and projects an additional 98,000 to 226,000 acres converted

14 Limin Yang, et al, A new generation of the United States National Land Cover Database: Requirement, research priorities, design, and implementation strategies, ISPRS Journal of Photogrammetry and Remote Sensing 146 (2018) 108–123, doi.org/10.1016/j.isprsjprs.2018.09.006.

15 Adam Terando et al, The Southern Megalopolis: Using the Past to Predict the Future of Urban Sprawl in the Southeast U.S., PLoS ONE, 2014, 9(7): e102261. doi:10.1371/journal.pone.0102261

16 Mohammad Sayemuzzaman and Manoj Jha, Modeling of future land cover change in North Carolina using Markov chain and cellular automata model, American Journal of Engineering and Applied Sciences 7 (3): 295-306, 2014, doi:10.3844/ajeassp.2014.295.306.

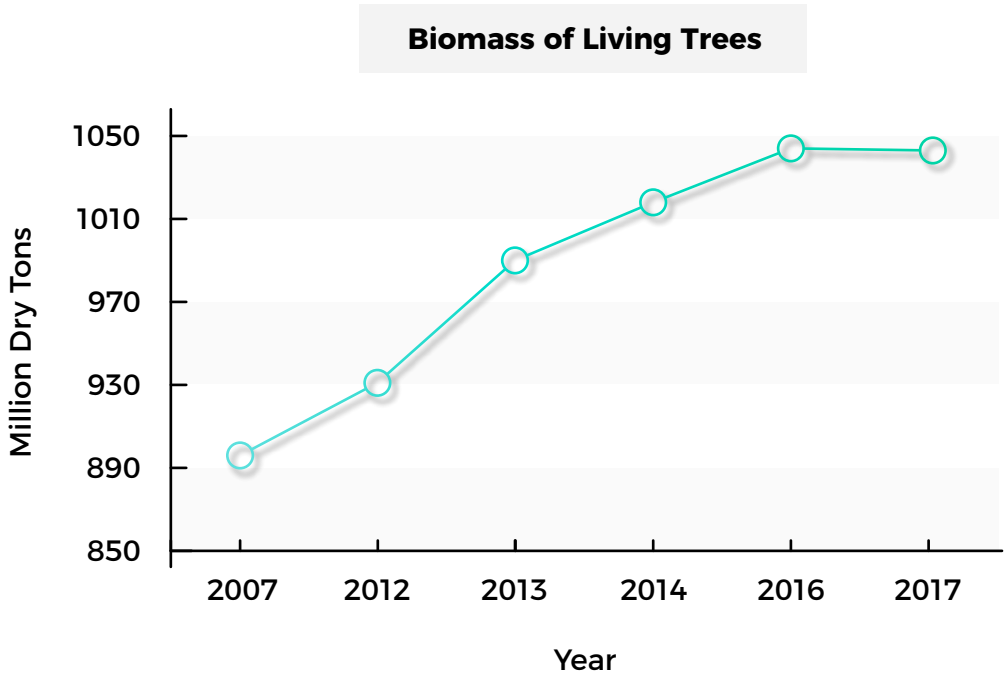
17 John Vogler et al, Mapping historical development patterns and forecasting urban growth in Western North Carolina, 1976-2030, July 2010.

to developed land cover by 2030, with perhaps a third coming from farmlands and the rest from forest and grass/shrubland.[18]

More recent analyses tend to consider a range of growth scenarios as a prelude to modeling impacts on hydrology. A 2017 study of western North Carolina through 2030 predicts a 23% increase in developed lands and a 7% to 12% loss of farmland under various patterns of development.[19] A 2018 analysis of the greater Charlotte region, using the same model, projects a doubling of the developed portion of the landscape, from 19% to 37% by 2030.[20]

Indicator 2.2: biomass of living trees.

Trend: Rising, good



Every five years, the US Forest Service (USFS) issues an updated version of Forest Resources of the United States, a compendium of forest and timber-related statistics. One of the measures tracked by USFS – and disaggregated by state but not by county – is an estimate of the total aboveground living tree biomass. We track this indicator because a sharp drop in it would imply the loss of many acres of forestlands, and the likely release of their stored carbon into the atmosphere. The data for various years is scattered among several sources, and is not available for every year.[21] Estimates for North Carolina in 1997 and 2002 were 1990 data,[22] so we start tracking from 2007. The data shows a steady increase in

18 Peter Claggett, et al, Historic and Forecasted Population and Land-cover Change in Southeastern North Carolina, 1992–2030, U.S. Geological Survey Open-File Report 2014–1125, http://dx.doi.org/10.3133/ofr20141125.

19 Brian Pickard, Forecasts of urbanization scenarios reveal trade-offs between landscape change and ecosystem services, Landscape Ecol, 2017, 32:617, doi 10.1007/s10980-016-0465-8.

20 Allen Roberts, Past, current, and projected landscape configurational effects on streamflow within the Rocky River HUC-8 watershed of the Charlotte metropolitan region, H2O Open Journal, 2018, 1:2, doi: 10.2166/h2oj.2018.108.

21 2007: Brad Smith, et al, Forest Resources of the United States, 2007, Gen. Tech. Rep. WO-78, 2009, Table 38a, at 272; 2012: Sonja Oswalt, et al, Forest Resources of the United States, 2012: a technical document supporting the Forest Service 2015 update of the RPA Assessment, Gen. Tech. Rep. WO-91, 2014, Table 38a, at 176; 2013, 2014: Forests of North Carolina, 2014. Reflects combination of seven panels, 2007-2014. Only 14% of the data is actually from 2014; 2016: Forests of North Carolina, 2016. Reflects combination of eight panels, 2008-2016, 45% of the data is from 2016; 2017: Sonja Oswalt, et al, Forest Resources of the United States, 2017: a technical document supporting the Forest Service 2020 update of the RPA Assessment, Gen. Tech. Rep. WO-xxx, 2018, at 100.

22 Brad Smith et al, Forest Resources of the United States, 2007, Gen. Tech. Rep. WO-78, 2009, Table 38b, at 275.

biomass with a leveling off in the last two years of data. Forest biomass has been rising over the last decade; we view this as a positive trend.

Indicator 2.3: tree canopy over North Carolina's developed landscapes.

Trend: Baseline

Tree canopy over developed landscapes has multiple benefits.23 Trees keep buildings cooler in the summer and warmer in the winter, reducing energy usage.24 Trees intercept rainfall, reducing frequency of rain-driven flooding and reducing the amount of pollution washed into streams and drinking water reservoirs.25 For this indicator, we are grateful to Jovian Sackett, Southern Environmental Law Center, who calculated the average canopy density for each of the US Census Bureau's designated urban areas.[26] The Census Bureau defines 'urban areas' as places that contain 50,000 or more people, which correlates well with North Carolina's developed urban landscapes. Because this is a snapshot rather than a trend, we record it as a baseline this year. It does, however, suggest that several North Carolina cities could benefit significantly from policies to restore and conserve urban tree canopy.

Urban Forest Cover, 2011

NAME	AREA (SQ. MI.)	AVE. CANOPY DENSITY
Durham	183.06	61.12%
Gastonia	139.28	54.01%
Raleigh	522.91	52.39%
Winston-Salem	324.99	48.08%
Asheville	267.09	48.04%
Charlotte	776.64	47.77%
Concord	180.76	47.42%
Burlington	91.19	45.96%
Hickory	265.15	45.64%
Greensboro	189.42	45.00%
High Point	114.78	44.34%
New Bern	44.50	43.08%
Jacksonville	73.03	42.07%
Wilmington	136.23	41.01%
Fayetteville	200.13	39.24%
Rocky Mount	46.04	38.55%

23 Kathleen Wolf, Community Economics - A Literature Review, Green Cities: Good Health, 2010.

24 David Nowak et al, Residential building energy conservation and avoided power plant emissions by urban and community trees in the United States, Urban Forestry & Urban Greening, 2017, 21:158 (finding that the average reduction in residential energy use thanks to trees is 7.2%).

25 Center for Watershed Protection, The Role of Urban Trees in Stormwater Management, Runoff Rundown, 66, January 2017.

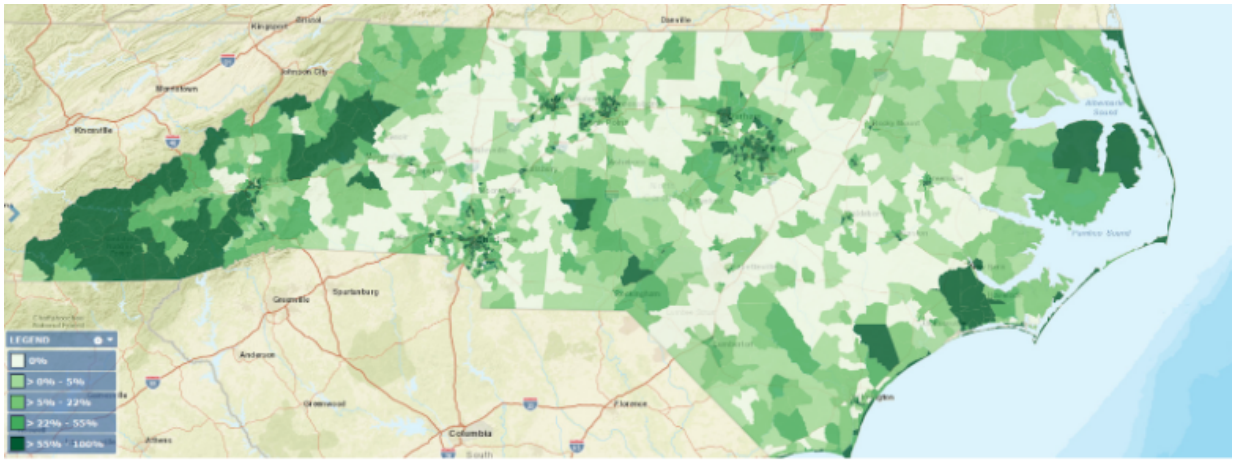
26 Analysis of 2011 National Land Cover Data layer, provided by Jovian Sackett, Southern Environmental Law Center, received by email, March 29, 2019.

NAME	AREA (SQ. MI.)	AVE. CANOPY DENSITY
Goldsboro	53.03	32.96%
Greenville	65.65	27.43%

Indicator 2.4: percentage of residents within ½ mile of a public park or elementary school.

Trend: Baseline

Access to open space is correlated with overall mental and physical health.[27] Yet, many North Carolinians do not have a local, state, or federal park nearby. This indicator tracks the percentage of North Carolinians who live within ½ mile of a public park or elementary school (to serve as accessible open space); the Centers for Disease Control estimates that 23% do.[28] It is illuminating to see how those residents are distributed in census tracts across the state:



map credit: US Centers for Disease Control.

Residents of North Carolina's larger cities fare well: settlement patterns are dense and these communities have substantial park systems. Residents in the far west benefit from ubiquitous national forest lands, as do residents near the Uwharries, or on the coast near national forests or national wildlife refuges. Residents of smaller cities and towns typically enjoy access if they live close to the urban core, but not in suburbs, exurbs, or genuinely rural reaches. Because this data point is not a trend, we present it as a baseline this year.

We have not found much data on how much time North Carolinians spend outdoors. A national 2017 study found that, even when the weather is good, 56% of Americans spend five hours or less in nature in a week, and 26% spend less than 2 hours in nature.[29] Even so, half of the people with the lowest actual time outdoors still count being outdoors among the more enjoyable activities they do.[30]

Indicator 2.5: Remaining acreage of wetlands.

Trend: Falling, bad

27 For a discussion of access to green space with special attention to equity and implications for disparities in health outcomes, see, Viniece Jennings et al, Urban green space and the pursuit of health equity in parts of the United States, Intl J of Env. Res. and Public Health, 2017, 14, 1432, doi:10.3390/ijerph14111432.

28 CDC, National Environmental Public Health Tracking Network, Community Design/ Access to Parks and Public Elementary Schools, 2015.

29 The Nature of Americans: Disconnection and Recommendations for Reconnection, 2017, at 54-55.

30 Idem, at 58.

In thousands of acres	PALUSTRINE WETLANDS	ESTUARINE WETLANDS
1992	4630.2	181.5
1997	4602.5	182.5
2002	4,573.2	184.5
2007	4,555.0	184.5
2012	4,539.2	181.7
2015	4,525.8	181.7

Wetlands serve a multitude of functions, cleaning water, recharging groundwater, absorbing floods, and providing habitat for fish and wildlife. Scientists generally sort wetlands into palustrine (fresh) and estuarine (brackish) wetlands. This indicator tracks North Carolina's remaining estimated acreage of wetlands on non-federal lands, relying on the USDA's Natural Resource Inventory (NRI). This data is not a perfect representation of what is on the ground, but it is the most robust state or federal wetland data series. The NRI data suggests that the acreage of North Carolina's estuarine wetlands has not changed much over the last 25 years, but that development pressures have resulted in the steady loss of freshwater wetlands. Roughly 90% of the remaining non-federal wetlands are described as 'forest' by the NRI.[31]

Goal 3: North Carolina's landscapes provide healthy habitat.

Trend: Good

Beyond providing services directly useful to people, North Carolina's landscapes provide vital habitat for fish and wildlife. The next four indicators all provide measures of the health of terrestrial and aquatic habitats: non-intensively managed forests; total impervious surface; the percentage of small watersheds with minimal impervious surface; and the percentage of known biodiversity hotspots that are under some kind of protective management. Although the two indicators for aquatic habitats provide only baseline data this year, we count the retention of non-commercial forests as a good trend, and the management of known biodiversity hotspots as positive also, drawing a positive rating for this goal.

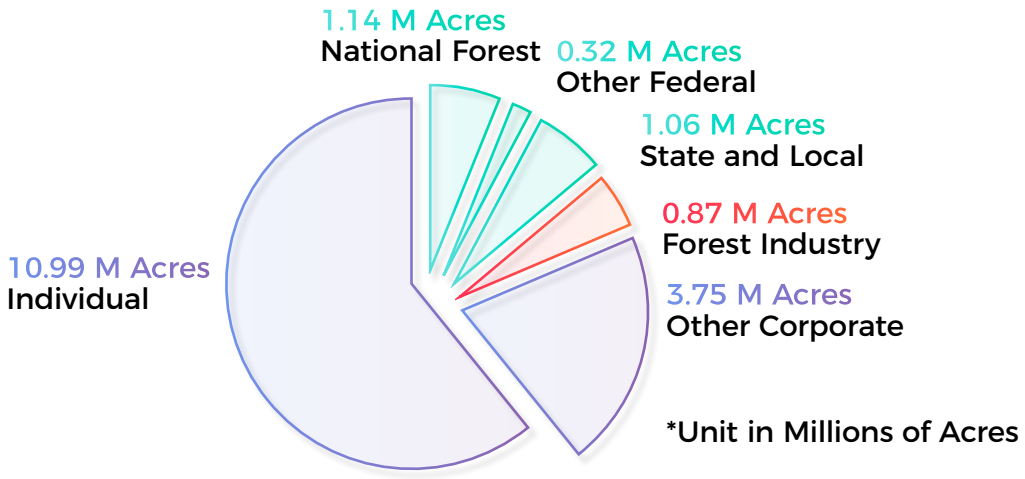
Solutions: Many of the same solutions recommended for goal 2 would help protect the ecological functions of terrestrial and aquatic habitats, including A1-A4, funding the natural resource trust funds, and A5, floodplain reconnection. In addition, B3, improving maintenance of stormwater control measures; B4, funding community conservation assistance; C5, promoting green stormwater infrastructure, and K4, avoiding induced sprawl, would greatly help aquatic habitats.

Indicator 3.1: Acreage of non-intensively managed forests

Trend: Unchanged, good

31 USDA, 2015 Natural Resources Inventory: North Carolina Wetlands (September 2018).

Forest Acreage Not In Commercial Production



North Carolina has roughly 18 million acres of forestlands, but a little under a million of that is intensively managed commercial timberland. Intensively managed commercial timberlands provide ecological services that cleared and developed land would not – such as absorbing rainfall, recharging aquifers, and releasing oxygen – but they are mostly monocultures, and do not sustain diverse and resilient ecological communities. This indicator tracks non-commercial forest acres. The vast majority are held by small, private landowners. Many of these acres may be ecologically degraded; it is likely most are not being managed closely for any particular purpose. Nonetheless, this indicator offers an upper bound on the acreage of natural or semi-natural forests in the state. The forest acreage is so large that the US Forest Service doesn't try to assess it all in one year. Instead, each year, the agency updates a portion of the records. In effect, that means that each annual estimate is a smear of results from the last three years, a sort of rolling average. For the most recent years, 2014-2016, the data has not changed much: North Carolina has roughly 17.26 million acres of non-commercial timberland, owned by a combination of federal, state, and local governments, non-timber corporations, and – larger than all other categories combined – private landowners. Because this land area appears fairly stable, we mark this as positive this year.

Indicator 3.2: Total impervious surface

Trend: Baseline

Developing a natural landscape doesn't just remove the habitat on the site; it also significantly changes what happens to rainfall. On undeveloped land, rain typically sticks to the foliage of trees and shrubs, or soaks into the ground, and only gradually begins to run off into nearby streams. In a densely developed landscape, water rapidly reaches the hard ground – pavement or compacted lawn – and promptly runs off, carrying whatever pollutants are lying around. The resulting runoff has larger volumes and moves faster, causing more erosion and flooding downstream. The percentage of impervious surface in a watershed or jurisdiction is thus a good indicator for the degree to which we have altered the natural hydrologic system through development.

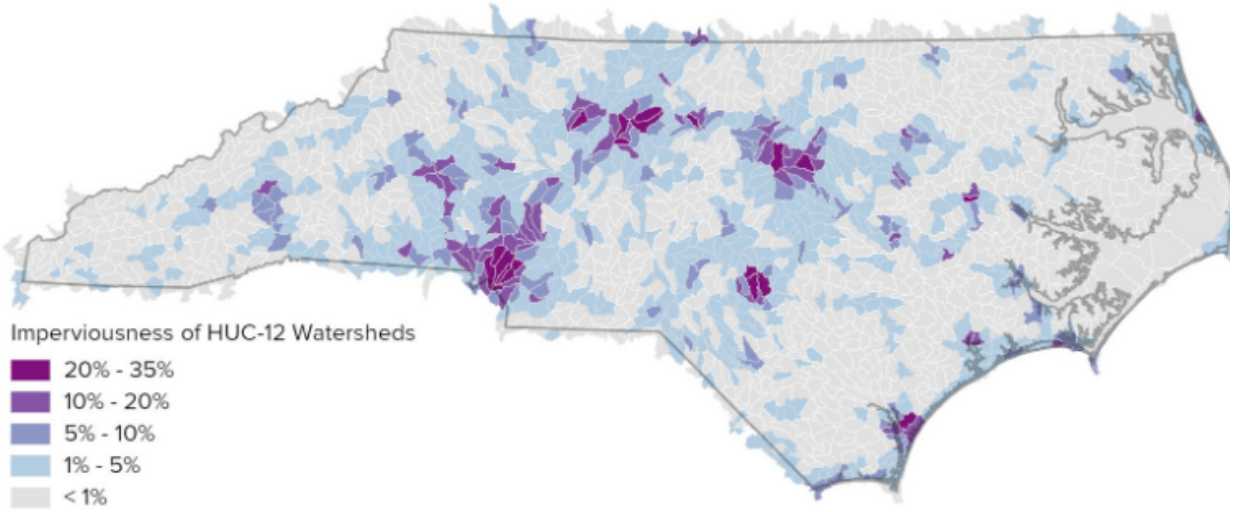
While recent orthophotography is available for the whole state, we have not found an interpreted data layer. In the absence of that, we rely on the 2011 NLCD impervious surface layer, which estimates that impervious surface comprised 2.21% of North Carolina's surface area in 2011.[32] Because the indicator provides a static snapshot, we count it as a baseline and do not assign it a positive or negative trend.

32 Analysis of 2011 National Land Cover Data layer, provided by Jovian Sackett, Southern Environmental Law Center, received by email, March 29, 2019.

A 2007 analysis found that just over 1% of the United States land area is impervious, a high percentage compared to most other countries.[33] On a per capita basis, the United States has far higher levels of impervious surface than other developed countries. For example, the United States has 296.8 square meters of impervious surface per person, while Germany has just 103.1 square meters, and Japan, 114.5 square meters.[34] The difference is largely accounted for by our emphasis on car-dependent development, which requires paving over a much larger fraction of the land surface.

Indicator 3.3: Percentage of watersheds that remain relatively un-degraded.

Trend: Baseline



In general, when impervious surface exceeds 7% of the area of a watershed, water quality in the watershed begins to decline rapidly. By the time a watershed reaches 20% impervious surface, increased volumes of runoff have largely destroyed habitat for bottom-dwelling species, severely degrading the streams.[35] However, it is important to look at a fairly fine resolution; using too large a watershed can mask concentrated areas of impervious surface that are degrading substantial lengths of streams or rivers. This indicator, relying on the 2011 National Land Cover Data (NCLD), measures the percentage of HUC-12 watersheds that have less than 5% and 10% impervious cover.

There are 1740 HUC-12 watersheds in North Carolina. An analysis by Jovian Sackett at the Southern Environmental Law Center finds that in 2011, 89.0% of HUC-12 watersheds had less than 5% impervious surface, and 95.4% had less than 10% impervious surface.[36] As the map above shows, watersheds with higher levels of imperviousness are clustered in a crescent that runs from Charlotte through the Triad to the Triangle. It is worth comparing this map to the maps of impaired waters and benthic health

33 Christopher Elvidge, Global Distribution and Density of Constructed Impervious Surfaces, Sensors (Basel), September 2007, 7(9): 1962-1979. 10.3390/s7091962.

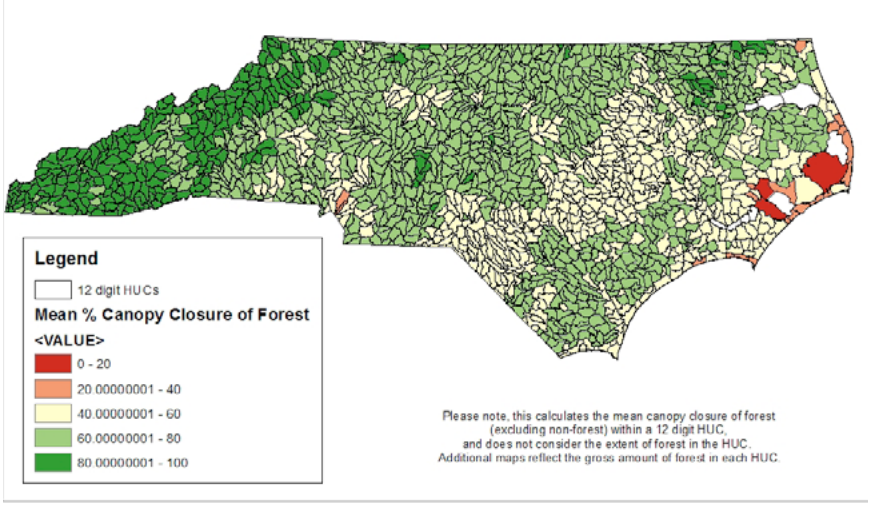
34 Daniel Herriges, Which countries have the most pavement per person?, Strong Towns, February 20, 2019.

35 Thomas Schueler et al, Is Impervious Cover Still Important? Review of Recent Research, Journal of Hydrologic Engineering, April 2009, 14:4 (309), doi: 10.1 061/(ASCE) 1 084-0699, at 313.

36 Analysis of 2011 National Land Cover Data layer, provided by Jovian Sackett, Southern Environmental Law Center, received by email, March 29, 2019. There are 1,740 HUC-12 watersheds in North Carolina; as of 2011, 191 (11%) had at least 5% impervious surface, 80 (4.6%) at least 10%, and 18 (1%) over 20%.

under indicators 7.1 and 7.2. Because this represents a single snapshot rather than a trend, we count it as a baseline value this year. The 2016 National Land Cover Database is slated for release sometime this year, and should make it possible to assess a trend in this indicator next year.

An alternative to impervious surface is tree canopy coverage. The two are not the same; developed landscapes can have extensive tree canopy, and marshes lack canopy but are neither developed nor impervious. Still, the data for canopy coverage is updated more frequently than the NLCD. The map below, based on a 2016 data layer, shows mean canopy closure for forests in each HUC-12 watershed in the state.[37] Canopy coverage of existing forest in these watersheds is upwards of 80% in the mountains and a few watersheds in northeastern NC; it drops below 60% around the Piedmont cities, in the agricultural fields of the upper Coastal Plain, and over the extensive open marshes of the coasts and the barrier islands.



Indicator 3.4: Percentage of 'natural areas' with protection.

Trend: Baseline, good

North Carolina's Natural Heritage Program tracks the location and condition of known valuable 'natural areas', including high quality examples of ecological communities and habitat for rare species. The program also tracks places under private or public management providing some protection for these features. Both files are updated continuously, but with an unpredictable lag behind changes in conditions on the ground.

Our indicator is the percentage of 'natural area' acres – land known to have special value – that are under protective management. To calculate this, staff scientists at the Natural Heritage Program took the 'managed lands' layer, deleted areas not based on land rights (such as outstanding resource water classifications), deleted county and municipal properties, and compared the remaining shapefile with the layer of 'natural lands' in ArcGIS. Areas of less than 2 acres were deleted to eliminate random slivers caused by mismatching between data layers, and the sum of the overlap was calculated with a statistics tool.[38]

Based on NHP data as of February 2019, out of 3,017,886 acres of natural areas, an estimated 2,117,124 acres, or 70.2%, are under some form of federal, state, or private easement protection or management.[39] This is a single-year snapshot, rather than a trend, but because it indicates that a significant share of known ecological treasures have some level of management, we count it as a positive starting point.

37 Analysis provided by Curtis Smalling, Audubon North Carolina, received by email, February 18, 2019.
38 Analysis received through email from Michael Schafale, NC Natural Heritage Program, NC Department of Natural and Cultural Resources, February 2019, based on North Carolina Natural Heritage Program Biotics Data.
39 Ibid.

Goal 4: North Carolina's landscape and waters support a full complement of animal and plant species and ecological communities.

Trend: Weak

The next two indicators attempt to capture a perspective on North Carolina's biodiversity. By tracking species associated with specific habitats and ecological communities, these indicators collectively suggest the extent to which North Carolina's living systems are thriving alongside the state's dynamic growth. Both show some gains, but rather more declines, so we rate progress towards the goal of thriving species as inadequate.

Indicator 4.1: populations of bird species.

Trend: Mixed, bad

North Carolina's diverse natural habitats are home to over 460 species of birds. For this indicator, Audubon North Carolina has identified 10 species that range across different habitats, and whose population trends over time offer a window not just on the wellbeing of those species, but also the broader habitats and ecological communities of which they are a characteristic part. For each species, the table below names its characteristic habitat, the most recent annual trend in the species' estimated population in North Carolina, and the data sources for each population count. The table also shows the current population status and trend for each species according to the state's Wildlife Action Plan, and its projected vulnerability to climate change.

SPECIES	HABITAT	ANNUAL TREND[40]	NC WILDLIFE ACTION PLAN TREND	NC WILDLIFE ACTION PLAN TREND	AUDUBON CLIMATE STATUS
Brown-headed Nuthatch	Coniferous Forest	2.03	**under 1M**	**Stable/ Declining**	**Endangered**
Wood Thrush	Deciduous Forest	-2.35	**under 1M**	**Stable**	**Threatened**
Hooded Warbler	Deciduous Forest	1	**under 1M**	**Stable/ Increasing**	**Threatened**
Prothonotary Warbler	Deciduous Forest	1.8	**under 1M**	**Declining**	**Stable**
Eastern Meadowlark	Grassland	-3.19	**under 1M**	**Declining**	**Stable**
Eastern Whip-poor-will	Open/Ag	-2.99	**under 1M**	**Declining**	**Endangered**
Chimney Swift	Urban/ Suburban	-2.36	**under 1M**	**Declining**	**Stable**

40 Annual population trends were calculated by Curtis Smalling, Director of Conservation, Audubon NC, on the basis of monitoring data from several sources: Brown-headed Nuthatch: Breeding Bird Survey (BBS), Nest box project, Climate Watch; Wood Thrush: BBS; Hooded Warbler: BBS; Prothonotary Warbler: BBS; Eastern Meadowlark: BBS; Eastern Whip-poor-will: Nightjar Survey; Chimney Swift: BBS, Audubon Swift Project; American Oystercatcher: Audubon Survey (AS), Colonial Waterbird Census (CWC); Brown Pelican: AS, CWC; Piping Plover: AS, Piping Plover Census.

SPECIES	HABITAT	ANNUAL TREND[40]	NC WILDLIFE ACTION PLAN TREND	NC WILDLIFE ACTION PLAN TREND	AUDUBON CLIMATE STATUS
American Oystercatcher	Marsh/ Estuarine	*	**under 1K**	**Stable**	**Endangered**
Brown Pelican	Coastal	6.26	**under 10K**	**Increasing**	**Endangered**
Piping Plover	Coastal	*	**under 250**	**Stable**	**Endangered**

Asterisks (*) reflect too-small sample sizes to project an annual trend. Over the last decade, the Piping Plover has experienced a decline of 46% while the American Oystercatcher has experienced an increase of 27%. Data credit: annual population trends calculated by Curtis Smalling, Audubon North Carolina using data from the national Breeding Bird Survey, USGS.

The 2015 North Carolina Wildlife Action Plan is a massive compendium covering the full range of animal species in North Carolina - not just birds, but also insects, molluscs, amphibians, reptiles, fish, and mammals, as well as the full suite of habitats across the state.[41] The Wildlife Action Plan 'trend' reflects an estimate of population changes over the 20 years before 2015. The Audubon climate status is derived from Audubon's 2014 Birds and Climate Change report, which considers the likely impact of shifting habitat ranges for 588 species of North American birds as the continent warms.[42] The report identifies 170 different species of birds native to North Carolina that are threatened by climate change.[43]

The data for this year shows a mix of population increases and decreases. While a 2% increase or decrease from year to year may seem small, it can build to a substantial change if the trend remains consistent over time. For the purpose of tracking the health of North Carolina's biodiversity, not just individual species, we want to see a substantial majority of populations improving, not just half. We expect this indicator will become more useful as data builds over time; for this year, we evaluate the data as showing inadequate progress towards sustainable bird populations across a variety of ecological communities.

41 North Carolina Wildlife Resources Commission, North Carolina Wildlife Action Plan, 2015. Bird population information is part of Appendix G of the Plan.

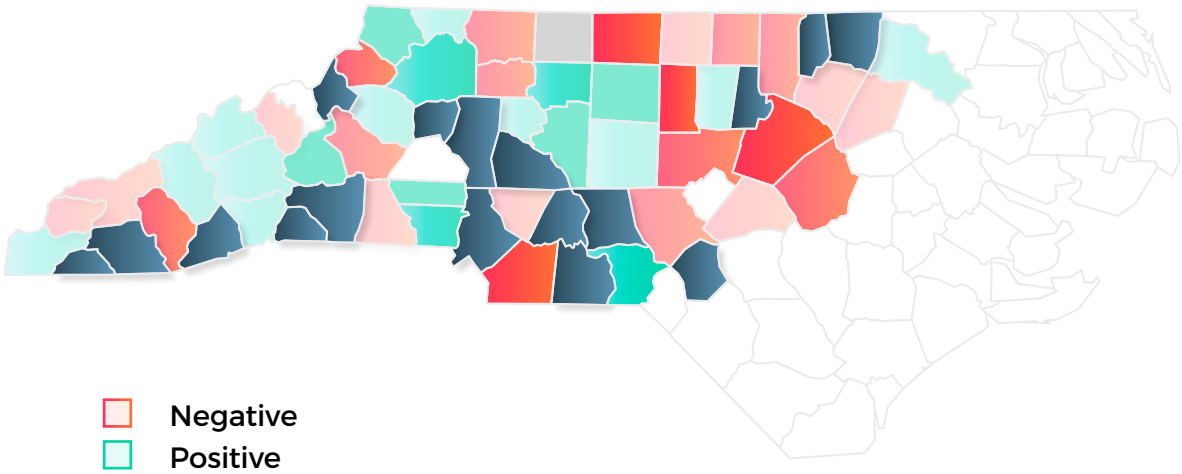
42 National Audubon Society, webpage: Birds and Climate Change Report, 2014.

43 Audubon North Carolina, webpage: NC's Climate Threatened Species, page retrieved April 9, 2019.

Indicator 4.2: health of freshwater fish communities.

Trend: Declining, bad

Net Change In Fish Community Assessment Sites



Negative
Positive
No Net Change

*Counties that have no data are white.

Freshwater fish are among the top predators in the aquatic food web, and are themselves eaten by mammals, birds, and people. Healthy fish populations, both in abundance and in diversity of species in the habitats that support them, are a sign of healthy aquatic habitats more broadly. Scientists estimate that the state is home to 228 native freshwater species, with another 23 introduced species that are now naturalized.[44] Two freshwater fish are listed as endangered under the federal Endangered Species Act (Cape Fear Shiner and the Roanoke Logperch), two are listed as threatened (Spotfin chub and Waccamaw Silverside), and two anadromous fish that migrate between fresh and saltwater are listed as endangered (Atlantic and Shortnose Sturgeon).[45] North Carolina's Wildlife Resources Commission (WRC) lists another 8 species as endangered and 14 as threatened under state law.[46]

We derived this indicator from data collected by NC DEQ's Fish Community Data Assessment. Starting in 1990, the program has sampled at roughly 960 sites, almost all road crossings and other access points where state scientists can use backpack electroshock equipment to stun and count fish.[47] Each time a site is visited, staff use a consistent protocol to assign it a value representing an index of biotic integrity.[48] Non-swamp sites are rated excellent, good, good-fair, fair, or poor, or are recorded as having insufficient data for a ranking (though such streams tend to have lower index scores). The protocol applies in the mountains, the Inner and Outer Piedmont, and the Sandhills, but not in coastal waters. [49]

For this evaluation, we sifted the data for sites with assigned values since 2011 and at least one other measurement previously at the same site.[50] In most cases, the measurement was 5 years (one basinwide cycle) previously; in some, 10 years (skipping a cycle, meaning the site was not sampled at the 5 year mark). This screen reduced the data to 286 pairs of assessments. We then tallied whether the assessed

44 NC Biodiversity Project, List of the Freshwater Species of North Carolina, retrieved February 27, 2019.
45 US Fish & Wildlife Service, website: Endangered Species of North Carolina, retrieved February 27, 2019.
46 15A NCAC 10I .0103, .0104. See also, NC WRC, Protected Wildlife Species of North Carolina, February 2014.
47 NCDEQ, website: Fish Community Data Assessment, retrieved February 23, 2019.
48 NCDEQ, Standard Operating Procedure Biological Monitoring: Stream Fish Community Assessment Program, 2013.
49 NCDEQ, website: Fish Community Data Assessment, retrieved February 23, 2019.
50 The data file is available here.

quality improved, remained the same, or declined between visits. Of the 286 pairs, 87 sites suffered a decline, 127 were the same, and 72 improved. For purposes of this report, that marks a trend away from the goal of healthy fish communities - but we also acknowledge that despite the sampling protocol, this data may have some degree of noise.

The net spatial distribution of those improvements and declines, shown above by county, is illuminating. This map shows the net number of sampling sites improving or declining, shaded by the strength of the change; counties in gray had no change; counties in white had no data. One takeaway: ongoing degradation appears to be happening around the furthest exurbs of North Carolina's largest cities, where new development is spreading impervious surface across the landscape, changing flows and degrading stream habitat.

Data gap: insect populations. Over the last year, scientific journals have published multiple articles reporting declines in native insect populations on the order of 60% - 80% from very different locations around the globe.[51] Given that insects are a foundation layer of terrestrial food webs, and play a critical role in the reproduction of many plant species, this is deeply troubling. Unfortunately, although North Carolina has gifted entomologists, the state has never invested in collection of time series data of insect abundance, so we cannot tell how steep the declines have been here. Many North Carolinians can point to the informal 'windshield test', recalling how, as recently as the 1990s, it was impossible to drive a rural NC road in the summer without having bugs smash all over the windshield.

Healthy Coasts and Estuaries

One goal addresses a vision for healthy coasts and estuaries.

Goal 5: North Carolina's coasts and estuaries are healthy and resilient. They nurture abundant fish and shellfish populations and sustain cherished coastal ways of life.

Trend: Mixed

When asked in polls what we love about our state, North Carolinians routinely point to our coasts. Coastal counties are home to just over one million people, 10% of the state's population.[52] For them, the coast is home, work, and daily community. For many more, our coasts are associated with family trips, memories of beaches, swimming, and fishing, and a culture of slow time, seafood, and salt water. Yet, North Carolina's coasts carry a heavy load, swelling with new residents and tourists even as sea level rise and more extreme weather challenges existing infrastructure and communities.

In 2016, several state commissions jointly released a new, detailed iteration of the state's Coastal Habitat Protection Plan.[53] The document identifies six habitat types that are under particular pressure, but are also vital to the region's economy, culture, and quality of life: the water column, shell bottoms, submerged aquatic vegetation, wetlands, soft bottom, and hard bottom.[54] A joint 2017 study by North Carolina Sea Grant and the Nicholas Institute at Duke University found that in its current condition, North Carolina's coastal environment - termed the 'ocean economy' in the report - contributed $2.1 billion to state GDP in 2013, and over 43,000 jobs.[55] The six habitats underpin this economy and are thus of significant economic and social as well as environmental importance.

51 Francisco Sanchez-Bayo and Kris Wyckhuys, Worldwide decline of the entomofauna, Biological Conservation, April 2019, v.232, 8-27, https://doi.org/10.1016/j.biocon.2019.01.020.

52 Calculated from official NC State Demographer 2017 certified county estimates, available here.

53 NC DEQ, NC Coastal Habitat Protection Plan, 2016. By statute, NCGS 143B-279.8, the plan must be approved by the NC Coastal Resources Commission, the NC Environmental Management Commission, and the NC Marine Fisheries Commission.

54 NCDEQ, NC Coastal Habitat Protection Plan Source Document, 2016, at 336.

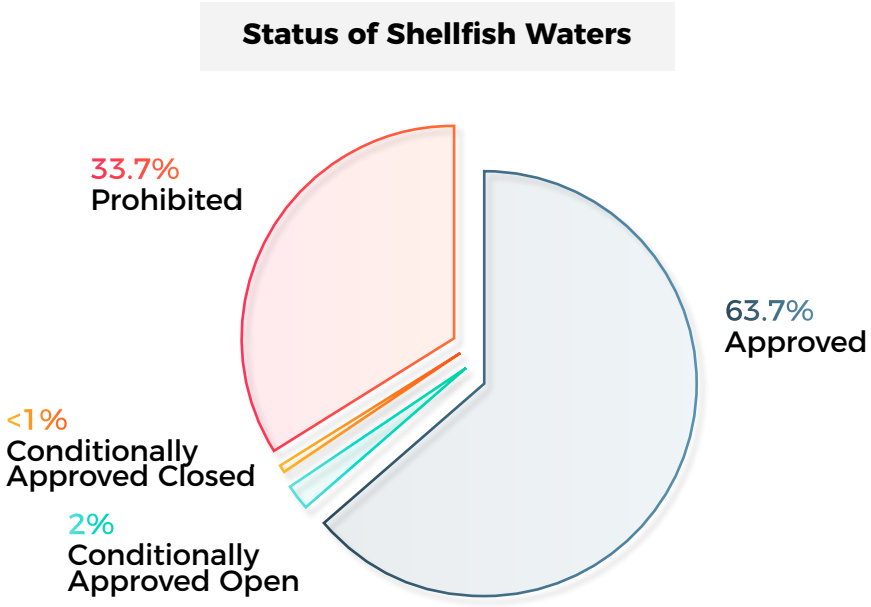
55 Jane Harrison et al, North Carolina's Ocean Economy: A First Assessment and Transitioning to a Blue Economy, January 2017, UNC-SG-17-02.

Between them, the four indicators we hope to track in this section, as well as indicators in other parts of this report, cover most of the six habitat types or major threats to them. Shellfish closures indicate problems with water quality, especially from polluted runoff. Bulkheads draw down the coast's resilience, reflecting wave energy back into vulnerable seagrass beds and soft bottom, while living shorelines offer protection for retreating wetland vegetation as the sea rises. Submerged aquatic vegetation, still poorly monitored, is a key estuarine habitat. This year we present data on fish stocks, but do not draw a trend from it, for reasons discussed below. Thus, two of the indicators provide baselines but no trends, one (shellfish waters) shows a slow trend in the wrong direction, and one (fish stocks) needs more refinement before next year. Net, we see mixed progress towards a sustainable coast.

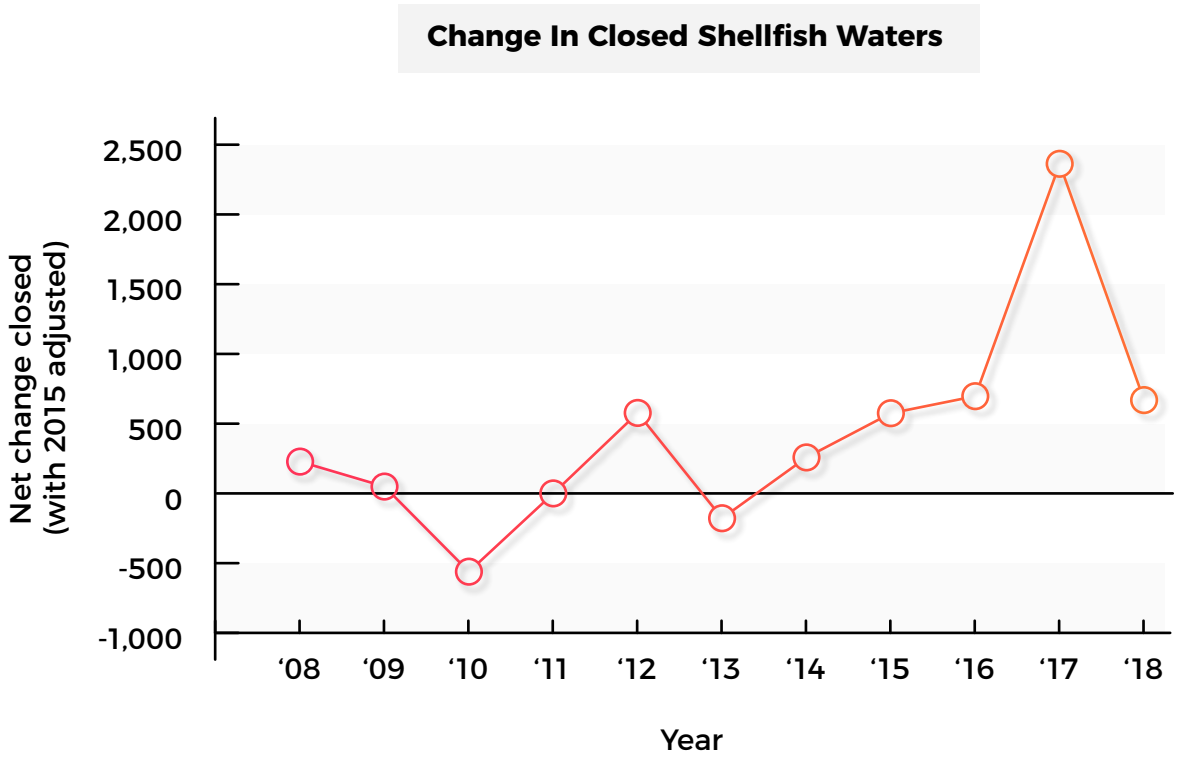
Solutions: To protect our coast, North Carolina should B1, expand oyster mariculture; B2, promote living shorelines over bulkheads; B3, improve maintenance of coastal stormwater measures; B4, expand funding for community conservation assistance; and B5, implement the Coastal Habitat Protection Plan.

Indicator 5.1: percentage of shellfish waters open.

Trend: Falling, bad



North Carolina's coast depends on clean coastal waters – to sustain our commercial and recreational fisheries, to attract tourists to beaches where they won't get sick, to sustain quality of life. One of the simplest indicators of coastal water quality is the oyster. As filter feeders, oysters take in huge volumes of water, spitting it back out, but retaining bits of food and whatever bacteria and particles of pollution are in the water column. Because of that pollution, the state Division of Coastal Management has placed large areas of natural shellfish beds off limits to shellfish harvesting, to protect human health. This indicator tracks the percentage of shellfish waters that are closed to harvesting because of pollution from stormwater runoff.



Note: for readability, this chart omits the 2015 administrative designation of over 314,710 acres as closed, but retains that year's net closure of 575 acres for actual conditions.

North Carolina classes all shellfish waters in one of four categories based on a running five years of data: approved (open except in emergencies); conditionally approved open (default open, but may be closed temporarily after rains); conditionally approved closed (default closed, but occasionally is opened when extended dry weather makes it safe); and prohibited (always closed).[56] For purposes of this indicator, we count conditionally approved open as open, and conditionally approved closed as closed. The data since 2007 shows a slow movement of acres from open to closed, punctuated by a huge jump in closed acres in 2015.[57] The slow trend reflects increasing coastal impervious surface and polluted runoff. The spike reflects a decision by the state agency, driven by legislative budget cuts, to administratively close over 300,000 acres in the Albemarle Sound to shellfishing. The FY18-19 state budget bill included a special provision to re-establish a northern coastal laboratory so these acres can eventually be reopened.[58] Setting aside the administrative closures, the overall trend shows gradually declining coastal water quality taking a toll on the shellfish resource, a trend in the wrong direction.

Indicator 5.2: ratio of living shorelines to bulkhead projects.

Trend: Better

As sea level rises, property owners are tempted to protect their properties for a time by reinforcing them against storms and waves. However, hard surfaces – armoring or bulkheads – reflect wave energy back into the near-shore environment, increasing erosion nearby and wiping out undersea vegeta-

56 North Carolina follows the guidelines of the Interstate Shellfish Sanitation Conference, published by US Food and Drug Administration, National Shellfish Sanitation Program, Guide for the Control of Molluscan Shellfish - 2017 Revision. The protocols for managing shellfish beds start at page 38; the four part classification of beds is at 44.

57 Data received through email from Andrew Haines, Shellfish Sanitation and Recreational Water Quality Section, NC DEQ Division of Marine Fisheries, February 2019.

58 SL2018-5 (S99), Appropriations Act of 2018, Joint Conference Committee Report, at D6.

tion.[59] North Carolina has been a leader among Atlantic Coast States in resisting beach armoring, but landowners along the sounds have had an easier time getting permission to install bulkheads. Working with coastal scientists, the NC Coastal Federation has pioneered a better alternative: 'living shorelines' that absorb rather than reflecting wave energy, while still helping to slow erosion.[60] There is no regularly updated tally of the miles of hardened beach and sound shoreline. However, state and federal regulators do track the linear feet of bulkheads permitted, and the NC Coastal Federation tracks linear feet of living shorelines built annually. The ratio between the two gives an ongoing measure of whether North Carolinians are responding to sea level rise with sustainable or unsustainable strategies.

According to the US Army Corps of Engineers, the Wilmington District (which covers North Carolina) authorized 5,651 linear feet of bulkheads in 2018. Meanwhile, NC Coastal Federation and partners installed 3,098 linear feet of living shorelines at 13 locations,[61] for a ratio of 0.548. We offer this figure as a baseline, hoping it moves towards 1:1 and then beyond in future years.

Indicator 5.3: area of submerged vegetation.

Trend: Baseline

North Carolina's Coastal Habitat Protection Plan describes submerged aquatic vegetation (SAV), one of six vital coastal habitat types, as 'underwater gardens'.[62] SAV is dependent on clear, sediment-free water, and provides rich and essential fish habitat. The annual economic value of the ecosystem services provided by healthy SAV has been estimated at $7,700 per acre.[63] North Carolina has the second-largest acreage of SAV on the East Coast, but it is likely that this represents a loss of as much as 50% of the historic extent.[64] Based on surveys from 1981 through 2011, state scientists in 2016 estimated that North Carolina has roughly 196,000 acres of SAV.[65] Given ongoing pressures, including recent years of heavy rainfall carrying sediment into the estuaries, it is likely that the actual area of SAV today is smaller. State scientists have recognized the need for better tracking of SAV as key data for coastal management, and the state's biennial implementation plan for coastal habitat protection calls for ongoing mapping of SAV and tracking on sentinel sites from which larger trends can be extrapolated. It is likely data on SAV will improve in the next few years; for this year, we count this indicator as providing a baseline.

59 See, for example, Christopher Patrick et al, The Relationship between shoreline armoring and adjacent submerged aquatic vegetation in Chesapeake Bay and nearby Atlantic coastal bays, Estuaries and Coasts, 2016, 39:158-170, DOI 10.1007/s12237-015-9970-2 (finding that armoring in the Chesapeake damaged SAV, and even assisted the growth of invasives in fresher estuarine waters).

60 NC Coastal Federation, website: Living Shorelines, retrieved March 5, 2019; see also, NOAA, website: Understanding Living Shorelines, June 19, 2017.

61 Data received through email from Lexia Weaver, NC Coastal Federation, March 26, 2019.

62 NC DEQ, NC Coastal Habitat Protection Plan, 2016, at 25-26

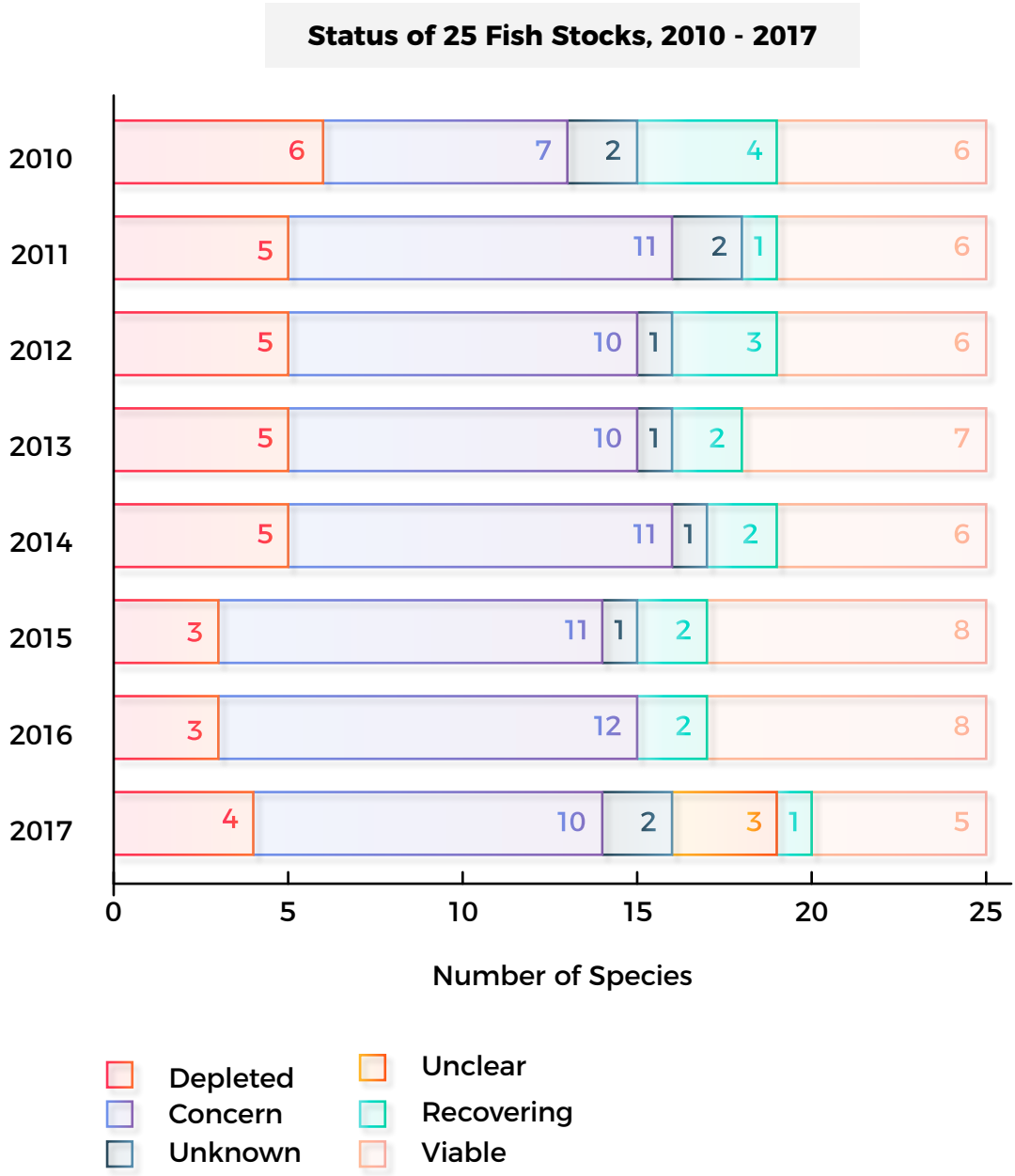
63 NC DEQ, NC Coastal Habitat Protection Plan Source Document, 2016, at 90.

64 Idem, at 97.

65 NC DEQ, NC Coastal Habitat Protection Plan Source Document, 2016, Table 4.3, at 89.

Indicator 5.4: populations of estuarine/marine fish species.

Trend: Unclear



Saltwater fish are of great economic importance to North Carolina's coast, both for the commercial and recreational fishing industries, so multiple species are closely monitored. Collectively, they depend on a wide variety of habitats, ranging from estuarine marshes for reproduction, to hardshell or rock bottoms, to seagrass beds or reefs. State and federal fish managers classify the status of each species as depleted, of concern, unknown, recovering, or viable (for a sustained fishery).[66] Their data, summarized below, tracks changes in the distribution of 21 species (including various subpopulations) and one

66 NCDEQ, Coastal Habitat Protection Plan - Source Document, at 15; Atlantic State Marine Fisheries Commission, ASMFC Stock Status Overview, January 2017; NC DEQ Division of Marine Fisheries, 2017 North Carolina DMF Stock Overview - State Managed Species, July 2017.

species complex.[67] Overall, since 2010 - and allowing for three species whose most recent information is not yet available - the data shows a very gradual net improvement in landings.

For multiple reasons, we decline to count that as a trend. First, we are concerned that landings may be a poor reflection of the actual condition of fish stocks. For some species, abundance may also be a poor signal of the health of North Carolina's coastal habitats. Over the next year, we hope to refine a better indicator that follows a smaller number of species with solid data and a close relationship to the health of North Carolina's coastal habitats.

Water

Five goals address various aspects of water: drinking water quality, surface water quality and quantity, groundwater supplies, water infrastructure, and water affordability.

Goal 6: Public drinking water supplies are safe.

Trend: Mixed

North Carolinians want and expect safe drinking water. We measure progress towards this goal with two indicators: the trend in violations of safe drinking water standards; and the number of unregulated contaminants showing up in water samples collected across the state. The first shows a positive trend, and the second a baseline value for this year. Given the continuing appearance of emerging contaminants in key watersheds - including the Haw RIver and the Lower Cape Fear - beyond what these two indicators can track, we view this goal as showing mixed progress this year.

Solutions: North Carolina can better protect public drinking water supplies by C2, updating surface water quality standards; C3, updating groundwater quality standards; C4, cleaning up nutrient-impaired lakes; C6, improving sludge management; C7, transitioning away from swine waste sprayfields; F2, funding lead testing and remediation; F4, funding monitoring of emerging contaminants; F5, limiting the discharge of perfluorinated toxics; and F6, banning the use of aqueous fire-fighting foams.

Indicator 6.1: number of drinking water violations.

Trend: Falling, good

	TYPE OF VIOLATION			
	STANDARDS	TREATMENT TECHNIQUE	MONITORING/ REPORTING	OTHER
2014	499	150	3369	2228
2015	531	95	3033	2402
2016	178	107	3958	1976
2017	139	76	2919	1883

At any given time, the vast majority of North Carolina's public water systems are in compliance with federal Safe Drinking Water Act standards. When new drinking water standards are adopted, they are usually phased in over a period of years, starting with the largest systems first. Typically, heavy violators are smaller systems that serve small communities, such as mobile home parks. This indi-

67 The various species, populations, and complexes are: American shad, Atlantic croaker, American eel, Atlantic menhaden, Bay scallops, Black drum, Black sea bass (N. of Hatteras), Black sea bass (S. of Hatteras), Blue crab, Bluefish, Gag, Oysters, Red drum, Reef fish (Snapper-Grouper Complex), River herring (Albemarle), Shrimp, Southern flounder, Spot, Spotted seatrout, Striped bass (Albemarle), Striped bass (Central/southern), Striped bass (Ocean), Striped mullet, Summer flounder, and Weakfish.

cator tracks the number of violations of state and federal drinking water rules, grouping them into violations of standards (the water exceeds a health standard), treatment technique violations (the utility did not carry out the water treatment process correctly), failure to monitor and report (which may or may not obscure an actual violation of standards), and 'other' violations. North Carolina's Public Water Supply (PWS) program, part of the Division of Water Resources in the NC Department of Environmental Quality, publishes this data for the preceding year each June.[68] Because the organization of the reports changed significantly in 2013, we present the trends from 2014-2017. The state reports show declines in all kinds of violations. That reflects water systems becoming accustomed to implementing the two newest federal drinking water rules, governing toxic disinfection byproducts and concentrations of lead and copper. Because violations are falling across the board, we evaluate this indicator as showing progress.

Indicator 6.2: prevalence of chemicals on the UCMR in public water supplies.

Trend: Baseline

While the vast majority of North Carolina's water systems comply with federal drinking water standards, many pollutants – including algal toxins, certain pesticides, and some toxic byproducts of the disinfection process – have no drinking water standard. EPA has been extremely slow to add standards for additional pollutants. Instead, the agency requires large water systems, and a random sample of smaller systems, to monitor – but not treat – a number of these compounds under the Unregulated Contaminant Monitoring Rule (UCMR). Under the Safe Drinking Water Act, EPA lists up to 30 UCMR chemicals for monitoring over each five-year period; we are currently in the Fourth UCMR, 2017-2021.[69] For each chemical, EPA sets a 'minimum reporting level', not based on a judgment of what concentrations are safe or unsafe, but at the smallest concentration laboratories can detect.[70] Water systems that find UCMR chemicals in their water are required to let their customers know as a part of the annual 'consumer confidence reports' sent to each household.[71]

Our indicator is the percentage of matched contaminant-samples that measure the presence of a UCMR contaminant. If a system sampled its treated water for 18 contaminants and found 3, we treat that as 3 out of 18 contaminant-samples. In 2018, North Carolina utilities reported 1,157 discrete contaminant samples, with 297 hits for contaminants on the UMCR4 list. In other words, UCMR4 contaminants showed up in 25.7% of samples. The specific contaminants found were were unregulated disinfection byproducts (253), manganese (40), germanium (1), and the algal toxin microcystin (1).

It is worth noting that the UCMR4 list does not include a number of other emerging but unregulated contaminants of concern, many of which have been found in state waters and are not removed by conventional drinking water treatment process. These include perfluorinated compounds (the family that includes GenX), several of which have been found in the Upper Cape Fear.[72] Other chemicals that occur widely and are not removed by most drinking water treatment processes include birth control hormones, various pharmaceuticals, and breakdown products from tire rubber.[73]

68 NC DEQ, Public Water Supply, North Carolina's Annual Public Water Systems Compliance Report for calendar years 2009-2017.

69 See US EPA website: Fourth Unregulated Contaminant Monitoring Rule (2018).

70 US EPA, The Fourth Unregulated Contaminant Monitoring Rule (UCMR4): Data Summary, October 20, 2018, at 3.

71 See, 40 CFR 141.153(d)(7), describing the required elements of the Consumer Confidence Report.

72 Kirk Ross, Elevated pollutants in rivers suspected in many parts of NC, Carolina Public Press, February 28, 2019.

73 Paul Bradley et al. Expanded Target-Chemical Analysis Reveals Extensive Mixed-Organic-Contaminant Exposure in USA Streams, 51 Environ Sci Technol 4792–4802 (2017).

Goal 7: surface water quality and flows are healthy.

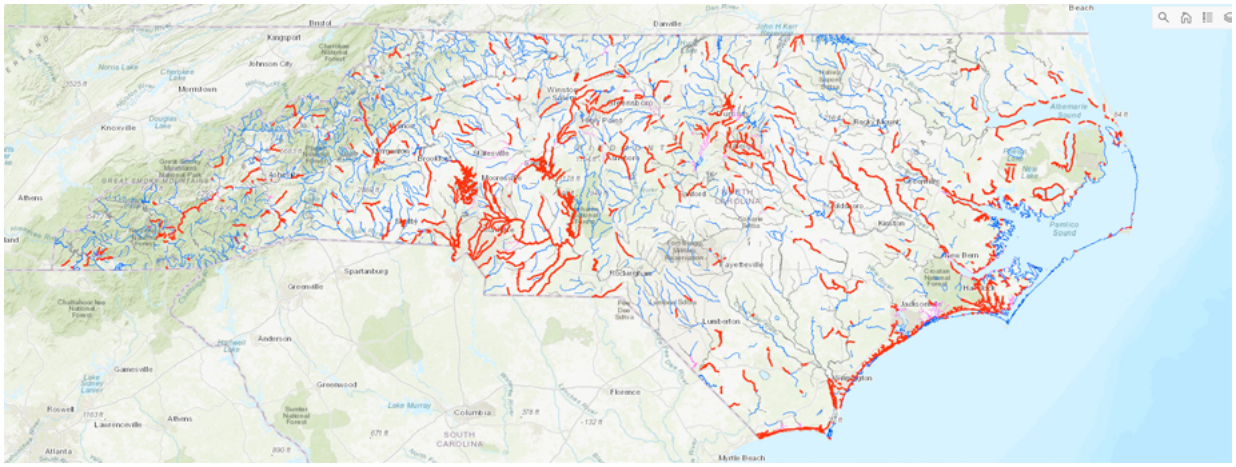
Trend: No change

To assess trends in surface water quality, we consider two indicators: the percentage of water bodies supporting their designated uses - for fish and wildlife, swimming, boating, or drinking - and the health of benthic organisms. The first yields a baseline this year; the second, signs of stasis. A third indicator, the adequacy of flows, is not yet supported by state analyses. Altogether, for this year, we identify neither progress towards nor backsliding from the goal of healthy surface waters.

Solutions: North Carolina can improve surface water quality and flows through all the water solutions, C1 - C8; and also through D4, reducing transportation-related air pollution; and F3 - F5, addressing emerging contaminants, including perfluorinated compounds. Authorizing local governments to adopt water-neutral growth ordinances, L3, is a key step to managing surface water flows sustainably.

Indicator 7.1: percentage of waterbody segments 'fully supporting' their assigned uses.

Trend: Baseline



This map shows waterbodies in North Carolina that meet water quality standards (blue), do not meet standards but have a cleanup plan (pink), or are impaired without a plan (red), from NC DEQ's 2018 list of impaired waters. Map credit: NC DEQ, Division of Water Resources.

The federal Clean Water Act aims to keep our rivers, lakes, and estuaries fit for all the ways we use them, and – at a minimum – safe for fish and wildlife. To that end, state environmental managers regularly test the quality of surface waters across the state, dividing waterbodies and rivers into 'segments' to better articulate where problems are. North Carolina has identified over 13,000 segments, but the state only collects data on between 3,000 and 4,000 of these in any given 5 year period.[74] The state is required to report the results of those tests to the US EPA every other year in a document called the 'Integrated Report'. The Integrated Report, based on the rolling previous five years of data, identifies waters that are not meeting water quality standards (these are called 'impaired') and describes the condition of all other waters as well. In any given five year span, many waters are not sampled, and many smaller streams have never been checked. Still, the list of impaired waters is the most comprehensive indicator we have for the health of our surface waters.

For this report, we rely on the 2018 impaired waters list, submitted to EPA in late March 2019. The full 2018 Integrated Report will be finished later this year, past the cutoff for this report, but the impaired

74 NCDEQ, Division of Water Resources, Annual Report to the General Assembly Environmental Review Commission, July 2017 to June 2018, at 22.

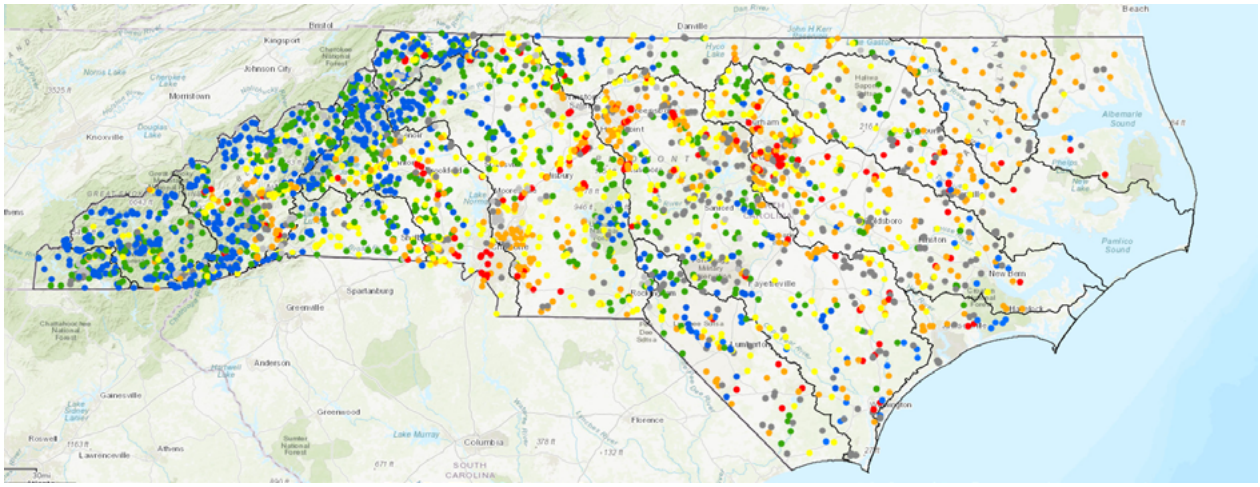
waters list provides sufficient data for this indicator. The data window for the 2018 list covers the years 2012-2017. All waters in the state are listed as impaired for mercury in fish tissue, but we exclude that from our analysis of trends, as otherwise that blanket impairment would mask all other improvements or declines in water quality.

For the 2018 impaired waters list, roughly 1,600 thousand segments met all water quality standards (except for mercury contamination in fish). Another 749 lacked sufficient data for state scientists to reach a conclusion using the state's listing methodology. Of the segments not meeting at least one federal water quality standard, 1,200 had no cleanup plan, while 162 did.[75] Altogether, excluding mercury contamination in fish, we calculate that roughly 37% of the segments are not meeting water quality standards, 42% are, and for 20% insufficient data means their status is unclear.

Impairment information has always been public, but the agency is gradually improving the way it is presented over time. Because past presentations have been structured differently, we cannot easily compare the 2018 results to 2016 or 2014 assessments, and so are classing this indicator as providing a baseline rather than a trend this year.

Indicator 7.2: percentage of waterbody segments with excellent or very good benthic health.

Trend: No change



This map shows the cumulative assessments of the health of benthic (water-bottom) life across the state. Map credit: NC DEQ, Division of Water Resources.

A key indicator of a stream's biological health is the vitality and diversity of the organisms that live on the bottom – the 'benthic' life, which also comprises the base of the aquatic and nearby terrestrial food web. State scientists assess benthic health along with sampling for other water quality data, and segments of streams rivers, lakes, and estuaries can be labelled as impaired for poor benthic communities.[76] Indeed, some 267 of the segments listed as impaired in 2018 are listed for benthic impairment.[77] Many of those have been so listed for years. The map above shows the cumulative results of decades of benthic sampling. The map provides no insight into trends, but the spatial distribution is evident: healthy streams (green and especially blue) are clustered in the mountains and the Sandhills, and a few are scattered across other rural counties. Runoff from the cities and roadways of the Piedmont crescent has scoured local streams (orange and especially red), devastating stream health in those watersheds.

75 NC DEQ, Draft Integrated Report Online Map, Assessment Unit Ratings Summary, visited February 23, 2019.
76 NCDEQ, Benthic Macroinvertebrate Community Assessment Program: Quality Assurance Project Plan, 2017.
77 NC DEQ, Draft Integrated Report Online Map, Step 4: List Parameter Summaries, visited February 23, 2019

For this indicator, we consider the number of segments newly listed as impaired for poor benthos against the number found to have recovered healthy benthic communities, for a sense of the net trend since the 2016 list. For the 2018 list, 8 segments are newly listed for impaired benthos. Meanwhile, 5 segments previously impaired for benthos are being delisted because they are now healthy; 2 are being delisted because they were previously listed through a data error; and 3 are being moved to a different category to reflect that a cleanup plan has started, though the streams are still years from regaining benthic health. That adds up to a net change of one more unhealthy stream, easily lost in the year to year noise. So, for this year, we evaluate benthic health as treading water, neither improving nor declining.

Data gap: river flows. River flows – high and low – are a key determinant of river health. Thanks to state legislation enacted in 2010, North Carolina's Department of Environmental Quality is modelling flows, withdrawals, and discharges to all of the state's 17 river basins.[78] As a result of the same legislation, a team of scientists studied North Carolina's waters and concluded that cumulative removal of more than 10% to 20% of river flows would jeopardize river health.[79] State environmental managers boiled this down to a possible rule of thumb: cumulative withdrawals greater than roughly 15% of flow at any point in a watershed probably need close scrutiny.[80] However – in contrast to water quality, which the state evaluates every two years – there is no official evaluation of whether actual flows remaining in our watersheds are sufficient to sustain river health.

Goal 8: Groundwater resources are being used sustainably.

Trend: Good

Over the last two decades, scientists and water managers have become increasingly explicit about the link between groundwater and surface water features: many kinds of wetlands are pathways for groundwater recharge, and groundwater supplies the base flow for most of our streams and rivers during drier months of the year. So, although we include separate goals for surface and groundwater, the two are really part of a single hydrological system.

Across the nation, American communities are withdrawing groundwater - for agriculture, industry, and residential uses - faster than it can naturally recharge.[81] North Carolina is generally blessed with abundant rainfall and groundwater resources, but even here, there are limits to how much groundwater can be sustainably withdrawn. For this goal, we track two indicators: groundwater levels in the Coastal Plain, as represented by conditions in the two aquifers under the greatest stress from heavy use; and well levels across the state generally. In a largely successful effort to avert an incipient crisis, North Carolina has poured resources into studying the Coastal Plain aquifers, and this indicator shows a positive trend. Statewide data needs analysis, but shortages do not appear to be looming, so we assign this goal a positive trend this year.

Indicator 8.1: levels in the Central Coastal Plain Capacity Use Area.

Trend: Good

The Central Coastal Plain Capacity Use Area (CCPCUA) was established by North Carolina's Environmental Management Commission (EMC) in 2003, five years after scientists and water managers

78 SL2010-143, codified at N.C. Gen. Stat. § 143-355(o).

79 North Carolina Ecological Flows Scientific Advisory Board, Recommendations for Estimating Flows to Maintain Ecological Integrity in Streams and Rivers in North Carolina, November 2013.

80 Tom Fransen, Report of the Ecological Flows SAB What does it mean for water planning and policy?, presentation to the UNC Institute of Government, March 21, 2014.

81 L.F. Konikow, Groundwater depletion in the United States, 1900–2008, 2013, U.S. Geological Survey Scientific Investigations Report 2013–5079.

realized that overpumping was dropping water levels in two economically vital aquifers in the North Carolina coastal plain. The Cape Fear and Black Creek aquifers are two of a series of water-bearing rock layers, arranged like a layer cake under a 13-county region of eastern NC. Given declining water levels, users depending on these aquifers were going to pump their wells dry. In an effort to forestall a crisis, the rule adopted by the EMC required users pumping from these two aquifers to cut their withdrawals by 25% in 2008, another 25% in 2013, and – if necessary – a final 25% in 2018 – or until water levels stabilized.[82]

Our indicator is the stability of water levels in the Cape Fear and Black Creek aquifers. The state Division of Water Resources' status report for 2018 found that water levels have stopped dropping and have even recovered a bit.[83] Some users reduced their water use; some communities switched to other aquifers or invested in new infrastructure to withdraw surface waters. State hydrogeologists are monitoring saltwater intrusion on the eastern edge of the aquifers, where sea level rise could force brackish groundwater up into the zone that communities are using.[84] Overall, the CCPCUA is a regulatory success story, and the trend for this indicator is positive.

Indicator 8.2: percentage of groundwater wells in state network with declining levels for more than 3 years in a row.

Trend: Unclear

Most of North Carolina's other groundwater resources are not so well studied as those in the Central Coastal Plain Capacity Use Area. In the Piedmont and the Mountains, groundwater is typically pumped from fractures in bedrock. State hydrogeologists would like to have a broader and denser dataset of groundwater resources, and have been slowly expanding the network of groundwater monitoring stations. The network now consists of 668 wells at 229 locations, heavily weighted to the Coastal Plain.[85] In theory, one could track the percentage of these wells that show steady declines over several years not accounted for by drought. In fact, state staff watch this data for odd signals, to identify places where shortages may be looming. However, distinguishing the signal from the noise for each well takes regression analysis, and the state does not conduct or publish those systematically. We are not treating this as a data gap – the data is robust, and available to the public – but we cannot draw any conclusions this year. State regulators have shared their professional sense that, although there are limits to the available groundwater, North Carolina does not yet appear to be running up against those limits except in rare and specific situations. For this year, lacking a systematic analysis, we count this as unclear.

Goal 9: North Carolina water systems are fiscally sustainable and resilient.

Trend: No trend

Good surface and drinking water quality requires healthy and well-managed utilities. To be sustainable over time, our water and wastewater systems must be fiscally viable and physically safe from destruction in storms and floods. Readily available data shows that just over 70 systems appear fiscally unsustainable, and need some intervention and resolution. On the other hand, although the data exists,

82 15A NCAC 02E .0501 - .0507.

83 NC DEQ Division of Water Resources, Ground Water Management Branch, Central Coastal Plain Capacity Use Area Assessment Report, June 2018.

84 Idem. See also, Kristen McSwain et al, Hydrogeology, hydraulic characteristics, and water-quality conditions in the surficial, Castle Hayne and Peedee aquifers of the greater New Hanover County area, North Carolina, 2012–13: U.S. Geological Survey Scientific Investigations Report 2014–5169. http://dx.doi.org/10.3133/sir20145169.

85 NC Division of Water Resources, Ground Water Management Branch, 2018 Annual Report. 2018.

no agency seems to have assessed to cumulative risk of flooding to water and wastewater systems statewide. Working from the two indicators, we cannot assign a trend to this goal this year.

Solutions: North Carolina would do well to M1, provide a transition path for fiscally non-viable water and wastewater systems, and M2, for fiscally non-viable municipalities. In addition, the state should work to M3, remove repetitive-loss infrastructure from the floodplan, and M4, use state flood-modeling capacity to site new infrastructure in safe locations.

Indicator 9.1: number of water systems where debt and operating costs exceed revenue.

Trend: Baseline

One critical measure of the sustainability of a water utility is whether it raises enough revenue to cover its operating costs and pay off long-term debt from capital expenses. Of the 341 public systems in North Carolina that answered a survey question on this in 2017, 21% did not raise enough revenue to cover operations and debt; that includes 10% that did not raise enough revenue even to cover their operating costs (including depreciation).[86] All of these systems have fewer than 10,000 connections. For some in the Coastal Plain, damage from Hurricane Florence has brought on the day of reckoning all too soon.[87] One challenge facing the NC General Assembly as it tackles hurricane recovery is to chart a viable path for these systems and their customers.

In its 2018 annual report, the NC Water Infrastructure Authority argues that such non-viable systems need to explore combining or contracting with other water systems.[88] There's also a connection between viability problems and water affordability on a household scale, discussed under indicator 10.1, below. As the Authority notes, "some of the smallest, most economically distressed communities have some of the highest water and sewer rates in the state."[89] There is no simple answer to this problem, but it also won't go away without state intervention.

Even when a utility can cover operating costs and long-term debt from its revenues, it may not be able to cover new capital costs or make major emergency repairs. In response to a survey from the UNC Environmental Finance Center, just 53% of 195 public utilities said they were generally able to cover more than half of their planned and emergency capital improvements from cash balances, capital funds, or debt capacity (that is, without state or federal grants). Only 24% said they could likely cover all planned or unplanned capital improvements.[90] As existing infrastructure ages, the state will need a strategy to ensure that the rest of the utilities can replace their failing systems.

Because the data offers a snapshot rather than a trend, we present the indicator as a baseline value this year.

Indicator 9.2: number of water systems with critical infrastructure in the 100-year floodplain.

Trend: Unclear

One week after Hurricane Florence, out of 758 drinking water treatment plants in the affected area, 16 systems were not producing water, and another 49 were operating with difficulty. Out of 474 wastewater plants, 15 were non-operational and 24 were only partially operational. Altogether, 59 facilities released

86 UNC Environmental Finance Center, 2018 North Carolina Water & Wastewater Rates Report, January 2018, at 25. A map showing the location of all the systems is at 28.

87 Kirk Ross, Florence Adds to Woes of Struggling Water and Sewer Systems, Carolina Public Press, October 10, 2018.

88 NC Water Infrastructure Authority, Annual Report, 2017-2018 Fiscal Year, September 2019, at 2-13, 2-14.

89 Ibid, at 2-14.

90 UNC Environmental Finance Center, Results of the 2017-2018 North Carolina Water and Wastewater Utility Management Survey (August 2018), at 9.

a total of 44.6 million gallons of untreated sewage directly to surface waters.[91]

Hurricanes Matthew and Florence flooded water and wastewater infrastructure well outside the 100-year floodplain, but facilities within that floodplain were particularly hard hit. A system in the 100-year floodplain is more likely to spill untreated sewage during a flood, and to experience damage to equipment that is costly to repair. For that reason, the number of water systems with critical infrastructure in the 100-year floodplain is an indicator of risk. North Carolina is fortunate to have excellent flood mapping capabilities, and the state program is in the process of generating detailed county-by-county analyses of vulnerability to flooding, down to the level of individual structures.[92] As best we can determine, however, no state entity has filtered and aggregated this information to evaluate the specific risk to waste and wastewater systems. For that reason, we assign no trend to this indicator this year.

Goal 10: North Carolinians have access to affordable clean water.

Trend: No trend

Clean drinking water and effective sanitation are essential for public safety and quality of life, but they are not free. Practical access to affordable drinking water and wastewater is a key element of environmental justice. For this goal, we track a single indicator: the affordability of public water and sewer service as measured against household income, but assign no trend to this goal this year.

Solutions: Building consideration of environmental justice, E1, into state and local infrastructure decisions will help assure water affordability, as will M1 and M2, providing transition paths for fiscally non-viable water systems and local government.

Indicator 10.1: affordability of public water and sewer service.

Trend: Baseline

Roughly 73% of North Carolinians are dependent for their water on public water utilities; another 8% depend on private water providers, and the remaining 19% rely on private wells.[93] On the wastewater side, we have found no recent estimates of the split between public and on-site wastewater management, though a standard but possibly obsolete estimate is that nearly half of North Carolina households depend on septic systems.[94] For this indicator, we focus on the rates paid by those connected to publicly-owned drinking water and wastewater utilities.

Until recently, a standard indicator of affordability has been the number of households for which drinking water costs exceeded 2.5% of income, or wastewater costs exceeded 1.5%. That arbitrary threshold was derived from a cost-based test used by the US EPA to determine whether a given drinking water treatment upgrade would create affordability problems for a community: would the new rates need

91 All statistics from Jim Gregson, NC DEQ Division of Water Resources, Hurricane Florence Impact on Water and Wastewater Facilities, presentation to the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources, November 13, 2018.

92 See, Randy Mundt and Scott Gentry, NC Department of Public Safety Floodplain Management Section, NC Flood Risk: Strategies for Resilience, presentation to NC Environmental Management Commission, Water Allocation Committee, March 13, 2019.

93 This is derived from US EPA, Safe Drinking Water Information System search, retrieved March 20, 2019. According to EPA's data, 7,388,003 North Carolinians receive water from systems owned by local government, 172,341 from federal systems (mostly military bases), and 780,000 from privately-owned water systems. Given a 2018 state population of 10.38 million, this implies that just over 2 million North Carolinians are on private wells. USGS estimates that 24% percent of North Carolinians are self-supplied from private groundwater wells. US Geological Survey, Estimated Use of Water in the United States, 2015, Table 6, at 23.

94 US EPA, webpage: Septic Systems Overview, December 4, 2018; see also, Julia Marie Naman and Jacqueline MacDonald Gibson, Disparities in Water and Sewer Services in North Carolina: An Analysis of the Decision-Making Process, Am J Public Health, 2015, 105:10, 10.2105/AJPH.2015.302731.

to be more than 2.5% of median household income for the utility's service area.[95] Even in its original context, this threshold was arbitrary, and has no intrinsic relationship to affordability for low-income residents, whose incomes are not represented by the median household income of the utility's service area.[96] For example, a recent analysis finds that residents at the 20th percentile income in Charlotte are likely paying an average of 6.6% of their monthly income for water and sewer service.[97] EPA's National Environmental Justice Advisory Council, in draft recommendations published in August 2018 and not yet finalized, has recommended that "EPA should update its affordability measures based on low income affordability ratios" rather the median household income metric.[98]

North Carolina is fortunate to host the nation's most complete resource for data and analysis on water rates and affordability, the Water Rates Dashboard at the Center for Environmental Finance at UNC's School of Government.[99] The dashboard is structured to provide system-specific analysis, but the Center's team conducts an overarching annual analysis of rates. While acknowledging the limits of the indicator, the 2018 analysis found that 57% of utilities in North Carolina charged more than 2.5% of median household income for 5,000 gallons/month of combined water and sewer service.[100] The analysis notes that the burden must be significantly higher for many low-income families. A downloadable spreadsheet offered by the Center allows local utilities to construct their own more nuanced analysis of the impacts of their rates, including using low income affordability ratios.[101] For this year, we present this as a baseline, hoping to identify a better statewide metric in the future.

Inability to keep rates within a zone of affordability can be a sign that a utility is struggling financially. One escape that some systems consider is to privatize, selling the system to a private company. Rate increases almost always follow, hitting lower-income ratepayers hardest. In North Carolina, private systems are regulated by the NC Utilities Commission, which has been criticized for allowing private water providers to raise rates without improving service or making significant capital investments in failing systems.[102]

Another dimension of water access and environmental justice is whether neighborhoods can get access to public water and sewer service at all, compared to other neighborhoods with similar spatial relationships to public systems. Recent papers have found disparities in public water service to peri-urban neighborhoods and attributed this to historically racist exclusion of these neighborhoods, perpetuated by a current focus on extending service only when the project is likely to have a positive financial return for the local government (via water bills and property tax revenue).[103] This has real implications for disparities in health outcomes, property values, and quality of life; one recent study found that 99% of emergency room visits for acute gastrointestinal illness were associated with contamination of private wells, generally from septic systems.[104] We recognize this as a continuing environmental justice problem, but do not have a metric to evaluate it this year.

Agriculture

This section considers three goals for North Carolina agriculture: that it is economically viable and rewarding for farmers; that agriculture manages farmland sustainably; and that intensive animal agriculture acts as a good neighbor.

95 Brett Walton, When it comes to water service how expensive is too expensive?, Circle of Blue, April 24, 2017.
96 Ibid; see also, Shadi Eskaf, Percent MHI as an Indicator of Affordability of Residential Rates: Using the U.S. Census Bureau's Median Household Income Data, The Environmental Finance Blog, January 9, 2013.
97 Manuel Teodoro, Measuring household affordability for water and sewer utilities, Journal of the American Water Works Association, January 2018, 110:1, at Table 3.
98 EPA, National Environmental Justice Advisory Council, EPA's Role in Addressing the Urgent Water Infrastructure Needs of Environmental Justice Communities, August 2018, at 20.
99 UNC Environmental Finance Center, website: NC Water and Wastewater Rates Dashboard, January 2019.
100 UNC Environmental Finance Center, 2018 North Carolina Water & Wastewater Rates Report, January 2018, at 23.
101 UNC Environmental Finance Center, tool: Water and Wastewater Residential Rates Affordability Assessment Tool, December 2018.
102 See, for example, Clean Water for North Carolina, The Stealthy Takeover of NC Drinking Water, 2014.
103 Julia Marie Naman and Jacqueline MacDonald Gibson, Disparities in Water and Sewer Services in North Carolina: An Analysis of the Decision-Making Process, Am J Public Health, 2015, 105:10, 10.2105/AJPH.2015.302731; Hannah Leker and Jacqueline MacDonald Gibson, Relationship between race and community water and sewer service in North Carolina,USA, PLoSONE, 2018, 13:3.https://doi.org/10.1371/journal.pone.0193225.
104 Nicolas DeFelice, et al, Reducing emergency department visits for acute gastrointestinal illnesses in North Carolina (USA) by extending community water service, Environ Health Perspect, 2016, 24:10, 1583, https://doi.org/10.1289/EHP160.

Goal 11: Agriculture is economically viable and rewarding for farmers.

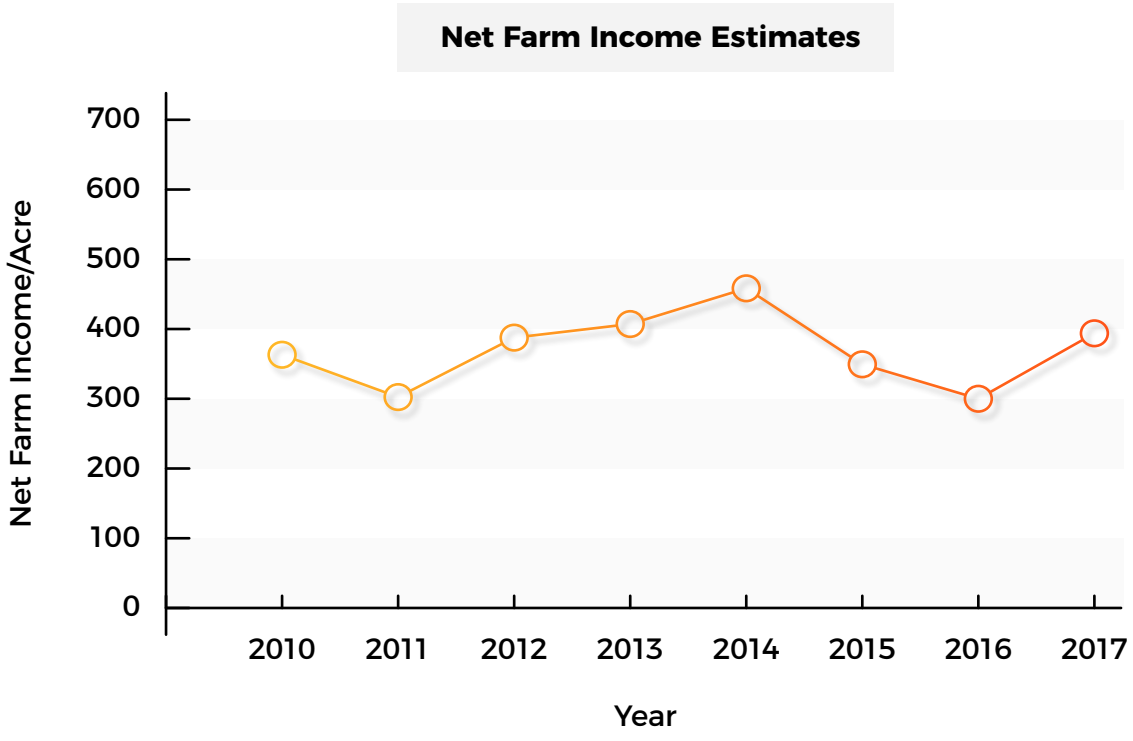
Trend: Mixed

Last year was challenging for many North Carolina farmers. Hurricane Florence caused an estimated $1.1 billion in agricultural losses.[105] The potential for agriculture to be caught in the crossfire of a trade war with China worried many farmers. On top of those uncertainties, strong national harvests of corn and soybeans over the last few years have meant that prices are lower, lowering returns to some farmers, even as production costs have increased. To evaluate this goal - that agriculture remain economically viable and attractive to farmers - we examine three indicators: net farm income per acre; net number of farms and farm acres in use; and the acreages of farms taking advantage of policies designed to keep land in agriculture. The results for the indicators are mixed, so we report mixed trends for this goal this year.

Solutions: There are undoubtedly solutions beyond the scope of this report, but A4, funding the Agricultural Development and Farmland Preservation Trust Fund; A5, investing in floodplain restoration; A6, establishing incentives for reforestation; H1, establishing healthy food financing; H2, promoting farm to school initiatives; K4, avoiding induced sprawl in transportation planning; and L2, adopting local farmland protection plans, could all help.

Indicator 11.1: net farm income per acre

Trend: No Trend



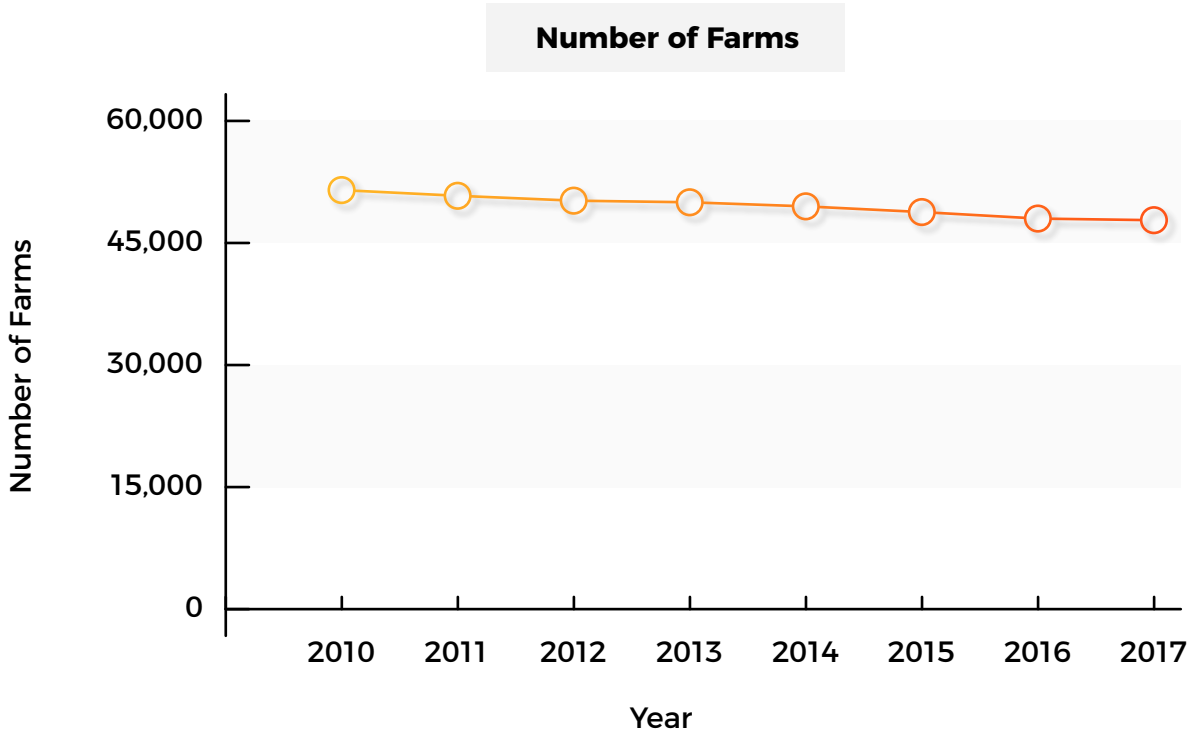
A basic determinant of whether farming remains economically viable is whether farmers can reliably make enough money to cover costs, manage debt, and support their families. Estimates of net farm income are available annually from the USDA Economic Research Service.[106] Based on these estimates, we have calculated net farm income per acre, 2010-2017. That's somewhat misleading, though, since

105 NC Department of Agriculture, Total agricultural losses estimated at over $1.1 billion, Sept. 26, 2018.
106 USDA, Economic Research Service, Farm Income and Wealth Statistics /Value added years by State, November 2018.

two-thirds of the value of North Carolina's agricultural production comes from animal agriculture, with an ownership structure and land use patterns that differ significantly from row crop and pasture agriculture. Thus, in 2017, North Carolina ranked 4th among the 50 states in aggregate net farm income, behind California, Texas, and Iowa, even though our state ranked only 32nd in farmland acreage.[107] The ERS data smears it all together, as does North Carolina's own annual compendium of agriculture statistics.[108] Net farm income per acre since 2010 shows a great deal of volatility, ranging from $300 to over $450 per acre, with no overarching trend.

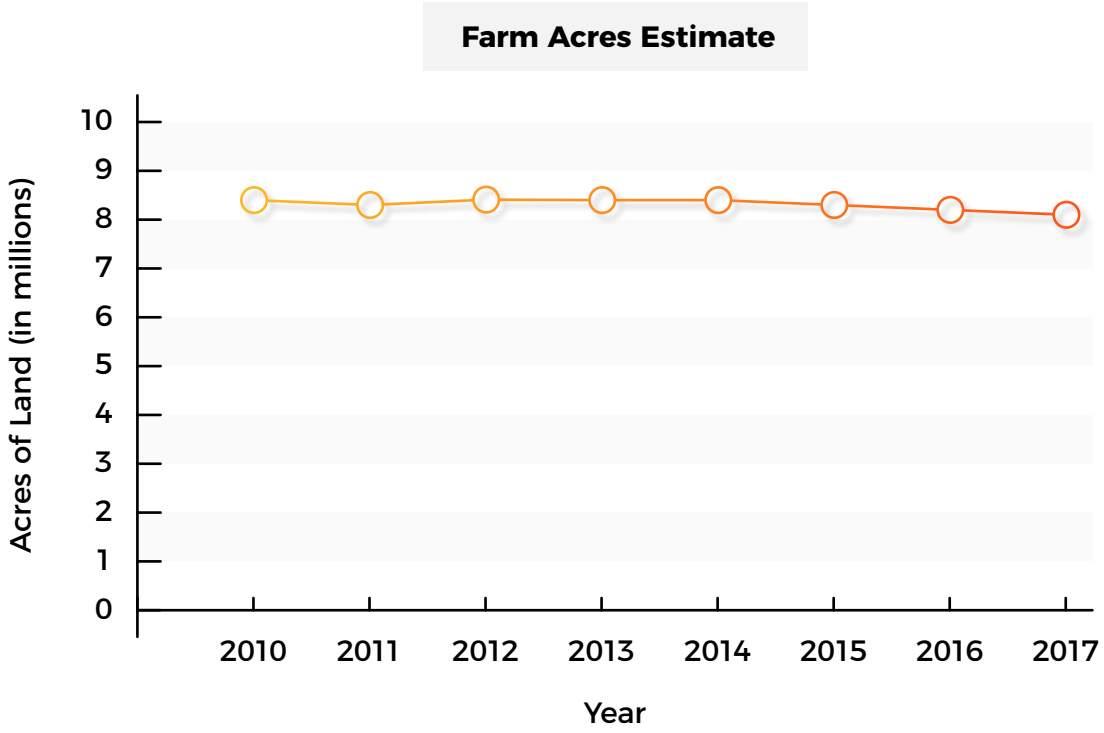
Indicator 11.2: acres in farm and agricultural use

Trend: Declining, bad



107 USDA Economic Research Service, Farm Finance Indicators, State Ranking, 2017; USDA National Agricultural Statistics Service, June Area Survey, Acres of farmland, 2017.

108 NC Department of Agriculture, North Carolina Agricultural Statistics 2017.



An empirical measure of whether agriculture remains viable is the acreage that stays in farm and agriculture use, as opposed to being abandoned or developed. The gold standard for agricultural statistics is the National Census of Agriculture, compiled and released every five years (2002, 2007, 2012) by the US Department of Agriculture. The 2017 edition was scheduled to be released in February 2019, but, delayed by the federal government shutdown in January, it is now scheduled for release in May 2019. That data will inform our analysis next year, but in the meantime, for this year, we rely on estimates from USDA's Economic Research Service, which suggest that the acreage in farm and agricultural use in North Carolina is gradually declining, as is the number of farms.[109]

Nationally, land being lost to development is some of the better cropland. American Farmland Trust, in a 2018 report built on a 2011 base layer of land cover data, concludes that "by 2012, the best land to support intensive food and crop production comprised less than 17 percent of the total land area" of the United States.[110] In addition, rising sea levels and saltwater intrusion threaten an unknown acreage of farmland in North Carolina's eastern counties.[111] We have found no analysis of the quality of farmland being lost specifically in North Carolina, but the trend for farmland and number of farms is running in the wrong direction.

109 USDA, Economic Research Service, Get to Know Farms in North Carolina, 2010-2017.

110 American Farmland Trust, Farms Under Threat, 2018, at 24.

111 Sarah Kaplan, Ruined crops, salty soil: How rising seas are poisoning North Carolina's farmland, Washington Post, March 1, 2019.

Indicator 11.3: total acres of farmland preserved in North Carolina.

Trend: Rising, good

Voluntary Agricultural Districts

10,183 farms enrolled

833,354 acres of farmland and forest

122 easments

16,614 acres protected

Several policies currently help preserve farmland in North Carolina. The NC Department of Agriculture calculates that as of December 2018, 90 of the state's 100 counties had county ordinances for Voluntary Agricultural Districts (VAD). Of those, 30 had 'enhanced' VAD, meaning that landowners can make a 10-year irrevocable commitment to keep the land in agriculture, with default renewal, and priority for various incentive payments.[112] Statewide, 10,183 farms are enrolled in VAD programs, covering 833,354 acres of farms and forests.[113] On a smaller scale, the Agriculture Development and Farmland Preservation Trust Fund estimates that, as of 2018, 132 farms have farmland protection easements that limit conversion of 18,586 acres.[114]

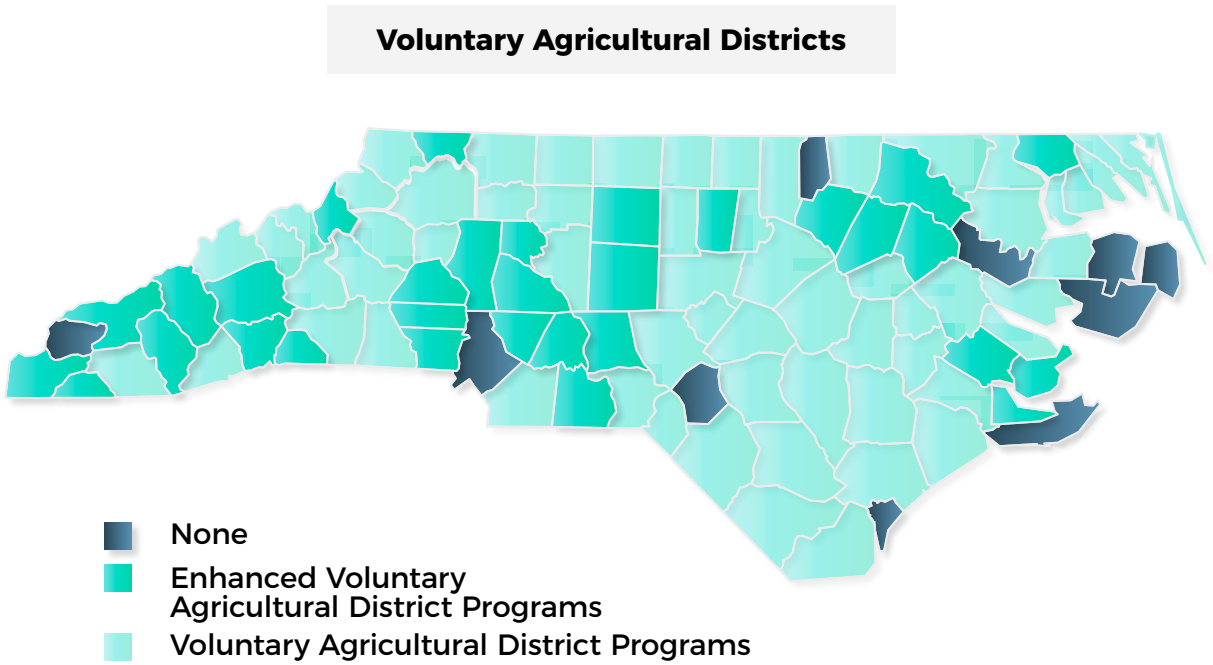
112 NC Agriculture Development & Farmland Preservation Trust Fund, Enhanced Farmland Protection for North Carolina Landowners.

113 NC Department of Agriculture, website: Voluntary Agricultural Districts, visited February 14, 2019.

114 American Farmland Trust, Farmland Information Center, Status of State PACE Programs, 2018.

North Carolina also provides a tax incentive to landowners who commit to keep land in farming, horticulture, forestry, or wildlife management. Known as 'present use value', the state law directs counties to assess property taxes on enrolled farmland at a lower rate.[115] If landowners withdraw property from the program for development, they must pay a penalty of several years' worth of back taxes at the full market rate. The data for this program is kept at the county level, and focuses on the value rather than the acreage covered, so is not readily available for inclusion here. Nonetheless, present use value is a vital tool to keep rising property values from pushing land-rich but cash-poor farmers off their land.

Based on the data that is available for voluntary agricultural districts and agricultural easements, we assess this indicator as moving in the right direction.



Map credit: adapted from NC Department of Agriculture.

Goal 12: Agricultural production is environmentally sustainable.

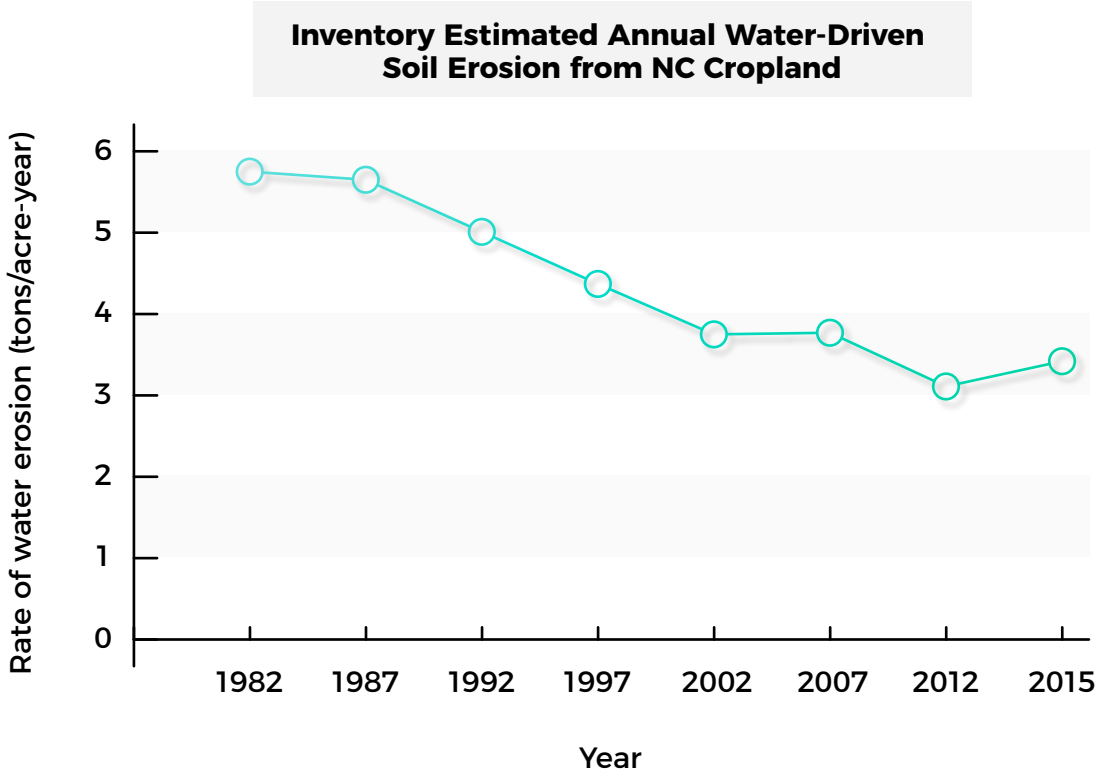
Trend: Good

Movement towards greater sustainability can take multiple forms, including setting sensitive lands aside to serve as conservation buffers, adopting practices that protect wildlife, reducing fertilizer and pesticide use, or moving towards fully organic methods. As the next three indicators suggest, North Carolina crop agriculture is trending in the direction of greater environmental sustainability.

115 NCGS 105-277 et seq. For a compendium of relevant sections, see NC Department of Revenue, North Carolina General Statutes Pertaining to Present Use Value Assessment and Taxation of Agricultural, Horticultural, and Forestlands.

Indicator 12.1: annual rate of soil erosion.

Trend: Decreasing, good

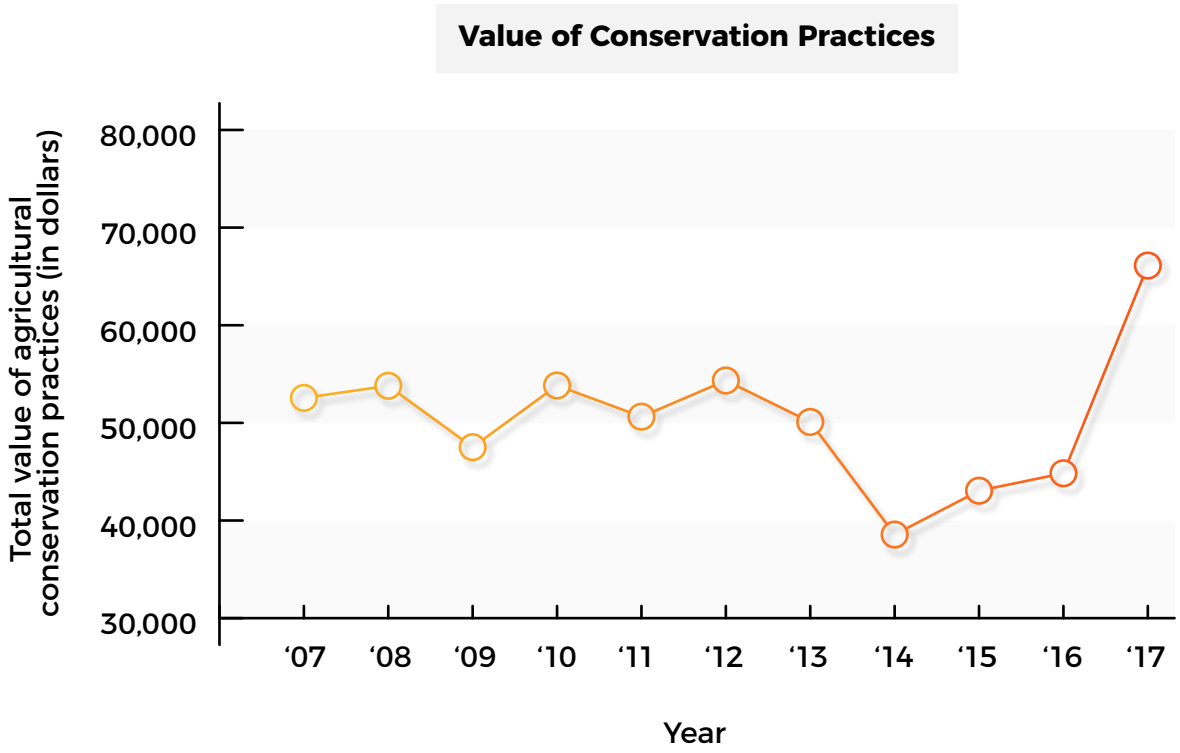


In 1938, in the midst of the Dust Bowl, USDA soil scientist Charles Kellogg wrote an essay on the history of the discipline for the USDA Yearbook of Agriculture: "all life depends on the soil... There can be no life without soil and no soil without life; they have evolved together."[116] Concern for soil health underlies a strong tradition of conservation in America. For this indicator, we track the rate of water-driven soil erosion on North Carolina cropland, estimated by the US Department of Agriculture's Natural Resources Inventory (NRI).[117] Since 2001, the NRI has been updated on a continuous basis, with statistics on different topics issued at unpredictable intervals. In North Carolina, the data shows a steady trend towards less erosion from cropland. Significant uncertainty in the estimates means that it could take several years for a reversal to show up in the data, but at the present time, the trend is positive.

116 Charles E. Kellogg, Soil and Society, 1938 Yearbook of Agriculture, at 864.
117 USDA, 2015 Natural Resources Inventory: North Carolina Soil Erosion, September 2018.

Indicator 12.2: value of conservation practices.

Trend: Rising, good

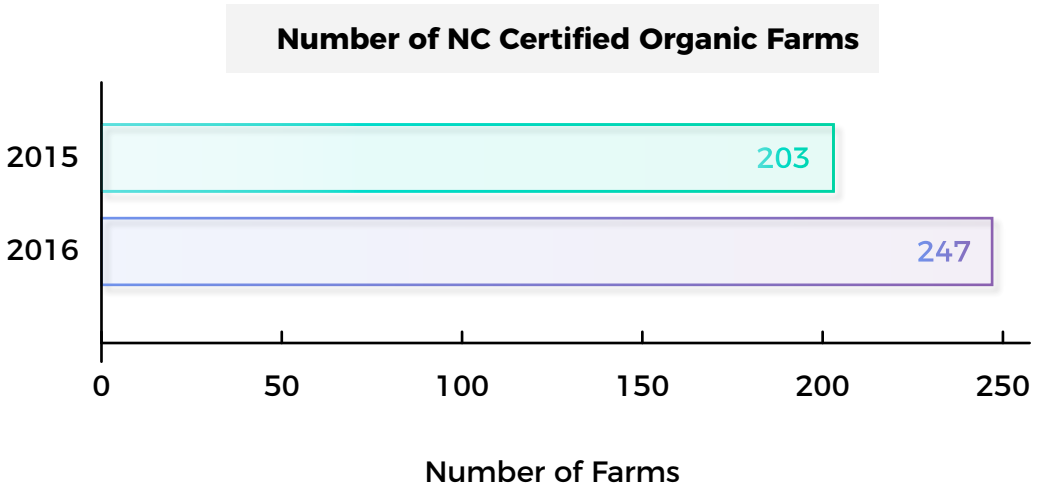


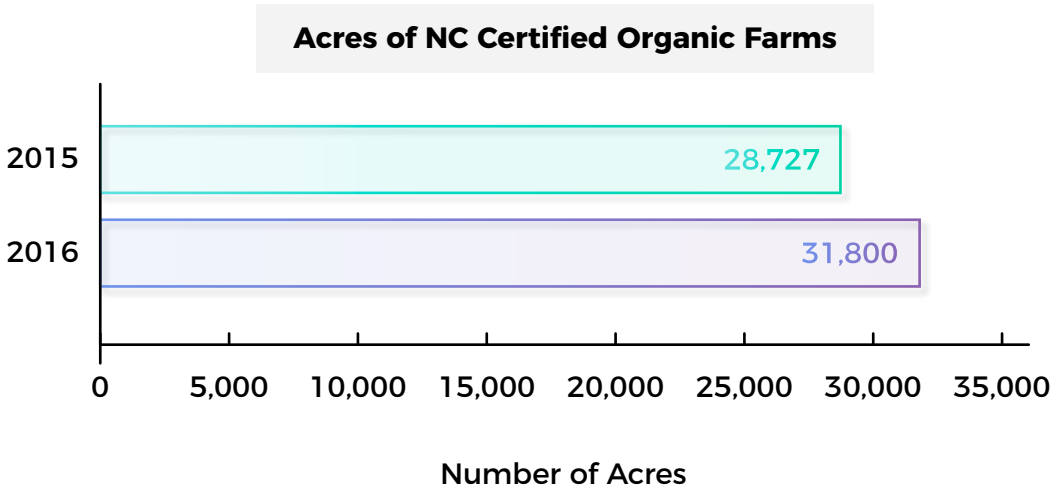
Many North Carolina farmers participate in programs that pay them to implement various sustainable practices on their farms, ranging from restoration of riparian buffers, to letting sensitive lands lie fallow, to fencing livestock out of streams, among others. Typically the farmer signs a contract or time-limited easement and then receives a stream of incentive payments for a period of years. This indicator tracks the total annual value of the various practices. We track total value rather than acreage because some of the most valuable practices do not take much physical space. This is not an ideal indicator, because rates of expenditures reflect funding decisions by the U.S. Congress as well as the performance of North Carolina farmers. Over the last decade, annual payouts in North Carolina have varied dramatically, but were up in 2017, the year with the most recent available data, so we count this as a positive trend.[118]

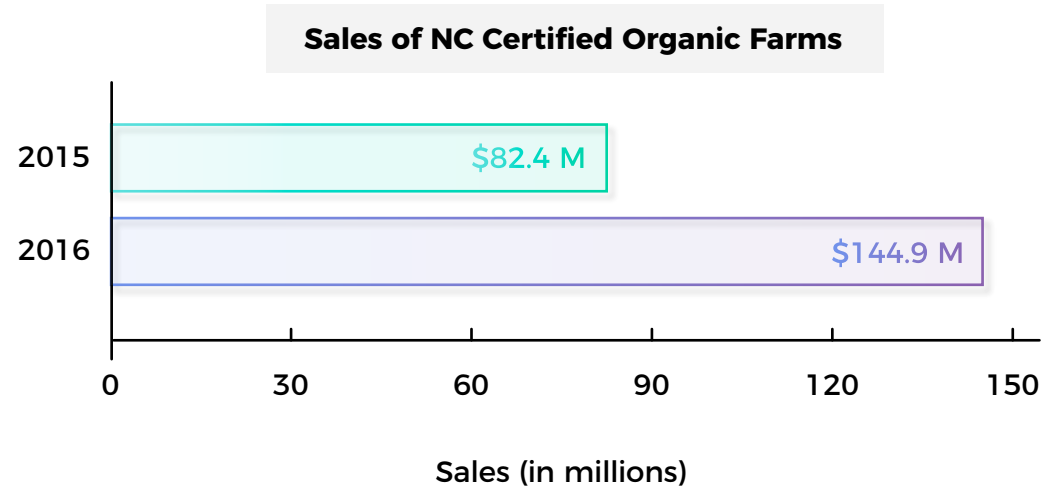
Indicator 12.3: acreage of and sales from certified organic farms.

Trend: Rising, good

118 USDA-NRCS, 2012-2017 data from Financial Management Modernization Initiative (FMMI); 2005-2011 data from Foundation Financial Information System (FFIS).







Many farms choose to be environmentally sustainable without seeking formal organic certification, a process that requires ongoing documentation. While statistics on certified organic farms thus underestimate the scale of sustainable farming in the state, they offer the best available official snapshot of highly sustainable operations. The data are collected annually by the National Agricultural Statistics

Service as part of the National Organic Survey; state breakout data are released with a two-year time lag, so the most recent data are from 2016. The 2017 Census of Agriculture, scheduled to be released in May 2019, will include more recent data.

From 2015 to 2016, certified organic acreage in North Carolina grew by 10.7%; sales grew by 75.8%.[119] As a state, North Carolina ranked 10th in the nation in certified organic sales, accounting for just 2% of the $7.5 billion national organic market. We count this indicator as showing a positive trend.

Goal 13: Animal agriculture is a good neighbor

Trend: Mixed

By and large, row crop farmers in sensitive watersheds have aggressively reduced their nitrogen and phosphorus pollution, and across the state have implemented best practices to protect the health of the land.[120] Animal agriculture, in contrast, is primarily carried out using industrial techniques that look nothing like the land-based animal agriculture of yesteryear, and have significant impacts on surrounding communities.

Animal agriculture is a huge part of North Carolina's agriculture sector. In 2017, animal agriculture in North Carolina accounted for an estimated $7.75 billion in receipts, 68% of the $11.47 billion in total receipts for the sector.[121] Ten commodities account for nearly 90% of agricultural receipts in North Carolina; half of those are animal products:

RANK IN NC[122]	COMMODITY	PERCENT OF STATE RECEIPTS	NC RANK NATIONALLY[123]
1	Broilers	31.1%	3
2	Hogs	20.4%	3
3	Turkeys	6.4%	1
4	Miscellaneous crops	6.4%	7
5	Tobacco	6.0%	1
6	Soybeans	5.6%	18
7	Corn	4.1%	16
8	Chicken eggs	4.0%	7
9	Sweet potatoes	3.0%	1
10	Cattle and calves	2.6%	35

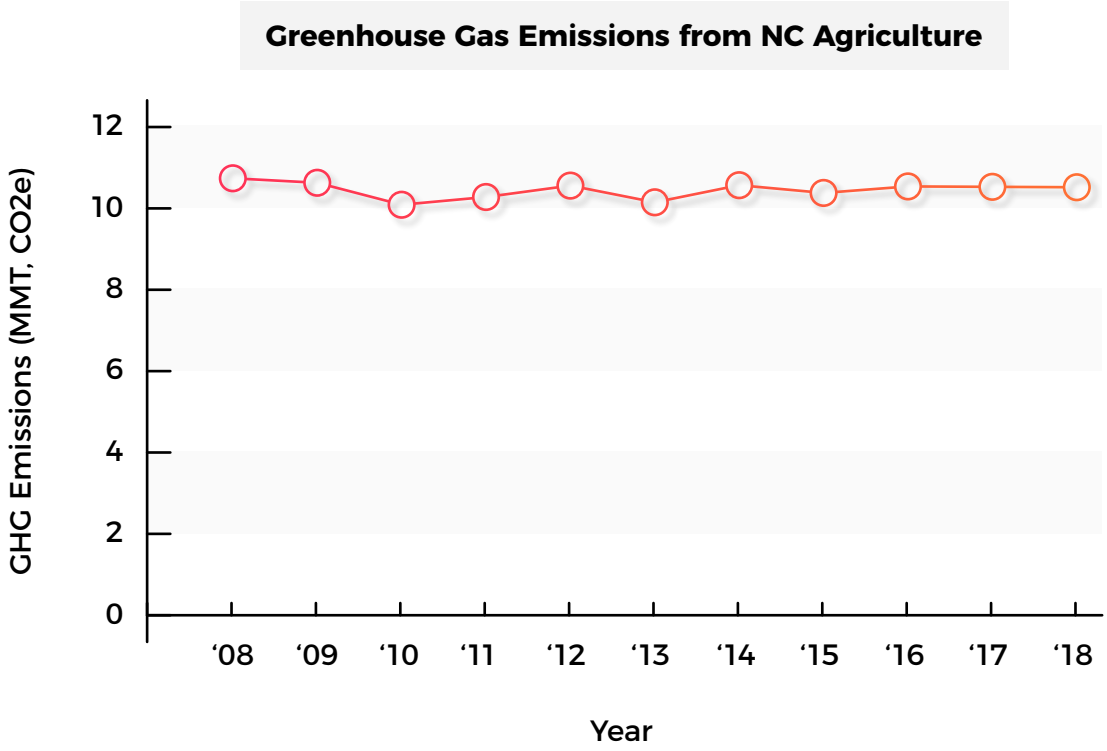
From a sustainability perspective, animal agriculture is a critical part of North Carolina's economy. It is essential that the industry be a good neighbor, protecting the state's air and water as it operates. The indicators below show a mixed record over the last year.

119 USDA, National Agricultural Statistics Service, 2016 Certified Organic Survey – North Carolina (March 2018).
120 See, for example, NC Department of Agriculture, 2018 Annual Progress Report (Crop Year 2017) on the Neuse Agricultural Rule (15A NCAC 2B.0238), 2018.
121 USDA, Economic Research Service, Cash receipts by state, commodity ranking and share of U.S. total, 2017.
122 USDA, Economic Research Service, Cash receipts by state, commodity ranking and share of U.S. total, 2017.
123 USDA, Economic Research Service, Cash receipts by commodity, state ranking, 2017.

Solution: North Carolina should, C7, transition swine farms away from sprayfields; and C8, require dry-litter poultry operations to obtain state permits. In addition, J4, if biogas moves forward as a way to reduce methane emissions, it must also transition the industry away from sprayfields.

Indicator 13.1: greenhouse gas emissions from agriculture.

Trend: No change



Agriculture in North Carolina counts for a relatively small share of the state's greenhouse gas emissions – in 2018, just 10.52 million metric tons (MMT) of CO_2 equivalents (CO_2e), out of gross state emissions of 142.21 MMT. Of the agricultural contribution, the bulk comes from animal manure, 6.06 MMT, and animal gut fermentation, 1.63 MMT. Management of farm soils contributes another 2.83 MMT; burning of crop waste rounds to zero. As with other greenhouse gas indicators, we rely on NC DEQ's Greenhouse Gas Emissions Inventory, finalized in January 2019.[124] Because the data shows no trend of reductions, we evaluate this as showing inadequate progress.

Indicator 13.2: annual volume of swine waste dependent on sprayfields for disposal.

Trend: Baseline

Use of sprayfields to dispose of hog waste is a major source of impacts to neighbors and the environment. In theory, waste is applied at a rate that plants on the sprayfields can absorb nitrogen and phosphorus, and the water component of the waste can either evaporate or soak deep into the ground. In practice, to keep open-air lagoons from overflowing in eastern North Carolina's wet climate, farmers regularly have to spray even when sprayfields are saturated or the weather is too cold for good uptake of nutrients or

124 NCDEQ, North Carolina Greenhouse Gas Emissions Inventory (FInal), January 2019. Table A-3: North Carolina GHG Emissions Inventory Data, (2003-2030) in MMT CO_2e, at 57-58.

water by the plants.[125] As a result, large volumes of waste run off into surrounding creeks and sloughs, and make their way into eastern North Carolina's rivers and estuaries.[126] Because these facilities are supposed to be 'non-discharging', these nutrient contributions have been left out of cleanup plans for North Carolina's nutrient impaired coastal rivers and estuaries, and may account for the lack of water quality improvements in the Neuse and Tar-Pamlico mainstems, even after cities upstream have invested in multi-million dollar wastewater treatment plant upgrades.[127] More immediately, residents complain that odors and drifting fecal matter from spraying contaminate their properties. So far, in all lawsuits brought by neighbors, juries have found that the large industrial integrators have wrongfully harmed neighbors' properties, and have awarded large punitive damages in several cases.[128]

It is possible to raise pigs in high-volume operations in eastern North Carolina without using sprayfields to dispose of nutrients. Because sprayfield use is so tightly associated with harmful impacts, this indicator tracks the annual volume of swine waste dependent on sprayfields for nutrient disposal. As swine farms migrate towards environmentally superior technologies, this number will drop. The most recent estimate of annual production of waste dependent on sprayfields was calculated in 2016 by the Environmental Working Group and the Waterkeeper Alliance, using counts of CAFOs from the NC Department of Environmental Quality and waste-per-animal estimates from the NC Department of Agriculture.[129] The analysis estimated that some 9.5 billion gallons of swine waste annually are currently dependent on sprayfields for disposal in North Carolina. That's a snapshot rather than a trend, so we treat it as providing a baseline value for trend analysis in future years.

Data gap: phosphorus application and poultry waste. Until the most recent reissuance of the general permit for swine feeding operations, state regulators have emphasized control of nitrogen rather than phosphorus in swine manure. From a sustainability perspective, phosphorus imposes the greater constraint, as it is not converted and released into air as nitrogen is, but continues to cycle in the local environment. Yet, data on phosphorus soil levels in land application fields across North Carolina is extremely poor. Adding to the obscurity, North Carolina has for two decades turned a blind eye to the expansion of dry-litter poultry operations, even shielding them from having to report their locations to the state environmental agency.[130] Unlike swine farms, poultry farms are not largely confined to the Coastal Plain, although 23% of new poultry operations are in Duplin and Sampson Counties, the epicenter of the swine industry in North Carolina. Poultry are now a larger source of both nitrogen and phosphorus pollution in North Carolina than swine.[131] Effectively, this means the state needs to close two data gaps: soil phosphorus levels on fields receiving animal manure across the state; and information on the location and size of industrial poultry operations.

125 See, for example, Noel Gollehon et al, Estimates of Recoverable and Non-Recoverable Manure Nutrients Based on the Census of Agriculture - 2012 Results, June 2016; and Database of Estimates by 6-digit HUC. Across four watersheds in North Carolina's Coastal Plan (Tar-Pam, Neuse, Whiteoak, and Cape Fear), the database identifies 1654 farms with insufficient farm acres to absorb the nutrients generated by the farm's animals. The database does not distinguish between poultry and swine farms.

126 Stephen Harden, Surface-Water Quality in Agricultural Watersheds of the North Carolina Coastal Plain Associated with Concentrated Animal Feeding Operations, 2015, U.S. Geological Survey Scientific Investigations Report 2015–5080, at 50-51. http://dx.doi.org/10.3133/sir20155080.

127 NC DEQ, Division of Water Resources, Basinwide Water Management Planning Annual Report to the General Assembly Environmental Review Commission, July 2017 to June 2018, November 2018, at 39, 42.

128 Alan Wooten, Fifth hog lawsuit won by plaintiffs, Bladen Journal, March 11, 2019.

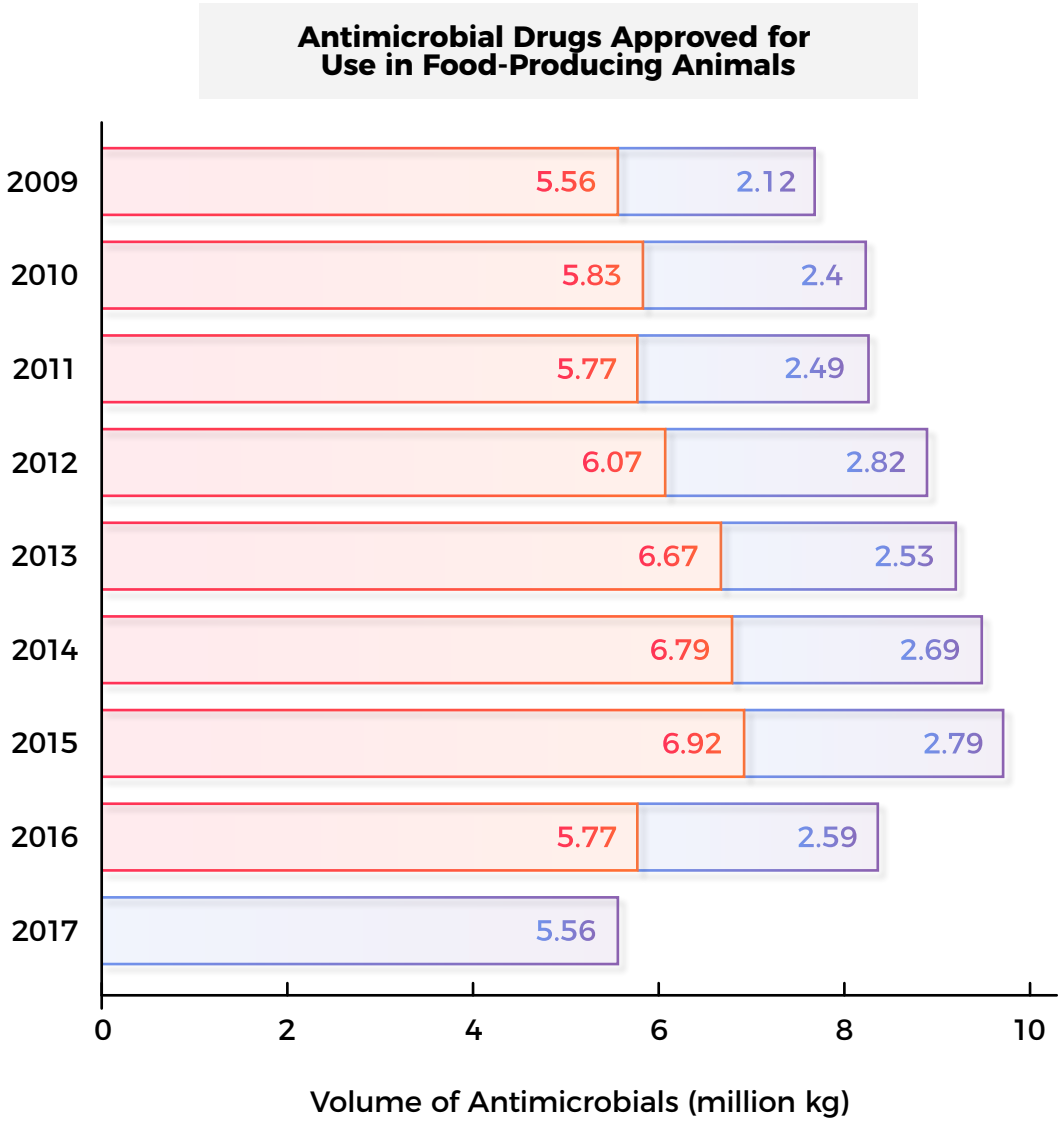
129 Environmental Working Group and Waterkeeper Alliance, website: Exposing Fields of Filth, Data and Methodology, June 2016, retrieved March 1, 2019.

130 Environmental Working Group and Waterkeeper Alliance, Under the Radar, February 2019.

131 Idem, at 5.

Indicator 13.3: volume of antibiotics used routinely in animal agriculture.

Trend: Falling, good



The federal Centers for Disease Control (CDC) estimates that every year, antimicrobial-resistant infections kill some 23,000 Americans and sicken another 2 million. Some of this antimicrobial resistance develops as a result of overprescription of antibiotics to humans; the massive, routine use of antibiotics in animal agricultural also contributes to gradual increases in the antimicrobial resistance of dangerous human pathogens.[132] Before 2014, purchase for use in agriculture accounted for 70% of the antibiotics sold in the United States.[133] Peer-reviewed research indicates that bacteria in and spreading from these facilities develop resistance to leading antibiotics.[134] For example, in 2015, 43% of Salmonella bacteria isolated from retail chicken, and 42% of Salmonella bacteria isolated from retail ground turkey, were resistant to tetracycline.[135]

132 Karin Hoelzer, et al. Antimicrobial drug use in food-producing animals and associated human health risks: what, and how strong, is the evidence? BMC Vet Res. 2017; 13: 211. Published online July 4, 2017. doi: 10.1186/s12917-017-1131-3.

133 Pew, Antibiotics and Animal Agriculture: A Primer, February 2018 update, citing U.S. Food and Drug Administration, 2014 Summary Report on Antimicrobials Sold or Distributed for Use in Food-Producing Animals (2015).

134 See, for example, Karina Yevenes, Assessment of Three Antimicrobial Residue Concentrations in Broiler Chicken Droppings as a Potential Risk Factor for Public Health and Environment, Int J Environ Res Public Health. 2019, 16(1): 24. doi: 10.3390/ijerph16010024 (finding high quantities of tetracyclines and sulfonamides – two important families of antibiotics – in broiler litter, which is often recycled into animal feed or 'organic' fertilizer). As noted above, broilers are North Carolina's #1 agricultural product.

135 Food and Drug Administration (FDA). NARMS Now: Resistance by Source and Place. November 2017.

In 2013, the US Food and Drug Administration issued guidance – which took full effect in 2017 – requiring the oversight of a veterinarian when antibiotics are given to animals. North Carolina does not track sales or use of antimicrobials within the state. Instead, this indicator tracks US Food and Drug Administration data on the volume of sales of medically important antimicrobial drugs for use in food-producing animals.[136] The most recent report, released December 2018, finds that sales and distribution of medically important antibiotics for use in animal agriculture has declined by 43% since 2015, the peak year, and decreased 28 percent since FDA first started tracking sales in 2009. It's also worth noting that in 2017, the amount of animal antibiotic use reported as 'therapeutic' (medically necessary) doubled as FDA rules took effect and forbade dosing 'for production' (to help animals put on weight).[137] If FDA takes a hands-off approach, volumes may not fall much more, but it seems likely that volumes in 'therapeutic' use have room to decrease further without harm to animal health. The reduction in antibiotic use over the last two years is a positive trend.

Air quality

We track progress toward four air quality goals (although one of them comprises a data gap): outdoor air quality, indoor air quality, equitable distribution of impacts, and reduction of total greenhouse gas emissions in North Carolina.

Goal 14: Outdoor air quality is good.

Trend: Mixed

Air pollution harms human health and wildlife, and damages crops, urban vegetation, and forests. Scientists have known for years that air pollution causes respiratory illness.[138] Increasingly, peer-reviewed research confirms that air pollution also drives sickness and death from heart disease.[139] Research also suggests that air pollution contributes to neurocognitive diseases, including autism, attention-deficit hyperactivity disorder, and adult neurodegenerative disease.[140] Beyond impacts on human health, air pollution acidifies waterbodies and disrupts nutrient movement in natural landscapes.[141]

For the goal of clean outdoor air, we consider three indicators: the number of unhealthy air days; emissions of persistent, bioaccumulating air toxics; and incidents of start up, shut down, and malfunction events, which are exempted from permitted emissions limits. The first is positive, the second negative, and the third variable but small; altogether, we judge progress towards the goal of fully health outdoor air as mixed.

Solutions: North Carolina could better protect state residents from poor outdoor air by, D1, improving monitoring of air pollution; D2, updating the list of toxic air pollutants; D3, setting emissions standards for methyl bromide; and D4, addressing transportation-related air pollution. As with all other areas of pollution regulation, E1, prioritizing environmental justice will help ensure equitable outcomes.

136 US Food and Drug Administration, 2017 Summary Report on Antimicrobials Sold or Distributed for Use in Food-Producing Animals, December 2018, Table 7b: Medically important antimicrobial drugs approved for use in food-producing animals, at 29.

137 Ibid, see Figure 7c, at 31 (sorting volumes between therapeutic and production uses, 2009-2017).

138 Yongping Hao, et al., Ozone, Fine Particulate Matter, and Chronic Lower Respiratory Disease Mortality in the United States, American Journal of Respiratory and Critical Care Medicine, Vol. 192, No. 3, Aug 01, 2015, https://doi.org/10.1164/rccm.201410-1852OC.

139 Wayne Cascio and Thomas Long, Ambient Air Quality and Cardiovascular Health, North Carolina Medical Journal September-October 2018 vol. 79 no. 5 306-312, doi: 10.18043/ncm.79.5.306.

140 David Peden, The Unexpected Health Effects of Pollution, North Carolina Medical Journal September-October 2018 vol. 79 no. 5 309-311, doi: 10.18043/ncm.79.5.309.

141 Mark Fenn et al, Setting Limits: Using Air Pollution Thresholds to Protect and Restore U.S. Ecosystems, Issues in Ecology n.14, Fall 2011.

Indicator 14.1: number of unhealthy air days.

Trend: Baseline, good

The federal Clean Air Act requires states to monitor the concentration of six common pollutants in outdoor air: ground-level ozone, particulate matter, carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide. Of these, ozone and particulate matter cause the greatest harm to public health in the United States today.[142]

This indicator tracks the number of 'unhealthy air days' as measured by the US EPA's Air Quality Index.[143] The Air Quality Index scales daily values of five of the common pollutants (it excludes lead), with an index value of 100 corresponding to the federal air quality standard for each. The Index then takes the highest of the five values for a given day, and that is the index for that day. As EPA explains, the Index reflects actual conditions this way:

AIR QUALITY INDEX (AQI) VALUES	LEVELS OF HEALTH CONCERN	COLORS
When the AQI is in this range:	...air quality conditions are:	...as symbolized by this color:
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Federal law requires that the Index be calculated and made public for all metropolitan statistical areas (MSA) with a population of greater than 350,000 residents. In North Carolina, that includes seven areas. Other areas of the state also periodically experience poor or dangerous air quality; for example, smoke from wildfires can cause very unhealthy or hazardous air quality even in rural areas with low populations.[144] In that sense, this indicator is incomplete; it covers 6.7 million residents, or just two-thirds of the state population. In fact, the coverage is smaller than that: air quality can vary widely within a single MSA, so the index as represented by a few monitoring stations is not necessarily accurate for the lived experience of all or most MSA residents. But, short of more widely crowd-sourced data, these are the best available estimates for 2017:[145]

MSA	POPULATION[146]	AQI>50	AQI>100	AQI>150	TOP POLLUTANTS
Charlotte (NC fraction)	2,057,059	143	4	0	O3 (200 days) PM2.5 (165)
Fayetteville	376,509	97	0	0	O3 (156) PM2.5 (208) PM10 (1)

142 American Lung Association, State of the Air 2018, at 35-42.

143 US EPA, Air Quality Index: A Guide to Air Quality and Your Health, February 2014.

144 Jennifer Saylor, Air Quality is Unhealthy All Over Western NC, News 13 WLOS, November 14, 2016 (describing the air quality impacts of 2016 forest fires in western NC); Ana Rappold et al, Peat Bog Wildfire Smoke Exposure in Rural North Carolina is Associated with Cardiopulmonary Emergency Department Visits Assessed through Syndromic Surveillance, Environ Health Perspect. 2011 Oct; 119(10): 1415–1420 (describing the air quality impacts of a 2008 peat bog wildlife in eastern NC), doi: 10.1289/ehp.1003206.

145 NC Division of Air Quality, Air Quality Index Summaries, 2009-2017, May 2018.

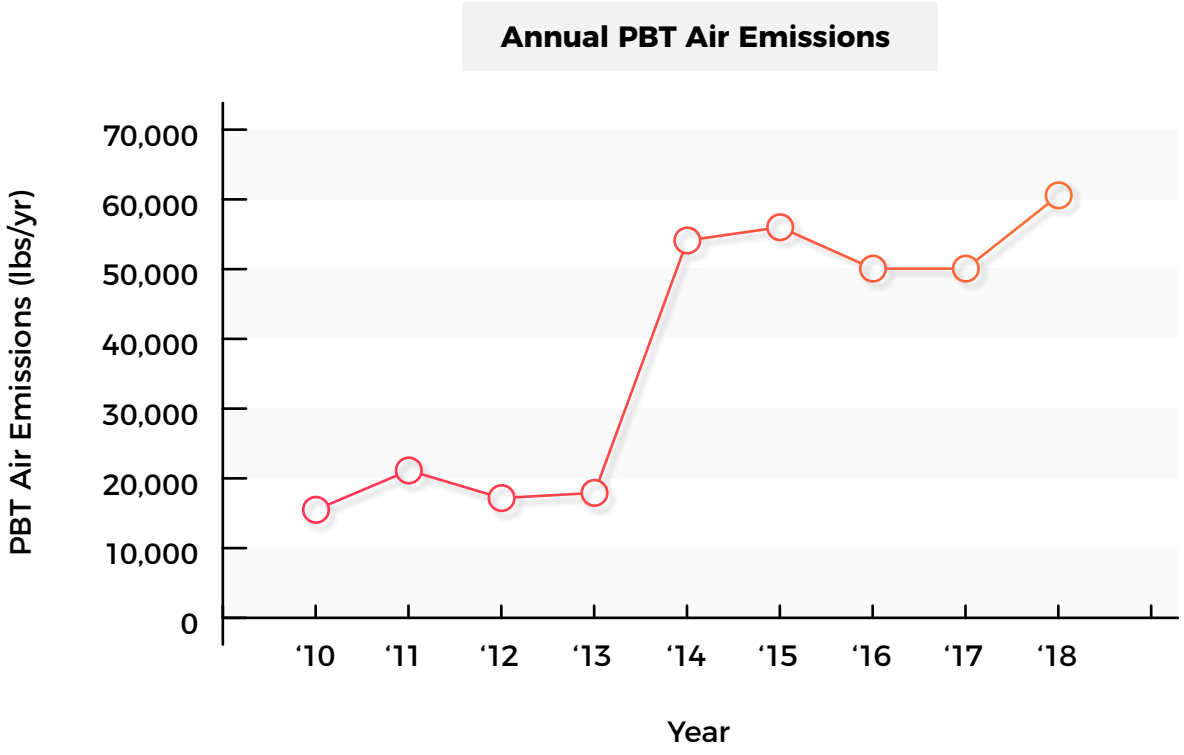
146 US Census estimate as of July 1, 2015.

MSA	POPULATION[146]	AQI>50	AQI>100	AQI>150	TOP POLLUTANTS
Greensboro-Winston-Salem	1,411,487	109	0	0	O3 (186) NO2 (7) PM2.5 (172)
Raleigh-Durham-Chapel HIll	1,826,061	123	0	0	O3 (156) NO2 (2) PM2.5 (207)
Wilmington	277,969	25	0	0	O3 (173) SO2 (9) PM2.5 (183)
Asheville	446,840	40	0	0	O3 (179) SO2 (1) PM2.5 (185)
Hickory-Morganton-Lenoir	362,510	91	0	0	O3 (189) PM2.5 (171)

This is a baseline value for 2017, but it also represents a significant improvement over conditions a decade ago, and we credit it as a positive starting point.

Indicator 14.2: annual releases to air of persistent bioaccumulating toxics (PBTs).

Trend: Rising, bad



Beyond the conventional air pollutants that contribute to unhealthy air days, federal and state laws regulate hundreds of toxic or hazardous air pollutants. Unfortunately, both programs work with lists

of chemicals that were adopted in the 1990s and are increasingly obsolete. Neither the state nor the federal laws provide for periodic updates and additions. There is no public data on volume of releases of unregulated toxics. With respect to known toxics that are on either the state or federal lists, the regulatory programs are intended to limit risks to public health, though there is little data to evaluate whether they are effective. However, one indicator is revealing: the volume of air emissions of toxics known to bioaccumulate (persistent bioaccumulating toxics, or PBT). Because these do not break down in the environment, and do accumulate in the bodies of people and animals who are exposed, these toxics represent a particular threat. EPA's Toxics Release Inventory (TRI) exempts some facilities, but offers at least an estimate of the minimum annual releases of PBTs into North Carolina's air, and this indicator tracks that number.

The PBTs currently tracked as a group by EPA include the following: lead (N420), mercury (N458), PAH (N590), dioxin-like (N150), hexabromocyclododecane (HBCD)(N270). For this indicator, we track the sum of fugitive and point source emissions of these PBTs in North Carolina.[147] This list does not include perfluorinated compounds (such as GenX or PFOS and PFOA), even though these are persistent and toxic, and some bioaccumulate. That is because perfluorinated compounds – along with a number of other 'emerging' contaminants – are not (yet) on the list of chemicals for which industry must report data to EPA's Toxics Release Inventory.[148] Even so, the North Carolina TRI data shows a substantial increase in total PBT emissions over the last decade. The largest jump appears to have happened between 2013 and 2014 with a 30,000-pound increase in emissions of polyaromatic hydrocarbons (PAHs), a category of carcinogens, from the SGL Carbon facility in Morganton. Even without the single increase, however, PBT emissions have been creeping up, a bad trend.

Indicator 14.3: Number of startup/shutdown/maintenance events annually.

Trend: No trend

Stationary sources of pollution – power plants and factories – that emit large amounts of pollution are required obtain emissions permits under Title V of the federal Clean Air Act. A typical permit requires a facility to limit its emissions of specific pollutants and to monitor and report emissions to the state. According to state modeling, if all the permitted facilities adhere to their permit limits, air quality across the state as a whole will comply with federal air quality standards. However, state rules have a loophole: emissions that occur when a facility is starting up, shutting down, or experiencing a 'malfunction' do not count against the permit limits. These are also times when combustion is likely to be incomplete and pollution control equipment likely to be less effective, making emissions the dirtiest.

By the nature of the loophole, there is little public data on how much unregulated pollution is released through it. However, permittees do have to report start up, shut down, and malfunction (SSM) incidents that last longer than four hours. So, this indicator tracks the number of SSM incidents reported annually. It does not document impacts to any particular population, but it does suggest a potential risk. In practice, some facilities report SSM incidents shorter than four hours, so the available data overestimates the number of incidents that are required to be reported and underestimates the total number of incidents.

147 TRI On-site and Off-site Reported Disposed of or Otherwise Released (in pounds), for All industries, for Persistent Bioaccumulative, and Toxic (PBT) Chemicals, North Carolina, 2010-2017

148 See, US EPA, webpage: TRI-Listed Chemicals (August 2018).

YEAR	SSMS REPORTED
2010	3
2011	5
2012	6
2013	9
2014	9
2015	5
2016	8
2017	2
2018	4

We are grateful to the NC Division of Air Quality, which compiled and shared its data on SSM incidents in response to our request. That data, shown above, suggests a small but variable number of reported incidents.[149] Based on this data, we do not assign this indicator a trend this year.

Goal 15: Indoor air quality doesn't threaten sensitive populations.

Data gap: indoor air quality. Most Americans spend the great majority of our time indoors – at home, at work, at school. Indoor air quality is influenced by outdoor air, but can also include a suite of location-specific pollutants. These include secondhand smoke, radon, mold, formaldehyde, cleaning agents, and carcinogens and developmental toxics that offgas from carpets and furniture.[150] Unfortunately, there is no broad dataset that tracks indoor air quality across North Carolina.

Goal 16: air pollution is equitably distributed.

Trend: No trend

A sustainable state is equitable: it does not allow the imposition of disparate risks on communities that are already heavily burdened. The federal Clean Air Act has cleaned common pollutants from the air over broad areas of the country, but both stationary sources (factories, power plants) and mobile sources (cars, trucks, heavy equipment) still create substantial disparities in local exposures. A recent sophisticated national analysis looks at the distribution of consumption that produces air pollution as well as the distribution of air pollution, and finds deep inequities: "On average, non-Hispanic whites experience a 'pollution advantage': they experience 17% less air pollution exposure than is caused by their consumption. Blacks and Hispanics on average bear a 'pollution burden' of 56% and 63% excess

149 Data received through email from Steve Hall, Technical Services Section, DEQ Division of Air Quality, March 2019.

150 Joseph Seguel, et al., Indoor Air Quality, American Journal of Lifestyle Medicine. Am J Lifestyle Med. 2017 Jul-Aug; 11(4): 284–295. Published online 2016 Jun 15. doi: 10.1177/1559827616653343; Luisa Lucattini, A Review of Semi-Volatile Organic Compounds (SVOCs) in the Indoor Environment: Occurrence in Consumer Products, Indoor Air, and Dust, Chemosphere, June 2018, v201, 466-482, doi.org/10.1016/j.chemosphere.2018.02.161.

exposure, respectively, relative to the exposure caused by their consumption."[151] For this goal, our state-level indicators are less complex: we consider the correlation between stationary source and mobile sources pollution and environmental justice communities. Because both of these indicators provide baselines rather than trends - and would benefit from methodological improvements - we do not assign a trend this year.

Indicator 16.1: correlation between air hazards and environmental justice communities.

Trend: Baseline

The Hazardous Air Pollutant list, established by the U.S. Congress as part of the 1990 Clean Air Act amendments, lists 187 chemicals that regulators at the time knew were released into the air by industry and posed health risks.[152] The list was not comprehensive, and it has become increasingly incomplete as new and existing industries have invented new chemicals and industrial processes – but it is still the benchmark for measuring and controlling air pollution beyond the common criteria pollutants.

In 2011, the US EPA conducted a National Air Toxics Assessment to evaluate the health risks posed by facilities that emit hazardous air pollutants, creating the 2011 NATA 'respiratory hazard index' from that data.[153] In 2012, EPA created an environmental justice-oriented 'demographic index' that combines measures of communities' income levels and percentage of minority residents.[154] This indicator tracks the degree of correlation between the those indices. An equitable distribution of risk would involve an essentially random correlation between the two indices. Our simple analysis found a weak correlation of 0.185, which we take as a baseline. If the correlation should become stronger over time, that would be a worrying sign.

EPA's 2011 NATA respiratory hazard index is static – the agency has not updated it – and it is now eight years old (the data underlying the demographic index is updated from the US Census Bureau with a couple-year lag time). Encouragingly, the NC Department of Environmental Quality has this year launched a community mapping tool. If that data is kept up to date, it should be possible to track improvement (or backsliding) in this indicator over time. This is also a fairly rudimentary indicator that we hope to improve with better analytical techniques.

Indicator 16.2: correlation between vehicle air pollution and environmental justice communities.

Trend: Baseline

We follow a similar process for evaluating the overlap between EJ census blocks and blocks with close proximity to high volumes of traffic. High volumes of traffic are associated with local concentrations of common pollutants, such as particulates and nitrogen oxides, that can differ radically from broader ambient conditions. Vehicles are also sources of carcinogenic air toxics.[155] EPA's EJScreen tool includes a layer that ranks census blocks by their exposure to high traffic volumes.[156] As with the previous indicator, this indicator consists of a simple estimate of the correlation between the two indices for North Carolina's census blocks. This analysis showed a weak correlation of 0.24, again presented here as a baseline.

As with the previous indicator, the EPA data layers are not current – the traffic data are from 2014,

151 Christopher Tessum, Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure, PNAS published ahead of print March 11, 2019 doi.org/10.1073/pnas.1818859116.

152 See, US EPA, webpage: Hazardous Air Pollutants, September 2018.

153 US EPA, webpage: 2011 NATA: Assessment Results, February 2019.

154 US EPA, webpage: Overview of Demographic Indicators in EJScreen, December 2016.

155 Robin C. Puett et al, Particulate matter air pollution exposure, distance to road, and incident lung cancer in the Nurses' Health Study Cohort, Env. Health Perspectives, September 1, 2014, https://doi.org/10.1289/ehp.1307490.

156 US EPA, webpage: Overview of Environmental Indicators in EJScreen, August 2018.

retrieved by EPA in 2016 – though it appears this layer may be periodically refreshed. Again, we hope that NC DEQ's community mapping tool will offer a more current resource for calculating this indicator in future years.

Goal 17: Emissions of greenhouse gases are declining.

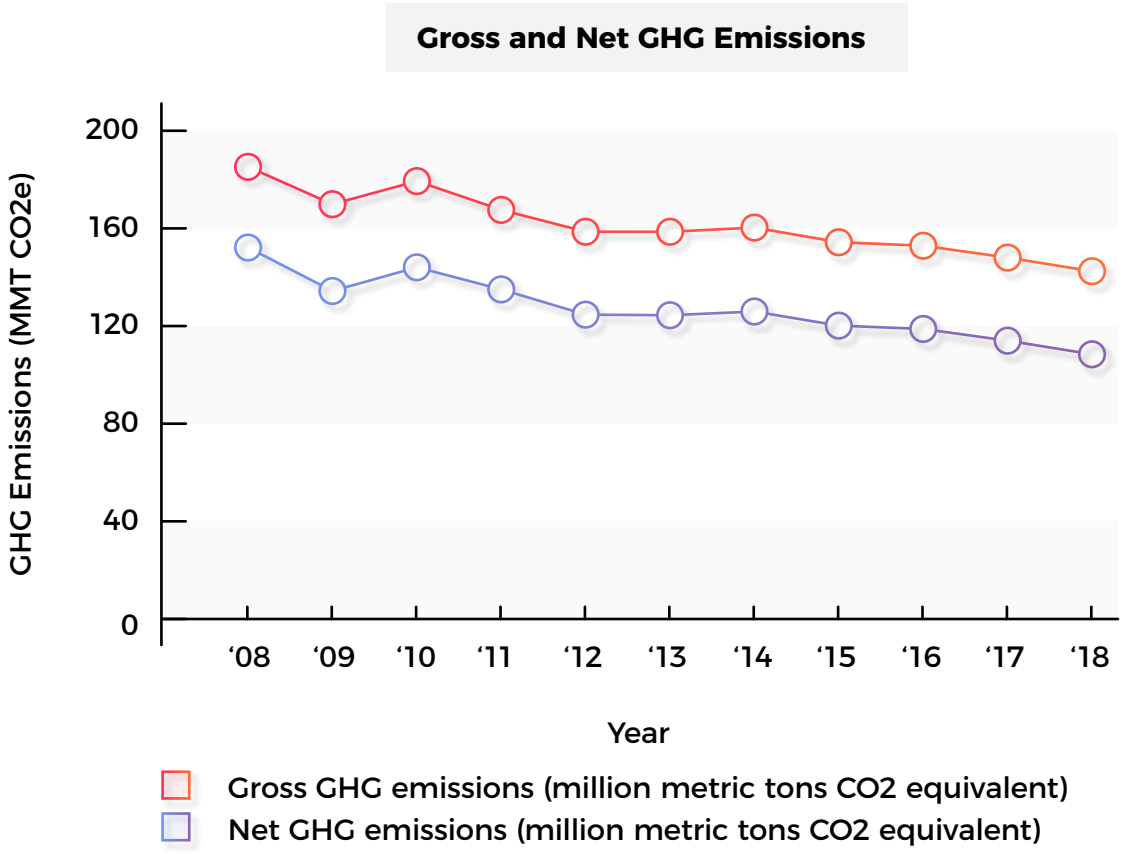
Trend: Mixed

This goal has a single indicator: total annual greenhouse gas emissions from North Carolina. Because emissions are falling - but neither far nor fast enough - we count this as a mixed trend this year.

Solutions: To reduce our greenhouse gas emissions, North Carolina should I1, adopt an overarching goal to reach carbon neutrality; J1, modernize the electric grid to support renewables; J2, expand renewable generation and storage; J3, expand energy efficiency; J5, curb wood pellet facilities; J7, avoid investments in expanded natural gas pipelines; K4, integrate avoidance of induced sprawl into transportation planning; and G2, divert food from landfills to composting. In addition, A6, incentives for reforestation, offers a way to boost carbon sequestration.

Indicator: 17.1: total annual GHG emissions.

Trend: Falling, mixed



For North Carolina to do our part to address climate change, we must achieve substantial reductions in greenhouse gas emissions – ultimately, net zero annual emissions, taking into account offsets and removals of carbon from the atmosphere. At the same time, the estimates of how much carbon is removed by various natural processes on an ongoing basis are among the most uncertain aspects of NCDEQ's emissions modelling. For that reason, for this indicator we track both gross greenhouse gas emissions and net emissions as modified by carbon sinks. As for all our greenhouse gas indicators,

we rely on NCDEQ's GHG Emissions Inventory.[157]

Two points stand out in the data. First, North Carolina's total greenhouse gas emissions have been generally dropping from a peak in 2007, reflecting the replacement of coal-fired power plants with natural gas plants, as well as a temporary reduction in economic activity during the 2008 Great Recession. The size of that reduction, 46 MMT, is larger than the annual sequestration of carbon in land use and forestry sinks, 34 MMT. The other takeaway is that North Carolina remains far, far away from net zero emissions. In fact NCDEQ projections through 2030 suggest that, without additional legislative and administrative actions, carbon emissions will flatten in 2019, and the state will make very little more progress, still emitting 141 MMT a year in 2030.[158]

To be useful, this indicator must measure not whether GHG emissions are dropping in an absolute sense (they clearly are for now), but whether they are dropping fast enough to get the state to net-zero emissions on a meaningful timeframe. Because the state and nation do not have a clear target for that, and because emissions from energy generation and transportation are on a trajectory that is expected to rise again (so current reductions are not permanent), we treat this indicator as showing mixed progress this year.

Our People

Health

For health, we track four goals: general longevity and health; access to health care; children's development; and healthy food access.

Goal 18: North Carolinians have long lives and good health.

Trend: Mixed

Good public health is a core component of sustainability. The field of behavioral health has tended to focus on behavioral changes that individuals can make to improve their health outcomes, on the premise that people care most about their own health and are in the strongest position to protect themselves. Most North Carolinians will have encountered public health education or campaigns focused on personal behaviors (i.e. smoking, diet, stress management, physical activity, sexual habits). However, many health outcomes - and also many personal habits that contribute to health outcomes - are not reflective of individual choices alone. Rates of heart disease and obesity are influenced by how hard or easy the built environment makes it for people to exercise. Rates of asthma reflect indoor and outdoor air pollution, among other factors. Increasingly, it appears that exposure to toxics, especially during critical windows of development, contributes to immunological and neurological conditions.

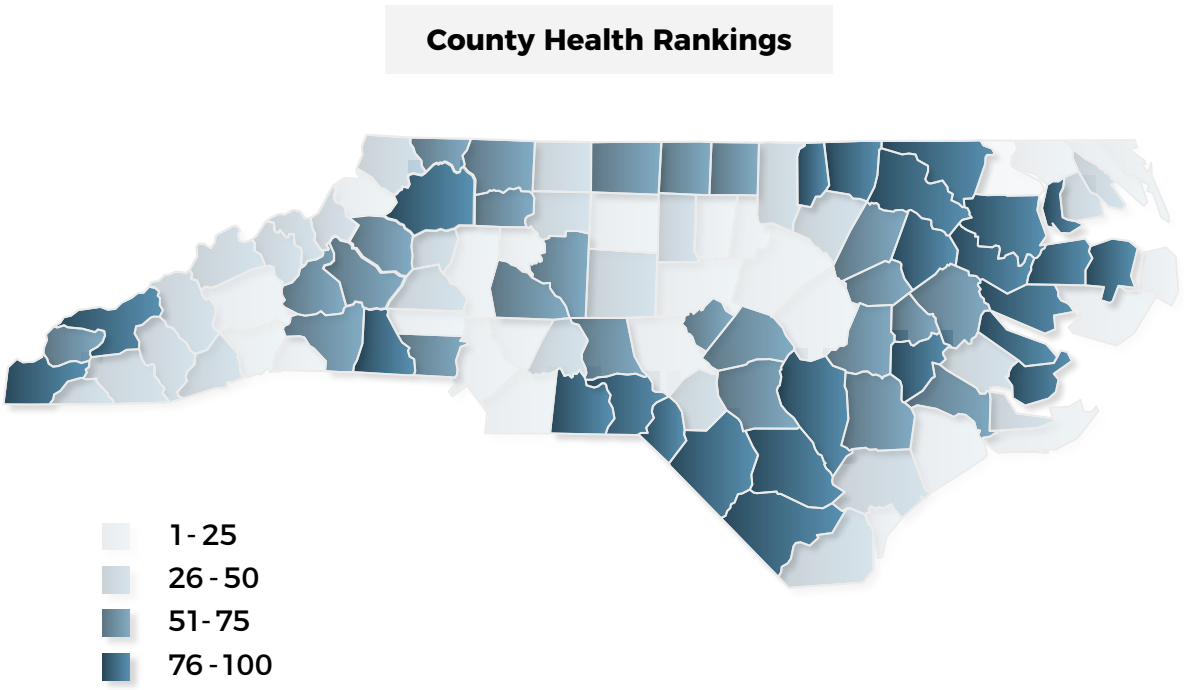
In contrast to other topics in this report, North Carolina is swimming in public health data. For purposes of this goal, we track the incidence of diabetes, the incidence of obesity, the rate of hospitalizations for asthma attacks, the incidence of cancer (all kinds), years of premature death, suicide rates, and absolute numbers of mosquito- and tick-borne illnesses. We chose these indicators to offer a cross-section of health threats tied, in a variety of ways, to both environment and personal behavior. Overall, we find positive trends in dropping incidence of diabetes and cancer, a relatively flat rate of hospitalizations for asthma (even as average air quality has improved statewide), and negative trends for obesity, suicide, and (at a much lower level of threat) vector-borne illness. Although we do not present it as a trend, the

157 NCDEQ, North Carolina Greenhouse Gas Emissions Inventory (Final). January 2019. Table A-3: North Carolina GHG Emissions Inventory Data, (2003-2030) in MMT CO2e, at 57-58.

158 Ibid.

most striking indicator is the racial disparity in early death, discussed below (18.5). Altogether, negative trends outweigh positive, and we are backsliding rather than making progress towards healthier lives.

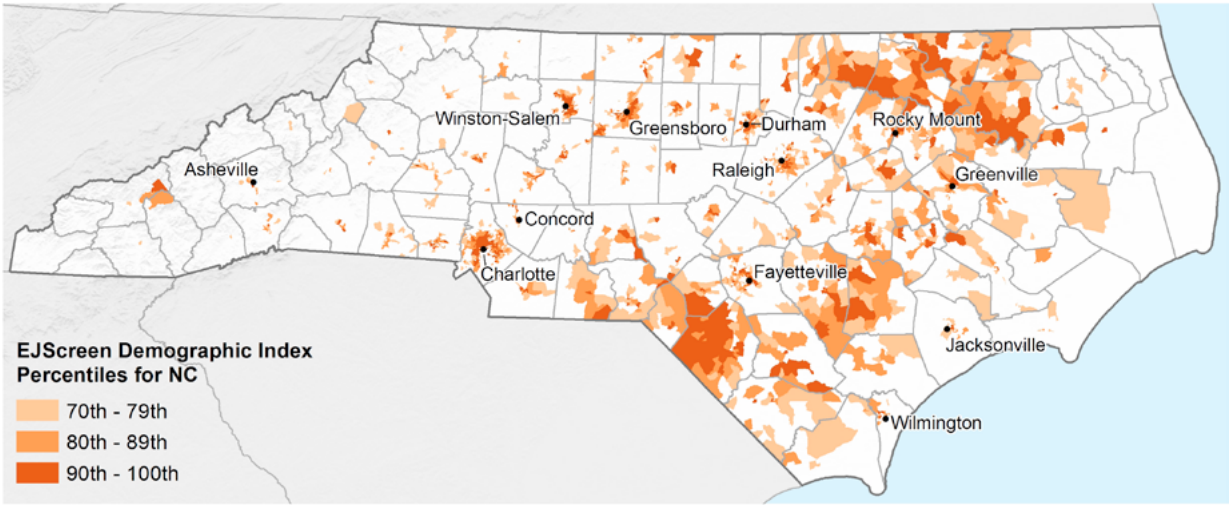
Before diving into the indicators, it's worth noting the significant geographic disparity in health outcomes across North Carolina. The Robert Wood Johnson Foundation (RWJ) issues an annual analysis of health outcomes and conditions across all US counties, the County Health Rankings Report. It includes a revealing ranking of North Carolina's counties by health outcomes, as shown below. RWJ explains: "health outcomes in the County Health Rankings represent measures of how long people live and how healthy people feel. Length of life is measured by premature death (years of potential life lost before age 75) and quality of life is measured by self-reported health status (% of people reporting poor or fair health and the number of physically and mentally unhealthy days within the last 30 days) and the percentage of low birth weight newborns. The map above shows the distribution of North Carolina's health outcomes, based on an equal weighting of length and quality of life. The map is divided into four quartiles with less color intensity indicating better performance in the respective summary rankings."[159]



map credit: adapted from Robert Wood Johnson Foundation, County Health Rankings.

Although the RWJ health outcome index does not include percentage of low-income residents or residents of color, the county health map closely tracks the spatial distribution of EPA's EJScreen demographic index in the map below. The stark spatial disparity in RWJ data - especially poor county health rankings in the northern and southern Coastal Plain - reflects many of the racial disparities in health outcomes explored below.

159 Robert Wood Johnson Foundation, 2018 County Health Rankings Report: North Carolina. It's worth noting that the RWJ ranking has been criticized for incorporating the wrong environmental factors. See Michael Hendryx et al, Improving the Environmental Quality Components of the County Health Rankings Model, Am J Public Health. 2013 April; 103(4): 727–732, 10.2105/AJPH.2012.301016. It appears that the RJW method has been improved since 2013, but some of the critique still applies. In this report, we rely on RWJ data about health outcomes and non-environmental contributing measures, but not environmental indicators.

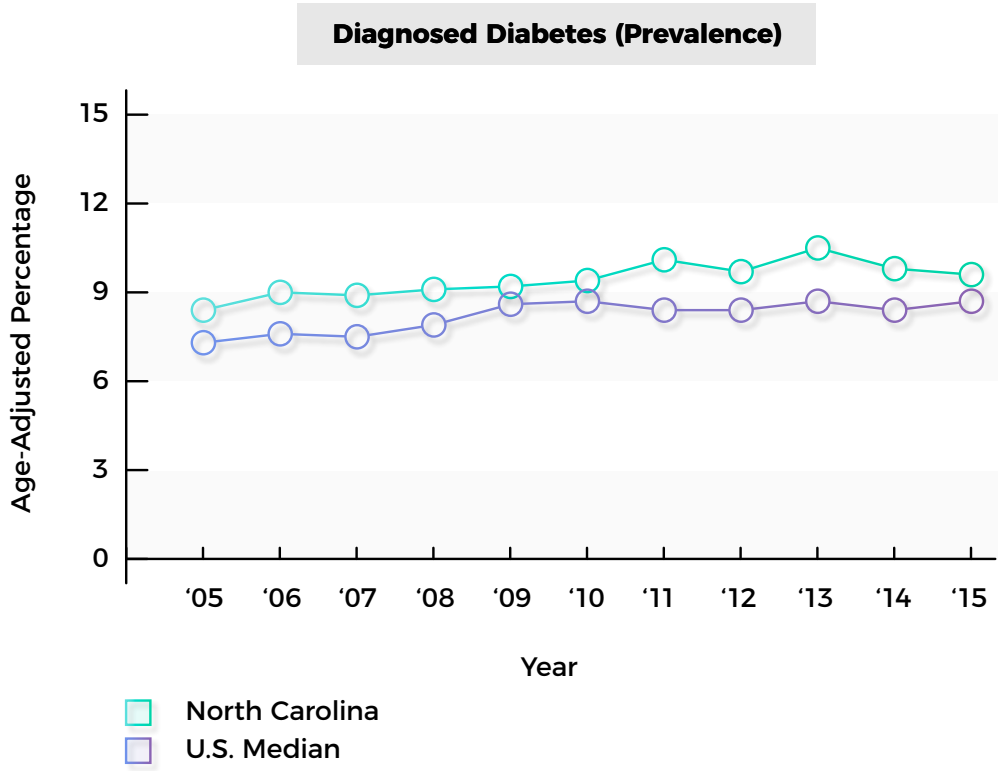


map credit: Andrew Pericak, using EPA EJScreen demographic data.

Solutions: Based on what we know about the environmental factors that contribute to diseases, North Carolina could improve public health by updating surface water, groundwater, and air toxics standards, C2, C3, D2; D4, addressing transportation-related air pollution; shielding children and adults from toxic exposures, F1 - F6; promoting access to healthy food, H1 - H2; K1, improving alternative modes of transportation; K4, avoiding sprawl; and K5, supporting robust implementation of Complete Streets to make walking and cycling safe options for more North Carolinians.

Indicator 18.1: prevalence of diabetes

Trend: Decreasing, good



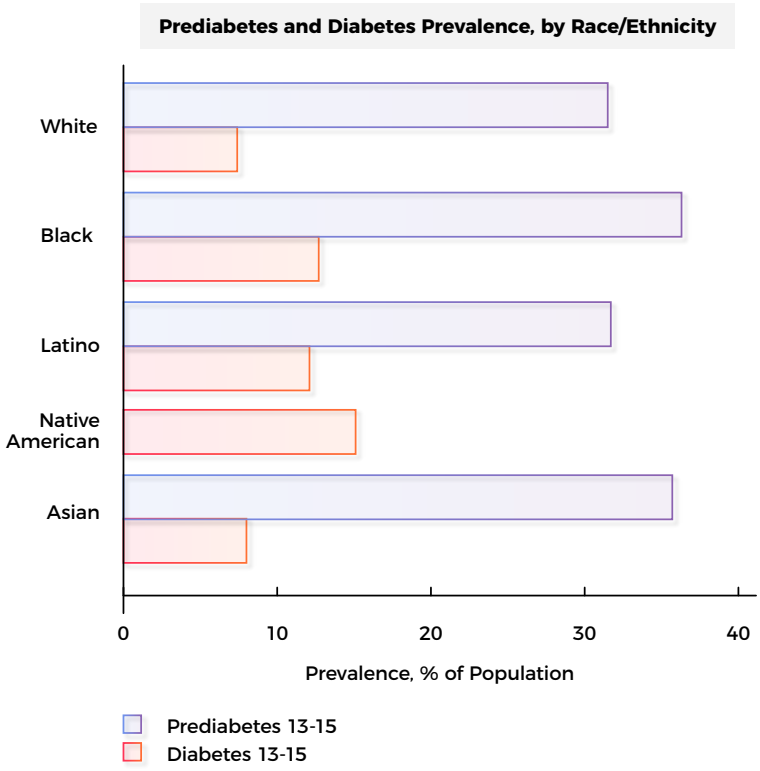
Like other widespread diseases, diabetes affects both individual health and the state economy as a whole. Medical professionals recognize three types of diabetes (Type 1, Type 2, and gestational); people with risk factors for developing diabetes may be classed as 'prediabetes'. In 2012, the American Dia-

betes Association estimated that the direct cost of diabetes was around $7,900 annually per person.[160] Based on the prevalence on diabetes in North Carolina (discussed below), that sums to direct costs of $8.2 billion annually for North Carolina residents.

Both types of diabetes occur when the body cannot make enough insulin or cannot use the insulin it produces. Type 1 diabetes may have a genetic component, but appears to have environmental triggers, possibly including infections, diets, or exposures to toxics in utero or infancy or early childhood.[161] Type 2 diabetes is usually diagnosed in adults and appears heavily related to environmental factors, including diet and levels of physical activity. Neighborhood walkability and access to green space are associated with lower risk of Type 2 diabetes; exposure to air pollution and noise are associated with higher risk.[162]

This indicator tracks the percentage of the population in North Carolina that has been diagnosed with diabetes (prevalence), using data from the Centers for Disease Control.[163] A significant methodological change was made to the survey in 2011, to take account of the increasing numbers of residents without land phone lines, but that does not seem to have altered the trend.

In North Carolina, the percentage of the population diagnosed with diabetes has dropped from a high of 10.5% in 2013 to 9.6% in 2015, the year of the most recent data, leading us to evaluate this indicator as showing progress. Despite the drop, North Carolina remains above the national median of 8.7% in 2015. Racial and ethnic disparities in the prevalence of diabetes have remained steady in recent years.[164] Data outlining disparities in diabetes and prediabetes are shown below.[165]



160 American Diabetes Association, Economic costs of diabetes in the U.S. in 2012, Diabetes Care, 2013, 36:4, 1033.

161 Marian Rewers and Johnny Ludvigsson, Environmental risk factors for type 1 diabetes, Lancet, 2016, 387:10035, 2340. doi: 10.1016/S0140-6736(16)30507-4.

162 Tashi Dendup et al, Environmental risk factors for developing Type 2 diabetes mellitus: a systematic review, Int J Environ Res Public Health, 2018, 15:1, 78. doi: 10.3390/ijerph15010078.

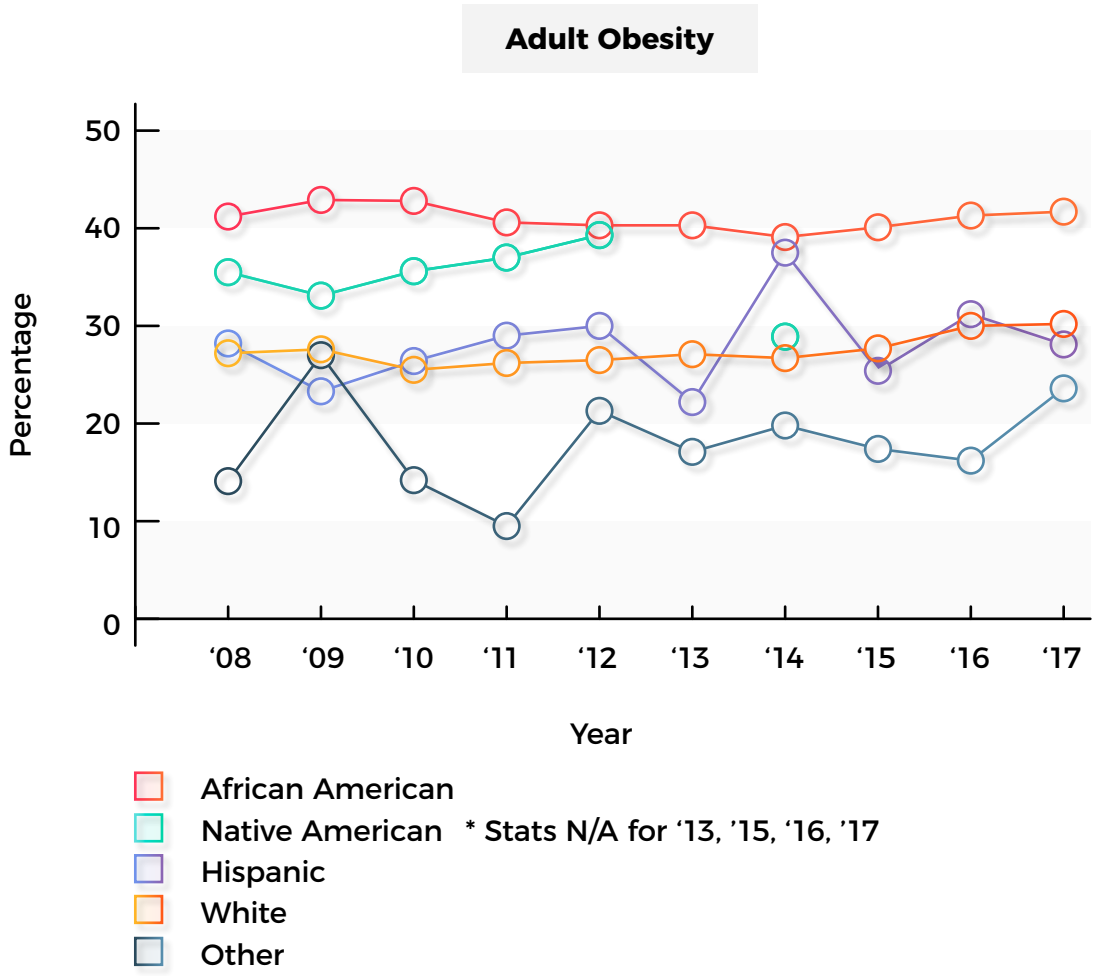
163 CDC, US Diabetes Surveillance System (2005-2015)

164 National Center for Health Statistics, Tables of Summary Health Statistics for U.S. Adults: 2013 - 2017 National Health Interview Survey. 2014-2018, Table A-4a.

165 CDC, National Diabetes Statistics Report, 2017, Table 3a (prediabetes 2013-2015), Table 1c (diabetes 2013-2015).

Indicator 18.2: rate of obesity.

Trend: Increasing, bad



State health statisticians track obesity not as a health outcome, but as a major risk factor for adverse outcomes, especially heart disease, type 2 diabetes, stroke, gallbladder disease, osteoarthritis, sleep apnea, and respiratory problems.[166] In addition, obesity correlates with an increased risk of cancers of the uterus, gallbladder, kidney, cervix, and thyroid, and leukemia.[167] In fewer studies, obesity also appears correlated with reduced midlife cognitive function and shows indirect links to dementia in later life.[168] Obesity has significant economic impacts, resulting in substantially less productivity for workers in many occupations, and accounting for over 12% of annual absenteeism in the US economy.[169] A recent study found that obesity is associated with reduced wages for women, and that in 2015, obesity-related conditions absorbed over 13% of all health spending in North Carolina.[170]

Current thinking suggests that incidence of obesity reflects a combination of genetic and environmental factors. The latter can be complex, including not only lifestyle choices, but also systemic lack

166 National Institute of Health, Clinical Guidelines on the Identification, Evaluation, and Treatment of OVerweight and Obesity in Adults, 1998, at 12.

167 Krishnan Bhaskaran, et al, Body-mass index and risk of 22 specific cancers: a population-based cohort study of 5.24 million UK adults. Lancet. 2014 Aug 30, 384:9945, 755-65. doi: 10.1016/S0140-6736(14)60892-8.

168 Louise Dye, et al, The relationship between obesity and cognitive health and decline, Proceedings of the Nutrition Society, November 2017, 76:4, 443-454, https://doi.org/10.1017/S0029665117002014.

169 Ian Kudel et al, Impact of obesity on work productivity in different US occupations: analysis of the National Health and Wellness Survey 2014 to 2015, J Occup. Environ Med, 2018, 60:1, 6-11, doi: 10.1097/JOM.0000000000001144.

170 Adan Biener et al, The impact of obesity on medical care costs and labor market outcomes in the US, Clinical Chemistry. 2018, 64:1, 108-117, DOI: 10.1373/clinchem.2017.272450, at 114 and Table 2.

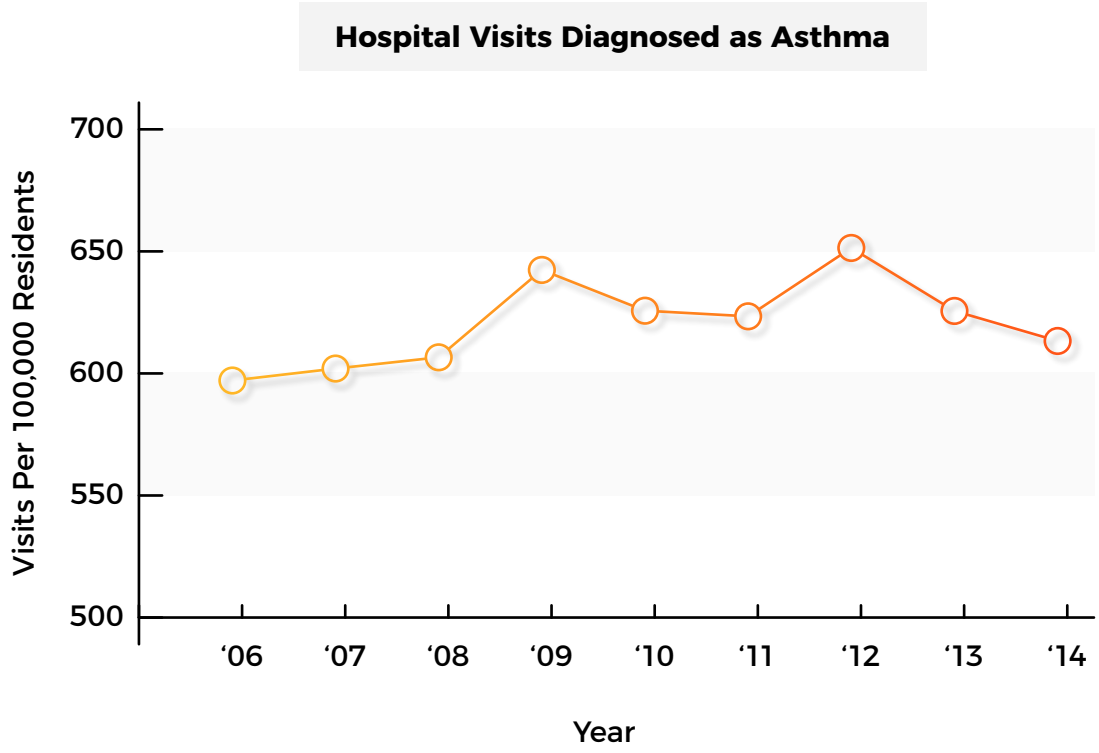
of healthy food options, and community land use patterns that limit opportunities for residents to move or safely exercise.[171] Peer-reviewed scientific research has also found that toxic chemicals in the human environment can act as obesogens, altering the human body's production of hormone in ways that promote fat storage.[172] Since many of these chemicals are themselves stored in body fat, this process can form a vicious circle.

For purposes of this report, this indicator tracks the incidence of obesity as reported in the state's annual publication, Resident Population Health Data by Race and Ethnicity. Date is drawn from the North Carolina Behavioral Risk Factor Surveillance System (NC BRFSS) and reported annually, with a one-year time lag (so, for example, the 2018 report shows 2017 data). The graph above is labeled with the year of the data collection rather than the year of the report.[173] The BRFSS is a collaboration between the federal Centers for Disease Control (CDC) and all 50 states, and defines obesity as a body mass index (BMI, weight in kilograms divided by height in meters squared) of 30 or greater.[174]

The data shows that over the last decade, the percentage of North Carolinians who are obese has increased slightly, from 29.5% in 2008 to 32.1% in 2017. It seems likely that volatility in the data for Native Americans, Latinos, and 'Other' is an artifact of smaller sample sizes. Because rates are rising, we evaluate this indicator as showing a trend in the wrong direction.

Indicator 18.3: rate of hospitalizations for asthma.

Trend: Flat, no trend



171 CL Brown et al, Addressing childhood obesity: opportunities for prevention, Pediatr Clin North Am., 2015 Oct, 62:5, 1241-1261, doi: 10.1016/j.pcl.2015.05.013; Tobias Lipek, et al, Obesogenic environments: environmental approaches to obesity prevention, Journal of Pediatric Endocrinology and Metabolism, 2015, 28:5-6, https://doi.org/10.1515/jpem-2015-0127.

172 Philippa Darbre, Endocrine Disruptors and Obesity, Curr Obes Rep. 2017, 6:1, 18-27, 10.1007/s13679-017-0240-4; Amanda Janesick and Bruce Blumberg, Obesogens: an emerging threat to public health, Am J. Obstet Gynecol, 2016 May, 214:5, 559-565, 10.1016/j.ajog.2016.01.182.

173 NC DHHS, North Carolina Resident Population Health Data by Race and Ethnicity, 2018, at 2, 4.

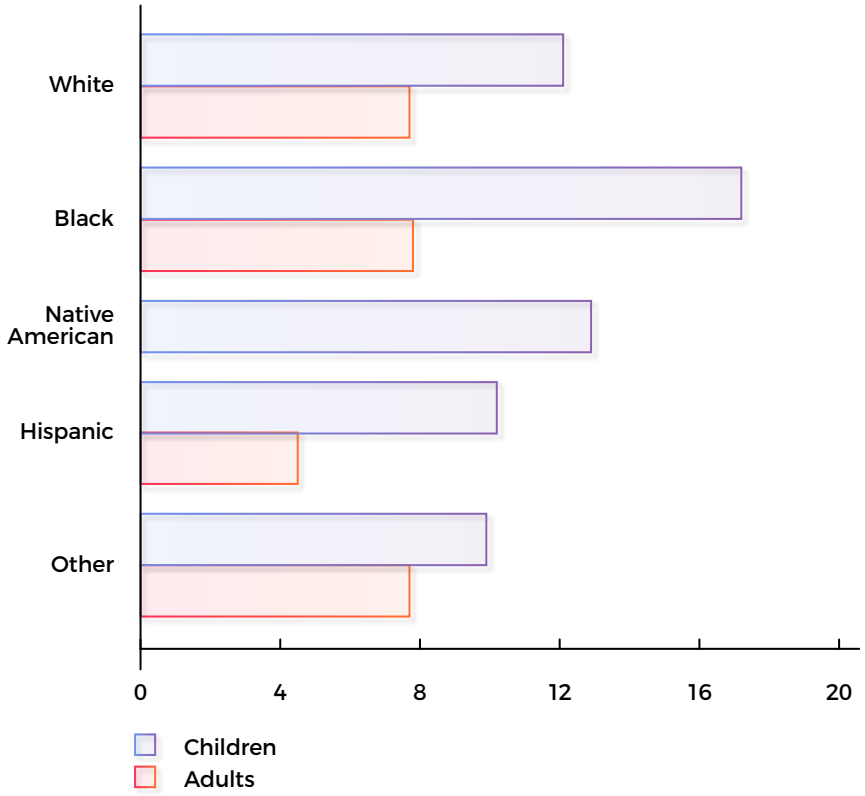
174 NC DHHS, 2017 BRFSS Survey Results: North Carolina, Derived Variables and Risk Factors, Body Mass Index Grouping-Underweight, Recommended Range, Overweight and Obese.

Asthma is the leading illness among North Carolina's children. The Centers for Disease Control estimates that 8.2% of adults and 13% of children in North Carolina suffer from asthma.[175] Asthma appears to have both genetic and environmental risk factors. Common environmental triggers include allergens, tobacco smoke, indoor/outdoor air pollution, airborne particulate matter, and ozone.[176] In 2013, asthma imposed a total cost of $81.9 billion on the U.S. economy.[177] The burden is especially heavy for those suffering from asthma, an average of $3,266 (in 2015 dollars) per person, or $3,581 for people living below the poverty line.

Data for asthma incidence and hospital visits in North Carolina are fragmented. For this indicator, we use the federal Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project, which tracks diagnoses associated with hospital visits. The most recent data is from 2014, and is expressed as visits to the hospital where the patient's complaint was diagnosed as asthma per 100,000 persons. The trend line has a lot of variation with no apparent overall direction this year.

As the figure below suggests, adults show minimal racial disparities in the prevalence of asthma, although Latino residents appear to suffer asthma at a notably lower rate than other groups.[178] On the other hand, Black children experience significantly higher rates of asthma than white, Latino, or 'other' children.[179] A recent study looking at a related racial disparity - why Black children are twice as likely to be readmitted to hospitals for asthma as white children - found that 80% of the disparity could be explained by disparate sensitivity to allergens, exposure to pollutants, access to health care, and economic status.[180]

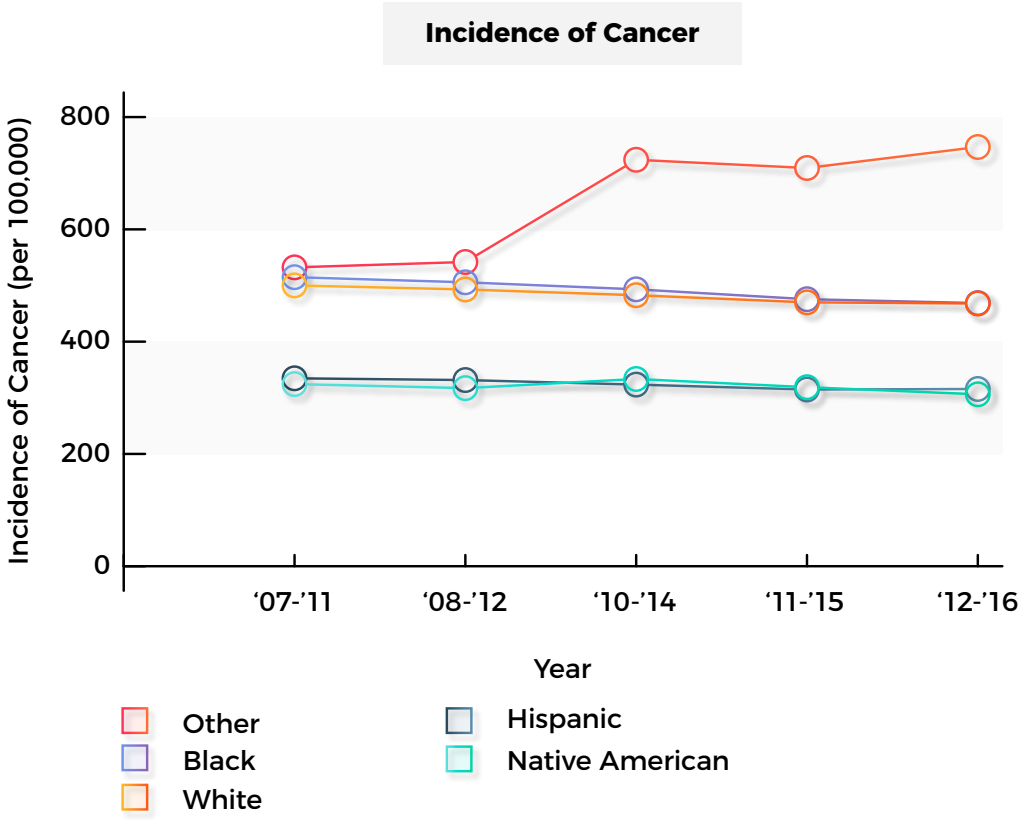
Racial/ethnic disarities in prevalence of asthma, 2017



175 Behavioral Risk Factor Surveillance System (BRFSS), Adult Asthma Data: Prevalence Tables and Maps, Table C1.
176 Centers for Disease Control, webpage: Asthma and the Environment, December 14, 2016.
177 T. Nurmagambetov et al, The economic burden of asthma in the United States, 2008-2013, Ann Am Thorac Soc. 2018 Mar;15(3):348-356. doi: 10.1513/AnnalsATS.201703-259OC.
178 Behavioral Risk Factor Surveillance System (BRFSS), 2017 Adult Asthma Data: Prevalence Tables and Maps, Table C1.
179 L. Black and V. Benson, Tables of Summary Health Statistics for U.S. Children: 2017 National Health Interview Survey, 2018.
180 Andrew Beck et al, Explaining racial disparities in child asthma readmission using a causal inference approach, JAMA Pediatr, 2016, 170:7, 695, doi: 10.1001/jamapediatrics.2016.0269

Indicator 18.4: rate of incidence of cancer.

Trend: Falling, good



Cancer is the leading cause of death in North Carolina. It edges out heart disease among white, Black, and Latino residents, but comes in second to heart disease among Native Americans.[181] According to a 2013 state report, five cancers account for the majority of deaths and new cancers in the state: breast, cervical, colorectal, lung-bronchial and prostate.[182] Several of these are strongly associated with lifestyle factors. Risk for many is also increased by exposures to toxic chemicals.[183] Additionally, cancer survivors have a greater risk than the general population of developing other chronic health conditions, including asthma (48% higher), chronic obstructive pulmonary disease (COPD, 30% higher), and kidney disease (54% higher), among others.[184]

This indicator relies on the state's annual publication, Resident Population Health Data by Race and Ethnicity. Cancer diagnosis is expressed as the incidence per 100,000 residents, drawing on five years of data that closes two years before publication (so, data published in 2018 reflects statistics from 2012-2016; data published in 2017 reflects statistics from 2011-2015).[185] The incidence reflects all cancers, not just the five most common. Because it reflects a five-year rolling incidence, the data smooths out year-to-year variation and better shows underlying trends.

181 NC DHHS, North Carolina Resident Population Health Data by Race and Ethnicity, 2018, at 1.

182 NC DHHS, Cancer in North Carolina, 2014.

183 Kathryn Rodgers et al, Environmental chemicals and breast cancer: an updated review of epidemiological literatures informed by biological mechanisms, Environmental Research, January 2018, 160, 152-182, https://doi.org/10.1016/j.envres.2017.08.045 (breast cancer); Agostino Di Ciaula et al, Bile acids and cancer: direct and environmental-dependent effects, Annals of Hepat, 2017, 16:1, s87-s105, doi: 10.5604/01.3001.0010.5501 (colon cancer and other cancers of the digestive tract); Ghassan Hamra et al, Outdoor particulate matter exposure and lung cancer: a systematic review and meta-analysis, Environmental Health Perspectives, September 1, 2014, https://doi.org/10.1289/ehp/1408092 (lung cancer); A.C.Gore et al, EDC-2: the Endocrine Society's Second Scientific Statement on Endocrine-Disrupting Chemicals, Endocrine Reviews, December 2015, 36:6, E1-E150, https://doi.org/10.1210/er.2015-1010, at box 5 (prostate cancer).

184 Herrick H. Cancer Survivors and Chronic Disease. SCHS Surveillance Brief No. 1. Raleigh, NC: DHHS, State Center for Health Statistics, October 2015.

185 NC DHHS, North Carolina Resident Population Health Data by Race and Ethnicity, 2018, at 4.

Over the last decade, the rate of the incidence of cancer has dropped, slowly but steadily, for the population as a whole and for all demographic groups except 'Other, non-Hispanic'. Because cancer primarily affects older men and women – prostate cancer is by far the most common cancer among men, and occurs in over half of men in their 70s[186] – we suspect that the increase in cancer incidence among 'Other' largely reflects an aging Asian American population, or may be an artifact of a smaller sample size. Latino and Native American residents show a much lower overall rate of cancers; both of those demographic groups are much younger overall.

Indicator 18.5: years lost to premature death

Trend: Rising, bad

When a person dies at a relatively young age, we are prone to think of them as 'gone too soon.' Health indicators that focus on mortality rates or incidence rates do not capture the additional sense of loss when those who die might have expected many more years to enjoy life and contribute to their communities. This indicator, years of potential life lost to premature death, addresses this. It aggregates the years by which people in the state die short of 75 years, per 100,000 residents. (It does not offset that with the number of years other residents live beyond 75; the indicator measures the gross shortfall, not the net). Thus, a resident who dies at 55 contributes 20 years to the count; one at 35, 40 years. The indicator can provide a particularly useful window on racial and ethnic disparities in health outcomes, highlighting whether members of a particular demographic group are dying at a higher rate at young ages than those of other groups.[187]

In 2018, using data from 2013-2015, the Robert Wood Johnson Foundation calculated that North Carolina residents lose 7,300 years to premature death per 100,000 residents.[188] This is lower than is the periods 1996-2000 (8,865 years) and 2006-2010 (7,684 years), but has been rising since 2011-2013 (7,200 years).[189] Individual counties range between 4,500 and 12,100 years of life lost to premature death, an indication of substantial geographic disparities. Disparities among racial and ethnic groups in North Carolina, as shown in the table below, are quite wide.[190] Both because the years of potential life lost has risen for the last several years, and shows significant racial disparities, we mark progress as inadequate this year.

GROUP	YEARS OF LIFE LOST PER 100,000 RESIDENTS
All	7,300
White	7,100
Black	9,900
Native American	10,200
Asian	2,900
Latino	3,600

186 Katy Bell et al, Prevalence of incidental prostate cancer: a systematic review of autopsy studies, Int. J. Cancer, 2015, 137:7, 1749-1757, doi: 10.1002/ijc.29538.

187 Katherine Jones and Christopher Mansfield, Premature Mortality in North Carolina: Progress, Regress, and Disparities by County and Race, 2000-2010, NC Med. J, 2014, 75:3, 159, doi: 10.18043/ncm.75.3.159

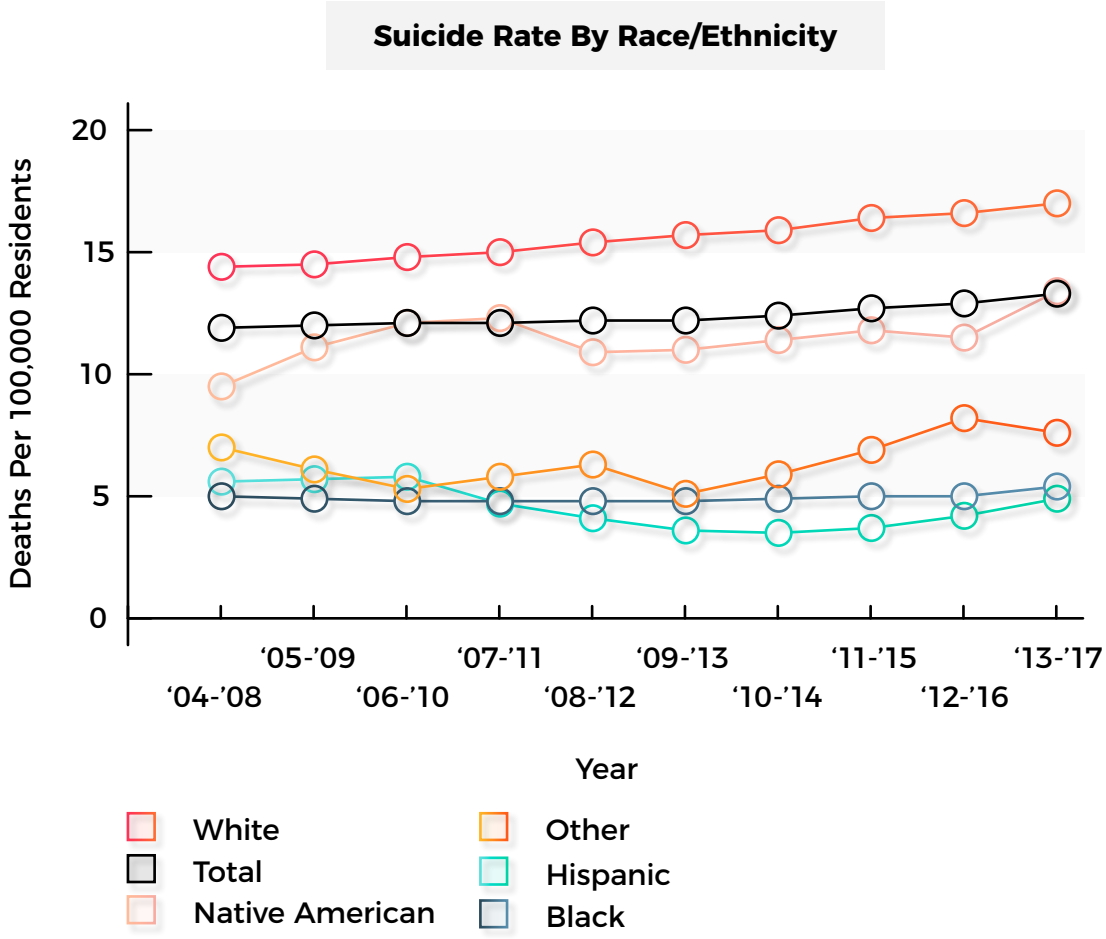
188 Robert Wood Johnson Foundation, 2018 County Health Rankings: North Carolina, data online here, based on data from 2013-2015.

189 Jones and Mansfield, at 160; Robert Wood Johnson Foundation, 2014, 2015, 2016,2017, and 2018 County Health Rankings: North Carolina, data online here.

190 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps: North Carolina, 2018 County Health Rankings Report, at 4.

Indicator 18.6: suicide rate.

Trend: Rising, bad



Suicide is a personal and community tragedy; the aggregate rate of suicide is also a strong signal of the effectiveness of the social support networks that surround those in need. Nationally, suicide rates have risen dramatically by 33% from 1999 to 2017, with the rise occurring among both women and men, of all ages.[191] The rate in North Carolina increased over the same period by 12.7%.[192]

This indicator uses the suicide rate per 100,000 residents, as published by the NC Department of Health & Human Services, working from death certificates. Because NC DHHS calculates the rate on a five-year moving average – that is, 2018 data covers the period 2013-2017 – the data smooths out year-to-year volatility to show more substantial trends over time.

The data for the last decade show a steady increase in the suicide rate among white North Carolinians, dragging up the rate for the state as whole from 11.3 per 100,000 residents between 2004-2008, to 13.3 per 100,000 residents, 2013-2017.[193] Suicide rates for Native Americans have approached the state rate over the decade. Rates for Black, Latino, and other residents are lower, but have started to climb over the last five years. We rate this indicator as showing an undesirable trend.

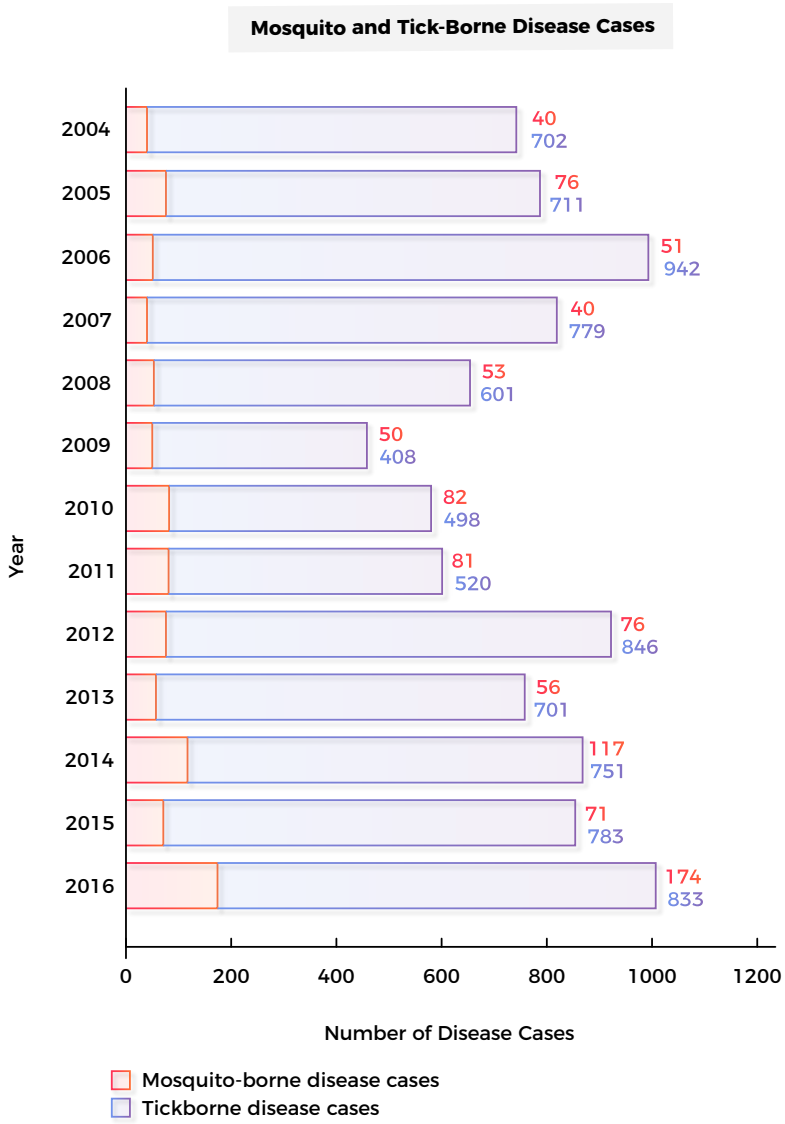
191 Holly Hedegaard, Sally C. Curtin, and Margaret Warner. Suicide Mortality in the United States, 1999–2017. NCHS Data Brief No. 330, November 2018.

192 CDC, Vital Signs: Suicide Rising Across the US (June 2018).

193 NC DHHS, North Carolina Resident Population Health Data by Race and Ethnicity, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018.

Indicator 18.7: mosquito- and tick-borne disease cases.

Trend: Rising, bad



Vector-borne diseases – including malaria and yellow fever – were a well-reported scourge in North Carolina in the 1700s and 1800s, though there are no reliable statistics.[194] Today, absolute numbers of vector-borne illnesses number in the hundreds per year, a tiny fraction of the state population. However, researchers have steadily found new species of vectors and new pathogens from other parts of the world showing up in North Carolina. Most recently, in fall 2018, the CDC announced the arrival and rapid spread of the Asian longhorned tick to eight states, including North Carolina.[195] Climate change is anticipated to make this worse by enabling tropical pathogens to develop a sustained presence here.

This indicator tracks the absolute number of mosquito and tick-borne illnesses diagnosed in North Carolina each year. Typically, the data lags between two and three years behind the current calendar year. The data shows a spike of cases in 2012 interrupting a steady increase in cases from 2009 through 2016. It is worth noting that tick-borne illness in North Carolina is likely under-diagnosed, which could make it difficult to properly assess in-state trends in vector-borne illness.[196] Nonetheless, because the error is likely to show up as an under- rather than an overestimate of cases, we count the

194 See, William Joyner, Infectious Diseases, NCPedia, 2006; Steven Case, History and Impact of Malaria in North Carolina, NCPedia, 2010.

195 Lena Sun, New tick species capable of transmitting deadly disease is spreading in the U.S., Washington Post, November 29, 2018.

196 Yen Duong, A new perspective on North Carolina tick-borne Illnesses, NC Health News, October 19, 2018.

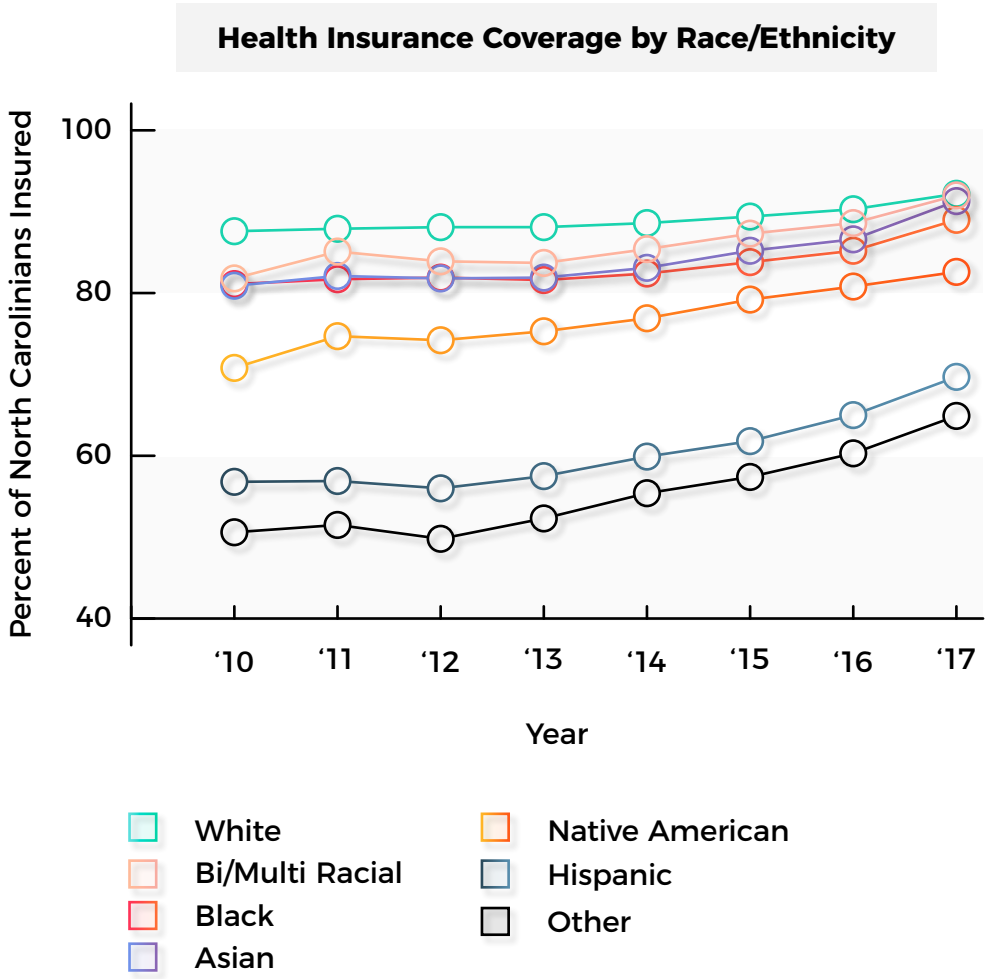
rise as a trend in the wrong direction.

Goal 19: All North Carolinians have access to health care.

Trend: Good

Indicator 19.1: percentage of North Carolinians with health coverage.

Trend: Rising, good



From a sustainability perspective, health care is important first because it extends people's lives and improves their quality of life, but also because inadequate health care is a huge and inefficient drain on the economy. Untreated conditions get worse and more expensive, and sick people are less productive. Our indicator is the percentage of North Carolinians with access to health care, with attention to racial and ethnic disparities.

The federal government collects at least two data series that track insurance coverage. The American Community Survey (ACS) – the series we use – records whether residents have insurance coverage at the time they are surveyed. The survey size is large, and thus supports state breakout statistics. ACS data is released in the late summer of the year after it is collected, and so has a one-year lag time. The other data series is the Current Population Survey Annual Social and Economic Supplement (CPS ASEC). It has been around longer, and tracks whether residents were without coverage at any time in

the previous calendar year. However, it has a much smaller sample size and cannot track rates accurately at the state level.[197]

North Carolina's recent data shows the impact of the recovering economy after the Great Recession and the expansion of coverage prompted by the Affordable Care Act. In general, rates of coverage have climbed significantly, and several racial and ethnic gaps have narrowed. It is unclear, however, what will happen in the next economic downturn, particularly if hard times hit different demographic groups unevenly. One demographic group notably lags all others: resident non-citizens are insured at a far lower rate than everyone else – although that too has improved with the growing economy.[198]

Demographic data does not show this, but North Carolina also suffers from strong geographic disparities in coverage between metropolitan and rural residents. As a recent paper notes, the state's 54 rural counties include 20 of the 22 counties with the highest percentage of uninsured residents.[199] That's not just a problem for those residents when they get sick; it also contributes to a disproportionate concentration of 'medically underserved' areas in rural counties. That means fewer local health care options for insured residents, and none of the economic activity that the health care sector brings to other communities across the state.[200]

Goal 20: Children are born healthy and grow up healthy

Trend: Weak

A sustainable society wants a great future for our children; their health from conception to adulthood will determine so much of what they are able to achieve as adults. Children's health and wellbeing is a complex topic and both deserves and receives its own detailed annual scorecard: the Child Health Report Card, released jointly by the North Carolina Institute of Medicine and NC Child.[201] For this report, we borrow two of the Report Card's overarching indicators: the percentage of babies born with low birthweight, and parents' self-reported sense of their children's health. The first indicator shows poor trends and both show disturbing racial disparities, so we rate progress on this goal as inadequate this year.

197 See, Edward R. Berchick, Emily Hood, and Jessica C. Barnett, Current Population Reports: Health Insurance Coverage in the United States: 2017 (September 2018), at 5.

198 US Census, American Community Survey. Selected Characteristics of Health Insurance coverage in the United States (2010-2017).

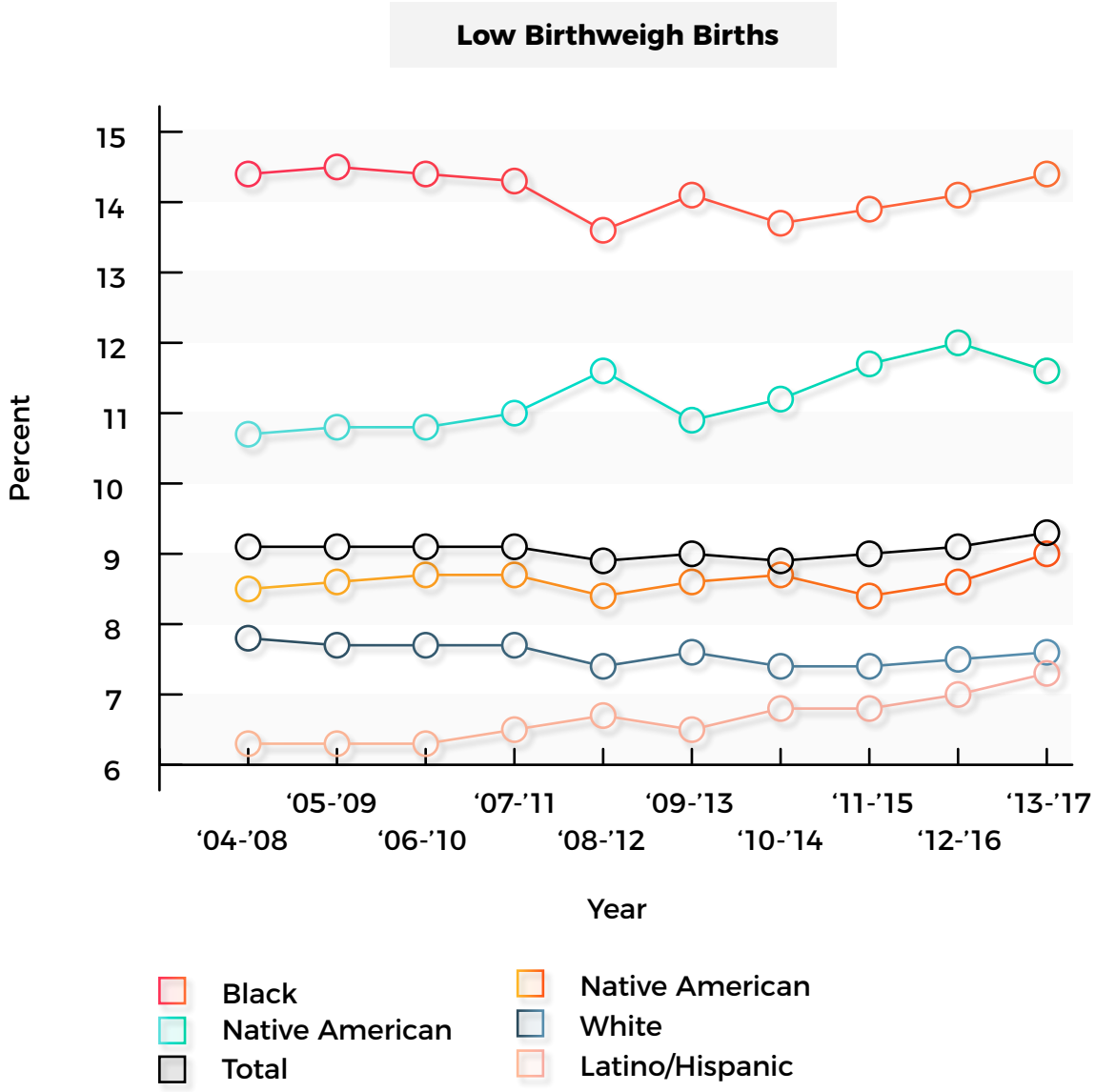
199 Randy Randolph and Mark Holmes, Running the Numbers: Health Insurance Coverage in North Carolina: the Rural-Urban Uninsured Gap. North Carolina Medical Journal November-December 2018 vol. 79 no. 6 397-401, doi: 10.18043/ncm.79.6.397.

200 Patrick Woodie, What's Economic Development Got to Do With It: The Economic Impact of Healthy Rural Communities, North Carolina Medical Journal November-December 2018 vol. 79 no. 6 382-385, doi: 10.18043/ncm.79.6.382.

201 NC Child and NC Institute of Medicine, Child Health Report Card 2019, February 2019.

Indicator 20.1: percentage of babies born with low birthweight.

Trend: Rising, bad



Low birthweight, defined by NC DHHS as having a weight at birth of less than 2500 grams (5.5 lbs), has a powerful correlation with infant mortality and with neurodevelopmental problems, learning disabilities, and poor adult health.[202] This indicator relies on the state's annual publication, Resident Population Health Data by Race and Ethnicity, which expresses low birthweight as a simple percentage of live births of the appropriate demographic. Each annual publication draws on five years of data that closes two years before publication (so, for example, data published in 2018 reflects statistics from 2012-2016; data published in 2017 reflects statistics from 2011-2015).[203] The chart is labeled to indicate the years of data represented rather than the year of publication.

Over the last decade, the percentages of low birthweight birth for all North Carolinians and for specific

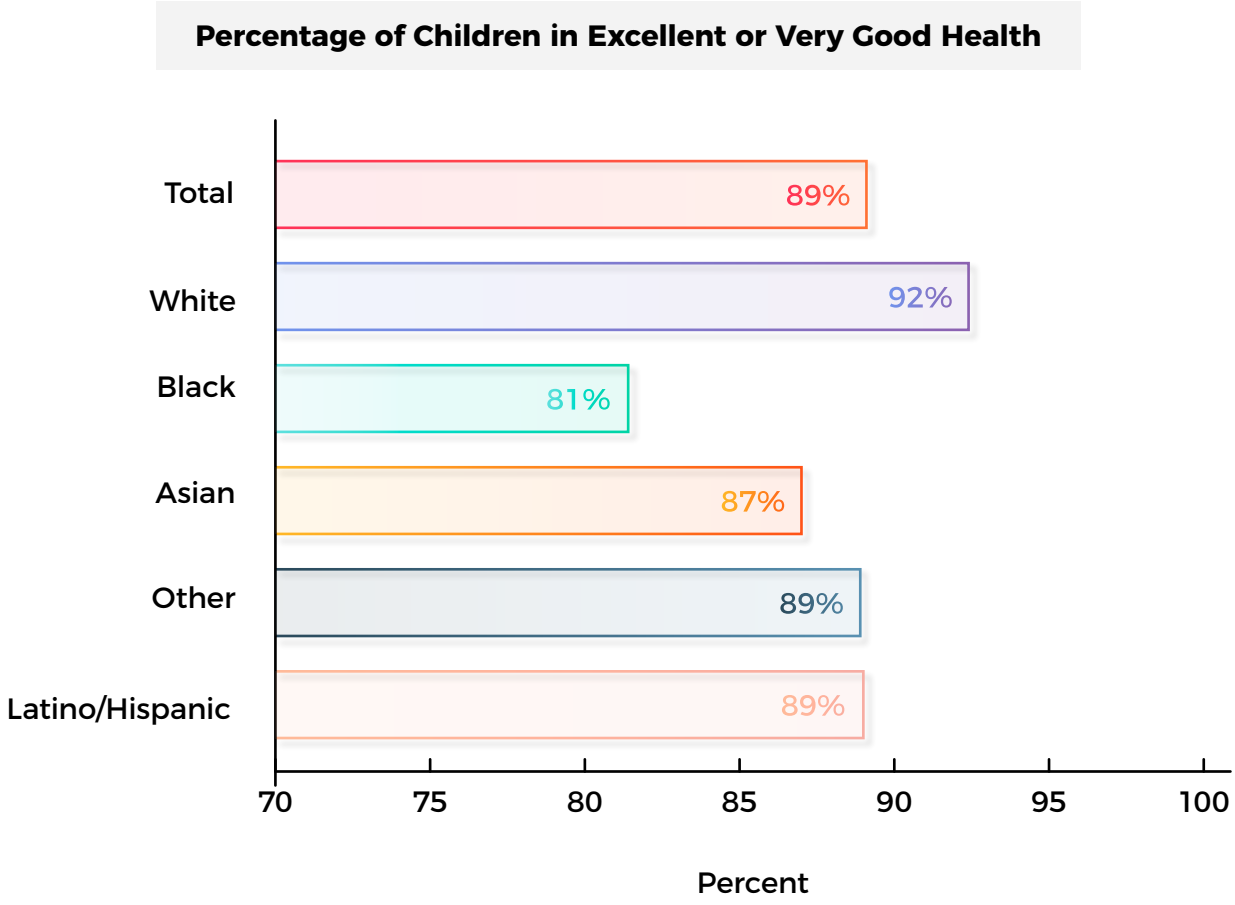
202 Jennifer Kane et al, Neighborhood context and birth outcomes: Going beyond neighborhood disadvantage, incorporating affluence, SSM – Population Health 3. 2017. 699-712.

203 NC DHHS, North Carolina Resident Population Health Data by Race and Ethnicity, 2018, at 4.

demographic groups have not changed much, although the rates for Native Americans and Latinos have increased slightly. What stands out in the data are the racial and ethnic disparities, with Black babies experiencing low birthweight at twice the rate of white or Latino babies; rates for Native American babies are also high. The scientific literature suggests that racial disparities in birthweight correlate with residential segregation, income inequality, disparate exposures to environmental toxics, and disparate levels of psychosocial stress.[204] Because incidence of low birthweight is generally trending up, and the racial disparities are substantial, we evaluate this indicator as showing inadequate progress this year.

Indicator 20.2: percentage of children in excellent or very good health.

Trend: Baseline



This indicator – the percentage of children who are in excellent or very good health – is fairly straightforward. It relies on data collected by the National Survey of Children's Health (NSCH) for 2016-2017 through a random survey by mail of over 1,200 North Carolina households.[205] This data is drawn from the respondents' answers to the first question on the survey, 'how is this child's health: excellent; very good; good; fair; or poor.' The NSCH revised its methodology before 2016, and so current rates are not comparable to past estimates, but should create a usable time series into the future. The most recent survey data reveal substantial racial disparities, with a full 10% fewer Black parents saying their children are in excellent or very good health than white parents do. Because this is a snapshot, we include it this year as a baseline.

Data gap: fetal and infant exposure to toxic chemicals. Infants and children are dispro-

204 Heather Burris, Birth outcome racial disparities: a result of intersecting social and environmental factors, Seminars in Perinatology, October 2017, 41:6, 360-366, https://doi.org/10.1053/j.semperi.2017.07.002.

205 Child and Adolescent Health Measurement Initiative. 2016-2017 National Survey of Children's Health (NSCH) data query.

portionately vulnerable to toxic exposures.[206] Children are typically closer to the ground and ingest more household dust and dirt than adults. Their metabolisms are faster, so they take in more air, water, and food per unit of body weight. Also, children's growing bodies pass through critical windows of vulnerability, during which even small exposures to specific toxics can have outsized impacts. Harms from toxic exposures can last a child's lifetime, or manifest years after the initial exposure; and – as relatively new discoveries about epigenetics are showing – can affect an exposed child's children and grandchildren. Even low chronic exposures to some common toxics can impose multigenerational costs. The primary source of time-series data for environmental exposures is the NHANES database, managed by the Centers for Disease Control. The NHANES database appears to be the best national dataset for environmental exposures, but the data cannot be broken out by state. North Carolina's new Early Childhood Action Plan calls for 'measuring, reliably tracking, and reducing' children's exposure to toxic substances, so we hope state-level data will be collected and made public in the future.[207]

Goal 21: All North Carolinians have access to sufficient and healthy food.

Trend: Weak

Access to healthy foods depends on two factors: whether a household can afford to buy food; and whether, even if they can afford to buy it, healthy or fresh foods are available reasonably close by. Unfortunately, the percentage of food insecure households in North Carolina has been growing, and too many low income households report poor physical access to healthy food, earning this goal a negative trend this year.

Solutions: Pennsylvania has found success in improving the reach of local food systems and promoting food access by establishing a Healthy Food Access Initiative, H1. Removing barriers to moving food from local farms to schools, H2, can also improve access to healthy food and strengthen the local economy. A broad coalition of stakeholders released a report in March 2019 identifying both of these among other steps to improve food access across North Carolina.[208]

Indicator 21.1: percentage of households that are food insecure.

Trend: Rising, bad

14.4% of NC households are food insecure.

The Economic Research Service of the US Department of Agriculture estimates the number of households that are 'food insecure,' meaning that people in the household must periodically resort to poorer quality or variety of food (low food security) or go hungry (very low food security) because they cannot afford food.[209] In North Carolina, that number has increased from 12.6% of households over the years 2005-2007 to 14.4% of households over the period 2014-2017, a 1.8% increase in the percentage of food insecure households, even as the total number of households in the state has grown as well. Roughly 590,000 North Carolina households now experience food insecurity. That's in contrast to a national

206 Virginia Rauh, et al., Neonatology and the Environment: Impact of Early Exposure to Airborne Environmental Toxicants on Infant and Child Neurodevelopment, Neoreviews, 2010, 11, 363, doi:10.1542/neo.11-7-e363.

207 NC DHHS, North Carolina Early Childhood Action Plan, February 2019, at 42.

208 North Carolina Health Food Retail Task Force, Supporting Health Food Access in North Carolina, March 2019.

209 Alisha Coleman-Jensen, et al., Household Food Security in the United States in 2017, 2018, ERR-256, U.S. Department of Agriculture, Economic Research Service, Table 1 (number of households) and Table 2 (change in rate of food insecurity by state); see also, North Carolina Alliance for Health, Food for Every Child: the Need for Healthy Food Access in North Carolina, July 2018.

rate of 11% in 2005-2007 and 12.3% in 2014-2017, a 1.3% increase.[210] North Carolina's rate is thus higher than the national average, and getting worse faster.

The percentage of households with very low food security – meaning members of the household are actually going hungry – is also troubling. The percentage rose from 4% in 2005-2007 to 5.6% in 2014-2017. That's an absolute number of over 229,000 households with members periodically experiencing hunger.[211] For both trends, we mark this indicator as getting worse.

Indicator: 21.2: percentage of low-income residents who are not close to a grocery store.

Trend: Baseline

Even if a person can afford food, their diet and health will suffer if they physically cannot access healthful food. Yet, millions of Americans lack close access to a supermarket. Low-income neighborhoods and communities of color are particularly likely to lack access to healthy foods. These are the same communities whose residents carry disproportionate health burdens.[212] Lack of access to healthy food also means that in-state farmers are missing a market that could otherwise help support a more robust rural economy for North Carolina.[213] While most 'food deserts' are associated with either urban or rural settings, evidence suggests that sprawl can bring them to suburbs as well, as low-income suburban neighborhoods lack the purchasing-power density to sustain grocery retailers.[214]

A 2017 USDA report found that, across the nation, by several different measures, the population of low-income residents without close access to a grocery store increased between 2010 and 2015, even as access improved for the national population as a whole.[215] In North Carolina, the NC Alliance for Health published a useful set of maps in 2017 that allow for a comparison between the geographic distribution of supermarket sales, income, and deaths from diet-related illnesses.[216] Because these offer a static snapshot, however, this report also relies on the Robert Wood Johnson Foundation's County Health Rankings, which presents data from USDA's 2015 Food Environment Atlas.[217] That source found that roughly 7% of the state's low-income population lacks access to a grocery store nearby; the rate by county varies from 0% to 14%, with two rural outliers: Caldwell County (17%) and Hyde County (35%).

For comparison, it is worth considering what North Carolinians say when surveyed about local options. In the most recent year (2017) of the NC Behavioral Risk Factor Surveillance System, respondents were asked, to what degree would you agree with the statement, "It is easy to purchase healthy foods in my neighborhood such as whole grain foods, low fat options, and fruits and vegetables."

They replied as follows:[218]

210 Coleman-Jensen, Table 2 (change in rate of food insecurity by state).

211 Alisha Coleman-Jensen, Matthew P. Rabbitt, Christian A. Gregory, and Anita Singh. 2018. Household Food Security in the United States in 2017, ERR-256, U.S. Department of Agriculture, Economic Research Service, Table 1 (number of households) and Table 3 (change in rate of very low food security by state).

212 Policy Link and the Food Trust, The Grocery Gap: Who Has Access to Food and Why It Matters, 2010; M. Ahern et al, A National study of the association between food environments and county level health outcomes, J Rural Health, 2011 Winter, 27:4, 367. doi: 10.1111/j.1748-0361.2011.00378.

213 See, John Mann et al, Healthy food incentive impacts on direct-to-consumer sales: a Michigan example, J of Agriculture, Food Systems, and Community Development, 8:1, 97, doi.org/10.5304/jafscd.2018.081.006 (finding that efforts to increase food access for low-income residents increased sales revenue for farmers).

214 Shima Hamidi, Measuring Metropolitan Form: Remaking Urban Form For Sustainability, 2015, at 113-122.

215 Alana Rhone et al, Low-Income and Low-Supermarket-Access Census Tracts, 2010-2015, EIB-165, U.S. Department of Agriculture, Economic Research Service, January 2017.

216 NC Alliance for Health, 2017 North Carolina Food Access Maps, 2017.

217 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps: Limited Access to Healthy Foods. 2018.

218 NC DHHS, NC State Center for Health Statistics, Perceived Nutrition Environment, presenting state data from the 2017 Behavioral Risk Factor Surveillance System.

	ALL	LOW-INCOME
Strongly Agree	41%	27%
Agree	44%	52%
Neutral	6%	8%
Disagree	7%	10%
Strongly Disagree	2%	3%

Although all of these are single-year snapshots, the multiple perspectives leave us comfortable evaluating this indicator as showing inadequate progress.

Education

Beyond health, education is another major contributor to quality of life. Within the category of education, we consider two goals: that all North Carolinians receive a quality education, and -- much smaller but still of significance -- that North Carolinians understand and can apply environmental sustainability concepts.

Goal 22: All North Carolinians receive a quality education.

Trend: Mixed

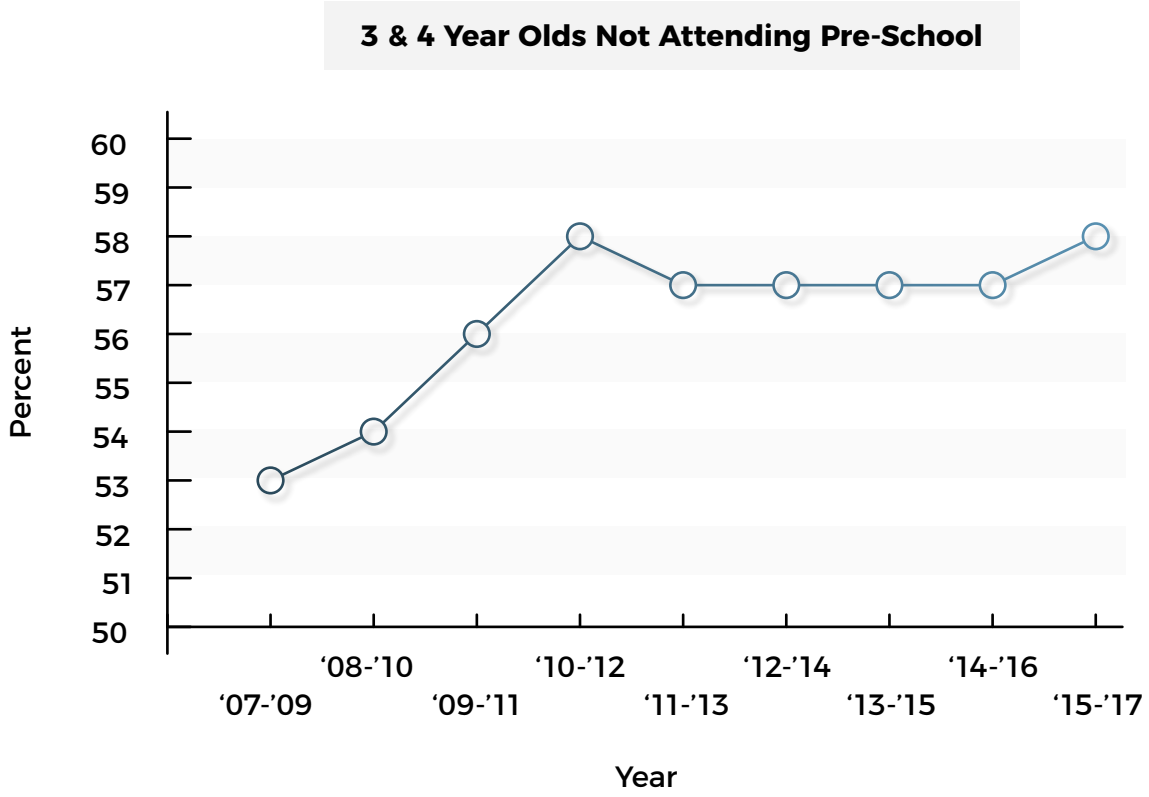
Article I, Section 15 of the North Carolina constitution famously asserts, "[t]he people have a right to the privilege of education, and it is the duty of the State to guard and maintain that right." In 1997, the North Carolina Supreme Court interpreted that provision to guarantee "a sound basic education" to all children in the state.[219] That does not extend to all the promise of a college degree; but at least through high school, the public school system is supposed to equip each student with the ability to read and write; understand math and science as needed to function "in a complex and rapidly changing society"; know enough of the social sciences to vote sensibly; and be ready to seek further training or hold a job in a competitive workplace.[220] All of those are fair expectations for what a strong and sustainable state needs a child to know, and the next four indicators all point toward that goal.

Because several of the indicators show no trend, and because attendance at college is rising but racial and ethnic disparities remain, we rate the state as showing mixed progress.

219 Leandro v. State, 346 N.C. 336 (1997).
220 Idem, at 5.

Indicator 22.1: percentage of children attending preschool.

Trend: No change



Children who are enrolled in a high-quality kindergarten program do significantly better in academic performance and educational outcomes later on.[221] The North Carolina General Assembly has wisely funded kindergarten programs; still, over half of children are not enrolled in kindergarten, thus missing this opportunity. This indicator tracks the number of children not attending preschool. It has remained flat at 57% of 3- and 4-year-olds for several years, moving to 58% not attending in 2015-2017.[222] We count this as showing no trend for this year.

Indicator 22.2: 8th grade average English and math performance

Trend: No change

ACHIEVEMENT[223]	2009	2011	2013	2015	2017
Math advanced	9%	10%	9%	9%	11%
Math proficient	36%	37%	36%	33%	35%
Math basic	75%	75%	75%	69%	68%
Reading advanced	3%	3%	4%	3%	3%
Reading proficient	29%	31%	33%	30%	33%

221 Andres Bustamante et al, Realizing the promise of high quality early childhood education, Brookings blog, March 27, 2017.

222 NC Kids Count database, drawing from Population Reference Bureau, analysis of data from the U.S. Census Bureau, pooled 2007-09 to 2015-17 one-year American Community Survey.

223 U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP)Assessment, North Carolina Profile, 2018.

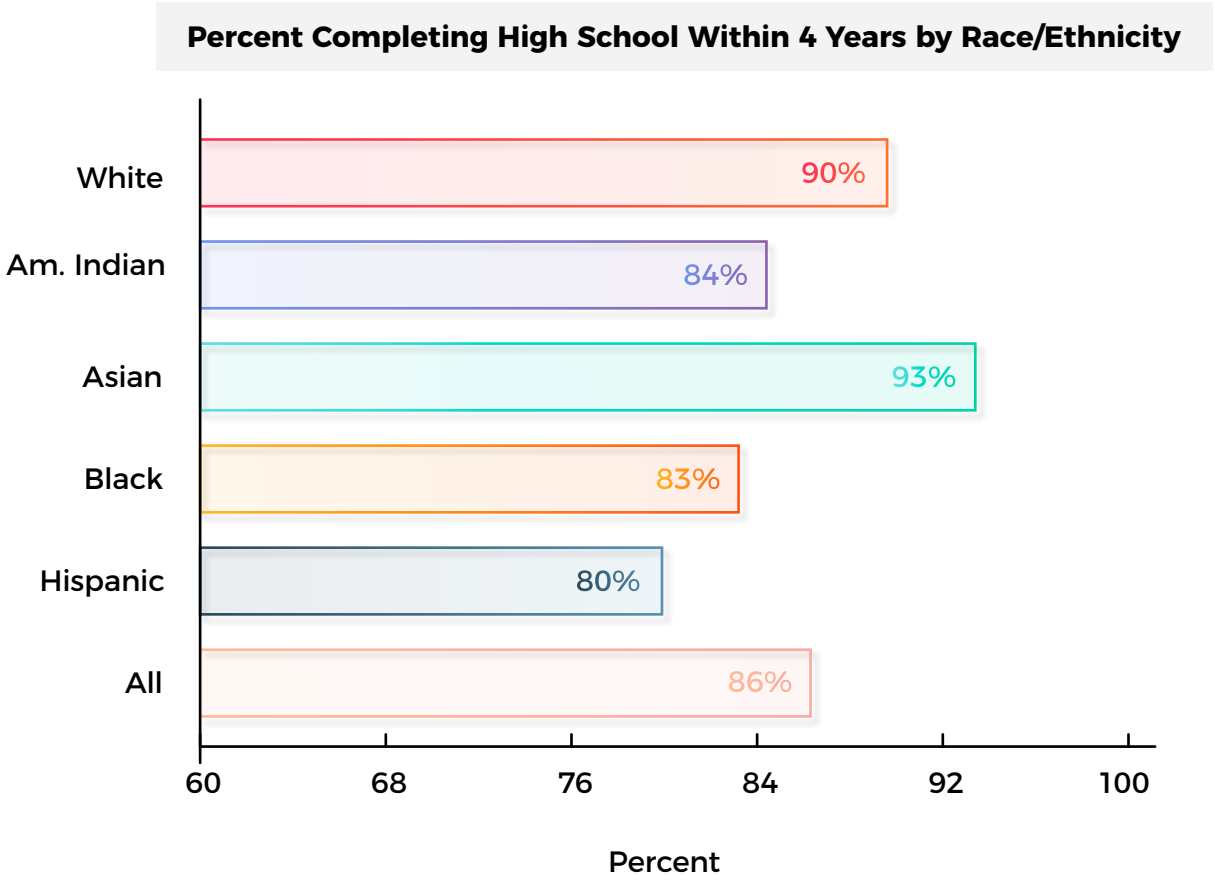
ACHIEVEMENT[223]	2009	2011	2013	2015	2017
Reading basic	70%	74%	76%	72%	74%

For fifty years, the US Department of Education has run the National Assessment of Educational Programs (NAEP), branded as the Nation's Report Card.[224] It consists of test results in math and reading administered to groups of 8th graders in all states, allowing for a comparison across the states as well as across time. Performance on the test is measured against three standards: basic, proficient, and advanced.

Over the last decade, North Carolina's scores have remained fairly flat, although basic math performance has dropped in the last two cycles (but not proficient or advanced math).[225] Compared to the rest of the country, North Carolina has generally been 2 to 4 percentage points ahead of the average on math, 1 to 3 points behind on reading, and 2 to 5 points behind on science. Because scores over time have been basically unchanged, we count this as showing no trend for this year.

Indicator 22.3: percentage of students completing high school within 4 years.

Trend: Baseline



Graduation from high school is correlated with greater economic security and a variety of positive health outcomes. Since 2011, the federal government has collected graduation statistics in a consistent format from all 50 states. That information is collected in North Carolina by the NC Department of Public Instruction, and provides a detailed demographic breakout for the most recent year.[226] The

224 The Nation's Report Card, webpage: About the Nation's Report Card, retrieved April 10, 2019.

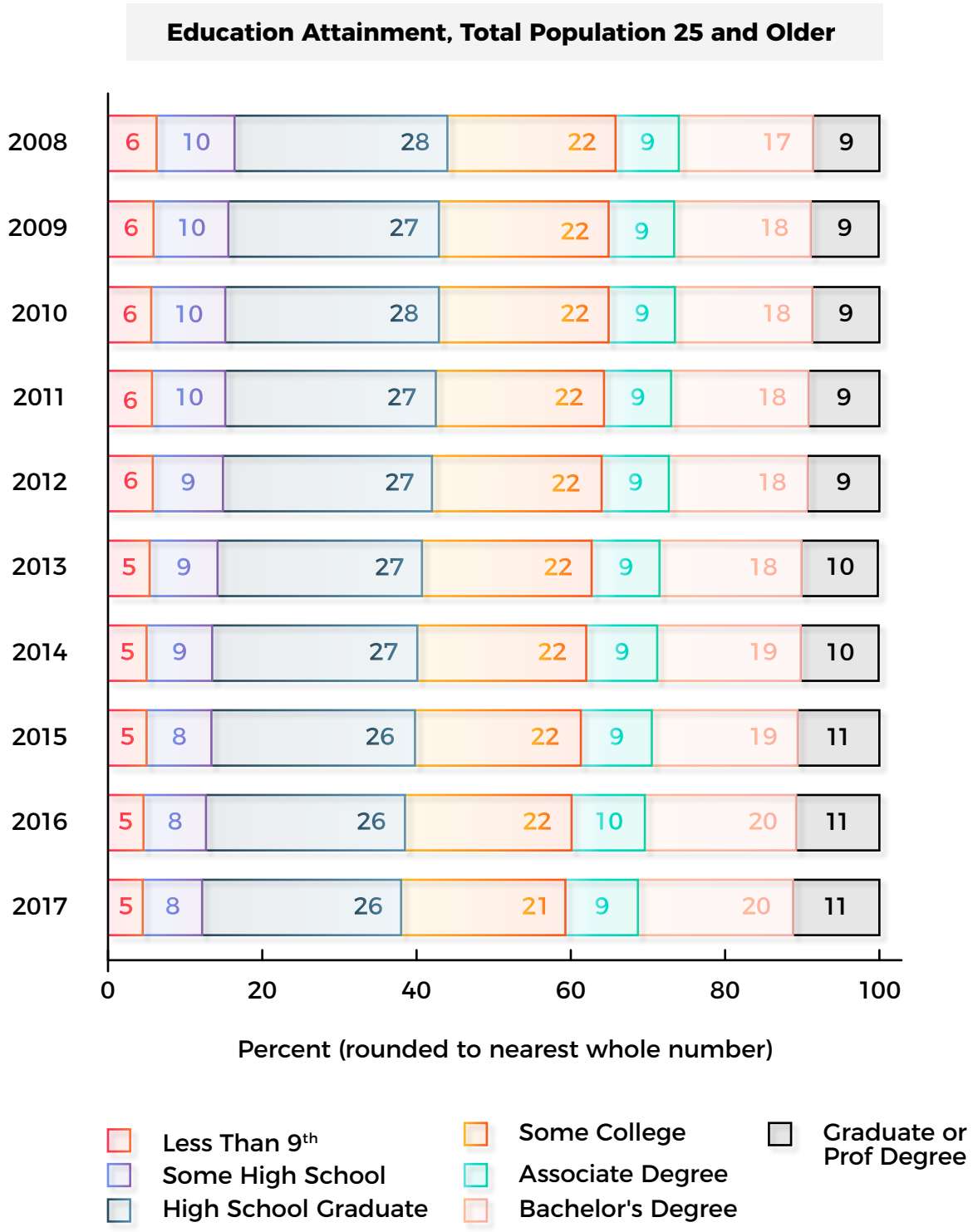
225 U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP)Assessment, North Carolina Profile, 2018.

226 NC DPI, webpage: Cohort Graduation Rates, 2018.

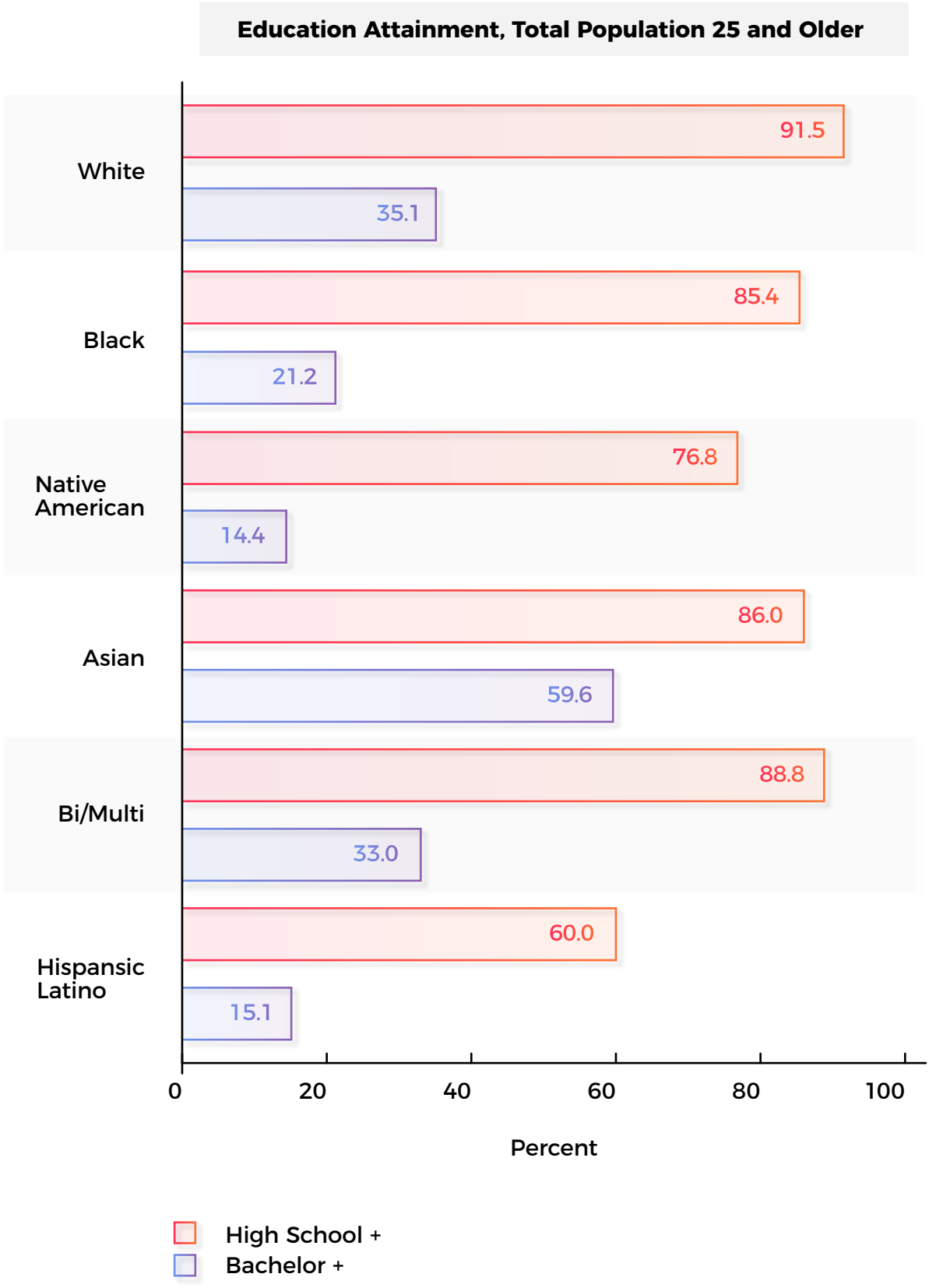
Robert Wood Johnson Foundation's County Health Rankings notes that individual counties in North Carolina have four-year graduation rates ranging from 73% to 94%.[227] Because the data is for the most recent year alone, we count this as a baseline and do not assign a trend this year.

Indicator 22.4: percentage attending college and achieving advanced degrees.

Trend: Rising, good



227 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps, Health Factors: High School Graduation, 2014-2015.


Education Attainment, Total Population 25 and Older
White
91.5
35.1
Black
85.4
21.2
Native American
76.8
14.4
Asian
86.0
59.6
Bi/Multi
88.8
33.0
Hispansic Latino
60.0
15.1
0
20
40
60
80
100
Percent
High School +
Bachelor +

This indicator follows the percentage of North Carolinians who have at least a high school degree or at least a bachelor's degree, using data from the US Census Bureau's American Community Survey.[228] Only tabulated data is available to show percentages of each racial demographic since 2015; this indicator will grow more useful in future years. With three years of data, this indicator shows wide racial disparities in the rate at which North Carolinians finish high school and college, but numbers for all demographics are moving gradually in the direction of greater educational achievement, and racial disparities are narrowing. We count this as a positive trend.

Goal 23: North Carolinians are exposed to and apply sustainability concepts.

Trend: No trend

From a sustainability perspective, a key component of education is environmental literacy. There are few data sources that track this directly, but professionals working in the field identify several components of environmental literacy, including both knowledge and inclination to shape one's behaviors based on that knowledge.[229] For this goal, we track two indicators that serve as proxies for these components: the ratio of environmental educators to state residents (a marker of residents' likely exposure to sustainability concepts in a practical, local context); and North Carolinians' self-reported inclusion of environmental considerations in their purchasing decisions. Because both indicators provide baseline data, we do not assign a trend to this goal this year.

Indicator 23.1: number of environmental educators in the state per capita.

Trend: Baseline

Environmental literacy is rarely measured directly, but one way that North Carolinians come to understand sustainability is through exposure to environmental education. This education can occur at state parks, local nature centers, and community fairs, as well as more formal educational settings. For years, the state Department of Environmental Quality has run a program that certifies environmental educators.[230] The program requires 50 hours of continuing education every five years, so it is possible to track the number of active, certified environmental educators in the state. As an imperfect but illustrative indicator of the degree to which North Carolina residents are likely to be hearing locally-relevant environmental information, we track the number of citizens per certified environmental educator. In 2018, there were 650 active environmental educators in North Carolina, or about 1: 15,924 state residents. The number of educators certified annually has gradually increased to between 50 and 60 new educators each year, more than enough to improve the ratio over time, even as the state grows. We treat it as a baseline this year.

Indicator 23.2: percentage of people who say environmental considerations shape their purchasing decisions.

Trend: Baseline

A second component of environmental literacy is the degree to which people act on their environmental knowledge. To evaluate that, NCCN commissioned a poll of a representative sample of North Carolin-

228 US Census Bureau, American Community Survey 1-Year Estimates, 2008-2017.

229 National Environmental Education Foundation, Environmental Literacy in the United States: An Agenda for Leadership in the 21st Century, 2015, at 11.

230 NCDEQ, Environmental Education & Public Affairs, website: Certification, retrieved February 26, 2019.

ians, posing the question, "When you are making a purchase as a consumer, do you often, sometimes, rarely, or never consider the environmental impacts of the product or service you are buying?" Consumption choices are only one way people can choose to act, but because most people are regularly in the market for products and services, the question has nearly universal relevance. The responses: 35% of respondents said they often consider environmental impacts; 33% said sometimes; 22% said rarely; 8% said never; and 2% were not sure. This is a snapshot rather than a trend, so it is presented here as a baseline; we expect to continue to poll this question for future editions of this report.[231]

Social Fabric

Community

Our analysis examines North Carolina's social fabric in the context of five goals: safe communities; strong civil society; thriving arts and culture; equity among communities; and rates of social connection for individual North Carolinians.

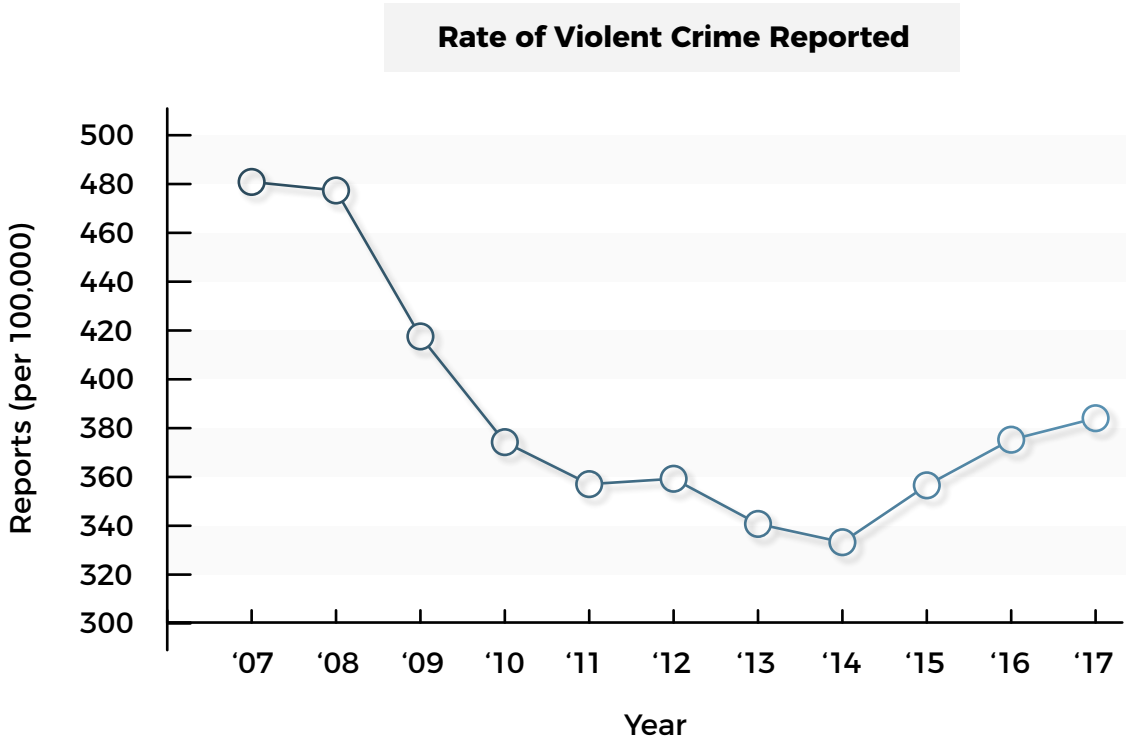
Goal 24: Communities across North Carolina are safe.

Trend: Good

As measures of the safety of North Carolina's communities, we consider three indicators: the rate of reported violent crime, the incarceration rate, and North Carolinians' self-reported sense of safety in their neighborhoods at night. The first indicator shows mixed results, the second positive trends, and the third a baseline value; altogether, we see positive movement towards safer communities.

Indicator 24.1: the rate of reported violent crime.

Trend: Mixed



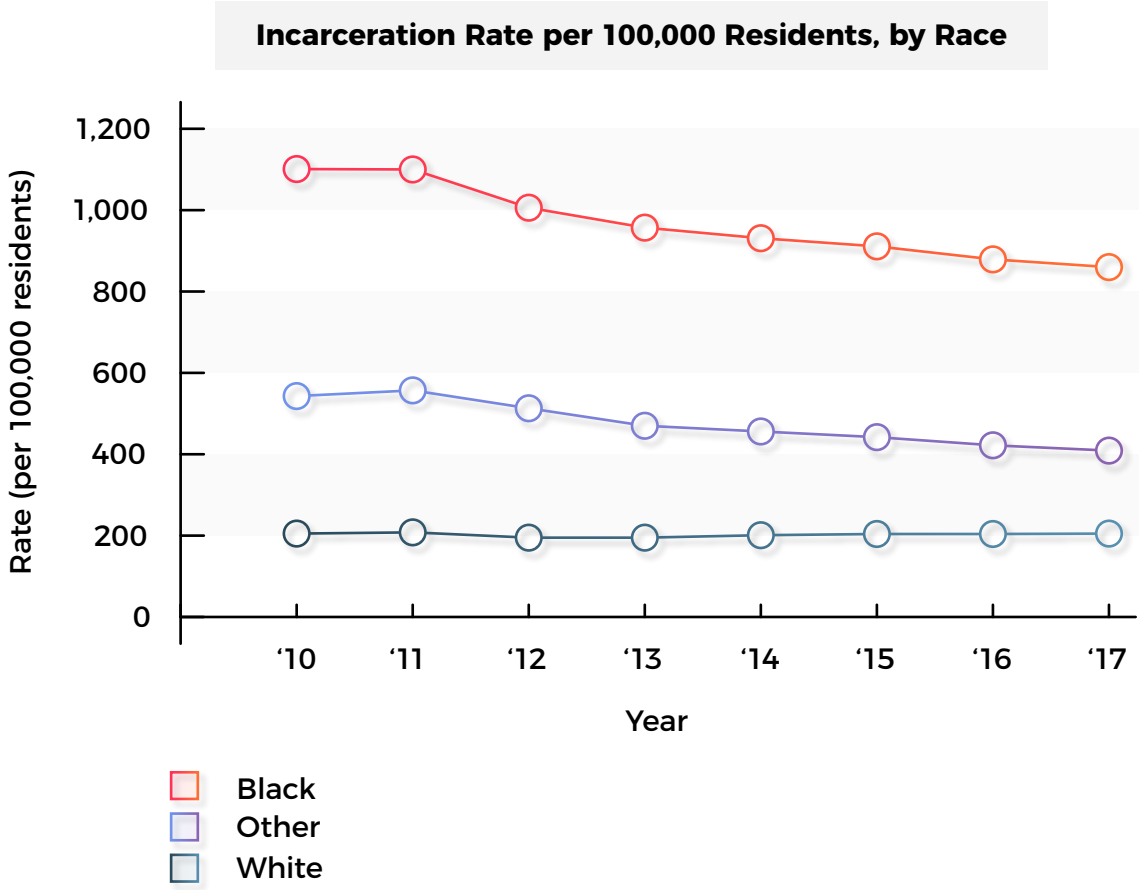
231 Public Policy Polling, Survey of 590 North Carolina voters, February 27-28, 2019.

Violence diminishes health and quality of life in a community. The rate of violent crime is a marker not just of harm to North Carolina's residents, but of the strength of our cultural fabric and aggregate psychological health. The data we use for this indicator is from the NC State Bureau of Investigation, collected as part of the national Uniform Crime Reporting Program, which defines violent crime to include murder and non-negligent manslaughter, rape, robbery, and aggravated assault (but omits suicide).[232]

In North Carolina, the rate of violent crime dipped sharply following the Great Recession, but has gradually climbed again since 2014.[233] Virtually all of the increase is in aggravated assault, even as rates of murder, rape, and robbery rates have stayed low. Across the same time, property crimes have fallen and stayed low, from over 4,100 per 100,000 residents annually to under 2,700. Because the data overall shows a substantial decline over the last decade, tempered with a recent rise, we count this as a mixed signal in this year's evaluation.

Indicator 24.2: the rate of incarceration.

Trend: Falling, good



The NC Department of Public Safety keeps track of the number of people in the prison population in North Carolina, along with a limited demographic breakout.[234] According to that analysis, the rate of incarceration for whites has been level for several years, while the rates of incarceration for black and all other non-white residents have been falling (although there is still a gross racial disparity in incarceration rates). We count the falling rates and narrowing disparity as a trend in the right direction.

232 US Federal Bureau of Investigation, website: 2017 Crime in the United States, Violent Crime, retrieved February 17, 2019.
233 NC State Bureau of Investigation, 2017 Annual Summary Report. December 2018.
234 NC DPS, Annual Statistical Reports, 2010-2017, Demographics of Prison Population on June 30.

It is worth noting that the incarceration rate greatly underestimates the rate at which North Carolinians are enmeshed in the criminal justice system. In 2016, for example, 1,587 out of 100,000 residents were under some kind of correctional control, as follows:[235]

CATEGORY	RATE (PER 100,000)
State prison	355
Federal prison	105
Local jail	195
Parole	121
Probation	804
Total	1,587

As of February 2019, NC DPS counted 36,403 prison inmates, 82,462 probationers, and 12,263 people on post release or parole.[236]

Indicator 24.3: (poll result) percentage of people who say they feel unsafe in their neighborhood at night.

Trend: Baseline

A more subjective indicator of safety is the degree to which North Carolinians feel safe in their neighborhoods at night, and a standard question used an an indicator of social cohesion. For this report, NCCN commissioned of poll of a representative sample of North Carolinians, and asked the question, "Generally speaking, would you say that you feel very safe, somewhat safe, somewhat unsafe or very unsafe in your neighborhood at night?" An impressive 45% percent of respondents said they feel very safe; 43% feel safe; 9% feel somewhat unsafe; and just 3% feel very unsafe (none were unsure).[237] The great majority of North Carolinians feel more safe than not in their neighborhoods at night, which is positive; because this is a single-year snapshot, we present it as a baseline this year.

Goal 25: civil society and volunteer organizations have adequate capacity.

Trend: Good

To measure the health of civil society, we consider two indicators: whether nonprofit leaders report they have adequate capacity to meet demand, and the rate at which North Carolinians volunteer. Both provide baseline values this year, so we assign no trend to this goal.

Indicator 25.1: organizational effectiveness.

Trend: Baseline

One feature that sets American society apart from many others around the world is the scale of the nonprofit sector. Nonprofits are defined in state and federal tax laws as having public benefit rather than private profit as their objective, in exchange for which nonprofits receive exemptions from various federal, state, and local taxes. Across North Carolina and the United States, nongovernmental organizations provide a wide range of services and advance many different visions of our future. A 2015 analysis by the NC Center for Nonprofits found that the nonprofit sector accounts for more than

235 Alexi Jones, Correctional Control 2018 (December 2018). This information is, unfortunately, not broken out by race or ethnicity.

236 NC DPS, website: Adult Correction, Offender Population, February 22, 2019.

237 Public Policy Polling, Survey of 590 North Carolina voters, February 27-28, 2019.

10% of employment in North Carolina and contributes $38.5 billion annually to the state economy.[238]

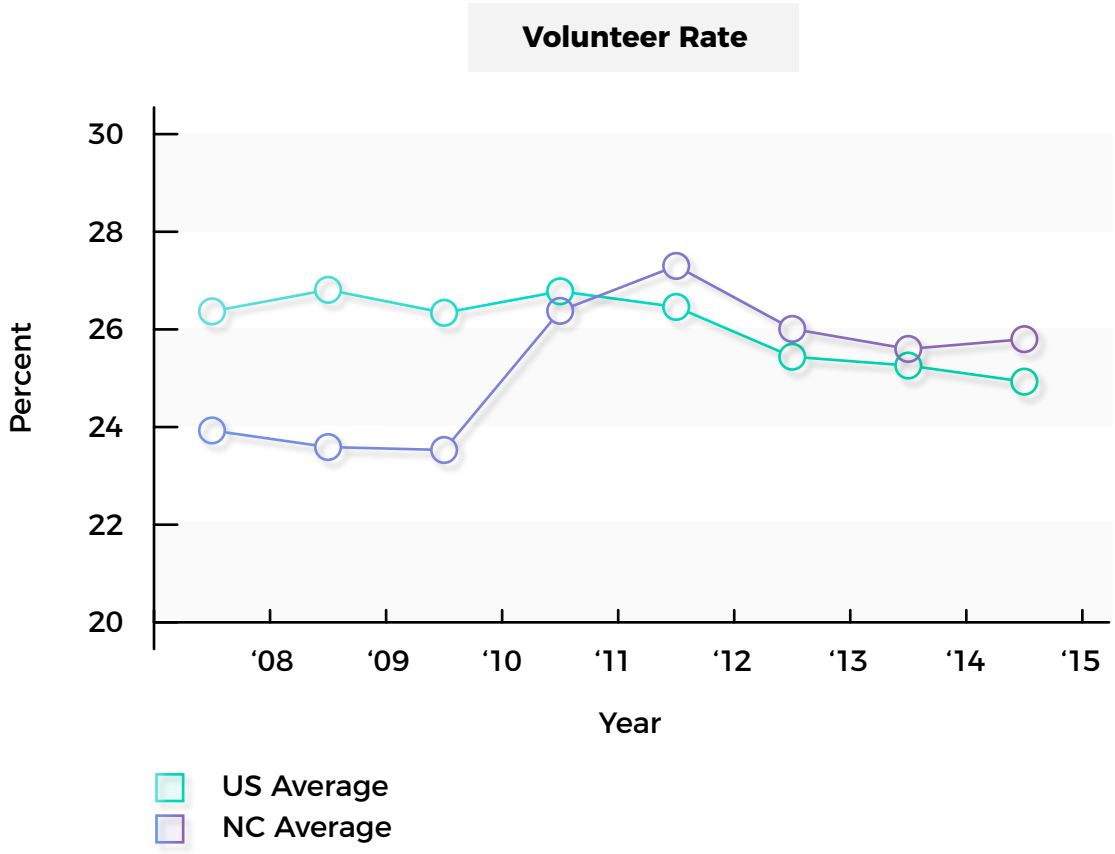
This indicator tracks the ability of the sector to meet the state's needs, as estimated by nonprofit leaders surveyed by the national Nonprofit Finance Fund.[239] In the 2018 survey, 56% of nonprofit leaders in North Carolina said that they were unable to meet the in-state demand for their services in 2017, and 53% expected to be unable to meet that demand in 2018. That closely matches the national response: 55% of leaders across the country said they couldn't meet demand for services in 2017, and 57% expected that they wouldn't be able to meet demand in 2018. That is not for want of strategic focus: a full 82% of North Carolina nonprofit leaders said they use output and outcome data to drive their programs.

Also illuminating for what it says about the health of the sector, 55% of leaders responding to the survey said they finished 2017 with an operating surplus, 27% broke even for the year, and 19% suffered an operating deficit.[240] That is in a year with a strong economy and robust charitable giving; the numbers are likely to look considerably worse in the next economic downtown.

Because this is a single-year snapshot, and North Carolina's degree of unmet demand does not seem out of line with the rest of the nation, we treat this indicator as setting a baseline this year.

Indicator 25.2: rate of volunteerism.

Trend: Rising, good



Rates of voluntarism in North Carolina echo national rates. For this indicator, we rely on data collected and published by the Corporation for National and Community Service, which ranks North Carolina 19th out of 50 states and the District of Columbia for voluntarism.[241] CNCS estimates that 35.1% of

238 NC Center for Nonprofits, Essential: Our State's Nonprofit Sector is a Vital Economic Engine, 2015.
239 Nonprofit Finance Fund, State of the Nonprofit Sector Survey 2018 (2018).
240 Idem.
241 Corporation for National & Community Service, webpage: North Carolina.

North Carolinians volunteer, for a total of 265.3 million hours of service annually; 32.2% of residents – roughly a third – participate in local groups or organizations. Given North Carolina's current rank among the states, and the fact that North Carolina's rate has bumped up slightly over the last decade, we recognize this indicator as positive this year.

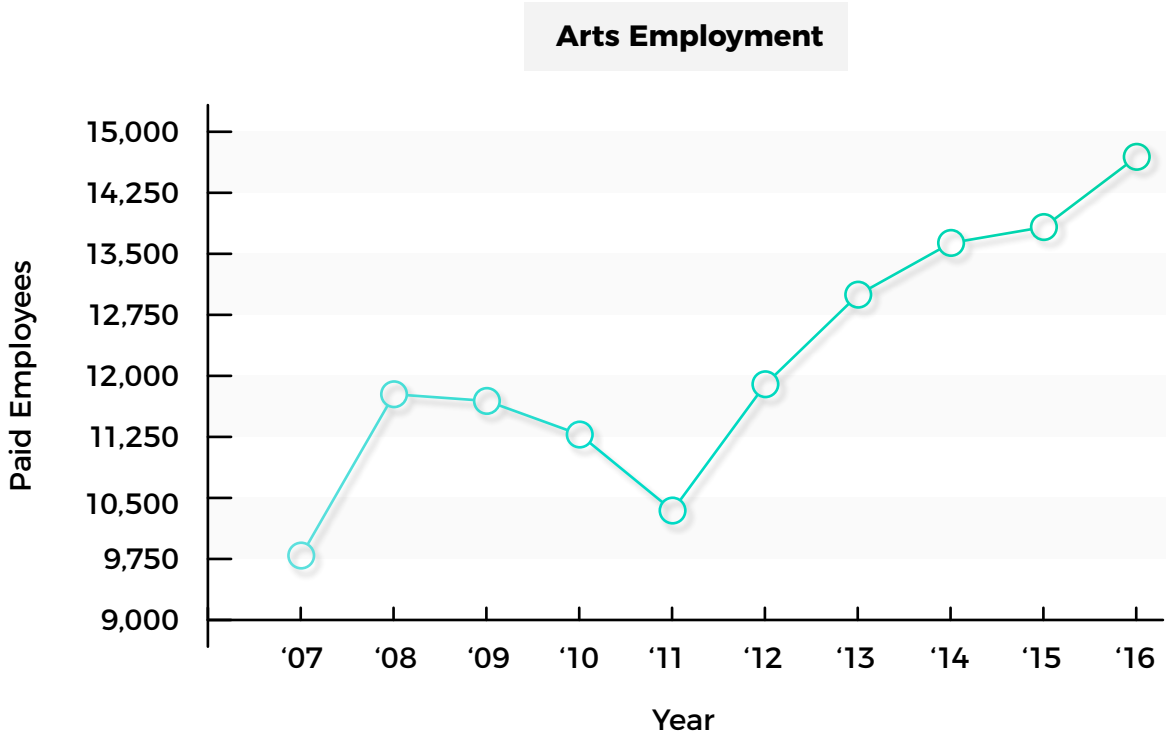
Goal 26: arts and culture are thriving.

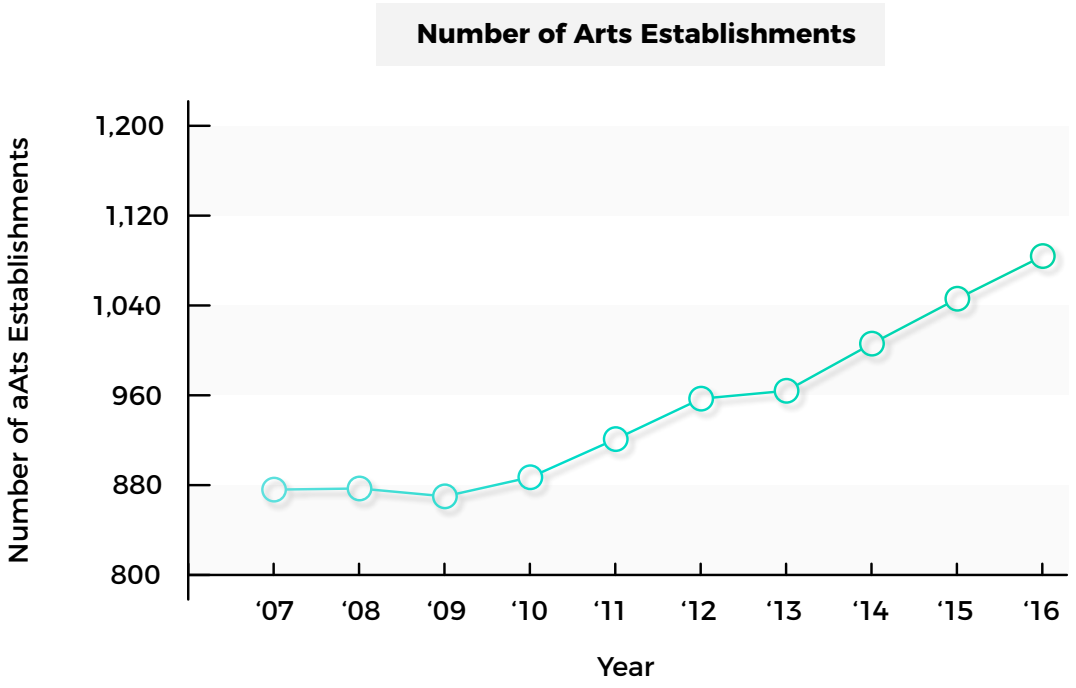
Trend: Good

Arts and culture are hallmarks of a strong society. For this goal, we track two indicators: the number of establishments and jobs in the arts sector; and per capita visits to natural and cultural heritage sites. Both show positive trends, so we assign a positive trend to this goal this year.

Indicator: 26.1: trend in arts establishment and employment.

Trend: Rising, good

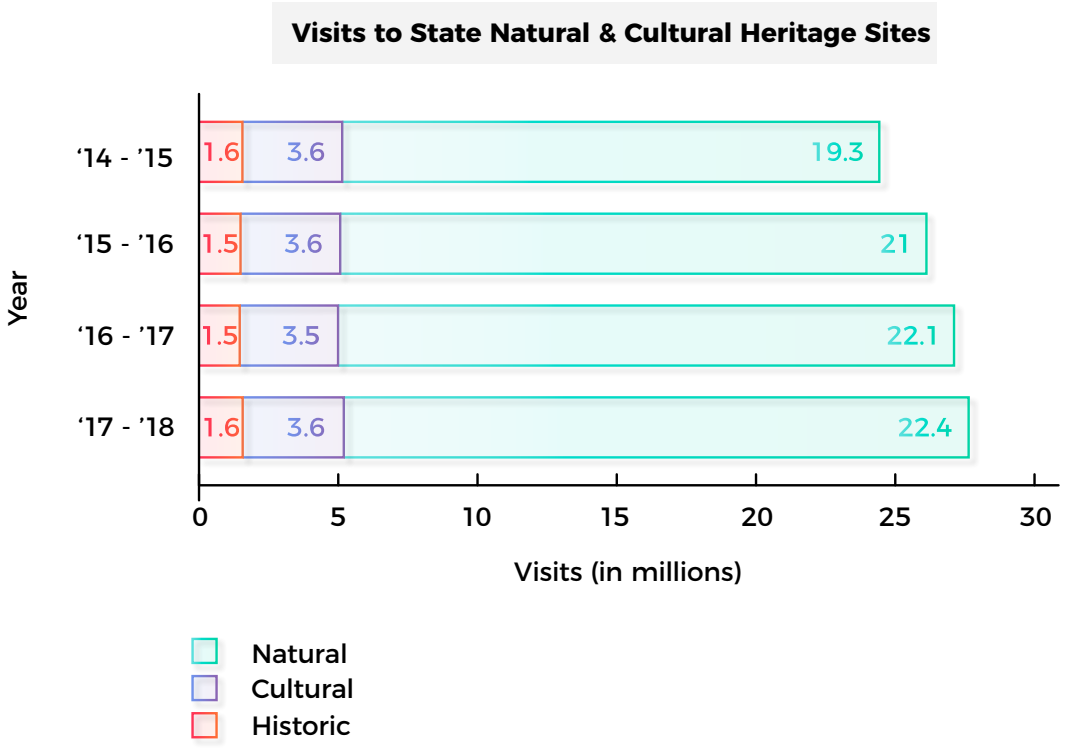




One basic measure of whether arts and culture are thriving in North Carolina is the number of people who make their living as artists, musicians, performers, athletes, and writers. This indicator is tracked annually by the US Census County Business Patterns series; for North Carolina, it shows a steady growth in both arts establishments and total arts payroll.[242] We view this indicator as showing strong progress.

Indicator 26.2: per capita visits to state natural & cultural heritage sites.

Trend: Rising, good



242 US Census Bureau, County Business Patterns (2007-2016).

Another indicator of thriving arts & culture is the visitor count at the state's public historic, cultural, and natural attractions. Historic attractions include State Historic Sites, Tryon Palace, the Roanoke Island Festival Park, and the battleship North Carolina. Cultural venues include the state art and history museums, and the NC symphony. Natural locations include the State Park System, the zoo, the aquariums, and the natural history museum. Altogether, state natural and cultural sites show a steady increase in annual visits, indicating a lively interest in the state's culture, history, and landscapes.[243]

Goal 27: All communities are treated with respect.

Trend: No trend

Social equity is a core component of sustainability. As we examine North Carolina's social fabric, it is essential to evaluate progress towards equity not just in individual health and educational outcomes, but also at the neighborhood and community level. This goal, built from three distinct indicators, embodies the concept that all communities in the state should be treated with respect, and that disparate environmental risks should not be piled on neighborhoods based on the race or income of their residents. We assign it no trend this year.

Solutions: From a sustainability perspective, one of the best ways to ensure that all communities are treated with respect is to ensure that, E1, state rulemaking, funding, and permitting decisions are made with consideration of environmental justice built into the process. In addition, L4, implementing smart affordable housing policies; K1, increased spending on bicycle and pedestrian facilities; and K5, robust implementation of Complete Streets, can reduce residential segregation while also blunting harmful side effects of gentrification.

Indicator 27.1: degree of residential segregation.

Trend: Baseline

We recognize that this indicator – the degree of racial segregation in the state's neighborhoods – is fraught. North Carolina's spatial demographics reflect a painful history of racial oppression: three centuries of slavery and one of Jim Crow. Even in the present, differences in inherited family wealth and continued (illegal) discrimination mean that many North Carolinians of color cannot buy or rent in neighborhoods where many white residents can. At the same time, many communities of color feel deep and justified pride in neighborhood history as a testament to achievement in the face of oppression.

We include trends in de facto racial residential segregation as an indicator for two reasons. First, it correlates with a variety of other social and educational disparities, including lifelong social mobility. Second, neighborhoods that are heavily populated with residents of color are all too often targeted for the siting of facilities that pose risks to neighbors. The more residential and income segregation we retain, the greater the opportunities for environmental injustice.

For this indicator, we follow two statistics: black/white residential segregation and non-white/white residential segregation, both as calculated by the Robert Wood Johnson Foundation. The measure reflects the degree to which the demographic distribution of census tracts within each county do not reflect the distribution in the county as a whole.[244] As RWJ explains, "The index score can be interpreted as the percentage of white or non-white that would have to move to different geographic areas in order to produce a distribution that matches that of the larger area." The analysis relies on data from the most recent 2012-2016 American Community Survey of the US Census. The analysis does not assess ethnicity (segregation or integration of Hispanic or Latino residents). The reason to include the non-white/white number is that it does take into account Native American populations that are overlooked in the black/white number.

243 Data provided by NC Department of Natural & Culture Resources, February 2019, on file.
244 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps: Residential Segregation, 2018.

For North Carolina, counties have indices of black/white residential segregation varying from 5 to 70 with a state average of 50. Counties have indices of non-white/white residential segregation varying from 0 to 70 with an average of 45. These averages confirm that in most counties, there is plenty of room for greater residential integration to develop without threatening the identity of historic communities of color. Because these are snapshots rather than trends, we count them as a baseline this year.

Indicator 27.2: distribution of releases of pollutants.

Trend: Baseline

US EPA's Toxics Release Inventory (TRI), established by the federal Emergency Planning and Community Right to Know Act (EPCRA), requires companies that meet certain criteria to report their annual releases of specific chemicals to EPA.[245] We include this as an indicator of stresses placed on communities because, while the TRI does not cover all pollutants or facilities, TRI releases are significantly correlated with increased cancer hospitalization rates at the county level.[246]

The 2014 Toxics Release Inventory (TRI) included an analytical tool that more recent TRIs have omitted: a calculation for each state of the percentage of residents within a mile of a TRI facility who are people of color, and the percentage who live in poverty. The analysis found that in North Carolina, out of a total state population of 9.5 million residents, roughly 1.2 million lived within 1 mile of a facility that reported releases of pollution to the TRI. Of that 1.2 million, 45% were 'minorities', and 21% were living in poverty.[247] That contrasts with the overall state population in 2014, of which 28.5% were people of color and 17.2% were in poverty.[248] In other words, people in poverty were a bit more likely to live near a TRI facility than the general population, while people of color were significantly more exposed than whites.

As with our analysis of disparities in exposure to air pollution, this analysis of disparate exposures to general pollutant releases relies on static data that is increasingly out of date. Again, we hope and expect that the new community mapping tool brought on line in 2019 by the NC Department of Environmental Quality will make it possible to update this indicator in a meaningful way each year to capture trends. For this year, we present the indicator as a baseline.

Indicator 27.3: number of neighborhoods experiencing gentrification and displacement.

Trend: No trend

Gentrification – the rapid replacement of housing in low-wealth neighborhoods with redevelopment that prices out the residents – can be understood as another form of disparate impact. It doesn't happen to wealthy white neighborhoods. Unlike a polluting facility, gentrification doesn't directly sicken nearby residents, but by forcing longtime residents out and reshaping the physical landscape, it dissolves community identities. Vulnerable residents displaced by gentrification often move to lower-income neighborhoods, implying poorer quality of life and worse health outcomes.[249]

245 42 USC §11023, Emergency Planning and Community Right to Know Act §313. See also, US EPA, website: Basics of TRI Reporting, August 23, 2018.

246 Michael Hendryx and Juhua Luo, Cancer hospitalizations in rural-urban areas in relation to carcinogenic discharges from Toxics Release Inventory facilities, Int J Environ Health Res. 2013;23(2):155-69. doi: 10.1080/09603123.2012.708919.

247 US EPA, 2014 TRI National Analysis (January 2016).

248 US Census Bureau, 2010-2014 American Community Survey 5-Year Estimates.

249 Lei Ding et al, Gentrification and Residential Mobility in Philadelphia, Reg Sci Urban Econ. 2016 November; 61: 38–51. doi:10.1016/j.regsciurbeco.2016.09.004 (based on a 50K person dataset, finding that lower income residents did not move from older gentrifying neighborhoods at a higher rate, but did move to poorer neighborhoods; also, noting that Philadelphia has substantial vacant properties, making gentrification less likely to displace residents there than in other cities).

At the same time, redevelopment of fading or downscale neighborhoods is our society's primary way to renew our supply of buildings. It creates new wealth while avoiding greenfield development that would degrade natural resources. Not all infill or redevelopment displaces residents, but in the absence of effective affordable housing strategies, some does, providing vital benefits to society as a whole while imposing burdens on those already struggling to get by. This is not just a function of the private market; local government investments in neighborhood amenities, such as parks and community gardens, can spur the process.[250]

A recent report from the National Community Reinvestment Coalition captures much of this nuance.[251] The report examines changes at the census tract level across the nation between 2000 and 2013. It defines gentrification narrowly based on tract-level changes in average education, home values, and income, and then evaluates the extent to which gentrification displaced Black and Latino residents. The report finds that gentrification is relatively rare outside large, rapidly growing cities. By the study's terms, Raleigh, Durham, Greensboro, Wilmington, and Asheville each had a single census tract gentrify before 2013; Charlotte had four.[252] On the other hand, Charlotte was second in the nation for the percentage of displacement of Black residents from those four tracts; the four lost 72% of their Black residents between 1990 and 2010, or 2,484 Black residents displaced between 2000 and 2010.[253]

For purposes of this year's report, we lack a compelling, plausible way to evaluate gentrification. Sociologists and geographers studying gentrification have identified a number of indicators. These range from the drily formal – percentage of residential units turning over in a census tract where the property values or rental rates jump by more than a certain factor – to the whimsical but demonstrably apt: number of new coffee shops opening in the last year.[254] There is no lack of data. Yet, this year, we do not have a sufficiently meaningful framework to choose a particular metric, so we include the indicator as capturing an aspect community integrity, but assign it a rating of 'no trend'.

Goal 28: North Carolinians are socially connected to one another.

Trend: Good

To measure trends in social connection, we consider two indicators of social connection: number of membership organizations per 100,00 residents, and where North Carolinians say they feel connected. Only the first measure provides a trend, but both are positive, and we rate North Carolina as performing well on this goal this year.

Indicator 28.1: North Carolinians are socially connected.

Trend: No trend

One way to evaluate social connectedness is to count the number of different social organizations to which state residents belong, on the premise that, apart from work and family, this is how most people know each other and build community. This indicator, compiled by the Robert Wood Johnson

250 Juliana Maantay and Andrew Maroko, Brownfields to Greenfields: Environmental Justice Versus Environmental Gentrification, Int. J. Environ. Res. Public Health 2018, 15, 2233; doi:10.3390/ijerph15102233.

251 National Community Reinvestment Coalition, Shifting Neighborhoods: Gentrification and cultural displacement in American Cities, March 2019. The report dovetails with a 2016 NCRC report outlining ways regulatory and community advocates can use the Community REinvest Act and Fair Housing Act to prevent displacement in the context of gentrification. NCRC, The Community Reinvestment Act: How CRA can Promote Integration and Prevent Displacement in Gentrifying Neighborhoods, December 2016.

252 NCRC, Shifting Neighborhoods, at 15.

253 Idem, at 21, 23.

254 See, Chris Bousquet, Where is Gentrification Happening in Your City, Data-Smart City Solutions, June 5, 2017 (describing GIS mapping algorithms used based a suite of cities to evaluate gentrification); Edward Glaeser et al. Nowcasting Gentrification: Using Yelp Data to Quantify Neighborhood Change, Harvard Business School working paper 18-077, 2018 (discussing coffee shops and other businesses as indicators of gentrification).

Foundation (RWJ), tracks the number of membership organizations in the state, calculated by adding up numbers of entities with specific North American Industry Classification System (NAICS) codes, covering civic groups, labor and business groups, certain recreational centers, and religious and professional organizations.[255] The indicator expresses that sum as the number of membership associations per 10,000 residents. For the most recent year of data – 2016 – RWJ estimates a statewide value of 11.5 associations per 10,000 population, with individual counties in the state varying from 6.8 to 26.7.[256] The statewide value is virtually unchanged for the last five years, and places North Carolina among the top tranche of states, so we count this as positive.

Indicator 28.2: North Carolinians feel socially connected to one another.

Trend: Baseline

Another way to measure social connection is how residents say they feel. For this indicator, NCCN commissioned a poll of a representative sample of North Carolinians, and asked them, "Outside of your immediate family, generally speaking, would you say that you feel very connected to your community, somewhat connected to your community, somewhat disconnected from your community, or very disconnected from your community?" Responses were strong; 33% of respondents said they were very connected, 50% somewhat connected, 12% somewhat disconnected, and just 4% very disconnected (with 1% not sure).[257] Altogether, 83% of North Carolinians feel more connected than not to a community beyond their immediate families. Because this is a snapshot rather than a trend, we present it as a baseline this year.

Political Process

The other half of our social fabric is our structure of governance. Under governance, we identify four goals: participation of state residents in government; avoidance of gerrymandering; reflection of the electorate in our state legislature; and integrity of government institutions.

Goal 29: North Carolinians participate in government.

Trend: Good

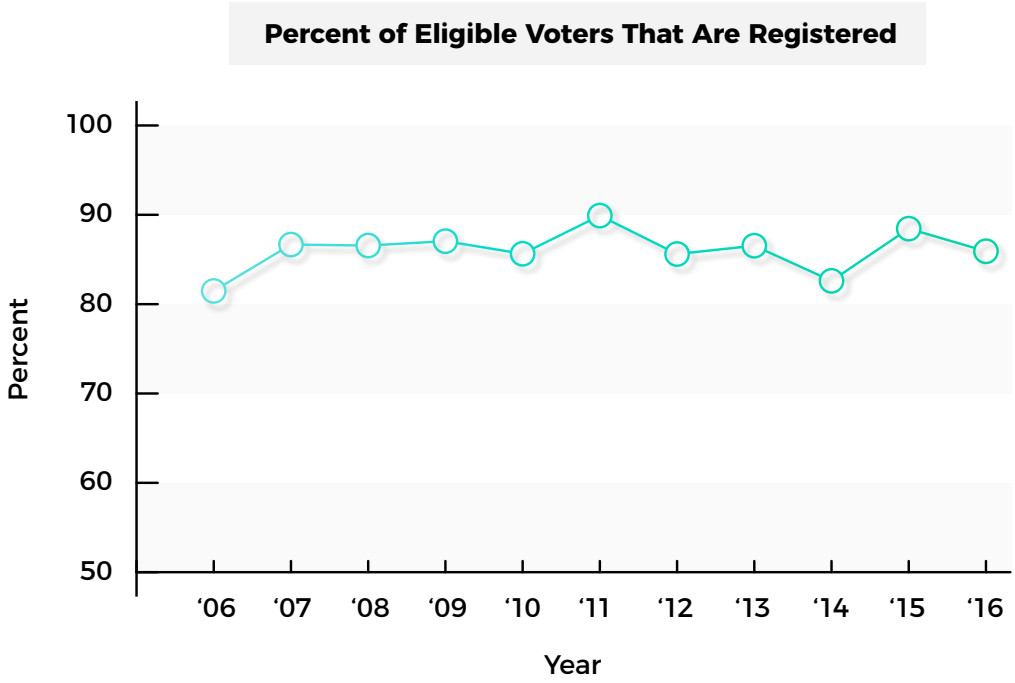
For this goal, we track two indicators - the percentage of eligible voters who are registered, and the percentage of registered voters who vote - both of which show positive trends.

Solutions: To strengthen participation in government, North Carolina should, N1, enact automatic voter registration. That doesn't make anyone vote, but it removes an unnecessary obstacle to citizens who want to vote.

255 RWJ Foundation, Health Factors: Social Associations, County Health Rankings & Roadmaps, 2019.
256 Ibid.
257 Public Policy Polling, Survey of 590 North Carolina voters, February 27-28, 2019.

Indicator 29.1: percentage of eligible voters that are registered.

Trend: No change



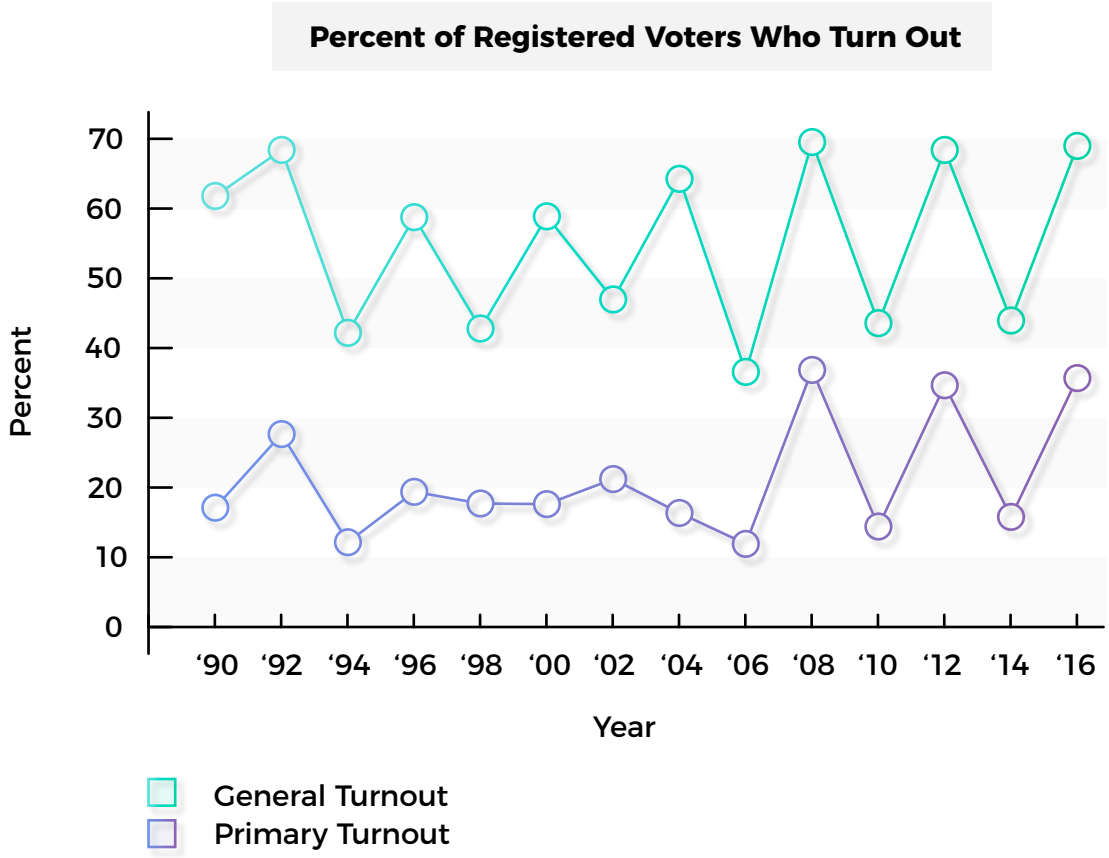
Democracy depends on the engagement of citizens, and the most fundamental form of engagement is voting. The threshold for whether a citizen can vote is whether they are registered. This indicator tracks the percentage of eligible voters who are registered to vote. In North Carolina, convicted felons cannot vote while in prison, on parole, or on probation.[258] However, voting rights are automatically restored when supervised release is completed – though, as with any other resident, the individual must register to vote. Over the last several years, voter registration as a percentage of eligible voters has remained mostly flat, but North Carolina's rate around 85% remains well above the national average of 62%.[259] We evaluate this as a trend in a good direction.

258 Jamie Markham, North Carolina's Voting Restriction for Felons, UNC School of Government, blog: North Carolina Criminal Law, October 6, 2016.

259 U.S. Census Bureau, Current Population Survey, November 2014 and 2016; Voting and Registration Tables, as provided by the Henry J Kaiser Family Foundation.

Indicator 29.2: percentage of registered voters that turn out.

Trend: Rising, good



A second step of political engagement, for registered voters, is actually to turn out to vote. This indicator tracks the percentage of registered voters who actually vote, as tallied by the NC State Board of Elections.[260] Participation in party primaries, particularly in midterm election years, when no US Presidential candidate is on the ballot, remains abysmally low. Voting in the general election, especially in Presidential election years, is once again approaching 70%, gradually rising from a period of apathy in the 1990s.

Goal 30: Elected representatives are accountable to their constituents.

Trend: No Trend

Gerrymandering undermines democracy by reducing the accountability of elected officials. This goal has one indicator - the degree of gerrymandering in the state legislature - but for reasons described below, we do not assign a trend this year.

Solutions: North Carolina can remove the spectre of gerrymandering by, N2, enacting a nonpartisan redistricting process.

Indicator 30.1: degree of legislative gerrymandering.

Trend: No metric

260 NC State Board of Elections, General and Primary Turnout as a Percentage of Registered Voters, 1990-2018.

A chief virtue of democracy, at least in theory, is that democratically elected legislators are answerable to their constituents, who can remove them at the next election if enough voters are dissatisfied. When legislators draw oddly-shaped districts to create safe districts in the legislature - usually by packing the minority party in a smaller number of districts where they have overwhelming majorities - accountability suffers. That's bad in a direct sense for democracy; it also results in greater ideological polarization, as the only vote that matters in a gerrymandered district is the primary, whose electorate reflects the ideological core of each party.

North Carolina has a gerrymandered legislature; state and federal courts have repeatedly said so.[261] Gerrymandering has had such a strong, polarizing impact on state politics that it would be bizarre to omit it from this report. However, the only really objective approaches we have found to assess gerrymandering (apart from the judgments offered by the judicial branch) are computer models that conduct massive numbers of simulations to calculate the relative distortion of various maps.[262] We do not have access to those programs. Simpler approaches, such as merely measuring the partisan balance in the legislature against the partisan balance in the electorate, can be severely misleading. That is, perhaps, one reason why supporters of reform have not called for a specific formula, but for a fairer redistricting process that would be harder for any political party to distort.[263]

For this reason, we view the current degree of gerrymandering as bad, but do not offer a metric for the indicator this year, and do not assign a trend to the goal. We hope to be better able to assign a trend to this vital goal next year.

Goal 31: The state legislature generally reflects the demographics of the electorate.

Trend: Baseline

Because the indicator for this goal provides just a snapshot this year, we do not assign a trend to this goal.

Indicator 31.1: gender/racial/ ethnic composition of the legislature compared to the electorate.

Trend: Baseline

Over time, in a representative democracy, lawmakers should resemble the electorate. We don't mean this in a quota driven sense, but in the sense that if political opportunity is equitably distributed, members of all demographic groups should be able to run and win elected office. This indicator tracks the degree to which the demographics of North Carolina's House and Senate resemble the demographics of North Carolina's electorate, based on data published by the NC House and Senate clerks, and ultimately on legislators' self-identifications on their voter registration forms.

	NC HOUSE (120 SEATS)		NC SENATE (50 SEATS)	
	ACTUAL	ELECTORATE	ACTUAL	ELECTORATE
WOMEN	34	62	10	24
MEN	86	58	41	24

261 David Lieb, Gerrymandering lawsuits are pending in a dozen states, Associated Press, March 21, 2019

262 See, Carrie Arnold, The Mathematicians Who Want to Save Democracy, Scientific American, June 7, 2017; see also, Gregory Herschlag, et al, Quantifying Gerrymandering in North Carolina, January 9, 2018.

263 See, for example, Nicholas Stephanopoulos, The Causes and Consequences of Gerrymandering, 2017.

	NC HOUSE (120 SEATS)		NC SENATE (50 SEATS)	
	ACTUAL	ELECTORATE	ACTUAL	ELECTORATE
WHITE	93	85	39	35
BLACK	26	27	10	11
NATIVE AMERICAN	1	2	0	1
ASIAN	0	4	2	2
BI- OR MULTIRACIAL	0	3	0	1

For the current biennium, 2019-2020, the North Carolina legislature retains a substantial gender imbalance, with far fewer women in office than in the general population. Racially, both chambers are closer to being in balance, though whites are overrepresented in both for their share of the population, and Asian Americans are underrepresented in the state House (but not the state Senate). Individuals identifying as bi- or multiracial – a growing segment of the electorate – are also underrepresented in each chamber. Perhaps most striking is the absence of legislators identifying as Hispanic or Latino in reports published by the House and Senate clerks. The U.S. Census Bureau treats Hispanic identity as an ethnic category that can overlap with any racial identification. The Census Bureau estimates that 9.5% of North Carolina's population is Latino; that would translate to roughly 11 NC House members and 5 NC Senators. For this year, this indicator provides baseline data but does not reveal a trend.

Goal 32: Government institutions are transparent, accountable, and not corrupt.

Trend: Baseline

The single, composite indicator for this goal does not enable us to assign this goal a trend this year.

Indicator 32.1: Government is transparent and accountable.

Trend: Baseline

In 2015, the Center for Public Integrity (CPI) issued a report, the State Integrity Investigation, evaluating all fifty states against 245 distinct and non-ideological indicators of transparency and accountability in all aspects and branches of state government. Few states fared well; North Carolina, then in the third year of Governor Pat McCrory's administration, received a D, ranking 18th out of the 50 states (very few states received good grades). Notably, CPI criticized North Carolina for providing poor access to public records, poor judicial accountability, state employees leaving to take related private-market positions, and inadequate barriers against conflicts of interests by state pension managers.

The CPI analysis is the best treatment we have found of government integrity as a complex whole, so we take it as an indicator. However, especially in this area, a lot can change in four years. The Cooper administration has a much better record of answering public records requests than the McCrory administration did, and has stressed transparency as a signature value. At the same time, the state budget process – hailed by CPI as one of North Carolina's stronger features – has become much less transparent, with the majority party negotiating the 2018-2019 budget in secret, with minimal or no opportunities for other legislators to offer amendments on the floor. The 2015 CPI report offers a detailed baseline; we hope that a new update of it appears in time for us to include a year from now.

Our Economy

Our analysis of North Carolina's economy focuses on six goals: steady overall growth; growth of sustainable sectors as a share of the economy; a robust business sector; improving household incomes; trends in income inequality; and the quality of available jobs.

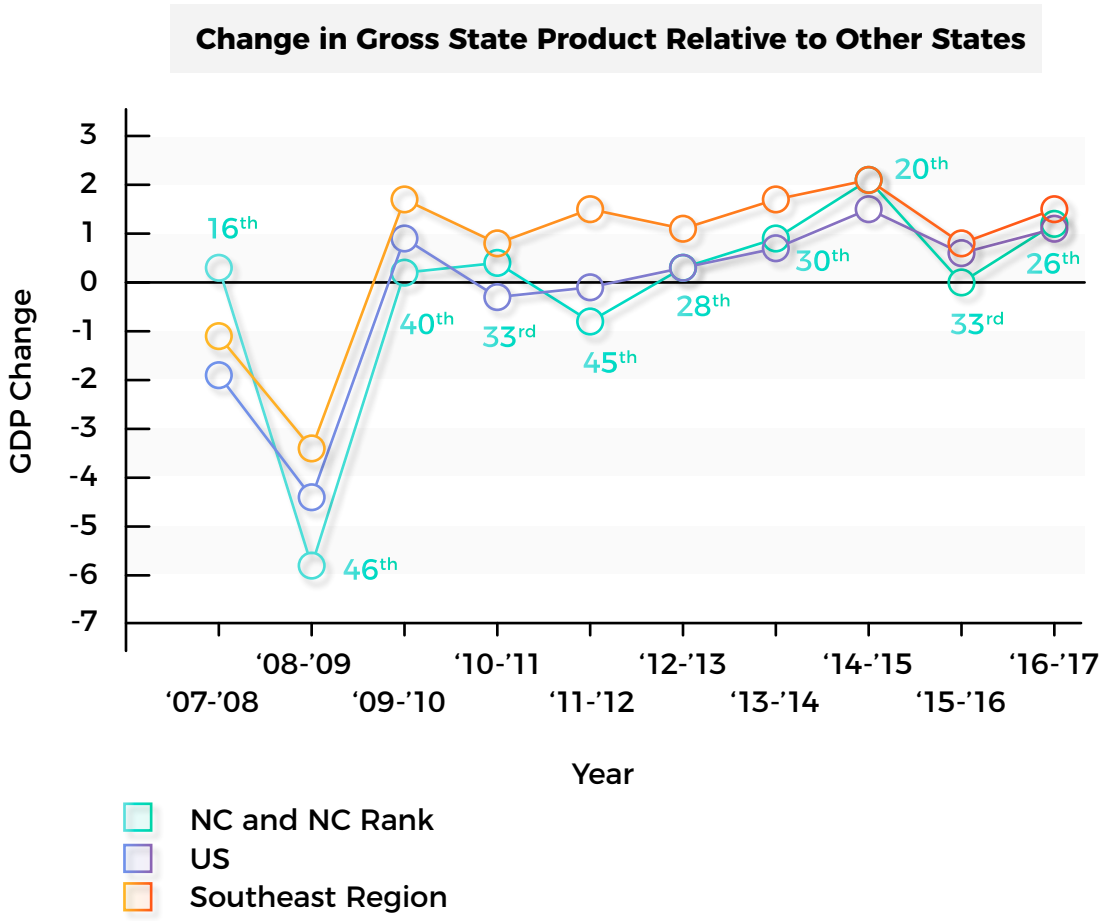
Goal 33: Economic activity is strong across business cycles.

Trend: Good

This goal has a single indicator; its performance shows a positive trend this year.

Indicator 33.1: state economic growth relative to other states.

Trend: Rising, good



This indicator that tracks growth is necessary but, but problematic in a report focused on sustainability, for two reasons. First, to be meaningful, the indicator needs to track growth across the business cycle, not just in prosperous times. Temporary booms followed by busts impose distinct harms on

marginal workers, the social fabric, government institutions, and the environment. Steady growth with dampened volatility is far better for sustainability.

Second -- and this is more fundamental -- our measures of economic activity are skewed. As Robert Kennedy famously noted half a century ago, the 'gross domestic product' counts all market activity, whether or not it is socially beneficial.[264] For our purposes, it signally fails to account for the contribution of natural capital, and especially ecosystem services that provide a steady stream of inputs to the rest of the economy. For example, rain falling on an unpaved landscape recharges groundwater, a portion of which can be withdrawn for human use without altering base stream flows. When we pave the land and shunt rainwater directly into streams, groundwater levels drop, as do stream flows in dry months of the year. Standard accounting includes paving over land as part of the gross domestic product, but doesn't count the loss of recharge or base flows - although both can be anticipated to weaken the state economy. We lack a generally accepted method for tallying changes in the state's reservoir of natural capital, whether we are drawing it down or building it up. In future reports, we hope to identify such measures, because they are key to understanding North Carolina's true economic health.

In the meantime, for this indicator, we track changes in North Carolina's per capita growth rate relative to the national and regional rate, and North Carolina's ranking among the states. Ideally, North Carolina's growth would be strong during national economic expansions, and avoid the worst contractions during downturns. In fact, North Carolina's performance over the last decade has lagged the nation. Compared to the Southeast region, North Carolina took a harder hit in the Great Recession but has come back a little stronger than the region as a whole. Between 2008 and 2016, the state economy grew, but thanks to the state's rapidly growing population, per capita market activity in 2016-2017, $47,142, remained lower than in 2008, $48,007 (both expressed in 2012 dollars). Because the state economy has grown on a per capita basis for the last several years, and we remain at least in the middle range of states, we evaluate this indicator as showing progress.

Goal 34: Sustainable sectors are growing as a share of the economy.

Trend: No metric

Another way to assess the sustainability of North Carolina's economy is to evaluate whether sustainable sectors of the economy are growing as a share of the state's total economic activity. Some initial work of identifying sustainable sectors has already been done. As discussed above, in the context of coastal indicators, a 2017 report from NC Sea Grant and the Nicholas Institute at Duke University describes the contribution of North Carolina's 'ocean economy' to state GDP.[265] The report introduces the concept of the 'blue economy', defined as emerging "when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy."[266] Industries that fit well as part of the blue economy include seafood, renewable energy, marine biotechnology, and tourism and recreation.

Another sustainable sector is the 'restoration economy', focused on conservation, restoration, and mitigation. A 2015 analysis suggests that the restoration economy generates roughly 33 jobs per $1 million invested and has a substantial multiplier in its economic impact.[267] Analysis by the same team concluded that the domestic ecological restoration sector directly contributes $9.5 billion and 126,000 jobs to the national economy.[268] However, calculating that required that the researchers send surveys to

264 Robert F. Kennedy, Remarks at the University of Kansas, March 18, 1968.

265 Jane Harrison, Amy Pickle, Tibor Vegh, and John Virdin, North Carolina's ocean economy: A first assessment and transitioning to a blue economy, January 2017, UNC-SG-17-02.

266 Idem, at 19.

267 Todd BenDor et al, Defining and evaluating the ecological restoration economy, Restoration Ecology, April 2015, https://doi.org/10.1111/rec.12206.

268 Todd BenDor et al, Estimating the size and impact of the ecological restoration economy, PLOS One, 10(6), June 2015, https://doi.org/10.1371/journal.pone.0128339.

a suite of firms participating in the sector and then tease out the percentage of activity in 15 different North American Industry Classification (NAICS) sectors that was tied to ecological restoration. Each attempt to calculate this value at the state level would require a major new research project.

In the absence of a practical metric to estimate the size of North Carolina's sustainable sectors, we do not evaluate this goal this year, but we include it as a target for future editions of this report.

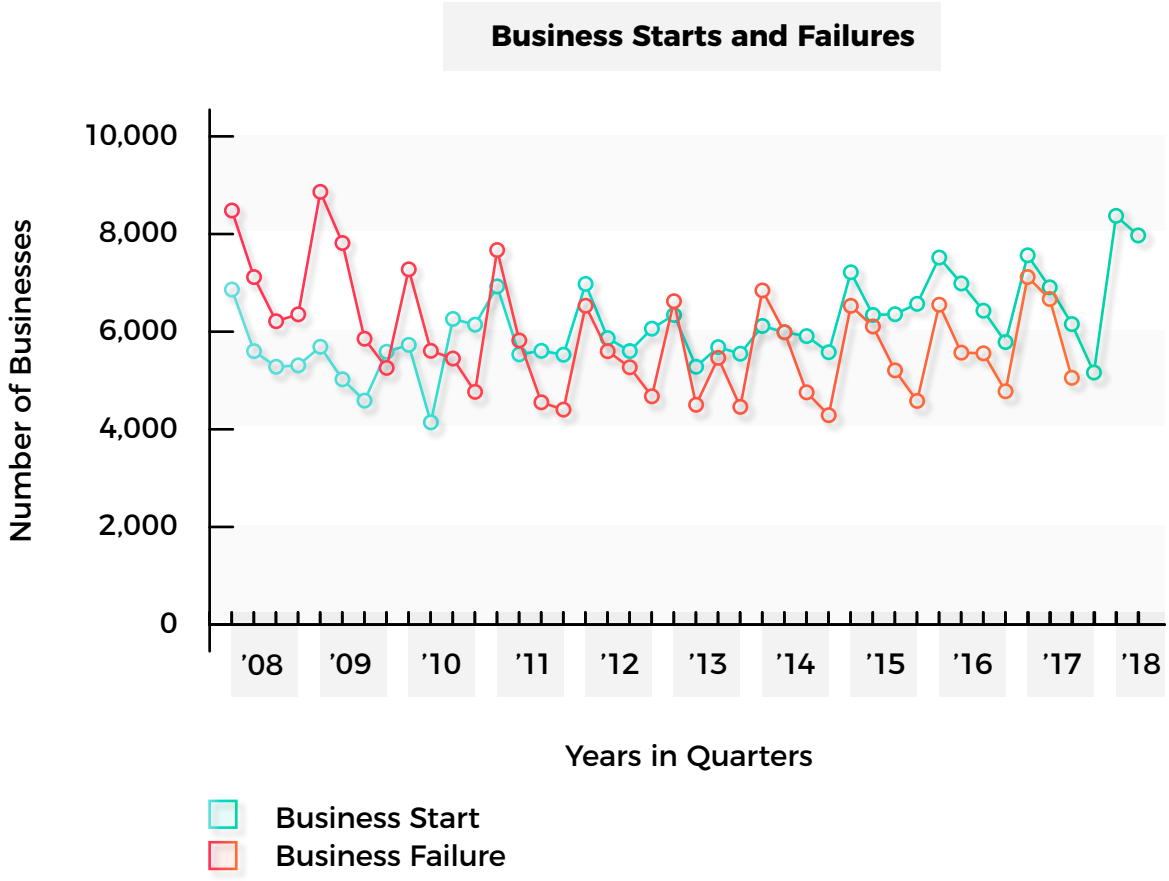
Goal 35: The business sector is robust.

Trend: Good

A robust business sector shows entrepreneurial spirit, generates jobs, and invests in its own continued growth. The following three indicators track those features; all are positive, leading us to assign this goal a positive trend.

Indicator 35.1: rates of business starts and failures.

Trend: Rising, good



The rate of new business starts and failures is one measure of the strength of the economy. As of 2015, about half of businesses failed within 6 or 7 years.[269] The US Bureau of Labor Statistics (BLS) tracks business starts and failures on a quarterly basis.[270] The BLS does not count company reopenings as births or plant closures as deaths, so the indicator is not a proxy for jobs growth, but is rather a measure of entrepreneurship – are new businesses starting, and are they surviving. The rate of closures

269 US Bureau of Labor Statistics, Entrepreneurship and the U.S. Economy, 2015, chart 3: survival rates of establishments.

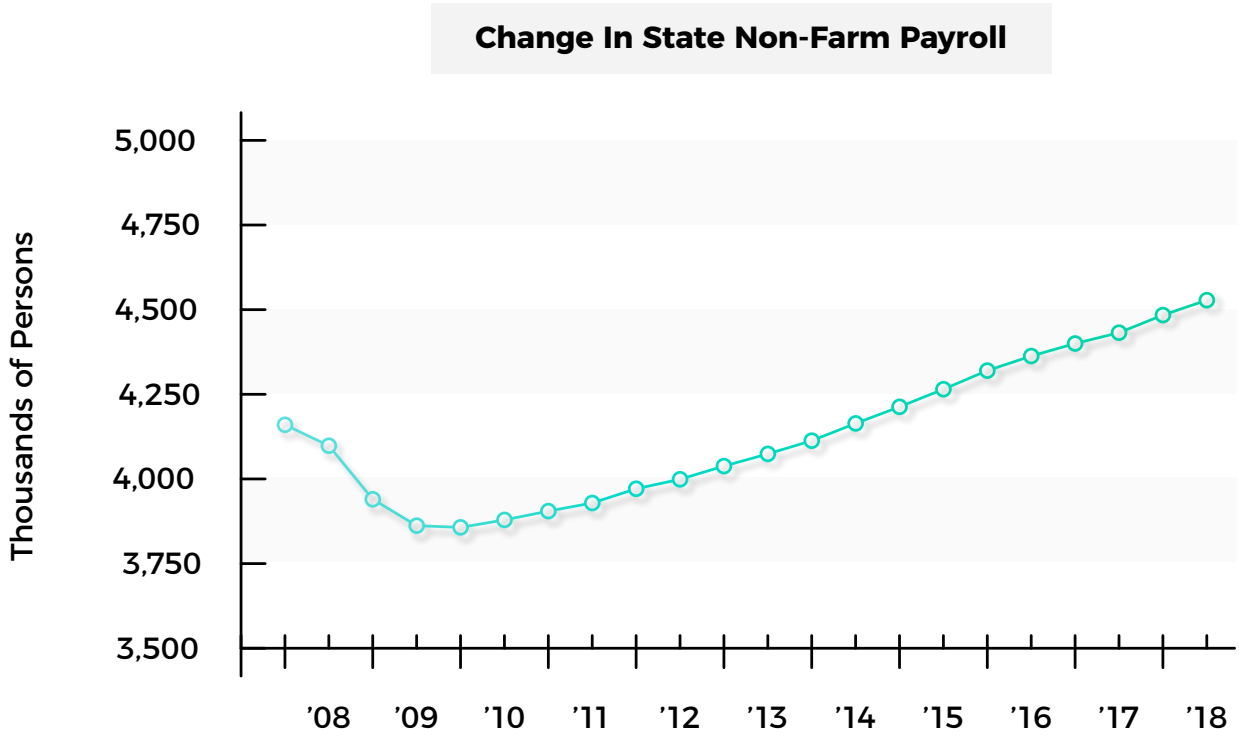
270 US Bureau of Labor Statistics, North Carolina private sector establishment births and deaths, not seasonally adjusted, 2008-2018.

by itself is not particularly significant, although closures spike during economic downturns. A higher rate of launches, with the rate of launches consistently higher than closures, signals a robust economy. Because BLS measures firm death as four consecutive quarters during which the firm has zero employees in the third month, the data on firm death has a year-long lag time; we won't know which firms died this quarter until this time next year.

Data for new business starts and deaths show significant seasonality; firm launches and especially exits are disproportionately timed to the end of the year. Looking past the noise, over the last decade, the number of firms launched each quarter has gradually increased. The number of firms dying has begun slowly to rise, but remains below the new starts. Based on these trends, we rate this indicator as showing progress.

Indicator 35.2: change in non-farm payroll.

Trend: Rising, good

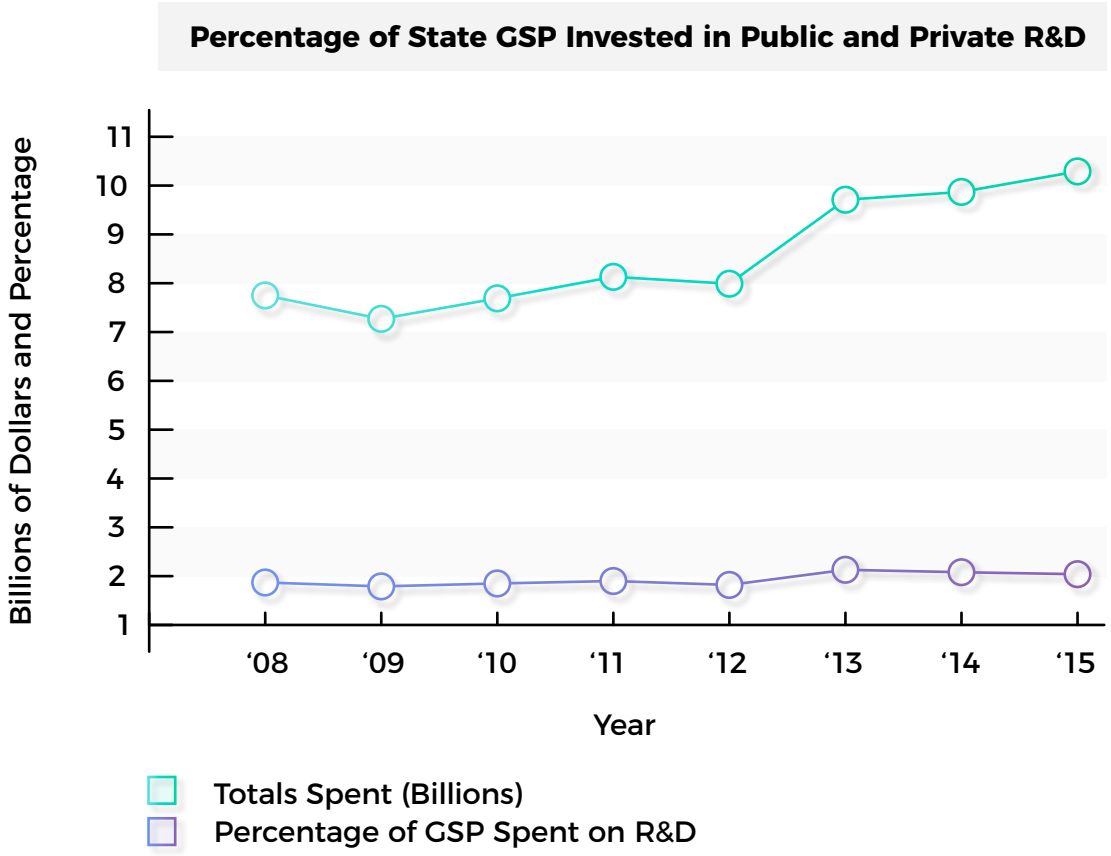


Non-farm payroll measures the size of the economy by the number of jobs it includes; statistics for the country as a whole and all 50 states are kept by the U.S. Bureau of Labor Statistics.[271] Both North Carolina and federal non-farm payrolls have increased steadily since the bottom of the economic slump in February 2010 following the 2008 Great Recession. From that low of 3.84 million workers, non-farm payroll has climbed to 4.54 million in December 2018, with a 1.96% increase from December 2017 to December 2018. The comparable national increase was 1.7%. Because these numbers show both absolute growth and good performance relative to the nation, we rate this as showing progress.

271 See, U.S. Bureau of Labor Statistics, All Employees: Total Nonfarm in North Carolina [NCNA], retrieved from FRED, Federal Reserve Bank of St. Louis; U.S. Bureau of Labor Statistics, All Employees: Total Nonfarm Payrolls [PAYEMS], retrieved from FRED, Federal Reserve Bank of St. Louis.

Indicator 35.3: percentage of state GSP invested in public and private research and development.

Trend: Risisng, good



A robust economy invests in research and development to power future growth. This indicator tracks public and private spending in North Carolina on research & development, both in absolute terms (billions of dollars) and as a percentage of the gross state product. Estimates for R&D spending between 2008 and 2015 are derived from several resources published by the National Science Foundation.[272] Estimates for the gross state product are from the US Bureau of Economic Analysis.[273] Since 2008, North Carolina's combined public and private spending on R&D has risen slightly faster than the growth of the economy, so we rate this as showing progress.

Goal 36: household income is adequate, and poverty reduced.

272 National Science Foundation, National Center for Science and Engineering Statistics. 2018. Business R&D and Innovation: 2015. Detailed Statistical Tables NSF 18-308. Alexandria, VA; National Science Foundation, National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Fiscal Years 2016–17.

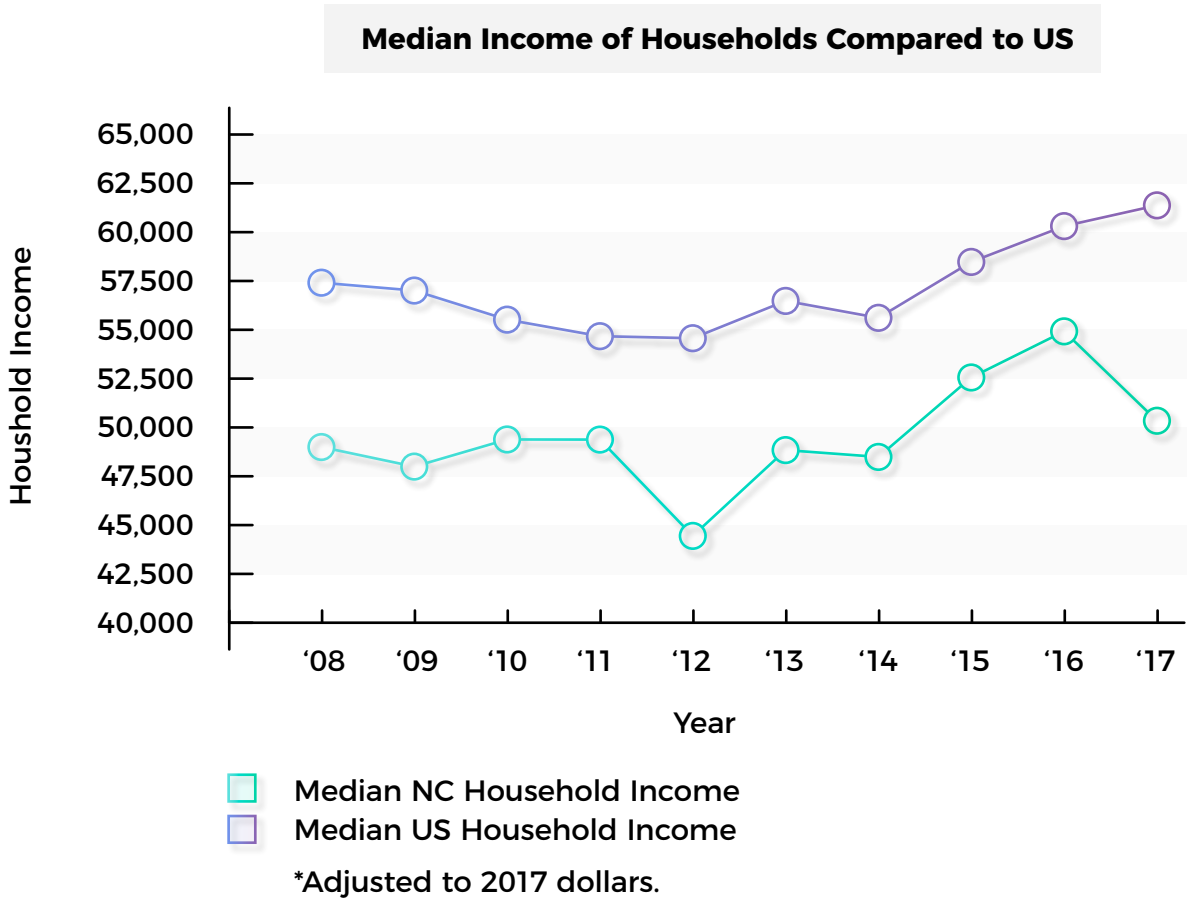
273 U.S. Bureau of Economic Analysis, Total Gross Domestic Product for North Carolina [NCNGSP], retrieved from FRED, Federal Reserve Bank of St. Louis.

Trend: Good

The indicators for this goal track two data points: median household income; and the number of people in poverty. The first has been improving, but showed a surprising reverse in the most recent year of data; the percentage of state residents in poverty has steadily dropped. Net, we recognize a positive trend toward this goal.

Indicator 36.1: median income of households, and compared to US average.

Trend: No trend



Another measure of the health of the economy is the median income of households. At the national level, median household income has not gained much in the last two decades; as of 2017, it was at roughly the same level as in 1999, even as per capita economic activity has grown. There are three main reasons for that.[274] First, the number of households has increased faster than the population (so median household income has increased slower than median personal income).[275] Second, an increasing share of what workers get from their employers comes as (non-taxable) health benefits and

274 The Puzzle of real median household income, the FRED Blog, December 1, 2016. North Carolina's median household income in 2016 was roughly the same as the state's median household income in 1999; the 2017 NC median household income is lower.

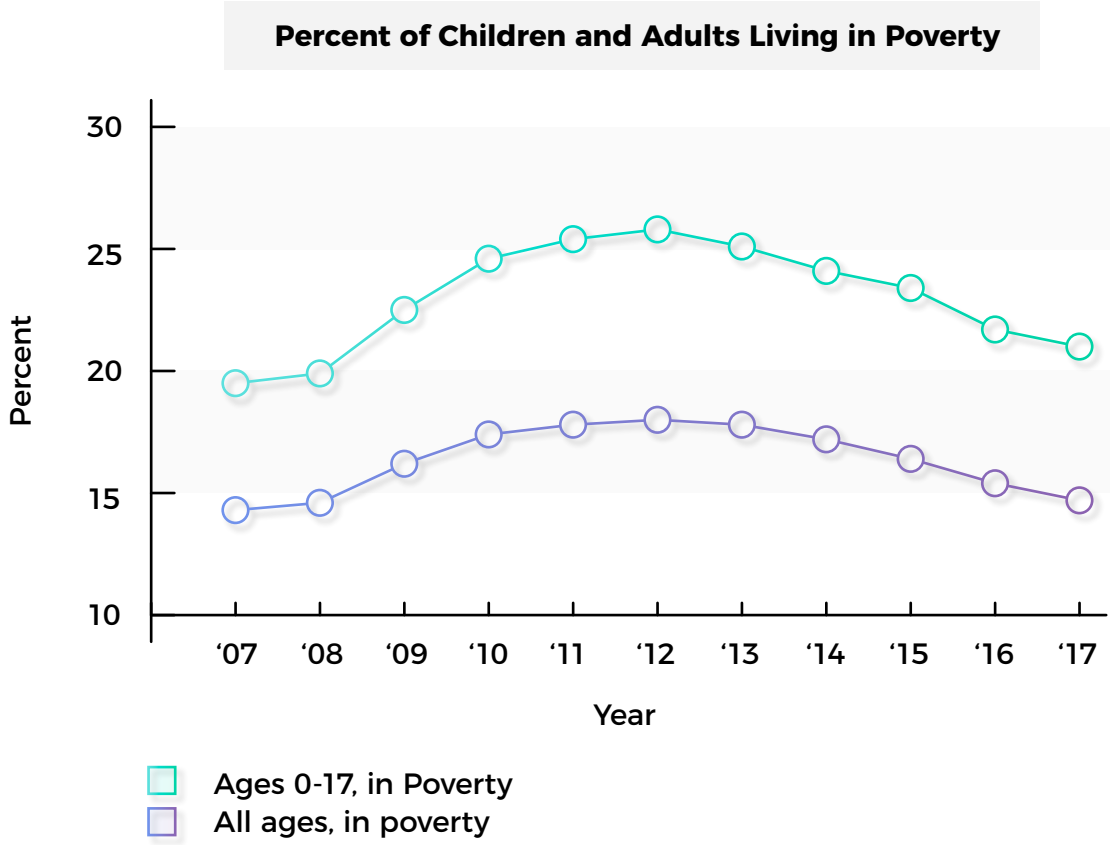
275 This is a reflection of long-term changes in family structure. From 2007 to 2017, the percentage of North Carolina households with 1 or 2 members increased by a percent each, to 28.6% and 35.6% respectively, while the percentage with 3 or more members declined. US Census Bureau, American Community Survey, S2501, Occupancy Characteristic, 2007-2017.

retirement contributions, and so isn't picked up as household income (although the workers are better off than if they hadn't received the benefits). Finally, if growth in the economy isn't widely shared – if the increased activity enriches a few without being broadly distributed – it will increase average (per capita) economic activity and income, but will not move the median income.

Over the last decade, North Carolina's median income (all presented in 2017 dollars) dipped, rose, and has dropped back slightly higher than it was in 2008, trailing the national median income the whole time.[276] A different dataset, from the American Community Survey, does not adjust for inflation but provides a window onto demographic disparities in median household income in 2017; these disparities have also been consistent across the last decade.[277] Given several years of rising median household income followed by a drop in the last year of data, we evaluate this as an ambiguous trend.

Indicator 36.2: percentage of children and of all North Carolinians in poverty.

Trend: Falling, good



The federal poverty level is quite low: $20,780 for a family of three in 2018, and $25,100 for a family of four. Most economists candidly acknowledge this is far too little to support a family of either size, but the number of people living below the poverty level does offer a window on a portion of the population is gravely challenging circumstances. For this indicator, we track the estimated percentage of children and of all North Carolinians living in poverty, that is, living in households with incomes below the applicable federal poverty threshold given the size of the household. Over the last decade, poverty in

276 U.S. Bureau of the Census, Real Median Household Income in North Carolina [MEHOINUSNCA672N], retrieved from FRED, Federal Reserve Bank of St. Louis; February 13, 2019; U.S. Bureau of the Census, Real Median Household Income in the United States [MEHOINUSA672N], retrieved from FRED, Federal Reserve Bank of St. Louis, February 13, 2019.

277 Source: American Community Survey, 1-Year Estimates (2007-2017).

North Carolina surged in the wake of the Great Recession, and has slowly ebbed during the recovery. Yet, as of 2017, a higher percentage of children and adults remained in poverty than a decade before.[278] Because the rate has continued to fall, we show this indicator as making progress.

Goal 37: Wealth and income inequality are not too extreme.

Trend: No trend

This goal has a single indicator with a baseline but no trend this year.

Indicator 37.1: Ratio of the 80th percentile income to the 20th percentile income.

Trend: Baseline

There are multiple ways to measure inequality; for this indicator, we pick a metric that captures some of the spread between those earning high incomes and those earning much less: the ratio of the 80th percentile of household income to the 20th percentile of household income. We rely on data from the American Community Survey as curated by the Robert Wood Johnson Foundation.[279] For North Carolina in the period 2012-2016, that ratio is 4.8, meaning that the top 20% household income is 4.8 times the lowest 20% household income. That is a larger spread than the national ratio of 4.5. Across North Carolina, county ratios vary from 3.5 to 7.4. The poorest and the wealthiest counties tend to have high ratios, while exurban counties and military-heavy counties have much lower ratios, suggesting more residents are within a band of similar incomes. Because this data represents a single snapshot of inequality, we count this as a baseline value this year.

278 U.S. Bureau of the Census, Estimated Percent of People Age 0-17 in Poverty for North Carolina [PPU18NC37000A156NCEN], retrieved from FRED, Federal Reserve Bank of St. Louis, February 13, 2019; U.S. Bureau of the Census, Estimated Percent of People of All Ages in Poverty for North Carolina [PPAANC37000A156NCEN], retrieved from FRED, Federal Reserve Bank of St. Louis, February 13, 2019.

279 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps, Income Inequality, drawing on ACS data from 2012-2016.

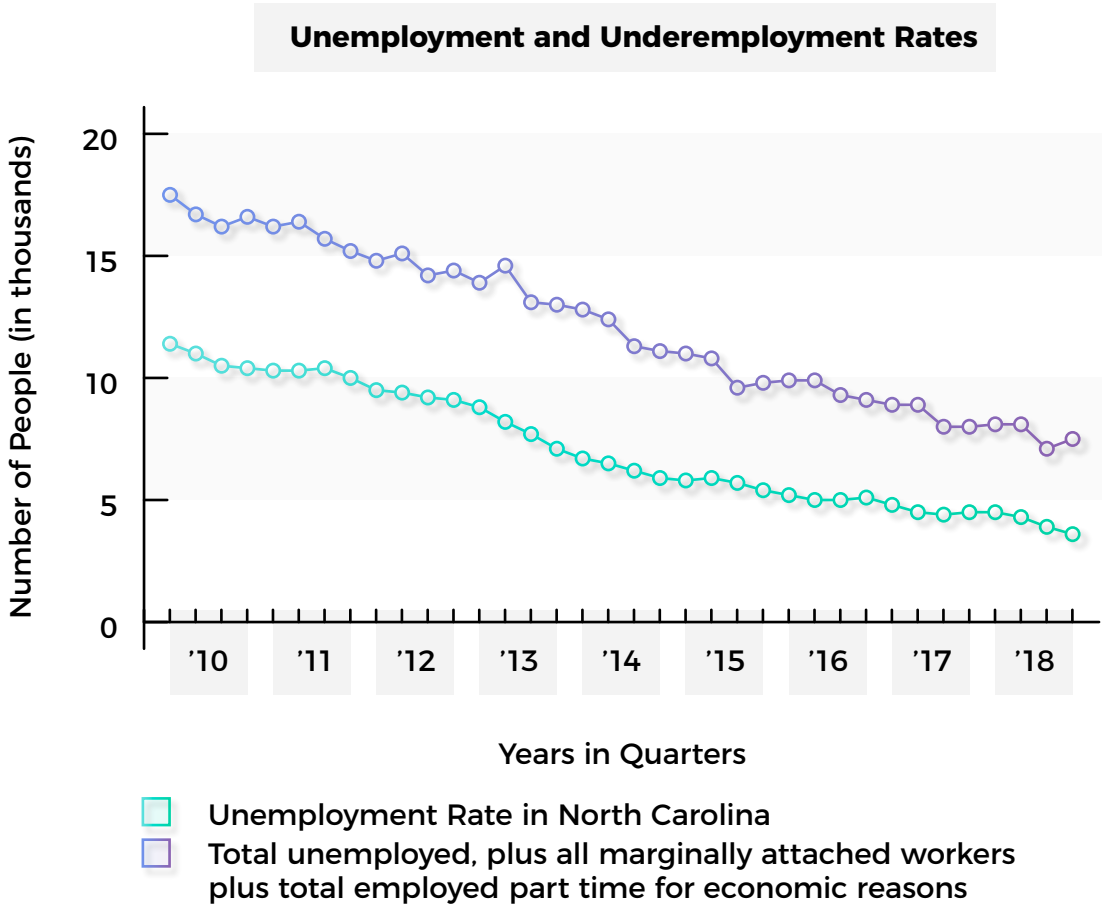
Goal 38: North Carolina's economy provides quality jobs.

Trend: Good

In an economy that provides quality jobs, there must be jobs available for those looking for work, and those jobs must pay sufficiently well to sustain households. The next two indicators track these points respectively.

Indicator 38.1: unemployment and underemployment rates.

Trend: Falling, good



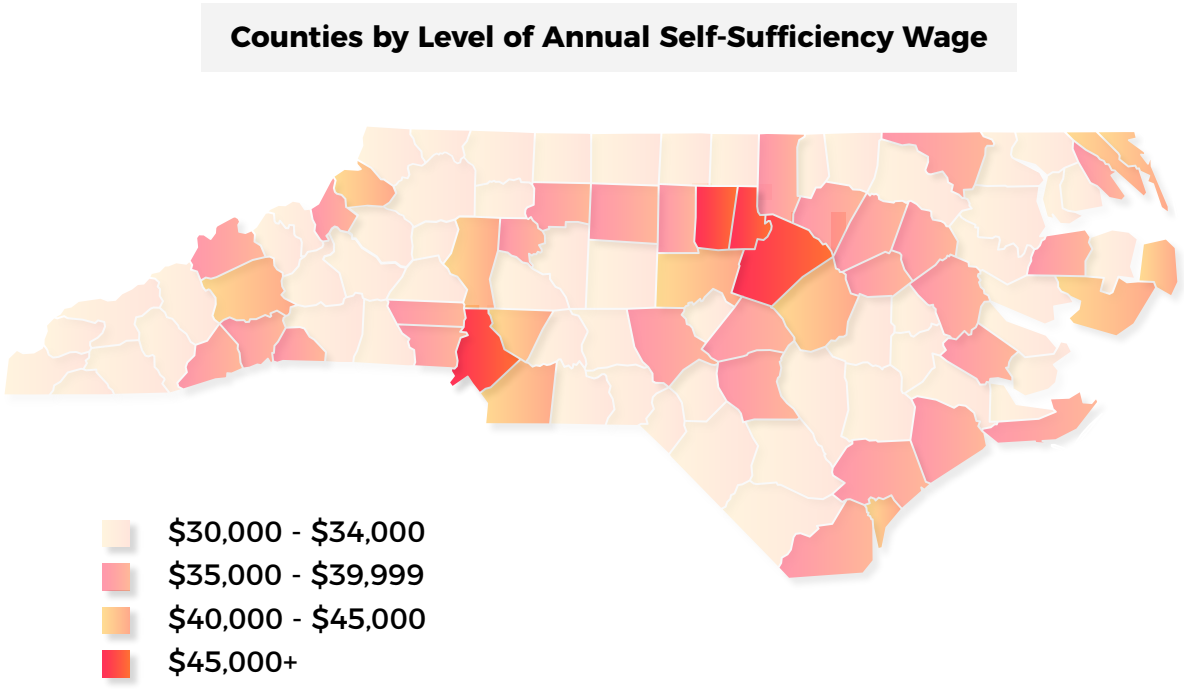
A key measure of the strength of the economy: can a person who wants a job get a job? This indicator tracks both the unemployment rate – people who are looking for jobs but have not been hired – and unemployment combined with underemployment – people who are working part time but would like to be working full time. Over the last eight years, steady growth in the economy has brought the unemployment and underemployment rates down to low levels.[280] This number is below what many economist have thought of as 'full employment'.[281] An economy at these levels faces a hazard of overheating; in theory, at least, tight labor markets should trigger wage increases but potentially also fuel inflation. Still, it's a good problem for the economy to have, and we rate this indicator as showing progress.

280 U.S. Bureau of Labor Statistics, Unemployment Rate in North Carolina [NCUR], retrieved from FRED, Federal Reserve Bank of St. Louis, February 12, 2019 ; Total unemployed, plus all marginally attached workers plus total employed part time for economic reasons [U6RATENSA], retrieved from FRED, Federal Reserve Bank of St. Louis, February 12, 2019.

281 Clive Crook, Quicktake: Full Employment, Bloomberg, July 6, 2018.

Indicator 38.2: number of counties where the median income is greater than the sufficiency income.

Trend: Baseline



map credit: adapted from Diana Pearce, The Self-Sufficiency Standard for North Carolina 2017.

Federal poverty measures do not take into account is the difference in costs of living in different parts of the state. In 2017, the United Way of North Carolina published a sophisticated analysis of what it actually costs families of various sizes to live in different counties: not just costs for housing and food, but also for child care, transportation, health care, and taxes.[282] The analysis showed that, for a single adult with two young children, or a couple with two young children, the income sufficient to cover basic necessities is far above the federal poverty line, and above what can be earned on a minimum wage. In many counties, the 'self-sufficiency' standard is even above median household income.

This indicator tracks the number of North Carolina's 100 counties where the sufficiency standard is at or above the median household income for the county, meaning that half of such households in the county (those below the median income) could not afford to have two young children without some kind of government or other external subsidy. In 2017, the sufficiency income for a single adult with two kids was above the median income for 26 counties; the sufficiency income for a two-adult family with two kids was above the median income in 36 counties.[283] We hope the United Way sufficiency analysis will be updated in the future; for this report, we include it as an insightful baseline.

282 Diana Pearce, The Self-Sufficiency Standard for North Carolina 2017, February 2017.

283 Idem, Table 3. The Self-Sufficiency Standard as a Percentage of Other Benchmarks of Income, 2017 Two Family Types, All North Carolina Counties, at 15-16.

Infrastructure

This section of the report covers the built environment: buildings and transportation systems. Drinking water and wastewater systems are folded into the discussion of water, above. Energy infrastructure we include under Energy & Waste, below. What remains here is housing, transportation, and patterns of land use. This year, progress on housing and the spatial pattern of development falls short, while transportation shows mixed indicators; overall, progress on infrastructure is inadequate.

Housing

Shelter is a fundamental need; no society can claim to be sustainable that cannot house its citizens. As of July 1, 2017, North Carolina's population of 10.27 million residents was organized into 3.87 million households. The state had 4.62 million housing units, of which 65% - 3.00 million – were owner occupied.[284] That leaves 1.62 million units to house 870,000 non-owner households, but not all units are on the market (some owners have multiple units but do not rent them out), and some renters may be unable to afford the available units at going rental rates. In 2017, local governments in North Carolina issued building permits for a total of 67,000 new units, a figure that includes both houses and apartments but excludes group quarters (such as dormitories) and hotels. It includes modular and prefabricated units but excludes mobile homes.[285]

Goal 39: North Carolinians have safe and affordable housing choices.

Trend: Weak

All North Carolinians should have access to affordable and safe housing choices, but many do not. This is true not just in the state's rapidly-growing urban areas, but also in rural eastern counties where a portion of the affordable housing stock, located in floodplains, was destroyed by Hurricanes Matthew and Florence.[286] As indicators for this goal, we consider both a theoretical measure - how many jobs a minimum wage worker would need to hold to be able to afford a two bedroom apartment - and a practical outcome - how many renters and owners are in houses with severe deficiencies, including overcrowding. Both indicators show negative trends, leading us to rate this year's progress toward the goal of safe and affordable housing choices as inadequate.

Solutions: North Carolina needs, L4, scalable affordable housing solutions; to keep total housing and transportation costs low, it would help for more housing to take the form of L1, transit-accessible development.

Indicator 39.1: how many jobs residents must hold to afford a two-bedroom apartment.

Trend: Baseline, bad

One way to evaluate the affordability of housing is the number a jobs workers making a minimum wage must hold to be able to afford a 2 bedroom apartment (one for the parent(s), one for children) at fair market rental rates without spending more than 30% of their income on rent. The National Low Income Housing Coalition (NLIHC) calculates this annually for all 50 states. In 2018, NLIHC estimated that, to afford a two-bedroom apartment in North Carolina, members of a household had collectively

284 These statistics are all from US Census Bureau, QuickFacts North Carolina.

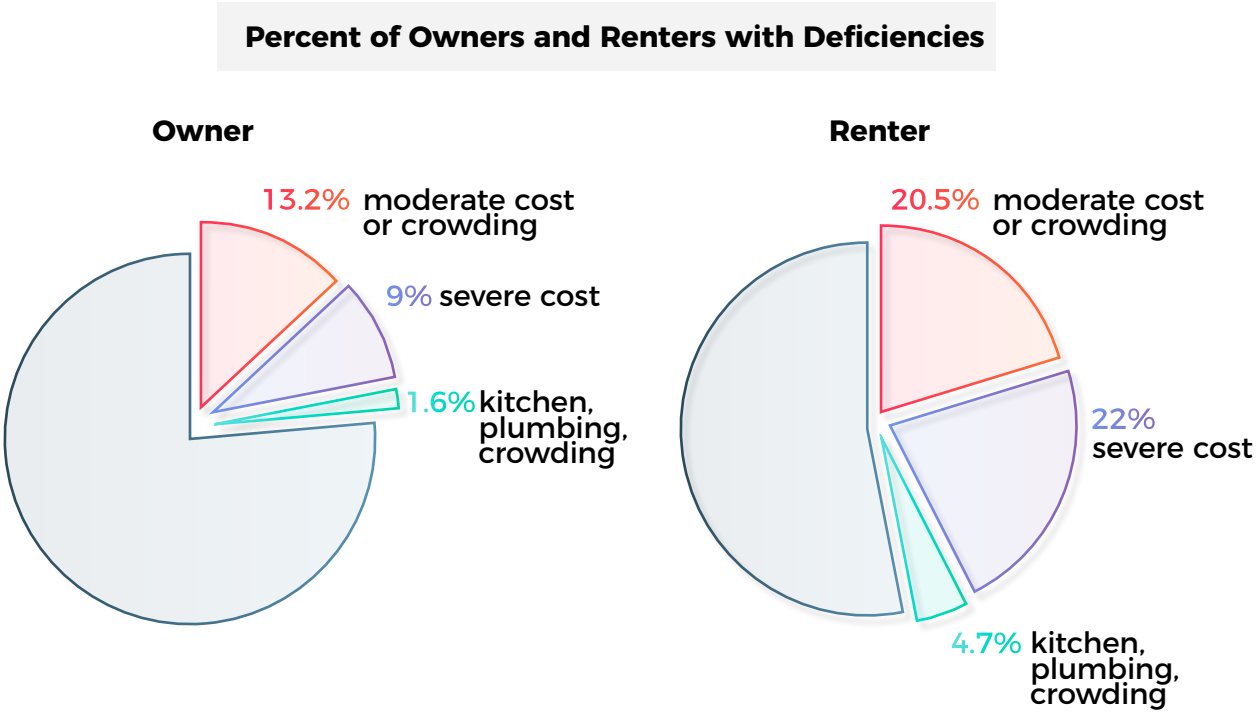
285 US Census Bureau, Construction-Building Permits, 2017.

286 See, for example, Cammie Bellamy, After Florence, most shuttered apartments still not open, Wilmington Star News, February 20, 2019; Michael Praats, Hurricane Florence, the 'missing middle', and government incentives: Councilman Paul Lawler weighs in on affordable housing in Wilmington, Port City Daily, March 4, 2019; Kelsey Stiglitz, Area buyers faced with housing race after Florence, Jacksonville Daily News, February 19, 2019.

to hold 2.3 minimum wage jobs.[287] That is a problem for any household in which only one adult is available to work, including single-parent households, home to 36% of North Carolina's children.[288] Although this reflects a single-year snapshot, because it indicates an unworkable situation for many North Carolinians, we rate performance on this indicator as inadequate.

Indicator 39.2: percentage of owners and percentage of renters in housing that has moderate or severe deficiencies.

Trend: Baseline, bad



Another way to track safety and affordability of housing is to see how North Carolinians are actually living. The US Department of Housing and Urban Development receives annual tabulations of data from the American Community Survey run by the US Census Bureau. These tabulations are known as the Comprehensive Housing Affordability Strategy (CHAS); each year covers a rolling five-year interval. This indicator tracks the percentage of owners and renters in housing with moderate or severe deficiencies. CHAS defines 'moderately' deficient housing as that which suffers from one or more of the following: incomplete kitchen facilities, incomplete plumbing facilities, more than one person per room, or a cost burden (ratio of housing costs: household income) greater than 30%. CHAS defines 'severely' deficient housing as that which suffers from one or more of the following: incomplete kitchen facilities, incomplete plumbing facilities, more than 1.5 persons per room, or cost burden greater than 50%.[289]

Over the period with the most recent data, 2011-2015, 24% of owners and an astounding 47% of renters were in homes with moderate or severe deficiencies. Some of these suffered from lack of kitchen facilities, bad plumbing, or severe overcrowding – 1.6% and 4.7% respectively for owners and renters.[290] By far, however, the greater problem for residents – and especially for renters – is affordability. This indicator shows the practical effect of the same conditions documented in the previous indicator and the Out of Reach report: some residents may work extra jobs, but many others simply pay too large a share of their income as housing costs, sacrificing other spending and saving.

287 National Low Income Housing Coalition, Out of Reach, 2018

288 U.S. Census Bureau, American Community Survey 5-year estimates, 2006-2010 through 2013-2017, Table B23008, provided via NC Child, January 2019.

289 US Dept of Housing and Urban Development, CHAS 2011-2015, released June 25, 2018.

290 Derived from US Dept of Housing and Urban Development, CHAS 2011-2015, released June 25, 2018.

Goal 40: North Carolina's housing is resilient to climate change.

Trend: No trend

This goal has a single indicator - the percentage of the housing stock in the 500-year floodplain - that provides a baseline but no trend this year.

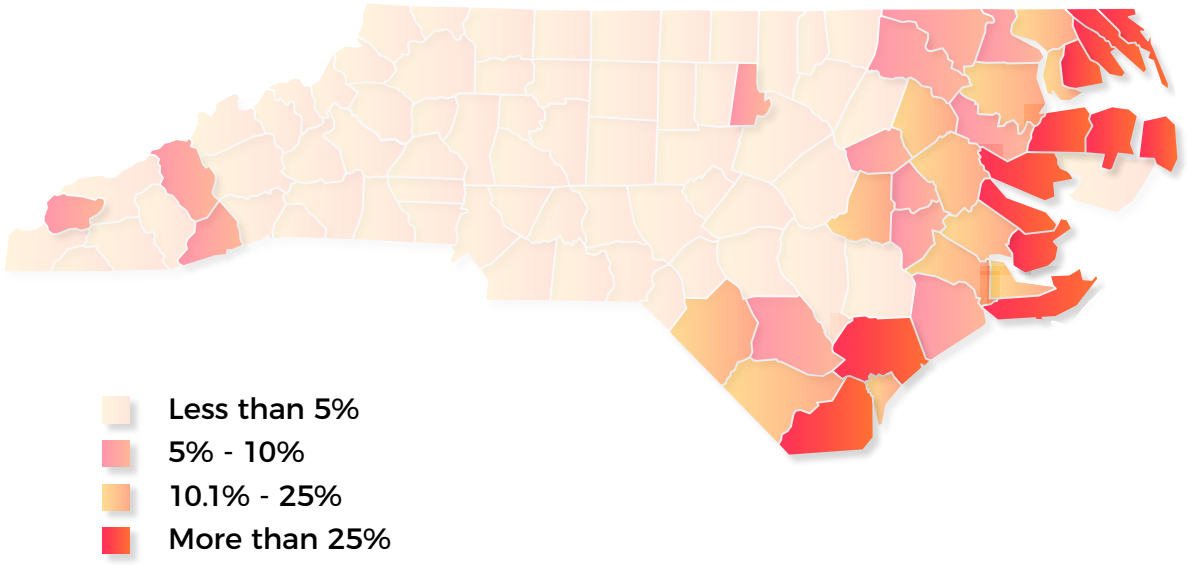
Solutions: North Carolina can improve the resilience of our housing stock by, M3, funding buyout of repetitive-loss properties, and M4, directing local governments to apply the state's amazing modeling capacities to guide planning and permitting of new development. In addition, A5, investing in floodplain restoration, can help minimize damage to existing housing from future storms.

Indicator 40.1: percentage of the housing stock in the 500-year floodplain.

Trend: Baseline

6.38% of North Carolina's housing stock is in the 500-year floodplain

Share of housing units in the 100 and 500-year floodplains



map credit: adapted from the NYU Furman Center Floodzone Data map for North Carolina.

Global climate models predict that one consequence of a warming planet will be increased moisture in the atmosphere, leading to more extreme rainfall and flooding. North Carolina is already experiencing this. Hurricanes Matthew 2016) and Florence (2018) did significant damage to homes well outside the 100-year floodplain, the zone with a 1% chance to flood in any given year. For this indicator, we consider the number of residences in the 500-year floodplain. Because the standard process for charting floodplains relies on decades of historical data, and takes years to produce new maps, the current 100-year floodplain is hardly a protective standard. For the time being, the 500-year floodplain appears a better measure of risk.

For this indicator, we rely on an analysis published in November 2017 by the NYU Furman Center that calculated residents in the 100- and 500-year floodplains for all counties in the nation.[291] The Center calculated that as of 2017, North Carolina had 281,882 residential units in the 100- and 500-year flood-

291 See NYU Furman Center, FloodzoneData.us map, retrieved February 24, 2019.

plains - over 70,000 of those occupied by renters. The units in the floodplain comprised an estimated 6.38% of the state's residential housing stock. The map above shows the distribution across the state. Virtually all counties have some housing stock in the floodplain, but the share is particularly heavy in the eastern counties directly adjacent to North Carolina's sounds. In Matthew and Florence, the bulk of the damage to housing was in the inner Coastal Plain, but the Center's analysis is a reminder of the vulnerability of the northeastern coast as well. It would be helpful to see an updated analysis that incorporates both a better sense, post-Florence, of the reach of the floodplains in eastern NC, and also that removes from the calculation residences that were destroyed in the floods and are not being rebuilt.

Transportation

NCDOT tracks project delivery rates as a key performance indicator for the agency. However, timely delivery of projects is only valuable if we are building the right projects. From a sustainability perspective, too often we are still not – the Strategic Transportation Improvement Program (STIP) includes dozens of highway projects that will induce sprawl and lock in decades of excess greenhouse gas emissions. Because some indicators are moving in a good direction, this subcategory aggregates to mixed score this year.

Goal 41: North Carolina's transportation system is efficient.

Trend: Mixed

We use two indicators to measure the efficiency of North Carolina's transportation system: the vehicle miles traveled per dollar of gross state product, and the total greenhouse gas emissions of our transportation sector. For this year, the first indicator yields a baseline value rather than a trend. The second yields a trend that is not declining fast enough, and is projected to reverse after 2035, if not sooner. For that reason, we rate North Carolina's progress towards an efficient transportation system as deficient this year.

Solutions: To maximize the efficiency of our transportation system, North Carolina needs to K1, increase the share of state spending directed to non-highway modes; K4, integrate climate mitigation and avoidance of sprawl into transportation planning; and J6, invest in zero-emission vehicle infrastructure, paired with J2, expended renewable generation and storage.

Indicator 41.1: vehicle miles traveled per dollar of gross state product.

Trend: Baseline

Moving freight and people is essential to sustaining a vibrant economy and high quality of life. This indicator measures the efficiency of our transportation system by tracking the number of vehicle miles traveled per dollar of gross state product. If the transportation system becomes more efficient over time, requiring less transportation to generate the same or greater level of economic activity, the number should drop. If the number rises, the share of state economic activity consumed moving goods and people is increasing, leaving less for all other purposes.

We calculate this indicator by dividing vehicle miles travelled for state fiscal year 2017-2018, 118 billion VMT,[292] by the gross state product (GSP) for calendar year 2017, $540.5 billion,[293] to get a ratio of 0.22 VMT per dollar GSP as a baseline for this year.

Apart from long-term efficiency trends, both VMT and GSP are likely to move up and down together, rising in a strong economy and falling during a recession - so the ratio should be relatively insulated

292 From NCDOT, 2018 Annual Report, January 2019, p35 'Highway Performance Profile: Highway Safety Rates'. The report covers the state fiscal year July 1, 2017 through June 30, 2018.

293 US Bureau of Economic Analysis, North Carolina, p3 (notes 'GDP last published November 2018'). The data covers the 2017 calendar year.

from distortion by the business cycle. However, because VMT is calculated by the state fiscal year while GSP is calculated by the calendar year, the time periods are six months off. Most of the time, that disjunct will not matter, but it could introduce some distortion if a sharp economic downturn or recovery hit during a period covered by one indicator but not the other.

Indicator: 41.2: annual GHG emissions from North Carolina's transportation sector.

Trend: Descending

Another measure of the efficiency of the transportation system is the amount of greenhouse gas emissions it generates in the process of delivering annual services. This can be measured as a per capita or per VMT number, but since the ultimate constraint on sustainability is the total emissions, this report tracks the total annual greenhouse gas emissions from the transportation sector.

Transportation is now the sector with the largest greenhouse gas emissions in North Carolina. It accounts for just over 30% of North Carolina's estimated gross 2018 greenhouse gas emissions, roughly 40 MMT CO2e from highway vehicles and 5 MMT CO2e from non-highway vehicles. In the near term, the source for reductions in greenhouse gas emissions from the transportation sector is improved mileage, driven by federal Corporate Average Fuel Economy (CAFE) standards for passenger cars, lights trucks, and fuel efficiency standards for heavier trucks and vans.[294] Those have been projected to keep total greenhouse gas emissions declining until around 2035, when growth in total vehicle miles travelled will overwhelm gains in fleet fuel efficiency.[295] The standards should prevent release of more than 6 billion metric tons of greenhouse gases over the lifetimes of cars from model years 2017 through 2025.[296] In September 2018, however, the Trump Administration proposed to freeze the fleet mileage standards, which would eliminate the anticipated emissions reductions (and also likely tip North Carolina counties back into nonattainment of federal air quality standards for conventional pollutants).[297] The comment period closed in November 2018; as this report goes to print, EPA has not issued a final rule.

Electrification of the transportation system offers a longer term option for reducing the sector's greenhouse gas emissions, but only if the electricity used to charge electric vehicles comes from climate neutral, renewable sources. NC Governor Roy Cooper's Executive Order 80 calls for North Carolina to increase the number of registered zero-emission vehicles in the state to at least 80,000 by 2025.[298] Given that renewable energy accounts for a small share of North Carolina's grid, reductions in transportation emissions will require a rapid deployment of alternatives to solo car use.

As with other greenhouse gas emissions indicators, for this indicator we rely on NCDEQ's GHG Emissions Inventory.[299] The state's final 2018 inventory shows greenhouse gas emissions for North

294 See, US EPA, website: Final Rule for Model Year 2017 and Later Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, October 15, 2012; US EPA, website: Final Rule for Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2, October 25, 2016.

295 Center for Climate and Energy Solutions, Decarbonizing U.S. Transportation, July 2018, at 3.

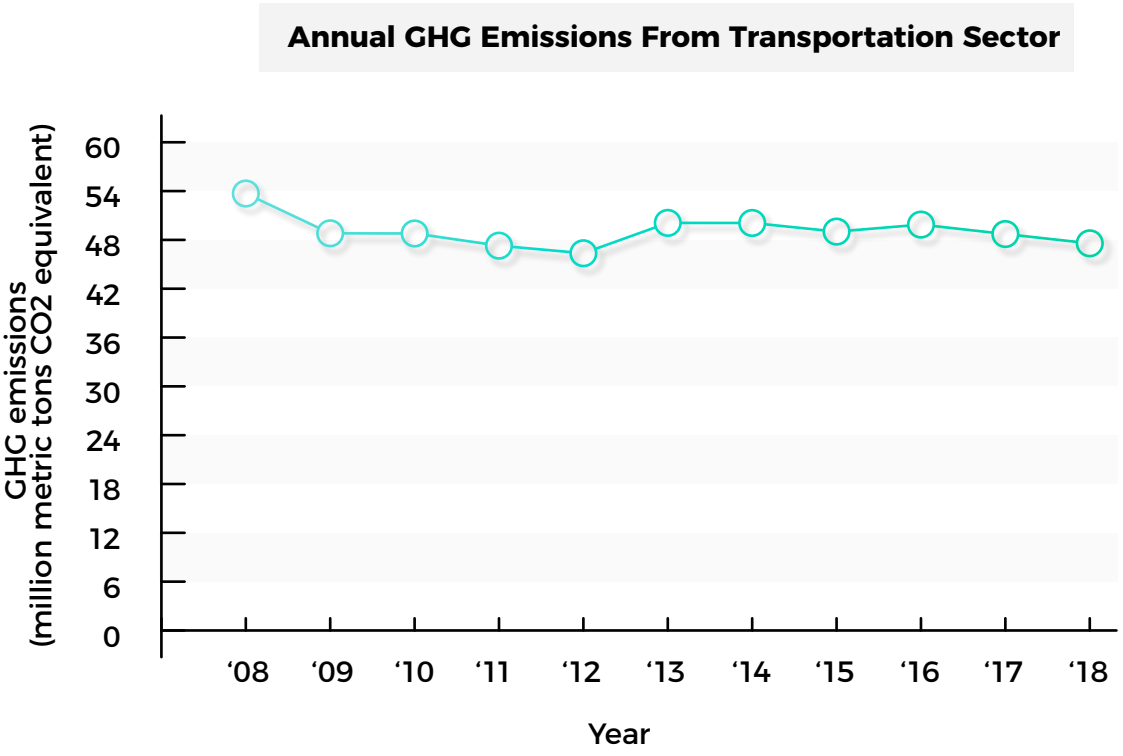
296 Marianne Lavelle and John Cushman, Why weakening fuel efficiency standards could be Trump's most climate-damaging move yet, InsideClimate, April 2, 2018.

297 US EPA, website: Proposed Rules for Technical Amendment to the Light-duty Vehicle Greenhouse Gas Program, OCtober 1, 2018. The administration's documentation for the proposal estimates that freezing fuel efficiency targets will also cost the national economy 60,000 jobs by 2030. See, Brian Palmer, Fuel efficiency standards don't just help curb climate change, they also create jobs, NRDC, August 28, 2018.

298 Executive Order 80, North Carolina's Commitment to Address Climate Change and TRansition to a Clean Energy Economy, October 29, 2018.

299 Source: NC DEQ, North Carolina Greenhouse Gas Emissions Inventory (Final), January 2018, Table A-2: North Carolina Historic GHG Emissions Inventory (2003-2030) in MMT CO2e, Transportation, at 56-57.

Carolina's transportation sector declining slowly over the last decade. Given the lethargy of the decline and the projected increase in the future, we view this as mixed progress.



Goal 42: North Carolina's transportation infrastructure is well maintained.

Trend: Mixed

The state highway system carries both freight and commuters, represents a huge historic investment, and supports much of the state's economic activity. Whereas other, non-highway modes desperately need investments to increase new capacity, the highway system requires massive sums simply to tread water. For that reason, our indicators for the maintenance of the state's transportation infrastructure focus on two aspects of the highway system: the percentage of lane miles in 'good' condition, and the percentage of bridges in 'good' condition.

Solution: Prioritizing highway spending to maintenance and improvements to existing infrastructure, K2, could help boost the overall condition of existing bridges and roads.

Indicator 42.1: percentage of pavement lane miles in 'good' condition.

Trend: Falling, bad

The NCDOT tracks the condition of highway pavement through an ongoing survey, and posts annual results online.NCDOT estimates that over the last several years, the percentage of pavement in good conditions has declined, from 68.9% in 2012 through 65.1% in 2017.[300] Thus, we mark this as a negative trend.

Indicator 42.2: percentage of bridges in 'good' condition.

Trend: Rising, good

300 NC Department of Transportation, webpage: Infrastructure Health, 'Pavement Condition Statewide'.

In addition to estimating pavement condition, NCDOT estimates the condition of bridges. Bridges in 'good' condition are deemed safe to carry typical commercial and passenger vehicles. Bridges that are not classified as being in 'good' condition may still be physically sound, just too narrow for the traffic they carry. By NCDOT's estimate, the percentage of bridges in good condition has improved in recent years, from 64.6% in 2012 to 73.8% in 2017.[301] This is a positive trend.

Another plausible indicator would be the American Society of Civil Engineers (ACSE) infrastructure report card, updated every four years (2013 and 2017 at the national level). However, the most recent North Carolina-level analysis dates from 2013; the chapter has not issued the 2017 update.[302] This may not matter; for transportation infrastructure, the ACSE analysis has generally relied on the same NCDOT indicators we cite here.

Goal 43: North Carolina's transportation infrastructure is reliable and resilient.

Trend: No trend

From a sustainability perspective, in addition to being effective and efficient, the transportation system should be resilient, able to endure changing weather conditions and economic stresses while still provided reliable and efficiency service.

Solutions: Above all, NCDOT should, K3, integrate climate adaptation and sea level rise projections into state transportation investment decisions. In addition, M3, removing repetitive-loss properties from the floodplain, and, M4, applying state flood models to guide future development, could minimize vulnerable structures in the floodplain; in turn, the transportation system could save resources not having to continually rebuild and repair access to those properties.

Indicator 43.1: 5-year moving annual average of disaster costs to the state transportation system.

Trend: Baseline

Disaster damage to the transportation system

In millions	SUM PER YEAR
2015	8,492,606
2016	14,095,719
2017	142,933,693
2018	79,595,198
2019	121,991,225

We track disaster damage to the transportation system as a signal of whether North Carolina has gotten sufficiently ahead of changing risks to manage them effectively. A rising 5-year moving average would suggest that the state is still playing catch-up to evolving risks; a falling five-year average of losses would suggest the state is getting ahead of risks – or that major risks have a longer recurrence interval – or the state has just been lucky. In response to our queries, NCDOT staff shared the following estimates of storm-driven damage to the transportation system over the last five years.[303]

301 NC Department of Transportation, webpage: Infrastructure Health, 'Bridge Health Statewide'.
302 ASCE, 2017 Infrastructure Report Card: North Carolina 2013 Report.
303 Data received through email from Steve Abbott, NCDOT Communications, February 2019.

This sums to an average disaster-driven expenditure, for federal and state declared and undeclared disasters, of $32.9 million a year over the last five years. That includes two years, 2016 and 2018, with exceptional flooding from hurricanes. The overall year-over-year trend appears to be rising, but because this data just covers one five-year interval, we present it as a baseline.

Goal 44: Transportation options are accessible and affordable to all residents.

Trend: Mixed

Transportation infrastructure includes multiple modes – highways, railroads, ferries, transit, and personal mobility options such as bicycles and scooters. Most North Carolinians commute and run errands by car, but for many - either because of youth, age, or income - driving is not an option. For others, it is a last resort. For this goal, we consider three indicators that track the degree to which North Carolinians really have alternatives to riding everywhere in a car: the share of state investments in new capacity going into non-highway modes; the percentage of workers doing something other than driving alone; and the rate of pedestrian and bicycle accidents, since perception of safety is key to unlocking walking and cycling for most of the public. For this year, the first indicator yields a baseline value, while the other two yield no trend towards or away from the goal; so we evaluate this goal as showing neither a positive nor a negative trend this year.

Solutions: To provide more and better transportation options for North Carolinians, the state should, K1, increase the share of state funding sent to non-highway modes; K5, support robust implementation of Complete Streets; and L1, promote transit-accessible development.

Indicator 44.1: mode split in funding for transportation projects.

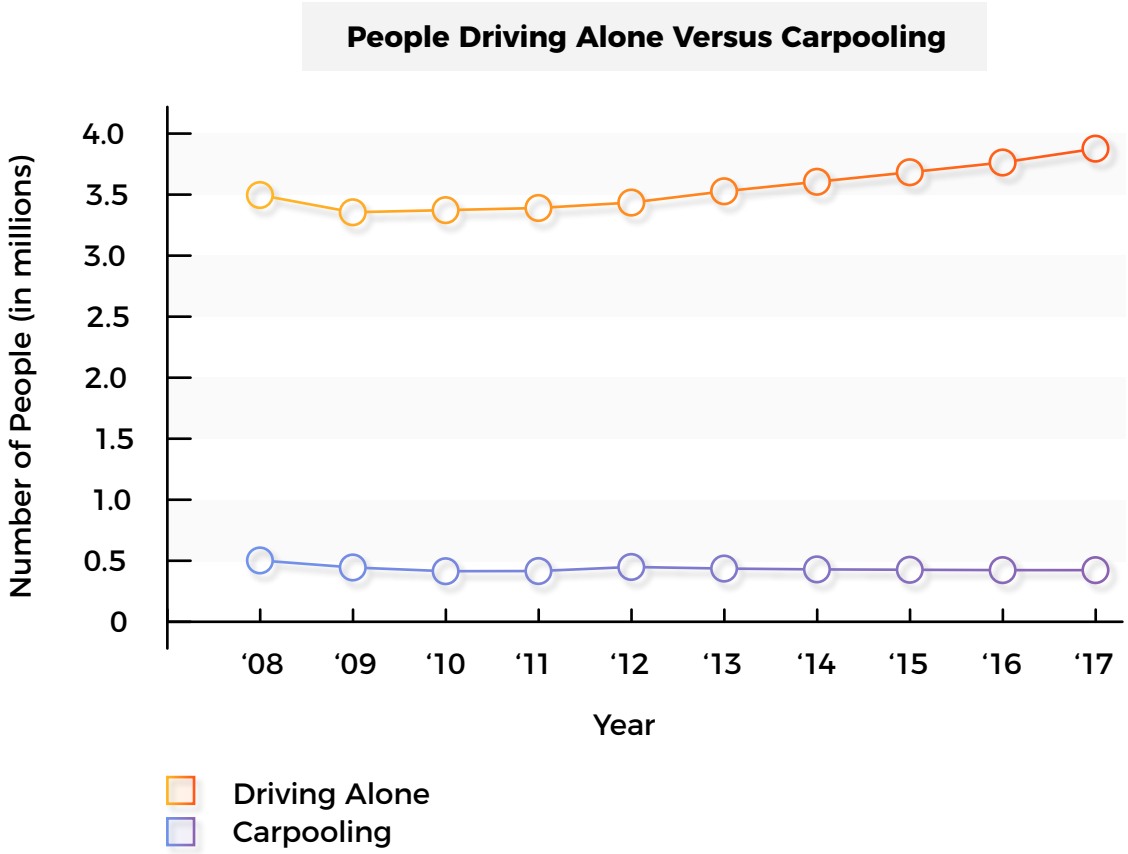
Trend: Baseline

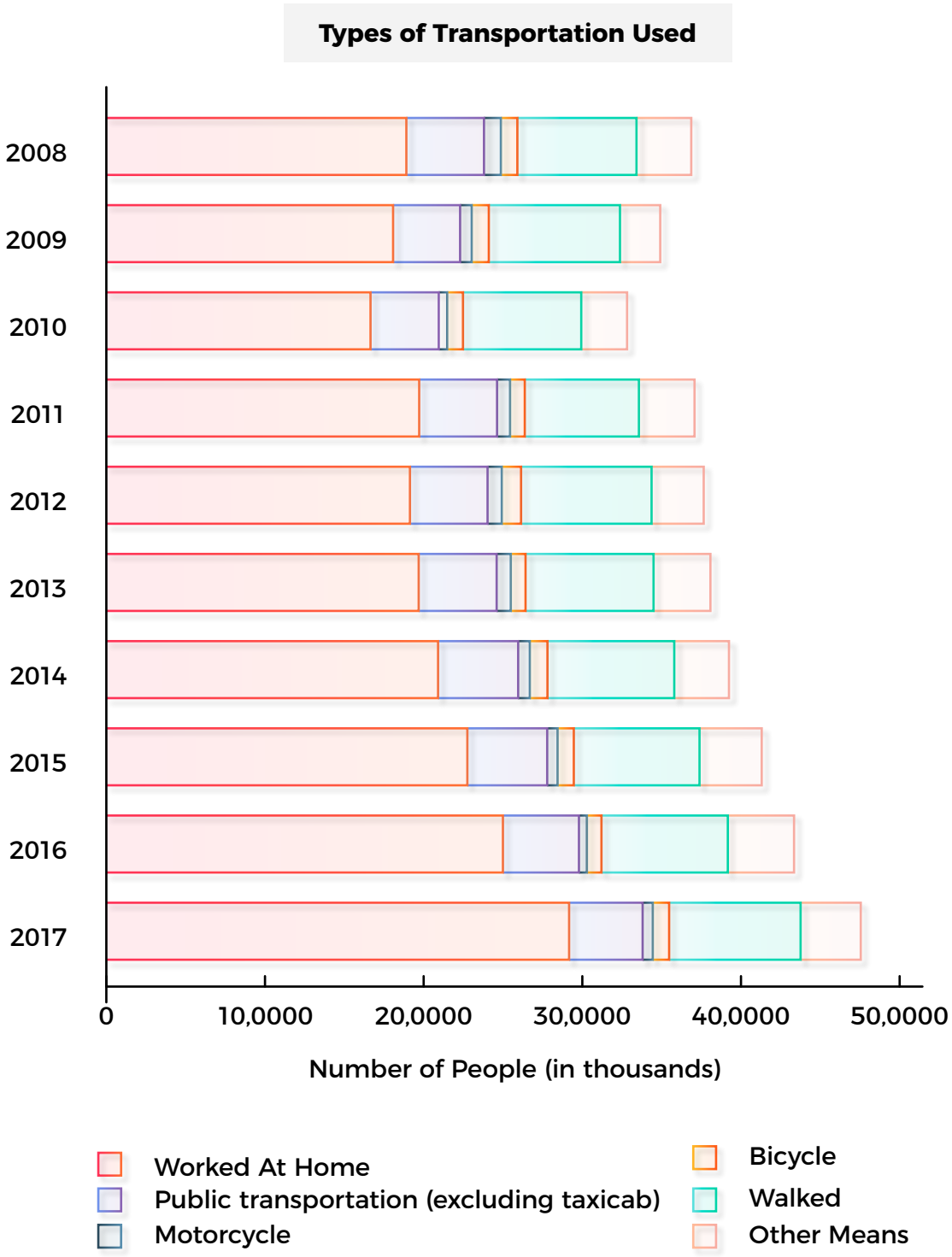
For decades, state and federal transportation spending has been overwhelmingly concentrated on road-building. In general, this report steers clear of indicators that reflect policy choices in favor of outcomes. However, the entire state transportation system itself is a policy choice, a massive government intervention. This indicator tracks a key outcome within that intervention: the share of state spending directed to non-highway modes.

To be clear, the so-called 'mode split' is not set by statute. Instead, the Strategic Transportation Investments (STI) workgroup recommends that a minimum of 4% and a maximum of 10% of spending from Regional and Division level funding categories be allocated to non-highway projects. In fact, the share of state spending on new capacity that is directed to other modes is tiny: 6% for all of them combined, despite strong public interest and support for better bike and pedestrian infrastructure, transit options, and safer streets for everyone. This mode split marks the state's commitment to investing in the full range of transportation options; we present it as a baseline for this year.

Indicator 44.2: percentage of the state's workers not commuting alone by car.

Trend: Flat, no trend





A practical indicator of the availability of transportation alternatives is the number of people who use them. This does not simply mean public transit ridership. For several years, public transit systems across the United States have seen ridership drop with the advent of rideshare services (Uber and Lyft), among other factors.[304] Ridership has dropped in North Carolina from a statewide annual high near 80,000 in 2014 to roughly 70,000 in 2017, though whether that reflects competition from rideshare services or fallout from state and local funding cuts is less clear. Displacement of transit ridership by rideshare services raises equity concerns: rideshare services are not cheap, and are not a workable solution for low-wage workers. The most recent one-year American Community Survey data (2017)

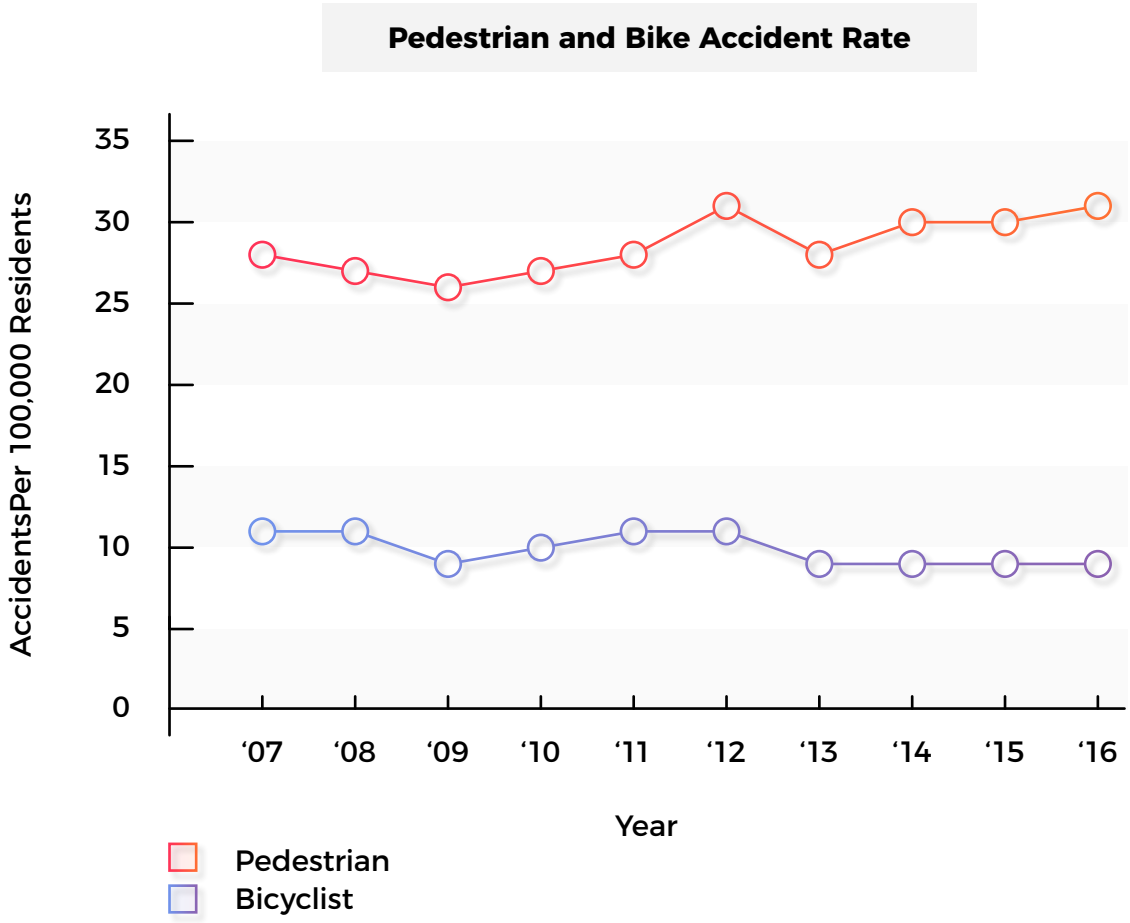
304 Laura Bliss, Another Study Blames Uber and Lyft for Public Transit's Decline, CityLab, January 24, 2019.

indicates that only 2.1% of working North Carolinians over 16 years old do not own a car. Yet, 29.7% of workers using public transit do not own a car.[305]

From a wider perspective, there are increasing and multiple alternatives to transit, including carpooling, walking, biking, and personal mobility devices such as electric scooters -- and an increasing number of people work from home, at least part time. For this indicator, we track the percentage of workers over 16 years of age who are commuting in some other way than driving by themselves. The chart shows the major alternatives to driving alone, including working from home.[306] But, while each of these alternatives are growing, they are barely keeping up with North Carolina's population growth, so the percentage of workers not commuting by driving alone has remained steady over the last several years at around 18.7%. We count that as showing neither a positive or a negative trend.

Indicator 44.3: rate of bike and pedestrian accidents.

Trend: Mixed



Walking and biking account for a small percentage of commuting and shopping trips, but putting these people in cars would significantly increase congestion and greenhouse gas emissions. Conversely, creating conditions that allow just a few percent more North Carolinians to walk or bike safely to their destinations would translate into less congested roads, lower emissions, and better health for the walkers and bikers.[307] Land use patterns, discussed in the next goal, play a central role

305 US Census Bureau, 2017 American Community Survey 1-year estimates, North Carolina, Means of Transportation to Work by Selected Characteristics for Workplace Geography, Vehicles Available.

306 US Census Bureau, American Community Survey 1 year estimates, 2008-2017, Means of Transportation to Work, Workers 16 and older.

307 ITRE, Evaluating the Economic Impact of Shared Use Paths in North Carolina: 2015-2017 Final Report, 2018.

in deciding whether people can bike or walk. But beyond that, research across the country confirms that a key factor in people's decisions to bike or walk is the degree of safety they feel en route to their destinations. When polled, 60% of the public "would like to ride more, but they are afraid of speeding and aggressive drivers... and prefer quieter streets and separate bicycle-only facilities."[308] That's why transportation experts recommend that infrastructure be designed to separate and shield pedestrians and cyclists from fast-moving vehicles.[309]

Because willingness to bike or walk is tied to perceptions of safety, for this indicator we track bike and pedestrian accidents. We rely on NCDOT's North Carolina Pedestrian and Bicycle Crash Data Tool, which has a two to three year lag, so the most recent data is from 2016.[310] The NCDOT data tool lists absolute numbers of accidents, and shows an increase over the last decade. Since population increased over that same timeframe, we have converted the data to a rate of accidents per 100,000 residents. The data shows a slight increase in the rate of pedestrian accidents and an essentially flat rate for bicycle accidents over the last decade. Pedestrian and bicycle fatalities are much rarer; even so, the Governors Highway Safety Association ranked North Carolina 14th in the nation for pedestrian fatalities for the first six months of 2018, with a pedestrian fatality rate of 0.98 per 100,000 residents.[311] We count the North Carolina data as showing a mixed trend for this year.

Fortunately, there's little mystery about how to design roads and streetscapes to make cyclists and pedestrians safer. The concepts are typically bundled under the rubric of 'Complete Streets', the proposition that as a general rule, non-highway roads should be designed to accommodate transit, bikes, pedestrians, and personal mobility devices, as well as cars.[312] The NC Board of Transportation adopted a complete streets policy for the state in 2009,[313] but it has been largely ignored for a decade. NCDOT is in the process of updating the policy and has expressed an intent to begin actually implementing it.

Patterns of Development

Goal 45: Land use patterns allow people to live near where they work.

Trend: Weak

North Carolina is the 15th densest of the 50 states, with an average of 206 residents per square mile, up from 136 residents per square mile in 1990, not quite 30 years ago.[314] Of course that density has never been evenly distributed; in 1990, county seats routinely had more than 1,300 residents per square mile. Over the last three decades, as people have poured into the state, patterns of urban land use have changed radically: town centers are, if anything, slightly less dense, while medium-density suburbs and exurbs reach far into formerly rural areas. That pattern of rapidly expanding low-density development - sprawl - is something most people can identify by sight.

In this section of the report, we are particularly interested in two major consequences of sprawl: the increasing per capita cost to government to provide services to residents in sprawling communities; and the impact that sprawl has on residents' lives by requiring them to travel further to get anywhere. The next two indicators focus on these aspects of sprawl. Sprawl has other consequences as well: impacts to water quality from increasing impervious surface, loss of open space, and increasing greenhouse gas emissions. All are predicted to continue to cause problems for North Carolina.[315] These impacts are picked up by other indicators in this report.

Solutions: North Carolina should, K4, manage its transportation investments to avoid inducing sprawl.

308 Governors Highway Safety Association, A Right to the Road: Understanding & Addressing Bicyclist Safety, 2017, at 23.
309 See, for example, Federal Highway Administration, Separated Bike Lane Planning and Design Guide, 2015; National Association of City Transportation Officials, Urban Street Design Guide, 2013.
310 NCDOT, North Carolina Pedestrian and Bicycle Crash Data Tool, 2010-2016.
311 Governors Highway Safety Association, Pedestrian Traffic Fatalities by State: 2018 Preliminary Data, February 2019.
312 See, Smart Growth America, The Elements of a Complete Streets Policy, 2018.
313 NC Board of Transportation, North Carolina Department of Transportation Complete Streets Policy, July 9, 2009, printed in NCDOT, North Carolina Complete Streets Planning and Design Guidelines, 2012.
314 U.S. Census Bureau, 1990 Census of Population and Housing: North Carolina, Table 8.
315 Adam Terando et al, The Southern Megalopolis: Using the Past to Predict the Future of Urban Sprawl in the Southeast U.S, PLOS One, July 2014, https://doi.org/10.1371/journal.pone.0102261.

Indicator 45.1: where growth is happening.

Trend: Weak

Over the last three decades, planners and economists have documented the higher costs to local government of providing services to sprawl.[316] A relatively recent study found that the most compact 20% of cities in the United State and Canada have annualized infrastructure costs of roughly $500 per capita, in contrast to $750 per capita for the most sprawling 20%.[317]

North Carolina's cities have been noted for their sprawl. A 2017 analysis looked at data for 162 urbanized areas in 2000 and 2010, considering 15 variables in 4 dimensions: development density, land use mix, activity centering, and street connectivity.[318] In 2000, the ten most sprawling cities on the list included Fayetteville (#153), Winston-Salem (#158), and Hickory (#161), with Charlotte just missing the list as the 11th most sprawling.[319] In 2010, the ten most sprawling cities included Fayetteville (#154), Charlotte (#158), Winston-Salem (#159), and Hickory (#161).[320] In 2016, UNC demographer Rebecca Tippett, without discussing sprawl as such, noted that North Carolina shows much less dense urban centers - and more densely-settled rural counties - than our neighbor to the north, Virginia.[321]

Growth in households since 2010, by census tract density in 2010.

CENSUS TRACT HEXILE	HOUSEHOLD DENSITY OF TRACTS IN 2010	AVERAGE NEW HOUSEHOLDS PER TRACT SINCE 2010	TOTAL NEW HOUSEHOLDS SINCE 2010 IN THIS HEXILE
1	1011 - 5786 hh/ sq mi	63	22,830
2	547 - 1011 hh/sq mi	92	31,455
3	243 - 547 hh/ sq mi	93	33,799
4	100 - 243 hh/ sq mi	95	34,455
5	40 - 100 hh/sq mi	23	8,380
6	Up to 40 hh/sq mi	-7	-2,770

For this indicator, we examined the spatial distribution of North Carolina's rapid growth. We sorted North Carolina's census tracts based on their household density in 2010, and broke them into six groups with equal number of tracts, from less dense to most dense. We then counted the average change in households between 2010 and the most current census data (the 2013-2017 American Community Survey) for each of the six groups, and counted the total number of households moving into the six groups. Those results are in the table above.[322] As the table indicates, the least dense sixth of census

316 See, Smart Growth America, Building Better Budgets, 2013 (finding that compact development costs local governments 1/3 less up front, saves 10% annually on costs of providing services, and generates 10x more tax revenue per acre); OECD, Rethinking Urban Sprawl: Moving Towards Sustainable Cities, 2018, at 125-127. https://dx.doi.org/10.1787/9789264189881-en.

317 The New Climate Economy, Analysis of Public Policies that Unintentionally Encourage and Subsidize Urban Sprawl, 2015, at 5.

318 Reid Ewing and Shima Hamidi, Costs of Sprawl, 2017.

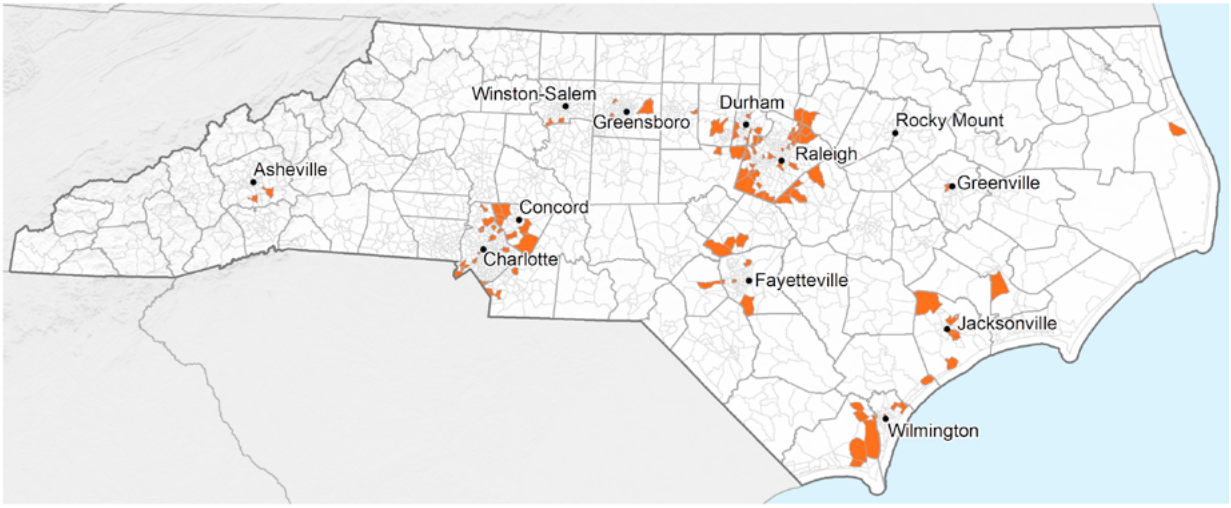
319 Idem, at 152 and 157.

320 Idem, at 151.

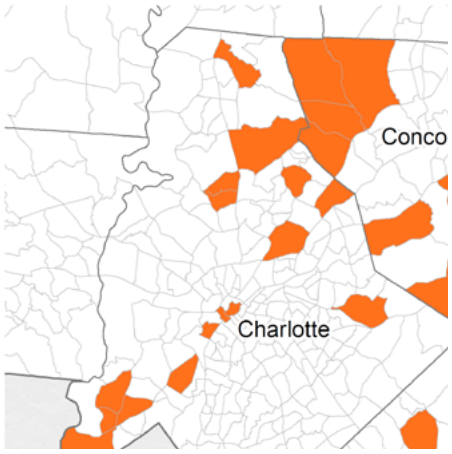
321 Rebecca Tippett, The persistent 'rurality' of North Carolina, Carolina Demography blog, March 21, 2016.

322 More than half of census tracts had a smaller increase in households than the margin of error for estimating total households in the American Community Survey, so we ran the analysis twice, first including and then excluding them. The results were very similar: net growth is expanding the exurbs more than densifying already developed areas.

tracts lost households since 2010; many of these are in rural areas. Strikingly, the greatest absolute number of new households moved into census tracts that had quite low density in 2010. That's a strong signal of sprawl.



map credit: Andrew Pericak, using data from 2010 Census and 2017 American Community Survey.



Another way to look at this is by the spatial distribution of census tracts receiving the greatest net growth in households since 2010, as shown in the state map above and regional breakouts. Ordered this way, just 5% of census tracts account for over half of North Carolina's net growth in households. The 'urban renaissance' of the state's largest cities is real - census tracts in downtown Charlotte and Raleigh show some of the greatest absolute increases in households - but those gains in density are outweighed several-fold by increases suburban and exurban tracts. On the basis of the distribution of growth into low density census-tracts, and the spatial distribution of the fastest-growing tracts in the exurbs, we evaluate this indicator as showing a continuing negative trend.

Indicator 45.2: percentage of solo drivers with long commute times.

Trend: Rising, bad

Sprawling land use patterns impose direct costs in time and money on residents as they commute to and from work, shuttle kids to school and activities, and run errands.[323] Longer commutes are associated with health risk factors, including higher blood pressure and habits of inactivity.[324] Each hour a person spends in a car daily correlates with a 6% greater probability they are obese.[325] This indicator tracks, of those North Carolinians who commute alone, the percentage that have to drive more than 30 minutes each way. The data, collected by the American Community Survey of the US Census Bureau,

323 Shima Hamidi and Reid Ewing, Is sprawl affordable for Americans?: Exploring the association of transportation affordability and urban sprawl, Transportation Research Record, 2015, 2500:1, 75-79. https://doi.org/10.3141/2500-09 (finding that increased transportation costs more than offset reduced house prices, yielding higher total household costs for residents of sprawling suburbs).

324 Christine Hoehner et al, Commuting distance, cardiorespiratory fitness, and metabolic risk, American Journal of Preventive Medicine, 2012, 42.6, 571-578. DOI: 10.1016/j.amepre.2012.02.020

325 Lawrence Frank et al, Obesity relationships with community design, physical activity, and time spent in cars, American Journal of Preventive Medicine, 2004, 27.2, 87-96. DOI: 10.1016/j.amepre.2004.04.011

is grouped in five-year intervals.[326]

In the period 2008-2012, rates of long commutes varied among counties from 15% to 66% of solo drivers, with a state average of 30%.[327] In the most recent period, 2012-2016, rates of long commutes varied among counties from 17% to 62%, with a slight increase for the state average to 31% of solo drivers.[328] Although that percentage change is small, is translates to nearly 40,000 people with longer commutes, so we count this as a trend in the wrong direction.

Goal 46: North Carolina's developed landscapes are resilient.

Trend: Mixed

As discussed under goal 1, climate change is already bringing disruptions to North Carolina, including stronger storms, more intense flooding, and more intense droughts and wildfires. 'Resilience' can meet many things; in this report, we use the term to mean strategies that decrease the vulnerability of human health and property to a rapidly-changing global and regional climate. We note that resilience also applies to natural systems - how well individual species and groups of species are adapting as their habitats change with the climate. We have not found good data series on that, but state and federal scientists are in the process of identifying 'sentinel sites' that can be used to track ecological resilience in coming years.

For this goal, we take a pragmatic approach, tracking losses from extreme events. If our losses from disasters keep increasing, that is a sign that our thinking hasn't gotten far enough ahead of the threats to minimize the harms they cause. For this goal, a resilient developed landscape overall, we track three kinds of damage: floods and flooding, wind and storm surge (relevant mostly on the coast), and wildfire. The downside of these metrics is that damages are highly volatile from one year to the next, making it hard to spot a trend. We've tried to address that by averaging damages across five-year intervals, but even that may be too short. The ultimate costs of failing to adapt are lost opportunities for growth and community stability; we do not have a metric for that. For this year, flood damages are rising, storm surge damages are basically flat (over the last ten years), and wildfire damage is falling. We count this as a mixed trend this year.

It's worth noting that several other indicators in this report also tie to resilience, including the percentage of housing stock in floodplains (40.1), disaster damage to the transportation system (43.1), vulnerability of water and wastewater infrastructure (9.2), and vulnerability of energy infrastructure (50.1). Two additional indicators reflect strategies of adaptation: the use of living shorelines rather than bulkheads to address coastal change (5.2), and, indirectly, the growth in sustainable sectors as a share of the state economy (34.1).

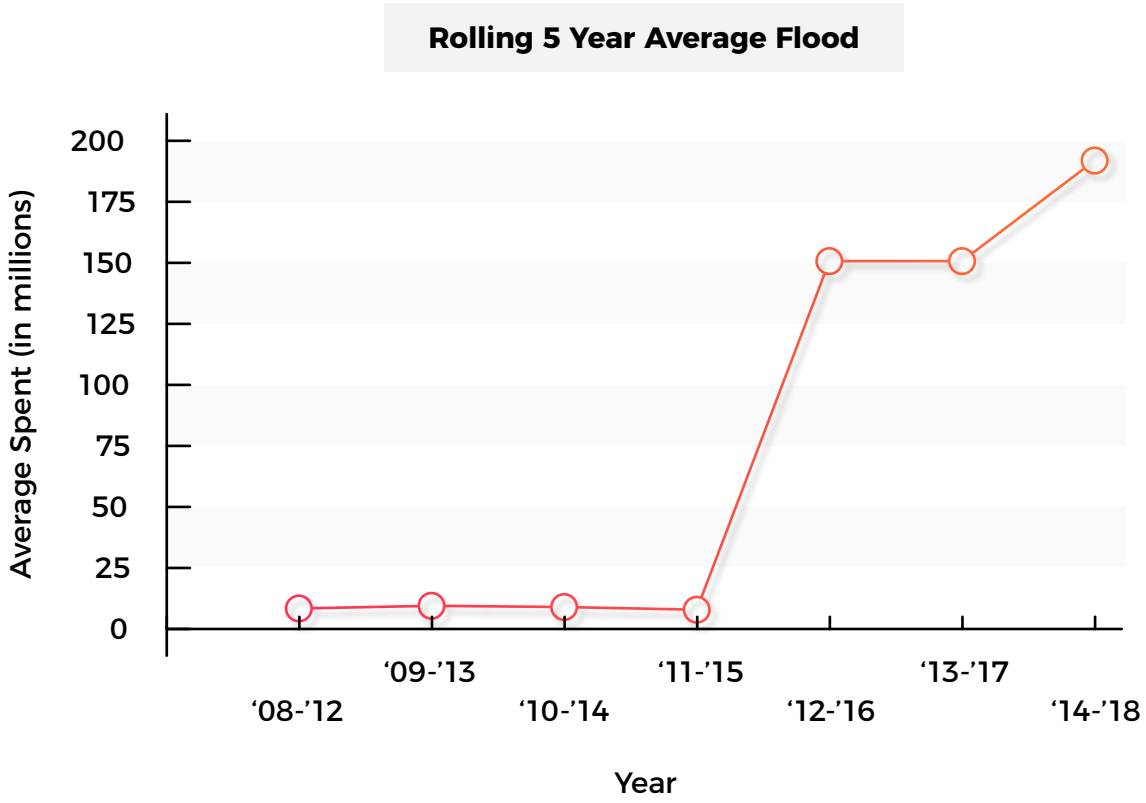
Solutions: North Carolina can improve the resilience of our developed landscapes by, A5, investing in floodplain restoration; B2, promoting living shorelines over bulkheads; C5, promoting green stormwater infrastructure; E1, prioritizing environmental justice; J2, expanding renewables paired with battery storage; K3, integrating climate adaptation into transportation planning; L3, authorizing local governments to adopt water-neutral growth ordinances; M3, funding buyouts of repetitive-loss

326 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps: Long Commute – Driving Alone, 2018.
327 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps: Long Commute – Driving Alone, 2014.
328 Robert Wood Johnson Foundation, County Health Rankings & Roadmaps: Long Commute – Driving Alone, 2018.

properties; M4, directing local governments to apply forward-looking flood modeling in planning and permitting decisions; and M5, directing local governments to adopt wildfire management plans.

Indicator 46.1: 5-year moving annual average of flood damages.

Trend: Rising, bad



The National Weather Service provides an annual estimate of flood and flash flood losses and fatalities to the US Army Corps of Engineers, broken out by state. It does not distinguish between losses within or beyond the 100-year (or any other) floodplain.[329] The National Weather Service freely acknowledges that this data may miss damage from a number of events. Despite using a five-year average to smooth annual volatility, the data is overwhelmed by the impact of flooding from Hurricanes Matthew and Florence, and shows a radical increase in average annual costs because of that. Over the last decade as a whole, floods and flash floods have cost North Carolina over a billion dollars in property damage, for an annual average impact of just over $101 million.

Perhaps surprisingly, the NOAA dataset appears more on point than records available from the Federal Emergency Management Agency (FEMA), which tracks the assistance FEMA provides following disasters rather than estimated damages.[330] Although the NC Division of Emergency Management publishes an annual report and a year-in-review document, these do not tally estimated damages, and in fact the state agency appears not to have any public data stream tracking disaster losses.[331] Such a dataset would be useful to inform state hazard mitigation and resilience policies.

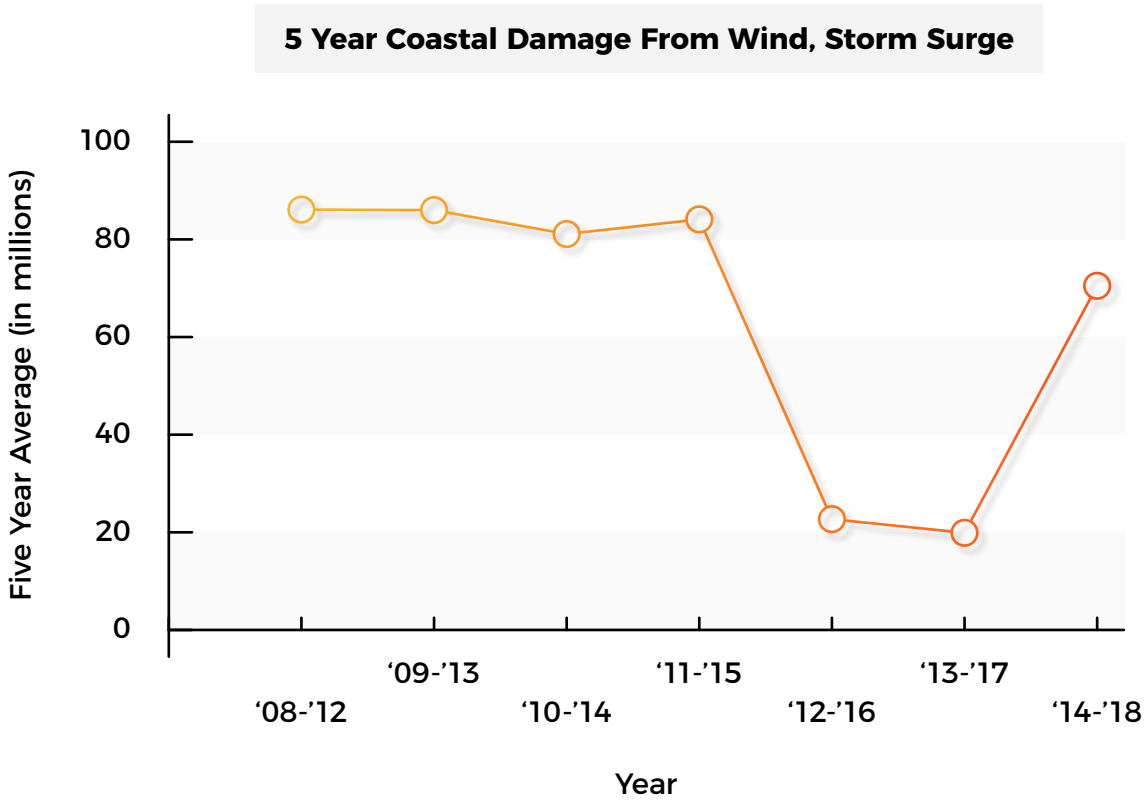
Indicator 46.2: 5-year moving annual average coastal damage from wind, coastal flooding, and storm surge.

329 Source: NOAA National Centers for Environmental Information, Storm Events Database, cumulative flood and flash flood damage in each year, 2008 -2018.

330 See, as a portal to FEMA resources, FEMA, webpage: Data Visualization.

331 NC Department of Public Safety, Division of Emergency Management, webpage: Documents.

Trend: No trend



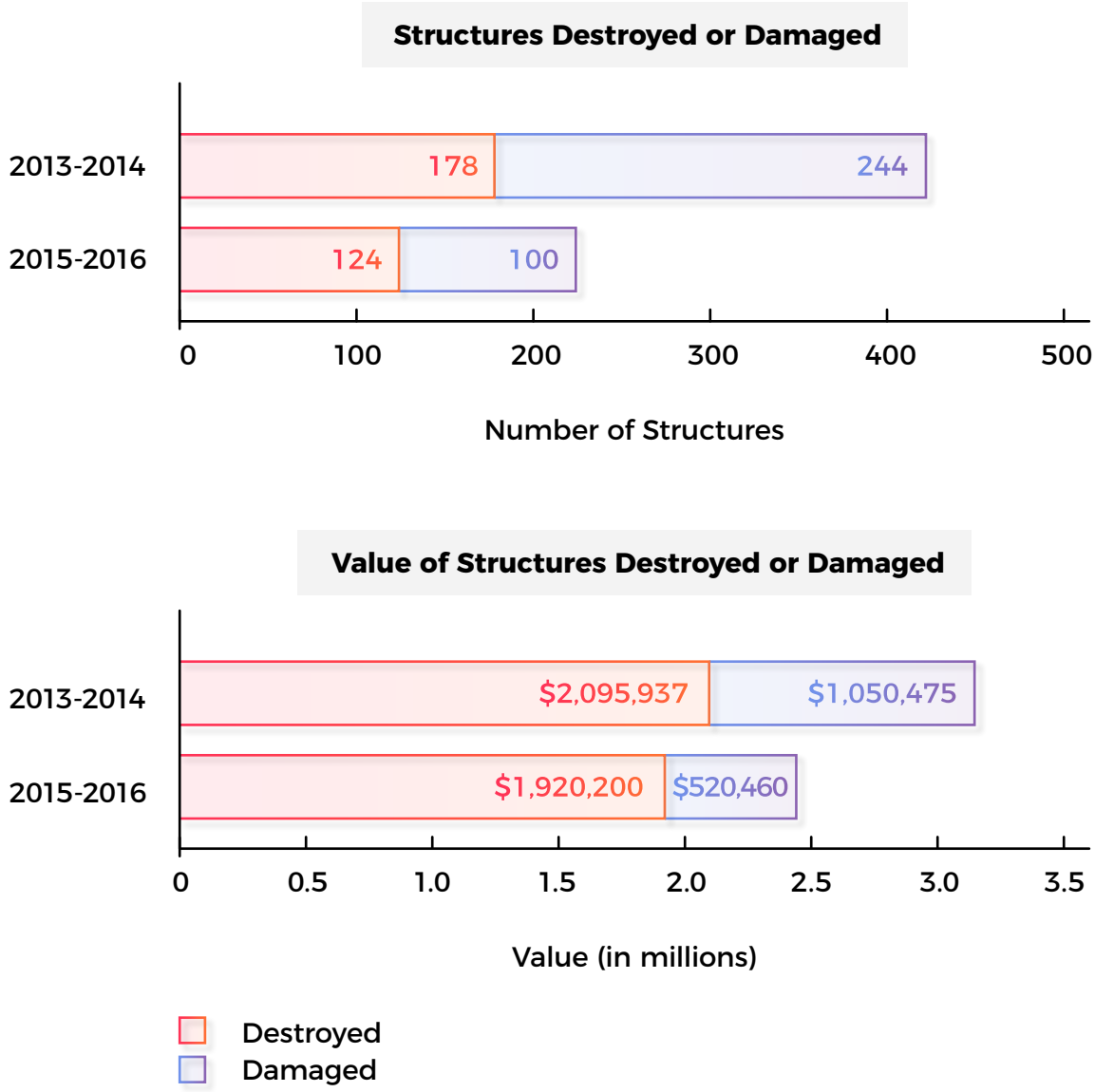
Infrastructure in the coastal counties bears the brunt of tropical storms and hurricanes, as well as high tides brought to new levels by sea level rise. As with other resilience indicators, this tracks the 5-year moving annual average of costs from storm winds, coastal flooding, and storm surge. As with damages from floods and flash floods, we derive the numbers from National Weather Service estimates published by NOAA's National Centers for Environmental Information.[332] The data shows a dip thanks to relative quiet in 2013-2015 and 2017, punctuated with major losses in 2016 and 2018. The ten-year losses are over $783 million, or roughly $78 million on average each year. Overall, we do not assign a

332 Source: NOAA National Centers for Environmental Information, Storm Events Database, cumulative damage from coastal flooding, storm surge, tropical depressions, tropical storms, and hurricanes in each year, 2008 -2018.

trend to this indicator this year.

Indicator 46.3: 5-year moving annual average number of structures lost to wildfires.

Trend: Falling, good



North Carolina ranks first in the nation in the number of acres of the state in the 'wildlands urban interface', where houses and natural vegetation 'meet or intermingle'.[333] That is measured via a federal standard: places where housing density is greater than 1 house per 40 acres and more than 50% of the area is in wildland vegetation (intermix), and areas that have less than 50% vegetation, but are within 1.5 miles of a densely vegetated area over 5 square kilometers in size (so, no neighborhood parks).[334]

North Carolina is fifth in the nation in the absolute number of homes in the interface. In an effort to get ahead of that threat, the NC Forest Service works with communities across the state to prepare

333 Volker C. Radeloff et al, Rapid Growth of the US wildland-urban interface raises wildfire risk, PNAS March 27, 2018, 115:13, 3314-3319, https://doi.org/10.1073/pnas.1718850115.

334 USDA, Urban wildland interface communities within vicinity of federal lands that are at high risk from wildfire. 66 Fed. Reg. 751–777, 2001.

Community Wildfire Protection Plans.[335] Still, as the climate warms and rainfall patterns become more erratic, North Carolina faces the possibility of growing losses from wildfires. The available data covers two biennia, 2013-2014 and 2015-2016, and suggests declining losses from wildfire (for now); we count that as progress in the right direction this year.

Flows of Energy and Waste

Much of this report measures the health of things: landscapes, people, businesses, infrastructure. This category, however, measures flows of energy and waste between the different categories. A bit like money, or water, energy and waste are part of the social metabolism that ties us to one another. Also like money and water, energy and waste need to flow in a circle. Energy from non-renewable sources is unbalancing North Carolina's climate. Wastes that cannot be recycled turn materials - a kind of wealth - into unrecoverable loss. In that sense, the indicators in this section measure whether we are successfully bending flows of energy and materials into a circular pattern, and doing it in a way that lifts the well-being all North Carolinians.

Flows of energy.

Goal 47: Risks to the environment from energy consumption are minimized.

Trend: Good

North Carolina does not have significant fossil fuel energy extraction within state boundaries, and our renewable energy sources are relatively benign. Energy impacts on the environment in North Carolina largely reflect generation and consumption of electricity. One exception to that is harvesting of biomass for export in the form of wood pellets to be burned overseas, which appears in practice to result in significant net carbon emissions.[336]

This goal relies on two indicators: greenhouse gas emissions from energy generation, which are falling, though not fast enough; and the energy efficiency of the state economy, which is gradually improving. Overall, we credit a marginally positive trend towards this goal this year.

Solutions: To reduce our greenhouse gas emissions from energy generation, North Carolina should, J1, modernize the electric grid to support renewables; J2, expand renewable generation and storage;

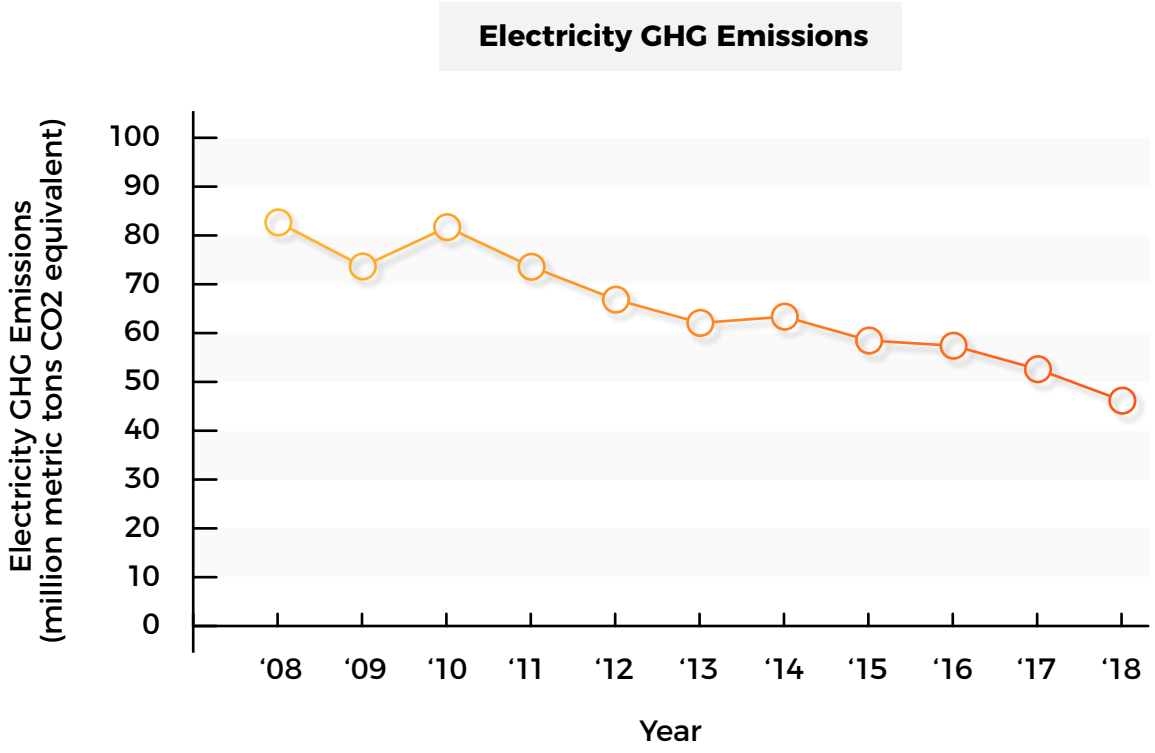
335 NC Forest Service, 2017 Biennial Report, 2017.

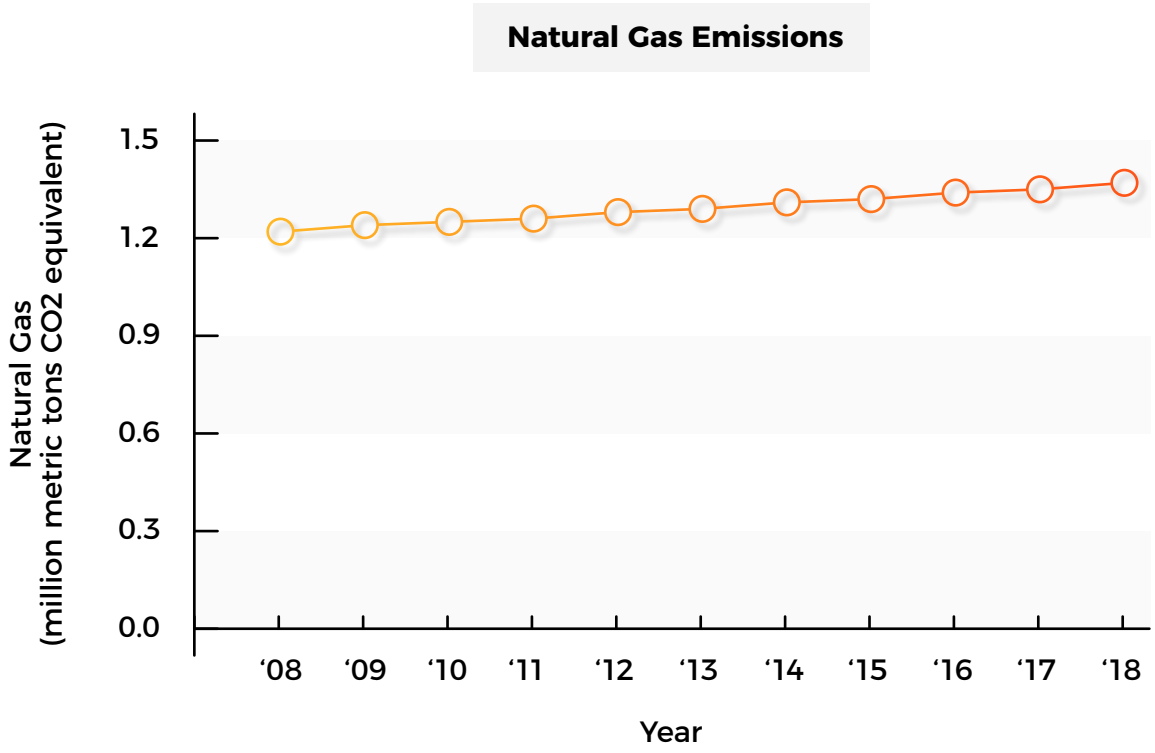
336 Rachel Carson Council, Clear Cut, February 2019; see also, Joby Warwick, How Europe's climate policies led to more U.S. trees being cut down, Washington Post, June 2, 2015.

J3, expand energy efficiency; J5, curb wood pellet facilities; and J7, avoid investments in expanded natural gas pipelines.

Indicator 47.1: Greenhouse gas emissions from energy consumption in NC.

Trend: Mixed



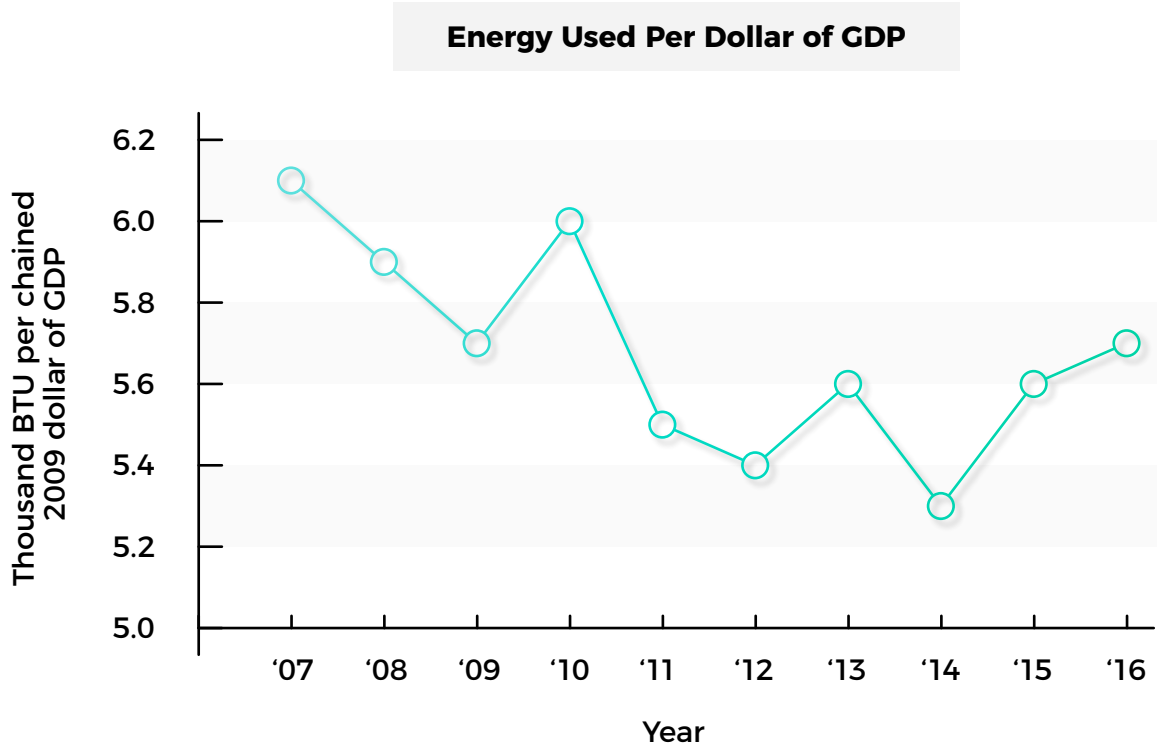


As with other greenhouse gas emissions indicators, for this indicator we rely on data from NC DEQ's GHG Emissions Inventory.[337] Greenhouse gas emissions from fossil fuel combustion have decreased by 26% since 2005.[338] This is primarily due to the retirement of old coal-fired power plants, whose energy production resulted in more emissions per unit of energy than the natural gas and renewables facilities that have replaced them. In addition, overall electricity consumption has remained essentially flat in North Carolina since the early 2000s, meaning that increased consumption is not driving a rise in emissions.

Of the main energy-generation types, emissions are growing only from the natural gas sector, as the investor-owned utilities replace energy produced from coal with energy produced from gas. Until 2012, industrial use accounted the majority of natural gas consumption in North Carolina, but it has since been passed by energy production, which accounted for almost 60% of total natural gas consumption in the state in 2017.[339] Decreasing greenhouse gas emissions is a positive trend; but the heavy reliance on natural gas generations tends to lock in emissions at levels that are still too high. The trajectory of declining emissions is not fast or - according to modelling - likely to continue long enough to accomplish North Carolina's share of needed global reductions. For that reason, we rate greenhouse gas emission declines as showing mixed performance - dropping, but not fast or permanently enough.

Indicator 47.2: Energy usage per dollar of Gross State Product.

Trend: Falling, good



A core measure of the energy efficiency of the state's economy as a whole is the amount of energy used per unit of economic activity. The federal Energy Information Administration (EIA) calculates this

337 Source: NC DEQ, North Carolina Greenhouse Gas Emissions Inventory (Final), January 2019. Table A-2: North Carolina Historic GHG Emissions Inventory (2003-2030) in MMT CO2e, Energy Generation, at 57-58.

338 NCDEQ GHG Inventory Final Report at 14.

339 Energy Information Administration, https://www.eia.gov/state/analysis.php?sid=NC#48

using Gross State Product adjusted for inflation; the data has a two year timelag.[340] This indicator is agnostic about the source of the power, and assumes that it is always better if a given level of energy use can generate more economic activity – or, conversely, that the same level of activity can be sustained with less energy consumption. Data since 2007 shows an overall drop in the energy intensity of North Carolina's economy, a positive trend.

Goal 48: North Carolina transitions to a diverse mix of renewable energy sources.

Trend: Mixed

This goal relies on two indicators: the percentage of electricity used in North Carolina that comes from renewable sources, and the trend in grid modernization. Overall, we find mixed trends for this goal.

Solutions: North Carolina needs our electric utilities to, J1, pursue sustainable grid modernization; J2, expand renewable energy generation paired with battery storage; and J3, expand energy efficiency.

Indicator 48.1: percentage of electric energy consumed in NC that comes from renewable sources.

Trend: Weak

The US Energy Information Administration (EIA) keeps statistics on all forms of electric energy generation.[341] For purposes of tracking renewable energy generation in North Carolina, we include solar, wind, hydro, and methane capture and generation from sources such as landfills. We do not include burning of woody biomass because it is not a renewable resource. We show generation from nuclear power – an important component of the Investor Owned Utility generation portfolios – but, like EIA, do not classify it as renewable.

So defined, the contribution of renewables to North Carolina's energy generation mix continues to rise gradually from 4% renewable energy, all hydroelectric, in 2005, to 9% renewable in 2016, comprised of 4% hydro, 4% solar and 1% wind energy.[342] In sum, while North Carolina's renewable portfolio continues to grow rapidly relative to other states in the region, renewable electricity is at present only a small percentage of total electricity generated in the state. Worse, forecasting suggests that, after declining through 2025, electric power sector emissions will increase from 2025 to 2030. Changes in state policy will be needed to maintain the current trajectory of decreasing emissions from electricity generation.[343] Because the current path does not move us permanently below emissions targets, we rate progress as inadequate.

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340 Energy Information Administration, Table 6. Energy Intensity by State (2000, 2005-2015), 2018; Energy Information Administration, Table C12. Total Energy Consumption Estimates, Real Gross Domestic Product (GDP), Energy Consumption Estimates per Real Dollar of GDP, Ranked by State, 2016, June 2018.

341 US Energy Information Administration, Detailed State Data, January 15, 2019.

342 US Energy Information Administration, Detailed State Data, Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923), January 15, 2019.

343 NC DEQ, North Carolina Greenhouse Gas Emissions Inventory (Final), January 2019, Table 1-1: North Carolina GHG Emissions Inventory by Source Sector (MMT CO2e), at 5

Indicator 48.2: How North Carolina's electric grid compares to those of other states.

Trend: Good

While North Carolina's electric grid is not seen as outstanding by national peer reviewers, evaluations of the state's efforts to modernize its electric grid trend in a positive direction since 2012.

Since 2012, the non-profit Gridwise Alliance has released annual reports ranking states on a Grid Modernization Index consisting of three components: Policy, Customer Engagement and Grid Operations.[344] These mean, respectively, state policies that promote modernization of the grid; responsiveness and data sharing with customers; and operational effectiveness and reliability. Evaluations indicate the assessment of state grids by a selection of industry professionals and analysts and acknowledge that their evaluation system tends to produce better scores for states which are a part of a regional transmission organization, which North Carolina is not.

In the initial 2013 report, only the top 15 states were rank ordered on a composite score across those three indices and North Carolina was not among them.[345] North Carolina ranked 24th in the 2014 assessment, but jumped to 11th place in 2015 and fell slightly to 15th in 2016. Overall, the trend is slightly favorable, with policy, or state support consistently being the state's highest ranking category, followed by grid operations. Customer engagement has consistently been the score factor keeping North Carolina from a higher ranking, suggesting that North Carolina's rate structures, customer outreach, and data collection practices lag behind as the state works to modernize the electrical grid.

Goal 49: Energy rates are affordable, and costs are fairly distributed among North Carolinians.

Trend: Neutral

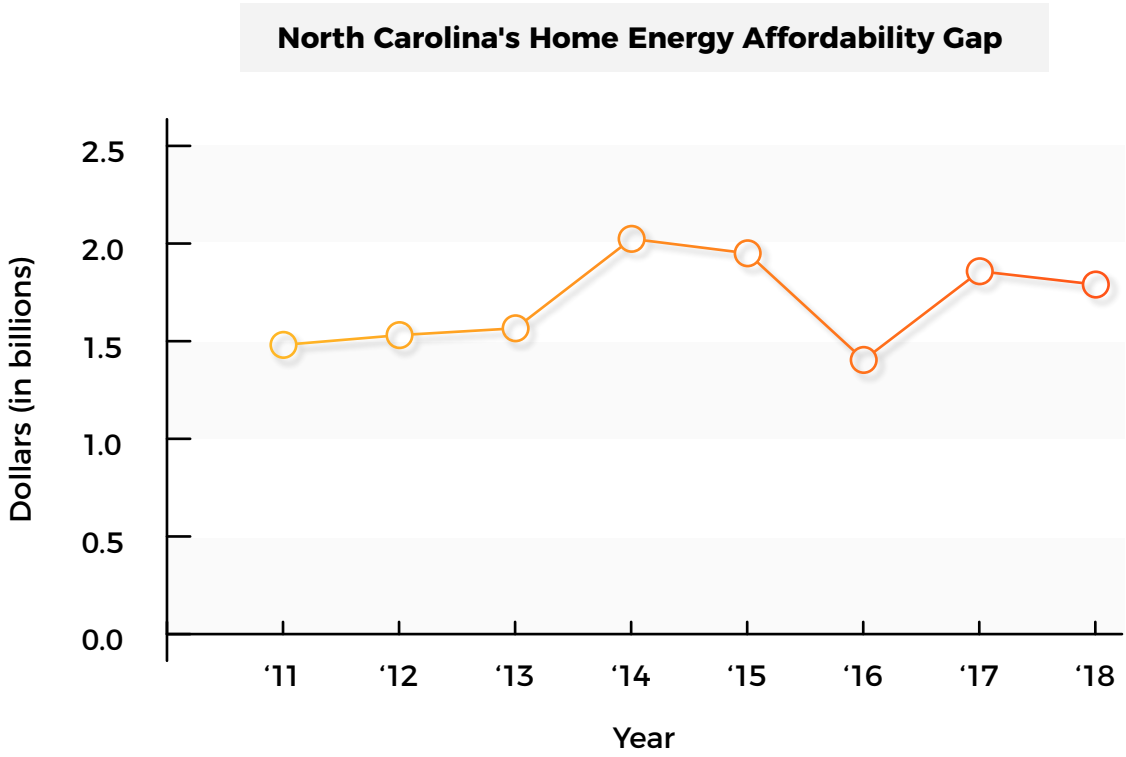
We measure progress towards energy affordability with a single indicator; it shows an ambiguous trend this year.

Solutions: Among other steps, J2, expanding renewable energy generation paired with storage can bring down rates; J3, increasing energy efficiency can reduce rates; and J7, avoiding investment in new natural gas pipelines can avoid hanging liability for paying off boondoggles on low-income ratepayers. In addition, E1, consistent consideration of environmental justice should help.

344 Gridwise Alliance, webpage: Grid Modernization Index, retrieved March 20, 2019.
345 Gridwise Alliance, Grid Modernization Index, July 2013.

Indicator 49.1: percentage of households that spend more than 6% of their budget on energy.

Trend: Mixed



The portion of income that a family spends on energy offers a pragmatic measure of energy affordability. For this indicator, we rely on the Home Energy Affordability Gap, a well-regarded analysis issued annually by the consulting firm of Fish, Sheehan, and Colton (FSC).[346] FSC uses a model to estimate the percentage of households with energy costs greater than 6% of the household budget in all counties in the United States. That threshold reflects the recommendation of the US Department of Housing that housing not exceed 30% of a household's income, combined with the empirical estimate that energy costs usually account for about 20% of total housing costs.[347]

On average, in 2017, a North Carolina family at or just below 200% of the federal poverty level spent 7% of their income on energy; roughly 30% of households fall at that level or below.[348] Households at federal poverty level or below spent 18% or more of their income on energy.[349] This reflects a number of variables including variations in the broader economy, weather and fuel cost, but, since FSC introduced this version of the indicator in 2012, consistently at least a third of North Carolinians have exceeded this threshold for household energy affordability, and the gap has increased relative to the baseline year of 2011. The FSC report also estimates the total amount by which all household energy bills in the state exceed 6% of household incomes, as per the chart above.[350] The amount varies year to year, ranging from $1.48 billion in 2011 to $1.79 billion in 2018. Overall, the FSC reports suggest energy has become less affordable for North Carolina households since 2011, but 2018 was better than several recent years. We count this as a mixed signal.

346 Fisher, Sheehan, and Colton, website: Home Energy Affordability Gap.
347 See, DEFG, Energy Affordability and Energy Service Choices. October 2014, at 2-3.
348 Fisher, Sheehan, and Colton, Home Energy Affordability Gap 2017: North Carolina factsheet. April 2018.
349 Ibid.
350 Fisher, Sheehan, and Colton, website: Home Energy Affordability Gap, 2017, 2018.

Goal 50: North Carolina's energy infrastructure is resilient and reliable.

Trend: Weak

Indicator 50.1: North Carolina compares favorably in reliability with other states.

Trend: Baseline, bad

The US Energy Information Administration tracks reliability on a utility-by-utility basis, calculating the number of minutes that an average customer lost power in a given year. In 2018, US News & World Report aggregated this information by state and published the resulting state rankings.[351] These list North Carolina as 40th out of 50 states for reliability. In 2017, Duke Energy Carolinas had System Average Interruption Duration Index with Major Event Days (SAIDI w/ MED) of 192 minutes; Duke Progress had a SAIDI of 143 minutes.[352] One striking finding of the US News analysis: utilities in the Southeast, as a class, offer much less reliability than their counterparts in other states.[353] Utilities in the region also, in contrast to most other parts of the country, continue to benefit from monopoly power in closed markets. It is possible that these two factors are connected; competition certainly creates an incentive for electric generators and distributors to invest in reliability, but without overbuilding or wasting resources.

Flows of Waste

William McDonough, in his 2002 book Cradle to Cradle, argues that modern American society suffers from a design problem.[354] Nature, he observes, constantly recycles detritus as the raw material for new landscapes and new living communities. Mountains erode to sand and are eventually compressed or melted into new rock; organic matter decays and its nutrients are absorbed by other organisms. Humans, however, waste: by indiscriminately mixing organic and inorganic components, we create 'monstrous hybrids' that can't be easily broken down into component parts. Instead, they are thrown away, creating disposal sites that must be tended indefinitely, and necessitating extraction of new supplies of resources - ores, minerals, aggregates - in natural areas that could otherwise have been left alone. He argues not for denial of human needs, but for better design to meet human needs without permanently reducing the world's supply of raw materials.

Nearly, two decades on, it is increasingly clear that smarter materials management would directly benefit our climate as well. A recent study finds that resource extraction accounts for over half of global greenhouse emissions.[355] That way of looking at climate emissions transcends state and national boundaries. For example, the North Carolina Greenhouse Gas Emissions Inventory counts natural gas burned in North Carolina to heat a home, but not the life-cycle emissions resulting from much of the clothing or furniture in the home, if those items were made overseas or in another state, even though they are consumed here. Zero waste and closed-loop materials management allows us to reduce global greenhouse emissions - emissions our consumption has caused - well beyond our state boundaries.

The five goals in this section reflect opportunities to reduce current waste, to avoid having to spend ever-expanding shares of the economy to manage legacy pollution, and to spare the rare and threatened natural areas that hold remaining stocks of raw materials.

351 US News & World Report, Energy Rankings: Measuring States' Energy Infrastructure, May 2018.

352 Energy Information Administration, Electric power sales, revenue, and energy efficiency Form EIA-861 detailed data files, October 2018.

353 US News & World Report ("The Southeast had the greatest power disturbance by far, with an average of more than two hours per customer").

354 William McDonough & Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things, 2002.

355 Jonathan Watts, Resource extraction responsible for half world's carbon emissions, The Guardian, March 12, 2019: International Resources Panel, Global Resources Outlook 2019, February 2019, at 8.

Goal 51: North Carolina minimizes production of solid waste.

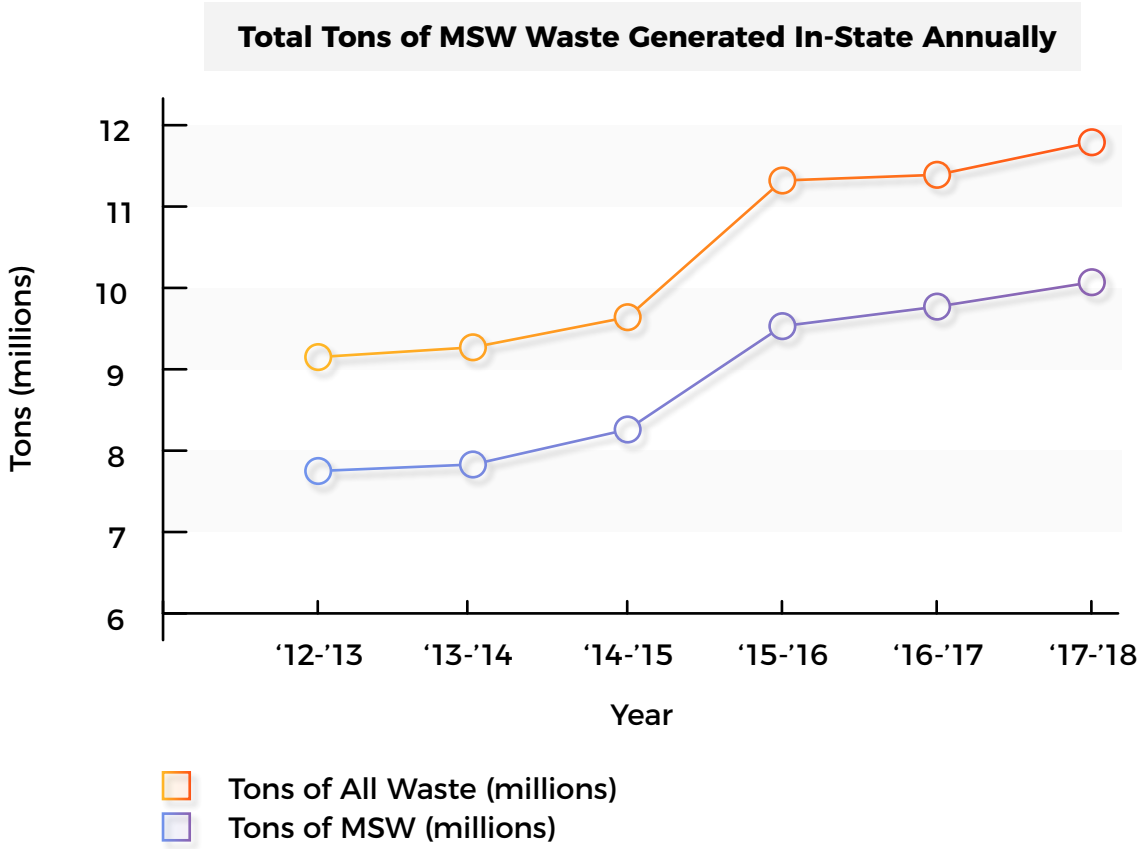
Trend: Weak

A first step to better materials management is to reduce how much we have to throw away. We measure progress towards this goal with two indicators: the total volume of municipal solid waste, and the number of local programs to divert organic waste into compost and out of the solid waste stream. Solid waste generation continues to trend upwards, and the very limited data on diversion of organic wastes suggests minimal change, so we evaluate the indicators as showing inadequate progress towards the goal of waste reduction this year.

Solutions: To reduce the volume of solid waste generated each year, North Carolina should G1, enact producer responsibility policies; G2, promote diversion of food waste to compost; and G3, reduce plastic pollution.

Indicator 51.1: total tons of municipal solid waste generated in North Carolina annually.

Trend: Rising, bad



North Carolina recognizes several different kinds of waste, with different rules governing the disposal of each: municipal solid waste, construction & demolition waste, land clearing & inert debris, hazardous materials, and coal combustion residuals, among others. For purposes of this indicator, we track municipal solid waste (MSW), which most directly reflects what ordinary North Carolinians are consuming and throwing away. It also avoids counting the ongoing excavation and reburial of Duke Energy's coal ash, which is counted as part of the state's estimate of total annual waste being managed but is not new waste. We rely on the data kept by NCDEQ Division of Waste Management and reported annually.[356]

356 NCDEQ, Division of Waste Management, Public and Private Municipal Solid Waste, FY12-13 through FY16-17, November 2018; NCDEQ, Division of Waste Management, Public and Private Municipal Solid Waste, FY 2017-2018, December 2018.

Generation of municipal solid waste continues to rise gradually, although the rise is smaller than population growth. In 2017, North Carolinians disposed of 1 ton of MSW per person per year, down from a peak of 1.36 tons per capita in 2005-2006, near the height of the economic boom before the Great Recession. State regulators estimate that in-state MSW landfills have a total remaining capacity of roughly 361 million tons, which should last about 44 years at current disposal rates – though different regions of the state have different practical capacities.[357] In coming years, greater diversion of food wastes and other compostable materials, and improved design of consumer goods by manufacturers to facilitate recycling, could stretch this capacity much further.

Indicator 51.2: number of local government compost diversion programs.

Trend: Baseline, bad

A largely untapped opportunity for waste reduction and costs savings is diversion of compostable wastes. Sent to MSW landfills, food and other organic wastes rot and release methane, a potent greenhouse gas. Sent to composting facilities, these wastes release carbon dioxide rather than methane and yield organic and inorganic nutrients that can be used to fertilize new crops. In 2017, North Carolina benefited from 47 composting and 16 mulching operations, diverting a total of 18,469 tons of food waste and 34,263 tons of yard waste.[358] Diverted foods wastes are still much smaller in weight and volume than yard waste (which includes winter storm and hurricane debris). The state's most thorough analysis of the potential for food waste diversion dates from 2016; the report found that in-state compost facilities had enough existing capacity to meet a US EPA goal of reducing North Carolina's landfill disposal of food waste by 50%.[359] The report also estimated that composting operations create 3.7 jobs per 10,000 tons of diverted materials. Yet, only two counties offered food scrap collection programs, and none offered curbside collection. We count recent trends in food diversion as showing inadequate progress.

357 Ibid.

358 NCDEQ, Division of Waste Management, Annual Report to the NC General Assembly, December 2017, at 67.

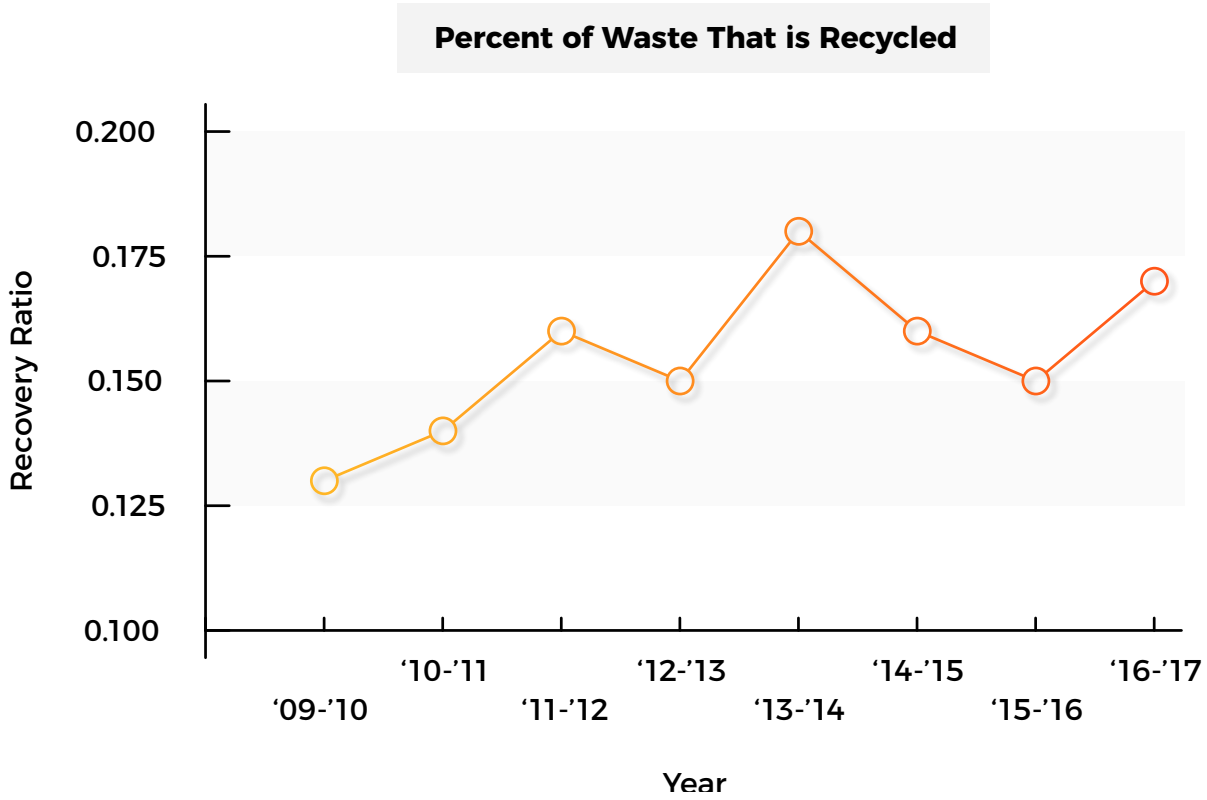
359 NCDEQ, Division of Environmental Assistance and Customer Service, NC Organics Recycling Study: Materials Managed 2011-2015 & Food Recovered 2015, June 2016.

Goal 52: North Carolina maximizes reuse and recycling of waste.

Trend: Neutral

Indicator 52.1: percentage of waste that is recycled.

Trend: No change



As noted above, every unit of material that is sent to a landfill is a loss in two senses. The waste itself requires indefinite management in a landfill to ensure that it does not leach and contaminate surrounding properties. Second, for us to maintain our habits of consumption, another unit of the same material must be extracted and processed somewhere in the world, with all the environmental impacts that implies. Well-designed recycling protects our quality of life while minimizing our footprint on both ends of the product life-cycle.

The important measure here is not the absolute amount of recycling, but the way we are managing materials – using them once, or repeatedly. Thus, our indicator is the 'recovery ratio', the tonnage or recycling divided by the tonnage of solid waste.[360] A recovery ratio of 1:1 would imply that for every unit of material we throw away, we are reusing another; we are far below this. There is good news: North Carolina's tonnage of wastes recycled annually continues to increase, even as manufacturers have made recyclable packaging lighter weight (by, for example, replacing hard plastic containers or cans with plastic pouches). On the other hand, the recovery ratio has been essentially stalled for several years in the range of 0.15 to 0.17, so we count this indicator as showing neutral progress this year.

Although it is not reflected yet in our data, China's decision in early 2018 to stop accepting most plastic and paper from overseas has dramatically disrupted global and domestic recycling patterns.[361] We expect to see a very negative impact begin to show up in the data next year.

360 NCDEQ, Division of Waste Management, Annual Report to the NC General Assembly, December 2017, Tables 4 & 5, at 75.

361 Cheryl Katz, Piling Up: How China's Ban on Importing Waste Has Stalled Global Recycling, Yale Environment 360, March 7, 2019.

Goal 53: North Carolina minimizes hazardous waste generation and remediates past contamination.

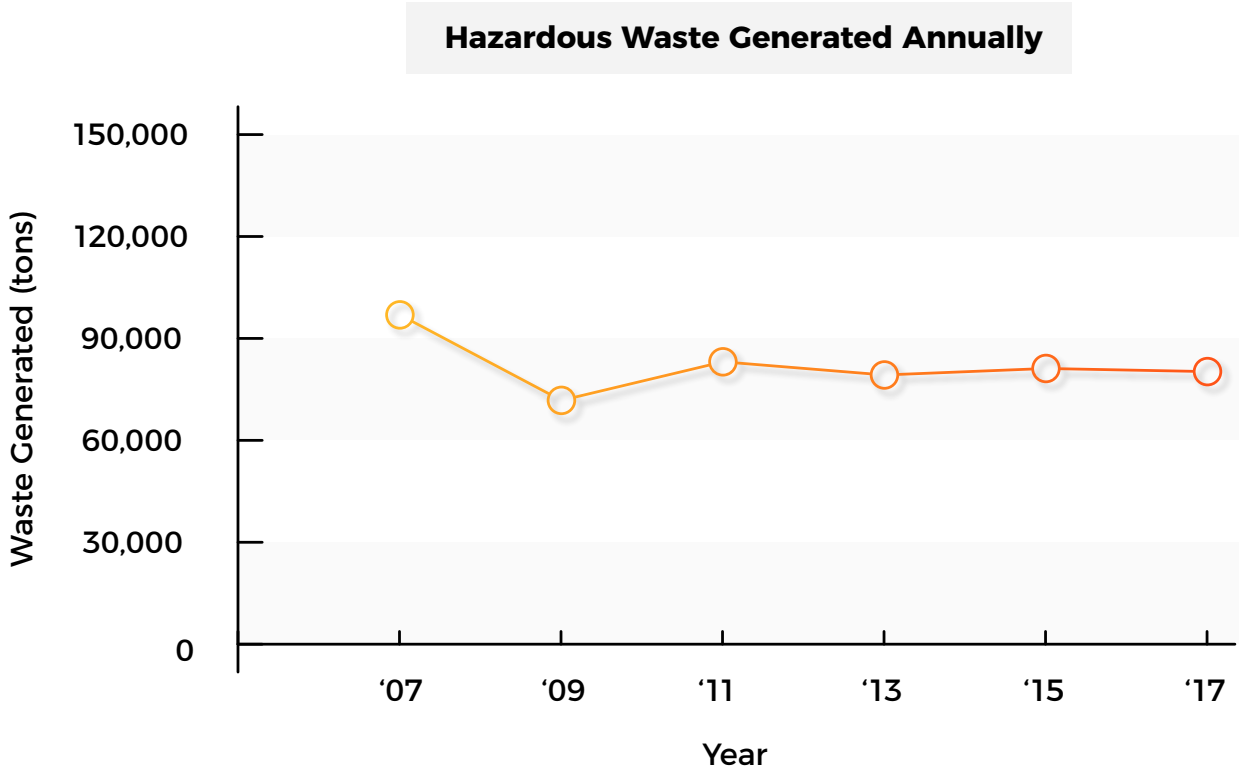
Trend: Weak

In addition to municipal waste and construction & demolition waste, North Carolina's economy generates hazardous waste that has to be managed with special care and at greater expense. Inevitably some spills, contaminating soil and water. For that reason, indicators for this goal track both how much hazardous waste the state is producing, and whether we are cleaning up past contamination as quickly as we are discovering new contaminated sites. Given that hazardous waste generation is relatively flat, and the list of unremediated sites continues to lengthen, we rate North Carolina as making less than adequate progress towards this goal this year.

Solutions: Avoiding creation of hazardous waste in the first place is the ultimate form of pollution prevention, and can be advanced through consumer pressure for clean supply chains and, F8, strategic state and private investments in green chemistry.

Indicator 53.1: hazardous waste generated annually.

Trend: No change



Some generation of hazardous waste is an inevitable part of economic activity in a modern, technologically advanced society. However, even when hazardous wastes are conscientiously managed, accidents happen, and management of hazardous wastes will impose recurring costs on future generations of

North Carolinians. So, a reduction in the volume of hazardous waste generated annually is desirable.

This indicator tracks the pounds of hazardous waste generated by businesses in North Carolina. The federal Resource Conservation and Recovery Act (RCRA) requires major generators to report their volumes of hazardous waste to EPA every other (odd) year, and the data is published late in the following (even) year, with a one year lag, so the most recent data is from 2017. Hazardous waste generation in North Carolina shows no strong trend since 2009. Not all waste is equally problematic; this indicator does not distinguish between wastes that are extremely toxic in low quantities and more generally hazardous materials, but it does given a sense of the direction of our waste generation.

Indicator 53.2: difference between numbers of known vs. remediated contaminated sites.

Trend: Rising, bad

North Carolina's Inactive Hazardous Wastes Sites Program, housed in NC DEQ's Division of Waste Management, identifies and cleans up contaminated sites.[362] Every year new sites are added to the inactive sites list, while at others, remediation activities conclude and the sites are assigned a 'no further action' (NFA) status. Legislative changes in 2013 introduced risk-based remediation to the program; now, on a site by site basis, levels of contamination can be left in the ground that are not expected to pose greater than 1 in a million risk of cancer from any one chemical, or 1 in 10,000 for any combination of chemicals.[363] NFA determinations have clauses that allow cleanups to be reopened if additional contaminants are later discovered on the site, or if additional remediation is found to be necessary to prevent a significant risk to human health or the environment.[364]

The indicator we track is the relative flow of sites into and out of the program: are we gaining or losing ground? As a result of enduring funding deficits, the state is gradually falling behind on cleanups. By 2017, the program cataloged 3,141 sites, with cleanup completed at 597 and 2,544 still 'open'. For fiscal year 2016-2017, the program added 50 newly-identified sites to its inventory and issued NFA determinations to 32.[365]

Goal 54: Risks from waste cycle distributed equitably.

Trend: No trend

We track the goal of equitable distribution of risks from the waste cycle with a single indicator; this year, it provides a baseline value but no trend.

Indicator 54.1: percentage of waste facilities in cumulatively burdened census tracts.

Trend: Baseline

The concept of environmental injustice was first articulated in North Carolina is the context of a waste management issue: the disposal of PCB-contaminated soil from the Triangle in a majority black community in Warren County. Research since then has confirmed the tendency of state and local authorities across the country to locate waste facilities in lower-wealth communities and especially in communities of color. Local impacts include not just air emissions and eventual leaks into groundwater from facilities, but also increased truck traffic, damage to local road infrastructure, and a deterrent effect on recruitment of other potential new employers.

362 NCGS 130A-310 et seq.; for more details on the program, see NCDEQ, Division of Waste Management, website: Inactive Hazardous Sites Guidance Documents, retrieved February 18, 2019.

363 NCGS 130A-310.66 - 310.77.

364 NCGS 130A-310.73(c).

365 NCDEQ, Division of Waste Management, Annual Report to the NC General Assembly (December 2017), at 31-32.

In North Carolina, as part of an overhaul of solid waste statutes in 2007, the NC General Assembly added explicit authority for state regulators to deny permits to proposed new landfill facilities on the basis of disproportionate adverse cumulative impacts.[366] A new legislative majority amended that provision in 2013, effectively limiting denials to the extraordinarily unlikely situation that project proponents explicitly express racially discriminatory intent during the application process.[367] That ignores the actual effects, intended or not, of concentrating waste facilities and other locally damaging uses in specific communities.

This indicator tracks the distribution of waste facilities in North Carolina against an index, compiled by the US EPA, that tracks the proximity of census tracts to sites licensed for the transportation, storage, and disposal of hazardous waste (different from municipal solid waste landfills).[368] To evaluate disparate impacts, we calculated the correlation between proximity to 'TSD' facilities and EPA's demographic index, which ranks census blocks based on their percentage of minority and low-income residents. Our analysis found a weak correlation of 0.19; we treat this as a baseline. Greater correlation in future years would be a trend of concern.

Goal 55: North Carolinians experience minimal unnecessary exposures to toxics

Trend: Weak

When most North Carolinians think of toxic exposures, we likely imagine contact with pollutants. But in fact, substantial exposures to toxic chemicals come from products we buy and use, including personal care products, clothes, and household items. These contain a variety of chemicals, often have prolonged contact with our skin, and often shed or break down into dust that we ingest or breathe. In 2018, the NC Conservation Network published a primer explaining the multiple paths by which we are exposed to toxic chemicals, and the implications for our families' health and for public policy.[369] Every week peer-reviewed scientific papers document new details of how specific chemicals affect human health or the broader environment. The challenge is complex; simply moving away from chemicals with known problems is not a solution if they are replaced them with 'regrettable substitutes', chemicals that turn out to be just as bad or worse.[370]

Solutions: North Carolina should, F3, establish state authority to protect residents from toxic in consumer products; in addition, F8, emphasizing green chemistry as an economic development strategy would help longer term.

Indicator 55.1: number of chemicals introduced into commerce annually with no toxicity testing.

Trend: Baseline, bad

The core policy problem of toxic exposures is that products are routinely introduced into the stream of commerce – into our homes, schools, and workplaces – and then turn out later to be unsafe. For this indicator, we take estimated number of new chemicals introduced annually with no toxicity testing. Not all of these will turn out to be problematic, but this does offer a broad measure of uncontrolled risk, without presuming the most effective policy solution for managing that risk.

Regulators in California estimate that roughly 2,500 'high volume chemicals' are produced at volumes

366 SL2007-550 (S1492), Solid Waste Management Act of 2007, §1.a.

367 SL2013-413 (H74), Regulatory Reform Act of 2013, §59.a. This legislation amended the 2007 authority with a sentence saying it applies only to the extent required by Title VI of the federal Civil Rights Act of 1964, which requires proof of discriminatory intent to trigger action.

368 US EPA, website: Overview of Environmental Indicators in EJScreen, August 2018.

369 Jessica Brandt, North Carolina and Toxics: What You Need to Know. April 2018.

370 National Research Council, A Framework to Guide Selection of Chemical Alternatives. 2014; see also, Christopher Weis, The Value of Alternatives Assessment, Environmental Health Perspectives, March 1, 2016.https://doi.org/10.1289/ehp.1611248 (introducing an issue focused on the problems of regrettable substitutes and alternatives analysis).

greater than 1 million pounds per year, and that roughly 45% of them been adequately screened for impacts to people or the environment. The regulators estimate that about 2,000 new chemicals enter the stream of commerce each year in the US, or an average of 7 new chemicals a day.[371] North Carolina does not have any state statutes assigning authority for screening chemicals in consumer products for toxicity, and does not currently have such a capacity in any state agency. North Carolina's economy is thoroughly integrated into to the national economy, so for purposes of this indicator, we assume that any chemical introduced into the stream of commerce nationally could show up in a product here. For 2019, we take 2,000 new chemicals a year as the baseline for this indicator, and we evaluate this indicator as showing no progress towards sustainability this year.

371 California Dept. of Toxic Substances Control, Webpage: Emerging Chemicals of Concern (December 2017).

Appendix 1: Sustainability Solutions for North Carolina

Throughout the State of the Environment technical document, we have included cross-references to policy solutions, gathered in this appendix, that would help turn specific indicators and goals in a positive direction, bringing benefits to North Carolina's residents, economy, and environment. Most of these solutions are already the focus of policy advocacy campaigns conservation or environmental advocacy groups or coalitions in North Carolina. For each, we include below a short description of the policy proposal.

Conservation

A1 Land transfer tax. In 1996, developers, conservationists, and state and local authorities agreed to establish a tax of $1 for every $500 dollars of underlying value in land transfers. The revenue was split 75% to the Parks & Recreation Trust Fund and 25% to the Natural Heritage Trust Fund. In 2013, the state legislature broke the deal and redirected these funds to the state General Fund, replacing the dedicated income stream with smaller annual appropriations and folding the NHTF into the Clean Water Management Trust Fund. It is time to keep faith with the original agreement and restore dedicated funding for land conservation from the land transfer tax.

A2 Fund the Clean Water Management Trust Fund. The CWMTF was established in 1996 to fund voluntary projects that protect or improve water quality, including land conservation; to protect land for natural, historical, and cultural benefits; to limit encroachment on military bases; and to improve stormwater treatment technology. It is North Carolina's largest non-regulatory program to protect water quality, but has been chronically underfunded as measured against demand. Recurring for the core functions of the CWMTF should be increased to $28 million annually.

A3. Fund the Parks & Recreation Trust Fund. The PRTF was established in 1994 and provides grants to expand, maintain, and enhance state and local parks across North Carolina. As our population grows, PRTF funding is essential to provide residents with safe, healthy places to gather with friends and family, recreate, and enjoy the state's incredible natural heritage. However, in recent year PRTF funding has fallen far short of state and local needs. Recurring funding for PRTF should be increased to $28 million annually.

A4. Fund the Agricultural Development & Farmland Preservation Trust Fund (ADFPTF). As the state's population continues to grow rapidly, North Carolina's agricultural and forest lands are under pressure from developed land uses. The ADFPTF helps provide a buffer against losing or most productive agricultural lands through grants to preserve or restore farmland. Recurring funding for the ADFPTF should be maintained and increased as demand for the program grows.

A5. Invest in floodplain restoration and reconnection. Two 500+ year floods in the last three years

signal that catastrophic flooding may not be unusual in the Coastal Plain. The best defense against staggering economic and social losses from floods is to let floodplains serve their natural functions of collecting and holding water. Funding floodplain restoration and reconnection, distinct from other land conservation programs and goals, offers a way to spare North Carolina much larger storm-driven losses in the future.

A6. Establish incentives for reforestation. North Carolina has million acres of forestlands, the great majority in private, non-commercial ownership. Felling timber releases carbon into the atmosphere; felling it for low-value products fails to bring significant dollars into rural communities. Beyond our industrial timber lands, North Carolina needs an incentives-based plan for private landowners to reforest, managing the forest as a basis for high-value products that feed local supply chains and return substantial revenue to rural communities.

Coastal

B1. Expand oyster mariculture. Oysters are a coastal resource on the rebound, wth the potential to become a source of significant revenue and jobs flowing into coastal counties. Continued state support - in the form of leasing policies but also strong efforts to improve coastal water quality - are needed for this industry to reach its potential in North Carolina.

B2. Promote living shorelines over bulkheads. As sea level rises, living shorelines offer a way for coastal landowners to respond that buffers property against storms without increasing erosion of neighboring properties or wiping out vital underwater habitat. State and federal permitting and infrastructure investment should consistently favor living shorelines over bulkheads.

B3. Improve maintenance of coastal stormwater measures. Developments along North Carolina's coast have been installing stormwater control measures since the early 1990s, but it is likely that the great majority of these have not been properly maintained - and are therefore not keeping bacteria and other pollutants out of coastal waters. North Carolina must educate and provide technical assistance to local landowner associations who are obligated to keep these measures in good repair.

B4. Expand funding for CCAP. The Community Conservation Assistance Program, housed in the NC Department of Agriculture, is a voluntary, incentive-based program that improves water quality through the installation of cost-shared stormwater control measures on urban, suburban and rural lands not in immediate agricultural use. Funding for CCAP is a direct investment in the water quality needed to support oyster mariculture, safe swimming, healthy estuary, and coastal quality of life.

B5. Implement the CHPP. The Coastal Habitat Protection Plan is a science-based blueprint for restoring and protecting the six vital aquatic habitats that underpin North Carolina's vibrant coastal economy. North Carolina's leaders should invest in the data collection, analysis and management strategies outlined in the CHPP 2018-2020 implementation plan.

Water

C1. Establish water withdrawal permitting. North Carolina, although traditionally blessed with abundant water resources, is one of just two states in the nation that lack a clear statewide requirement for permitting of surface water withdrawals. Enacting a statutory system that provides clear protections for instream uses would give certain to all stakeholders and – as specific watersheds bump up against the limits of supply – help avoid the kinds of water wars that have undercut other states' economies and development.

C2. Update surface water quality standards. The primary mechanism for protecting North Carolina's surface waters – drinking water sources for over half the state – is implementation of state surface water quality standards. Under the federal Clean Water Act, these are supposed to be reviewed and updated every three years. It is past time of a comprehensive upgrade for North Carolina to reflect new science on bacteria, ammonia, and emerging toxics.

C3. Update groundwater quality standards. Unlike surface water quality standards, which are required by

the Clean Water Act, groundwater standards are a product of state law, reflecting the state legislature's insight that groundwater contamination permanently undermines economic growth and community health. But, North Carolina's groundwater standards are years overdue for a upgrade, and the staff responsible for the process has been chronically underfunded.

C4. Pilot an alternative cleanup strategy for nutrient-impaired lakes. For the last decade, much-needed plans to cut polluted runoff into Jordan and Falls Lakes have been slowed or stalled by local government fears over their uncertain financial liabilities. It is time to pilot an alternative approach to clean-up that establishes annual financial contributions and lets the local governments in each watershed collectively direct spending to projects that broadly improve water quality.

C5. Promote and ultimately require green stormwater infrastructure (GSI). Since the mid-1990s, state and local stormwater rules have required detention and release of stormwater - better than no control, but still bad for bank stability, stream health, and flooding downstream. On-site retention of stormwater using green stormwater infrastructure offers a way to minimize post-development increases in runoff, and must become the norm for new and retrofitted development.

C6. Improve land application of municipal waste sludge. As municipal wastewater systems have become increasingly effective at removing pollutants before discharge, the removed material – biosolids, or sewage sludge – has become increasingly nasty. Biosolids are typically land-applied to farm fields, where it can contaminate groundwater and runoff into surface waters. State land-application statutes and rules need an upgrade to better address this threat.

C7. Require swine farms to transition away from using lagoons and sprayfields to manage waste. North Carolina's roughly 2,200 industrial swine farms virtually all manage waste by storing it in a hole in the ground and then pumping liquids onto nearby sprayfields. In North Carolina's wet climate, this inevitably means untreated wastes are flowing into wetlands and rivers and down to our estuaries. It is past time to mandate a move to environmentally superior technologies, possibly with state investment.

C8. Permit dry-litter poultry operations. Unlike swine farms, which have an extensive regulatory program, poultry farms do not have siting restrictions or permit requirements, although they have surpassed swine operations as the largest sources of nutrients from animal waste in the state. The industry has exploded over the last fifteen years, with many dry-litter waste operations located in floodplains, and massive overapplication of phosphorus containing wastes. State legislators should close both of these loopholes and establish sensible regulatory oversight for poultry farms.

Air quality

D1. Improve monitoring of air pollution. The North Carolina Department of Environmental Quality monitors air quality to ensure that the state's air complies with federal 'ambient air quality' standards. However, there are a limited number of monitors, and they are not well-placed to record pollution from certain sources or in certain counties. The agency needs funding and direction to expand the air monitoring network to better protect state residents.

D2. Update state list of toxic air pollutants. North Carolina was one of the first states to establish a program to regulate toxic air pollutants released from various industrial sources, before the US Congress added control of hazardous air pollutants to the federal Clean Air Act in 1990. Unfortunately, neither the state nor the federal list of chemicals has been updated since, even though North Carolina's economy has evolved significantly. North Carolina industries today use a number of toxics that are unregulated by state or federal law. The state list should be updated to protect North Carolinians from dangerous exposures.

D3. Set emissions standard for methyl bromide. One chemical that is regulated – albeit inadequately – is methyl bromide. This intensely toxic gas is used in North Carolina to fumigate logs for export; the gas also breaks down the stratospheric ozone layer that shields Earth from UV rays. State regulators need to adopt an updated standard that minimizes or bans the release of methyl bromide into the state's air.

D4. Address transportation-related air pollution. Peer-reviewed science shows that concentrations of

pollutants are significantly higher close to major roads, placing serious health burdens on communities even when overall air quality seems good. State regulators should apply existing authority – and the state legislature may need to enact new authority – to protect children and adults from the highly local impacts of transportation-related air pollution.

Environmental justice policy

E1. Prioritize environmental justice. To ensure environmental equity, North Carolina should build consideration of cumulative impacts, and evaluation of disparate and disproportionate risks, into the basic procedures agencies follow when drafting rules, developing policy, and issuing permits. It makes sense for NC DEQ and NC DNCR to tackle this first, but consideration of environmental justice should ultimately be built into agencies processes across state government.

Toxics

F1. Track the toxic exposures of infants and children. Month by month, scientists uncover new insights into the ways toxic chemical interfere with fetal and child development. But the data to understand the risks to North Carolina's children is weak because there is no program specifically tracking North Carolina infant and children's toxic exposures. State funding in collecting such data would be a wise investment in the health of all our residents.

F2. Fund lead testing and remediation. After decades of research, scientists have concluded that there is no safe level of lead exposure for infants and children; high levels of lead in the blood diminishes a child's intelligence, impulse control, school performance, and life outcomes. Funding is needed to ensure that at risk children as screened for high blood lead levels, and that sources of exposure can be closed off when identified.

F3. Establish state authority to protect against toxics in consumer products. North Carolina has laws to address toxic exposures to pollution, but not to toxics in consumer products, which comprise a major pathway of exposure for pregnant women, infants, and developing children. Protecting residents from toxics in consumer products will require state legislation.

F4. Fund monitoring of emerging contaminants. Spurred by the discovery of GenX and related compounds in the Cape Fear River, scientists and concerned citizens have identified a range of emerging toxic contaminants in other watersheds as well. The state Department of Environmental Quality needs equipment and funding to monitor watersheds for emerging contaminants.

F5. Limit the discharge of PFAS and other emerging contaminants. GenX is one of over 3000 chemicals in commerce in the larger class of perfluorinated substances (PFAS). Little health data exists for most, but they are expected to be toxic in many of the same ways as GenX and other relatives for which we do have data – PFOA, PFOS. State regulators need to use existing authority to curb discharges of PFAS and other emerging contaminants.

F6. Ban aqueous fire-fighting foams and dispose of existing stocks safely. Other toxic PFAS are found in a group of fire-fighting foams called 'aqueous fire-fighting foams' (AFFF); these are responsible for groundwater contamination at airports and military bases across the country, including locations in North Carolina. Our state legislature should follow the example of the State of Washington and ban use of AFFFs, providing for safe disposal of existing stocks, and requiring the use of safe alternatives.

F7. Ban the use of neonicotinoid pesticides. Neonicotinoid pesticides rely on chemicals related to nicotine; the class was introduced in the 1980s and has proven exceptionally toxic to a wide swath of insects, including vital pollinators. The European Union has banned distribution and use of 'neo-nicotinoids'; North Carolina should follow suit.

F8. Promote green chemistry as an economic development strategy. Synthetic chemical play a vital role in our economy, but the ubiquity of toxic compounds in the stream of commerce threatens public health. By recruiting and rewarding the green chemistry sector in North Carolina, state leaders can

have the best of both worlds – a growing, hi-tech economy and healthy public and environment.

Waste

G1. Enact producer responsibility policies. Too many products – packaging and contents – are designed to be used and discarded, permanently losing the resources that went into making them. The fastest way to improve product and packaging design is to close the loop by making the company that makes or packages a product responsible for disposing of the product or packaging after it is used. The European Union has led the way in promoting producer responsibility for a variety of products; North Carolina can follow suit for a much more efficient economy.

G2. Create state incentives for food waste diversion to compost. Food waste takes up space in landfills, where it generates methane that can contribute to climate change. Diversion of food waste to composting frees up landfill space, reduces greenhouse gas emissions, and recovers food nutrients as valuable fertilizers rather than locking them up forever in lined landfills.

G3. Reduce plastic pollution. North Carolinians use a lot of plastic. Much of it ends up in landfills, but a lot blows up, drops onto the ground, or otherwise ends up in the natural environment, where it breaks into smaller and smaller pieces. Some plastics contain toxic plasticizers; others simply act as vehicles for man-made toxics to ride on - and scientists are now finding bits of plastic showing up in organisms throughout the food chain. North Carolina needs policies to promote biodegradable alternatives to plastics, to reduce single-use plastics, and to boost plastics recycling.

Sustainable food system

H1. Establish a Healthy Food Financing Initiative. Many North Carolinians lack practical options to consume healthy food on a daily basis. To address this, we should experiment with a model that's been successful in other states: a Healthy Food Financing Fund that helps launch local initiatives.

H2. Clear the way for 'farm to school' initiatives. Sustainable and local farmers can benefit from local markets, and school districts need healthy food for their students. Changes in state law and school district contracting practice can clear the way for matches that deliver healthier students and a more robust food system.

Climate change

I. Overarching Climate Goal. Halve carbon emissions from 2017 levels by 2030 and achieve carbon neutrality by 2050, as the Fall 2018 IPCC Special Report estimates is necessary to keep global mean temperature below a rise of 1.5 degrees Celsius.

Energy

J1. Pursue sustainable grid modernization. Any major grid modernization plan should be explicitly designed to deliver a 40% emissions reduction goal by 2025 (from a 2005 baseline) for the electric-generating sector, as articulated in Governor Cooper's Executive Order 80. Any grid modernization plan should include an independent audit and prioritize competitive solicitation of new generation over investor-owned utility (IOU) facilities. The NC Utilities Commission should formally separate grid modernization, on an ongoing basis, from the rate case and IRP processes. Duke Energy should be required to complete independent audits and assess stakeholder approval of 'gridmod' proposals before it take them to the Utilities Commission.

J2. Expand renewable energy generation and storage. North Carolina needs to increase the share of electric power generation that comes from renewables plus storage, and retire coal. Energy market competition will save ratepayers money. North Carolina should develop a NC Green New Deal legislative agenda to accelerate deployment of renewables after 2020.

J3. Expand energy efficiency savings. Following the majority of U.S. states, the state legislature should

establish a stand-alone energy efficiency resource standard (EERS) of at least three years duration that sets a hard annual target for energy efficiency to displace retail electric consumption.

J4. Ensure if biogas moves forward, that it benefits communities. Proponents of generating electricity from biogas claim it can help reduce greenhouse gas emissions from animal agriculture and provide relief to neighboring communities. But as far as the relief goes, that is only true if it is combined with technologies that eliminate land application of nutrients and limit the spread of antibiotic resistant bacteria. If biogas moves forward in North Carolina, it must bring surrounding communities along, not leave them further behind.

J5. Curb wood pellet facilities. Efforts to move away from fossil fuels have created a market for wood pellets – but cutting North Carolina's timber for wood pellets returns minimal value to the state's economy, damages habitat, imposes burdens on nearby communities, and still releases lots of carbon into the atmosphere. North Carolina should not approve new or expanded wood pellet facilities.

J6. Invest in statewide ZEV charging infrastructure. The future of passenger cars is zero emission cars – electric vehicles that can charge from renewable power on the grid. To move rapidly into that future, however, North Carolina needs in invest in charging infrastructure along highways and in large and small towns.

J7. Minimize new natural gas pipelines. Shifting electric generation form coal to natural gas has reduced greenhouse gas emissions, but to meet North Carolina's share of greenhouse gas emissions reductions, we need to transition from natural gas to renewable sources sooner than later. New large-scale natural gas pipelines are a burden to landowners, communities, streams, and ratepayers; as sunk costs, they are also an obstacle to the transition to a carbon-neutral economy. North Carolina needs to avoid permitting or requiring ratepayers to subsidize major new natural gas pipelines.

Transportation

K1. Increase share spent on non-highway modes of transportation. North Carolina spends just 6% of the state's budget for new projects on anything but roads – railroads, airports, ports, transit, bike paths, sidewalks. That share – set by NCDOT policy, not state law – needs to be steadily increased to meet the growing demand for energy-efficient, climate-efficient alternatives to roads.

K2. Prioritize highway spending to maintenance and improvements to existing infrastructure. Since the Great Depression, state government has owned and maintained most of North Carolina's roads. While some new capacity is needed, metropolitan planning organizations and the state Department of Transportation should view proposals for major new highways – and especially unfinished legacy projects – with skepticism, recognizing that existing roads already represent a significant maintenance load.

K3. Integrate climate adaptation and SLR projections into state transportation investments. In the face of projections for climate-driven sea level rise and extreme weather, some transportation projects on the state's master list, the Strategic Transportation Improvement Program (STIP), no longer make sense and should be revisited or cut. For example, the state Department of Transportation needs to rethink the future of the much-beloved NC highway 12 along the Outer Banks.

K4. Integrate climate mitigation and avoidance of induced sprawl into STI investments. For years, the NC Department of Transportation has downplayed the ways that major new suburban roads and loops drive sprawl. For North Carolina to meet greenhouse gas emission targets – and to avoid fragmenting rural and natural landscapes – state and regional planners must incorporate climate mitigation and accurate analyses of induced sprawl into planning and road design.

K5. Support robust implementation of Complete Streets. In 2009, the NC Board of Transportation adopted a 'Complete Streets' policy for the state, saying that non-highway roads should be designed by default to include other modes – transit, bike, pedestrian, and (now) personal mobility. NCDOT is currently revising the policy; a strong rollout it is one of the fastest, most effective ways NCDOT can curb future greenhouse gas emissions while protecting quality of life.

Growth & land use

L1. Promote transit-accessible development. Affordable housing works best when it is located near transit routes. Transit delivers the greatest reductions in emissions and improvements in local economies when residential and commercial development is nearby, and provides a competitive alternative to sprawl. The state legislature should study and then adopt policies to promote transit-accessible development in North Carolina's metro regions.

L2. Encourage counties to adopt farmland protection plans. Agricultural economic pressures and suburban sprawl continue to chew up some of North Carolina's best agricultural soils. Counties can take the lead in protecting the state's best farmland through regularly updated farmland protection plans.

L3. Authorize local governments to adopt 'assured supply'/ water-neutral growth ordinances. In North Carolina as in other states, rapid development has often dragged communities into expensive, catch-up infrastructure projects. The state legislature should give local governments the authority to avoid water allocation train wrecks by tying new development approvals to the availability of water to support new residents and businesses, or to adopt ordinances that ensure development is water-neutral.

L4. Support scalable affordable housing solutions. Across the state, rapidly growing urban areas are wrestling with the disappearance of housing that essential working people – including teachers, police, municipal employees, and service workers – can afford. Loss of affordable housing skews communities and hollows out the promise of representative government. The state legislature should provide funding to test and scale affordable housing solutions in the state's fastest-growing cities.

Resilient local communities

M1. Provide transition path for fiscally non-viable water systems. The UNC Environmental Finance Center recently found that 21% of water utilities do not raise enough revenue to cover their costs of operation and debt service. The state legislature, Treasury, and Department of Environmental Quality must to develop a path for fiscally non-viable systems to transition to a viable future.

M2. Provide a transition path for fiscally nonviable municipalities. Similarly, a fraction of North Carolina's 532 municipalities do not have enough revenue capacity to function as viable towns – and therefore cannot protect residents against threats to public health or the environment. Again, the state legislature needs to provide for these jurisdictions to transition to a viable status.

M3. Fund buyout of repetitive-loss properties. National analyses have identified thousands of 'severe repetitive loss properties' - structures that have flooded at least five times since 1978 and been built back, usually with federal and state subsidies.[372] North Carolina should invest in acquiring these properties and taking them out of developed uses, to minimize damage (and costs to the state) from future floods.

M4. Direct local governments to apply flood maps to guide future development. North Carolina has invested in one of the nation's best floodplain mapping and modelling systems. It is time to use the forward-looking capability of the system to drive local land use decisions and prevent future flood losses.

M5. Direct counties to adopt proactive wildfire management plans. Among the 50 states, North Carolina has the fourth highest number of inhabited structures in the 'urban-wildlands interface', the part of the landscape most vulnerable to wildlife. Communities can take a number of steps to become more resilient to wildfire; a starting measure is for all counties to adopt and regularly update proactive wildfire management plans.

M6. Establish a 'Mountain Resilience Commission'. North Carolina's gorgeous mountains face a number of distinct impacts and threats from climate change as well as other environmental and economic trends. The state legislature should charter a Mountain Resilience Commission to inventory these distinct threats and recommend additional public and private steps to manage them.

372 See, Natural Resources Defense Council, Seeking Higher Ground, 2017; Pew Charitable Trusts, infographic: Repeatedly Flooded Properties Cost Billions, October 2016.

Healthy political processes

N1. Enact automatic voter registration. Voting is the both a core right for adults in our democracy and the fundamental mechanism of accountability for our elected leaders. States that register residents by default, allowing them to opt-out by choice, having demonstrably higher rates of participation in elections that states that require residents to take the extra step of registering. North Carolina should adopt out-out voter registration.

N2. Enact a nonpartisan redistricting process. When districts are gerrymandered, legislators are less

accountable to their constituents, and increasing numbers of elected officials become ideologically polarized. North Carolina needs a redistricting process that eliminates gerrymandering and gives voters of all political stripes a basis for faith that our state legislature reflects the actual choice of the state's electorate.

Appendix 2

This appendix includes all the categories, subcategories, goals, and indicators, along with the status assigned to each. This year, many of the indicators offer baseline values, shown in gray; we hope the chart will look more colorful next year, as at least two years of data will allow us to make more judgments about trends.

CLIMATE	
Goal 1. Rate of change from historic norms slows or stabilizes.	WEAK
1.1. atmospheric CO_2 concentrations,	RISING
1.2. global average temperature	RISING
1.3. rate of sea level rise.	RISING
LAND & HABITAT	
Goal 2. Landscapes support our economy and quality of life.	MIXED
2.1: loss of open space	DATED
2.2. forest biomass	RISING
2.3. urban tree canopy	BASELINE
2.4. access to parks	BASELINE
2.5. extent of wetlands	FALLING
Goal 3. Landscapes provide healthy habitat.	GOOD
3.1. extent of non-managed forests.	GOOD
3.2. impervious surface	BASELINE
3.3. percentage of HUC-12 watersheds with less than 5% or 10% impervious surface	BASELINE
3.4. acreage of protected biodiversity hotspots	GOOD
Goal 4. NC retains a full complement of species and biodiversity.	WEAK
4.1. avian diversity and abundance	MIXED
4.2. freshwater fish populations	FALLING
gap: terrestrial insect populations	GAP

COASTS	
Goal 5. NC's coasts and estuaries are healthy and resilient.	**MIXED**
5.1. net change in closed shellfish waters.	**FALLING**
5.2. ratio of living shorelines to bulkheads.	**GOOD**
5.3. extent of submerged aquatic vegetation.	**BASELINE**
5.4 estuarine/marine fish populations.	**UNCLEAR**
WATER	
Goal 6. Drinking water is safe.	**MIXED**
6.1. Safe Drinking Water Act violations,	**GOOD**
6.2. unregulated chemicals in tap water	**BASELINE**
Goal 7. Water quality and flows support healthy rivers and estuaries.	**NO CHANGE**
7.1. surface water quality.	**BASELINE**
7.2. benthic health	**NO CHANGE**
gap: surface water flows	**GAP**
Goal 8. Groundwater levels are sustainable.	**GOOD**
8.1. Coastal Plan groundwater levels	**NO CHANGE**
8.2. statewide groundwater levels	**UNCLEAR**
Goal 9. Water systems and sustainable and resilient.	**NO TREND**
9.1. fiscally unsustainable water systems	**BASELINE**
9.2. resilient water infrastructure	**UNCLEAR**
Goal 10. North Carolinians have access to affordable water.	**NO TREND**
10.1. affordability for residents based on household income	**BASELINE**
AGRICULTURE	
Goal 11. Agriculture is economically healthy	**MIXED**
11.1. farm income	**NO TREND**
11.2. land in agriculture.	**FALLING**
11.3. preserved farmland	**RISING**
Goal 12. Agriculture is environmentally sustainable	**GOOD**
12.1. topsoil erosion	**FALLING**
12.2. conservation practices	**RISING**
12.3 organic sales	**RISING**
Goal 13. Animal agriculture is a good neighbor	**MIXED**

13.1. ag sector GHG emissions	NO CHANGE
13.2. volume of swine waste sprayed	BASELINE
gap: rates of phosphorus overapplication	GAP
13.3. antibiotic volumes	FALLING
AIR	
Goal 14. Outdoor air quality is good	MIXED
14.1. unhealthful air days	BASELINE
14.2. releases of persistent air toxics	RISING
14.3 number of startup, shutdown, and malfunction events (SSMs)	NO TREND
Goal 15. Indoor air quality doesn't threaten sensitive populations.	GAP
gap: exposure to bad indoor air	GAP
Goal 16. Air pollution is not concentrated in overburdened communities.	NO TREND
16.1. 2011 NATA respiratory hazard index	BASELINE
16.2 proximity to traffic	BASELINE
Goal 17. Total greenhouse gas emissions are reduced.	MIXED
17.1 total NC greenhouse gas emissions	FALLING
HEALTH	
Goal 18. North Carolinians have long lives and good health.	MIXED
18.1. diabetes	FALLING
18.2. obesity	RISING
18.3. rates of emergency room visits diagnosed as asthma	NO TREND
18.4 cancer	FALLING
18.5 early death	RISING
18.6 suicide	RISING
18.7 vector-borne illness	RISING
Goal 19. All North Carolinians have access to good health care.	GOOD
19.1. percent of residents with health insurance	RISING
Goal 20. Children's development is protected.	POOR
20.1. low birthweight	RISING
20.2. children's health as reported by their parents	BASELINE
gap: children's exposures to toxics	GAP

Goal 21. All North Carolinians have access to sufficient and healthy food.	POOR
21.1 household food insecurity	RISING
21.2 healthy food access as reported by residents	BASELINE
EDUCATION	
Goal 22. All North Carolinians receive a quality education.	MIXED
22.1. preschool	NO CHANGE
22.2. 8th grade achievement levels in math and reading	NO CHANGE
22.3. high school graduation rates	BASELINE
22.4. levels of educational attainment for adults over 25.	RISING
Goal 23. North Carolinians understand and apply sustainability concepts.	NO TREND
23.1. environmental educators per capita	BASELINE
23.2. poll question: do you consider the environment when buying goods and services?	BASELINE
COMMUNITY	
Goal 24. Communities are safe.	GOOD
24.1 violent crime	MIXED
24.2. incarceration rate	FALLING
24.3. poll question: how safe do you feel in your neighborhood at night?	BASELINE
Goal 25. Social organizations have adequate capacity.	GOOD
25.1. adequately resourced nonprofits	BASELINE
25.2. rate of volunteerism	RISING
Goal 26. Arts and culture are thriving.	GOOD
26.1. arts establishments and employment	RISING
26.2. annual visits to natural & cultural heritage sites	RISING
Goal 27. All communities are treated with respect.	NO TREND
27.1. Indicators: residential segregation	BASELINE
27.2. disparate environmental burdens	BASELINE
27.3. gentrification pressures	NO METRIC
Goal 28. Individuals are socially connected.	GOOD
28.1. people are connected	NO TREND
28.2. poll question: how connected do you feel to a community beyond your family?	BASELINE

GOVERNANCE	
Goal 29. North Carolinians are empowered to participate in government.	GOOD
29.1. percentage of eligible voters who are registered	NO CHANGE
29.2. percentage of registered voters who vote	RISING
Goal 30. Elected representatives are accountable to their constituents.	NO TREND
Indicators: gerrymandering limited	NO METRIC
Goal 31. Elected bodies generally reflect the demographics of the electorate.	BASELINE
Indicators: NC House and NC Senate are representative	BASELINE
Goal 32. Government institutions are transparent, accountable, and not corrupt.	BASELINE
Indicators: state integrity index	BASELINE
ECONOMY	
Goal 33. Economic activity is strong across business cycles.	GOOD
33.1. per capita GDP growth and state rank	RISING
Goal 34. Sustainable sectors are expanding as a share of the economy.	NO TREND
34.1 sustainable sectors as a percentage of the economy	NO METRIC
Goal 35. The business sector is robust.	GOOD
35.1. business starts and failures	RISING
35.2 changes in payrolls	RISING
35.3. annual investment in research & development	RISING
Goal 36. Household incomes are improving.	GOOD
36.1. median household income	NO TREND
36.2. adults and children in poverty	FALLING
Goal 37. Income inequality is not too extreme.	NO TREND
37.1. ratio of 80th percentile income to 20th percentile income	BASELINE
Goal 38. North Carolina's economy supports quality jobs.	GOOD
38.1. unemployment and underemployment	FALLING
38.2. sufficiency>median income	BASELINE
HOUSING	
Goal 39. North Carolinians have safe and affordable housing choices.	WEAK

39.1. jobs to afford a 2 bedroom apartment	BASELINE
39.2. homes with deficiencies	BASELINE
Goal 40. Housing is resilient to climate change.	NO TREND
40.1. housing stock in floodplains	BASELINE
TRANSPORTATION	
Goal 41. North Carolina's transportation system is efficient.	MIXED
41.1. vehicle miles traveled/dollar GDP	BASELINE
41.2. transportation GHG emissions	FALLING
Goal 42. North Carolina's transportation infrastructure is well-maintained.	MIXED
42.1. roads in good condition	FALLING
42.2. bridges in good conditions	RISING
Goal 43. North Carolina's transportation system is resilient.	NO TREND
43.1. damages to the transportation system from disasters	BASELINE
Goal 44. North Carolinians have multiple transportation options.	MIXED
44.1. mode split in funding	BASELINE
44.2. workers driving alone	NO TREND
44.3. bike/pedestrian fatalities	MIXED
LAND USE PATTERNS	
Goal 45. North Carolinians have safe and affordable housing choices.	WEAK
45.1. where growth is happening	WEAK
45.2 commuting distance	RISING
Goal 46. Communities are resilient to climate change.	MIXED
46.1. damage from floods	RISING
46.2. damage from wind and storm surge	NO TREND
46.3. damage from wildfire	FALLING
ENERGY	
Goal 47. Risks to the environment from energy extraction and use are minimized.	GOOD
47.1. GHG emissions from energy consumption	MIXED
47.2. energy use per dollar of Gross State Product	FALLING
Goal 48. North Carolina transitions to a diverse mix of renewable energy sources.	MIXED

48.1. energy from renewable sources	WEAK
48.2. quality of grid modernization	GOOD
Goal 49. Energy rates and affordable, with costs fairly distributed.	NEUTRAL
49.1. household affordability of energy	VOLATILE
Goal 50. Energy infrastructure is reliable and resilient.	WEAK
50.1. outages/reliability of grid	BASELINE
WASTE	
Goal 51. North Carolina minimizes solid waste production.	WEAK
51.1. volume of solid waste generated	RISING
51.2. waste diverted to composting	BASELINE
Goal 52. North Carolina maximizes reuse and recycling of wastes.	NEUTRAL
52.1. ratio of recycling: disposal	NO CHANGE
Goal 53. Hazardous wastes are minimized, and past contamination remediated.	WEAK
53.1. hazardous waste reduction	NO CHANGE
53.2. net change in contaminated sites	RISING
Goal 54. Risks from the waste cycle are distributed equitably.	NO TREND
54.1. proximity to transportation, storage, and disposal sites	BASELINE
Goal 55. Unnecessary production of and exposures to toxics are minimized	WEAK
55.1. unstudied chemicals in the marketplace	BASELINE

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