COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

The Future of Forecasting: Building a Weather-Ready Nation on All Fronts

Thursday, October 14, 2021
11:00 a.m. ET
Online Via Zoom

PURPOSE

The purpose of this hearing is to examine recent reforms, successes, and modernization efforts at the National Weather Service (NWS), how they support the goal of building a "weather-ready nation," and what these efforts mean for the NWS workforce. It will also be an opportunity to discuss the findings and recommendations of several recent Government Accountability Office (GAO) reports on these topics and the status of NWS implementation of the recommendations. Additionally, the hearing will include a discussion of the science and technology advancements needed to support forecasting improvements.

WITNESSES

- **Dr. Louis Uccellini,** Assistant Administrator for Weather Services and Director of the National Weather Service, National Oceanic and Atmospheric Administration
- **Mr. Cardell Johnson,** Acting Director, Natural Resources and Environment, U.S. Government Accountability Office
- **Mr. John Werner,** President, National Weather Service Employees Organization
- **Mr. Erik Salna,** Associate Director for Education and Outreach, International Hurricane Research Center, Extreme Events Institute, Florida International University

OVERARCHING QUESTIONS
- How have reforms at the National Weather Service (NWS) in recent years helped the U.S. become a "Weather-Ready Nation"?
- What is the importance of Impact-Based Decision Support Services (IDSS)?
- What is the NWS doing to build and maintain a robust workforce?
- What additional investments are needed in both human capital and science and technology at the NWS to improve weather forecasting?
- How is the NWS responding to the findings of, and implementing the recommendations from, recent Government Accountability Office (GAO) reports?

BACKGROUND

The National Weather Service (NWS) is the nation's official and authoritative source for weather information. Its mission is to "provide weather and climate data, forecasts and warnings for the

protection of life and property and enhancement of the national economy."[1] NWS collects and analyzes 6.3 billion observations per day and issues approximately 1.5 million forecasts and 50,000 warnings annually, including weather, river, flood, and aviation.[2] NWS is divided into six regional offices—or regional headquarters—which include 122 weather forecast offices (WFO) and nine national centers.[3] The local WFOs are responsible for issuing advisories, warnings, statements, and short-term forecasts for their local county warning areas, and operate 24 hours a day, 7 days a week, year-round, to protect the public from weather hazards. Local forecasters are at the center of this work, monitoring weather observations, preparing various forecast and warning products, and working with local partners. The Science Committee held a hearing in May 2019 on the U.S. Weather Enterprise that explored the roles of the NWS and its key partners, including those in the private sector and in academia.[4]

In the last 30 years, the forecast and warning skill of the NWS has improved significantly due, in part, to enhanced observations, research, and supercomputing capabilities. However, the need for accurate weather and climate predictions will continue to grow as the U.S. experiences more frequent and intense severe weather events due to climate change. According to NOAA, in 2020 alone the U.S. experienced 22 billion-dollar disasters[5]—the highest on record.[6] In 2021 (as of October 8), there have already been 18 weather/climate disaster events exceeding $1 billion losses.[7]

Accurate forecasts on their own have no value; forecasts provide value by influencing decision-making. The quality of the NWS's warning capability correlates with having a fully trained and robust workforce at the local WFOs. This was brought to light during a 2011 tornado outbreak in Alabama and neighboring states. Despite having significantly more lead time for forecasts and warnings than decades earlier, the event still caused over 300 deaths. NWS and NOAA in 2011 defined the strategic goal of building a "Weather-Ready Nation" (WRN), one that is ready, responsive, and resilient to extreme weather, water, and climate events.[8] Enhancing Impact-based Decision Support Services (IDSS) to NWS's State, local, Tribal, and emergency management partners is a focus of building a WRN.

NWS Staffing and Workforce Issues

Several studies have highlighted issues with NWS's workforce over the last decade, including vacancies and hiring difficulties at NWS's operational units. A 2012 review by the National Academy of Sciences found that the NWS workforce faced several challenges, and recommended actions related to "evolving" the NWS workforce to ensure that it is fully able to respond to changing needs.[9] Subsequently, a 2013 National Academy of Public Administration (NAPA) report recommended that NWS conduct a workforce analysis and assess staff alignment and

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[1] https://www.weather.gov/about/
[2] https://www.weather.gov/about/forecastsandservice
[3] https://www.weather.gov/about/nws
[4] https://science.house.gov/hearings/the-future-of-forecasting-building-a-stronger-us-weather-enterprise
[5] Weather and climate disaster events with losses exceeding $1 billion
[6] https://www.ncdc.noaa.gov/billions/
[7] Ibid.
[8] https://www.weather.gov/media/wrn/NWS_Weather-Ready-Nation_Strategic_Plan_2019-2022.pdf
[9] https://www.nap.edu/catalog/13429/weather-services-for-the-nation-becoming-second-to-none

functions across the agency, among other recommendations.[10] A 2017 analysis by GAO found that the number of vacancies across NWS operational units has increased since fiscal year (FY) 2010, from about 5 percent (211 positions) at the end of FY 2010, to about 11 percent (455 positions) at the end of FY 2016.[11] The highest number of vacancies is in meteorology roles.[12] The 2017 GAO report, which was requested by several Democratic Members of the Science Committee, found that the vacancy rate in NWS operational units had reached a point where NWS employees were "unable at times to perform key tasks." Furthermore, the report stated that NWS "staff experienced stress, fatigue and reduced morale resulting from their efforts to cover for vacancies" due to lack of time off and a loss of training.

In part, the trend in vacancies can be explained by a mismatch in NWS mission requirements and resources to recruit, retain, and develop staff at the NWS, which has led to insufficient hiring services.[13] Starting in 2013, an agency-wide hiring freeze in response to the 2013 federal budget sequestration led to a hiring backlog at NWS. Due to high rates of attrition during the freeze and high hiring demands across NOAA, the agency's Workforce Management Office (WFMO), responsible for hiring and other personnel actions at the NWS, could not backfill the positions when the freeze was lifted. Agency data showed that filling hiring requests ranged from 64 to 467 days in FY 2016.[14]

Beginning in June 2014, WFMO started using contractors to process the majority of NWS's hiring requests. However, the contractors have been unable to fully meet NWS's demand.[15] Section 410 of the Weather Research Forecasting and Innovation Act of 2017[16] called for a report to Congress on the use of contractors at NWS. Delivered over two and a half years late, the report did not provide the requested information on the number of full-time equivalent (FTE) contractors at the NWS, stating that "NOAA does not track or maintain information that identifies or characterizes contractors' employees as FTEs."[17]

NWS has taken some steps to address hiring issues and vacancies. GAO reported that as of January 2020, the NWS has taken steps to address the two recommendations from their 2017 report to ensure that complete information on hiring requests is routinely communicated to NWS managers by WFMO throughout the hiring process, and evaluating the extent to which NWS's actions are reducing the hiring backlog and achieving the goal of sustaining a highly skilled workforce.[18] Despite these actions being taken, NWS continues to suffer from a hiring backlog and substantial number of vacancies. In a September 15, 2021 briefing to Committee staff, NWS officials reported that as of July 3, 2021, 4,326 employees were on board, excluding reimbursables, at a fill rate of 98.3% compared to total funded positions. NWS's time to hire continues to decrease from an

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[10] https://s3.us-west-2.amazonaws.com/napa-2021/studies/forecast-for-the-future-assuring-the-capacity-of-the-national-weather-servi/ForecastfortheFuture-AssuringtheCapacityoftheNationalWeatherService.pdf
[11] https://www.gao.gov/products/gao-17-364
[12] https://www.weather.gov/media/nws/OWA_Catalog_09072017.pdf
[13] https://www.gao.gov/products/gao-17-364
[14] Ibid.
[15] Ibid.
[16] P.L. 115-25
[17] https://repository.library.noaa.gov/view/noaa/23644
[18] https://www.gao.gov/products/gao-17-364

average of 108 days in FY 2020 to 86 days in the third quarter of FY21 with a cumulative FY21 time-to-hire of 92.5 days.

As NWS continues to rebuild its workforce, it is important that it ensures its workforce is diverse and highly trained. The Science Committee Majority Staff's Brain Drain report of 2021 found that NOAA's STEM workforce experienced a 1.6 percent decline over the past decade and suffers from gender, racial, and ethnic disparities.[19] For example, NOAA employs roughly 8.5 male engineers for every 1 female engineer, and 3.9 white employees for every 1 employee from a racial minority group, with the greatest disparity for Black/African American STEM staffers. However, the report did not examine demographics of the NWS workforce specifically.

Efforts to "Evolve" the NWS

In response to the 2013 NAPA report recommendations, NWS hired the consulting firm McKinsey & Company in 2015 to conduct an Operations and Workforce Analysis (OWA) to generate findings and recommendations to help the NWS move toward its vision to provide IDSS for a WRN. The OWA generated a number of findings and ideas to support the vision of a WRN. Importantly, it found that the NWS workforce was highly skilled, trained, and motivated in their mission delivery. However, it also found that the demand for IDSS was greater than the NWS's ability to provide it throughout the country. The OWA described improvements were that needed to the NWS structure, workflow and processes to better support IDSS across the country. Additionally, it suggested that NWS could better incorporate science and technology to improve the services it provides.[20]

The NWS launched its Evolve Program in 2017 in response to the findings of the OWA. A Program Management Office (PMO) was established to lead the Evolve Program. The Evolve Program had five objectives: (1) enhance IDSS, (2) improve workforce opportunities, (3) develop a collaborative forecast process, (4) match workforce to workload, and (5) support innovation, science, and technology. To achieve these objectives, NWS established 20 reform initiatives.[21] A select few reform initiatives include:

- *National Blend of Models (NBM):* To improve weather modeling, NWS began incorporating NBM, which is a blend of both NWS and non-NWS numerical weather prediction guidance with the goal to provide a nationally consistent starting point for forecasters.[22] NBM is intended to help reduce forecast inconsistencies across offices and improve the quality of IDSS.

- *GS 5-12:* NWS created a career progression initiative to establish a career track for NWS forecasters to progress non-competitively from the General Schedule (GS)-5 to GS-12 by demonstrating competencies at each level.

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[19] https://science.house.gov/staff-reports/scientific-brain-drain-quantifying-the-decline-of-the-federal-scientific-workforce
[20] https://www.weather.gov/media/nws/OWA_Catalog_09072017.pdf
[21] The full list of reform initiatives is included as an appendix to the 2021 GAO report.
[22] https://www.weather.gov/mdl/nbm_home

- *Weather balloon auto-launchers:* NWS has typically launched weather balloons at least two times daily from 92 sites. Manually launching weather balloons is time consuming; launches can take hours at some sites. To free up staff time to develop forecasts and provide IDSS, NWS has begun implementing weather balloon auto-launchers.[23]

The McKinsey review prompted members of the Science Committee to seek a better understanding of the findings and recommendations and subsequent reforms at NWS, including the Evolve Program and NBM. In February 2018, Democratic Science Committee Members sent a letter to GAO requesting that it conduct a review of the NWS OWA activities to better understand the decisions made by NWS. In their letter, they requested GAO evaluate whether McKinsey had fully satisfied the requirements of their contract. They also asked GAO to evaluate the decision behind the inclusion of NBM in the Evolve process, expressing the concern that NBM might "reduce the necessity of the forecaster labor pool or reduce forecaster hours."[24]

GAO has since responded to this request letter in two separate reports. The first was released January 2020, and it confirmed that McKinsey did, in fact, provide NWS with the materials and services as necessitated by its contract.[25]

The second GAO report was released in October 2021.[26] This report analyzed the extent to which NWS followed eight leading practices for effective agency reforms for its 20 initiatives under the Evolve Program. GAO found that while NWS had substantially followed five major reform practices, NWS was unsuccessful in implementing three reform practices—establishing goals and outcomes for Evolve, involving employees and key stakeholders by means of two-way communication that listens and responds to employee concerns about Evolve, and providing dedicated leadership to the Evolve Program. Accordingly, GAO made three recommendations to NWS.

First, GAO found that while NWS did establish goals for the Evolve program, it did not establish performance metrics for key elements of the program, such as improving the provision of IDSS. Therefore, GAO recommended that NWS incorporate key attributes of performance measures as it develops the Evolve Program. The report did, however, note that the Evolve PMO is in the process of developing such performance measures.

Second, the report recommended that NWS develop a two-way communication strategy to outline how the agency listens and responds to employee concerns. GAO found that because the Evolve Program lacked a full communications strategy to inform employees about the program, employees had varied levels of awareness program, and some were concerned about the effects of the proposed reforms. In some cases, employees were concerned that the reforms would lead to office closures or job losses.

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[23] https://www.gao.gov/products/gao-21-103792

[24] https://science.house.gov/imo/media/doc/2.13.18%20to%20Dodaro%20on%20NWS%20from%20EBJ_Tonko_Bonamici_Crist.pdf

[25] https://www.gao.gov/products/gao-20-271r

[26] https://www.gao.gov/products/gao-21-103792

Third, the GAO report recommended that NWS revise its approach to staffing the Evolve Program. GAO found that NWS relied on a rotating staff to fill PMO leadership and staff positions. Some at NWS saw this as beneficial, as it led to a range of perspectives, skills, and experiences. Others, however, believed the frequent turnover made it difficult to maintain momentum, led to lost time spent on educating new staff, and resulted in overall instability. The report stated that NWS officials are working to secure funding for permanent staffing in the future, but future Evolve efforts will require additional planning and prioritizing within NWS.

GAO also examined specifically the implementation of NBM. The 2021 GAO report outlines the ways in which NBM is currently being used and describes NWS's plans for future implementation. According to the report, NBM is available for all WFOs to use. Additionally, while no agency-wide requirements have been set yet regarding its use, three regions (Central, Eastern, and Western) are required to use NBM as the starting point for the forecast process. These three regions include approximately 70 percent of all WFOs. The report notes that the Southern region is still determining how it will use NBM, and the Alaska and Pacific regions are still examining NBM's performance in their local areas. GAO also found that NBM is better for forecasting some conditions than others. Finally, like with the findings for the broader Evolve Program, GAO found that NWS lacked a robust communications strategy. This contributed to some forecasters' resistance to using the new modeling tool and concerns that it could lead to job losses. Additionally, some forecasters expressed concerns that they did not know what went into the modeling tool, which resulted in reduced confidence in NBM. Therefore, GAO reiterated the need for improved communication within NWS about its reforms.

Advancements in Weather Forecasting Science & Technology

Science and technology advancements over the last decade have led to dramatic gains in forecast accuracy. For example, a giant step forward was the implementation of the High Resolution Rapid Refresh (HRRR) model in 2014, which allows forecasters to see hourly high resolution model runs for more accurate lead time of severe weather impacts.[27] NWS has a collaborative partnership with NOAA's Office of Oceanic and Atmospheric Research (OAR) and the National Environmental Satellite, Data, and Information Service (NESDIS), which conduct cutting-edge atmospheric and oceanic research and collect Earth system observations that feed into models, respectively. NOAA also has robust partnerships with academic research labs and the private sector. One of the main challenges and opportunities of NWS and NOAA has been the transition of research to operations (R2O) and operations to research (O2R). Transitioning research and observations into the operational forecast models used by NWS forecasters is essential to ensuring the success of NWS's mission.

NWS uses numerical weather prediction (NWP) to develop forecasts by utilizing data from space- and ground-based observation platforms that feed into computer models that make predictions about weather conditions.[28] NOAA is modernizing the NWS's approach to weather modeling through developing the next generation global prediction system based on a "dynamic core." The new GFS-FV3 (FV3 stands for Finite-Volume Cubed-Sphere dynamic core) became operational in June 2019, replacing the Global Forecasting System (GFS), which was the foundation of NWS

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[27] https://www.weather.gov/about/wrn
[28] https://www.weather.gov/rah/virtualtourforecast

weather models for over 30 years.[29] The GFS-FV3 offers unprecedented accuracy to forecasts through running more efficiently on supercomputers, integrating vertical equations of the atmosphere, and more realistically representing weather phenomena. NOAA continues to make improvements to the GFS-FV3, including the most recent improvements in March 2021.[30]

The Weather Research and Forecasting Innovation Act of 2017[31] instructs NOAA to prioritize improving weather data, modeling, computing, forecasting and warnings for the protection of life and property and for the enhancement of the national economy. It authorized a number of research and development activities at NOAA, primarily at OAR, to advance subseasonal (two weeks to three months) to seasonal (three months to two years) forecasts and supported a pilot program for commercial satellite data acquisition.

The National Integrated Drought Information System (NIDIS) Reauthorization Act of 2018[32] instructed NOAA to create the Earth Prediction Innovation Center (EPIC) to accelerate community-developed scientific and technological enhancements into the operational applications for NWP. The Unified Forecast System (UFS) is EPIC's solution to a community-based, coupled, comprehensive Earth modeling system used for various NWP applications. The Science Committee held an oversight hearing on the development of EPIC in November 2019.[33] In April 2021, NOAA announced that Raytheon Intelligence and Space was awarded the contract to develop EPIC.[34]

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[29] https://www.gfdl.noaa.gov/fv3/
[30] https://www.noaa.gov/media-release/noaa-upgrades-flagship-us-global-weather-model
[31] P.L. 115–25
[32] P.L. 115-423
[33] https://science.house.gov/hearings/a-task-of-epic-proportions-reclaiming-us-leadership-in-weather-modeling-and-prediction
[34] https://www.noaa.gov/media-release/raytheon-intelligence-and-space-to-lead-new-center-dedicated-to-advancing-us-weather