



October 2017

WATER POLLUTION

Some States Have Trading Programs to Help Address Nutrient Pollution, but Use Has Been Limited

GAO Highlights

Highlights of [GAO-18-84](#), a report to the Honorable Sheldon Whitehouse, U.S. Senate

Why GAO Did This Study

Nutrient pollution—caused by excess nitrogen and phosphorus entering water bodies—poses significant risks to the nation’s water quality. Nutrients can enter water bodies from point sources and nonpoint sources. The Clean Water Act establishes the basic structure for regulating discharges of pollutants, including excess nutrients. Under the act, authorized states—assisted and overseen by EPA—set limits on nutrients impairing a water body and limits on point source discharges. EPA encourages states to use nutrient credit trading to address nutrient pollution. According to EPA, trading allows a point source to meet nutrient discharge limits by buying pollutant credits from a source that has reduced its discharges more than required.

GAO was asked to examine nutrient credit trading programs. This report describes (1) the extent to which nutrient credit trading programs have been used and what the outcomes of the programs have been, (2) how states and EPA oversee nutrient credit trading programs, and (3) what key factors stakeholders view as affecting participation in nutrient credit trading. GAO reviewed EPA documents and interviewed EPA officials to gather information on trading programs. GAO then selected a nongeneralizable sample of three programs with the most trades in 2014 (based on the most recent available data); reviewed program documents; and interviewed EPA, state, and program officials and other stakeholders about the programs.

View [GAO-18-84](#). For more information, contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

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Some States Have Trading Programs to Help Address Nutrient Pollution, but Use Has Been Limited

What GAO Found

In 2014, 11 states had 19 nutrient credit trading programs, and trading provided flexibility for some point sources, such as wastewater treatment plants, to meet nutrient discharge limits, according to Environmental Protection Agency (EPA) data and officials. The majority of nutrient credit trading during 2014 occurred in three state programs—programs in Connecticut, Pennsylvania, and Virginia. A review of trading data from these programs showed that most point sources participating in the three state programs did not purchase credits in 2014 to meet their discharge limits, which are established in National Pollutant Discharge Elimination System (NPDES) permits under the Clean Water Act. For the point sources that did purchase credits in 2014, state officials in the three states told GAO that the total amount in pounds of nutrients that point sources purchased as credits was generally small. Nevertheless, state officials explained that nutrient credit trading was useful because it allowed point sources to manage risk, reduce the cost of compliance, and better manage the timing of upgrades of nutrient removal technology.

States oversee nutrient credit trading programs, and EPA helps ensure that programs are consistent with the act. States oversee nutrient credit trading programs by approving and verifying the generation of credits to ensure that credits represent real reductions in nutrient pollution. A state’s approval and verification process varies depending on whether the credit generator is a point or nonpoint source, such as runoff from agricultural and urban areas. For point sources, the states GAO reviewed followed a process for verifying credits that is based on the existing oversight process for NPDES permits. Because nonpoint sources do not have NPDES permits, states use a separate process to approve and verify that nonpoint sources’ pollution reduction activities have generated credits for trading. When questions or concerns arise, EPA uses its oversight authority to ensure that trades and trading programs are fully consistent with the act. EPA officials told GAO that they conduct oversight primarily through the regional offices, which (1) review NPDES permits, (2) review and comment on state regulatory frameworks for trading, (3) conduct periodic on-site inspections, and (4) provide national-level guidance and training to state programs and stakeholders.

According to stakeholders, two key factors have affected participation in nutrient credit trading—the presence of discharge limits for nutrients and the challenges of measuring the results of nonpoint sources’ nutrient reduction activities. Officials from the three states GAO reviewed and other stakeholders cited the importance of discharge limits for nutrients as a driver to create demand for trading. Without such a driver, point sources have little incentive to purchase nutrient credits. The challenges of measuring nutrient reductions by nonpoint sources create uncertainties about the value of credits generated by nonpoint sources. In part, because of these uncertainties, the states GAO reviewed either did not allow nonpoint sources to trade or created special rules for nonpoint sources. State officials and stakeholders also told GAO that even if a program allows nonpoint sources to trade, point sources often prefer to trade with other point sources because they have similar permit and monitoring requirements.

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Abbreviations

BMP best management practice
EPA Environmental Protection Agency
NPDES National Pollutant Discharge Elimination System
TMDL total maximum daily load
USDA U.S. Department of Agriculture

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October 16, 2017

The Honorable Sheldon Whitehouse
United States Senate

Dear Senator Whitehouse:

Nutrient pollution, caused by excess nitrogen and phosphorus entering the environment, poses significant risks to the nation's water quality and presents a growing threat to public health and local economies. Excess nutrients can enter water bodies from point sources, such as industrial facilities and wastewater treatment plants, and from nonpoint sources, such as runoff from agricultural and urban areas. Nutrient pollution contributes to a trend of increasing numbers of harmful algal blooms in surface waters. These blooms can release toxins that can contaminate drinking water sources and adversely affect recreation, tourism, and fisheries. For example, in 2014, about 500,000 residents of Toledo, Ohio, lost access to public drinking water for 4 days because of algal toxins in the city's drinking water. The National Aquatic Resource Surveys, conducted by the Environmental Protection Agency (EPA) and state and tribal partners, have shown that nutrient pollution is a widespread issue affecting the nation's waters. The 2012 survey of lakes, issued in December 2016, found that 40 percent of the nation's lakes had high levels of phosphorus and 35 percent had excessive levels of nitrogen associated with harmful ecological impacts.¹

The Clean Water Act, enacted in 1972, establishes the basic structure for regulating discharges of pollutants, including excess nutrients, into the waters of the United States and regulating quality standards for surface waters.² The act requires states to establish water quality standards that protect public health and the environment and consider aquatic wildlife and human consumption and recreation, among other uses. The act also requires EPA to maintain and improve water quality by assisting and

¹Environmental Protection Agency, *National Lakes Assessment 2012: A Collaborative Survey of Lakes in the United States*, EPA 841-R-16-113 (Washington, D.C.: December 2016).

²The Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, § 2, 86 Stat. 816, codified as amended at 33 U.S.C. §§ 1251-1388 (2017) (commonly referred to as the Clean Water Act). For consistency throughout this report, we refer to the statute and its amendments as the Clean Water Act.

overseeing states' efforts, among other responsibilities. States are required to monitor and assess the conditions of water bodies, and those that do not meet state water quality standards are considered impaired. The Clean Water Act generally requires states to develop a pollutant budget, known as a "total maximum daily load" (TMDL), for each pollutant impairing a water body. In the case of nutrient impairment to a water body, a TMDL would reflect the maximum amount of that nutrient that the water body could contain and still be considered in compliance with water quality standards.

The act also made it unlawful to discharge any pollutant except in compliance with law, which requires that point sources must obtain a permit before discharging into navigable waters. Through its National Pollutant Discharge Elimination System (NPDES) program, EPA requires every point source to hold a permit limiting pollutant discharges, including discharges of nutrients where appropriate. Under the act, EPA can authorize state, tribal, and territorial governments to implement the NPDES program, enabling them to develop NPDES permits and enact other administrative and enforcement aspects of the NPDES program. Currently, 46 states and one territory are authorized to administer and enforce the NPDES program. For these entities, EPA retains oversight responsibilities at multiple levels across the agency, including its headquarters and 10 regional offices, and carries out those responsibilities by establishing monitoring requirements, enforcement provisions, and reporting requirements.

Unlike point sources, nonpoint sources are not subject to regulation under the Clean Water Act. Nonpoint source pollution, including pollution from nutrients, remains a leading cause of impairment of the nation's waters, according to EPA. In 1987, Congress amended the Clean Water Act, adding section 319 to explicitly address nonpoint source pollution through a cooperative, grant-based program with states, which funds projects to reduce nonpoint source pollution and restore impaired water bodies.³ Through this program EPA awards federal funds to states to develop and implement nonpoint source management programs.

In recent years, EPA has called on states and stakeholders to take further actions that support or enhance the agency's efforts to reduce nutrient

³Water Quality Act of 1987, Pub. L. No. 100-4, § 316 (1987), adding § 319 to the Clean Water Act, codified at 33 U.S.C. § 1329 (2017).

pollution's effects on public health.⁴ As part of this effort, EPA has continued to support water quality trading as an approach to help address nutrient pollution. Water quality trading can address water quality impairments from sediments and temperature, but most often trading is used to address nutrients; specifically, total nitrogen and total phosphorus.⁵ This type of water quality trading is also known as nutrient credit trading and is the focus of this report. According to EPA, nutrient credit trading allows a point source to meet its obligations for compliance with a nutrient discharge permit limit by purchasing pollutant reductions, or credits, created by another source or sources that achieved nutrient reductions beyond what was required often through a market-based approach. In their role as NPDES permitting authorities, states take the lead in developing nutrient credit trading programs.⁶ Sellers of nutrient credits may be point or nonpoint sources, depending on the framework of an individual trading program. In 1992, when we last reported on water quality trading to address water pollution, we identified four trading programs nationwide, with only one trade made at the time of the report's issuance.⁷ The limited activity in water quality trading nationwide was attributed largely to uncertainties surrounding the use of trading. Since 2003, EPA has developed policy and guidance to facilitate the development of water quality trading programs. In 2013, EPA and the U.S. Department of Agriculture (USDA) signed a partnership agreement to implement and coordinate policies and programs encouraging water quality trading.

⁴Environmental Protection Agency, *Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions* (Washington, D.C.: Mar. 16, 2011), and *Renewed Call to Action to Reduce Nutrient Pollution and Support for Incremental Actions to Protect Water Quality and Public Health* (Washington, D.C.: Sept. 22, 2016).

⁵Other pollutants may be considered for trading on a case-by-case basis, according to EPA documents. According to these documents, EPA does not support trading of persistent bioaccumulative toxics, a class of chemicals that pose risks because they are toxic even in small quantities, persist in ecosystems, bioaccumulate in food chains, and can travel great distances (via equipment or products, food, or the environment). This report focuses on nutrient credit trading.

⁶For the purpose of this report we use "states" when referring to permitting authorities, as the majority of permitting authorities are states.

⁷GAO, *Water Pollution: Pollutant Trading Could Reduce Compliance Costs If Uncertainties Are Resolved*, [GAO/RCED-92-153](#), (Washington, D.C.: June 15, 1992).

You asked us to review issues related to nutrient credit trading.⁸ This report (1) examines the extent to which nutrient credit trading programs have been used and what the outcomes of the programs have been, (2) describes how states and EPA oversee nutrient credit trading programs, and (3) describes what key factors stakeholders view as affecting participation in nutrient credit trading.

To examine the extent to which nutrient credit trading programs have been used and what the outcomes of the programs have been, we first reviewed an internal EPA list of water quality trading programs and estimated trades for 2014, the most recent data available at the time we conducted our review.⁹ EPA officials explained that the data reported by states to EPA varied somewhat in completeness and consistency. For example, not all programs reported data on the number of trades for calendar year 2014. To gather additional information about EPA's list of programs, we emailed or interviewed officials from all 10 EPA regions to obtain confirmation on the presence or absence of trading programs in each state in 2014. We identified 7 EPA regions that had some form of water quality trading program in one or more of the states in their regions. We interviewed EPA regional officials to determine which of the programs (1) included point sources with NPDES permits that allowed for water quality trading and (2) were established for the specific purpose of trading nutrient credits (i.e., nutrient credit trading programs). From this list of nutrient trading programs, we then selected a nongeneralizable sample of three programs to examine in more detail. We selected three programs that in 2014 had the most trades and the most participating point sources. Because these programs were judgmentally selected, the results of our review of these programs cannot be generalized. To gather information about the establishment and structure of the programs, number and type of trades in 2014, and outcomes of the programs, we reviewed program documents. Specifically, we reviewed state laws and regulations, NPDES permits, watershed implementation plans, program rules and policies, annual summaries of nutrient credit purchases and sales, and assessments of state trading programs when available. We also

⁸This review was conducted in response to a 2015 request from Senator Sheldon Whitehouse—then Ranking Member, Subcommittee on Fish, Water, and Wildlife, Senate Committee on Environment and Public Works—to review the use of nutrient credit trading programs.

⁹EPA officials told us that they were updating the list of trading programs for 2017, but the list was not finished at the time we conducted our work.

interviewed state and program officials and other stakeholders knowledgeable about these programs.

To describe how states and EPA oversee nutrient credit trading programs, we reviewed relevant federal laws, regulations, and EPA policies and guidance related to nutrient credit trading. We also interviewed agency officials from EPA's Office of Water and the 7 EPA regions with nutrient credit trading programs. In addition, we reviewed documents and interviewed state and program officials and other stakeholders for our nongeneralizable sample of three nutrient credit trading programs.

To describe what key factors stakeholders view as affecting participation in nutrient credit trading, we spoke with officials from EPA's Office of Water, officials from the 7 EPA regions with nutrient credit trading programs, and officials and stakeholders from the nongeneralizable sample of three nutrient credit trading programs. We also reviewed documents and interviewed officials for one nongeneralizable multi-state trading program to provide an additional example of the key factors and how they affect participation in nutrient credit trading programs.¹⁰ Finally, we interviewed representatives of stakeholder groups, such as those representing wastewater treatment facilities, national organizations for water issues, and agricultural conservation districts. Appendix I contains more detailed information on the objectives, scope, and methodology of our review.

We conducted this performance audit from August 2016 to October 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

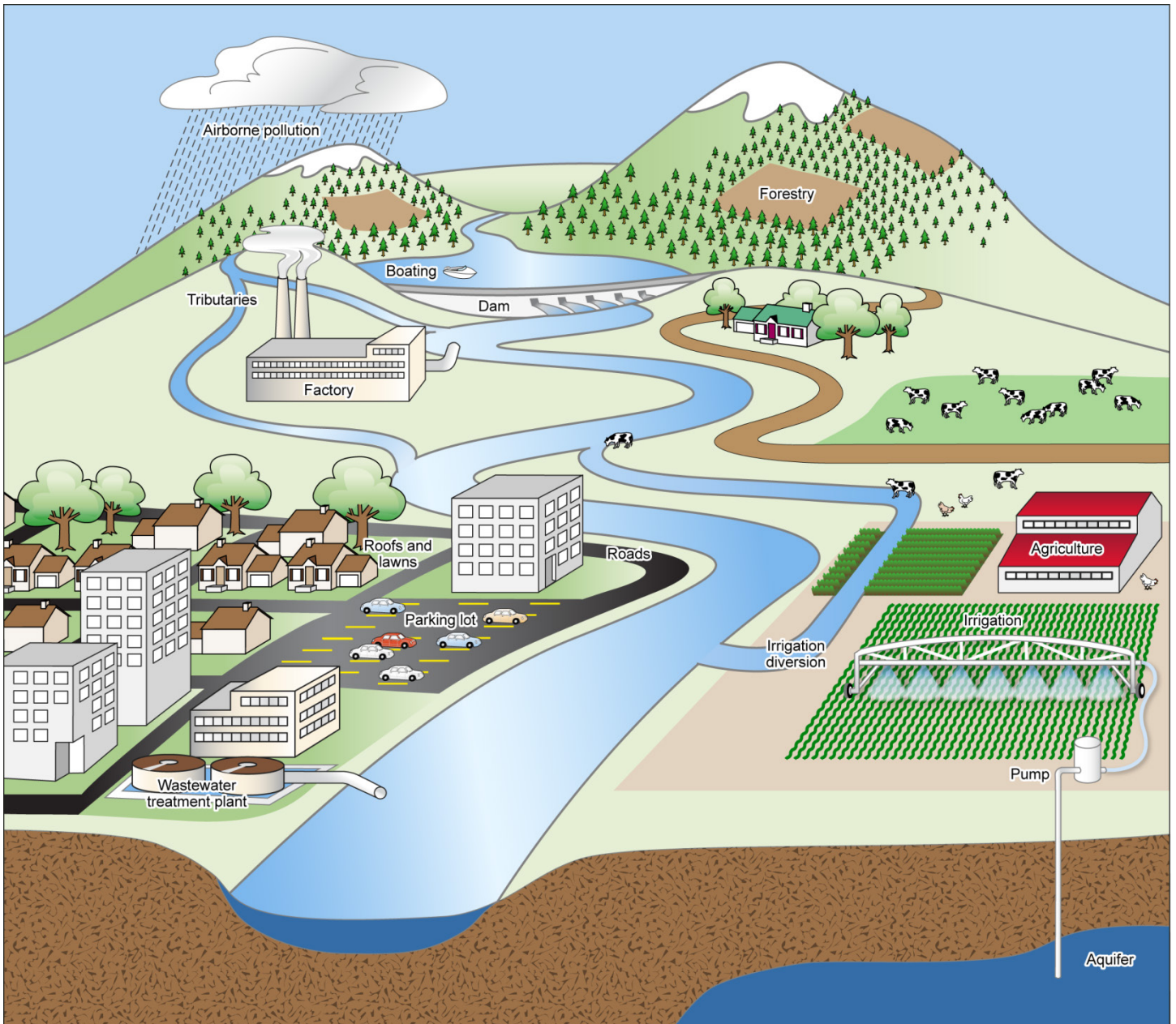
This section provides a brief background into nutrient pollution, federal and state activities to address water pollution, and nutrient credit trading.

¹⁰This program was not in our list of nutrient credit trading programs because none of the participating states have NPDES permits with nutrient discharge limits. This multi-state program, however, helps illustrate the challenges of operating without established discharge limits.

Nutrient Pollution

According to EPA, nutrient pollution is one of America's most widespread, costly, and challenging environmental problems. Nutrients are natural parts of aquatic ecosystems that support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish, and smaller organisms that live in water. However, when too many nutrients enter the environment, often as the direct result of human activities, the air and water can become polluted. The primary sources of nutrient pollution are fertilizer, animal manure, wastewater treatment plants, power plants, storm water runoff, cars, detergents, failing septic tanks, and pet waste. (See fig. 1.)

Figure 1: Sources of Nutrient Pollution to Water Bodies



Source: GAO. | GAO-18-84

Note: The figure shows that impairment of water bodies may stem from pollution by point sources—which include industrial facilities, such as factories and wastewater treatment plants, and other sources that discharge wastewater from pipes or other discrete points—or from nonpoint sources such as airborne pollution; agricultural fields; forestry; and runoff from roofs, lawns, parking lots, and roads.

Too much nitrogen and phosphorus in surface waters can cause algae to grow faster than ecosystems can handle. Significant increases in algae can harm water quality and habitats. Large growths of algae, called algal blooms, can severely reduce or eliminate oxygen in the water, leading to the illnesses and death of large numbers of fish. Some algal blooms are harmful to humans because they produce elevated levels of toxins and bacteria that can make people sick if they come into contact with or drink contaminated water or consume tainted fish or shellfish. According to a 2016 memorandum from EPA, nutrient pollution contributes to a trend of increasing numbers of harmful algal blooms in surface waters and consequentially a growing threat to public health and local economies. For instance, in 2016, algal blooms occurred along U.S. coastlines from Alaska to Florida, closing beaches, affecting tourism and local economies, and resulting in a state of emergency declaration in four coastal counties in Florida and more than 250 health advisories nationwide.¹¹

Federal and State Activities to Address Water Pollution

The Clean Water Act establishes a nationwide approach improving and maintaining the quality of rivers, streams, lakes, and other surface water bodies. Under this approach, states—overseen by EPA—are to set water quality standards, monitor water quality, and assess water quality against the applicable standards. Water quality standards define the water quality goals of a water body, or portion thereof, by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses. These standards establish an additional legal basis for controlling pollution entering the waters of the United States from point sources, such as wastewater treatment plants.¹² Water quality standards include the following, among other things:

- designated uses of the water body, such as the protection and propagation of fish, shellfish, and wildlife;
- criteria to protect designated uses, such as specific criteria or levels for toxic or nutrient pollutants that could harm aquatic life;

¹¹While this report primarily focuses on the impact of nutrient pollution on surface water bodies, nutrient pollution in untreated ground water, such as water in the wells that millions of people in the United States use as their drinking water source, can be harmful, even at low levels, according to EPA.

¹²The Clean Water Act also imposes technology-based control and treatment requirements.

-
- anti-degradation requirements that describe the conditions under which water quality may be lowered in surface waters while still protecting existing uses and high quality waters; and
 - other general policies to address implementation issues.

To protect a water body's designated uses, a state must establish numeric criteria, or, where numeric criteria cannot be established or as a supplement to them, narrative or biomonitoring criteria. EPA has encouraged states to incorporate numeric criteria into water quality standards and TMDLs for water bodies with nutrient impairments because they require less interpretation to implement than narrative criteria. Numeric criteria express precise, measurable levels of particular chemicals or conditions allowable in a water body. In contrast, narrative criteria express in a qualitative form how to protect a designated use of a water body. Narrative criteria often describe the desired conditions of a water body as being "free from" certain negative conditions. For instance, to protect a designated use, narrative criteria could require that a particular water body be free from floating non-petroleum oils of vegetable or animal origin. According to EPA, under most circumstances, water quality criteria that limit specific toxic pollutants are expressed numerically. However, according to EPA officials, most water quality criteria that limit nutrient pollutants are expressed narratively. EPA has provided support to states on how to develop numeric criteria through written guidance, webinars, and workshops. According to EPA officials and data, however, there has been limited state progress in developing numeric criteria for nutrients. As of 2017, six states had at least one statewide numeric criterion for either nitrogen or phosphorus for some water bodies.¹³

Through the monitoring and assessment process, states are to identify water bodies that do not meet established water quality standards and are therefore considered to be impaired. The Clean Water Act generally requires—for each water body that a state has identified as impaired—that the state develop a TMDL for each pollutant impairing the water body. A TMDL reflects the calculation of the maximum amount of a

¹³According to EPA, numeric criteria can be developed for three different types of water bodies known as water types: lakes/reservoirs, rivers/streams, and estuaries. As of August 2017, 16 states had developed partial numeric criteria for either nitrogen or phosphorus or both in some but not all water bodies. For more information on states' progress in developing numeric water quality standards from 1998 through 2017, see EPA's online tracking tool, available at <https://www.epa.gov/nutrient-policy-data/state-progress-toward-developing-numeric-nutrient-water-quality-criteria>.

pollutant that a water body can receive, while meeting and continuing to meet water quality standards for that particular pollutant. A TMDL determines a pollutant reduction target and allocates load reductions necessary to meet that target to both point and nonpoint source(s) of the pollutant, although under the Clean Water Act only point sources can be required to reduce pollutants. For a point source, legal discharge limits based on the targets identified in the TMDL are incorporated into an NPDES permit.¹⁴ An NPDES permit can be issued as an individual permit to a single facility, written to reflect site-specific conditions of that facility, or as a general permit for multiple facilities with similar operations and types of discharges. For example, Connecticut uses a general permit to implement the Long Island Sound TMDL. This permit authorizes 79 wastewater treatment facilities to discharge nitrogen into the sound and includes a specific nitrogen limit for each facility.

Under the Clean Water Act and EPA's regulations, states or EPA can typically determine the most appropriate geographic area and pollutants for each TMDL. The Chesapeake Bay TMDL is the largest TMDL that EPA has developed. This TMDL identifies the necessary nutrient pollution reductions across the bay jurisdictions, which encompass seven states in a 64,000-square-mile watershed, and comprise 276 smaller TMDLs for 92 individual Chesapeake Bay tributaries.¹⁵ Similarly, the Long Island Sound TMDL identifies the necessary nitrogen pollution reductions for parts of Connecticut and New York that discharge into the sound. In contrast, many TMDLs cover a single water body, such as a lake or a segment of a river.

Unlike its approach for point sources, the Clean Water Act's approach to curtailing nonpoint source pollution is largely voluntary. One of the primary ways that EPA addresses nonpoint source nutrient pollution is

¹⁴Under EPA regulations, the TMDL calculation includes an allocation of pollutant loadings to point sources known as "wasteload allocation" and an allocation to nonpoint sources known as "load allocation". For the purposes of this report, we will use the term "discharge limit" to mean the wasteload allocation used in calculating a TMDL for nutrients and the resulting discharge limits stated in the relevant NPDES permit or permits.

¹⁵The bay jurisdictions include: Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. See <https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-fact-sheet> accessed August 18, 2017.

with the section 319 program.¹⁶ Through this grant-based program, EPA funds voluntary projects aimed at reducing nonpoint source pollution, particularly runoff from agricultural production. Grants from this program support a wide variety of activities including the development and implementation of best management practices (BMP), which are used to reduce or eliminate the introduction of pollutants into receiving waters. Some common agricultural BMPs include planting strips of trees or shrubs along stream banks to serve as buffers or planting cover crops, such as clover, in fields near water bodies to reduce nutrient runoff.

Nutrient Credit Trading

EPA also encourages states to use nutrient credit trading to help address nutrient pollution. Nutrient credit trading programs are designed to allow a point source to purchase pollutant reduction credits from another point source or a nonpoint source in the same watershed with the intent of meeting the discharge limits established in an NPDES permit.¹⁷ These limits establish a baseline that credit generators must discharge below before they can sell credits. According to EPA guidance, point sources that exceed their discharge limit can buy credits to be compliant with their permits, and point sources that have discharged below their limits can sell credits. Because the Clean Water Act does not require nonpoint sources to meet nutrient reduction targets established in a TMDL, there is no demand to buy credits. However, nonpoint sources can sell credits in some programs once these sources have reduced pollution below the targets established in the TMDL for the watershed or geographic area. To provide states with guidance on developing and implementing trading programs, EPA issued its Water Quality Trading Policy in 2003 and its

¹⁶Section 319 of the Clean Water Act includes various minimum conditions that states must meet to receive grants, including the development of nonpoint source management programs—which EPA must approve—and annual reports on states' progress in achieving the goals and management of their programs. See 33 U.S.C. §1329. We have previously reported on challenges associated with addressing nonpoint source pollution. See GAO, *Clean Water Act: Changes Needed If Key EPA Program Is to Help Fulfill the Nation's Water Quality Goals*, [GAO-14-80](#) (Washington, D.C.: Dec. 5, 2013), and *Nonpoint Source Water Pollution: Greater Oversight and Additional Data Needed for Key EPA Water Program*, [GAO-12-335](#) (Washington, D.C.: May 31, 2012).

¹⁷EPA guidance supports water quality trading in three scenarios: (1) to maintain water quality standards in a water body that is meeting its water quality standards, (2) to achieve progress in water quality standards in an impaired water body prior to a TMDL being implemented, and (3) to achieve progress in an impaired water body for which a TMDL has been established.

Water Quality Trading Toolkit for Permit Writers in 2007.¹⁸ According to the EPA toolkit, states have the flexibility to structure a trading program to meet state needs including the type of entities allowed to trade; the types of pollutants traded, such as nutrients; and the mechanism for carrying out the trades. Additionally, the legal and policy framework for trading programs can vary.

The Clean Water Act does not explicitly identify trading as an option to comply with NPDES permits. According to EPA's guidance, however, the act provides authority for EPA and states to develop a variety of programs and activities to control pollution; including trading programs, provided that these programs are consistent with the act. For instance, trading must not violate any of the act's provisions, such as the anti-degradation policy, which maintains and protects the existing uses of water bodies, or the anti-backsliding policy, which prohibits the modification of existing NPDES permits with less stringent standards than those established in the previous permit.

Eleven States Had Nutrient Credit Trading Programs in 2014, and Trading Provided Flexibility for Some Point Sources to Meet Nutrient Discharge Limits in the 3 States We Reviewed

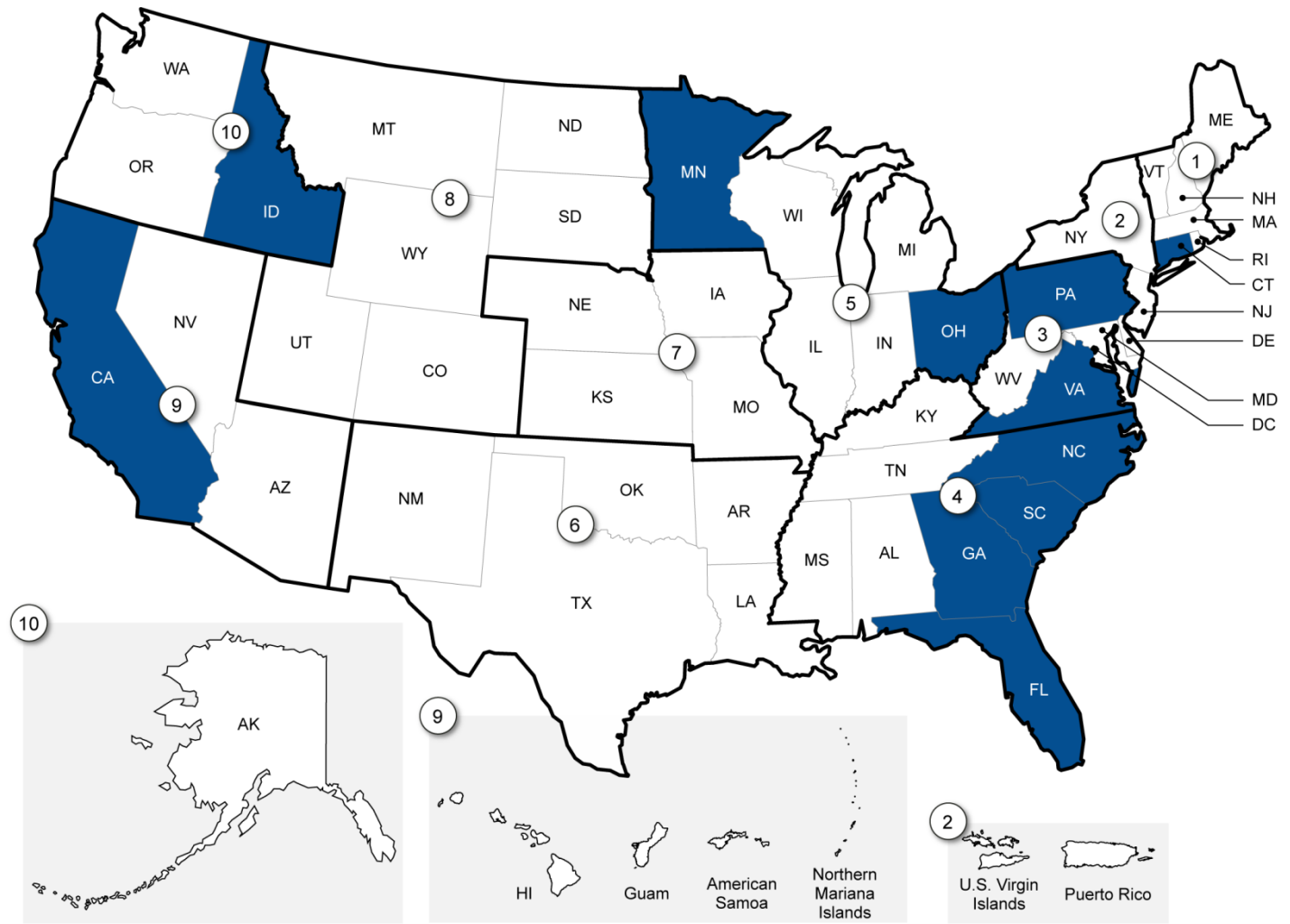
According to EPA data and interviews with EPA officials, in 2014, a total of 19 nutrient credit trading programs existed in 11 states. The majority of nutrient credit trades occurred in 3 states—Connecticut, Pennsylvania, and Virginia. Most point sources participating in these 3 state programs in 2014 did not purchase credits. However, EPA and state officials and stakeholders told us that trading provided point sources with flexibility that allowed them to manage risk, reduce the cost of compliance, and better manage the timing of upgrades of their nutrient removal technology.

¹⁸This toolkit specifically focuses on providing states with guidance on how to authorize and incorporate trading into NPDES permits.

Eleven States Had a Total of 19 Trading Programs in 2014, and 3 States Accounted for the Majority of Trades, According to EPA

In 2014, a total of 19 nutrient credit trading programs existed in 11 states, according to EPA data and interviews with EPA officials. These 11 states were California, Connecticut, Florida, Georgia, Idaho, Minnesota, North Carolina, Ohio, Pennsylvania, South Carolina, and Virginia. Three of the states—Georgia, Minnesota, and North Carolina—had more than one nutrient credit trading program. Each program covered a specific watershed, portion of a watershed, municipality, or permit holder (see fig. 2). See appendix II for a list of the 19 programs.

Figure 2: States with Nutrient Credit Trading Programs in 2014 by EPA Region



States with nutrient credit trading programs as of 2014
 EPA region

Sources: GAO analysis of Environmental Protection Agency (EPA) data; Map Resources (map). | GAO-18-84

EPA documents and officials indicated that trading may be less viable in some locations than in others. EPA’s documentation discusses factors that can affect the viability of trading. For example, trading should occur within an area—such as a watershed—that is appropriately defined to ensure that trades will maintain water quality standards within that area.

In a 2008 evaluation of water quality trading, EPA identified other location-specific conditions that influence whether trading occurs, including the regulatory environment, the nature of participants, and watershed characteristics. EPA officials in Region 9 explained, for example, that they do not see strong demand for nutrient credit trading in their region because there are not many nutrient impaired watersheds with a favorable combination of point sources that need credits and willing credit generators.

Trading activity varied among the 19 programs. According to EPA data, not every state with a trading program had trades in 2014. According to EPA data and officials, the majority of nutrient credit trades occurred in 3 states—Connecticut, Pennsylvania, and Virginia—which were also the largest programs in terms of the number of participating point sources. According to state data and officials, the number of trades in these states in 2014 ranged from 31 to 151. (See table 1.)

Table 1: Number of Nutrient Credit Trades and Participating Point Sources in Selected States in 2014

State, watershed	Number of trades	Number of participating point sources
Connecticut, Long Island Sound	39	79
Pennsylvania, Chesapeake Bay	151	204
Virginia, Chesapeake Bay	31	136

Source: GAO analysis of state information. | GAO-18-84

Note: Data for Connecticut and Virginia are for calendar year 2014. Data for Pennsylvania are for its water compliance year, which ran from October 1, 2013, through September 30, 2014.

Under EPA guidance, each state has the flexibility to establish or approve a nutrient credit trading program or programs to meet its own situation. The three programs we reviewed are each structured somewhat differently. Specifically, see the following:

- Connecticut adopted legislation for a nutrient trading program in 2001.¹⁹ The state also issued a general permit in 2002 that allows 79

¹⁹Connecticut’s trading program legislation was established by Public Act No. 01-180, § 3 (2001), codified at Conn. Gen. Stat. § 22a-521-27.

point sources in the Long Island Sound watershed to trade nitrogen credits. Connecticut's program does not allow nonpoint sources to generate credits. All nutrient credit trades are automatically processed annually by the state credit exchange, known as Connecticut's Nitrogen Credit Exchange Program. Connecticut state officials explained that, at the end of the year, the exchange compares each point source's total pounds of nitrogen discharged to its discharge limit. Each point source that discharges less than its limit receives a payment from the exchange. Each point source that discharges more than its limit—and thus would be out of compliance with the general permit if it failed to secure credits in a timely manner—is billed for the credits needed to bring it into compliance with its discharge limits. Because these transactions are conducted annually, the number of trades reported for Connecticut in 2014 is the same as the number of participating point sources that purchased credits in 2014.

- Pennsylvania established its trading policy and guidance in 2005.²⁰ The state issues individual NPDES permits to point sources that allow for trading both nitrogen and phosphorus credits in the Chesapeake Bay watershed. In this program, both point sources and nonpoint sources may generate credits to sell to point sources for compliance with permit limits. Like Connecticut, Pennsylvania has an exchange for buying and selling credits, which is called PENNVEST. Unlike Connecticut, the exchange does not automatically conduct trades at the end of the year. Instead, point sources and nonpoint sources can choose whether to use the exchange to buy or sell credits, or whether to conduct sales outside the exchange.²¹ Pennsylvania officials told us that sales typically occur outside the exchange. According to Pennsylvania officials, the proportion of trades going through the exchange has been less than 10 percent annually since 2014.

²⁰Pennsylvania's policy was established in the Nutrient and Sediment Reduction Credit Trading Interim Final Policy and Guidelines, which was finalized in 2006. In 2010, Pennsylvania codified its trading policy in state legislation through 25 Pa. Code § 96.8 entitled "Use of offsets and tradable credits from pollution reduction activities in the Chesapeake Bay Watershed."

²¹According to Pennsylvania officials, any trades conducted through PENNVEST would still have to be approved by the Pennsylvania Department of Environmental Protection.

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- Virginia established its trading program through state legislation in 2005.²² The state uses a general NPDES permit that allows point sources within the Virginia portion of the Chesapeake Bay watershed to trade nitrogen and phosphorus credits. The general permit does not normally allow point sources to use credits generated by nonpoint sources for compliance with the general permit.²³ Point sources covered under this permit generally trade with each other through the Virginia Nutrient Credit Exchange Association, although there can be a handful of bilateral trades, according to Virginia officials and state data.

Most Point Sources Participating in the Three State Programs We Reviewed Did Not Purchase Credits, but Trading Provided Flexibility, According to Officials

In the three states we reviewed, most point sources participating in the trading programs did not purchase credits to meet nutrient discharge limits, according to state data and officials. Officials from each state explained that many point sources have upgraded their nutrient removal technology in order to help them meet discharge limits. For example, from 2002, when Connecticut's trading program began, through 2014, 53 of the 79 point sources in Connecticut's trading program had invested in new technology to improve nutrient removal, according to state documents. As a result, many of those point sources generate nutrient reductions that they can sell as credits and do not usually need to purchase credits, according to state data and officials. Most point sources in the three states we reviewed did not purchase credits in 2014. (See table 2.)

²²In Virginia, the authority for trading and offsets to account for new and expanded sources is provided for in Va. Code § 62.1-44.19:12 and implemented through two regulations: 9 Va. Admin. Code § 25-720 (the Water Quality Management Planning Regulation), and 9 Va. Admin. Code § 25-820 (the General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia (Virginia Watershed General Permit).

²³In certain limited circumstances involving offsets, nonpoint source credits may be used. For instance, according to Virginia state officials, point sources are allowed to use nonpoint source credits to offset discharges as required under a separate statewide program involving new or increased nutrient discharges in excess of established discharge limits that result from either facility expansion or new development.

Table 2: Number of Point Sources Participating in the Trading Programs That Purchased Credits in Selected States in 2014

State	Number of point sources in the trading program	Number of point sources that purchased credits	Percentage of point sources that purchased credits
Connecticut	79	39	49
Pennsylvania	204	60	29
Virginia	136	19	14

Source: GAO analysis of state information. | GAO-18-84

Note: Data for Connecticut and Virginia are for calendar year 2014. Data for Pennsylvania are for its water compliance year, which ran from October 1, 2013, through September 30, 2014.

The percentage of point sources in those trading programs that did purchase credits to meet discharge limits ranged from 14 to 49 percent, depending on the state. Specifically, see the following:

- In Virginia, 14 percent of point sources in the trading program purchased credits in 2014—the lowest percentage in the states we reviewed. Virginia officials told us that few point sources purchased credits because many point sources upgraded their nutrient removal technology before implementing the TMDL in anticipation of the stricter discharge limits and were able to meet discharge limits without purchasing credits.
- In Pennsylvania, 29 percent of point sources in the trading program purchased credits in 2014. Officials in Pennsylvania told us, however, that the demand for credits has continued to drop as point sources upgrade their nutrient removal technology. They said that most point sources that were planning to upgrade have done so.
- In Connecticut, 49 percent of point sources in the trading program purchased credits in 2014—the highest percentage of the states we reviewed. According to Connecticut’s 2014/2015 program report, the number of point sources that bought credits in 2014 was due to (1) increased discharges from three large wastewater treatment facilities that were under construction that year and (2) cold weather that affected the ability of point sources to remove nutrients from their discharges using biological processes. For comparison, 35 percent of point sources bought credits in Connecticut in 2015. A member of the Nutrient Credit Exchange Advisory Board in Connecticut told us that since the program began in 2002, the number of point sources that have needed to buy credits has generally decreased over time as these facilities have upgraded their nutrient removal technology. State

officials expect this trend to continue in the future as more point sources complete their technology upgrades.

For the point sources that did purchase credits in 2014, state officials in the three states we reviewed told us that the total amount (in pounds) of nutrients that point sources purchased as credits to meet their individual discharge limits was generally small relative to the aggregate discharge limits (see table 3). In addition, the number of credits purchased by point sources was generally much less than the number of credits generated (see table 4). However, because the three programs collect data differently, we could not make comparisons across all three states for both measures. Specifically, for two of the states—Connecticut and Virginia—we were able to compare the amount (in pounds) of nutrients purchased to the aggregate discharge limit, but we did not have comparable data for Pennsylvania. For the number of credits purchased relative to the number of credits available, we were able compare the data for Pennsylvania and Virginia, but we could not make the comparison for Connecticut. Nevertheless, the available state data show that the amount (in pounds) of nutrient credits purchased in these three programs in 2014 was generally small.

Table 3: Amount (in Pounds) of Nutrient Credits Purchased by Point Sources Relative to Aggregate Discharge Limit in Selected State Programs in 2014

State (nutrient)	Pounds of credits purchased to meet individual discharge limits	Aggregate discharge limit (in pounds)	Pounds of credits purchased as percentage of aggregate discharge limit
Connecticut (nitrogen)	645,000	3.3 million	20
Virginia (nitrogen)	164,000	19.0 million	1
Virginia (phosphorus)	35,000	1.6 million	2

Source: GAO analysis of state information. | GAO-18-84

Note: Pounds refers to delivered pounds (also called equalized pounds), which is the number of pounds of discharge after accounting for the natural attenuation of a nutrient as it travels through water before it reaches the impaired water body. In these programs, one credit equals one delivered or equalized pound of a nutrient.

Pennsylvania could not provide comparable figures for the number of pounds of nitrogen and phosphorus credits purchased in 2014.

This table is not meant to imply that the maximum number of credits traded could equal the aggregate discharge limits. See table 4 for the number of credits that could have been traded.

Table 4: Nutrient Credits Purchased by Point Sources and Credits Generated in Selected State Programs in 2014

State (nutrient)	Number of credits purchased	Number of credits generated
Pennsylvania (nitrogen)	805,000	1.9 million
Pennsylvania (phosphorus)	85,000	111,000
Virginia (nitrogen)	164,000	6.0 million
Virginia (phosphorus)	35,000	797,000

Source: GAO analysis of state information. | GAO-18-84

Note: Connecticut could not provide comparable figures for the number of credits available in its program in 2014.

The state data for 2014 showed that the amount of nutrient credits purchased in these three programs was generally small. Specifically, see the following:

- Point sources participating in Connecticut’s nutrient credit trading program in 2014 purchased about 645,000 pounds of nitrogen credits to meet individual discharge limits. In total, point sources in the program had an aggregate discharge limit of about 3.3 million pounds for nitrogen. Point sources in Connecticut purchased the most pounds relative to the aggregate discharge limit among the states we reviewed—about 20 percent. However, in 2014, point sources removed far more nutrients—5.3 million pounds of nitrogen—than the 645,000 pounds purchased.
- Point sources participating in Virginia’s nutrient credit trading program in 2014 purchased about 164,000 pounds of nitrogen credits and 35,000 pounds of phosphorus credits to meet individual discharge limits. In total, point sources in the program had an aggregate discharge limit of about 19 million pounds for nitrogen and 1.6 million pounds for phosphorus. Therefore, the pounds of nitrogen and phosphorus traded in Virginia in 2014 represented about 1 percent and 2 percent, respectively, of the aggregate discharge limit for these nutrients. In addition, the number of credits purchased by point sources in Virginia was less than the number of credits generated. Specifically, point sources in Virginia purchased about 164,000 nitrogen credits out of 6 million nitrogen credits generated, and about

35,000 phosphorus credits out of 797,000 phosphorus credits generated.

- Officials in Pennsylvania told us that the amount of nutrients traded in their program was small relative to the aggregate discharge limits, but they could not provide data in terms of pounds that we could use to make the comparison. However, data from Pennsylvania show that the number of credits purchased by point sources was generally much less than the number of credits generated. Specifically, point sources in Pennsylvania purchased about 805,000 nitrogen credits out of 1.9 million nitrogen credits generated, and about 85,000 phosphorus credits out of 111,000 phosphorus credits generated.

In the three states we reviewed, most credits sold were generated by point sources, not nonpoint sources. As previously discussed, Pennsylvania was the only state we reviewed that allowed nonpoint sources to generate and sell credits. Of the credits sold in Pennsylvania, a relatively small percentage was sold by nonpoint sources. Specifically, nonpoint sources sold 36 percent of all nitrogen credits purchased in 2014 and 11 percent of all phosphorus credits. According to state officials, there were seven nonpoint source sellers of credits, including at least four sellers that aggregate credits generated by multiple agricultural operations.

Although most point sources in these states did not buy credits in 2014, EPA officials, state officials, and point source stakeholders told us that nutrient credit trading was important because it gave point sources flexibility in meeting nutrient discharge limits. According to officials and stakeholders, this flexibility allowed point sources to manage risk, reduce the cost of compliance, and better manage the timing of upgrades of point sources' nutrient removal technology. Specifically, see the following:

- **Managing risk.** Although each point source's permit contains specific discharge limits, a point source's actual discharge varies from year to year. For example, an official from the Virginia Nutrient Credit Exchange Association explained that point sources will forecast their anticipated discharge over a 5-year period. However, there can be considerable variance from the forecast for any given year because of, for example, unpredictable weather, which can upset biological nutrient removal processes. Therefore, nutrient trading gives point sources insurance against unexpectedly high discharges by allowing them to "true up" at the end of the year by buying credits from point sources that discharged below their limits. This reduces the risk that an individual point source faces noncompliance with its permitted limit.

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- **Reducing the cost of compliance.** Stakeholders said that upgrading nutrient removal technology to meet discharge limits is economically feasible for some point sources but is potentially unaffordable for point sources with fewer financial resources and smaller economies of scale. For example, one point source credit buyer in Connecticut told us that the buyer's facilities had invested in upgrading nutrient removal technology, but any additional upgrades to meet the discharge limits would not be economically feasible. The buyer explained that, within a trading program, those point sources with lower pollution control costs can generate additional reductions in pollution, which they can use to generate credits to sell to those point sources with higher pollution control costs. As a result, trading can make nutrient reduction efforts more cost-efficient system-wide.
 - **Managing the timing of upgrades.** Trading helps point sources better manage the timing of upgrades to their nutrient removal technology, according to state officials and point source stakeholders. For example, a point source stakeholder in Virginia told us that it would have been difficult for all point sources to upgrade at once to meet the new discharge limits established in the NPDES permit under the TMDL, since there was a limited pool of engineers and construction companies that could install these upgrades, and that trading gave point sources time to schedule upgrades over several years. Additionally, in Pennsylvania, a point source credit buyer explained that the point source planned to complete a multi-year \$34 million upgrade of its facilities in 2017 to meet discharge limits that came into effect in October 2012. To meet discharge limits in the meantime, the point source developed a program to purchase nitrogen credits from local nonpoint sources that would implement cover crop conservation practices to generate the necessary reductions. Therefore, trading allowed the point source to meet discharge limits during the period it was planning and completing the upgrade.

Although nutrient credit trading has provided point sources with flexibility in meeting discharge limits, trading is not responsible for reducing nutrient pollution, according to EPA, state, and other stakeholders. These stakeholders told us that pollution reduction largely results from nutrient discharge limits in permits and the nutrient removal technology that point sources invest in to meet or reduce below those limits.

States Oversee Nutrient Credit Trading Programs by Approving and Verifying Credit Generation, and EPA Reviews Permits That Allow for Trading

States oversee nutrient credit trading programs by approving and verifying credit generation to ensure that credits represent real nutrient pollution reductions. EPA reviews permits, conducts periodic evaluations of point source facilities to ensure that trading is consistent with the Clean Water Act, and issues national-level guidance for nutrient credit trading.

States Approve and Verify Credit Generation

States oversee nutrient credit trading programs by approving and verifying credit generation to ensure that credits represent real nutrient pollution reductions. A state's approval and verification process varies depending on whether the credit generator is a point or nonpoint source. For point sources, the states we reviewed followed a process for verifying credits that is based on the existing oversight process for NPDES permits. Because nonpoint sources do not have NPDES permits, states use a separate process to approve and verify that nonpoint sources' pollution reduction activities have generated credits for trading.

Process for Approving and Verifying Point Source Credits

States we reviewed approve credit generation by point sources by including language that allows for trading in point sources' individual or general NPDES permits.²⁴ In Connecticut and Virginia, point sources covered under the states' general permits are automatically approved to generate nutrient credits for trading. In Pennsylvania, point source facilities with language that allows for trading in their individual permits and that meet requirements in the state's watershed implementation plan are approved to generate credits.²⁵ In all three states, the language that allows for trading in these permits includes the individual discharge limit

²⁴According to EPA's 2003 *Water Quality Trading Policy*, the Clean Water Act and federal regulations provide authority to incorporate provisions for trading into NPDES permits issued to point sources.

²⁵Pennsylvania's Chesapeake Watershed Implementation Plan – Phase 1 was prepared in 2011 to address EPA's expectations for the Chesapeake Bay TMDL. Pennsylvania updated the plan in 2012, and in 2016 included a supplement for nutrient trading that further specifies the requirements for point source credit generation.

for each point source, which is called a baseline, for trading purposes.²⁶ An approved point source is able to generate credits when it reduces its discharge below its baseline.

To verify point source credits, the states we reviewed each use an oversight process based on its NPDES authority to oversee permits that include discharge monitoring and reporting, and inspections. Federal regulations require point sources with NPDES permits to periodically monitor compliance with the effluent limitations established in their permits and report the results to the permitting authority.²⁷ Specific monitoring and reporting requirements, including the frequency of monitoring, are included in each permit. State officials in the three states we reviewed all told us that they use discharge monitoring reports to determine how many credits a point source has generated. For example, according to the terms of the general permit for nutrient discharges in Virginia, point sources must sample nitrogen and phosphorus from one time per month to three times per week, depending on the volume of discharge. By February 1 of each year, point sources must submit total annual nitrogen and phosphorus discharges to the Virginia Department of Environmental Quality using a discharge monitoring report, which covers discharges during the previous calendar year. State officials in Virginia told us that they review these reports for data quality and determine which point sources generated credits and which point sources must buy credits to meet discharge limits. Any credits that point sources intend to use for compliance during the previous calendar year must be purchased by June 1.

In addition, state officials in all three states told us that they conduct periodic inspections of point source facilities to ensure that facilities are appropriately monitoring and reporting nutrient discharges as required under their permits. For example, officials in Pennsylvania told us that for point sources, the state's Department of Environmental Protection conducts periodic inspections of point sources to ensure that they are meeting requirements that allow them to generate credits. These officials said that they generally inspect each facility at least once per year.

²⁶According to EPA guidance, baselines for generating pollution reduction credits should be derived from and consistent with water quality standards. For example, where EPA has established or approved a TMDL, the applicable baseline limits are the wasteload allocation for point sources.

²⁷40 C.F.R. §§ 122.41(j), 122.44(i) (2017).

Process for Approving and Verifying Nonpoint Source Credits

In Pennsylvania, according to state officials and program documents, such as state regulations, a nonpoint source that seeks to generate credits must submit a request for credit certification. The request includes a description of how the nonpoint source intends to reduce nutrient pollution, such as through a BMP, and information about steps the nonpoint source will take to verify the credits including any relevant calculations, maps, and photographs. State officials review the request for technical acceptability and consistency with program requirements before approving credit generation.²⁸

To verify nonpoint source credits after the credit-generating activity has taken place, officials in Pennsylvania told us that they review information about the performance of that activity, such as a BMP. According to the Pennsylvania Department of Environmental Protection's website, officials review documentation to ensure that the credit-generating activity was implemented as described in the verification plan submitted with the certification request, and that all program requirements are met. In addition to reviewing documentation, officials may conduct activities such as monitoring the credit-generating activity, inspecting sites, and performing compliance audits. For example, as part of the verification process, a nonpoint source credit generator official told us that they had to provide before and after photos of the cover crop that was intended to prevent nutrient pollution in a local water body. They said that they provided documentation that the crops were planted at a certain time and were the appropriate types of crops. In addition, they provided calculations related to the crops planted and types of soil they were planted in, before the credits could be verified.

EPA Reviews Permits and Conducts Periodic Evaluations of Point Source Facilities to Ensure That Trading Is Consistent with the Clean Water Act

EPA oversees trading programs as part of its oversight of NPDES to ensure that they are fully consistent with the Clean Water Act and its implementing regulations, in particular when questions or concerns arise, according to EPA policy. EPA officials told us that they conduct oversight primarily through the regional offices, which (1) review NPDES permits; (2) review and comment on state regulatory frameworks for trading; and (3) evaluate point source facilities by collecting discharge information and

²⁸In order to be eligible to generate credits in the Pennsylvania nutrient credit trading program, nonpoint sources must comply with state trading rules and regulations. Depending on the nonpoint source this might require generators to write erosion and sediment control plans, or to establish and maintain a minimum of 35 feet of permanent vegetation between the field and body of water at the location of credit generation.

conducting periodic on-site inspections to ensure, for example, that sampling and record keeping practices are in order. Additionally, EPA headquarters provides national-level guidance and training to state programs and stakeholders.

Review of NPDES Permits

According to EPA officials, EPA's regional offices review NPDES permits that allow for trading to ensure that these permits meet the standards of the Clean Water Act and are consistent with EPA's policy and guidance on trading. The regional offices can object to these permits, if necessary. EPA can request changes to permits to ensure that they align with federal requirements. Although EPA does not review every NPDES permit, it will generally review permits that allow for trading because these permits could be considered more complicated, controversial, or challenging, according to EPA officials.

In the states we reviewed, officials told us that EPA has reviewed NPDES permits that allow for trading and has at times requested that states make changes to the permits. For example, officials in Pennsylvania told us that EPA has reviewed 180 permits from large facilities in the state's trading program and objected to 14 of them, requiring state officials to modify those permits. Officials in Virginia said that EPA has reviewed its general permit that allows for nutrient credit trading. Virginia officials said that, during the most recent EPA review, the agency issued a formal objection to the permit and asked the state to increase the sampling frequency in the permit's monitoring guidelines. As a result, Virginia modified the permit to satisfy EPA's request.

Review of State Regulatory Frameworks for Trading and Evaluation of Facilities

In addition to reviewing NPDES permits, EPA regional officials told us that they review and comment on states' regulatory frameworks for trading. Officials said that they review these frameworks to identify any issues in developing and implementing the programs and that they request that state permitting agencies make changes when necessary. For example, in 2012, EPA Region 3 completed reviews of all six states and the District of Columbia in the Chesapeake Bay watershed, including the trading programs for both Virginia and Pennsylvania. After reviewing Pennsylvania's trading program, EPA raised concerns about the state's calculation of the baseline for nonpoint source credit generation. In response to EPA's concerns, officials in Pennsylvania told us that they made changes in the way nonpoint source credits are calculated.

EPA's involvement in reviewing state trading frameworks can vary, according to EPA and state officials. For example, because of specific authorities written into the Chesapeake Bay TMDL, EPA Region 3 plays a

very active role in reviewing state trading programs, according to officials from Region 3. By comparison, Connecticut state officials told us that since EPA Region 1 granted its initial approval of Connecticut's trading program, there has been little direct involvement by EPA in overseeing the program.

Stakeholders in the states we reviewed and EPA regional officials told us that EPA conducts periodic evaluations of point source facilities by collecting discharge monitoring data and conducting inspections.²⁹ Officials at EPA Region 3 told us that they conduct inspections of facilities, review records and sampling procedures, and evaluate credit generators. A nutrient credit generator in Pennsylvania told us that EPA has audited the facility's process for converting nutrient-rich manure into energy, mineral products, and nutrient credits. State officials in Virginia and Connecticut told us that they report nutrient discharge data to EPA for review.

EPA Provides National-Level Oversight

In addition to oversight activities conducted by the regions, EPA conducts some oversight of nutrient credit trading at the national level. EPA's oversight at the national level involves: (1) setting national guidance for trading, (2) offering training on nutrient credit trading to state officials and stakeholders, and (3) periodically collecting some data on nutrient credit trading programs. Specifically, see the following:

- **Guidance.** EPA has issued three documents that provide guidance to states to assist them in developing and implementing nutrient credit trading programs: EPA's 2003 Water Quality Trading Policy; the 2004 Water Quality Trading Assessment Handbook; and the 2007 Water Quality Trading Toolkit for Permit Writers, which EPA updated in 2009.³⁰

²⁹According to EPA guidance, EPA inspects NPDES facilities where it directly implements the program (i.e., in states without NPDES permitting authority) and sometimes conducts inspections in states with NPDES permitting authority at the request of states to complement the states' own inspection efforts. EPA guidance states that the primary role of a NPDES inspection is to gather information that can be used to determine the reliability of a facility's self-monitoring data and evaluate compliance with permit conditions, applicable regulations, and other requirements.

³⁰Some trading programs predate EPA's guidance. For example, Connecticut's trading program began in 2002 before EPA issued its policy on nutrient credit trading. Both Pennsylvania and Virginia began their trading programs in 2005, after EPA's policy was issued but before EPA issued the toolkit for permit writers.

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- **Training.** EPA has offered training for NPDES permit writers to help them better understand how to write NPDES permits that incorporate provisions for nutrient credit trading, according to EPA officials. EPA and USDA also sponsored a 3-day water quality trading workshop in September 2015 in Lincoln, Nebraska, on a range of different subjects related to water quality trading. According to the workshop’s summary document, over 200 attendees participated, including water resource professionals; third-party environmental market makers; academics; representatives of federal, state, and local governments; representatives of non-governmental organizations; and agricultural and environmental stakeholders.
 - **Data collection.** According to EPA officials, there is no requirement for permittees to report data about trading programs at a national level and EPA has no systematic way to collect this information. However, EPA manually collects some trading data, such as the names of programs with permits that allow for trading, which provides the agency with a general understanding of the extent to which trading is being used nationally. Officials told us that they plan to update national trading data at least every 2 years and make them available online in the fall of 2017.

The Presence of Discharge Limits and the Challenges of Measuring Nonpoint Sources’ Nutrient Reductions Affect Participation in Trading Programs, According to Stakeholders

Stakeholders cited two key factors that have affected participation in nutrient credit trading—the presence of discharge limits for nutrients and the challenges of measuring nutrient reductions resulting from nonpoint sources’ implementation of BMPs.

First, officials from the three states we reviewed, and other stakeholders we interviewed, cited the importance of discharge limits for nutrients as a driver to create demand for nutrient credit trading. Without such a driver, point sources have little incentive to purchase nutrient credits. According to EPA guidance, discharge limits—most commonly established in a TMDL—are the leading driver for nutrient credit trading markets.³¹ For the Pennsylvania and Virginia programs, the nutrient discharge limits are established in the Chesapeake Bay TMDL. For the Connecticut program, nutrient discharge limits are established in the Long Island Sound TMDL. The TMDL nutrient discharge limits are ultimately translated into discharge limits in the NPDES permits for point sources.

³¹EPA guidance notes that state regulations may be another driver for trading. For example, the primary regulatory driver for point sources that participate in Wisconsin’s Red Cedar River trading program is chapter NR 217 of the Wisconsin Administrative Code.

Pennsylvania officials explained how discharge limits serve as a driver for trading. Officials stated that although the state established its nutrient trading program in 2005, the TMDL for Chesapeake Bay was not established until 2010. Officials noted that in the first years of the program, little trading took place because point sources did not have to meet nutrient discharge limits. Once EPA established the TMDL for the Chesapeake Bay—and Pennsylvania established discharge limits for point sources in the NPDES permits—demand for nutrient credit trading increased, according to Pennsylvania officials. Officials explained that if point sources had not yet upgraded their nutrient removal technology, and could not meet the NPDES permit discharge limits, they could buy nutrient credits to comply with discharge limits. EPA officials added that demand for trading could increase over the long term because of economic or population growth.

In addition to programs in the three states, we also reviewed a program in the Ohio River Basin where nutrient credit trading activity has been limited, according to program officials.³² This multi-state trading program allows point and nonpoint sources in Ohio, Indiana, and Kentucky to generate and sell nutrient credits, and was designed as a pilot to test nutrient credit trading in case discharge limits were established. Program officials told us that while some credits have been generated and sold, participation in the program has been limited because there is no requirement—in either a TMDL or numeric water quality standards—for the point sources in these states to meet discharge limits. As the program is currently implemented, they said that credits are not purchased by point sources to comply with discharge limits but rather by corporations to meet internal sustainability goals or by philanthropists who want to invest in BMPs that address nutrient pollution in the Ohio River Basin.

Unlike point sources, the Clean Water Act does not require nonpoint sources to meet nutrient discharge limits established in TMDLs or numeric water quality standards, and as a result, EPA said there is no federal regulatory driver creating demand for nonpoint sources to participate in nutrient credit trading programs.

³²This program is known as the Ohio River Basin Interstate Water Quality Trading Project. We did not count this program on our list of nutrient credit trading programs because none of the participating states have discharge limits in their NPDES permits. However, we included this program in our review because it illustrates the importance of discharge limits for trading programs.

The second factor affecting participation in trading programs relates to the challenges of measuring nutrient reductions that result from nonpoint sources' implementation of BMPs. According to EPA officials and guidance, federal and state agencies typically do not directly monitor nonpoint source pollution or the effectiveness of BMPs because the diffuse nature of nonpoint source pollution makes monitoring costly and impractical. Instead, agencies and other stakeholders rely on models to estimate the amount of pollution discharged by nonpoint sources and the effectiveness of BMPs. These models incorporate information about variables such as land use, soil type, and precipitation to estimate the amount of nutrients that will be reduced as the result of implementing a specific BMP. Even with these models, EPA guidance recommends that the programs use a rule that calls for nonpoint source credit generators to generate credits at a greater than a one-to-one basis to account for uncertainties in modeling.³³ According to this guidance, the rule can also mitigate other uncertainties such as how well BMPs are designed and maintained and the risk of a BMP failing to produce the expected results.

In part because of this uncertainty, two of the states we reviewed did not allow nonpoint sources to generate credits in their programs. State officials in Connecticut told us that it was easier for Connecticut to implement nutrient trading with point sources, as their discharges are easy to quantify.³⁴ State officials in Virginia told us that point source to nonpoint source trading is complicated and they felt that they could meet their TMDL reduction goals solely with point source reductions.

Pennsylvania does allow nonpoint sources to generate and sell credits but the state has developed a rule to help address some of these uncertainties. Specifically, Pennsylvania implemented a rule in 2016 requiring nonpoint sources to generate three nutrient credits for every nutrient credit sold. This rule was developed as an interim step to address EPA's concern that the state's calculation of the baseline for nonpoint source credit generation was not consistent with the reductions needed to meet the Chesapeake Bay TMDL goals. Pennsylvania's rule, however, appears to have reduced the use of nonpoint source credits. State program data show that in 2016 approximately 115,000 nitrogen credits

³³This rule is known as an uncertainty ratio.

³⁴Connecticut officials also told us that in addition to being easier to get reductions from point sources, point sources also accounted for the largest portion of nutrient pollution in the Connecticut portion of the Long Island Sound TMDL. Therefore, program officials decided to build the program around point sources.

were available from nonpoint sources after the implementation of the rule, almost one-third the approximately 381,000 nitrogen credits that were available in 2014. An official at a wastewater treatment facility in south central Pennsylvania told us that the rule increased the cost to generate nonpoint source credits and reduced the number of nonpoint source credits available in Pennsylvania's trading program. Specifically, to meet its discharge limits in 2014, this facility purchased approximately 75,000 nitrogen credits, 52,000 of which were generated from local farmers who installed BMPs on their land. In 2016, after the rule was implemented, the same facility purchased 95,000 nitrogen credits, only 5,000 of which were generated from local farmers. According to the point source officials, they could no longer rely solely on purchasing credits generated from local farmers because there were fewer nonpoint source credits available to purchase in 2016. To meet the discharge limit, this facility purchased the remaining credits they needed from other point sources because nonpoint source credits were not available. Pennsylvania officials told us that the decline in the number of nonpoint source credits is mostly due to the new rule. However, they said that other factors such as the low price of credits have also decreased the incentive to generate nonpoint source credits.

According to EPA officials, the program should implement a stricter baseline, based on the pollution reduction targets established in the Chesapeake Bay TMDL. Pennsylvania officials told us that if they make the baseline requirements stricter, there may be no incentive for nonpoint sources to generate credits because it would be much more difficult to meet the minimum requirements and the cost of generating credits would be prohibitive.

State officials and stakeholders also told us that even if a program allows nonpoint sources to trade, point sources often prefer to trade with other point sources because they have similar permit and monitoring requirements and are both legally liable for meeting discharge limits. Trading between point sources provides buyers with the assurance that the credits they purchase represent actual reductions and can be used for compliance with an NPDES permit.

Agency Comments

On September 12, 2017, we provided a draft of this report to EPA for review and comment. On September 29, 2017, EPA responded by email stating that its Office of Water had reviewed the draft report and EPA had no comments.

We are sending copies of this report to the appropriate congressional committees, the Administrator of the Environmental Protection Agency, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff members who made key contributions to this report are listed in appendix III.

Sincerely yours,

A handwritten signature in black ink that reads "Alfredo Gómez". The signature is written in a cursive style with a large, stylized 'G'.

J. Alfredo Gómez
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

This report (1) examines the extent to which nutrient credit trading programs have been used and what the outcomes of the programs have been, (2) describes how states and the Environmental Protection Agency (EPA) oversee nutrient credit programs, and (3) describes what key factors stakeholders view as affecting participation in nutrient credit trading.

To examine the extent to which nutrient credit trading programs have been used and what the outcomes of the programs have been, we first spoke with EPA headquarters and EPA regional officials and reviewed EPA data. EPA does not have a formal definition for water quality trading programs, of which nutrient credit trading is a subcategory, and is not required to keep information on these programs. EPA periodically gathers some limited information on trading programs, including the type of trading program, location, facilities participating, and estimated trades. The most recent data EPA had at the time we conducted our review were for 2014. EPA officials explained that the completeness and consistency of the data reported by states to EPA varied somewhat. For example, not all programs reported trading data for calendar year 2014. To verify the accuracy of EPA's list of trading programs, we interviewed or e-mailed officials from all 10 EPA regions to confirm the presence or absence of trading programs in each state in 2014. For the 7 EPA regions with some form of trading program in their regions, we interviewed regional officials to gather more information about the type of trading conducted and whether there was trading activity in 2014.

Using EPA's information as a starting point, we developed a modified list of nutrient credit trading programs that existed in 2014. For our modified list, we excluded two programs, one from Region 5 and one from Region 10, from EPA's data that did not trade nutrient credits. Based on our discussion with EPA officials, we also excluded trading programs that let residential septic system owners "trade" credits to encourage wastewater treatment facilities to take their systems online. We also excluded one program that included three states—the Ohio River Basin Interstate Water Quality Trading Project—because none of the participating states have discharge limits in their permits. In the process of interviewing EPA regions, we also added one program from Region 4 and two programs from Region 5 that EPA officials told us had been inadvertently left off EPA's 2014 list.

From this list, we then selected a nongeneralizable sample of the three nutrient credit trading programs—Connecticut, Pennsylvania, and Virginia—which appeared to have done the most trading and had the

most participating point sources in 2014 for a more detailed examination. Because these programs were judgmentally selected, the results of our review of these programs cannot be generalized. For these three programs, we reviewed state laws and regulations, National Pollutant Discharge Elimination System (NPDES) permits, watershed implementation plans, program rules and policies, annual summaries of nutrient credit purchases and sales, and assessments of state trading programs when available. We also interviewed state and program officials and other stakeholders, such as point source and nonpoint source credit generators and buyers, to gather information on the programs, including structure, participants, number and type of trades, authorizing mechanisms, and outcomes.

Specifically, to determine the number of trades we asked each state for its official list of trades from 2014, the most recent year for which we could get complete data from all programs. We counted each time a point source purchased credits as one trade. In addition, we asked states to provide us the number of point sources that purchased credits and the number of point sources in the trading programs, which we used to determine the percentage of point sources that purchased credits. The states post the number of point sources that purchased credits online, and the number of point sources in the program is identified in state documents.

We also asked the states for the number of credits purchased and the aggregate discharge limit for point sources to determine the percentage of credits purchased in pounds of nutrients relative to the aggregate limit. The aggregate discharge limit is the maximum allowable discharge for point sources in the program. Because this limit represents the maximum amount of pollution allowable to meet water quality standards, it served as a point of reference for comparing the amount of discharge that was traded. We took these numbers from state records, and they are derived from the total maximum daily load, according to EPA policy. According to Virginia and Connecticut officials, in their programs one credit is equal to one equalized or delivered pound of pollution—that is, a pound of pollution after accounting for the delivery ratio. Pennsylvania could not provide us the number of pounds purchased. According to Pennsylvania officials, a nutrient credit does not equal a pound of pollution in their program because they use trading ratios, such as delivery ratios. This means that credits generated from different sources represent different nutrient reductions depending on where they are relative to the polluted water body. However, the aggregate discharge limit does not represent the pounds of nutrients that could have been traded, since the volume of

trading was limited by the supply of credits, which was less than the aggregate discharge limit in Virginia and Pennsylvania. Specifically, to show this, we used state data on the number of credits generated and compared them with the number of credits purchased. Connecticut does not have data on the number of credits available. To assess the reliability of the state data, we visually reviewed the data for completeness and interviewed state officials responsible for collecting and using data about their quality assurance protocols and their confidence in the data. We found the data to be sufficiently reliable for our purposes and confirmed all final numbers with state officials.

We interviewed state program officials in all three states to better understand the extent to which nutrient credit trading programs have been used and what the outcomes have been. During these interviews, we discussed the management of the programs, reviewed state trading data, and discussed the benefits and challenges of nutrient credit trading. We visited Pennsylvania to meet with program officials and stakeholders. Specifically, we met a representative of a credit aggregator that buys and sells credits from nonpoint source generators and toured a wastewater treatment facility that generates credits and a facility that generates nutrient credits by processing chicken manure into energy. We also spoke with buyers and sellers of nutrient credits in Connecticut and officials from the nutrient credit exchange in all three states. We did not audit these state trading programs or analyze their effectiveness or efficiency in meeting discharge limits or water quality standards.

We also conducted a literature review of academic and economic journals. We searched peer-reviewed journals for articles published from 2011 through 2016 discussing water quality trading or nutrient credit trading. We did not find any additional trading programs in the United States that had not already been identified.

To describe how states and EPA oversee nutrient credit programs, we reviewed relevant federal laws, regulations, and EPA policies and guidance related to nutrient credit trading. We reviewed state requirements for implementing the NPDES program, under the Clean Water Act and implementing regulations, which defines responsibilities applicable to states that serve as permitting authorities for overseeing point source permittees' monitoring and reporting. These same authorities are used by states to oversee state trading programs. The Clean Water Act does not specifically authorize water quality trading, according to EPA officials; however, EPA has developed trading guidance for states interested in developing trading programs. We reviewed this guidance,

specifically, EPA's 2003 Water Quality Trading Policy and 2007 Water Quality Trading Toolkit for Permit Writers. We also reviewed state documents, such as watershed implementation plans, that identify trading program rules, and interviewed state officials and other stakeholders for our nongeneralizable sample of three nutrient credit trading programs. In our interviews we asked state officials how they oversee their trading programs. In particular, we asked how they approve point and nonpoint sources to generate credits, verify that a credit represents a real reduction in nutrient pollution, and monitor the buying and selling of credits to ensure that permit obligations are met. We also interviewed officials from EPA's Office of Water and the 7 EPA regions with nutrient credit trading programs and asked them to describe EPA's oversight role at the regional and national level.

To describe what key factors stakeholders view as affecting participation in nutrient credit trading, we spoke with officials from EPA's Office of Water, the 7 EPA regions with nutrient credit trading programs, and officials and stakeholders from the nongeneralizable sample of three nutrient credit trading programs. In addition, we reviewed documents and interviewed officials for one nongeneralizable multi-state trading program in the Ohio River Basin. We reviewed this program to better understand the key factors that can affect participation in nutrient trading programs. We interviewed officials from the institute that developed the program and corresponded with state officials from Kentucky and Ohio, two of the states involved in the Ohio Basin program. Finally, we interviewed representatives of stakeholder groups, such as those representing wastewater treatment facilities, national organizations for water issues, and agricultural conservation districts to get a broad perspective on the key factors that affect participation in nutrient credit trading programs.

Appendix II: Nutrient Credit Trading in the United States in 2014

We identified 19 nutrient credit trading programs in 11 states and seven Environmental Protection Agency regions, in 2014.¹The 11 states that had programs are: California, Connecticut, Florida, Georgia, Idaho, Minnesota, North Carolina, Ohio, Pennsylvania, South Carolina, and Virginia (see table 5).

Table 5: Nutrient Credit Trading Programs in the United States in 2014

Program count	Environmental Protection Agency (EPA) region	State	Trading program name
1	Region 1	Connecticut	Connecticut Nitrogen Credit Exchange
2	Region 3	Pennsylvania	Pennsylvania Chesapeake Bay Trading Program
3	Region 3	Virginia	Virginia General Permit for Nutrients
4	Region 4	Florida	Lower St. Johns River Basin Pilot Trading Program
5	Region 4	Georgia	Cobb County
6	Region 4	Georgia	City of Atlanta
7	Region 4	North Carolina	City of Greensboro
8	Region 4	North Carolina	City of Burlington
9	Region 4	North Carolina	Charlotte Mecklenburg Utilities District
10	Region 4	North Carolina	Neuse River Basin Compliance Association
11	Region 4	South Carolina	Western Carolina Regional Sewer Authority
12	Region 4	South Carolina	Saluda River Aggregate Phosphorus Allocation
13	Region 4	North Carolina	Tar-Pamlico
14	Region 5	Minnesota	Rahr-Malting Company
15	Region 5	Ohio	Alpine Cheese Company
16	Region 5	Minnesota	Southern Minnesota Beet Sugar Cooperative
17	Region 5	Minnesota	Minnesota River General Phosphorus Permit
18	Region 9	California	Santa Rosa Nutrient Offset Program
19	Region 10	Idaho	Idaho Water Quality Pollutant Trading Program

Source: GAO analysis of EPA information. | GAO-18-84

¹The Ohio River Basin Interstate Water Quality Trading Project is a single program even though it exists in multiple states (Ohio, Indiana, and Kentucky). We did not count this as a nutrient credit trading program because point sources in these states do not have nutrient discharge limits in their permits.

Appendix III: GAO Contact and Staff Acknowledgments

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Staff Acknowledgments

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