Final Environmental Assessment

for

Mattamuskeet National Wildlife Refuge Cyanobacteria Treatment in Lake Mattamuskeet

March 2024

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Final Environmental Assessment for Cyanobacteria Treatment in Lake Mattamuskeet

Date: March 2024

This Final Environmental Assessment (EA) is being prepared to evaluate the effects associated with the proposed action and complies with the National Environmental Policy Act in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (43 CFR 46; 516 DM 8) and U.S. Fish and Wildlife Service (550 FW 3) regulations and policies. The National Environmental Policy Act (NEPA) requires examination of the effects of proposed actions on the natural and human environment. Appendix A outlines all law and executive orders evaluated through this Environmental Assessment.

Proposed Action

The U.S. Fish and Wildlife Service (Service) is proposing to conduct a pilot study of a treatment of cyanobacteria, also known as blue-green algae, using a sodium percarbonate-based algaecide, Lake Guard® Oxy, in Lake Mattamuskeet at Mattamuskeet National Wildlife Refuge (MNWR). This treatment is intended to reduce the cyanobacteria populations to allow for the re-establishment of beneficial algae and phytoplankton communities and to increase water clarity in portions of Lake Mattamuskeet. The treatment would take place in a controlled pilot study over approximately 400 acres in several coves around the lake's perimeter, with turbidity curtains effectively isolating the treatment's effects in these areas. The treatment area represents 1% of the lake's 40,276-acre surface area. The treatment would be extensively monitored prior to, during, and after treatment to determine its success in reducing cyanobacteria and to evaluate possible impacts to other resources. Results of the study would be used to evaluate the treatment for use as part of a restoration strategy in other areas of the lake to improve water quality and restore healthy aquatic communities of submerged aquatic vegetation (SAV). Any subsequent treatments on other parts the lake would be subject to additional permitting by the North Carolina Division of Water Resources (NCDWR), and would be subject to all applicable laws, regulations, and policies, including additional review under NEPA.

In addition to serving the refuge's purposes, the proposed action directly supports the below-listed goals and objectives from the refuge's Comprehensive Conservation Plan (CCP) / EA / Finding of No Significant Impact (FONSI) (U.S. Fish and Wildlife Service [USFWS] 2008a, 2008b), Habitat Management Plan (HMP) / Categorical Exclusion (CatEx) / Environmental Action Statement (EAS) (USFWS 2018), and the Lake Mattamuskeet Watershed Restoration Plan (LMWRP, North Carolina Coastal Federation [NCCF] 2019).

CCP:
Objective 1-1: Migratory Waterfowl – Annually provide the foraging, sanctuary, and other biological needs for 200,000+ migratory waterfowl.

Objective 1-2: Fish – Continue to protect fish and their habitats and expand cooperation with universities and other agencies to monitor fish population status; increase applied research especially with regard to baseline surveys and carp management.
Objective 2-1: Open Water Habitat – Maintain 40,276 acre (16,299 hectare) as open water habitat in Lake Mattamuskeet and associated canals. In addition, cooperate with the North Carolina Department of Environment and Natural Resources to develop and implement a SAV [submerged aquatic vegetation] monitoring program for the lake.

HMP:
Goal 4.1: Maintain good water quality and healthy SAV communities in the 40,276-acre (16,299-hectare) Lake Mattamuskeet.

LMWRP:
Goal: Restore water quality and clarity: Reduce nutrients, sediments, and phytoplankton blooms; promote the growth of SAV and remove the lake from the NC 303(d) list of impaired waters; establish and maintain SAV within the lake; enhance and maintain the health of the lake's natural resources (waterfowl and wildlife).
Objective: Determine how to effectively improve and meet water quality standards within the watershed. Actions: Evaluate water quality monitoring results within the lake watershed.

A proposed action is often iterative and evolves over time during the process as the agency refines its proposal and learns more from the public, Native American Tribes, and other agencies. Therefore, the final proposed action may be different from the original proposed action. The final decision on the proposed action will be made after the conclusion of the public comment period for the EA.

Background

National Wildlife Refuges are guided by the mission and goals of the National Wildlife Refuge System (Refuge System), the purposes of an individual refuge, Service policy, and laws and international treaties. Relevant guidance includes the Refuge System Administration Act of 1966, as amended by the Refuge System Improvement Act of 1997 (16 U.S.C. 668dd et seq.), Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations (CFR) and Service Manual.

Mattamuskeet NWR was established in 1934 pursuant to the listed authorities.

- 16 U.S.C. §742f (a) (4) (Fish and Wildlife Act of 1956)
- 16 U.S.C. §715d (Migratory Bird Conservation Act of 1929)
- 48 Statute 195 (National Industrial Recovery Act 1934)
- Executive Order 6924 (December 18, 1934)

The primary purposes of the refuge are listed.

"…as a refuge and breeding ground for birds and wild animals, and (2) that such portions as the Secretary of Agriculture [Interior] may deem proper be reserved for use as a shooting area, to be operated under a cooperative agreement or lease…With regard to the waters…the Secretary of Agriculture [Interior]…may enter into a cooperative agreement or lease…said waters may be used for fishing purposes…" (Executive Order 6924, dated December 18, 1934)

"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 USC 715d (Migratory Bird Conservation Act of 1929)

…for the development, advancement, conservation, and protection of fish and wildlife resources… 16 U.S.C. §742f (a) (4) … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to §742f (b) (1) (Fish and Wildlife Act of 1956)."

The mission of the Refuge System, as outlined by the Refuge System Administration Act, and as amended by the Refuge System Improvement Act, is:

"... to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

The Refuge System Improvement Act mandates the Secretary of the Interior to administer the Refuge System to:

- provide for the conservation of fish, wildlife, and plants, and their habitats within the Refuge System;
- ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans;
- ensure that the mission of the Refuge System described at 16 U.S.C. §668dd(a)(2) and the purposes of each refuge are carried out;
- ensure effective coordination, interaction, and cooperation with owners of land adjoining refuges and the fish and wildlife agency of the states in which the units of the Refuge System are located;
- assist in the maintenance of adequate water quantity and water quality to fulfill the mission of the Refuge System and the purposes of each refuge;
- recognize compatible wildlife-dependent recreational uses as the priority general public uses of the Refuge System through which the American public can develop an appreciation for fish and wildlife;
- ensure that opportunities are provided within the Refuge System for compatible wildlife-dependent recreational uses; and
- monitor the status and trends of fish, wildlife, and plants in each refuge.

In accordance with the purposes of the refuge and the mission of the Refuge System, it is a priority of the Service to provide a healthy aquatic ecosystem at Mattamuskeet NWR by restoring SAV and improving water quality and clarity in Lake Mattamuskeet for the benefit of Service trust species and priority resources of concern. The 50,180-acre (20,307-hectare) refuge is dominated by the 40,276-acre (16,299-hectare) lake, which is a shallow basin ranging from 0.1 to 6 feet (0.03-to 2 meters) deep.

Historically, the lake's vegetation was dominated by SAV, including wild celery (*Vallisneria americana)*, sago pondweed (*Stuckenia pectinate)*, southern naiad (*Najas guadalupensis)*, redhead grass (*Potamogeton perfoliatus)*, and algae *(Chara* spp. and *Nitella* spp). In shallow lake systems such as Lake Mattamuskeet (averaging just 2 feet in depth), an abundance of SAV is a critical component of the aquatic ecosystem as it stabilizes substrate, prevents wind-driven re-suspension of fine sediments, and constitutes critical habitat and food sources for birds, fish, and invertebrates (Geist & Hawkins 2016). The SAV was the primary food source for wintering waterfowl in the area, providing over 34,000,000 energy use days of forage. Collectively, annual wintering waterfowl populations on the lake often exceeded 250,000 ducks, geese, and swans. In 2020, during a revision to update waterfowl objectives for the refuge, calculations determined that the absence of SAV and associated invertebrates and seeds in the lake, compared to values from the literature, resulted in a loss of over 20,000,000 energy use days for waterfowl (Hagy 2019, McCain et al. 2019, Bauer 2018, Gross et al. 2020).

Unfortunately, due to excessive nutrients, reduced flow to Pamlico Sound, and an overabundance of invasive common carp (*Cyprinus carpio*), the lake conditions began to decline in the early 1990s in both water quality and clarity. During this period of decline, water quality monitoring documented increases in nutrients, harmful algae blooms, and turbidity in the lake. A summary of monitoring data collected since 1981 indicates that SAV declines in the lake were attributed to poor water quality and clarity, mainly regarding observed increases in nitrogen and phosphorous content, followed by lake-wide eutrophication – contributing to cyanobacterial harmful algal blooms (cyanoHABs) – and an overabundance of invasive carp. The increased turbidity and decreased water clarity from these phytoplankton and suspended sediments prevent sunlight penetration, which is required for SAV to germinate and photosynthesize. The excessive nutrients shifted the lake from a clear lake dominated by SAV to a turbid lake dominated by phytoplankton, like cyanobacteria (Moorman et al. 2017). By 2017, refuge staff were unable to locate a single plant during the annual SAV survey. Having suffered a total loss of SAV, the Lake Mattamuskeet substrate is barren today (Moorman et al. 2017). In 2016, NCDWR listed the lake on the 303(d) list of impaired waters due to high pH and chlorophyll-*a*, both of which are indicators for cyanoHABs which produce cyanotoxins (U.S. Environmental Protection Agency [USEPA] 2016).

In a multi-stakeholder effort to improve water quality in Lake Mattamuskeet, the Service, North Carolina Wildlife Resources Commission (NCWRC), Hyde County, North Carolina Coastal Federation (NCCF), and local stakeholders collectively drafted the LMWRP, which was released

in 2018 with an Addendum approved in 2019 (NCCF 2019). The plan includes Best Management Practices (BMPs) and strategies to improve Lake Mattamuskeet's water quality and restore SAV to the lakebed. The stakeholder team continues to pursue implementation of the plan's goals and objectives.

In 2022 the Service was approached by the University of North Carolina Institute of Marine Sciences (UNC-IMS) and BlueGreen Water Technologies (BlueGreen), who were evaluating water bodies in North Carolina for a pilot study of a cyanobacteria treatment. After further discussions, the project team determined that Lake Mattamuskeet was their preferred site for the study. The Service recognizes the potential of the proposed study to inform restoration efforts and help achieve goals identified in the LMWRP (NCCF 2019).

For clarity, the Service relies on the listed four tiers of analysis for the use of pesticides on a unit of the National Wildlife Refuge System.

- Pesticide specific analysis by the U.S. Environmental Protection Agency;
- Pesticide specific analysis through the Service's Pesticide Use Proposal (PUP) process;
- Analysis of pesticide use in general for a specific NWR or NWR complex through an EA / FONSI or EIS / Record of Decision (ROD); and
- Analysis of pesticide use in general through an Environmental Action Statement (EAS) that documents the pesticide use planned for a particular NWR or NWR complex.

The Service only considers the use of EPA-registered pesticides, which means that we only consider the use of pesticides that have undergone appropriate EPA risk assessment and have been released on the market for use as outlined on the label. Pesticide specific analysis is conducted by the Service through its PUP process, which includes impacts analysis under the Endangered Species Act and may include Best Management Practices (BMPs) and conditions more restrictive than a pesticide's label requirements. Pesticide use in general was analyzed in the refuge's CCP/EA/FONSI (USFWS 2008a, 2008b) and HMP/CatEx/EAS (USFWS 2018). This EA provides additional analysis specific to the proposed pilot study and the use of Lake Guard® Oxy.

Purpose and Need for the Action

The purpose of this proposed action is to treat cyanobacteria (i.e., trigger a population collapse of cyanobacteria) within four isolated bays totaling 400 acres (1%) on Lake Mattamuskeet, in compliance with the refuge purposes and establishing legislation. The need for this action is to evaluate the effectiveness of a cyanobacteria treatment and the role it may play in restoring the ecosystem integrity of the lake (i.e. improving water quality and clarity, re-establishing SAV, and re-establishing populations of green algae within the pilot study areas). Concurrently, extensive monitoring using a Before-After Control-Impact (BACI) experimental design will be conducted by independent researchers at UNC-IMS. The results of this study would be used to determine the effectiveness of cyanobacteria treatments and their possible environmental

impacts within these pilot study areas of Lake Mattamuskeet. Cyanobacteria treatments may be a valuable component of a larger effort to improve the lake's biological integrity, diversity, and environmental health. Treating these algal blooms may be an important step in SAV restoration, which is imperative for the refuge to meet its goals and objectives in its CCP (USFWS 2008), HMP (USFWS 2018), and the LMWRP (NCCF 2019).

Alternatives

Alternative A – Continuance of Current Management Practices (No Action)

Under Alternative A, a cyanobacteria treatment would not occur, and refuge management would continue without changes. Control of cyanobacteria would be solely dependent on indirect approaches to reduce the excessive nutrients that cause the cyanobacteria blooms. The refuge does not control or regulate off-refuge nutrient inputs. Drainage from the watershed is allowed to flow through existing canals and enter the lake, so efforts to redirect drainage or reduce these inputs are dependent on voluntary actions by landowners and other partners. The Service would continue to pursue the completion of projects to reduce nutrient inputs from the watershed, recognizing that such projects often involve multiple partners, require lengthy planning and design, and are dependent on available funding.

Under Alternative A, the proposed pilot study and treatment would not be implemented on Lake Mattamuskeet and thus, the potential to improve water quality and clarity in the pilot study areas through the application of an algaecide would not be tested. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake would also be lost. The proposed management action would not be implemented and would not contribute to meeting the goals and objectives in the refuge's CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment within Lake Mattamuskeet Using Lake Guard® Oxy (Proposed Action)

Under the Proposed Action Alternative B, the refuge would implement a pilot study of a cyanobacteria treatment within Mattamuskeet NWR. The treatment phase could occur over one consecutive nineteen-month period with treatments occurring only between April 1 and October 31. Treatments would be subject to permits from the NCDWR and applied in accordance with a Service Special Use Permit (SUP) issued by the Service on an annual basis. To ensure that specific conditions and restrictions outlined in the EA/FONSI are followed in order to minimize adverse impacts, the Service would require permits for both BlueGreen and UNC-IMS as part of the proposed pilot study. Lake Guard® Oxy was reviewed and approved through the Service's Pesticide Use Proposal system, which included a separate Section 7 biological evaluation under the Endangered Species Act.

The treatment would occur in four bays – two in the West Basin and two in the East Basin for a total of 400 treated acres or 1% of the total surface area of the lake. Each bay would be

separated from the remainder of the lake by turbidity curtains extending from the water surface to the lake bottom. Each of the bays would have another similar bay to act as a control, having a turbidity curtain but not receiving treatment (Figure 2, Appendix B). UNC-IMS would provide independent monitoring before, during, and after the treatment (see Appendix C). The results of this monitoring would allow UNC-IMS to provide an independent evaluation of the treatment's success and an assessment of any positive or negative impacts to water quality and ecosystem health.

To reduce the likelihood of negatively impacting wildlife, monitoring efforts will be employed, and several restrictions would be imposed on the methods of application. First, application will be limited to the time period of April 1 through October 31. Limiting application in the treatment bays to this time period will minimize the likelihood that large numbers of waterfowl will come in contact with the product. It will also minimize disturbance associated with treatment activities to waterfowl present on and around the lake during the winter months. Additionally, to ensure the product is effectively placed in the appropriate location, only boat application will be allowed. This application method will ensure that all pellets make immediate contact with water and begin to dissolve as soon as dispersed, limiting unnecessary exposure to wildlife. Monitoring efforts will also be independently conducted by the Service during treatment activities. Monitoring will occur during daylight hours from the time of dispersal until the product is dissolved. If birds or other wildlife are present in areas where undissolved product is present, or move to those areas during this monitoring period, they will be "hazed", i.e., disturbed to the point of leaving the area. Bird and other wildlife observations and any hazing activity will be recorded by those monitoring the area. In addition, applicators will be required to monitor levels of pH and dissolved oxygen (DO) which will be verified by the Service during treatments. Treatments will be stopped if DO drops below 4 mg/L for more than 8 hours or below 2 mg/L for any length of time. Treatments will be stopped if pH drops below 6 or exceeds 10.5. If these thresholds are exceeded, the technical advisory group will be consulted on treatment modifications that would avoid future exceedances before treatments could resume.

Application of Lake Guard® Oxy depends on water quality characteristics during the period of treatment. BlueGreen will assess these characteristics through their own monitoring efforts that are separate from the independent monitoring conducted by UNC-IMS. Treatments will be guided by current detailed satellite imagery data analysis and monitoring efforts via 38 autonomous probes to capture the turbidity, temperature, chlorophyll-b (Chl-b, used as indication of the total biomass of green algae), phycocyanin (PC, used as indication of the total biomass of cyanobacteria), and conductivity. These data would be used to create a BlueGreen Intelligence Map, a proprietary mapping tool from BlueGreen, used to track and target cyanobacterial bloom locations, duration, and intensity. With these monitoring efforts, the treatment would be timed and customized to fit Lake Mattamuskeet's unique characteristics, minimizing the amount of algaecide required to meet the goal of collapsing the cyanobacteria population, and to track subsequent blooms for preventive treatments. As a result, the

treatment process must be adaptive in terms of rates, timing, and frequency so prescriptive details cannot be provided in advance, only a general approach.

Data collected on algal bloom activity during 2023 by the array of monitoring probes and satellite imagery analysis, indicated several bloom periods during spring and summer with the most prevalent bloom of cyanobacteria occurring in mid-summer (Rozman 2024). Actively tracking these cycles and timing an initial treatment to occur just prior to a cyanobacteria bloom, will more effectively target harmful cyanobacteria as opposed to beneficial phytoplankton. Cyanobacteria cell counts will be closely monitored following initial treatments to determine if supplemental treatments are warranted. A minimum two-week period will be maintained between treatments to allow the full effect of each prior treatment to be realized. Supplemental treatments would use lower dosages to further suppress cyanobacteria cell density to an acceptable level of less than 20,000 cells/mL. If needed, additional maintenance treatments may be implemented to maintain low cyanobacteria cell densities through the end of the treatment period.

As indicated by the label for Lake Guard® Oxy and Table 1 in Appendix B, the dosage for each treatment is dependent on the cyanobacteria cell density. Table 2 in Appendix B shows a more specific Treatment Protocol for Lake Mattamuskeet based on the different cell count scenarios that will be encountered. This adaptive approach will ensure that the minimum amount of product required would be used. Based on results of several toxicity tests, explained more fully in the impacts sections below, the maximum single dosage rate to be used will be 50 pounds per acre of Lake Guard® Oxy.

The results of this experimental approach would establish the efficacy of the product, the specific needs for Lake Mattamuskeet, and the effects of the product on the ecosystem. A technical advisory group consisting of staff from UNC-IMS, BlueGreen, NCDWR, and the Service, in coordination with the Lake Mattamuskeet Technical Working Group, would evaluate the results and provide recommendations on whether to pursue additional cyanobacteria treatments in other parts of the lake. Subsequent treatments in other areas of the lake would be subject to additional permitting by the NCDWR and the Service as well as requirements under NEPA.

Affected Environment and Environmental Consequences

Lake Mattamuskeet's size and strategic location along the Atlantic Flyway make it the area's premiere overwintering site for migratory waterfowl. The priority species and identified resources of concern (ROCs, in Fiscal Year 2020 Memo from Refuge System Chiefs for biological planning and identifying ROCs on refuges) for the lake include tundra swans (*Cygnus columbianus)*, dabbling ducks (e.g., American wigeon [*Mareca americana]* and gadwall [*M. strepera*]), and diving ducks (e.g., ring-necked duck [*Aythya collaris]* and redhead [*A. americana]*). Species of concern include wintering and migratory waterfowl, long-legged wading birds (breeding and wintering), nesting ospreys (*Pandion haliaetus*), and anadromous

and catadromous fish that depend on a healthy lake ecosystem to complete their life cycles. Lake Mattamuskeet also provides habitat and food resources for a plethora of wetland-dependent wildlife throughout the year, namely nesting habitat for osprey, great blue heron (*Ardea herodias)* rookeries, and resting and feeding areas for long-legged wading birds and shorebirds. Beneath the surface, Lake Mattamuskeet supports several economically and ecologically valuable freshwater fish, such as largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and bluegill (*Lepomis macrochirus*). Lake Mattamuskeet is connected to the Pamlico Sound through four main drainage canals. This unique connection creates a corridor for use of lake habitats by diadromous fish and crustacean species, including the identified ROC alewife (*Alosa pseudoharengus*), the American eel (*Anguilla rostrata*), and the blue crab (*Callinectes sapidus),* which are highly regarded for their relatively large size. This level of biodiversity has long promoted a healthy stream of public interest, attracting over 58,000 visitors annually who use the refuge for educational and recreational activities such as hunting, fishing, crabbing, and wildlife observation (Frew et al. 2018).

Collectively, Lake Mattamuskeet's rich history, cultural significance, and biodiversity make it a unique and invaluable public destination for Hyde County and North Carolina. However, since the 1990s, due to excessive nutrients and high turbidity, the clear water and abundance of SAV has shifted to an algal-dominated, hyper-eutrophic system with high turbidity, poor water quality, and an overabundance of invasive carp. This has resulted in a public outcry to restore the health of the lake and prompted the development of the LMWRP (NCCF 2019).

This section analyzes the environmental consequences of each alternative on the affected resources, including direct and indirect effects as well as cumulative impacts. This EA only includes the written analyses of the environmental consequences on a resource when the impacts on that resource could be more than negligible and therefore considered an "affected resource." The following resources either (1) do not exist within the project area or (2) would either not be affected or only negligibly affected by the proposed action: geology and soils, air quality, floodplains, wilderness, and cultural resources. If a future action should cause ground disturbance, the Service would follow all regulations and policies related to managing cultural and historic resources. For more information regarding the affected environment, please see Section 2.2.1 *Lake Mattamuskeet* of the refuge's HMP, which is incorporated herein by reference (USFWS 2018).

Terrestrial Wildlife and Aquatic Species

Affected Environment

Description of Affected Environment for the Affected Resource

The refuge and its surrounding waters support many species of resident and migratory fish and wildlife. Of these, 48 species are fish, 145 are birds, 48 are reptiles and amphibians, and 40 are mammals. The refuge supports wildlife species that are important from both a regional and a national standpoint. Its large size and vegetative diversity make the refuge a haven for species that require aquatic and wetland habitats.

The refuge is situated roughly at the midpoint of the Atlantic Flyway and is a valuable feeding and resting area for numerous species of wintering waterfowl. Tundra swans, coots, and more than 25 duck species winter either on the refuge or in the sounds and rivers adjacent to the refuge. Populations of migratory waterfowl peak from November through February.

Lake Mattamuskeet provides over 40,000 acres of open water for resting, feeding, and escape cover. The most prevalent wintering species are found in Lake Mattamuskeet, moist-soil units, and refuge marshes and include northern pintail *(Anas acuta*), green-winged teal (*Anas carolinensis)*, gadwall, American wigeon, mallard (*Anas platyrhynchos*), and American black duck (*Anas rubripes*). Other species wintering or migrating on the refuge and surrounding waters may include blue-winged teal (*Anas discors*), ring-necked duck, northern shoveler (*Spatula clypeata*), greater scaup (*Aythya marila*), lesser scaup (*Aythya affinis*), canvasback (*Aythya valisineria*), ruddy duck (*Oxyura jamaicensis*), redhead, bufflehead (*Bucephala albeola*), hooded merganser (*Lophodytes cucullatus*) and red-breasted merganser (*Mergus serrator*). Tundra swan numbers increased steadily to a peak of over 30,000 birds counted during the mid-winter survey in 2008. Since this time, mid-winter counts have decreased to under 10,000 swans recorded in 2016, with a notable decline in the number of swans observed on the lake. This could potentially be attributed to the loss of SAV that has occurred during this period.

Although celebrated primarily for its waterfowl, Mattamuskeet NWR also provides habitat for formerly listed species, such as the bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus anatum*). During the summer months, the refuge provides important habitat for breeding ospreys, herons, wood ducks, and other migratory bird species.

Submerged aquatic and emergent vegetation in the lake provide an important nursery habitat and refuge for migratory fish, blue crabs, and other aquatic invertebrates. Anadromous fish and blue crabs can enter the lake through the water control structures when the gates are open. In addition, resident finfish require aquatic habitat of adequate depth and structure, good water quality, appropriate salinity levels, and access to the habitats in which they spawn.

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

Water quality degradation caused by excessive nutrients and sediment entering the lake, an overabundance of carp, and harmful algal blooms continues unabated. Rising water levels in the Pamlico Sound and sediment-filled drainage canals continue to reduce drainage of the lake, causing it to function much like a sediment basin. Unconsolidated sediment continues to accumulate in the lake and is readily resuspended by the bottom-feeding behavior of common carp as well as wind and wave action. Algal blooms also cover the lake surface and block light from reaching the SAV, meaning that the vegetation cannot photosynthesize (Moorman et al. 2017). Consequently, each of these factors contribute to high light attenuation resulting in an environment unconducive to SAV establishment and growth. The loss of this SAV-dominated ecosystem has had notable negative effects on fish and wildlife resources.

Restoration of the SAV community is one of the goals identified in the LMWRP, which includes several strategies and BMPs. The likely reduction of cyanobacteria in the pilot areas under the proposed action could temporarily improve water clarity to a level suitable for SAV growth and reestablishment which could help address some of the priority concerns identified in the LMWRP (NCCF 2019). Reducing cyanobacteria through the application of an algaecide is one strategy being considered that could be part of a larger restoration plan. The project would be conducted concurrently with BMPs and other ongoing stakeholder efforts to reduce nonpoint source nutrient loading to the lake. Additionally, the refuge is currently working with a contractor to conduct a massive removal of invasive common carp, which would remove a source of turbidity and help to improve water clarity and quality, thereby further enhancing the possible benefits of a cyanobacteria treatment.

Impacts on Affected Resource

Alternative A – No Action

Treatments of the harmful algal blooms using Lake Guard® Oxy would not occur or be evaluated and cyanobacteria would continue to dominate the treatment areas unless other measures are successfully implemented. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake by improving water quality and clarity would also be lost. The refuge would not take this step towards the fulfillment of the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019) to evaluate a possible method of helping restore SAV and a healthy aquatic ecosystem. As a result, short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat for wildlife, especially aquatic species, unless other measures are successfully implemented. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

While treatment of the cyanobacteria with this product is expected to temporarily improve water quality in the four treatment bays, there are potential adverse impacts to wildlife to be considered. The Environmental Protection Agency (EPA) label for Lake Guard® Oxy indicates that it is toxic to birds. This statement was originally used in the EPA's Registration Document for the active ingredient used in Lake Guard® Oxy (USEPA 2002). This original product was intended to be applied to terrestrial environments, presumably making it more accessible to ingestion by birds. The EPA's Biopesticides Registration Document states:

> The end-use product is to control algae, moss and slime molds and is sold for use on lawns and ornamental plants around residences, and for horticultural and commercial use, as shown on the label of the product. When applied in accordance with directions on the label, the unstable nature of the chemical accounts for the use of the product without harm to birds and other terrestrial animal species. In the presence of water, the active ingredient rapidly breaks down to hydrogen peroxide and sodium carbonate, and

hydrogen peroxide rapidly breaks down, on contact, to water and oxygen, neither of which presents toxicological concern (USEPA 2002).

Lake Guard® Oxy is a granular product that would be applied directly to the water surface and expected to fully dissolve within a matter of hours, limiting the likelihood of consumption by wildlife. There are no research studies available addressing whether birds would consume hydrogen peroxide (H_2O_2) or sodium percarbonate, the active ingredient in Lake Guard® Oxy (correspondence between BlueGreen and NCDWR 2023). Multiple studies show that the cells of birds and bats are remarkably resistant to the oxidative stress brought on by H_2O_2 (Ogburn et al. 1998; Brunet-Rossinni 2004). Additionally, veterinary medicine has found H_2O_2 to be an effective emetic in dogs, with mild adverse effects (e.g., lethargy and nausea, Khan et al. 2012).

BlueGreen recently had toxicity tests performed on mallards (*Anas platyrhynchos)* and bobwhite quail (*Colinus virginianus)* to determine the acute LD50. The initial tests conducted on the mallards were unsuccessful because the mallards regurgitated the product, so the decision was made to complete the tests on bobwhite quail. Results calculated the LD50 for bobwhite quail to be 2472 milligrams active ingredient per a kilogram of body weight with a 95 percent confidence that the LD50 is greater than 1921 mg active ingredient per a kilogram of body weight (Blue Green, personal communication, January 15, 2024). This provides an LD50 of 539 mg active ingredient if we assume an average weight of 218 g for a bobwhite quail. Lake Guard® Oxy would need to be applied at a rate of 50 pounds per an acre in order for product to be present at a rate of approximately 510 mg per a square foot (assuming 98% active ingredient). Based on these toxicity results, the Service is limiting application rates of Lake Guard® Oxy to a maximum of 50 pounds per acre during the proposed cyanobacteria treatment on Lake Mattamuskeet.

For fish, treatment using H_2O_2 has been instrumental in sanitization efforts against such diseases as columnaris and has been used as a safe emetic for largemouth bass (Bowker et al. 2013; Speare & Arsenault 1997; Miranda 1986). Furthermore, they have observed that fish have actively avoided the product, which has been attributed to the nociceptors in their mouths detecting the small amounts of H_2O_2 being slowly released into the water (correspondence between BlueGreen and NCDWR 2023).

There is limited data from most of the previous applications of Lake Guard® Oxy but two applications in the U.S. provide some insights on impacts to terrestrial and aquatic species. BlueGreen Technologies monitored 2000-acre Lake Minneola during a previous pilot study that was conducted over a seven-month period. Their results suggest treatment was successful in preventing cyanobacteria blooms and toxins during the period, dissolved oxygen levels remained above 50% and pH remained above 5 standard units (BlueGreen Technologies 2021). A review of data and observations from the application of Lake Guard® Oxy in Lake Anna, VA, by the Lake Anna Civic Association suggests similar results. Dissolved oxygen did not fall below 50 percent saturation or 4 milligrams per a liter and pH levels remained above 6 standard units following treatments (Lake Anna Civic Association 2022b, Lake Anna Civic Association 2022a).

At Lake Anna, observers were actively monitoring for wildlife mortality each day following the treatment until the capsules dissolved. No evidence of a fish kill was observed with only one dead striper reported by the observers during the multiple treatments that occurred over the course of the summer season (Lake Anna Civic Association 2022a). In all study reports, no observation of wildlife consumption or illness was noted (Lake Anna Civic Association 2022b, BlueGreen Technologies 2021). Experiences at Lake Minneola, Florida and Lake Anna, Virginia suggest that Lake Guard Oxy can provide effective short-term reductions of cyanobacteria and cyanotoxins when applied according to labelled dosage instructions with no apparent negative impacts to birds, fish, and other aquatic species.

To evaluate Lake Guard Oxy's effect on the zooplankton community, an acute toxicity test (modified LC50), using water from Lake Mattamuskeet, was conducted on *Ceriodapnia,* a small aquatic invertebrate commonly used in toxicity tests to determine a product's effect. The results of the toxicity test indicated a half maximal inhibitory concentration (IC50) of 37.5 mg/L, which means that 50% of the *Ceriodaphnia* organisms had biochemical or biological functions inhibited at the concentration of 37.5 mg/L of Lake Guard® Oxy. However, in consulting the aquatic toxicologist at the Division of Water Resources of North Carolina Department of Environmental Quality, the recommendation was to use the test's resulting Chronic Value of 36.7 mg/L of product as the maximum use limit (MUL) when applying Lake Guard® Oxy. As indicated by the product label and Table 1 (see Appendix B), all dosage rates fall under this MUL except for the highest doses, in which case the treatment area would be reduced by half. It is worth mentioning that on Lake Guard Oxy's product label, which is certified to NSF/ANSI/CAN/60, there is a MUL of 33 mg/L when using the product to meet drinking water standards. Therefore, the Chronic Value of 36.7 mg/L resulting from the *Ceriodaphnia* toxicity test is above the MUL 33 mg/L that is listed on the Lake Guard Oxy product label, further emphasizing the relative safety of the product regarding sensitive aquatic organisms like *Ceriodaphnia*. Per the results of the acute toxicity tests, 36.7 mg/L would be the maximum dose concentration or MUL allowed for the proposed treatment. However, as stated previously, the Service is limiting application rates of Lake Guard® Oxy to a maximum of 50 pounds per acre which equates to a sodium percarbonate concentration of approximately 5 mg/L, well below the MUL derived from toxicity testing for *Ceriodaphnia*.

Another potential adverse effect from this project would be the temporary disturbance to waterfowl, nesting ospreys, and heron rookeries from boat traffic associated with treatments and monitoring. Due to the loss of SAV in the lake, bird use along the shoreline and in the bays proposed for initial treatment is lower than in years when SAV was present. Most waterfowl using the lake in winter are in large open water areas where disturbance from monitoring activities would be limited. Disturbance associated with treatments should be minimal since treatments will be limited to April to October when most migratory waterfowl are not present. Terrestrial and aquatic species may temporarily avoid or move away from areas of activity, which would be limited to an estimated 40 days/year and 8 hours/day during treatment and monitoring activities. As described in the description of Alternative B, Service staff will monitor the treatment area and haze any birds using areas where undissolved product exists to

minimize the potential for ingestion of the pellets by birds or for prolonged exposure. Bird presence and hazing activities will be recorded. As a result of these measures, impacts would be expected to be minimal and temporary.

The 38 autonomous probes for the monitoring efforts prior to a potential treatment were installed in January 2023 under SUP R23-001, with special conditions to ensure the right of the refuge to revoke or revise BlueGreen's methodology to accommodate the needs of the wildlife and aquatic species. There is routine maintenance associated with the probes that requires boating to the locations of the probes approximately monthly. Additionally, SUP R23-003 with special conditions was issued to UNC-IMS to conduct routine independent monitoring and water sampling (Figure 3, Appendix B). Both permits require notice to the refuge prior to the visit, and the disturbance to the wildlife and aquatic species would be monitored closely. If at any point the monitoring efforts cause undue disturbance to the habitat and/or wildlife, the refuge would re-evaluate the methodology and make necessary changes to ameliorate the issues.

A second SUP to BlueGreen would be required for them to conduct the proposed treatment. In addition to the limitations mentioned above, the SUP would include a general stipulation that if at any point application of the product itself caused unreasonable harm to the habitat and/or wildlife, the refuge would re-evaluate the methodology and make necessary changes. As noted above in the description of Alternative B, thresholds have been established for pH and DO. Both parameters will be monitored during treatments, and if thresholds are exceeded, treatments will be stopped until normal conditions return. The technical advisory group will be consulted on treatment modifications that would avoid future exceedances.

The potential beneficial effects of this project would be: 1) a temporary increase in water clarity in the pilot area by reducing the cyanoHABs, 2) decreased cyanotoxins, 3) increased green algae, and, perhaps, 4) increased biodiversity of fish. The increased water clarity could potentially allow for the regrowth of SAV in the 400 acres of bays identified for the pilot study which were some of the last areas in the lake to lose SAV. As noted, SAV provides essential habitat for fish and other aquatic life and an important food source for waterfowl. The reduction of cyanobacteria populations and the associated cyanotoxins would reduce this threat to wildlife and public health in the 400-acre treatment area. Additionally, one study found that a diversity of green algae species proved to be a strong competitor against dominant cyanobacteria (Nolan & Cardinale 2019). Thus, this treatment would have the potential to reduce the cyanobacteria to the point that beneficial green algae species could effectively compete and control the cyanoHABs. Finally, BlueGreen has observed in some of their previous projects that there was an increased biodiversity in fish species found after the cyanobacteria populations collapsed (correspondence between BlueGreen and NCDWR 2023). For instance, following treatment using Lake Guard® Oxy in Lake Minneola in Florida, the Florida Fish and Wildlife Conservation Commission noticed that the largemouth bass populations showed increasing trends in weight, length, and biomass post-treatment, indicating that the treatment

did not negatively affect the fish populations and may instead have had a positive impact (Rozman et al. 2022).

Successful implementation of the proposed action is expected to improve water quality and clarity, and possibly promote reemergence and successful restoration of SAV in the four bays to be treated. Further, hydrogen peroxide cyanobacteria treatments would be evaluated to determine their suitability as a tool for restoration in other parts of Lake Mattamuskeet. In addition, the monitoring associated with the pilot study would provide valuable information on the status and impacts of cyanobacteria blooms and associated cyanotoxins in the lake and shed light on options for reducing those impacts. Monitoring efforts could also reveal new information and help inform all of the projects and strategies intended to support the restoration of Lake Mattamuskeet.

Threatened and Endangered Species, and Other Special Status Species

Affected Environment

Description of Affected Environment for the Affected Resource

The refuge supports several species of special status. The state endangered American peregrine falcon primarily uses the grassland and wetland habitats on the refuge. The federally endangered red wolf (*Canis rufus*) can occur on the refuge but has not been documented along the perimeter of the lake where the treatment would take place as there is more suitable habitat for the red wolf in other areas of the refuge. There are no known red wolves with established territory using the refuge. The secretive, federally threatened eastern black rail (*Laterallus jamaicensis jamaicensis*) has not been recorded on the refuge, but there is marsh habitat that may be suitable for them. The following federally threatened species may occur but have not been documented on the refuge: rough-leaved loosestrife (*Lysimachia asperulaefoliaI),* red-cockaded woodpecker (*Picoides borealis*) rufa red knot (*Calidris canutus rufa*), and piping plover (*Charadrius melodus*). In 2021, the federally threatened sensitive joint-vetch (*Aeschynomene virginica*) was planted in Farm Area 2 (FA-2) in a restoration effort on the refuge and was documented again in 2022 in FA-2 with a possible plant in impoundment 10N. Since the treatment would take place solely in the lake, these plants should be far enough away to be undisturbed by the project. There is suitable habitat for the federally endangered northern long-eared bat (*Myotis septentrionalis*), and the proposed tricolored bat (Perimyotis subflavus) but these species have not been documented on the refuge and should not be affected by the proposed cyanobacteria treatment other than through temporary disturbance from vehicle and boat traffic to access the lake. Monarch butterfly (*Danaus plexippus*) is a Candidate species that occurs on the refuge and is most abundant during migration. This species primarily uses upland grassland habitats. The American alligator (*Alligator mississippiensis*) is listed as threatened due to similarity in appearance to other listed crocodilian species that do not occur on the refuge. Bald eagles are frequently observed on the refuge, especially in winter, and might experience minor temporary disturbance from noise and boat traffic. Their use of the lake has diminished with a decrease in water quality and a

decrease in prey species using the lake. Nesting has occurred on the refuge in the past but there are currently no known nest sites.

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

Water quality degradation and the subsequent loss of the SAV community has had notable negative effects on numerous fish and wildlife resources including Threatened, Endangered, and Special Status species. Restoration of the SAV community is one of the goals identified in the LMWRP, which includes several strategies and BMPs. Additionally, the refuge is currently working with a contractor to remove invasive common carp which would remove a source of turbidity and help to improve water clarity and quality.

Impacts on Affected Resource

Alternative A – No Action

Treatments of the harmful algal blooms using Lake Guard® Oxy would not occur or be evaluated and cyanobacteria would continue to dominate the treatment areas unless other measures are successfully implemented. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake by improving water quality and clarity would also be lost. The refuge would not take this step towards the fulfillment of the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019) to evaluate a possible method of helping restore SAV and a healthy aquatic ecosystem. As a result, short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat for wildlife, especially aquatic species, unless other measures are successfully implemented. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

Under Alternative B, there would be minimal expected adverse impacts to threatened, endangered, and special status species. Limited habitat disturbance along roads and waterways used to access the lake and near emergent zones around the perimeter of the lake during cyanobacteria treatments would occur with up to ten vehicle or boat trips per day on approximately 40 days per year. These disturbances could have minimal adverse effects on peregrine falcons, American alligators, northern long-eared bat, tricolored bat, red wolves, and monarch butterflies by causing them to temporarily avoid or move away from areas of activity. Other Federally threatened or endangered species such as sensitive joint vetch, do not occur in access or treatment areas and several species have not been documented on the refuge and are not suspected to be present (i.e., eastern black rail, rufa red knot, red-cockaded woodpecker, rough-leaved loosestrife, and piping plover). Thus, the proposed treatment would be expected to have minimal to no impact on those species. Bald eagles may experience increased energy expenditure due to being flushed during treatment and monitoring activities (Boyles 1995). Similar habitat in undisturbed areas would be available in adjacent areas.

Successful implementation of the proposed action is expected to temporarily improve water quality and clarity in the four treatment bays and possibly promote conditions to support the reemergence of SAV. Restoring this natural community would result in indirect benefits to Threatened, Endangered, and Special Status species. The refuge consulted with the Service's Raleigh Ecological Services Field Office pursuant to Section 7 of the Endangered Species Act and received concurrence. The Proposed Action was determined to have "No effect" on five species that are not expected to occur on the refuge, be "Not likely to adversely affect" four species that likely occur on the refuge, and "Not likely to jeopardize" the proposed and candidate species considered. The Section 7 Biological Evaluation is incorporated herein by reference.

Habitat and Vegetation (including vegetation of special management concern)

Affected Environment

Description of Affected Environment for the Affected Resource

Today, the Lake Mattamuskeet substrate is barren, having suffered a total loss of all SAV due to poor water quality (i.e., eutrophication, high pH, high Chl-a, and phytoplankton dominance, Moorman et al. 2017). As a result, Lake Mattamuskeet is listed on the 303(d) list of impaired waters and is subject to cyanoHABs that produce cyanotoxins (USEPA 2016). Further monitoring efforts confirmed that three cyanotoxins (cylindrospermopsin, microcystin, and saxitoxin) were present in the lake, with cylindrospermopsin concentrations bordering federal limits for no recreational contact (Moorman et al. 2017).

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

Declines in SAV were first observed in the late 1990s with a total absence of SAV observed by 2017. A summary of monitoring data collected since 1981 indicates that SAV declines in the lake were attributed to poor water quality and clarity, mainly regarding observed increases in nitrogen and phosphorous content, followed by lake-wide eutrophication. Ongoing stakeholder efforts to implement BMPs and develop projects that reduce nonpoint source nutrient loading to the lake will continue. Additionally, the refuge is currently working with a contractor to remove invasive common carp which would remove a source of turbidity and help to improve water clarity and quality.

Impacts on Affected Resource

Alternative A – No Action

Treatments of the harmful algal blooms using Lake Guard® Oxy would not occur or be evaluated and cyanobacteria would continue to dominate the treatment areas unless other measures are successfully implemented. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake by improving water quality and clarity would also be lost. The refuge would not take this step towards the fulfillment of the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019) to evaluate a possible method of helping restore SAV and a healthy aquatic ecosystem. As a result, short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat for wildlife, especially aquatic species, unless other measures

are successfully implemented. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

The proposed action alternative would treat cyanobacteria in four bays which is expected to temporarily improve water quality and clarity, promote conditions for SAV restoration, and provide a healthier aquatic ecosystem in those areas. Though effects are variable depending on the site, the efficacy of the algaecide is typically short-term. One study showed that cyanobacteria levels remained low for 7 weeks after a single treatment of a hydrogen peroxide-based algaecide (Matthijs et al. 2012). SAV restoration is the indicator for a healthy lake ecosystem. The return of SAV (e.g., wild celery, sago pondweed, southern naiad, redhead grass, and beneficial algae) would restore an important habitat for waterfowl, native fish, and other aquatic species. Further, hydrogen peroxide cyanobacteria treatments would be evaluated to determine their suitability as a tool for restoration in other parts of Lake Mattamuskeet. In addition, the monitoring associated with the pilot study would provide valuable information on the status and impacts of cyanobacteria blooms and associated cyanotoxins in the lake and shed light on options for reducing those impacts. Monitoring efforts could also reveal new information and help inform all of the projects and strategies intended to support the restoration of habitat and vegetation in Lake Mattamuskeet.

Water Quality and Resources

Affected Environment

Description of Affected Environment for the Affected Resource

Lake Mattamuskeet drains to the Pamlico Sound through four outfall canals. Each of the four outfall canals has a tide gate that opens when the head pressure is greater on the lake side. This prevents the saltier sound water from entering the lake but allows drainage of lake water into the Pamlico Sound, an estuary of national significance along with the Albemarle Sound. Due to higher water levels in the Pamlico Sound, the tide gates are remaining closed for longer periods of time, thus reducing water flow out of the lake. Three cyanotoxins (cylindrospermopsin, microcystin, and saxitoxin) are present in the lake, with cylindrospermopsin concentrations bordering federal limits for no recreational contact (Moorman et al. 2017). During high lake head pressure on the tide gates, lake water containing cyanobacteria and the associated cyanotoxins drains through the four outfall canals into the Albermarle-Pamlico Sound.

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

Reducing cyanobacteria through the application of an algaecide is one strategy being considered that could be part of a larger restoration plan. The project would be conducted concurrently with BMPs and other ongoing stakeholder efforts to reduce nonpoint source nutrient loading to the lake. Additionally, the refuge is currently working with a contractor to conduct a massive removal of invasive common carp, which would remove a source of turbidity and help to improve water clarity and quality. Successful implementation of the proposed

action is expected to improve water quality and clarity in the treatment areas and promote conditions suitable for the reemergence and successful restoration of SAV.

Impacts on Affected Resource

Alternative A – No Action

Treatments of the harmful algal blooms using Lake Guard® Oxy would not occur or be evaluated and cyanobacteria would continue to dominate the treatment areas unless other measures are successfully implemented. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake by improving water quality and clarity would also be lost. The refuge would not take this step towards the fulfillment of the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019) to evaluate a possible method of helping restore SAV and a healthy aquatic ecosystem. As a result, short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat for wildlife, especially aquatic species, unless other measures are successfully implemented. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

The proposed alternative would lead to the reduction of cyanoHABs in four bays on Lake Mattamuskeet which would address one of the priority actions identified in the LMWRP (NCCF 2019). This action would treat cyanobacteria and is expected to result in temporary improvements in water quality and clarity in portions of the lake by reducing algal blooms that increase light attenuation. Though effects are variable depending on the site, one study showed that cyanobacteria levels remained low for 7 weeks after a single treatment of a hydrogen peroxide-based algaecide (Matthijs et al. 2012). Reducing the cyanoHABs would also cause a decrease in the cyanotoxins they produce (i.e., cylindrospermopsin, microcystin, and saxitoxin), promote conditions for SAV restoration, and provide a healthier aquatic ecosystem. The cyanobacteria treatment may also help in meeting the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018) and the LMWRP (NCCF 2019) to restore SAV and a healthy aquatic ecosystem.

Visitor Use and Experience

Affected Environment

Description of Affected Environment for the Affected Resource

The refuge provides opportunities for compatible wildlife-dependent recreational uses, including hunting, fishing, wildlife observation and photography, environmental education, and interpretation. Most of these uses occur in the general vicinity of the refuge visitor center and along Hwy. 94 that crosses the lake. The polluted conditions in the lake, due in part to active cyanoHABs, have reduced the quality of visitation on the refuge. The loss of SAV has resulted in less use of the lake by wildlife, particularly waterfowl, fish and crabs. There has been a

subsequent decrease in the quality of wildlife observation, photography, and fishing opportunities on the lake itself.

The Hyde County Chamber of Commerce lists the refuge as one of the area's main attractions. Historically, the refuge averages about 37,000 visitors per year (Caudill & Carver 2019). Visitors come to hunt, fish, observe wildlife, and be present in nature.

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

Visitation to the refuge has been increasing in recent years. Visitation for consumptive uses, include hunting and fishing, and non-consumptive uses, such as wildlife observation and photography and environmental education. Between 2016 to 2019, the refuge recorded an increase in visits, going from 76,500 to 87,516 visits. In 2020, the number of visits dropped to 78,247 due to the closure of Hyde County in April 2020 because of the Coronavirus Pandemic (USFWS 2020). Tourism in the general area, related primarily to the county's abundant wildlife, has remained strong. There has been a recent increase in interest by local and state partners in restoring the Mattamuskeet Lodge and promoting it as a tourist attraction.

Impacts on Affected Resource

Alternative A – No Action

Treatments of the harmful algal blooms using Lake Guard® Oxy would not occur or be evaluated. The opportunity to test a method that could be a useful component of SAV restoration in the lake by improving water quality and clarity would be lost. The refuge would not take this step towards the fulfillment of the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019) to evaluate a possible method of helping restore SAV and a healthy aquatic ecosystem. As a result, short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat and water quality which result in a decrease in the quality of visitation. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

The deteriorated and polluted state of the lake reduces the quality of visitor experiences. The refuge was required to post water warning signs at popular visitor locations to inform refuge visitors about the cyanoHABs present in the lake. The reduction of cyanoHABs in the four treatment bays is expected to temporarily improve water quality but that alone would have little impact on visitor use. If treatments support the successful restoration of SAV in those bays, it will improve fishing opportunities and possibly other public uses. If the pilot study proved cyanobacteria treatments to be an effective tool in restoring SAV and led to a larger restoration effort, a positive impact on fishing and other wildlife dependent uses would be more substantial.

Disturbance (noise and rapid movement) from boating for monitoring treatment efforts would be a short-term, direct impact. Boating activity would result in a small amount of disturbance to the visiting public, including those on shore and in boats. In addition, some of the bays along the perimeter of the lake may be temporarily closed to fishing for the dispersal of the product. Probes placed in the water for the continuous monitoring efforts may impact navigation as they would have to be avoided by boaters. Boating restrictions and the presence of probes may have a short-term, indirect effect on other recreational users such as visitors engaged in wildlife observation near these activities.

Long-term impacts of a cyanobacteria treatment are expected to promote SAV restoration and lead to improved habitat that would provide higher quality opportunities for hunting, fishing, and wildlife observation and photography for refuge visitors. Improved habitat and water quality would provide a more aesthetically pleasing experience as well as healthier and more diverse populations of fish and wildlife, benefiting all refuge visitors.

Administration, Refuge Management, and Operations

Affected Environment

Description of Affected Environment for the Affected Resource

BlueGreen would conduct routine maintenance on the 38 probes deployed in January 2023 under SUP R23-001 to monitor water quality and the University of North Carolina UNC-IMS would independently conduct routine water quality monitoring at several locations on the lake (Figure 3, Appendix B), so the refuge would incur no cost and very little time commitment for monitoring water quality. In addition, the dispersal of the product Lake Guard® Oxy would be done by BlueGreen or other licensed professionals under refuge supervision. Refuge staff may provide support and guidance but are not responsible for carrying out any of these activities. Refuge staff would be responsible for monitoring bird and other wildlife use during treatments and hazing any birds that visit areas where undissolved product exists. There are two permanent refuge staff members and three additional Service employees that would conduct monitoring activities, interact with project partners, and potentially provide support and guidance.

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

The administration and maintenance related to implementation of the proposed alternative would not materially interfere with or detract from fulfillment of the refuge purpose(s) and the Refuge System mission.

Impacts on Affected Resource

Alternative A – No Action

With this no action alternative, the refuge would continue daily operations with no short-term impacts. The opportunity to test a method that could be a useful component of SAV restoration in the lake by improving water quality and clarity would be lost. As a result, the long-term impacts may include reduced chances of success in fulfilling the goals and objectives in the CCP

(USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019) to restore SAV and a healthy aquatic ecosystem. Refuge staff would continue to invest time and effort looking for alternatives to achieve management plans' goals and objectives. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

Under Alternative B, the cyanobacteria treatment using Lake Guard® Oxy would take place via licensed professionals contracted by BlueGreen under refuge supervision. Maintenance done to the autonomous probes or other water quality instruments would also be completed by BlueGreen as well as UNC-IMS. The effects of the treatment would be evaluated and monitored jointly by BlueGreen, UNC-IMS, and Service staff. Service staff would be primarily responsible for monitoring wildlife response during and immediately following treatment, refuge staff would also be present to confirm observations and ensure no unreasonable harm to wildlife. BlueGreen may be required at times to provide access to Service observers. Close coordination with refuge staff would be required for all activity taking place on the refuge. The time commitment and effort of Service staff would have negligible long-term negative effects. Potential positive impacts of SAV restoration and a healthier aquatic ecosystem would outweigh any inconvenience. Relatively minor costs associated with overtime as well as costs for operating and maintaining boats or other equipment will be required for monitoring activities conducted by Service staff. No additional increase in costs for administration or law enforcement are anticipated.

Socioeconomics: Local and Regional Economies

Affected Environment

Description of Affected Environment for the Affected Resource

The refuge draws visitors, which provides local businesses and the county with many opportunities for ecotourism, hunting, fishing, photography, and wildlife observation. In 2006, a study found that the total, annual direct expenditures directly related to refuge visits were over $7 million while the total, annual, direct expenditures not directly related to refuge visits were over $4.5 million (Vogelsong 2006). Plus, the contribution of recreational spending in local communities was associated with about 23 jobs, $554,000 in employment income, $115,000 in total tax revenue, and $1.8 million in economic output (Caudill & Carver 2019). This increased spending in the local area generates and supports economic activity within Hyde County.

Description of Cumulative Impacts, Environmental Trends, and Planned Actions

Wildlife-dependent recreation is an important socioeconomic driver in this local area. People come from around the world to see the wintering migratory waterfowl, hunt, fish, and experience the wonders of Lake Mattamuskeet and Hyde County. The refuge provides an important sanctuary to the area's wintering waterfowl that helps maintain quality hunting

experiences on surrounding private lands. Hunting guides, outfitters, restaurants, and lodging businesses rely on ecotourism. Because of the lake's importance to the county's economy, the quality of the habitat for wildlife is a prominent concern. Improved habitat for wildlife and aquatic species would mean better opportunities for hunting, fishing, wildlife observation and photography, and any other wildlife-dependent recreational activity.

Impacts on Affected Resource

Alternative A – No Action

The refuge would continue current management without conducting a pilot study cyanobacteria treatment in the lake. This alternative would have no short-term impacts; however, the local economy could suffer in the long term due to the loss of an opportunity to improve visitor experience and draw in more business to the various tour guides, restaurants, and lodging found in the county. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

Under Alternative B, the cyanobacteria treatment would take place and is expected to temporarily improve the water quality and clarity in the four treatment bays and possibly provide conditions suitable for SAV restoration. That alone would have little impact on socioeconomics. If the pilot study proved cyanobacteria treatments to be an effective tool in restoring SAV and led to a larger restoration effort, a positive impact on the local economy would be more substantial. In as much as these improvements lead to a healthier lake, they would increase the quality of hunting, fishing, and other wildlife-dependent recreational activities that are a major draw for tourists to the area. Consequently, the local economy would be positively impacted in the short term and the long term.

Environmental Justice

Affected Environment

Description of Affected Environment for the Affected Resource

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities.

In Hyde County – the county in which MNWR is located – the median household income is approximately $48,577 compared to the national average of $69,021; about 25% of the families in the county live below the poverty level; and approximately 45% of the county's population belong to a minority group (USDOC 2022).

Description of Cumulative Impacts, Environmental Trends, and Planned Actions
The Service has not identified any potential adverse environmental or human health impacts from these alternatives. Minority or low-income communities will not be disproportionately affected by any impacts from either of the alternatives.

Monitoring

The refuge and NCWRC have conducted long-term monitoring to document the aquatic health of the lake and effectiveness of present management actions to inform future management. Since 2012, intensive water quality monitoring has been conducted in the lake and in each of the four outfall canals. In addition, two U.S. Geological Survey Continuous Water Quality Stations were installed in the east and west basins of the lake. Parameters collected include nutrients, pH, chlorophyll a, dissolved oxygen, specific conductance, and Secchi disk readings for water clarity. Since the early 1980s and during the summer months, the refuge conducts annual surveys for SAV and, in some years, osprey productivity in the lake. From November through early March, the refuge conducts aerial and ground wintering migratory waterfowl surveys. Every fall, the NCWRC conducts annual fish surveys in the lake and canals to monitor sportfish.

Extensive monitoring, specific to the proposed action, would be conducted before, during, and after the proposed treatment. Some monitoring was initiated in 2023 to learn more about cyanobacteria in the lake and to establish baseline values to evaluate the pilot study should it be conducted. UNC-IMS will be responsible for monitoring the lake's water quality and effects of the proposed treatment. Their proposed monitoring plan states that they would, "monitor the phytoplankton community, optical water quality constituents, zooplankton community, and toxin levels" (Hall and Paerl 2024). UNC-IMS will collect discrete samples to test several parameters of water quality (e.g., ammonia, nitrate and nitrite, total phosphorus) before and after the treatment. A total of 20 sampling sites were established under SUP R23-003, with two sites located at the two U.S. Geological Survey's continuous water quality monitoring stations in each basin; two additional sites in the middle of the east and west basins; and two sites within each of the proposed treatment and control bays (Figure 3, Appendix B). Monitoring by UNC-IMS is intended to capture any positive and negative impacts of the proposed action to water quality and ecosystem health. Their independent monitoring results would be used by the technical advisory group as the primary measure of the project's effectiveness. Details of the UNC-IMS monitoring efforts are described in their Proposed Monitoring Plan for Assessing the Efficacy of Peroxide Treatment of Cyanobacteria in Lake Mattamuskeet (see Appendix C).

Additional monitoring would be conducted by BlueGreen to track cyanobacteria blooms and help direct algaecide treatments. The proposed action entails monitoring efforts via 38 autonomous probes to capture the turbidity, temperature, chlorophyll-b (Chl-b, used as indication of the total biomass of green algae), phycocyanin (PC, used as indication of the total biomass of cyanobacteria), and conductivity. These data, in addition to satellite imagery and historical data, would be used to create a BlueGreen Intelligence Map to track and target

cyanoHAB locations, duration, and intensity. With these monitoring efforts, the treatment would be customized to fit Lake Mattamuskeet's unique characteristics, minimizing the amount of product that would be required to meet the goal of collapsing the cyanobacteria population and would determine if any follow-up spot treatments would be required.

Visual assessments by refuge staff, the professional applicators, site visits from the project manager, and periodic flyovers by BlueGreen would also be relied upon (correspondence between BlueGreen and NCDWR 2023). BlueGreen would provide an email address for the public to use to send in observations and other comments during treatment. During treatments, pH and dissolved oxygen will be monitored in real-time and application will be stopped if thresholds are exceeded. As detailed in the description of Alternative B, refuge staff will monitor wildlife use of the area from the time of product dispersal until the product is dissolved. Birds will be hazed during this period and wildlife observations will be recorded. If at any point the product itself is deemed harmful to the habitat, wildlife, or water quality or monitoring efforts cause undue disturbance to the wildlife, the refuge manager will re-evaluate the methodology and work with the project team to make necessary changes to minimize adverse impacts.

Summary of Analysis

Alternative A – No Action

As described above, treatments of the harmful algal blooms would not occur or be evaluated and cyanobacteria would continue to dominate the treatment areas unless other measures are successfully implemented. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake by improving water quality and clarity would also be lost. Short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat for wildlife, especially aquatic species, unless other measures are successfully implemented. Refuge and Lake Mattamuskeet goals, outlined in the CCP (USFWS 2008), the HMP (USFWS 2018), and the LMWRP (NCCF 2019), to restore SAV and a healthy aquatic ecosystem for the protection of habitat and wildlife would be less likely to be achieved in the foreseeable future. Wintering waterfowl numbers would likely continue to decline as well as the quality of the visitor experience on the refuge, which may lead to a reduction in benefits to the local economy. Under Alternative A, the Service would continue to work with the partners to pursue other measures to improve conditions in Lake Mattamuskeet, serving the CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

Alternative B – Cyanobacteria Treatment

This proposed alternative helps meet the purpose and need of the Service by evaluating the effectiveness of a cyanobacteria treatment to improve water quality and contribute to re-establishing SAV and green algae in four bays on Lake Mattamuskeet. This action would meet the refuge's goals of maintaining open water habitat in Lake Mattamuskeet and associated canals, maintaining good water quality and healthy SAV communities, protecting fish and their

habitats, and providing foraging for 200,000 migratory waterfowl. Additionally, wildlife-dependent recreational opportunities may be improved for the public.

The benefit of reducing the cyanobacteria populations in the four treatment bays would be cleaner water in the lake and in water discharging into the Albemarle-Pamlico estuary from the lake. This would benefit Service trust species and priority resources of concern including wintering and migratory waterfowl (e.g., American black duck, northern pintail, tundra swan), long-legged wading birds (breeding and wintering), nesting ospreys, and anadromous and catadromous fish that depend on a healthy lake ecosystem to complete their life cycles. Furthermore, Hyde County is largely reliant on a healthy and thriving Lake Mattamuskeet ecosystem, which remains one of the primary economic drivers for the area. Improvements in the habitat would provide higher quality wildlife-dependent recreational opportunities to the public. In addition, the cyanobacteria treatment may contribute to meeting the goals and objectives in the CCP (USFWS 2008), the HMP (USFWS 2018) and the LMWRP (2019) to restore SAV and a healthy aquatic ecosystem. Subsequently, this action could contribute to other efforts and BMPs to remove the lake from the 303(d) list for impaired waters and benefit the nationally significant downstream Albemarle-Pamlico estuary. Though effects are variable depending on the site, one study showed that cyanobacteria levels remained low for 7 weeks after a single treatment of a hydrogen peroxide-based algaecide (Matthijs et al. 2012).

In summary, given the pilot study nature and limited scope of the Proposed Action (which is limited to 400 acres, or 1% of the lake), the measures to minimize impacts, the ongoing monitoring and evaluation, and the analysis of the Section 7 Biological Evaluation which found no significant adverse or beneficial impacts, minimal negative direct, indirect, or cumulative impacts would be anticipated from the implementation of the Proposed Action Alternative of conducting a pilot study of a cyanobacteria treatment in Lake Mattamuskeet. This alternative would help meet the purpose and needs of the Service as described above by improving the habitat conditions for Service trust species, providing higher quality experiences for wildlife-dependent recreation, and meeting the Service's priorities and mandates. The Service believes that the Proposed Action is supportive of the purposes of the refuge and the mission of the Refuge System.

List of Sources, Agencies, and Persons Consulted

BlueGreen Water Technologies
Lake Mattamuskeet Watershed Restoration Technical Working Group
Lake Mattamuskeet Watershed Restoration Collaboration, including local stakeholders and Hyde County
North Carolina Department of Water Resources
North Carolina Wildlife Resources Commission
University of North Carolina Institute of Marine Sciences
U.S. Fish and Wildlife Service Ecological Services, North Carolina Field Office, Raleigh
U.S. Fish and Wildlife Service Division of Migratory Birds

List of Preparers and Reviewers

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State Coordination

The refuge collaborated with the NCWRC and Hyde County to develop the approved LMWRP (NCCF 2019). In addition, the refuge and NCWRC collaborate on the Mattamuskeet Watershed Restoration Technical Working Group that has thoroughly discussed the proposed cyanobacteria treatment, BMPs, and other actions to improve the health and quality of Lake Mattamuskeet's ecosystem. The Service requested review of the draft EA by the State Clearinghouse on September 6, 2023. Through the State Clearinghouse (SCH), the state of North Carolina determined that the Service's EA meets the provisions of the State Environmental Policy Act and the State Historic Preservation Officer concurred that the project would have no effect on historic resources (SCH File #14-E-0000-0081). Comments were received from the North Carolina Department of Administration, North Carolina Department of Environmental Quality, and North Carolina Wildlife Resources Commission. The Service provided notice of its decision to the state. (Appendix D summarizes all the substantive comments received and provides the Service's responses to those comments.)

Tribal Consultation and Cultural Resources

Pursuant to the National Environmental Protection Act, the National Historic Preservation Act, the Service's Native American Policy, Secretarial Order 3206 (American Indian Tribal Rights, Federal-Trust Responsibilities, and the Endangered Species Act), and Executive Order 13175

(Consultation and Coordination with Indian Tribal Governments), this action would have "no effect" upon any of the refuge's historic properties, including the architectural ruins and canal system associated with the early 20th century town of New Holland. Due to the nature of the action, the undertaking is deemed to be routine maintenance. Section 106 of the National Historic Preservation Act is not triggered and consultation with the Tribes and the North Carolina State Historic Preservation Office is not necessary. Should the scope of the project change, further review by the Service would be required.

On September 13, 2023, the Service provided notice of availability of the draft EA for public review and comment to two Native American Tribes: Catawba Indian Nation and Tuscarora Nation of New York. During public review and comment on the draft EA, the Service received a letter from the Catawba Indian Nation. "The Catawba have no immediate concerns with regard to traditional cultural properties, sacred sites or Native American archaeological sites within the boundaries of the proposed project areas. However, the Catawba are to be notified if Native American artifacts and / or human remains are located during the ground disturbance phase of this project." The Service values the continuing engagement of the Catawba Indian Nation, including at Mattamuskeet NWR. In the event the Service were to encounter and/or identify cultural material and/or human remains during the pilot study, the Service would implement the measures identified in its Unanticipated Site Discovery Plan (Archaeological and Historic Sites) for Mattamuskeet NWR, which outlines a notification tree that includes contacting the Catawba Indian Nation, as well as other potentially affected Native American Tribes.

Mimicking the notice of the draft EA, the Service provided notice of the final EA and the Service's decision to the Catawba Indian Nation and Tuscarora Nation of New York.

Public Outreach

The LMWRP (2019) was a collaboration process with stakeholders representing private landowners, Hyde County, Service, NCWRC and local businesses that met regularly and included numerous public meetings and updates. In addition, following the approval of the LMWRP, a new Memorandum of Understanding between Service, NCWRC and Hyde County was approved to continue the collaboration to implement the LMWRP.

The draft EA was made available for public review and comment from September 15, 2023 to October 30, 2023. The document was posted on the refuge's website (https://www.fws.gov/refuge/mattamuskeet) with information provided through that website and on the refuge's Facebook page (https://www.facebook.com/USFWS.NC/). A public information bulletin was provided to the local media and posted on the refuge's website. The Service received comments from 6 state agencies, the Catawba Indian Nation, several organizations, and 230 individuals, including the North Carolina Wildlife Resources Commission, North Carolina Department of Environmental Quality, North Carolina Department of Administration, and Southern Environmental Law Center. Appendix D summarizes all the substantive comments received and provides the Service's responses to those comments. As

outlined in Appendix D and in response to substantive comments received and updated monitoring data, the final EA was updated to provide clarity, additional information, and additional restrictions.

Announcing the Service's decision, the final EA, with the FONSI, was posted on the refuge's website (https://www.fws.gov/refuge/mattamuskeet) with information posted on the refuge's website and on the refuge's Facebook page (https://www.facebook.com/USFWS.NC/).

Determination

This section will be filled out upon completion of any public comment period and at the time of finalization of the Environmental Assessment.

☒ The Service's action will not result in a significant impact on the quality of the human environment. See the attached "Finding of No Significant Impact" (Appendix E).

☐ The Service's action may significantly affect the quality of the human environment and the Service will prepare an Environmental Impact Statement.

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Appendix A. Other Applicable Statutes, Executive Orders, and Regulations

Cultural Resources

- American Indian Religious Freedom Act, as amended, 42 U.S.C. 1996 – 1996a; 43 CFR Part 7
- Antiquities Act of 1906, 16 U.S.C. 431-433; 43 CFR Part 3
- Archaeological Resources Protection Act of 1979, 16 U.S.C. 470aa – 470mm; 18 CFR Part 1312; 32 CFR Part 229; 36 CFR Part 296; 43 CFR Part 7
- National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470-470x-6; 36 CFR Parts 60, 63, 78, 79, 800, 801, and 810
- Paleontological Resources Protection Act, 16 U.S.C. 470aaa – 470aaa-11
- Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001-3013; 43 CFR Part 10
- Executive Order 11593 – Protection and Enhancement of the Cultural Environment, 36 Fed. Reg. 8921 (1971)
- Executive Order 13007 – Indian Sacred Sites, 61 Fed. Reg. 26771 (1996)

Fish and Wildlife

- Bald and Golden Eagle Protection Act, as amended, 16 U.S.C. 668-668c, 50 CFR 22
- Endangered Species Act of 1973, as amended, 16 U.S.C. 1531-1544; 36 CFR Part 13; 50 CFR Parts 10, 17, 23, 81, 217, 222, 225, 402, and 450
- Fish and Wildlife Act of 1956, 16 U.S.C. 742 a-m
- Lacey Act, as amended, 16 U.S.C. 3371 et seq.; 15 CFR Parts 10, 11, 12, 14, 300, and 904
- Migratory Bird Treaty Act, as amended, 16 U.S.C. 703-712; 50 CFR Parts 10, 12, 20, and 21
- Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds, 66 Fed. Reg. 3853 (2001)
- Natural Resources
- Environmental Assessment for Maximum Common Carp Removal at Lake Mattamuskeet 35
- Clean Air Act, as amended, 42 U.S.C. 7401-7671q; 40 CFR Parts 23, 50, 51, 52, 58, 60, 61, 82, and 93; 48 CFR Part 23
- Wilderness Act, 16 U.S.C. 1131 et seq.
- Wild and Scenic Rivers Act, 16 U.S.C. 1271 et seq.
- Executive Order 13112 – Invasive Species, 64 Fed. Reg. 6183 (1999)

Water Resources

- Coastal Zone Management Act of 1972, 16 U.S.C.
- 1451 et seq.; 15 CFR Parts 923, 930, 933

- Federal Water Pollution Control Act of 1972 (commonly referred to as Clean Water Act), 33 U.S.C. 1251 et seq.; 33 CFR Parts 320-330; 40 CFR Parts 110, 112, 116, 117, 230-232, 323, and 328
- Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.; 33 CFR Parts 114, 115, 116, 321, 322, and 333
- Safe Drinking Water Act of 1974, 42 U.S.C. 300f et seq.; 40 CFR Parts 141-148
- Executive Order 11988 – Floodplain Management, 42 Fed. Reg. 26951 (1977)
- Executive Order 11990 – Protection of Wetlands, 42 Fed. Reg. 26961 (1977)

Appendix B. Figures and Tables

Figure 1: Location of Mattamuskeet National Wildlife Refuge in the U. S. Department of Interior, Fish and Wildlife Service Southeast Region, in relation to the Albemarle and Pamlico Sounds (estuaries).

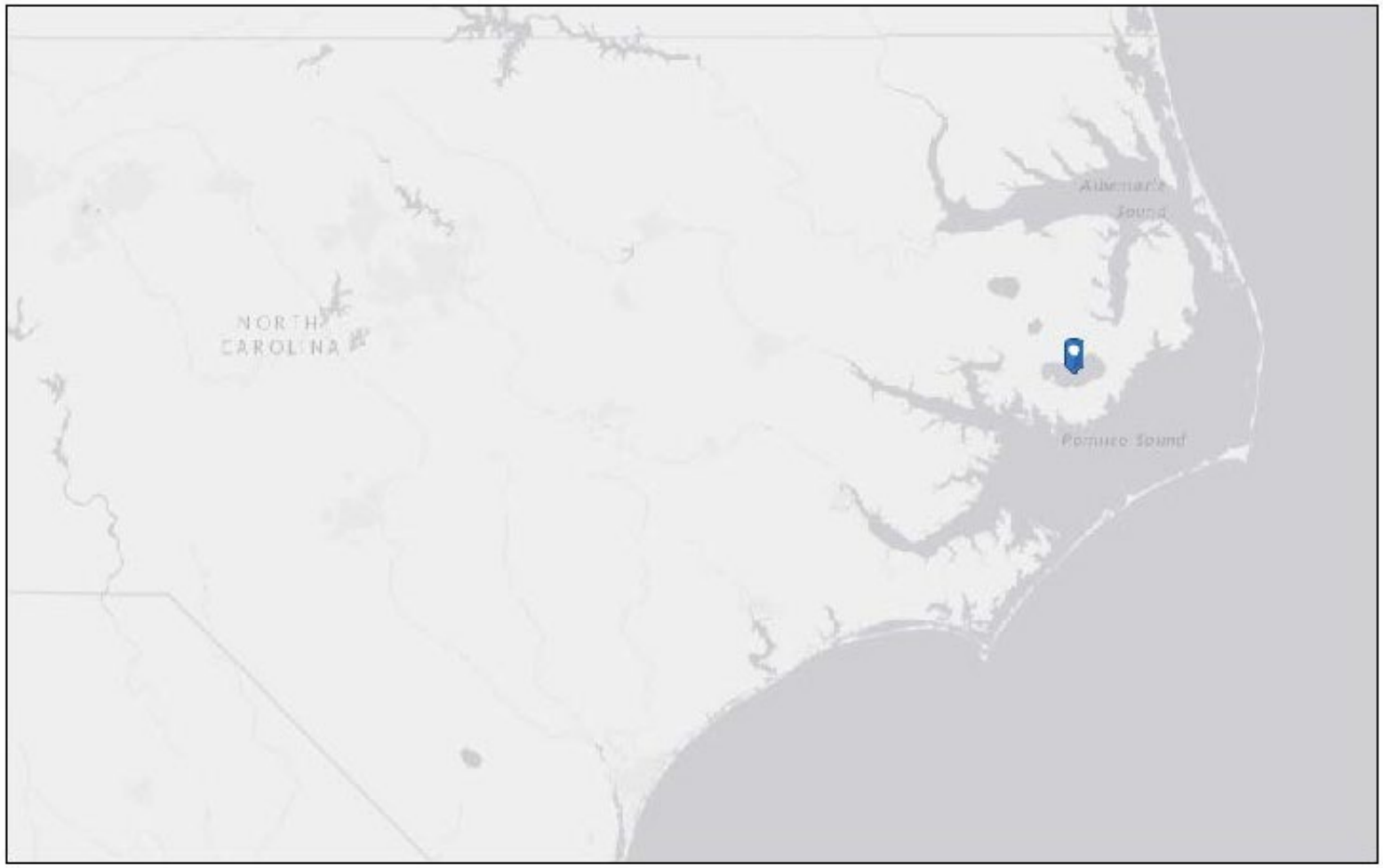

Figure 2: An aerial image of Lake Mattamuskeet and the proposed sites for treatment with Lake Guard® Oxy and control sites. The red lines depict Treatment and Control sites with white lines denoting turbidity curtain locations. This image was provided by BlueGreen Water Technologies on March 2, 2024.

Figure 3: A map of the 20 water sampling stations monitored by the University of North Carolina Institute of Marine Sciences. Red and white lines denote proposed project areas with two sampling stations within each project area. The two sites closest to the road dividing the lake are located at the U.S. Geological Survey monitoring stations (Hall & Paerl 2024).

Table 1: Lake Guard® Oxy dosage is dependent on cyanobacteria cell density and biomass; this chart illustrates the changes in dosage as the cell density changes. The chart was provided by BlueGreen Water Technologies in correspondence with the North Carolina Division of Water Resources on February 3, 2023.

Lake Guard Oxy® Dosage Instructions

Cyanobacteria cell density (cells/mL)	**Cyanobacteria biomass (Chl-a, µg/L)**	**Dose amount (lbs/acre)**	**Dose amount (mg/L or ppm)**
5,000-20,000	10	0.5-5	0.18-1.85
20,000-100,000	10-50	5-30	1.85-11.10
>100,000	>50	30-98	11.10-36.26
Significantly exceeds 100,000	Significantly exceeds 50	>98 (but treat only half of water body area)	>36.26 (but treat only half of water body area)

Table 2: Treatment scenarios for a cyanobacteria treatment pilot study in Lake Mattamuskeet using Lake Guard® Oxy. Illustrates the changes in dosage as the cell density changes and the monitoring frequency during and following treatments. The chart was provided by BlueGreen Water Technologies March 1, 2024.

LAKE MATTAMUSKEET TREATMENT PROTOCOLS

- LAKE GUARD OXY TREATMENT CASE SCENARIOS

SCENARIO BASED ON CYANO-BACTERIA CELL DENSITY	IF	THEN	MONITORING METRICS	MONITORING FREQUENCY
1.	CYANOBACTERIA CELL DENSITY >100,000 CELLS/ML	LAKE GUARD OXY DOSE @ 50LBS/ACRE (18.4 PPM)	CELL COUNTS	@ T0, T12, T24, T36, T48, T72, T96, T120, T144 OR UNTIL TARGET CYANOBACTERIA CELL DENSITY 20,000 CELLS/ML IS MET, WHICHEVER COMES FIRST
2.	CYANOBACTERIA CELL DENSITY >20,001-100,000 CELLS/ML	LAKE GUARD OXY DOSE @ 30LBS/ACRE (11.04 PPM)	CELL COUNTS	@ T0, T12, T24, T36, T48, T72, T96, T120, T144 OR UNTIL TARGET CYANOBACTERIA CELL DENSITY 20,000 CELLS/ML IS MET, WHICHEVER COMES FIRST
3.	CYANOBACTERIA CELL DENSITY >5,000-20,000 CELLS/ML	LAKE GUARD OXY DOSE @ 5LBS/ACRE (1.84 PPM)	CELL COUNTS	@ T0, T12, T24, T36, T48, T72, T96, T120, T144; A MAINTENANCE STRATEGY TO ENSURE CYANOBACTERIA CELL DENSITY DOES NOT EXCEED 20,001 CELLS/ML

FOR LAKE MATTAMUSKEET:

A TREATMENT EVENT IS DEFINED AS 2 WEEKS IN DURATION

PERIOD OF PERFORMANCE IS DEFINED AS APRIL 1-OCTOBER 31, 2024

THE MAXIMUM # OF TREATMENTS BASED ON THE ABOVE IS 2 PER MONTH (OR A TOTAL OF 14).

Appendix C. Monitoring Plan

Nathan Hall and Hans Paerl
UNC Institute of Marine Sciences

2/19/2024

Monitoring Plan for Assessing the Efficacy of Peroxide Treatment of Cyanobacteria in Lake Mattamuskeet

Currently, Lake Mattamuskeet is hypereutrophic with an average chlorophyll a concentration of 95 μg/L, nearly 2.5 times the 40 ug/L NC State water quality standard. The phytoplankton community is dominated by thin filamentous cyanobacteria that do not produce highly visual surface scums. The primary use impairments associated with the excessive cyanobacteria biomass in Lake Mattamuskeet are decreased light penetration for submerged aquatic vegetation (SAV) (Moorman et al. 2017) and toxin production that may accumulate in blue crabs that are fished for human consumption (Moorman 2018). Experimental treatments of isolated areas on both the east and westerns sides (east and west of HWY 94) of Lake Mattamuskeet are proposed to reduce cyanobacteria biomass to levels, improve water clarity, and reduce cyanotoxins. We expect that treatments will occur during late spring/ early summer of 2024. From January 2023 through February 2024, we have monitored the phytoplankton community, nutrient levels, and optical water quality constituents prior to the treatment to establish a robust baseline. Intensive monitoring prior to the treatment will include additional parameters aimed at quantifying and characterizing the zooplankton community and cyanobacterial toxin levels. Intensive monitoring immediately following the treatment will capture rapid changes in the phytoplankton assemblage, toxin levels, zooplankton community, and water clarity that result from the treatment but will also capture any negative side effects such as drops in dissolved oxygen or acute changes in zooplankton community structure. Monitoring will continue, on a less intensive basis, for the remainder of the year following treatment to quantify the longevity of the treatment's impact on reducing cyanobacteria and to document other longer-term changes in conditions (e.g. improved water clarity). Four treatment areas and four control sites will be equally distributed between the east and west sides of the lake and will be isolated from the rest of the lake using turbidity curtains. By comparing before and after and the inclusion of replicated control and treatment areas, this project design fulfills the design requirements for a before/ after/ control/ interrupted (BACI) experimental design, the "gold standard" for environmental experiments.

Monitoring Schedule

During 2023, monitoring occurred approximately monthly during the winter months (Dec-Mar) and the frequency was increased to approximately twice monthly during spring through fall.

We plan to keep this schedule during 2024 except that we plan to conduct high frequency, approximately daily, monitoring during the week following treatment in late spring early summer 2024.

Table 1. Sampling schedule

Month	# Sampling Trips
Jan	1
Feb	1
Mar	2
Apr	2
May (treat)	8
Jun	2
Jul	2
Aug	2
Sep	2
Oct	1
Nov	1
Dec	1

Monitoring sites

Eight project areas will be assigned as four control and four treatment areas with two controls and two treatment areas on each side of the lake (Figure 1). Two monitoring stations have been established within each project area. In between each area's two monitoring stations, an In Situ Aqualtroll 600 water quality instrument has been deployed with continuous monitoring capabilities for temperature, conductivity, pH, and dissolved oxygen (see continuous monitoring description below). Additionally, Bluegreen has equipped each area with an AquaRealTime probe that continuously measures turbidity, and in vivo fluorescence of chlorophyll a and phycocyanin. Both stations will be sampled on each sampling trip to provide duplicate observations from each area. Representativeness of these project areas will be gaged by comparison against four main lake stations that will include the USGS real time monitoring locations in both the east (EM) and west (WM) sides of Lake Mattamuskeet (Figure 1).

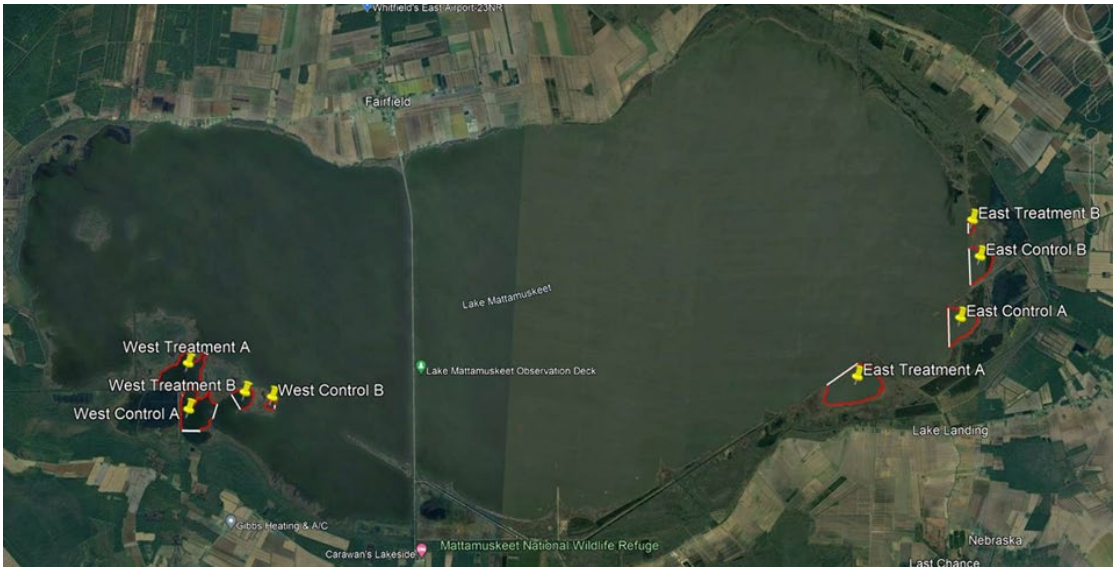

Figure 1. Map showing the planned set of four treatment and four control project areas to assess treatment efficacy. Red lines outline the project areas and white lines indicate the turbidity curtains that will isolate these areas from the rest of the lake. Representativeness of these project areas will be gaged by comparison against four main lake stations that will include the USGS real time monitoring locations in both the east (EM) and west (WM) sides of Lake Mattamuskeet.

Parameters: Discrete sampling, unattended continuous data collection, and remote sensing will be used to measure a broad range of water quality and habitat characteristics to provide a comprehensive assessment of the treatment impacts on the phytoplankton community, and habitat suitability for fish and submerged aquatic vegetation in Lake Mattamuskeet. Table 2 shows a list of proposed parameters and their utility for the project.

Continuous measurements: Aqua Real Time Algae Tracker © continuous in vivo fluorescence sensors are deployed within the project areas and the main lake by Blue Green Water Technologies to measure total phytoplankton biomass as chlorophyll *a* fluorescence, cyanobacterial biomass as phycocyanin fluorescence, and suspended sediments as turbidity. Data from these sensors are available to UNC-IMS via an online dashboard. Dissolved oxygen, pH, temperature, and salinity is being monitored continuously at one centralized station within each of the project areas using an In situ Aqua Troll 600 multiparameter sonde. The USGS real time instruments will continuously monitor pH, dissolved oxygen, temperature, and salinity within the main lake. Continuous dissolved oxygen and pH measurements will be used to evaluate any potential negative side effects such as sags in dissolved oxygen or pH that result from the mortality of significant levels of cyanobacterial biomass. Temperature and salinity data will be used as fundamental habitat information for phytoplankton, SAV, and fish, and also to help evaluate circulation features during the course of the study. For example, salinity intrusions from Pamlico Sound may cause changes in cyanobacteria biomass and monitoring salinity will allow those events to be detected. Additionally, spatial gradients in salinity may be

used to indicate the degree to which turbidity curtains are able to isolate treatment and control project areas from the surrounding lake water.

Discrete sampling: As described above, a total of 20 stations for discrete sampling have been established with 2 stations in each of the 8 project areas and 2 stations in each of the east and west sides of the main lake area (Figure 2).

Figure 2. Map showing the planned 20 sampling stations within the project areas outlined in red/white lines and the main lake.

Table 2. Coordinates for 20 planned sampling locations

Station Number	Latitude	Longitude
3	35.5132	-76.2585
4	35.4829	-76.2725
5	35.4832	-76.2699
6	35.4750	-76.2714
7	35.4698	-76.2691
8	35.4733	-76.2574
9	35.4766	-76.2599
11	35.4773	-76.2495
12	35.4768	-76.2499
13	35.5056	-76.2537
22	35.5064	-76.1839
26	35.5106	-76.1313
29	35.4878	-76.1043
30	35.4892	-76.0988
31	35.5041	-76.0755
32	35.5016	76.0733
35	35.5160	-76.0715
36	38.5135	-76.0711
37	35.5223	-76.0740
20	35.5217	-76.0739

Discrete sampling stations are co-located with unattended monitoring instrumentation to provide the maximum capacity for data comparisons and post calibration of the continuous data streams. A total of 25 sampling trips are planned for each project year to provide adequate information on pre and post treatment conditions in the treatment, control, and main lake areas. The temporal frequency of sampling trips throughout the year will be varied to achieve higher resolution during the period when treatments occur and during summer when cyanobacterial bloom activity is most likely (Table 1).

On each sampling event, measurements of chlorophyll *a* and accessory pigments determined via high pressure liquid chromatography and phycocyanin via in vitro fluorometry are providing a robust estimation of the total and class-level changes in phytoplankton biomass emphasizing cyanobacteria. An aliquot of each sample is preserved in 1% Lugol's iodine and selected samples are microscopically examined to assess changes in the abundance of known toxin producers (e.g. *Cylindrospermopsis raciborskii*) and determine how the abundance of toxin producers relates to measurements of cyanotoxins. Dissolved and particulate nitrogen and phosphorus concentrations (nitrate+nitrite, ammonium, total dissolved nitrogen, dissolved organic nitrogen, particulate nitrogen, o-phosphate, and total P) are measured from every sample to provide information on how the peroxide treatment affects dynamics between the phytoplankton and nutrient pools. These nutrient data will be critical for understanding changes in community composition, and the efficacy of the treatment in achieving long-term water quality improvements.

On each sampling event, depth profiles of chlorophyll *a* and phycocyanin fluorescence, turbidity, pH, dissolved oxygen, conductivity, and temperature are measured using a YSI 6600 multiparameter data sonde. Depth profile data will be used to understand the vertical distribution of these parameters and the near surface values will be compared against the continuous, real-time data collected by the Algae Tracker and Aqua Troll 600 instruments as a quality assurance measure. Vertical profiles of photosynthetically active radiation (PAR) are measured to quantify how changes in the phytoplankton community impact light availability for SAV. Chlorophyll *a*, turbidity and colored dissolved organic matter are the primary indicators for light attenuating substances in water. These substances are at each sampling event to enable modeling PAR attenuation to tease apart their contributions to PAR attenuation and isolate the impact due to changes in cyanobacterial abundance.

Zooplankton biomass and community structure will be monitored during the period immediately before and after treatments to assess positive or negative impacts to the zooplankton community which supports the lake's fishery. Similarly, cylindrospermopsin, microcystin, and BMAA cyanotoxins will be measured from discrete sample collected prior to and immediately after treatment.

Remote sensing:
Blue Green Water Technologies plans to use remote sensing to provide data necessary for determining their treatment strategy. They have agreed to share their remotely sensed data products with the UNC-IMS research team. The UNC-IMS team will evaluate the remotely sensed data products and will use those data as additional information on treatment efficacy if we feel the data strengthen our assessment capacity.

Table 3. Parameter List

Parameters	Assessment Purpose
Chlorophyll *a*	Total phytoplankton biomass
Phycocyanin	Cyanobacterial biomass
Accessory pigments by HPLC	Taxa-specific phytoplankton biomass
Phytoplankton species-microscopy	Cyanobacterial species
Chlorophyll *a* fluorescence	Continuous total phytoplankton
Phycocyanin fluorescence	Continuous cyanobacteria biomass
Nutrients (N and P)	Limit algal growth
Cylindrospermopsin	Primary cyanotoxin in Lake Mattamuskeet
Microcystin	Most common cyanotoxin in NC coastal waters
BMAA	Emergent toxin of concern in eastern NC
Dissolved oxygen	Fish habitat
pH	Fish habitat
Zooplankton biomass/ community structure	Fish habitat/ ecosystem health

Parameters	Assessment Purpose
Turbidity	Light availability for SAV
Colored dissolved organic matter	Light availability for SAV
PAR attenuation	Light availability for SAV
Salinity	Fundamental habitat information
Temperature	Fundamental habitat information

Appendix D. Summary of Public Comments and Response from the U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (Service, USFWS) is committed to fulfilling the purpose of Mattamuskeet National Wildlife Refuge and working collaboratively with partners to improve water quality and clarity within Lake Mattamuskeet. Building upon collaboration with the North Carolina Wildlife Resources Commission and Hyde County and the Lake Mattamuskeet Watershed Restoration Plan (North Carolina Coastal Federation [NCCF] 2019), the USFWS coordinated with the state of North Carolina (including the North Carolina Department of Water Resources and the North Carolina Wildlife Resources Commission), Hyde County, the Lake Mattamuskeet Watershed Restoration Technical Working Group, the University of North Carolina Institute of Marine Sciences, and other interested parties to develop this Environmental Assessment (EA). Due to the nature of the Proposed Action, the undertaking is deemed to be routine maintenance, thus coordination is not required with the North Carolina State Historic Preservation Office and the Native American Tribes with current or historic interest in this area. The Draft Environmental Assessment (EA) for Mattamuskeet National Wildlife Refuge, Cyanobacteria Treatment in Lake Mattamuskeet (USFWS 2023) was made available to the public for review and comment from September 15, 2023 to October 30, 2023. The Service also requested review of the draft EA by the state and the Tuscarora and Catawba Native American Tribes. The document was posted on the refuge's website (https://www.fws.gov/refuge/mattamuskeet) with information provided through that website and on the refuge's Facebook page (https://www.facebook.com/USFWS.NC/). A public information bulletin was provided to the local media and posted on the refuge's website. The Service received comments from 6 state agencies, the Catawba Indian Nation, several organizations, and 230 individuals, including the North Carolina Wildlife Resources Commission, North Carolina Department of Environmental Quality, North Carolina Department of Administration, and Southern Environmental Law Center. Through the State Clearinghouse (SCH), the state determined that the Service's EA meets the provisions of the State Environmental Policy Act and the State Historic Preservation Officer concurred that the project would have no effect on historic resources (SCH File #14-E-0000-0081).

Under the National Environmental Policy Act (NEPA), the Service must respond to substantive comments. For purposes of this planning process, a substantive comment is one that was submitted during the public review and comment period, which was within the scope of the proposed action, was specific to the proposed action, had a direct relationship to the proposed action, and included reasons for the Service to consider it. (For example, a substantive comment could be that the document referenced 500 individuals of a particular species, but that current research found 600. In such a case, the Service would likely update the document to reflect the 600, citing the current research. While a comment that would not be considered substantive would be, "We love the proposal.") Comments outside the scope of the proposal were not addressed.

The Service reviewed all comments received in the development of the final EA. The substantive comments were summarized, and those comments and associated responses are grouped together under four general topics of concerns: NEPA and planning process, wildlife and habitat, chemical product, and cultural resources.

Acronyms and abbreviations used in this appendix are listed.

- ® – Registered Trademark
- § – Section
- BG, BG Algae, BG Water Tech, BlueGreen – BlueGreen Water Technologies
- BMP – Best Management Practice
- CatEx – Categorical Exclusion
- CCP – Comprehensive Conservation Plan
- CFR – Code of Federal Regulations
- DOC – dissolved organic carbon
- EA – Environmental Assessment
- EAS – Environmental Action Statement
- EIS – Environmental Impact Statement
- EPA – United States Environmental Protection Agency
- FONSI – Finding of No Significant Impact
- FW – Fish and Wildlife Manual
- GA – Georgia
- HMP – Habitat Management Plan
- NC – North Carolina
- NCCF – North Carolina Coastal Federation
- NCDWR – North Carolina Division of Water Resources
- NEPA – National Environmental Policy Act
- NPDES – National Pollutant Discharge Elimination System
- NWR – National Wildlife Refuge
- PUP – Pesticide Use Proposal
- ROD – Record of Decision
- SAV – submerged aquatic vegetation
- SCH – State Clearinghouse
- Service – U.S. Fish and Wildlife Service
- UNC – University of North Carolina
- USC – United States Code
- USFW, USFWS – United States Fish and Wildlife Service

NATIONAL ENVIRONMENTAL POLICY ACT AND PLANNING PROCESS

Comments received included National Environmental Policy Act (NEPA) and planning process concerns, including planning process, alternatives, long-term solution alternatives, choice of location, lack of data to understand and analyze impacts, skewed impacts discussion, and need for Environmental Impact Statement (EIS).

PLANNING PROCESS

Comment: Multiple comments were received expressing concerns over the planning process; excerpts are listed to provide context.

- "belies a predetermined decision process that began with the project's inception in a special state legislative appropriation and has since extended to commencing the initial phases of the project before preparing this Draft EA"
- "The way in which this plan arose reflects the political route that was taken to allow this plan of action to get this far. This is yet another example of why the formal EPA process of review was put in place in the first place and why it should be honored at this time."

Service's Response: Comments noted. As outlined in the Draft Environmental Assessment (EA) for Mattamuskeet National Wildlife Refuge, Cyanobacteria Treatment in Lake Mattamuskeet (USFWS 2023), the Service was approached in 2022 by the University of North Carolina Institute of Marine Sciences (UNC-IMS) and BlueGreen Water Technologies (BlueGreen). In their evaluation of potential pilot study sites to test a specific cyanobacteria treatment to trigger a population collapse of the cyanobacteria, UNC-IMS and BlueGreen determined that Lake Mattamuskeet was their preferred site for a pilot study. The Service recognizes the potential of the proposed study to inform restoration efforts and help achieve goals identified in the Lake Mattamuskeet Watershed Restoration Plan (North Carolina Coastal Federation [NCCF] 2019). The political process mentioned in the comments and the subsequent determination of site selection criteria and the evaluation of potential sites by UNC-IMS and BlueGreen are separate and apart from the Service and outside of the Service's planning process.

The Service's engagement began with the proposal presented to the Service by UNC-IMS and BlueGreen to conduct a cyanobacteria pilot study in Lake Mattamuskeet at Mattamuskeet NWR. The consideration of a proposed pilot study on a NWR triggered multiple laws, regulations, and policies, including NEPA. To evaluate this proposal presented to the Service for Mattamuskeet NWR, the Service prepared the draft EA in compliance with all applicable laws, regulations, and policies, including NEPA. As articulated in the EA, two alternatives were considered by the Service for Mattamuskeet NWR: Alternative A - Continuance of Current Management Practices (No Action Alternative) and Alternative B - Cyanobacteria Treatment within Lake Mattamuskeet Using Lake Guard® Oxy (Proposed Action Alternative). With the selection of Alternative B for implementation through the Finding of No Significant Impact (FONSI) in Appendix E, the Service would then work with UNC-IMS and BlueGreen to implement the pilot study as outlined in the EA. If the Service were to select Alternative A, UNC-IMS and

BlueGreen would have to consider other sites that met their site selection criteria. UNC-IMS and BlueGreen would be required to conduct any planning and permitting associated with the potential site(s) under consideration in compliance with all applicable laws, regulations, and policies.

The Service allowed UNC-IMS and BlueGreen, under Special Use Permits, to initiate monitoring efforts in 2022 to both confirm Lake Mattamuskeet met the requirements of their proposed pilot study and to begin establishing baseline data that could be used to evaluate any potential future treatments. This action is considered separately from the proposed action stated in the Draft EA because it was covered by the following categorical exclusion, 43 CFR §46.210(e), as the activity involves "nondestructive data collection, inventory (including field, aerial, and satellite surveying and mapping), study, research and monitoring activities." UNC-IMS and BlueGreen initiated monitoring efforts with the full understanding that additional environmental review under NEPA (including environmental analysis and a Service decision) and additional permitting would be required. It was made clear to them that any treatment would require all associated reviews and approvals prior to application.

ALTERNATIVES

Comment: Multiple comments were received that expressed concerns that only one action alternative was considered; excerpts are listed to provide context.

- "…only includes one action alternative…"
- "The draft fails to adequately describe and assess a range of alternatives"
- "...the Draft EA includes only a single action alternative (Alternative B), evaluating the specific Lake Guard Oxy product from BlueGreen.53 The Draft EA considers no other action alternatives and does not even list other alternatives considered but rejected for further evaluation."
    - "53: Draft EA at 7."

Service's Response: Comments noted. The Service continues to focus on larger watershed restoration efforts identified in the Lake Mattamuskeet Watershed Restoration Plan to reduce excess nutrients and sediment entering the lake. These efforts include projects to redirect and treat agricultural run-off, best management practices to reduce nutrient and sediment inputs, maximum carp removal, canal dredging, and improving water management capabilities. This broader approach to improving water quality and clarity within Lake Mattamuskeet will continue regardless of whether the proposed action is implemented. The Service considers the proposed pilot study of a cyanobacteria treatment supplemental to these other restoration strategies.

As discussed above, the Service's engagement began with the proposal presented to the Service by UNC-IMS and BlueGreen to conduct a cyanobacteria pilot study in Lake Mattamuskeet at Mattamuskeet NWR. The consideration of a proposed pilot study on a NWR triggered multiple laws, regulations, and policies, including NEPA. To evaluate this proposal

presented to the Service for Mattamuskeet NWR, the Service prepared the draft EA in compliance with all applicable laws, regulations, and policies, including NEPA. An EA may consider just the No Action Alternative and the Proposed Action Alternative (43 Code of Federal Regulations [CFR] §46.310). As articulated in the EA, two alternatives were considered by the Service for Mattamuskeet NWR: Alternative A - Continuance of Current Management Practices (No Action Alternative) and Alternative B - Cyanobacteria Treatment within Lake Mattamuskeet Using Lake Guard® Oxy (Proposed Action Alternative). With the selection of Alternative B for implementation through the Finding of No Significant Impact (FONSI) in Appendix E, the Service would then work with UNC-IMS and BlueGreen to implement the pilot study as outlined in the EA. If the Service were to select Alternative A, UNC-IMS and BlueGreen would have to consider other sites that met their site selection criteria; UNC-IMS and BlueGreen would be required to conduct any planning and permitting associated with the potential site(s) under consideration in compliance with all applicable laws, regulations, and policies.

LONG-TERM SOLUTION ALTERNATIVES

Comment: Multiple comments were received expressing concerns over the lack of long-term solutions and offering potential alternatives; excerpts are listed to provide context.

- "Use of the pesticide is not a long-term solution to the water quality problems in the lake".
- "It is untested, unproven, and is a futile attempt to treat only the symptoms rather than addressing the real cause of the algae and carp proliferation: High nutrient concentrations in the Lake at much higher than historic levels."
- "I realize that Lake Mattamuskeet is facing concerning water quality issues, but I would much prefer addressing the sources of the excessive nutrients (agricultural runoff) and reducing the carp populations within the lake."
- "The use of algaecide to manage cyanobacteria treats a symptom of an overall problem; it does not provide a solution. While algaecide use may have an effect on cyanobacteria densities immediately after treatment, a watershed approach to address management needs is recommended. "
- "Further, the proposed study would not provide a long-term solution to the problem it is intended to address: the buildup of blue-green algae that is hampering growth of native aquatic vegetation. "
- "Funding to address the water quality problems should be used to support the plan to address reduction of nutrients entering the lake and removal of carp which are the real cause of the problem."
- "Any money spent on this would be wasted--we would much rather that any money be used to buy land and create wetlands at the inflowing streams, to filter out agricultural pollutants before they reach the lake. This is the only hope of changing nutrient status."

Service's Response: Comments noted. As mentioned in the previous response, the Service continues to focus on larger watershed restoration efforts identified in the Lake Mattamuskeet Watershed Restoration Plan to reduce excess nutrients and sediment entering the lake. These other efforts will continue regardless of whether the proposed action is implemented. However, most of the restoration efforts currently underway or planned for the near future do little to address nutrients that are already in the lake and contributing to cyanobacteria blooms. Cyanobacteria blooms and suspended sediments are the two major factors limiting the amount of light available to support germination and growth of SAV, and both need to be addressed for successful SAV restoration. Additional tools, efforts, and activities, that have the potential to address recurring cyanobacteria blooms, including pilot studies such as proposed under Alternative B, should be considered and evaluated.

If the pilot study were to be implemented and were to prove successful in helping restore SAV, it would at a minimum, improve conditions in the bays that are treated. Reducing cyanobacteria, re-establishing SAV, and promoting the growth of beneficial green algae are the goals of the proposed treatment. If present, SAV and green algae will utilize nutrients currently supporting the cyanobacteria blooms. Further, hydrogen peroxide cyanobacteria treatments could become one of the many tools, efforts, and activities for restoration in other parts of Lake Mattamuskeet. In addition, the study would provide valuable information on the status and impacts of cyanobacteria blooms and associated cyanotoxins in the lake and shed light on options for reducing those impacts. The extensive water monitoring associated with the pilot study could also reveal new information and help inform all of the projects and strategies intended to support the restoration of Lake Mattamuskeet.

It is important to note that the Proposed Action is a pilot study in support of the refuge's Comprehensive Conservation Plan (CCP) / EA / FONSI (USFWS 2008a, 2008b) and Habitat Management Plan (HMP) / Categorical Exclusion (CatEx) / Environmental Action Statement (EAS) (USFWS 2018) and in support of the multi-agency and multi-stakeholder Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019). The funding that would be used to implement the proposed action was allocated by the state of North Carolina to conduct a study of a cyanobacteria treatment and is not available for other purposes.

CHOICE OF LOCATION

Comment. Multiple comments were received questioning the use of the proposed product on a National Wildlife Refuge (NWR).

- "A wildlife refuge is not the place to conduct an experiment of a pesticide, especially one that states on its label that it's toxic to the wildlife in question."
- "The EPA has mandated that Lake Guard Oxy must carry a warning that it is toxic to birds. As such, its proposed use at Lake Mattamuskeet is incompatible with the NWR's purpose"

- "Better yet, an alternative should have considered conducting a trial treatment at a different location in North Carolina prior to any experimental application on the Refuge."

Service's Response: Lake Guard® Oxy has been utilized in locations around the world including over 200 reservoirs in Israel, and U.S. locations including Florida, Virginia, Ohio, and Utah. Treatments in Lake Minneola, Florida and Lake Anna, Virginia were extensively monitored and successful in preventing cyanobacterial blooms during the period of treatment. Additionally, no adverse impacts to the environment, including wildlife or water quality were detected during the treatment periods (BlueGreen Technologies 2021, Lake Anna Civic Association 2022b, D. Dobberfuhl, personal communication, Jan. 17, 2023). The Terrestrial Wildlife and Aquatic Species impacts section of the EA was updated to reflect pertinent information from these treatments.

Recent research suggests that hydrogen peroxide-based algaecides are relatively benign in the environment and thus an effective way to temporarily mitigate and reduce cyanobacteria blooms and toxins (Matthijs et al. 2012, Barrington et al. 2013, Sinha et al. 2018). With numerous treatments in other locations experiencing similar issues, testing another site in North Carolina is unlikely to provide any new information to inform our assessment. Lake Mattamuskeet is a unique water body with a unique assemblance of phytoplankton. A study of a cyanobacteria treatment in Lake Mattamuskeet would provide the most useful and dependable data to inform further assessments and guide future efforts in the lake.

As a pilot study, the treatment will be limited to four bays totaling 400 acres, representing only 1% of the 40,276-acre lake. These bays were selected due to their ability to be easily isolated from the rest of the lake and their suitability for SAV restoration. Historical SAV data show that these areas were some of the last places in the lake to have SAV and are therefore the most appropriate areas to target for SAV restoration (Moorman et al. 2017). SAV restoration potential will be enhanced by the use of turbidity curtains placed across the mouths of each bay to isolate them from the rest of the lake. These curtains should reduce variability in research results, help concentrate treatment effects, and reduce turbidity inside of the bays thereby further promoting improved water clarity. If water quality and clarity in the bays can be improved through the application of the Lake Guard® Oxy treatment and the use of turbidity curtains, a shift in these bays back to submerged aquatic vegetation (SAV) may result (Scheffer 2004). Improving water quality and clarity is a specific objective of the Lake Mattamuskeet Watershed Restoration Plan (North Carolina Coastal Federation 2019). Restoring SAV on any portion of the lake will improve habitat for migratory waterfowl and help the Service fulfill the purpose for which the refuge was established (USFWS 2008a, 2008b).

The statement, "toxic to birds", included on the label of Lake Guard® Oxy must be considered in the context of the use of the product. The Service believes that use of Lake Guard® Oxy in the manner and location in which it is proposed will have little risk of negative impact to birds. The potential long-term benefits of the proposed action for birds and refuge habitats outweighs the

potential for negative impacts. This topic is more fully addressed in the "TOXICITY" section of this Appendix.

For clarity, the Service relies on the listed four tiers of analysis for the use of pesticides on a unit of the National Wildlife Refuge System.

- Pesticide specific analysis by the U.S. Environmental Protection Agency;
- Pesticide specific analysis through the Service's Pesticide Use Proposal (PUP) process;
- Analysis of pesticide use in general for a specific NWR or NWR complex through an EA / FONSI or EIS / Record of Decision (ROD); and
- Analysis of pesticide use in general through an Environmental Action Statement (EAS) that documents the pesticide use planned for a particular NWR or NWR complex.

The Service only considers the use of EPA-registered pesticides, which means that we only consider the use of pesticides that have undergone appropriate EPA risk assessment and have been released on the market for use as outlined on the label. Pesticide specific analysis is conducted by the Service through its PUP process, which includes impacts analysis under the Endangered Species Act and may include Best Management Practices (BMPs) and conditions more restrictive than a pesticide's label requirements. Pesticide use in general was analyzed in the refuge's CCP/EA/FONSI (USFWS 2008a, 2008b) and HMP/CatEx/EAS (USFWS 2018). This EA provides additional analysis specific to the proposed pilot study and the use of Lake Guard® Oxy.

As outlined in the EA and FONSI (Appendix E), and as evaluated in the associated biological evaluation (Section 7) and the Service's PUP process and the PUP's Section 7, the Service has determined that the proposed pilot study would not have significant impacts.

LACK OF DATA TO UNDERSTAND AND ANALYZE IMPACTS

Comment: Multiple comments were received expressing concerns over the lack of data to understand and analyze impacts; excerpts are listed to provide context.

- "…fails to provide necessary details, including the method, timing, or frequency of application to inform the analysis of impacts…"
- "fails to consider the uncertain efficacy of the algaecide, including failing to disclose or discuss any of the previous applications of the algaecide in other locations that have failed to eradicate cyanobacterial algal blooms"
- "they [BG Algae] have used this product in several other projects without a single report or observation of wildlife consumption, illness, mortality related to this product, it provides no citations for that statement and it is not clear that BG or any other body was actively monitoring for wildlife outcomes during any of its prior application event'
- "The Service should have considered the patterns of avian use at the Lake when assessing the proposed locations of the pilot study, and it must evaluate this information in its NEPA analysis."

Service's Response: The Service recognizes that additional clarity is needed in the EA regarding available data to analyze impacts. However, some details of the treatments, such as timing, frequency, and dosage, are determined by observed data of cyanobacteria blooms just prior to treatment. Treatments are most effective and require the least amount of chemical to be used when applied just prior to high bloom activity. Constant monitoring is required to determine the timing of treatment and only general predictions can be provided ahead of time. Additional information on the expected timing, frequency, and dosage has been added to the EA in the description of Alternative B.

As discussed in other responses, previous studies at Lake Minneola, Florida and Lake Anna, Virginia have demonstrated that Lake Guard Oxy can provide effective short-term reductions of cyanobacteria and cyanotoxins when applied according to labelled dosage instructions prior to and during the summer bloom season. Though effects are variable depending on the site, it is noted that the efficacy of the algaecide is typically a short-term solution. Research by Matthijs and others on the use of a hydrogen peroxide-based algaecide showed that cyanobacteria remained low for 7 weeks following a single treatment (2012). At Lake Anna, Lake Guard Oxy was applied at a rate of four to six pounds per acre. The best results were achieved at the AOI Pamunkey treatment area (~200 acres). Here Lake Guard Oxy was applied in June, prior to a summer cyanobacteria bloom, with follow-up maintenance treatments in July and August. At the other three sites, treatments were only applied in July and the results were more mixed, but in general phycocyanin and chlorophyll-a levels remained below thresholds of concern while other non-treated areas of Lake Anna were placed under recreational advisories due to cyanobacterial cell counts. In all study reports, no observation of wildlife consumption or illness was noted (Lake Anna Civic Association 2022b, BlueGreen Technologies 2021). At Lake Anna, observers were actively monitoring for wildlife mortality each day following the treatment until the capsules dissolved (Lake Anna Civic Association 2022a).

The proposed locations of the pilot study were selected based on their appropriateness for meeting the objectives of the study in terms of size, their ability to be isolated using turbidity curtains, and their history of supporting SAV. The Service presumes that these areas will be both the most suitable and most beneficial areas to restore SAV. Anecdotal observations and limited survey data suggest bird use of the proposed areas is lower after the loss of SAV in those areas. Mitigating measures to deter bird use of the bays during treatments, continuous monitoring during treatments, and restricting the seasonality for treatments will further reduce potential risks to birds. A more detailed description of the measures to be employed have been added to the EA in the description of Alternative B.

SKEWED IMPACTS DISCUSSION

Comment: Multiple comments were received regarding the discussion of impacts; excerpts are listed to provide context.

- "The Draft EA's cursory and uneven portrayal of the respective effects of the Action Alternative and No Action Alternative maintains the EA's entire discussion of impacts. The draft EA's No Action Alternative (Alternative A) represents a hyperbolic worst-case scenario, rather than a true baseline scenario, claiming that "cyanobacteria would continue to dominate the lake unless other measures are successfully implemented" and "short and long-term impacts from this no action alternative would be a perpetuation of degraded habitat and water quality unless other measures are successfully implemented."58 These oblique references to "other measures" fail to acknowledge the Refuge's ongoing work to implement the Lake Mattamuskeet Watershed Restoration Plan, as well as its work to remove invasive common carp from the lake, 59 and the benefits that these actions are expected to have for SAV restoration."
    - "58: Draft EA at 17."
    - "59: See, e.g., U.S. Fish & Wildlife Serv., Lake Mattamuskeet Aquatic Grass Restoration, https://www.fws.gov/project/lake-mattamuskeet-aquatic-grass-restoration, Attachment 1.
- "The draft EA's skewed discussion of impacts assumes benefits beyond the scope or duration of treatment "
- "...a "hard look" requires "thorough investigation into the environmental impacts of an agency's action and a candid acknowledgement of the risks that those impacts entail"). Failure to take a "hard look" at the direct, indirect, and cumulative impacts of the agency action is arbitrary and capricious."
- "The Draft EA also fails to supply and consider information from other similar projects in accounting for potential beneficial and adverse impacts"
- "Rather than assuming that the Lake Guard Oxy treatment will be effective, FWS must actually grapple with the possibility that the treatment could fail."
- "The lack of clarity about the proposed action renders the action analysis deficient and taints the impacts analysis as discussed below."
- "Because the agency's assessment of environmental impacts is the "scientific and analytic basis for the comparison[]"of alternatives, the agency must provide more than conclusory statements that the indirect and cumulative effects will be minimal."

Service's Response: In several instances in the Draft EA, the Service uses conclusory statements describing impacts as minimal. Each of those statements are found in summary sentences and in the Summary of Analysis section and refer to details and more thorough analysis in the preceding paragraphs and sections of the document.

The Service recognizes that additional clarification is needed in the EA regarding the scope of the action and potential adverse and beneficial impacts. The treatment process must be adaptive in terms of rates, timing, and frequency so prescriptive details cannot be provided in advance, only a general approach. The array of monitoring probes on the lake as well as

satellite data on algal bloom activity would be used to guide the details of the treatment. The description of Alternative B in the EA was updated and Table 2 was added to Appendix B in the EA to provide additional details on the treatments.

In the Alternatives section of the Draft EA, under Alternative A, the Service states that under the No Action alternative, "Control of cyanobacteria would be solely dependent on indirect approaches to reduce the excessive nutrients that cause the cyanobacteria blooms". The Service goes on to explain that these indirect approaches primarily rely on voluntary actions of private landowners and only affect nutrient and sediment loads draining to the lake. They do not reduce the nutrient loading currently in the lake which contributes to cyanobacteria blooms. While removing carp is beneficial in reducing turbidity due to suspension of sediments, it's impact on reducing the overabundance of nutrients will be limited. There are no current strategies for reducing the nutrient loads already in the lake and, with the exception of the proposed treatment, there are no strategies to reduce cyanobacteria blooms in the near term. Re-establishing SAV and beneficial green algae, which are the goals of the proposed action, are the most promising strategies to utilize nutrients within the system. The Service supports the goals and strategies outlined in the Lake Mattamuskeet Watershed Restoration Plan and is actively engaged in implementing them. The Service views and describes the proposed action as one that would contribute to the plan and be complementary to other project activities. Implementation of the plan should include the evaluation of a wide range of potential tools, efforts, and activities, including conducting pilot studies such as proposed under Alternative B.

The Service recognizes that the impacts analysis of Alternative B often assume success and extend the benefits of that success to the entire lake. While success is not guaranteed, results from applications at other locations serve as the most reliable basis for expected results on Lake Mattamuskeet. Though effects are variable depending on the site, research by Matthijs and others on the use of a hydrogen peroxide-based algaecide showed that cyanobacteria remained low for 7 weeks following a single treatment (2012). Additionally, evidence suggests that dissolved oxygen and pH levels will remain within state standards, Lake Guard Oxy capsules will be dissolved within the 72-hour window as stated on the label, and wildlife mortality will be unlikely (BlueGreen Technologies 2021, Lake Anna Civic Association 2022b). While benefits of the treatments would be expected to affect only the bays that are treated, the lessons learned from those treatments could become part of a longer-term strategy to improve water quality on other areas of the lake and possibly the entire lake. Even if treatment of other areas is determined to be impractical or unwarranted, successful restoration of SAV on any portion of the lake is a worthwhile effort. It is important to note that the EA only addresses treatment of the four bays. Any consideration of an action on other parts of the lake would be subject to all applicable laws, regulations, and policies, including NEPA.

The total acreage being treated will be limited to 400 acres of the 40,276-acre lake, which represents only 1% of Lake Mattamuskeet. If water quality and clarity in the bays can be improved through the application of the Lake Guard® Oxy treatment and turbidity curtains,

there could be the opportunity to create a shift in these bays back to submerged aquatic vegetation (SAV) (Scheffer 2004). Improving water quality and clarity is a specific objective of the Lake Mattamuskeet Watershed Restoration Plan (North Carolina Coastal Federation 2019). Historical SAV data also shows that these areas were some of the last areas to have SAV and thus we expect that they may be some of the first areas to target for SAV restoration (Moorman et al. 2017). As outlined in the EA, the loss of SAV and associated invertebrates and seeds in the lake resulted in a loss of over 20,000,000 waterfowl energy use days (Hagy 2019, McCain et al. 2019, Bauer 2018, Gross et al. 2020). Thus, although we don't anticipate that this project will completely restore the lake, we do expect that it has the potential to provide positive benefits in the four important bays for wintering waterfowl at Lake Mattamuskeet.

References and discussion related to the scope of the action and the potential adverse and beneficial impacts were updated in several Impacts on Affected Resource sections in the EA.

NEED FOR ENVIRONMENTAL IMPACT STATEMENT

Comment: Multiple comments were received suggesting the preparation of an Environmental Impact Statement (EIS).

- "The Service must prepare an environmental impact statement to fully assess the short and long-term effects of the experiment, including possible violations of the Migratory Bird Act and NWR System Improvement Act"
- "EA must "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact", which they claim the EA lacks the information necessary to choose between [those] the two options of action "resulting in a significant impact" or the action "may significantly affect the quality of the human environment"".
- "NEPA requires federal agencies to prepare a "detailed" environmental impact statement ("EIS") on any "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(C). NEPA requires federal agencies to "study, develop, and describe technically and economically feasible alternatives" to the agency's proposed course of action. 42 U.S.C. § 4332(F)"

Service's Response: Comments noted. Under 42 United States Code (USC) §4336(b) and 40 CFR §1501.3, an EIS shall be prepared for an action that has a reasonably foreseeable significant impact on the quality of the human environment, while an EA shall be prepared for an action that does not have a reasonably foreseeable significant impact or for an action for which the significance of impact is unknown. Further, 40 CFR §1501.5, 40 CFR §1508.1, 43 CFR §46.300, and 550 Fish and Wildlife Manual (FW) 3.3(B) outline that an agency prepares an EA to assist in planning and decision-making and to determine whether to prepare a FONSI or an EIS. Given the limited scope of the Proposed Action (which is limited to 400 acres, or 1% of the lake), given the pilot study nature of the Proposed Action, given the included measures to minimize impacts and the Monitoring Plan (Appendix C), and given the analysis outlined in the EA and the Section

7 Biological Evaluation which found no significant adverse or beneficial impacts, the Service has determined in the attached FONSI (Appendix E) that preparation of an EIS is not warranted.

WILDLIFE AND HABITAT

Comments received addressing wildlife and habitat include concerns regarding toxicity, method of application, monitoring, lack of inclusion of current research, and appropriateness and compatibility.

TOXICITY

Comment: Multiple comments were received regarding toxicity to birds; excerpts are listed to provide context.

- "dismisses the algaecide's warning that it is toxic to birds without acknowledging the risk posed by the pellets floating on the surface of the lake for several hours or days"
- "You list assurances that no birds have been known to be harmed by the product, but given the way birds move in and out of a location and the lack of long-term study, the makers of this chemical cannot assert that. It is not scientifically sound."
- "The Environmental Protection Agency (EPA) label for Lake Guard® Oxy indicates that it is toxic to birds. This statement was originally used in the EPA's Biopesticides Registration Document for the active ingredient used in Lake Guard® Oxy (USEPA 2002)."
- "The Draft EA fails to mention that the same 2002 EPA document also instructs that sodium percarbonate should carry environmental hazards labelling stating: "Keep out of lakes, ponds and streams. This pesticide is toxic to birds, fish and aquatic invertebrates."
- "Second, hydrogen peroxide is known to degrade keratin, and the outer layer of bird beaks is made of keratin. The Draft EA does not even acknowledge the existence of this corrosive effect, much less these warnings on similar algaecides."
- "Risking poisoning wildlife for the sake of commercial (and likely political) interests is irresponsible at a minimum and probably illegal."
- "While the Draft EA attempts to dismiss concerns about birds ingesting sodium percarbonate by stating that cells of birds and bats are resistant to oxidative stress from hydrogen peroxide,77 this discussion of histological studies on oxidative stress does nothing to engage with the potential acute effects that ingesting concentrated sodium percarbonate, as found in undissolved Lake Guard pellets, could have on birds at Mattamuskeet. It also neglects more recent studies showing that chemically-induced oxidative stress can adversely impact multiple avian organ systems and bodily processes. 78"
    - "77: Draft EA at 12 (citing Ogburn et al. 1998 and Brunet-Rossinni 2004). However, the Brunet-Rossinni study dealt only with bats, mice, and shrews, not

with birds. See Anja K Brunet-Rossinni, Reduced free-radical production and extreme longevity in the little brown bat (Myotis lucifugus) versus two non-flying mammals, MECHANISMS OF AGEING & DEVELOPMENT (Jan. 2004), https://www.sciencedirect.com/science/article/pii/S0047637403001957?via%3Dihub#TBL1. The Ogburn et al. study generated inconclusive results using outdated techniques of determining survival only by cell counting, as opposed to flow cytometry staining for apoptotic markers (such as Annexin-V) or necrotic markers (such as propidium iodide). See Charles E. Ogburn et al., Cultured Renal Epithelial Cells From Birds and Mice: Enhanced Resistance of Avian Cells to Oxidative Stress and DNA Damage, J. OF GERONTOLOGY (1998), https://academic.oup.com/biomedgerontology/article/53A/4/B287/592661?login=false."

- "78: See, e.g., Oldrich Tomasek et al., Opposing effects of oxidative challenge and carotenoids on antioxidant status and condition-dependent sexual signalling, Sci. Reps. (Mar. 22, 2016), https://www.nature.com/articles/srep23546, Attachment 39 (showing that herbicide-induced oxidative stress in male zebra finches is correlated with reduced beak redness, which is a marker of health and survival); Li'E Hou, et al., Effects of Oxidative Stress on the Autophagy and Apoptosis of Granulosa Cells in Broody Geese, INT'L J. MOLECULAR SCIS. (Jan. 21, 2023), http://www.ncbi.nlm.nih.gov/pmc/articles/PMC9916681/pdf/ijms-24-02154.pdf, Attachment 40 (showing that ovarian cell death in broody geese is caused by oxidative stress and that treatment of ovarian follicular cells with hydrogen peroxide resulted in a significant increase in cell death); Oldrich Tomasek et al., Trade-off between carotenoid-based sexual ornamentation and sperm resistance to oxidative challenge, Proc. Royal Soc'y Biology, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5310042/pdf/rspb20162444.pdf, Attachment 41 (herbicide-induced oxidative stress linked to decreased sperm velocity in male zebra finches); Canwei Xia & Anders Paper Moller, Long-lived birds suffer less from oxidative stress, AVIAN RSCH. (Dec. 6, 2018), https://avianres.biomedcentral.com/articles/10.1186/s40657-018-0133-6, Attachment 42 (showing inverse correlation between longevity and markers of oxidative stress in birds); Gianni M. Castiglione et al., Adaptation of the master antioxidant response connects metabolism, lifespan and feather development pathways in birds, NATURE COMMC'N (May 18, 2020), https://www.nature.com/articles/s41467-020-16129-4?utm_campaign=related_content&utm_source=ECOEVO&utm_medium=communities, Attachment 43 (concluding that controlling oxidative stress is critical for proper development of feathers and other keratincontaining avian structures like beaks, scales, and claws)."

- "Emetic effects that could deprive birds of nutrition should be considered for their adverse impacts on birds at Mattamuskeet, rather than touted as "safe" just because involuntary emesis is considered a lesser physical harm than lethal toxicity."

Service's Response: Product labelling indicates that Lake Guard® Oxy is toxic to birds. In light of the abundant bird populations that rely on Mattamuskeet NWR and the agency's commitment to upholding the mission of the refuge as a sanctuary for migratory birds, the Service has considered this statement very carefully. However, as described more fully in the paragraphs below, we believe that the level of risk suggested by this statement is misleading when the origin of this statement is considered, especially in the context of the proposed treatment. Past experience with similar treatments in other locations also suggest that the treatment can be conducted safely without harm to birds. Further, by providing monitoring during daylight hours during treatments, employing mitigating measures such as hazing to deter bird use of treatment areas, and restricting the seasonality of treatments to periods of low bird presence, we can further reduce potential risks.

The Biopesticides Registration Action Document (USEPA 2002) referred to in the bulleted comments above provides information on both the active ingredient sodium carbonate peroxyhydrate and an end-use product, TerraCyte. The environmental hazards statement referenced in the comment clearly pertains to the End-use Product, TerraCyte which is only approved for terrestrial applications. As referenced in the draft EA, the EPA document states the following about sodium carbonate peroxyhydrate: "In the presence of water, the active ingredient rapidly breaks down to hydrogen peroxide and sodium carbonate, and hydrogen peroxide rapidly breaks down, on contact, to water and oxygen, neither of which presents toxicological concern." (USEPA 2002). This statement also informs the risks associated with the corrosive effect of the active ingredient to the beaks of birds. With the breakdown of the active ingredient in the presence of water, it is unlikely that birds would be exposed to the chemical for a long duration. Mitigating measures described elsewhere in this appendix such as limiting the seasonality of treatments and hazing, will further reduce the likelihood of prolonged contact.

BlueGreen Technologies recently had toxicity tests performed on mallards (*Anas platyrhynchos)* and bobwhite quail (*Colinus virginianus)* to determine the acute LD50. The initial tests conducted on the mallards were unsuccessful because the mallards regurgitated the product, so the decision was made to complete the tests on bobwhite quail. Results calculated the LD50 for bobwhite quail to be 2472 milligrams active ingredient per a kilogram of body weight with a 95 percent confidence that the LD50 is greater than 1921 mg active ingredient per a kilogram of body weight (Blue Green, personal communication, January 15, 2024). This provides an LD50 of 539 mg active ingredient if we assume an average weight of 218 g for a bobwhite quail. Lake Guard® Oxy would need to be applied at a rate of 50 pounds per an acre in order for product to be present at a rate of approximately 510 mg per a square foot (assuming 98% active ingredient). Labeled rates of Lake Guard® Oxy range widely from 0.5 to 294 pounds per acre.

For comparison, a max rate of 40 pounds per an acre was applied to the Caloosahatchee River when it was experiencing a harmful algal bloom and 44 pounds per an acre were applied to Mantau Lake (BlueGreen, personal communication). Based on the toxicity results described above, the Service is limiting the application rates of Lake Guard® Oxy to a maximum of 50 pounds per acre during the proposed cyanobacteria treatment on Lake Mattamuskeet. The description of Alternative B and the Impacts section for Aquatic Resources in the EA was updated to reflect this dosage limit.

During a 2022 treatment at Lake Anna, observers were deployed each day following the treatment until the capsules had dissolved (Lake Anna Civic Association 2022a). No adverse effects to wildlife health were observed and they concluded that no environmental issues were noted during the demonstration period of May to October (Lake Anna Civic Association 2022b). Similar to Lake Mattamuskeet, Lake Anna is a highly eutrophic lake that is experiencing cyanobacteria blooms and SAV loss. The Lake Anna Civic Association is looking to develop integrative management strategies aimed at reducing nutrients and sediment resuspension and restoring SAV. Their plan identifies similar strategies as Lake Mattamuskeet to improve water quality such as carp removal and implementation of watershed BMPs. They also identify using algaecides as a low-cost, short-term solution to reduce cyanobacteria with a preference for peroxide-based algaecides because they are more selective for cyanobacteria and relatively benign (Solitude Lake Management 2022).

Research by Matthijs and others on the use of hydrogen peroxide-based algaecide on an entire lake found that the treatment selectively killed cyanobacteria without major impacts to other species and found that the toxins degraded rapidly afterwards. They concluded that a key advantage of using sodium peroxide-based treatments was that they left no long-term chemical trace in the environment (2012).

In order to address concerns for abundant wintering waterfowl, the application of Lake Guard® Oxy will be limited to April – October when migratory waterfowl are largely absent from the treatment sites. During daylight hours, there will be observers present during the time of application until the active ingredient in the product is fully dissolved, to minimize exposure of migratory birds and other wildlife to the product and to observe any unanticipated impacts. Observers will disturb or haze any birds landing in areas where undissolved product is present. The description of Alternative B in the EA was updated to reflect these clarifications.

Comment: Multiple comments were received regarding possible negative impacts to fish and other aquatic organisms; excerpts are listed to provide context.

- “Adverse impacts to phytoplankton, zooplankton, mixotrophs, diatoms, and/or other unicellular organisms and macroinvertebrates in Lake Mattamuskeet could all have significant impacts to the composition of aquatic diversity, oxygen and nutrient levels in the lake. These adverse impacts to non-target organisms are even more concerning in light of scientific evidence demonstrating that the genus of toxin-producing

cyanobacteria that is most abundant at Lake Mattamuskeet-- Cylindrospermopsis-- is also the most resistant to hydrogen peroxide." 101
    - "101: Email from Kendall Smith to BlueGreen (Nov. 4, 2022) and attached paper: Mark W. Lusty and Christopher J. Gobler, The Efficacy of Hydrogen Peroxide in Mitigating Cyanobacterial Blooms and Altering Microbial Communities Across Four Lake in NY, USA (June 2020), TOXINS, Attachment 61. That study again concluded that peroxide-based treatments may not be an ideal mitigation approach in high biomass ecosystems."
- "The Draft EA fails to acknowledge and discuss the well-documented risk of oxygen depletion caused by large die-offs of cyanobacteria, which can have detrimental effects on all levels of aquatic organisms and lead to fish kills."
- "Data provided on the website of the Lake Anna Civic Association, which contracted with BlueGreen to apply Lake Guard Oxy in the summer of 2022, also show very mixed results in terms of effects of treatment on dissolved oxygen levels, pH, and phycocyanin and chlorophyll levels, and the Draft EA should have discussed results of this treatment." 115
    - "115: See Lake Anna Civic Association, 2022 Cyanobacteria Mitigation Project Content, https://www.lakeannavirginia.org/2022-CMP; see also Lake Anna Civic Association, Cyanobacteria Mitigation Project Final Report, Attachment 66."
- "The potential stressing effects to fish of hydrogen [peroxide in the water column should also be considered alongside] this issue, and how the Draft EA fails to discuss at what [levels peroxide is safe to fish]"
- "Finally, the Draft EA fails to discuss any impacts that the turbidity curtains used in the pilot study might have on aquatic life, including how they may disrupt wildlife dispersal or feeding patterns or exacerbate the stressing effects of the foregoing potential adverse impacts of Lake Guard Oxy on non-target aquatic organisms."
- "The Safety Data Sheets for sodium percarbonate state that it is toxic to aquatic life and should not be released into the environment."
- "The Draft EA fails to consider the likelihood that cyanotoxins will be released from the algal blooms that are killed by the treatment, and what potential adverse impacts the sudden increase in cyanotoxins may have on fish and other aquatic organisms as well."
- "the Draft EA fails to support its presumption that Lake Guard Oxy treatments will not adversely impact fish or other aquatic organisms or potentially alter the aquatic environment in negative ways. The Draft EA does not just fail to provide positive scientific evidence and discussion demonstrating the safety of the product when applied to a shallow lake like Mattamuskeet; it also fails to consider or discuss negative evidence of potential adverse impacts to aquatic organisms and the aquatic ecosystem that the agency had before it."
- "fails to consider recent research about possible adverse impacts to the aquatic ecosystem, including to other beneficial types of algae"

Service's Response: Comments noted. Currently, Lake Mattamuskeet is listed by the North Carolina Division of Water Resources (NCDWR) as impaired due to high pH and chlorophyll-a. In 2012, phytoplankton sampling revealed a dominance of Cylindrospermopsis, Aphanizomenon, and Anabaena and cyanotoxin sampling indicated high levels of cylindrospermopsin (Moorman, 2018). Though full analysis of the cyanobacteria populations in Lake Mattamuskeet is lacking, recent monitoring by UNC-IMS indicates a diverse phytoplankton assemblage with a high proportion of Pseudanabaena (UNC-IMS, personal communication).

There is limited data from previous applications of Lake Guard® Oxy. BlueGreen Technologies monitored 2000-acre Lake Minneola during a previous pilot study that was conducted over a seven-month period. Their results suggest treatment was successful in preventing cyanobacteria blooms and toxins during the period, dissolved oxygen levels remained above 50% and pH remained above 5 standard units. During the same period, nearby lakes did experience cyanobacteria blooms (BlueGreen Technologies 2021). A review of data and observations from the application of Lake Guard® Oxy by Lake Anna Civic Association suggests similar results, dissolved oxygen did not fall below 50 percent saturation or 4 milligrams per a liter and pH levels remained above 6 standard units following treatments. At Lake Anna, observers traversed the entire waterway each day after treatment until the capsules dissolved which occurred within the 72-hour window prescribed on the label. No evidence of a fish kill was observed with only one dead striper reported by the observers during the multiple treatments that occurred over the course of the summer season (Lake Anna Civic Association 2022b, Lake Anna Civic Association 2022a). The effect of the treatments on reducing phycocyanin and chlorophyll-a were mixed, particularly at sites where only a summer application occurred suggesting a spring application with follow-up treatments is most effective (Lake Anna Civic Association 2022).

A review of other recent research on a similar hydrogen peroxide-based algaecides (PAK-27) suggests that when applied according to the label, the algaecide is environmentally friendly compound that is effective in selectively suppressing cyanobacteria blooms and toxins. They found that other species including eukaryotic plankton and macrofauna were largely unaffected and that cyanobacterial toxins degraded rapidly (Barrington et al. 2013, Geer et al. 2016, Matthijs et al. 2012, Sinha et al. 2018). Toxicity tests by Meinertz and others did not find significant evidence of toxicity on *Dafnia* (2013). Results from application of Lake Guard® Oxy at Lake Minneola, Florida suggests that the lake remained bloom free during the treatment period and that Largemouth bass (*micropterus salmoides)* populations increased in number and biomass (BlueGreen Technologies, 2021). In a laboratory experiment, Geer and others found that fathead minnow (*Pimephales promelas*) were not likely affected by concentrations of hydrogen peroxide that would be used to control algae (2016).

There are plans to carefully monitor the application of Lake Guard® Oxy during the application process. This includes having a team of water-quality experts to set water quality thresholds for parameters including pH and dissolved oxygen, monitor data from the treatment areas in real-

time and stop application of the lake immediately if the specified thresholds are exceeded. The description of Alternative B and the monitoring section of the EA was updated to reflect these clarifications.

The Service recommended the use of turbidity curtains for the cyanobacteria treatment for several reasons. We believe SAV restoration potential will be enhanced by the use of turbidity curtains placed across the mouths of each bay to isolate them from the rest of the lake. These curtains should reduce variability in research results, help concentrate treatment effects, and reduce turbidity inside of the bays thereby further promoting improved water clarity. If water quality and clarity in the bays can be improved through the application of the Lake Guard® Oxy treatment and the use of turbidity curtains, a shift in these bays back to submerged aquatic vegetation (SAV) may result (Scheffer 2004). It is the Service's opinion that these benefits outweigh any possible negative impacts of the curtains to aquatic life which would be limited to a small area of the lake.

METHOD OF APPLICATION

Comment: Multiple comments were received regarding the seasonality, timing, frequency, and method of application; excerpts and summaries are provided for context.

- "To minimize the risk of Lake Guard Oxy pellet ingestion by avian and terrestrial species, the product should only be applied to the treatment bays by boat. The vessel application method minimizes the likelihood of pellet placement on shore or other areas where pellet dissolvement may not occur in a timely manner. While this may increase application time or costs, the removal of pellet ingestion opportunities is important due to the toxicity of the algaecide in pellet form."
- "The Action Alternative fails to explain the frequency or scope of anticipated treatments—will it be a single treatment, or several across a specific time period? Would the trial treatment period occur during a single season or year, or extend across multiple years? Even the timing of application is left open, with the Draft EA equivocally stating treatment would happen "in the winter or early spring" if possible, immediately followed by a statement that "the product may still be used in other seasons for similar effect."54 The timing of application is critical to understanding possible impacts on migratory bird species"
    - "54: Draft EA at 8."
- "Pellet application is stated to occur during the winter or early spring months. This is also the time large populations of waterfowl utilize the lake. Therefore, application of pellets should not occur when large numbers of waterfowl are present."

Service's Response: In consideration of comments received and additional information collected, Alternative B, as described in the Alternatives section of the EA, was updated to include several restrictions on method and timing of application. First, to ensure the product is effectively placed in the appropriate location, only boat application will be allowed. This

application method should ensure that all pellets make immediate contact with water and begin to dissolve as soon as dispersed. Additionally, application will be limited to the time period of April 1 through October 31. A compilation of ground waterfowl surveys on Mattamuskeet NWR over the period of 2018-2022 show peak numbers over 100,000 in December and January with an average around 78,000. Average counts on this survey route drop below 2,000 over the month of March. The average count during the month of April was 165 birds (USFWS, 2024). While these surveys are conducted on refuge impoundments surrounding the lake, they represent the seasonal migration of wintering waterfowl in the area. Limiting application in the treatment bays from April through October, will minimize the likelihood that waterfowl will come in contact with the product.

The treatment process must be adaptive in terms of rates, timing, and frequency so prescriptive details cannot be provided in advance, only a general approach. Updates have been made to the description of Alternative B in the EA and Table 2 was added to Appendix B to better outline this general approach. These include more details on possible supplemental or maintenance treatments and a statement that the treatment phase will be limited to one consecutive nineteen-month period with treatments only allowable from April-October.

MONITORING

Comment: Multiple comments were received regarding monitoring; excerpts and summaries are provided for context.

- "All monitoring protocols presented to USFWS should be fully implemented."
- "Hazing of birds from the project area prior to and after pellet application is recommended. This should be done until applied pellets have dissolved."
- "Observational surveys should be conducted within areas of application to ensure pellets were applied within the bays of the lake and not onshore. Any misplaced pellets should be removed."
- "Project reports should be presented to state and federal agencies as soon as available and prior to any additional application proposals."
- "The Service should require that BlueGreen and the UNC researchers make all data and analysis resulting from monitoring efforts of this treatment publicly available."

Service's Response: In consideration of comments received, Alternative B, as described in the Alternatives section of the EA, was updated to include monitoring requirements and hazing of birds present in the treatment areas during treatment. These activities will be conducted by the Service and the information collected will be public record. Other on-site monitoring efforts are directed by a Special Use Permit from the Service which includes reporting requirements to the Service. These reports and all monitoring information obtained by the Service will be made readily available to project partners including state agencies and are considered public records.

Given the nature of the treatment sites, no exposed shoreline areas are expected to exist. The shorelines in these bays are vegetated almost entirely by phragmites typically out to a depth of six inches. Observers will be present to detect and record all bird and wildlife observations and address any unanticipated conditions.

APPROPRIATENESS AND COMPATIBILITY

Comment: Multiple comments were received questioning the appropriateness and compatibility of the proposed pilot study; excerpts are listed to provide context.

- "Congress established Lake Mattamuskeet National Wildlife Refuge as an inviolate sanctuary for migratory waterfowl. As such, activities and actions there must be compatible with the purpose of the refuge."
- "As such, its proposed use at Lake Mattamuskeet is incompatible with the NWR's purpose."
- "This project falls outside the scope of research uses envisioned by the Compatibility Determination. The experimental "trial treatment" of this algaecide is not focused on the Refuge's priority species—birds—and purports to in fact be toxic to those priority species, thus undermining fulfillment of the Refuge's purposes."
- "As described in the Draft Ea, no effort has been made to minimize impacts to migratory birds or other natural resources. In fact, given the possibility of "impairing existing wildlife-dependant recreational uses" through harm to birds, the use fails to even meet the pre-requisite "appropriateness" finding."

Service's Response: As discussed above in a previous response, it is important to note that the Proposed Action is a pilot study in support of the refuge's CCP/EA/FONSI (USFWS 2008a, 2008b) and HMP/CatEx/EAS (USFWS 2018) and in support of the multi-agency and multi-stakeholder Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019). The refuge's HMP and the Lake Mattamuskeet Watershed Restoration Plan specifically recognize the need to address cyanobacteria. The refuge's CCP/EA/FONSI (USFWS 2008a, 2008b) articulated the Service's vision, goals, and objectives for the refuge in support of refuge purposes, including fish and wildlife population management, habitat management, resource protection, visitor services, and refuge administration. Stepping down from the CCP, the refuge's HMP (USFWS 2018) further refined refuge objectives under the existing habitat management goal. The Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019) articulates three main goals, one of which is to "Restore Water Quality and Clarity". A number of projects designed to meet this goal, such as carp removal and treating agricultural run-off, are currently being planned or implemented. The Service fully supports and prioritizes these projects and their role in watershed restoration. The proposed pilot study also supports the goal to restore water quality and clarity. If the pilot study were to be implemented and prove successful, it could be one of the many tools used for restoration in Lake Mattamuskeet.

For clarity, the Service requires that a public use of a unit of the NWRS be determined to be an appropriate and a compatible use. In short, an appropriate and compatible use of a unit of the NWRS is a public use that, based on sound professional judgement, will not materially interfere with or detract from fulfillment of the NWRS mission or the purposes of the unit of the NWRS. The process of determining appropriateness and compatibility is specific to public uses and does not apply to refuge management actions since these management actions are inherently designed to serve a refuge's purpose(s), vision, goals, and objectives. (See 603 FW 1 and 603 FW 2 for more information.) Specific to the Proposed Action, as outlined in the EA, the treatment phase of the proposed pilot study would be a refuge management action supporting the refuge's purposes and vision, as well as supporting multiple refuge goals and objectives expressed in the refuge's CCP (USFWS 2008b) and HMP (USFWS 2018) and the Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019).

To ensure that specific conditions and restrictions outlined in the EA/FONSI are followed in order to minimize adverse impacts, the Service would require permits for both BlueGreen and UNC-IMS as part of the proposed pilot study. BlueGreen would be required to submit an application for a refuge Special Use Permit that conformed to the EA/FONSI for the pilot study, and, if approved, the Service would issue a Special Use Permit that aligned with the EA/FONSI and that included the measures and restrictions outlined in the EA/FONSI. The pilot study's baseline monitoring that was initiated in 2023 and the independent monitoring by UNC-IMS (outlined in the Monitoring Plan in Appendix C) will occur under separate Research Special Use Permits, which were included and analyzed in the EA and which would be, independently, appropriate and compatible uses under the refuge's existing Research Compatibility Determination. The description of Alternative B in the EA was updated to provide this clarity.

CHEMICAL PRODUCT

Comments were received regarding the specific chemical product selected for the pilot study and the proposed rate of application.

LAKE GUARD® OXY

Comment: Multiple comments were received regarding the product chosen for application; excerpts and summaries are provided for context.

- "There is another management option for reducing sediments, filamentous cyanobacteria, and nutrients: aluminum sulfate. The company that is proposing the treatment has a granular formulation (Lake Guard Dew) which would seem to be a better option at Mattamuskeet. However, it is not classified as an algicide, as is the product that is proposed (Lake Guard Oxy), which means that an NPDES permit would be required for testing. Data on total and dissolved aluminum and dissolved organic carbon (DOC) would also need to be collected, as this is a low alkalinity system."

- "FWS does not explain why it did not consider any of the other algaecides on the market as alternatives to the Lake Guard Oxy Product"
- "...Lake Guard Oxy was observed still floating on the surface of the water a full three days after treatment.75 Notably, no observations were made on subsequent days to determine if Lake Guard Oxy persisted on the lake surface for an even longer period of time."
    - "75: Lake Anna Civic Association, Cyanobacteria Mitigation Program Application Event #1-Area of Interest (AOI)-Pamunkey, Attachment 36, https://www.lakeannavirginia.org/CMP-Application-Event-1. (Lake Guard Oxy was applied to the study area on Days 1 and 2, and lake conditions were monitored for three consecutive days after the second day of product application. Observations provided by the Lake Anna Civic Association project managers state that "The Lake Guard Oxy product was seen on the surface through Day 5 of the application event.")"

Service's Response: Comments noted. One of the noted benefits of hydrogen peroxide-based algaecides is that they break down into water and oxygen relatively quickly in the environment (Matthijs et al. 2012, Sinha et al. 2016). Other copper-based and aluminum-based algaecides have been used for decades but pose concerns because the metals remain in the environment and pose risks of eco-toxicity to other species oh phytoplankton, zooplanton and fishes (Jancula and Marsalek 2011).

As discussed above, the Service was approached in 2022 by UNC-IMS and BlueGreen with a proposal to conduct a pilot study to test a specific cyanobacteria treatment to trigger a population collapse of the cyanobacteria in Lake Mattamuskeet. The Service recognizes the potential of the proposed study to inform restoration efforts and help achieve goals identified in the Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019). Some details of the proposed pilot study, such as the product to be used, were determined by the project team or through contracting procedures prior to the Services' involvement. Recent research suggests that hydrogen peroxide-based algaecides are relatively benign in the environment and thus an effective way to temporarily mitigate and reduce cyanobacteria blooms and toxins (Matthijs et al. 2012, Barrington et al. 2013, Sinha et al. 2018).

One commenter referred to a statement in the referenced document from the Lake Anna Civic Association that states, "The Lake Guard Oxy product was seen on the surface through Day 5 of the application event." This sentence is part of a bulleted statement that continues with a second sentences which reads, "The product developer's statements that the product remains viable for 24-72 hours and then dissipates into water and oxygen are consistent with our observations." Lake Guard® Oxy has a biodegradable coating that allows the granule to float and prolongs the release of the active ingredient (BlueGreen 2023). This coating often remains visible and can be observed after the active ingredient is dissolved (BlueGreen, personal

communication). It is likely that the observers with the Lake Anna Civic Association observed the coating portion of the product beyond the 72-hour period.

RATE OF APPLICATION

Comment: Multiple comments were received regarding the rate of product to be used; excerpts and summaries are provided for context.

- "The Draft EA also lacks detail about the volume of the product to be applied in a given treatment, which matters for understanding the concentration of the product and possible toxic or other impacts to lake inhabitants, including while the product is floating on the surface of the water before it dissolves."
- "Furthermore, while the Draft EA indicates that sodium percarbonate concentrations to be used in the experiment will not exceed 36.7 mg/L, which the Draft EA claims will be safe for Ceriodaphnia,99 other scientific evidence in possession of the Collaboratory suggests that sodium percarbonate concentrations should be limited to less than 10.0 mg/L, and possibly less than 5.0 mg/L, to be safe for zooplankton. 100"
    - "99: Draft EA at 12."
    - "100: Robin Thoo, Waldemar Siuda, and Iwona Jasser, The Effects of Sodium Percarbonate Generated Free Oxygen on Daphnia—Implications for the Management of Harmful Algal Blooms, 1, 9 Water (2020), Attachment 60."

Service's Response: As previously mentioned, the description of Alternative B in the EA was updated and Table 2 was added to Appendix B in the EA to provide additional details on the volume of the product to be applied in any given treatment.

As referenced in the Terrestrial Wildlife and Aquatic Species section of the EA under Impacts, acute toxicity tests were completed for *Ceriodaphnia* using water from Lake Mattamuskeet to arrive at a half maximal inhibitory concentration of 37.5 mg/L. In consultation with NCDWR, using the test's resulting Chronic value of 36.7 mg/L of product as the maximum use limit (MUL) was recommended. This site-specific test should more accurately reflect expected impacts of sodium percarbonate to zooplankton in Lake Mattamukskeet. However, as discussed in the Toxicity section above, application rates of Lake Guard® Oxy will be limited to 50 pounds per acre during the proposed cyanobacteria treatment. This restriction reduces the maximum sodium percarbonate concentrations of any application to approximately 5 mg/L, well below the MUL and more closely aligned with the cited research by Thoo, et.al.

CULTURAL RESOURCES

The Catawba Indian Nation submitted a comment regarding the proposal.

CULTURAL RESOURCES

Comment: "The Catawba Indian Nation reiterated that "...the Catawba are to be notified if Native American artifacts and / or human remains are located during the ground disturbance phase of this project.""

Service's Response: Comment noted. The Service values the continuing engagement of the Catawba Indian Nation, including at Mattamuskeet NWR. Given the pilot study nature of the Proposed Action, the application of the chemical by boat, and the outlined monitoring activities, and as outlined in the EA in the Tribal Consultation and Cultural Resources Section, the Proposed Action would have "no effect" upon any of the refuge's historic properties, including the architectural ruins and canal system associated with the early 20th century town of New Holland. Due to the nature of the action, the undertaking is deemed to be routine maintenance. In the event the Service were to encounter and/or identify cultural material and/or human remains during the pilot study, the Service would implement the measures identified in its Unanticipated Site Discovery Plan (Archaeological and Historic Sites) for Mattamuskeet NWR, which outlines a notification tree that includes contacting the Catawba Indian Nation.

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Appendix E. Finding of No Significant Impact

FINDING OF NO SIGNIFICANT IMPACT
AND DECISION TO
IMPLEMENT CYANOBACTERIA PILOT STUDY AT
MATTAMUSKEET NATIONAL WILDLIFE REFUGE
HYDE COUNTY, NORTH CAROLINA

Building on collaboration with the North Carolina Wildlife Resources Commission (NCWRC) and Hyde County and the Lake Mattamuskeet Watershed Restoration Plan (LMWRP) (North Carolina Coastal Federation [NCCF] 2019), the U.S. Fish and Wildlife Service (Service, USFWS) coordinated with the state of North Carolina (including the North Carolina Department of Water Resources and the NCWRC), Hyde County, the Lake Mattamuskeet Watershed Restoration Technical Working Group, the University of North Carolina Institute of Marine Sciences, and other interested parties to develop an Environmental Assessment (EA; USFWS 2024) to evaluate a pilot study to control cyanobacteria in Lake Mattamuskeet at Mattamuskeet National Wildlife Refuge (NWR, refuge). The control of cyanobacteria in Lake Mattamuskeet supports multiple goals and objectives in the refuge's Comprehensive Conservation Plan (CCP) / EA / Finding of No Significant Impact (FONSI) (USFWS 2008a, 2008b) and Habitat Management Plan (HMP) / Categorical Exclusion (CatEx) /Environmental Action Statement (EAS) (USFWS 2018) and the multi-agency and multi-stakeholder Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019). Based on the analysis of the pilot study in the Section 7 Endangered Species Act Biological Evaluation and the EA, and as outlined in this FONSI, the Service has determined that no significant beneficial or adverse impacts would result from implementation of the pilot study. The Service is thus implementing the pilot study to control cyanobacteria in Lake Mattamuskeet at Mattamuskeet NWR.

Selected Action

Alternative B – Cyanobacteria Treatment within Lake Mattamuskeet Using Lake Guard® Oxy (Proposed Action Alternative)

Under the Proposed Action Alternative B, the refuge would implement a pilot study of a cyanobacteria treatment within Mattamuskeet NWR. Following public review of the draft EA (USFWS 2023), this Alternative was updated to clarify the spatial and temporal scope of impacts, limitations on timing, frequency, methods, and rates of applications, added requirements for monitoring and hazing bird activity, added thresholds for water quality parameters that will be monitored during treatments, and added data on bird toxicity testing.

The treatment phase of the pilot study would occur over one consecutive nineteen-month period with treatments occurring only between April 1 and October 31. Treatments would be subject to permits from the NCDWR and applied in accordance with a Service Special Use Permit (SUP) issued by the Service on an annual basis. To ensure that specific conditions and

restrictions outlined in the EA are followed in order to minimize adverse impacts, the Service would require permits for both BlueGreen and UNC-IMS as part of the proposed pilot study. Lake Guard® Oxy was reviewed and approved through the Service's Pesticide Use Proposal system, which included a separate Section 7 biological evaluation under the Endangered Species Act.

The treatments would occur in four bays – two in the West Basin and two in the East Basin for a total of 400 treated acres or 1% of the total surface area of the lake. Each bay would be separated from the remainder of the lake by turbidity curtains extending from the water surface to the lake bottom. Each of the bays would have another similar bay to act as a control, having a turbidity curtain but not receiving treatment. UNC-IMS would provide independent monitoring before, during, and after the treatment. The results of this monitoring would allow UNC-IMS to provide an independent evaluation of the treatment's success and an assessment of any positive or negative impacts to water quality and ecosystem health.

To reduce the likelihood of negatively impacting wildlife, monitoring efforts will be employed, and several restrictions would be imposed on the methods of application. First, application will be limited to the time period of April 1 through October 31 to minimize impacts to the large numbers of waterfowl that winter on the refuge. Additionally, only boat application will be allowed to ensure that all Lake Guard® Oxy pellets are appropriately placed and make immediate contact with water to begin dissolving. Monitoring efforts will also be independently conducted by the Service during treatment activities. This will include "hazing" any birds present in areas where undissolved product is present. Bird and other wildlife observations and any hazing activity will be recorded by those monitoring the area. In addition, applicators will be required to monitor water quality parameters and will stop treatments if DO drops below 4 mg/L for more than 8 hours or below 2 mg/L for any length of time and if pH drops below 6 or exceeds 10.5.

Application of Lake Guard® Oxy depends on water quality characteristics during the period of treatment. BlueGreen will assess these characteristics using current detailed satellite imagery data analysis and monitoring efforts via 38 autonomous probes currently in the lake. Actively tracking cyanobacteria levels and timing an initial treatment to occur just prior to a cyanobacteria bloom, will more effectively target harmful cyanobacteria as opposed to beneficial phytoplankton. Cyanobacteria cell counts will be closely monitored following initial treatments to determine if supplemental treatments are warranted. A minimum two-week period will be maintained between treatments. Supplemental treatments would use lower dosages to further suppress cyanobacteria cell density to an acceptable level of less than 20,000 cells/mL. If needed, additional maintenance treatments may be implemented to maintain low cyanobacteria cell densities through the end of the treatment period.

This alternative was selected over the other alternative because it best met the stated purpose and need of improving water quality and clarity in portions of Lake Mattamuskeet. This alternative will treat cyanobacteria within four isolated bays on Lake Mattamuskeet and is

expected to temporarily improve water quality and clarity in those bays and possibly promote conditions to support the reemergence of SAV. The pilot study will also evaluate the effectiveness of a cyanobacteria treatment and the role it may play in making water quality improvements and helping restore SAV in other portions of the lake. Concurrently, extensive monitoring associated with the study will provide valuable information on the status and impacts of cyanobacteria blooms and associated cyanotoxins in the lake, shed light on options for reducing those impacts, and could reveal new information and help inform all of the projects and strategies intended to support the restoration of Lake Mattamuskeet.

The results of this experimental approach would establish the efficacy of the product, the specific needs for Lake Mattamuskeet, and the effects of the product on the ecosystem. A technical advisory group consisting of staff from UNC-IMS, BlueGreen, NCDWR, and the Service, in coordination with the Lake Mattamuskeet Technical Working Group, would evaluate the results and provide recommendations on whether to pursue additional cyanobacteria treatments in other parts of the lake. Subsequent treatments in other areas of the lake would be subject to additional permitting by the NCDWR and the Service as well as requirements under NEPA.

Other Alternatives Considered and Analyzed

Alternative A – Continuance of Current Management Practices (No Action Alternative)

Under Alternative A, a cyanobacteria treatment would not occur, and refuge management would continue without changes. Control of cyanobacteria would be solely dependent on indirect approaches to reduce the excessive nutrients that cause the cyanobacteria blooms. The refuge does not control or regulate off-refuge nutrient inputs. Drainage from the watershed is allowed to flow through existing canals and enter the lake, so efforts to redirect drainage or reduce these inputs are dependent on voluntary actions by landowners and other partners. The Service would continue to pursue the completion of projects to reduce nutrient inputs from the watershed, recognizing that such projects often involve multiple partners, require lengthy planning and design, and are dependent on available funding.

Under Alternative A, the proposed pilot study and treatment would not be implemented on Lake Mattamuskeet and thus, the potential to improve water quality and clarity in the pilot study areas through the application of an algaecide would not be tested. The opportunity to test a method that could be a useful component of SAV restoration in other areas of the lake would also be lost. The proposed management action would not be implemented and would not contribute to meeting the goals and objectives in the refuge's CCP (USFWS 2008), HMP (USFWS 2018), and LMWRP (NCCF 2019).

This alternative was not selected, because it did not best meet the stated purpose and need. Alternative A would rely solely on indirect approaches to reduce excessive nutrients that cause cyanobacteria blooms. While these indirect approaches are critical for long-term restoration

and perpetuation of a healthy lake ecosystem, they do not address nutrients that are already in the lake and contributing to cyanobacteria blooms.

Summary of Effects of the Selected Action

Draft (USFWS 2023) and final EAs (USFWS 2024) were prepared in compliance with the National Environmental Policy Act (NEPA) to provide a decision-making framework that: 1) explored a reasonable range of alternatives to meet project objectives; 2) evaluated potential issues and impacts to the refuge, resources and values; and 3) identified minimization measures to lessen the degree or extent of these impacts. The final EA (USFWS 2024) evaluated the effects associated with the Proposed Action and the No Action alternatives; it is incorporated herein as part of this finding.

Given the pilot study nature and limited scope of the Proposed Action (which is limited to 400 acres, or 1% of the lake), the measures to minimize impacts, the ongoing monitoring and evaluation, and the analysis of the Section 7 Biological Evaluation which found no significant adverse or beneficial impacts, minimal negative direct, indirect, or cumulative impacts would be anticipated from the implementation of the Proposed Action Alternative of conducting a pilot study of a cyanobacteria treatment in Lake Mattamuskeet.

Implementing the selected action will help meet the purpose and needs of the Service as described above by improving the habitat conditions within the four treated bays, evaluating the effectiveness of a cyanobacteria treatment and the role it may play in making water quality improvements in other portions of the lake, and using data from extensive monitoring to learn more about the status and impacts of cyanobacteria blooms and associated cyanotoxins in the lake. The potential beneficial effects of this project would be: 1) a temporary increase in water clarity in the pilot area by reducing the cyanoHABs, 2) decreased cyanotoxins, 3) increased green algae, and, perhaps, 4) increased biodiversity of fish. The increased water clarity could potentially allow for the regrowth of SAV in the 400 acres of bays identified for the pilot study.

Minimization Measures
Measures to minimize adverse effects have been incorporated into the selected action, including the listed items.

- Limiting treatment to 400 acres or 1% of the lake.
- Limiting treatments to the period of April 1 to October 31 to avoid large numbers of wintering waterfowl.
- Using turbidity curtains to isolate the treatment bays from the rest of the lake.
- Completing one year of pre-project monitoring to better assess annual cycles of cyanobacteria blooms
- Using several monitoring methods to track cyanobacteria blooms and timing treatments to the more effectively treat blooms with the least amount of algaecide needed.
- Limiting the maximum single dosage rate based on results from toxicity tests.

- Limiting application to boat (not aerial) to ensure proper placement
- Monitoring bird use during treatments and disturbing or "hazing" any birds coming in close contact with floating algaecide granules.
- Setting threshold limits for dissolved oxygen and pH and suspending treatments if they are exceeded.

While refuges by their nature are unique areas protected for the conservation of fish, wildlife and habitat, the Proposed Action will not have a significant impact on refuge resources and uses for several reasons, as listed.

- The action is limited to 400 acres, which is 1% of Lake Mattamuskeet.
- Treatments are limited in time and space to minimize adverse impacts.
- Minimization measures outlined above will help minimize adverse impacts, including to biological integrity, diversity, and environmental health.
- Adaptive management, monitoring activities, and hazing activities will help minimize adverse impacts.
- Monitoring activities will help minimize the amount of pesticide to be applied.
- Temporary beneficial impacts are expected, including increasing water clarity and decreasing cyanotoxins. The action is expected to result in limited beneficial impacts to the human environment, including to the biological integrity, diversity, and environmental health of the refuge, as well as to wildlife-dependent recreational opportunities on the refuge and economic benefits to local communities.
- Adverse direct and indirect impacts are expected to be minor and temporally and spatially limited. Beneficial impacts, while minor, are expected to outweigh any adverse impacts.
- No adverse cumulative impacts are anticipated.
- The action, including minimization measures, will ensure that there is a low danger to public health and safety.
- The action is not in an ecologically sensitive area.
- The action will not impact threatened or endangered species or any Federally designated critical habitat.
- The action will not impact any cultural or historic resources.
- The action will not impact any Wilderness areas.
- There is no significant scientific controversy over the impacts of this action and the impacts of the action are relatively certain with minimization measures in place.
- The action is not expected to have significant impacts on wetlands and floodplains pursuant to Executive Orders 11990 and 11988. The action is designed to improve and restore the natural and beneficial values of wetlands and floodplains.

Public Review

The proposal has been thoroughly coordinated with all interested and/or affected parties.

The refuge collaborated with the NCWRC and Hyde County to develop the approved Lake Mattamuskeet Watershed Restoration Plan (NCCF 2019). In addition, the refuge and NCWRC collaborate on the Mattamuskeet Watershed Restoration Technical Working Group that has thoroughly discussed the proposed cyanobacteria treatment, BMPs, and other actions to improve the health and quality of Lake Mattamuskeet's ecosystem. The Service requested review of the draft EA by the State Clearinghouse on September 6, 2023. Through the State Clearinghouse (SCH), the state of North Carolina determined that the Service's EA meets the provisions of the State Environmental Policy Act and the State Historic Preservation Officer concurred that the project would have no effect on historic resources (SCH File #14-E-0000-0081). Substantial comments were received from the North Carolina Wildlife Resources Commission pertaining to monitoring and safeguarding birds during treatment. The Service incorporated all recommendations provided by the NCWRC into the EA including several minimization measures listed above. Other comments were summarized and addressed in Appendix D of the EA.

On September 13, 2023, the Service provided notice of availability of the draft EA for public review and comment to two Native American Tribes: Catawba Indian Nation and Tuscarora Nation of New York. During public review and comment on the draft EA, the Service received a letter from the Catawba Indian Nation. "The Catawba have no immediate concerns with regard to traditional cultural properties, sacred sites or Native American archaeological sites within the boundaries of the proposed project areas. However, the Catawba are to be notified if Native American artifacts and / or human remains are located during the ground disturbance phase of this project." In the event the Service were to encounter and/or identify cultural material and/or human remains during the pilot study, the Service would implement the measures identified in its Unanticipated Site Discovery Plan (Archaeological and Historic Sites) for Mattamuskeet NWR. No response was received from the Tuscarora Nation of New York.

The draft EA was made available for public review and comment from September 15, 2023 to October 30, 2023. In addition to the state agencies and the Catawba Indian Nation mentioned above, the Service received comments from 230 individuals as well as the Southern Environmental Law Center who commented on behalf of twelve other organizations as well. The substantive comments received were summarized and grouped under four general topics of concerns: National Environmental Policy Act (NEPA) and planning process, wildlife and habitat, chemical product, and cultural resources. Comments included a claim that the Service had indicated a pre-decisional position by issuing a Special Use Permit (SUP) to allow monitoring work to begin. Other comments claimed that analysis was limited to only two alternatives and that the impacts analysis was skewed by assuming benefits beyond the scope of the project. The most common concern expressed pertained to the warning label on the product that it is "toxic to birds". This also raised questions about compatibility and appropriateness for this project on a national wildlife refuge with a purpose of protecting migratory birds. Other comments related to a failure to sufficiently consider results of previous applications of the chemical and research on treatments using similar product and a claim that an Environmental Impact Statement (EIS) should be completed to fully address short and long-

term impacts. Appendix D of the EA summarizes the substantive comments received and provides the Service's responses to those comments. As outlined in Appendix D, the final EA was updated to provide clarity, additional information, and additional restrictions.

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U.S. Fish and Wildlife Service. 2024. Final Environmental Assessment, Mattamuskeet National Wildlife Refuge, Cyanobacteria Treatment in Lake Mattamuskeet. Mattamuskeet National Wildlife Refuge, National Wildlife Refuge System, Southeast Region, U.S. Fish and Wildlife Service, U.S. Department of the Interior. March 2024. Swan Quarter, NC.

Finding of No Significant Impact

Based upon a review and evaluation of the information contained in the EA as well as other documents and actions of record affiliated with this proposal, the Service has determined that the proposal to implement the cyanobacteria control pilot study on Mattamuskeet NWR does not constitute a major Federal action significantly affecting the quality of the human environment under the meaning of section 102(2)(c) of the National Environmental Policy Act of 1969 (as amended). As such, an environmental impact statement is not required.

Decision

The Service has decided to implement the pilot study which includes treating cyanobacteria in four bays in Lake Mattamuskeet at Mattamuskeet NWR. Implementation of some treatment phase activities could begin April 1, 2024, with actual treatments being initiated in early to mid-summer of 2024 to most effectively treat cyanobacteria blooms. The project would span one consecutive nineteen-month period. Treatments are subject to permits from the NCDWR and a Special Use Permit (SUP) issued by the Service on an annual basis.

The action is consistent with applicable laws and policies.

PAMALA WINGROVE

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Name/Date

Acting Deputy Assistant Regional Director, National Wildlife Refuge System, Southeast Region
Title