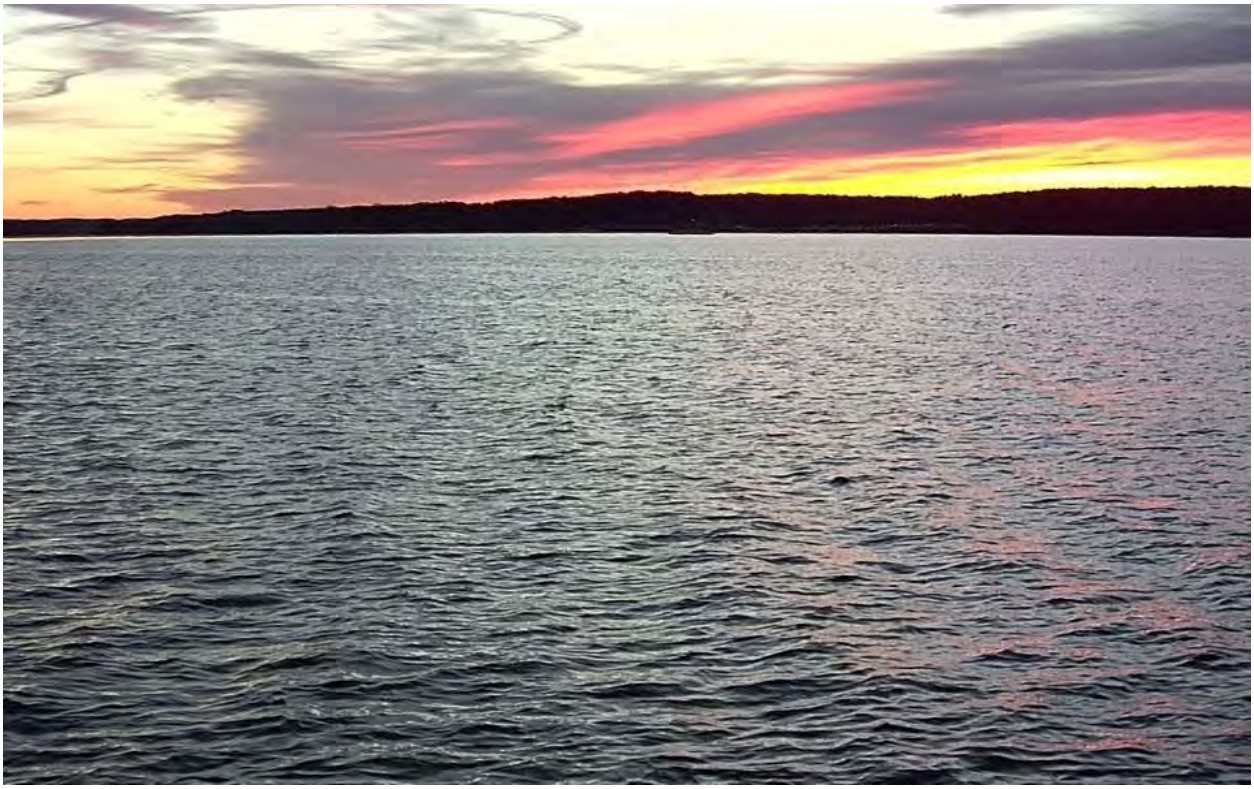
Interim Update to the North Carolina General Assembly



UNC Jordan Lake Study

December 2018

NC Policy Collaboratory

https://collaboratory.unc.edu/

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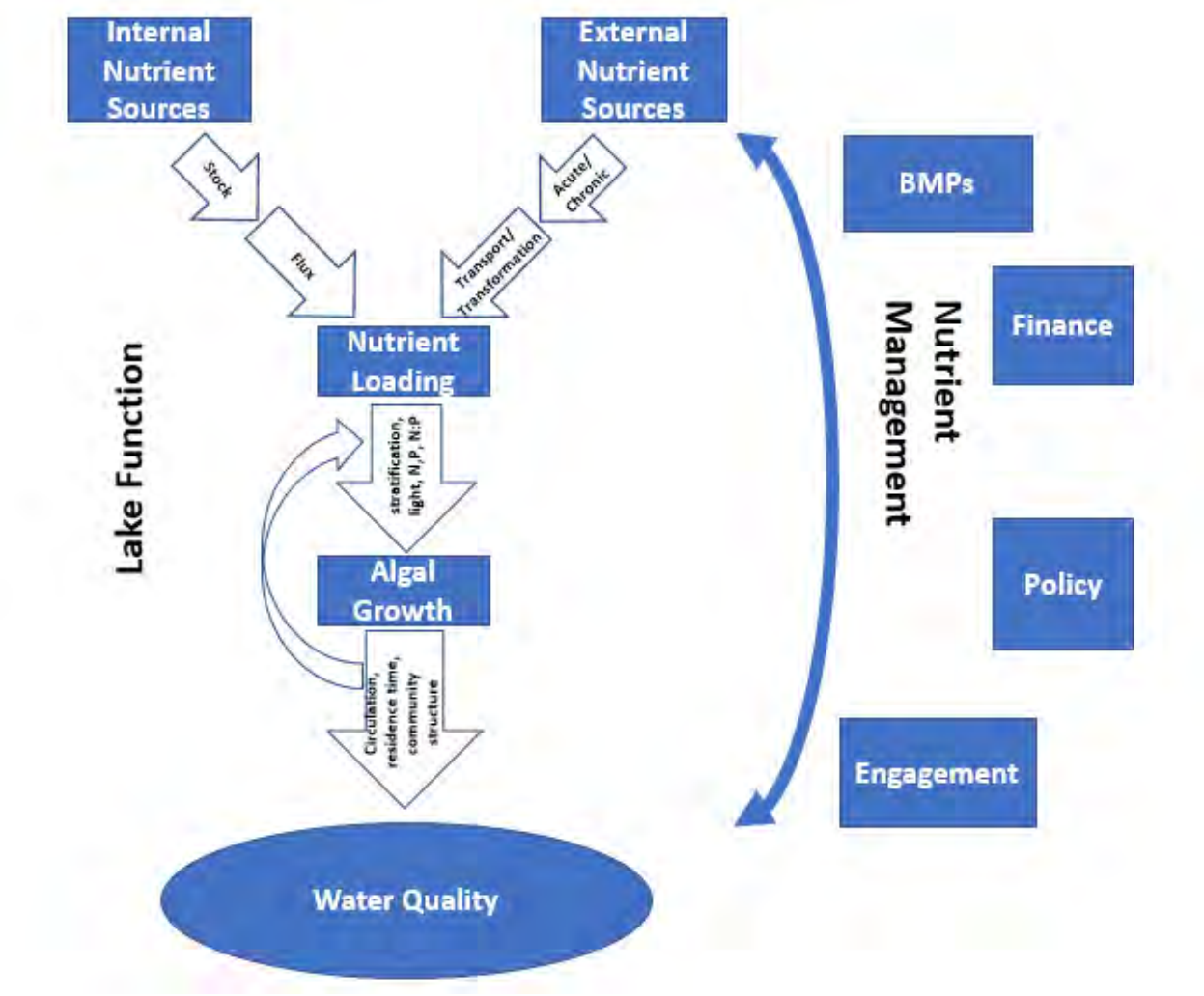
Executive Summary

In 2016 the North Carolina General Assembly approved legislation directing UNC-Chapel Hill to conduct a multi-year study and analysis of nutrient management strategies and compilation of existing water quality data specifically in the context of Jordan Lake and Falls Lake. The legislation required that the study begin with Jordan Lake.

A team of more than two dozen researchers have been working on the study over the last two years. A fundamental aspect of the work is that researchers are taking a holistic approach to studying Jordan Lake and the watershed. Importantly, the team has committed to fully integrating the project as illustrated in the graphic below. This integration provides management-ready information to answer questions from multiple perspectives and bridge topics, including management interventions, water quality and the cost of actions.



Study team approach to UNC Jordan Lake project.

2018 Research Highlights

Below are some of the major research questions the study team has been working to address over the last two years. Much of the scientific research and policy analysis is still ongoing, but some preliminary findings are also identified below.

Research Question: **What policy options can be learned by examining other state and regional nutrient management reduction programs?**

Outcomes and Findings:

- North Carolina's water quality standards for nutrient sensitive waters were not created for the purpose of protecting reservoirs. Appropriate water quality standards based on scientific criteria—likely site specific and seasonal—should be tailored to support designated uses.
- Every opportunity to create and adapt the nutrient management system to create local gains and co-benefits should be explored and developed.
- Maintaining a constant concern for cost-effectiveness is critical.

Research Question: **Which entities are currently incurring costs ("paying for") nutrient management in the Jordan Lake watershed and are their more effective alternative options for generating revenue to support water quality protection?**

Outcomes and Findings:

- Some local governments expressed confusion about the current provisions of the Jordan Lake rules, and what is required under such rules. Some jurisdictions held off on implementing certain nutrient management strategies which would otherwise benefit the lake, because of this confusion and out of a concern for maintaining statutory compliance. All jurisdictions in the watershed would benefit from more clarity in any future nutrient management strategy.
- Holistic regional approaches to spending and raising revenue for watershed protection, which can be found in other areas of the country, are not currently being utilized in the Jordan Lake watershed. The state could utilize some of these approaches to capture revenue for watershed protection from Jordan Lake water supply allocation holders, a practice which is not currently occurring under the state's present nutrient management strategy.
- Under current state law, there are various existing revenue generating mechanisms for local governments to use for watershed protection, some of which are not currently in use and others which could be better utilized. Highlighting, expanding, or modifying such mechanisms in order to promote more widespread revenue generation should be a part of any nutrient management strategy going forward.

Research Question: **What is the fundamental nature of water circulation and water quality in the lake?**

Outcomes and Findings:

- Monitoring equipment on the lake allows for continuous data collection. Results can be found at: www.jordanlakeobservatory.unc.edu
- Major rain events in the Haw River watershed have a significant impact on much of the lake, including the upper portions.
- Lake circulation during "normal" conditions is complex and frequently bi-directional.
- Water circulation and quality data collected will inform development of the new lake modeling.

Research Question: **When and where are nutrients coming from within the urban watersheds and under what flow conditions?**

Outcomes and Findings:

- Streams draining watersheds on septic systems exhibit higher nutrient concentrations than streams draining similarly developed watersheds on sanitary sewer.
- During wet times of the year, nutrient loading from watersheds on sanitary sewer can be as high as loading from similar watersheds on septic systems.
- These preliminary findings can be used to inform nutrient management strategies in urban watersheds, including siting and design of control measures.

Research Question: **What is the suspended sediment load into the lake and where are sediments transported and deposited within the lake?**

Outcomes and Findings:

- The Haw River is the main sediment source to the lake, accounting for 80-85% of input during the sampling periods.
- Preliminary results suggest that as the Haw River discharge increases, sediment inputs far exceed sediment outputs, indicating a large rate of sediment deposition within the lake.
- Nutrient rich bottom sediments present the potential to be a major contributor of nutrients in the lake.

Research Question: **Through the use of biological assessments (bioassays) which nutrients (nitrogen, phosphorous, or both) fuel algal growth?**

Outcomes and Findings:

- While nitrogen is the primary nutrient controlling algal growth, dual reductions of both nitrogen and phosphorous are necessary to reduce algal biomass.
- Algae in Jordan Lake are better adapted to growing in low light than previously thought.

Research Question: **How well do some urban stormwater control measures and agricultural conservation practices reduce nutrients into the lake?**

Outcomes and Findings:

- Agriculture in the Jordan Lake watershed is dominated by pasture and hay with many buffered streams and under-fertilized fields.
- One of the state's most popular stormwater practices, bioretention, may perform as originally designed more than a decade after installation.
- Consistent engagement with communities and residents is a critical component in the implementation of stormwater and green infrastructure projects.

2018 Jordan Lake Research Symposium

A full day research symposium was held on March 22, 2018 for the purposes of representing the breadth of research included in the study; sharing initial research results; and facilitating dialogue.

Over 125 people from across the watershed attended the symposium, including attendees from local and state government, academia, developers, environmental non-profits and members of the public. The symposium featured talks from nine researchers, organized in three segments: natural science research, stakeholder and community perspectives, and policy and finance. In each segment, researchers provided brief overviews of their research protocols and initial results and answered participants' questions. These presentations were followed by small group discussions organized around a question relevant to each group of talks.

Jordan Lake Model Development

In the 2018 legislative session the General Assembly directed the NC Policy Collaboratory, which is managing the UNC Jordan Lake study, to create an updated quantitative model of Jordan Lake.

The Collaboratory is charged by the legislature with presenting results of the model along with (i) recommendations for revisions or additions to the Jordan Lake Water Supply Nutrient Strategy and (ii) identification and analysis of issues and areas identified by its study where no scientific consensus exists or where data is unavailable or incomplete. Researchers from North Carolina State University and UNC-Charlotte have been added to the research team and are in the process of developing the model.

Jordan Lake Collaborations

It is important to note that the work of the UNC Jordan Lake study is taking place concurrently with other initiatives designed to improve water quality in the Jordan Lake watershed. In particular, the Triangle J Council of Governments is working with local elected officials and many stakeholders through the Jordan Lake One Water process. This new entity seeks to facilitate dialogue and integrated water resource management in the Jordan Lake watershed.

In addition, the Triangle Land Conservancy and partners are actively evaluating conservation priorities in the Jordan Lake watershed to develop the Upper Cape Fear Watershed Conservation Strategy. This work is the first step in the process of implementing a program similar to the Upper Neuse Clean Water Initiative, which protects lands most critical to ensuring the long-term health of water supplies in the upper Neuse Basin.

Introduction

Study Background

In the 2016 legislative session, the North Carolina General Assembly directed UNC-Chapel Hill to conduct a six-year Study of nutrient management strategies for Jordan and Falls Lakes. The legislation, Session Law 2016-94, includes several sections related to the "Development of a New Comprehensive Nutrient Management Regulatory Framework."

One of these sections, 14.13(c) directs UNC-Chapel Hill to conduct a multi-year study and analysis of nutrient management strategies and compilation of existing water quality data specifically in the context of Jordan and Falls Lake. (*The full text of the legislative language from 14.13 (c) can be found in Appendix I).*

The legislation outlines two specific provisions that are to be included in the study:

- review data collected by the Department of Environmental Quality and by other stakeholders from water sampling in areas subject to the Falls Lake or Jordan Lake Water Supply Nutrient Strategies and compare trends in water quality to the implementation of the various elements of each of the Strategies and;
- examine the costs and benefits of basinwide nutrient strategies in other states and the impact (or lack of impact) those strategies have had on water quality.

The original legislation provides $500,000 annually over six years beginning in FY 2016 – 17 and ending in FY 2021 -2022. The legislation required a final report on the results of the study and recommendations for action for Jordan Lake no later than December 31, 2018 and for Falls Lake, no later than December 31, 2021. The legislation also calls for interim updates every year. Interim updates on the Study were submitted by the Collaboratory in December 2016 and December 2017.

In the 2018 legislative session the General Assembly amended the original study language to move the final UNC Jordan Lake study report date to December 31, 2019. As such, this modification will allow the research team a full three years to gather new data and better inform the study's final recommendations.

Leadership at UNC-Chapel Hill chose to place the UNC Jordan Lake study under the oversight and management of the North Carolina Policy Collaboratory, which is an entity housed at UNC-Chapel Hill. The study team is comprised of more than two dozen researchers, including faculty members, staff, graduate and undergraduate students from UNC-Chapel Hill, UNC-Charlotte and N.C. State University. (*A full roster of Study team members can be found in Appendix IV).*

What follows in this report is a summary of the research and activities that have been conducted over the last year.

Jordan Lake

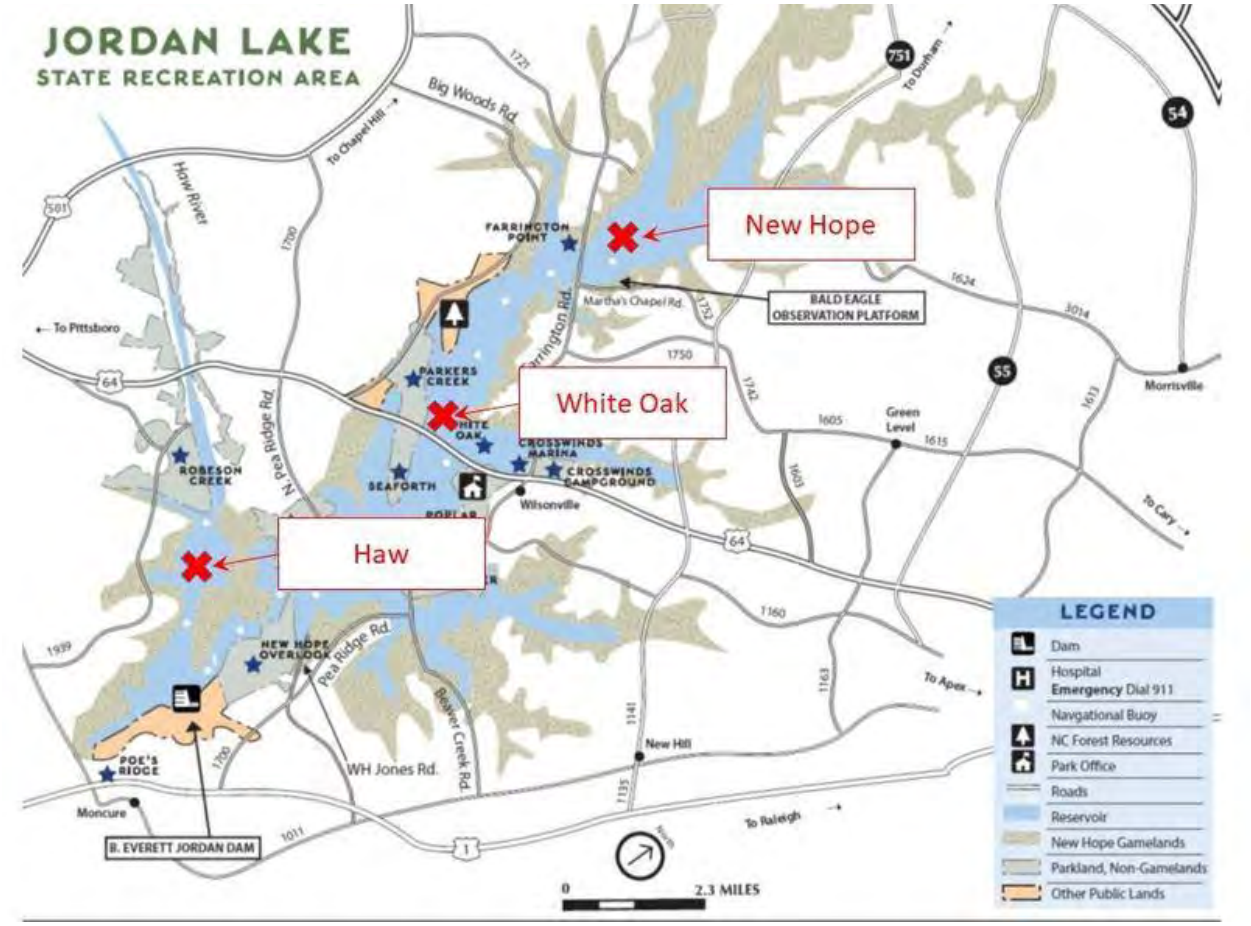


Figure 1. Map of Jordan Lake indicating location of UNC monitoring profilers.

Jordan Lake is a reservoir west of Raleigh and south of Durham in Chatham County. Jordan Lake is owned and operated by the U.S. Army Corps of Engineers which dammed and flooded the Haw River and New Hope River between 1973 and 1983.

The reservoir receives water input from the Haw River, Upper New Hope, and Lower New Hope watersheds.

	Haw River	Upper New Hope	Lower New Hope	TOTAL
Acres	859,185	147,485	71,861	1,078,531
Percent of Total	79.7	13.7	6.7	100

Table 1. Watersheds draining into Jordan Lake (Tetra Tech 2014)

Associated with these water inputs are nutrients, sediments, and in some cases, significant debris. The Haw River watershed is mixed agricultural, rural, and urban land while the Upper and Lower New Hope watersheds are principally urban. The primary outflow from the lake occurs over the Jordan Lake Dam

and comprises the starting point of the Cape Fear River. The Haw River drains the Haw River watershed and discharges into the southern Haw River arm of Jordan Lake approximately five miles upstream of the Jordan Lake Dam. The Haw River provides 70-90% of the annual flow into the lake.

The Upper and Lower New Hope watersheds drain into the New Hope Creek arm of Jordan Lake which extends approximately 17 miles upstream from the dam. The Haw River arm and the New Hope Creek arm are naturally separated by a narrow channel referred to as the "s-bends" or "narrows."

Jordan Lake serves as a drinking water supply for hundreds of thousands of Triangle residents. In addition, the lake is a prime recreation area for millions of visitors each year. Jordan Lake also provides critical aquatic habitat and flood control for the downstream region.

In 2002 Jordan Lake was designated as impaired by the U.S. Environmental Protection Agency for high levels of chlorophyll A and high alkalinity. Under this designation the Clean Water Act requires the state to prepare a plan to restore the lake's health by reducing pollution. The Jordan Lake rules are intended to serve as the state's plan.

Jordan Lake in October 2018 after Hurricane Florence. While commonly referred to as a lake, including in this report, it is important to note that Jordan Lake is a man-made reservoir. (Photo Credit Donn Young, UNC College of Arts and Sciences.)

2018 Research Updates

Policy Considerations

In the 2017 UNC Jordan Lake Study Interim Report the policy team outlined several principles that should apply to the development of a new nutrient strategy for Jordan Lake. This year's report highlights some specific issues that should be explored as policy recommendations are developed.

The issues noted below were identified after a review of nutrient management programs across the country and discussions with leaders and stakeholders of those programs.

State Water Quality Standards

Neither the current designated uses of Jordan and Falls Lakes nor the state's long-standing, broad nutrient-sensitive waters criterion (an instantaneous chlorophyll-a standard of 40 mg/l applied everywhere) should be taken as a given. An effort should be made to create a more sophisticated, appropriate, consensus-based set of water quality standards for each reservoir based on science and accounting for actual uses and applicability.

Once the designated uses are understood in greater detail and accepted by all stakeholders, then appropriate criteria can be developed to protect those uses. Chlorophyll-a may well be an important part of these criteria. But among the others that should be considered are dissolved oxygen, algal toxins and perhaps aquatic macrophytes. The important policy principle is that the uses and the criteria should be real, widely understood and important.

Maximize Local Gains and Co-benefits

The primary policy goal is the sustainability of the designated uses of these reservoirs. This primary policy goal may not resonate with everyone in the watershed, especially those who do not use these reservoirs for either recreation or drinking water. Thus, no opportunity should be lost to maximize local benefits, including benefits for upstream communities. Each local government unit and other stakeholder in the watershed has its own set of concerns and needs for water. Nutrient management strategies will be accepted and sustained much more readily if they help address those local concerns.

For example, the Chesapeake Bay program has evolved to stress local benefits. Stakeholders with no direct connection to the Bay have grown very committed to the Bay Program because it has helped with local projects. Similarly, the complicated models on which the Bay Program relies have increasingly been developed to work in smaller and smaller footprints, so that they can be useful to local governments as well as to the overall watershed.

Constant Concern for Cost-Effectiveness

All the major nutrient management efforts of which we are aware, and that can claim some measure of success, have evolved, in some cases over decades, to a constant concern for cost-effectiveness. That is, they may have started with the desire to just make some progress on primary goals or to work with whatever policy options were most obvious at the time. But eventually their leaders have come to realize that nutrient management strategies are perpetual efforts. These strategies cannot be sustained over the long term without attention to cost-effectiveness. In other words, is this (whatever decision is at hand) the best way to commit resources in order to attain the policy goals.

Financing Nutrient Management

During the first year of the nutrient study, the finance team focused on identifying the entities in the Jordan Lake watershed currently contributing resources to nutrient management and how they were paying. During the second year of research, the team started by asking:

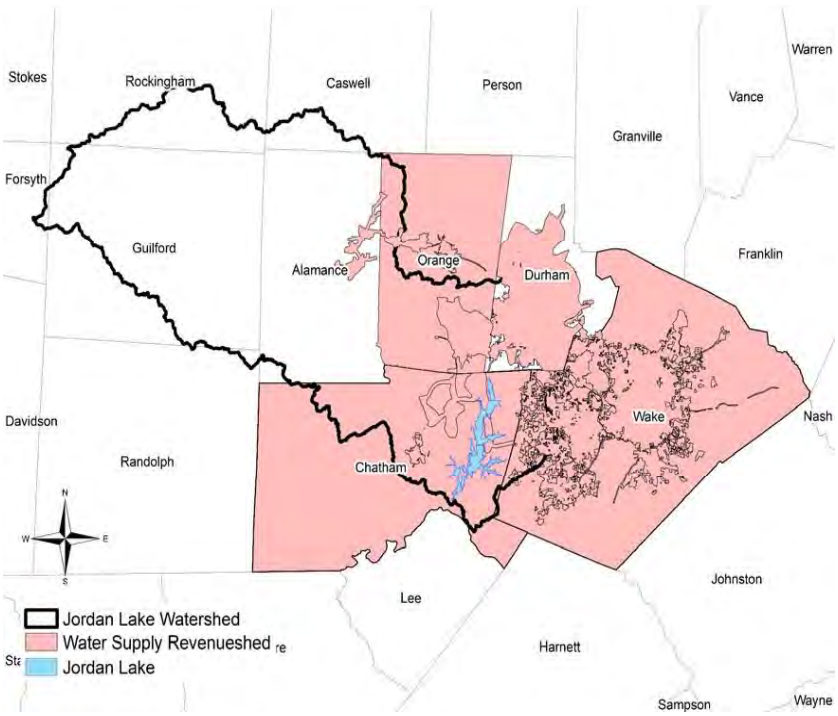
- If the system remains fragmented, what existing approaches may be used to raise revenue for more effective and likely costly nutrient management?
- What additional revenue raising tools and/or institutions could the state or local governments use to manage nutrients in Jordan Lake?

In evaluating these and other questions, the team has been working to identify how to bring in the most revenue for watershed protection, both within the existing regulatory framework, and within a new potentially more holistic nutrient management framework.

As a starting point in its second year of research, the finance team looked at expanding the revenue generation associated with the current "watershed drainage basin revenueshed,"[1] which included identifying existing mechanisms that could be used to generate revenue for watershed protection. Under current state law, there are various existing revenue generating mechanisms for local governments to use for watershed protection, some of which are not currently in use and others which could be better utilized. The team found that highlighting, expanding, or modifying such mechanisms in order to promote more widespread revenue generation should be a part of any nutrient management strategy going forward.

Because the boundary of the current "watershed drainage basin revenueshed,"encompasses only the regulated entities under the Jordan Lake rules, the finance team then began exploring ways to draw the revenueshed boundary wider, most notably pulling in the Jordan Lake water allocation holders as a new source of revenue. This more holistic approach corresponds to several national initiatives that have begun promoting different approaches to water quality, including the "One Water" approach, as well as the creation of regional watershed utilities. The team will continue to dig into other state models to identify characteristics that have made those models a success, both in terms of financial viability and ability to impact water quality.

[1] The "watershed drainage basin revenueshed" is intended to cover the current entities which are currently regulated under the Jordan Lake rules as point or nonpoint source dischargers into the watershed.



The finance team then investigated how much more revenue could be generated by bringing in additional revenue from the Jordan Lake "water supply revenueshed,"[2], which includes the pure beneficiaries[3] of the lake, and not just those contributing to nutrients. Additionally, the team explored and left open the possibility of drawing the boundary around the revenueshed to be even wider (such as to include recreation users of the lake, or to try to draw a boundary which aligns with flood control benefits).

Figure 2. Concept map of Water Supply Revenueshed

In the final year of the Jordan Lake study, the finance team's research will turn to the development of possible models for financing nutrient management in the Jordan Lake watershed. The models will comprehensively flesh out different options for expanding sources of revenue to include jurisdictions not currently contributing significant resources to Jordan Lake water quality improvement.

In-Lake Monitoring and Data Collection

One major component of the Study involves a multi-part observational program of Jordan Lake's water circulation, water quality, and other relevant factors affecting movement and quality. Much of the data being collected as described below can be viewed at: www.jordanlakeobservatory.unc.edu

Specific objectives of the observational program are:

1) To identify water circulation and exchanges in the lake, in particular, the extent to which the large volume of water entering via the Haw River influences the New Hope Creek arm of the lake.

[2] See Figure 1. The "water supply revenueshed" is made up of 8 municipalities, 3 counties, and 1 water authority. These entities currently have access to Jordan Lake water or could have access in the future based on allocations and current planning initiatives, and include allocation holders as well as members of Jordan Lake Water Supply Partnership.

[3] "Pure beneficiaries" of the lake refers to those entities which are not in the drainage basin and therefore don't contribute directly to nutrients in the watershed, but which rely on the lake for water supply.

2) To better quantify the response of important water quality parameters in the lake based on changing conditions (variations in flow, temperature, light and wind) via high frequency (hourly) in situ observations.
3) To better quantify phytoplankton dynamics in Jordan Lake, including nutrient limitation and productivity that are causing the lake to be out of compliance with water quality standards.

Profilers have been deployed to measure water velocities through the water column at four locations along the lake, the lower Haw River, the narrows, the highway 64 bridge and the Farrington Road bridge. A final recovery of all instruments was completed in the fall of 2018.

Figure 3a. Locations of profilers in lower lake. *Figure 3b. Locations of profilers in New Hope Creek arm.*

The data gathered from these profilers over the last two years shows several distinctive flow behaviors that provide valuable insight into water movement and transport in the lake.

Most obvious are the flow responses to the major and moderate discharge events that are characterized by rapid, strong, up-lake flow in the New Hope Creek arm throughout the water column. This up-lake flow is accompanied by an increase in lake water level. Thereafter, the flow reverses and a weaker, down-lake flow ensues with an accompanying drop in water level that extends over a week or more.

The storage and gradual drawdown of water reflects the operation of Jordan Lake as a flood control reservoir. In so doing, it provides a mechanism for moving water, particulates and dissolved constituents in the up-lake direction in the New Hope Creek arm. While the volume of water and water surfaces elevation eventually return to pre-event levels, the up-lake flow mixes, sediments settle, nutrients are consumed, etc. in the receiving lake basin and therefore the water that flows down-lake may have significantly different properties than the preceding water that flowed up-lake.

In this case, discharge events provide a mechanism for occasional constituent transport in the up-lake direction. In particular, this may bring constituents associated with the Haw River discharge into areas that are up-lake of the Narrows.

Evaluation of Controls of Algal Blooms

Research is being conducted to determine which nutrients are controlling algal growth. Through the deployment of seasonal biological assessments (bioassays) researchers are gathering information to assist in determining the nutrient reductions necessary to maintain Jordan Lake below the bloom thresholds.

A series of bioassays and laboratory analysis using water collected from Jordan Lake are being conducted to:

- Determine the degree of nitrogen and phosphorous limitation on phytoplankton productivity and biomass;
- Determine the potential effectiveness of nutrient reduction (dilution) for reducing algal biomass/chlorophyll a in the lake;
- Provide laboratory validation of observations from in situ instrumentation and determine additional parameters such as nutrient concentrations in the lake; and
- Quantify phytoplankton productivity and the impact of light limitation on productivity and biomass.

The 2018 experiments in combination with the work in 2017 suggest that while nitrogen may be the primary driver of algal growth, efforts to reduce phytoplankton biomass will need to address both nitrogen and phosphorous reductions.

Another key finding from our recent work is that the previous Jordan Lake Nutrient Response Model assumed that light limitation is a significantly greater impediment to phytoplankton growth than what our current research demonstrates. Consequently, Jordan Lake phytoplankton are much better adapted to growing in low light than previously thought.

Water Quality Data and Stream Monitoring

As part of the study researchers are examining when and where nutrients are coming from within the urban watersheds and under what flow conditions.

Existing discharge data and water quality samples were collected by various entities over time, often in different locations and for different periods of time. While this information is useful for background and context, the spatial and temporal resolution of the available data is insufficient to determine where and when nonpoint source pollution is delivered to the stream network.

The study has instituted a watershed monitoring plan that will enhance the understanding of the factors controlling nutrient loading over a large spatial area. The sampling will highlight specific differences in nutrient loading between high and low density developed watersheds and watersheds on sanitary sewer versus septic systems. Given the region's shared climate, similar soil and geology, these findings will be applicable to the entire Jordan Lake watershed.

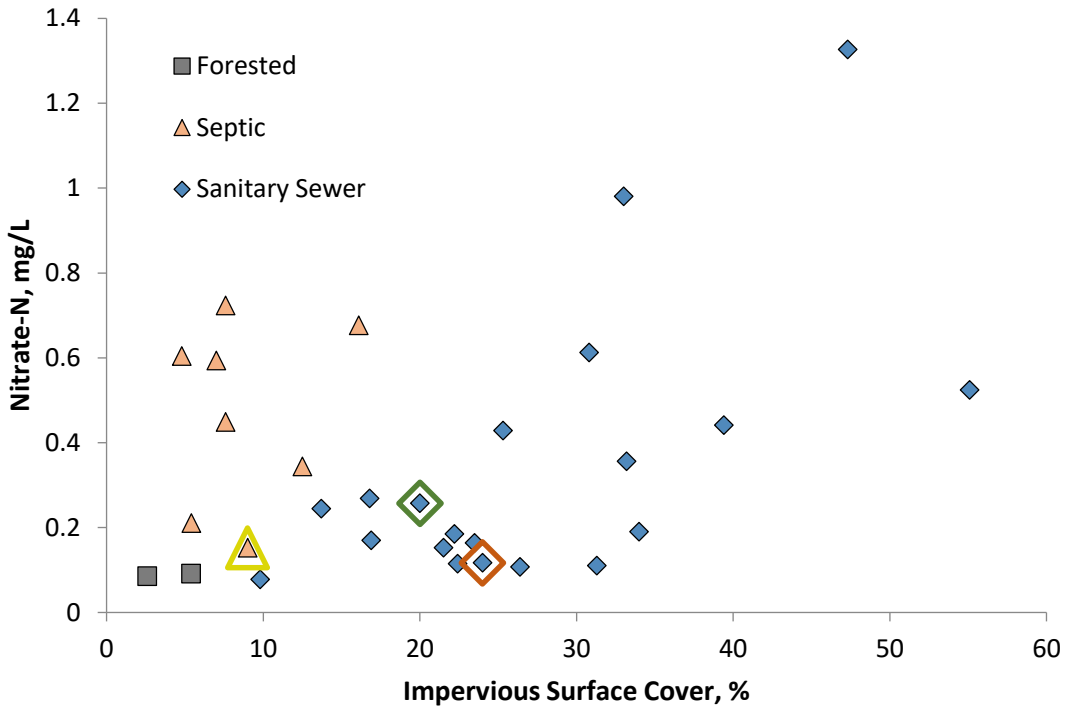


Figure 4. Mean base flow nitrate as nitrogen concentration for 31 watersheds spanning a range of development intensity as measured by percent impervious surface cover (ISC). All sites have greater than 10 samples and sampling in all seasons. The outlined yellow, orange and red data points are septic, low density sewer and medium density sewer watersheds respectively for which there is also continuous monitoring.

Prior to this study, the largest nutrient datasets in the region using traditional sampling methods consisted of approximately 200 observations spanning decades. This is the number of nitrate observations that we are currently collecting at a single high-intensity sampling station every two days. With the incoming data we are building a highly detailed dataset of both the hydrologic and nutrient dynamics in headwater streams in the Jordan Lake watershed.

Results from the data collection during the 2017 and 2018 timeframe support the following preliminary findings:

- Streams draining watersheds on septic systems exhibit higher nutrient concentrations than streams draining similarly developed watersheds on sanitary sewer.
- During wet times of the year, nutrient loading from watersheds on sanitary sewer can be as high as loading from similar watersheds on septic systems.
- The hydrologic controls on nutrient loading and dominant sources of nutrients vary with sanitary infrastructure, land-use, and time of the year (wet versus dry). To be effective, nutrient reduction management strategies should address the interplay of the variables at various times of the year.

Suspended Sediment Inputs

Suspended sediments in Jordan Lake are a problem for several reasons. In addition to making the lake less aesthetically appealing, high suspended sediment concentrations make it more difficult to filter for water intakes causing additional problems for municipal water supplies. Also, various forms of contaminants and nutrients are associated with sediments that enter the lake.

Sediments are being measured in waters entering the lake from creeks and rivers at four input sites. Weekly samples are being collected at these sites. In addition, weekly samples are also being collected at the outflow from the lake at the damn in Moncure.

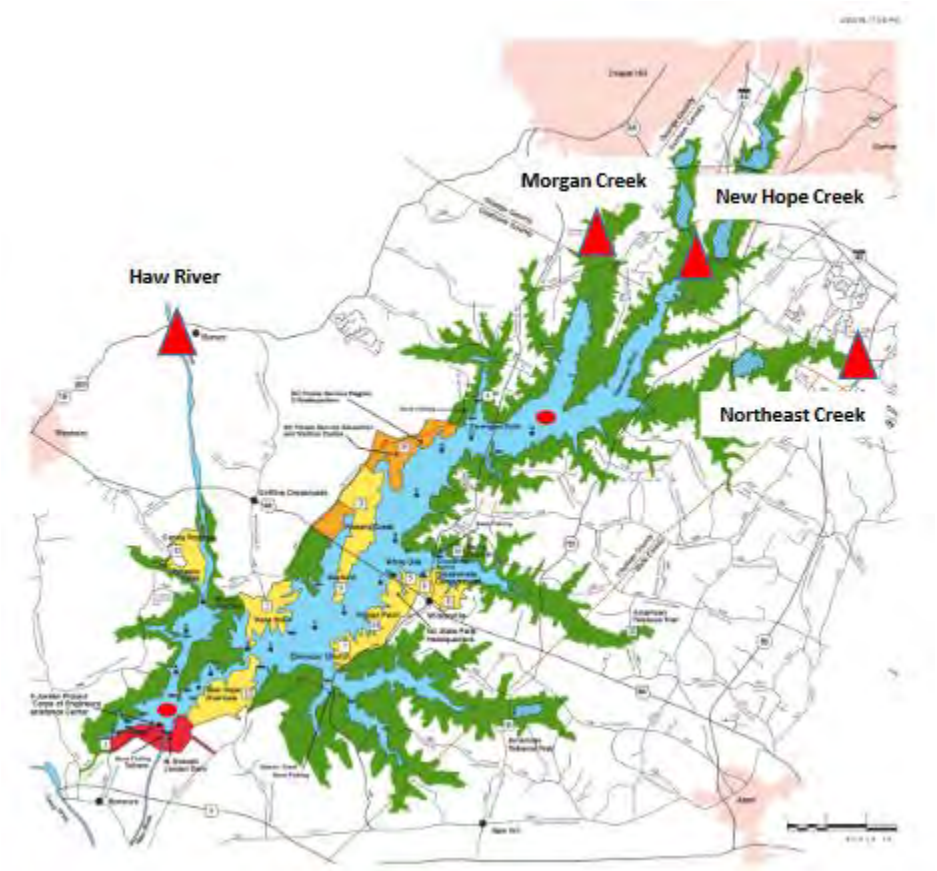


Figure 5. Sediment sampling sites around Jordan Lake.

Preliminary results from this research indicate that the Haw River accounts for 80-85% of the water and sediment discharge to the Lake. One important finding to note is that at low Haw River discharge rates, the mass of sediment entering the lake from the Haw and the mass of sediments exiting the lake via the dam are very similar. As the Haw River discharge increases, sediment inputs far exceed sediment outputs, inferring a large rate of sediment deposition within the lake.

Effectiveness of Nutrient Mitigation Measures

As noted in the 2017 UNC Jordan Lake Study Interim Update a comprehensive evaluation of nutrient mitigation measures is beyond the scope of the study. However, it is important to acknowledge this issue which forms a component to any large-scale nutrient management strategy. As such, the study has benefitted from involvement of N.C. State faculty who are nationally recognized experts on the topics of stormwater control measures and agricultural best management practices.

Bioretention and Sand Filters

One of the most popular stormwater practices in urban and suburban North Carolina is bioretention. The N.C. Department of Environmental Quality defines bioretention as, "the use of plants and soils for removal of pollutants from stormwater via adsorption, filtration, sedimentation, volatilization, ion exchange, and biological decomposition."

A bioretention cell (BRC) installed in the Jordan Lake watershed more than a decade ago was evaluated for its effectiveness. Overall, this research provides evidence to support BRC guidance in North Carolina, and in nutrient sensitive watersheds. If designed, built, and maintained correctly, bioretention provides excellent treatment of stormwater runoff for nitrogen and phosphorus for prolonged periods of time. Sand filters are becoming a very popular practice, yet little field research has been conducted on them. To better understand sand filter nutrient removal rates, a sand filter column study began in 2018.

Agricultural Best Management Practices

Data from the National Land Use Land Cover Dataset classified land use in the Jordan Lake watershed as:

Land Use	Forest	Agriculture	Urban	Other
1992	62%	22%	11%	5%
2011	46%	22%	21%	11%
% Change	-16%	0	+10%	+6%

Table 2. Land use change in the Jordan watershed

Taken together, this twenty-year period in the Jordan Lake watershed indicates that there is increasing urbanization and decreasing forestation, whereas agriculture has remained consistent at less than 25% of the total land area. These land use changes have significant implications for water quality.

One important characteristic of the watershed is that erosion is well controlled and many streams (approximately 60%) are already buffered. The largest nutrient losses are derived from pasture lands due to animal excrement, but research indicates that these losses can be reduced by approximately 50% using a narrow exclusion fence and nutrient management. Additional nutrient losses may also be derived from reducing phosphorous applications on fields that do not need more, but since this represents the minority of agricultural lands, it is doubtful than any real water quality reductions will be realized.

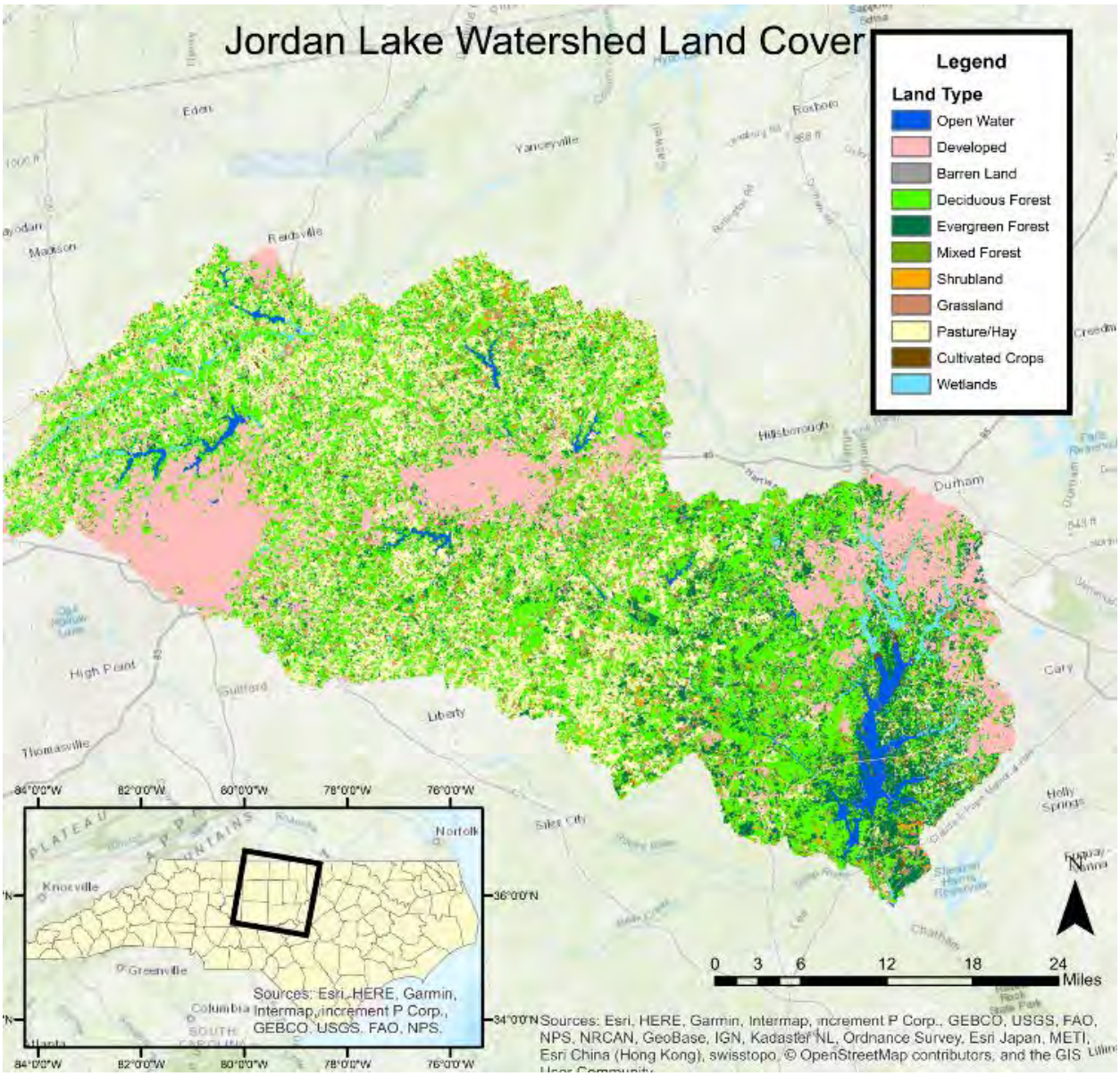


Figure 6. Jordan Lake watershed land cover

Community Engagement for Stormwater Management

Effective and efficient implementation of nutrient mitigation measures in an urban setting, including stormwater controls necessitates the placement of those controls on private property, and thus, requires significant community buy-in. Some common themes emerged in community level discussions about implementing stormwater controls on private property. These themes include:

- Quality of communication and trust
- Data and Design
- Funding

Public Engagement

Research Symposium

A full-day research symposium was held on March 22, 2018, with goals of (a) representing the breadth of research included in the study, (b) sharing initial research results, and (c) facilitating dialogue among researchers and stakeholders. Over 125 people from across the watershed attended this symposium, which was held in Chapel Hill, NC; and participants represented local and state government, academia, developers, and environmental nonprofits, among others. The symposium featured talks from nine researchers, organized in three segments: natural science research, stakeholder and community perspectives, and policy and finance. (See *Appendix II: Research Symposium Agenda*.) In each segment, researchers provided brief overviews of their research protocols and initial results and answered participants' questions.

Links to researcher presentations can be found on this web page: https://ie.unc.edu/nutrient-study/symposium/.

Science Seminars and Science Cafes

In focus groups with key stakeholders in year 1, participants expressed strong interest in learning about the science underpinning the UNC Jordan Lake Study. For this reason, we conducted two science seminars, one each in the Research Triangle and Triad regions. Each seminar featured researchers presenting their work and engaging with stakeholders.

The first of these seminars was held in Greensboro, NC and featured UNC's Environmental Finance Center. The seminar included a brief overview of several research projects and an in-depth presentation on options for paying for nutrient management In Jordan Lake. Participants included water resource professionals from Triad-area municipalities as well as representatives from the Triad-area real estate and building industries.

The second seminar was held in Durham, NC and featured Dr. Mike Piehler, the UNC Jordan Lake Study technical lead and director of the UNC Institute for the Environment. Piehler shared an overview of several the research projects and gave an in-depth presentation on water circulation within Jordan Lake. Participants included water resource professionals from Triangle-area municipalities, representatives from environmental nonprofits, and elected officials from the Jordan Lake watershed.

To reach broad public audiences, two science cafés were conducted, in partnership with the NC Museum of Natural Sciences in Raleigh, NC and the Kathleen Clay Public Library in Greensboro, NC. Science cafés typically feature brief presentations by scientists in casual environments, to encourage dialogue about the impact of science on daily life. Each science café featured a research project from the UNC Jordan Lake Study.

Jordan Lake Model Development

In the 2018 legislative session the North Carolina General Assembly allocated funding and directed that the development of a model of Jordan Lake and the watershed be incorporated into the larger UNC Jordan Lake Study. As such, the study has added faculty members to lead the modeling work. Below is a brief description of the modeling work that will take place in 2019.

A multi-dimensional mechanistic model of Jordan Lake will be developed and calibrated using existing monitoring data. Several model test scenarios will be developed, implemented, and analyzed to investigate how water quality conditions in the lake are affected by potential changes in nutrient loading, sediment conditions, and characteristics affecting lake circulation and flushing. A set of model input files will be delivered that will enable model stakeholders to run the model themselves at a later date.

To better understand and predict water quality outcomes for the reservoir, complimentary watershed and water quality models will be developed. These models will simulate nutrient dynamics over a 30-year time scale. The long study period will help resolve drivers of eutrophication at various time scales and facilitate rigorous model calibration and validation. Once developed, the models will be used to predict the response of the lake to various watershed management (e.g., nutrient reduction) and climate (e.g., flood/drought) scenarios that will be determined with input from the study team and stakeholders.

To support the modeling work research will also be done to map the sediment thickness in the lake. This work is designed to get a better understanding of the contribution of nutrients from the Jordan Lake sediments. The research will help determine where sediments are accumulating, what the composition of those sediments are, and the degree to which the parts of the lake are connected in terms of sediment transport and deposition. In addition, research will be done to characterize the nutrient fluxes in Jordan Lake sediments to inform the modeling effort.

From the Classroom to the Lake

One of the more interesting aspects of the UNC Jordan Lake study has been the involvement of undergraduate students as part of the study. Over the last year UNC has administered capstone courses as part of the study. These semester long classes give undergraduate students an opportunity to work on a current issue and present their findings and recommendations. As part of the study these semester long classes have taken on independent research projects that support the ongoing work of the study.

In the fall of 2017 a capstone class of students studied five sites in the Jordan Lake watershed that span a range of impervious surface cover and stormwater control measures. Metrics concerning land cover and stormwater control measures were calculated in ArcGIS for both data analysis and inputs into a model. The students looked at determining the potential impact urban streams can have on nutrient loading to Jordan Lake. The class also analyzed water chemistry and measured water level and flow at several sites with different aspects of urban development.

In the spring of 2018 another class of students created an interactive map during the course of the semester and tracked all of the nutrient management initiatives in the Jordan Lake watershed that they

could find. They looked for what sorts of projects were most cost-effective, and whether there were opportunities for collaboration that were not occurring. The class evaluated what was driving local governments to implement nutrient management initiatives, such as state or local environmental regulations. The class also tried to link all of the initiatives to the concept of One Water, which focuses on managing drinking water, wastewater, and stormwater in an integrated manner.

Most recently in the fall semester of 2018 a class of students worked with to conduct a bathymetric survey (underwater depth) of a portion of Jordan Lake. A couple of the findings from the class were:

- The geology of the Jordan Lake watershed is dominated by softer, sedimentary rock, whereas the waterbodies that directly feed the lake are dominated by harder, metamorphic rock. The underlying geology may contribute to sediment loads that reach Jordan Lake.
- Bathymetric analyses of White Oak Creek, a popular tributary of the main lake body, revealed that shallow lake areas are not well characterized by existing Jordan Lake maps. There are also gradual changes from shallow to deeper depths moving from the creek mouth to lake body.

A summary of their work can be found here at the website created by the class: http://bit.ly/2zGlz15

The Year Ahead

In the 2018 legislative session the North Carolina General Assembly modified the final reporting date of the UNC Jordan Lake Study to December 31, 2019. The extension of the reporting deadline was critical to allowing the scientists who are collecting data at the lake and in streams throughout the watershed to monitor and gather information over a longer period of time. This additional time will allow researchers to reach to draw conclusions and deliver findings with more confidence given an increased data set.

In the same legislative session the General Assembly directed that the study undertake a modeling effort to complement the ongoing research. Importantly, the modeling effort will identify how different land use decisions made throughout the watershed could affect the water quality in the lake. Scenario tests will be developed in consultation with stakeholders and will likely include considerations of the water quality conditions that would result from changes in nutrient loading, sediment conditions, and physical changes in the lake that would affect flushing and circulation.

As noted above, there are many stakeholders with interest in Jordan Lake and the findings of the study. As such, the study will strengthen its outreach efforts to promote the current research underway. In order to do so, the study team will continue to participate in related events and conferences sharing the latest results and findings. Included among those efforts will be another public forum in the spring of 2019. In addition, the study team will continue to work closely with the Jordan Lake One Water that is serving as a forum for local governments to learn about Jordan Lake and identify opportunities for initiatives that improve water quality in the watershed.

As directed by the legislation in July of 2019, the study team will turn its attention to begin the three-year study of Falls Lake. Concurrent with the beginning of that research the study team will be in the process of developing a final report on Jordan Lake to submit to the General Assembly by the end of 2019.

Appendix I

Legislative Text of Session Law 2016-94, Section 14.13. (c)

Of the funds appropriated to the Board of Governors of The University of North Carolina, the sum of five hundred thousand dollars ($500,000) for each of the fiscal years from 2016 – 2017 through 2021 – 2022 is allocated to the Chief Sustainability Officer at the University of North Carolina at Chapel Hill to designate an entity to oversee a continuing study and analysis of nutrient management strategies (including in situ strategies) and compilation of existing water quality data specifically in the context of Jordan Lake and Falls Lake.

As part of this study, the entity shall

(i) review data collected by the Department of Environmental Quality and by other stakeholders from water sampling in areas subject to the Falls Lake or Jordan Lake Water Supply Nutrient Strategies and compare trends in water quality to the implementation of the various elements of each of the Strategies and;

(ii) Examine the costs and benefits of basin wide nutrient strategies in other states and the impact (or lack of impact) those strategies have had on water quality.

The entity shall report to the Environmental Review Commission, the Environmental Management Commission, and the Department of Environmental Quality as set forth below:

(1) With respect to Jordan Lake, the final results of its study and recommendations for further action (including any statutory or regulatory changes necessary to implement the recommendations) no later than December 31, 2018, with interim updates no later than December 31, 2016, and December 31, 2017.

(2) With respect to Falls Lake, the final results of its study and recommendations for further action (including any statutory or regulatory changes necessary to implement the recommendations) no later than December 31, 2021, with interim updates no later than December 31, 2019, and December 31, 2020. No indirect or facilities and administrative costs shall be charged by the University against the funds allocated by this section. The Department of Environmental Quality shall provide all necessary data and staff assistance as requested by the entity for the duration of the study required by this subsection. The Department shall also designate from existing positions an employee to serve as liaison between the Department and the entity to facilitate communication and handle data requests for the duration of the project.

Appendix II

Jordan Lake Nutrient Management Study Research Symposium

Thursday, March 22, 2018
North Carolina Botanical Garden
Chapel Hill, NC

The **purpose** of this symposium is to **share the breadth of research** in the Jordan lake Nutrient Management Study and **facilitate dialogue** among various stakeholders within the Jordan Lake watershed.

10:00	Welcome *Brad Ives*
10:15	Nutrient Management Study Background *Mike Piehler*

Natural Science Research

10:30	Quantifying Nutrient Loading Across Gradients of Sanitary Infrastructure and Development Intensity *Diego Riveros-Iregui and Joseph Delesantro*
10:40	Circulation and Structure in Jordan lake *Rick Luettich, Harvey Seim, Tony Whipple, and Ryan Neve*
10:50	Nutrient and Light Limitation of Phytoplankton Growth in Jordan Lake *Hans Paerl and Nathan Hall*
11:00	Break
11:15	Sediment Inputs to Jordan Lake *Brent Mckee*
11:25	Clarifying Questions
11:45	Table Discussion Topic: What unanswered science questions need to be addressed to more effectively manage nutrients in Jordan Lake?

12:00 Lunch

Stakeholder and Community Perspectives

12:45	Stakeholder Perceptions of Water Quality in Jordan Lake *Grant Parkins, Kathleen Gray, Megan Rodgers, and Victoria Triana*
12:55	Agriculture in the Jordan Lake Watershed *Deanna Osmond*
1:05	Community Engagement, Private Property, and Stormwater Infrastructure *Danielle Spurlock*
1:15	Clarifying Questions
1:30	Table Discussion Topic: How can we engage the public to find a solution to the nutrient management issues in Jordan Lake?
1:45	Break

Policy and Finance

1:55	Policy Recommendations from Year 1 of the Nutrient Management Study *Richard Whisnant, Ellen Gilinsky, and Jay Sauber*
2:05	Paying for Nutrient Management in the Jordan Lake Watershed *Erin Riggs and Jeff Hughes*
2:15	Clarifying Questions
2:30	Table Discussion Topic: What lessons learned from other regions are most informative in shaping Jordan Lake's nutrient management policies?
2:45	Closing Remarks *Mike Piehler*
3:00	Adjourn

* All presenter slides will be made available following the symposium at:

https://ie.unc.edu/nutrient-study/symposium/

Appendix III

Study Principles

- **Utilize Science-Based Results to Guide Findings**

The UNC Jordan Lake Study will identify those topics in which further research can assist in addressing existing data gaps, trends in water quality, and financial consequences of management decisions.

- **Build Upon Previous Work to Advance the Discussion**

The efforts to address water quality in Jordan Lake have taken place over a number of decades. It is imperative that the UNC Jordan Lake Study build on that foundational work and not duplicate previous and existing efforts.

- **Integrate Existing Initiatives**

The research team recognizes that the UNC Jordan Lake Study is one project of many that are currently underway in relation to how North Carolina develops and implements nutrient management strategies. As such, the study will incorporate new findings of these related projects when appropriate.

- **Leverage Current Research**

The research and work undertaken as part of the UNC Jordan Lake Study will utilize ongoing research partnerships and expand the scope of current research projects to identify outcomes and results in the most timely and cost-effective manner.

- **Operate in a Transparent Manner**

Results and conclusions from the UNC Jordan Lake Study and the background information and data that formed the basis of those conclusions will be publicly available.

- **Engagement with Stakeholders**

A key component of the UNC Jordan Lake Study will be to incorporate the guidance and perspectives of a diverse array of citizens and stakeholders throughout the watershed that will help inform not only the study but future management and policy decisions for the Jordan Lake watershed.

Appendix IV

Roster of UNC Jordan Lake Study Team Members

Name	Affiliation
Mike Piehler, Technical Lead	UNC Institute of Marine Sciences
Marc Alperin	UNC Department of Marine Sciences
Jim Bowen	UNC-Charlotte Department of Civil and Environmental Engineering
Joseph Delesantro	UNC Environment and Ecology
Kaylyn Gootman	UNC Environment and Ecology
Kathleen Gray	UNC Institute for the Environment
Nathan Hall	UNC Institute of Marine Sciences
Jeff Hughes	UNC Environmental Finance Center
Bill Hunt	NCSU Department of Biological and Agricultural Engineering
Jeffrey Johnson	NCSU Department of Biological and Agricultural Engineering
Rick Luettich	UNC Institute of Marine Sciences
Brent McKee	UNC Department of Marine Sciences
Jonathan Miller	NCSU Department of Civil, Construction and Environmental Engineering
Dan Obenour	NCSU Department of Civil, Construction, and Environmental Engineering
Deanna Osmond	NCSU Department of Crop and Soil Sciences
Hans Paerl	UNC Institute of Marine Sciences
Grant Parkins	UNC Institute for the Environment
Erin Riggs	UNC Environmental Finance Center
Diego Riveros-Iregui	UNC Department of Geography
Megan Rodgers	UNC Institute for the Environment
Tony Rodriguez	UNC Institute of Marine Sciences
Harvey Seim	UNC Department of Marine Sciences
Danielle Spurlock	UNC Department of City and Regional Planning
Sarah Waickowski	NCSU Department of Biological and Agricultural Engineering
Richard Whisnant	UNC School of Government

NC Policy Collaboratory Staff

Brad Ives, Director
Kasia Grzebyk, Research Assistant
Jeff Warren, Research Director
Steve Wall, Outreach Liasion

UNC Jordan Lake Study Capstone Students

Semester/Instructor(s)	Class Title/Students
Fall 2017	
Joseph Delesantro	"The Effect of Land Use and Stormwater Controls in the Jordan Lake Watershed"
Department: UNC Curriculum for the Environment and Ecology	
	Drew Hoag
	Celia Jackson
	Naomi Lahiri
	Maddie Omeltchenko
	Aditya Shetty
Spring 2018	
Erin Riggs, Jeff Hughes, and Evan Kirk	"Inventory of Nutrient Management Strategies in Jordan Lake"
Department: UNC Environmental Finance Center	
	Maya Burgess
	Erin Danford
	Jane Ehrbar
	Jere Freeman
	Ayla Gizlice
	Katie McQuillan
	Robby Morgan
	Basil Rodts
	Gunar Swartzlander
Fall 2018	
Kaylyn Gootman	"Jordan Lake Bathymetry and Water Quality"
Department: UNC Curriculum for the Environment and Ecology	
	Gus Elmore
	Caitlin Gross
	Carter Schmitt
	Tyler Souza
	Vanessa Wigmall