

Unsettling Sediment: How Sedimentation and Other Water Quality Issues can be Combated with Stakeholder Help

Mary Marsh, Megan Owens, Eric Parker, and Kristin Vinduska

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Advisor Kari Bigham

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Abstract

Marion County Lake is a public water resource widely used for recreation and is surrounded by both agricultural and some residential property. The objectives of this study are to evaluate the erosion rates and understand landowner perception and knowledge of conservation methods. The goal of this report is to provide an informational resource to lake managers for use as a management tool. The stakeholders around the lake are actively concerned about the longevity and condition of the lake. This study examines the rates and source of the sedimentation coming into the lake. Out in the field, cross sections were taken and the erosion rate was determined by surveying the current stream and overlaying the results from a previous group's measurements. An estimated retreat rate of 0.61 feet per year was found and the lack of vegetation on the streambanks was a cause of concern for the group. After going out to the site, another water quality issue was revealed to the group- excessive algal growth in the lake. Agricultural runoff is a potential cause of the algal growth. This could compromise the health and prosperity of the lake just like excessive sedimentation would. Another part of the study was to provide lake managers and landowners methods to prevent sedimentation before it becomes a serious issue. Before starting in on implementing certain conservation methods, it would behoove lake managers to understand landowner mentalities and current level of knowledge on potential conservation methods. A landowner questionnaire that would address these concerns would be the first step to prevention or remediation. There are certain communication strategies, like incentives and social norms, which would work for the landowners and might cause them to adopt conservation methods. Lastly, if the water quality problems are not prevented and become a serious issue, potential remediation methods such as flushing were examined. The full study was unable to be conducted and concluded due to unfortunate circumstances surrounding COVID-19 and Kansas State University's response to limiting the spread of the disease.

Introduction

The Marion County Park and Lake has been a staple of community enjoyment since 1940. It has been a place of restoration for hard-working locals and far-away visitors seeking a slower pace of life. This lake and the memories it creates are special to the stakeholders who find refuge there. It is not only important for recreation uses, but for local landowners who use the lake as a source of water and flood control. Lake recreation users and landowners should be educated about environmental studies and involved in the management of resource issues such as sedimentation. This report looks at identifying potential water quality issues, such as sedimentation at the Marion County Park and Lake. The study of water quality issues at the site was focused on surveying the upstream landscape. After measurements of the streambank were taken, the group was able to compare some of these measurements with a study done at the same sites in 2018. The group also marked their measurement points so that readings could be taken with more accuracy in the future. These measurements not only help managers understand how conservation practices could improve water quality, but it can be information that is shared with stakeholders and landowners to involve them in caring for their natural resources. Passionate stakeholders can be a powerful management tool when education about existing or growing issues is utilized correctly to fuel local's desire to sustain their outdoor spaces. In summary, this paper reports on streambank erosion change gathered on a local landowner's ground upstream of Marion County Park and Lake and provides the reader with information on how to engage stakeholders in their watersheds to help develop management techniques and solutions for long-term lake conservation.

Marion County Lake Park and Lake Site Description

Marion County Park and Lake is used for various activities, such as enjoying natural views, fishing, hiking, swimming, and picnicking (Brennan et al, 2019). The lake and park was opened in 1940 after being constructed by the Civilian Conservation Corps Black Veteran Company #4755 (*Marion County Park and Lake*, n.d.). The lake is not only diverse in its recreational uses but in its land cover.

Based on a StreamStats report of the watershed (USGS, 2016), 59% of the land is herbaceous cover, 26% is cultivated land (crops and hay), and 9% is urban (see Figure 1). The average annual precipitation amount is 34 inches. The watershed area is 6.28 square miles. Twelve soil series make up the land, with the majority of the soil types being silty clay loam. There is an average watershed slope of about 2.3%. Land within the watershed has a T factor from one to five tons of soil loss per acre per year, with the majority falling into the two tons per acre per year. Based on the wind erodibility index, the soils present in the watershed are not susceptible to wind erosion (USDA-NRCS, n.d.). Almost all soil series fall into the D category of hydrological soil group, which means there is little infiltration and more runoff (USDA-NRCS, n.d.). All of this information is crucial in developing the proper management plan of the natural resources and can affect water quality issues.

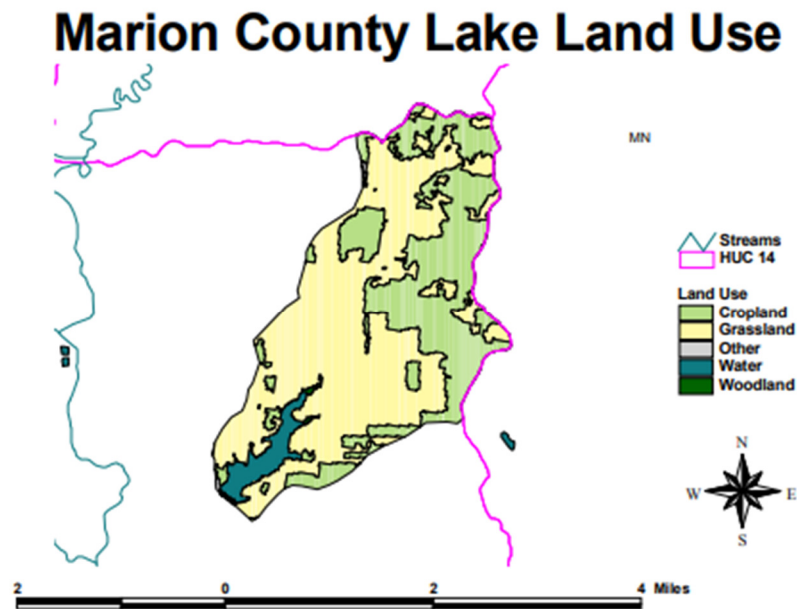


Figure 1: Watershed uses for the Marion County Lake (KDHE, 2002).

Marion County Lake has issues with algal blooms in the summer, which is caused by excess nutrients (e.g., phosphorus and nitrogen) in the water. These nutrients can come from places like crops, pastures, and lawns. According to the Kansas Department of Health and Environment (2002), this watershed has a moderate potential for nonpoint source pollutants. From the concentrations of phosphorus in Marion County Lake, it is estimated that a total of 1,043 pounds of phosphorus per year is entering the lake from the surrounding area (KDHE, 2002). A potential source is runoff from agricultural land where nutrients have been applied (KDHE, 2002). Phosphorus doesn't only come from nutrient runoff, it can

also be transported through soil erosion in phosphorus rich soils. It is estimated that 0.309 kg phosphorus is lost annually through soil erosion near Marion County Lake (Bauer et al., 2019).

A serious health issue in reservoirs is blue-green algae growth. This happens when there is an excess of nutrients in the water (Stillwell et al., 2018). Algal growth is also a problem for recreational uses and limits the activities that can happen on lakes and reservoirs. Phosphorus and nitrogen are the main nutrients studied when it comes to water quality. Changing the landscape in the watershed can affect the nutrient level in water, such as changing pervious cover to impervious cover can increase water runoff and increase nutrient runoff (Stillwell et al., 2018).

Sediments cause water quality issues but it is not as serious of a health issue as nutrients. It is more of a problem of reservoir and lake longevity. With growing populations, we will be forced to rely on reservoirs for more of our water supply. Sedimentation can cause economic problems with silting in reservoirs (Annandale, 2005).

Juracek and Ziegler found that for the Perry Lake basin, most sediments came from surface soils and channel banks (Juracek & Ziegler, 2009). Various factors were considered, such as if conservation practices were implemented on cropland and if stream banks were stable or not. In areas where there were more conservation practices implemented in fields, the surface soil sediments were comparably lower than bank sediments. By monitoring streambanks, erosion rates and sources of sediments in lakes can be documented and used for making management plans.

Streambank Erosion Monitoring

Assessing streambanks is useful because it allows property owners or the government to focus resources on areas of high ratings. In order to understand sediment sources, surveying is done along stream banks to maintain a record of where erosion is happening. Without knowing where erosion is occurring the most frequently, it is hard to tailor conservation practices within the watershed that will reduce erosion and therefore reduce sedimentation and nutrient runoff into water bodies.

Methods

To better understand bank erosion rates in Marion County Park and Lake watershed, cross sections were installed and measured using laser level surveying equipment (Lecia Rugby 610). To do this, a CamLine measuring string was placed perpendicular to the water channel to be used as a guide to keep the measurements in a straight line across the stream cross section, as shown in Figure 2. At the ends of the CamLine, a 2' long x 1/2" diameter steel rebar was hammered flush into the ground with an orange plastic cap on top. This will allow future teams to locate the cross sections and re-survey. The tripod with the laser level was set on a high landform so the laser could see the land around it and be able to hit the measuring rod. The first height measurement was taken on top of the left bank rebar pin (when facing downstream) and the last measurement was taken on the top of the right bank rebar pin. Whenever a change in slope was felt, a measurement would be taken to try to capture the shape of the slope. If the land was relatively flat, a measurement was taken about every three feet. Table 1 summarizes the location of the cross section pins. A relative elevation datum at each cross section was established so that the graphs would not show negative numbers.

A past group of students surveyed cross sections from the same stream in the pasture utilized in this study which is upstream of the Marion County Lake. The 2018 group measured cross sections using a leveling system similar to how the 2020 group conducted the survey. However no rebar pins were put in the locations of the cross sections for future groups to locate and use the exact cross section again. The 2020 group placed rebar pins in the ground where measurements were taken. This will help any future groups that are interested in this project to set up their equipment exactly where the 2020 group had set up.



Figure 2: Team doing cross section of Site 2

	Site 1	Site 2	Site 3
Station	L: 1' R: 94'	L: 1' R: 43'	L: 1' R: 43'
Elevation	L: 100' R: 100.14'	L: 100' R: 101.58'	L: 100' R: 94.5'
Latitude/Longitude Left pin	38.344214, -96.970300	38.342265, -96.971517	38.340933, -96.972402
Latitude/Longitude Right pin	38.344049, -96.970494	38.342383, -96.971499	38.340984, -96.972535

Table 1: Elevations and Locations of rebar pins

Excel was used to plot the measurements to create the cross sections. To overlay the previous group's cross section, 2018 measurements were plotted in the same Excel sheet as northern site 1 and the soil sample location that was provided in the 2018 report. Using the program RiverMorph, the change in area between the right banks of 2018 and 2020 was calculated to obtain an estimated annual streambank erosion rate.

The weakness in the measuring methods is primarily that it has to be repeated after a few years in order to be able to calculate the erosion rate. This report group had data from 2018, but it is unlikely that the 2020 survey was repeated in the exact same place. The current study practices fixed this problem for

future projects by adding rebar where the survey coordinates were pinpointed. Figures 3 through 8 provide the cross section survey results. Figure 3 is unique in that it also provides estimated 2018 data for erosion rate comparison. However, it is noted that this is an estimated overlay due to the lack of monumented pins from the 2018 survey.

Results & Discussion

As mentioned, there is a strong possibility that 2020 cross sections do not exactly match the 2018 cross sections. The CamLine was placed in the spot that it was based on pictures and coordinates from the 2018 survey. Although the graphs line up similarly, there are some differences. Based on the RiverMorph analysis of the 2018 and 2020 cross sections, the estimated erosion rate was found to be 0.61 feet per year. It is noted that this rate is an estimate as it is not clear if the cross section data from 2018 and 2020 were correctly overlaid due to a lack of monumented points placed in 2018. The newly installed cross sections with rebars will keep cross sections precise and allow future surveys to collect accurate bank erosion rates.



Figure 3: Below is the cross section view at Site 1, looking towards right bank.

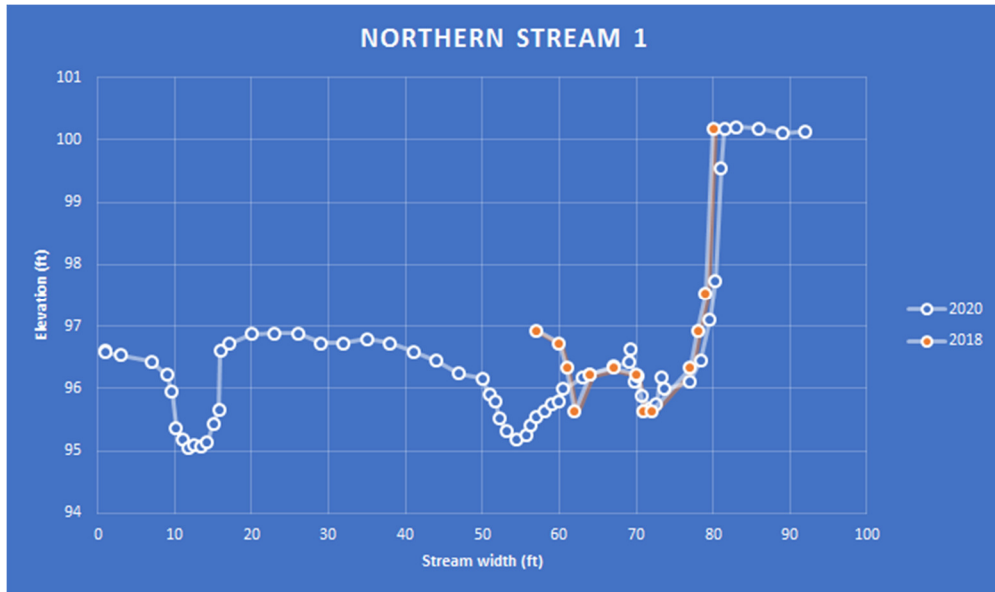


Figure 4: This is the cross section created in Excel of the northern stream site 1.

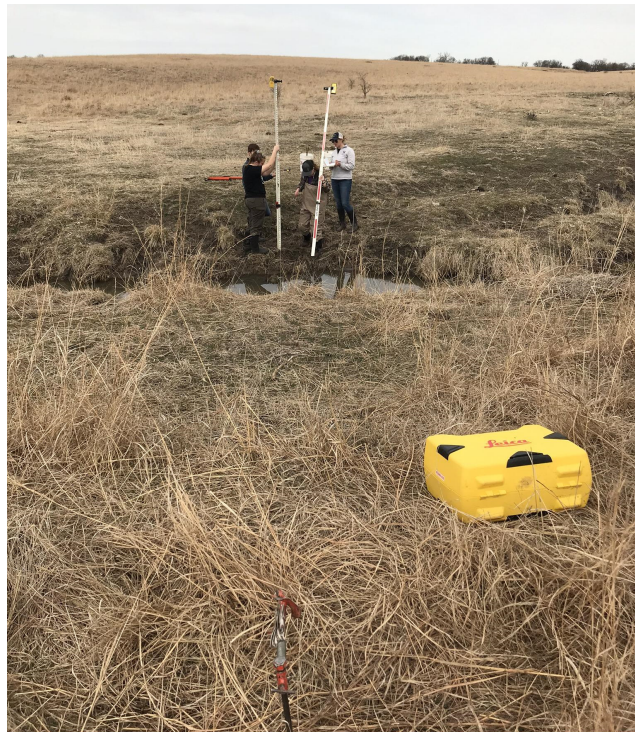


Figure 5: Site 2 looking towards the right bank.

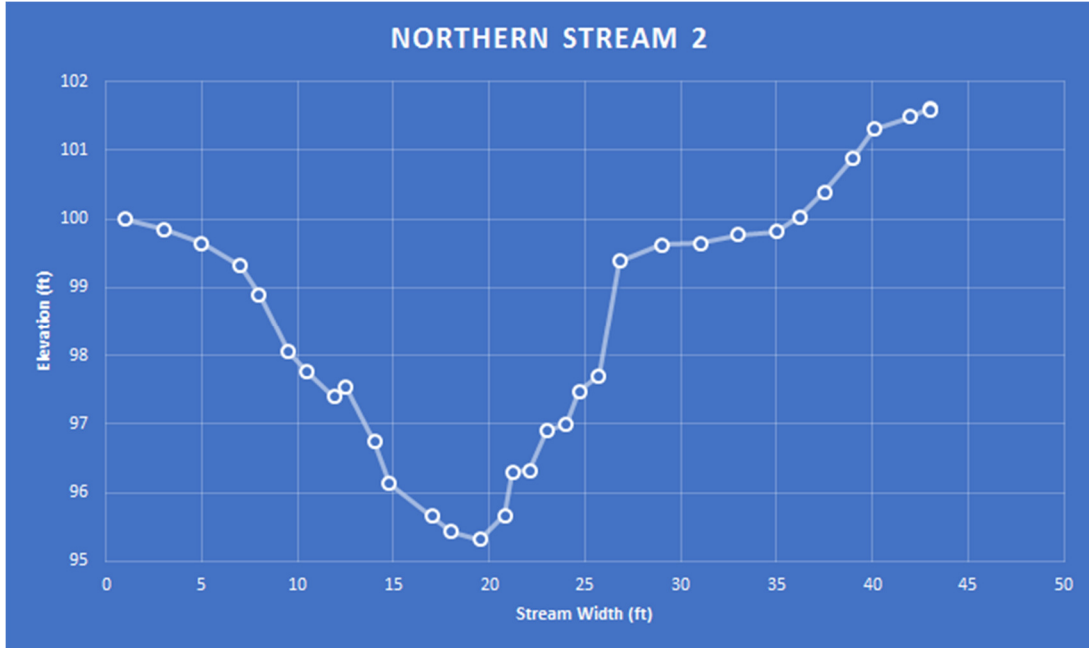


Figure 6: This is the cross section of the northern stream site 2.



Figure 7: Site 3 looking towards the left bank.

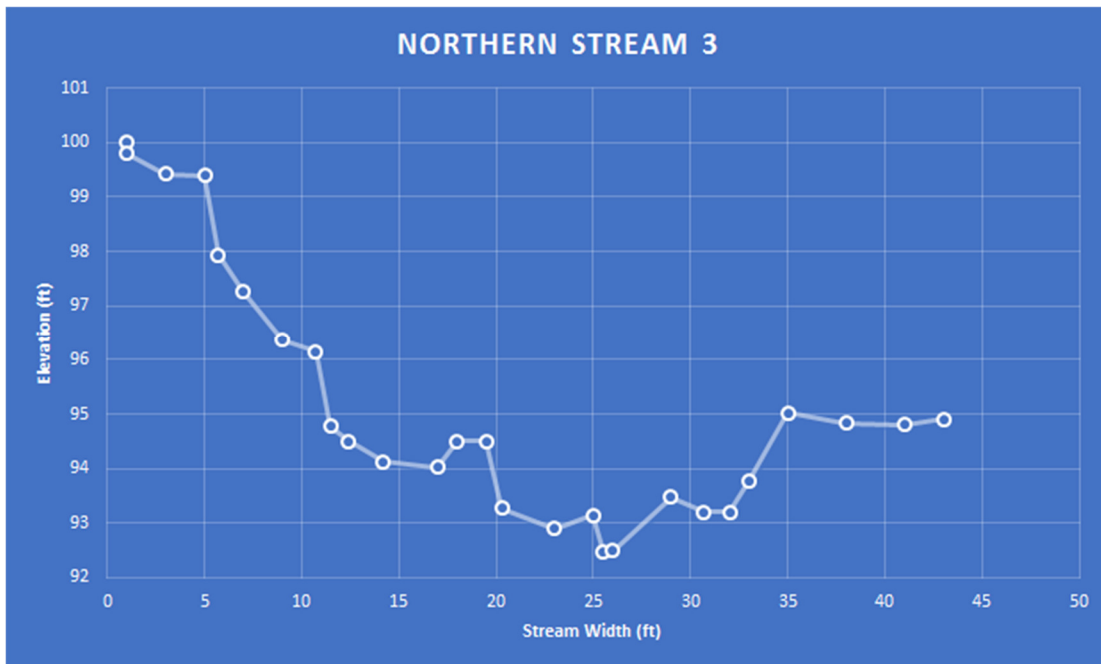


Figure 8: This is the cross section of the northern stream site 3.

While surveying cross sections, several observations were made about the pasture. Cattle have full access to the stream throughout the whole pasture. They are able to stand on the streambanks and disturb the soil around the stream. There was little vegetation on the streambanks. Northern site 1 had three small stream channels that were measured. The northern site 2 had the deepest channel. At the northern stream site 3, the land owner had put a tree across the stream to create a dam, as shown in Figure 9. However, the water had flowed around the tree and continued to move downstream. The left bank was very steep while the right bank was shorter and less steep.

Algae was observed growing in the water in March. This is a sign of water health and that pollutants are present in the water. As mentioned, the main nutrients that would be responsible for algae growth are nitrogen and phosphorus (Stillwell et al., 2018). The sources for some of these nutrients are fertilized crop land and lawns, and runoff from pastures and feedlots.

Summary

With studying bank erosion and knowing where sediments are coming from, lake managers at Marion County Lake can create a plan of action. Knowing the sources of nutrients will help in understanding what conservation practices should be used within this watershed. Sediments are coming from runoff on land but also along stream banks which has been documented in this report. The Marion site managers can also look into the possibility of engaging stakeholders and landowners in decisions about the fate of their watershed.



Figure 9: The dam at site 3

Strategies to Maximize Stakeholder Involvement in Marion County Lake Watershed Conservation

The potential water quality issues discussed above in the Marion County Lake and Park are tough challenges to combat from a management standpoint. The weight of these challenges can be alleviated with help from invested stakeholders and landowners. From looking at landowner perceptions and surveys, certain conservation methods will stand out amongst the rest. Not only will lake managers have a better handle on what landowners will want for their own operations, but the managers will be able to create plans to help alleviate any sedimentation issues. In one study, the group looked over landowner willingness by issuing a mail survey asking about landowner preferences. The results showed residential landowners were significantly less likely to implement change than the agricultural landowners. The study also showed neighbor friendliness increased perceptions of riparian conservation methods (Bogner, 1983). This relates to the study and survey of landowners because both agricultural users and nonagricultural users are in the Marion County Park and Lake area. Understanding the local dynamic might help the study the group is conducting to get better questions and see what kinds of conservation methods would resonate with the target audience.

Landowner and Stakeholder Spatial Scales and Surveying Values

Due to the effects of COVID-19, the research team was unable to conduct landowner and stakeholder surveys. The goal of these surveys was to help the managers of the Marion County Park and Lake understand landowner and stakeholder values and current practices when visiting the lake and practices of watershed management. This survey could be used in conjunction with the sediment study mentioned earlier in this report to further determine management shortfalls. In place of the research, the

group has put together a summary of the importance of involving landowners and stakeholders in natural resources management and how they can include them in these processes. A section of this report highlights how future surveys could be conducted to include both landowner practices and stakeholder interests. Before these methods are discussed, listed below are a sample of the questions the group was hoping to ask stakeholders.

Questions:

How important is water quality management to you?

1-5 (one is not at all, two is mostly not important, three is neutral, four is mostly important, and five is the most important issue)

How big of an issue do you consider sedimentation (sediment deposits filling in the lake) to be in this watershed?

1-5 (one is not an issue, two is mostly not an issue, three is neutral, four is mostly an issue, five is a serious problem that requires immediate action)

How much do water quality issues (like blue-green algae) affect your lake use or recreation?

1-5 (one is not at all a factor, two is mostly not a factor, three is neutral, four is mostly a factor, five is a major factor)

Managers of our natural resources are tasked with making tough decisions about the practices that must be implemented to sustain our natural resources while still providing use of them. While this is not an easy job, the pressure of the decision making can be lessened with input from stakeholders. Stakeholders and their analysis from a natural resource management standpoint is defined as, “analysis in the context of natural resource management identifies distinctive interest groups affected in the utilization and conservation of natural resources (Dandy, N. et al. 2009).” Stakeholders are people who feel as if they have some sort of stake in the natural resource because they benefit from it in one way or another. They can provide insight into how much they are willing to invest in protecting their natural resources both economically and hands-on. These natural-resource-users can help to pay for water quality improvements, and they can also help clean up the pollution by being responsible stewards of the land and water. For the managers, this creates allies that can help sustain the resource and all its uses. At the Marion County Park and Lake, landowners and stakeholder inputs can be used to gather perceptions on potential water quality issues like the sedimentation and blue-green algae. This input, when paired with the monitoring measures of bank erosion, help the managers to develop a stronger management plan.

Every landowner and lake user will value different parts of the resource for different reasons. Their value of the ecosystem service will also depend on how they are scaled spatially within the natural resource. The first step is understanding how stakeholders benefit from the natural resource and what aspects of the resource they value the most. Then, it is important to identify how natural resources users perceive the management practices that are or could be implemented not only on the public resource like the Marion County Park and Lake, but the practices that they implement on their own land, especially if they are an upstream landowner. It is crucial to ask if the stakeholders are satisfied with the current management practices and if they can see the effects of this management in their everyday use of the natural resource. This can also facilitate conversation about whether or not the landowner would be

willing to implement more sustainable practices on their own land. Lastly, it is important to be aware of the stakeholders' preference of natural resource practices, especially when trying to address issues that largely affect them like water quality management. The manager will benefit from having this additional input on how to take action against natural resource issues.

Understanding Stakeholder Values of Ecosystem Services

The first part of initiating the involvement of stakeholders in natural resources management is understating how they value the resource for its different uses across varying spatial scales. A study analyzing the De Wieden wetlands in The Netherlands researched the value of ecosystem services to stakeholders in different spatial scales. The authors define ecosystem services as “the goods or services provided by the ecosystem to society, and provide the basis for the valuation of the ecosystem (Hein, van Koppen, de Groot, & van Ierland, 2005, p. 211).” Spatial scales of ecosystem services were defined as “the ecological scales at which ecosystem services are generated, and the institutional scales at which stakeholders benefit from ecosystem services (Hein et al., 2005, p. 209).” Spatial scales provide a way for the authors to categorize the levels at which the services are affecting the stakeholders and how they benefit from them. The managers at the Marion County Park and Lake could also develop spatial scales to help them determine park and lake use.

The environment of the wetlands places value on ecosystem services that provide industrial uses like reed cutting and fisheries, recreation use, and nature conservation. The authors were able to develop a diagram with the ecosystem value framework and three different categories of ecosystem services (Figure 10 and Table 2). The value of this research is in the identification of varying values placed on different ecosystem services in diverse spatial scales. The research answers the question of what attaches a person to a place or its resources and, therefore, creates an advocate for its protection or use. At the Marion site, there is a large community of dedicated stakeholders who may place value on recreational and industrial ecosystem services.

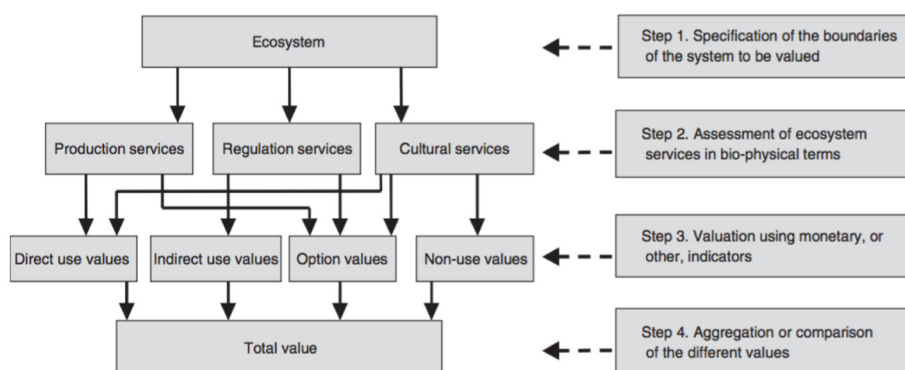


Figure 10. This is the study's interpretation of the ecosystem valuation framework. The solid arrows symbolize the most significant link between the elements that make up the framework. The dashed arrows represent the four main steps in the evaluation of ecosystem services. (retrieved from Hein, van Koppen, de Groot, & van Ierland, 2005, p. 211).

Category	Definition	Examples of goods and services provided
Production services	Production services reflect goods and services <i>produced</i> in the ecosystem.	Provision of: –Food –Fodder (including grass from pastures) –Fuel (including wood and dung) –Timber, fibers and other raw materials –Biochemical and medicinal resources –Genetic resources –Ornamentals
Regulation services	Regulation services result from the capacity of ecosystems to regulate climate, hydrological and bio-chemical cycles, earth surface processes, and a variety of biological processes.	–Carbon sequestration –Climate regulation through regulation of albedo, temperature and rainfall patterns –Regulation of the timing and volume of river and ground water flows –Protection against floods by coastal or riparian systems –Regulation of erosion and sedimentation –Regulation of species reproduction (nursery function) –Breakdown of excess nutrients and pollution –Pollination –Regulation of pests and pathogens –Protection against storms –Protection against noise and dust –Biological nitrogen fixation (BNF)
Cultural services	Cultural services relate to the benefits people obtain from ecosystems through recreation, cognitive development, relaxation, and spiritual reflection.	–Nature and biodiversity (provision of a habitat for wild plant and animal species) –Provision of cultural, historical and religious heritage (e.g., a historical landscape or a sacred forests) –Provision of scientific and educational information –Provision of opportunities for recreation and tourism –Provision of attractive landscape features enhancing housing and living conditions (amenity service) –Provision of other information (e.g., cultural or artistic inspiration)

Table 2. An example list of ecosystem services (retrieved from Hein, van Koppen, de Groot, & van Ierland, 2005, p. 212).

The way that stakeholders value ecosystem services is very valuable information from a management standpoint. For example, if the public values a lake for flood control and use for drinking water over recreational use, the management can focus more of their resources on upgrading tools for less water escape and better water quality and focus fewer resources on trails and stocking the lake with fish. Management will still need to abide by federal, state, or local legislature and laws that are set for maintaining the lake, but having the additional input from invested stakeholders can help with decisions of what kind of uses to provide. These principles can also be applied in management approaches at the Marion County Park and Lake. Although the survey could not be conducted with the Marion stakeholders at this time, the group predicts that the result would have supported management that prevents the potential water quality issues of sedimentation and blue-green algae invasion.

Understanding Landowner Perceptions and Practices of Natural Resource Protection

The next step of initiating the involvement of the public in natural resources management is including both stakeholders and local landowners, which in many cases, is the same person. Perhaps the most influential group of landowners in a watershed environment are those who are upstream of the lake. The land and water management actions taken by landowners upstream in the Marion County Park and Lake Watershed can have a significant positive or negative effect on the lake. This is where issues with sedimentation, nutrient overloading, or other sources of water pollution can start. Public water managers must have positive relationships with their upstream landowners and work with them to make sure their management practices do not harm the public's natural resources. All land can be managed sustainably if there is cooperation between public land managers and private landowners.

A peer-reviewed article researching Blue Ridge and Piedmont ecoregions of South Carolina focused on the topic of how the public can protect vital species habitat on public and private land. The research placed emphasis on identifying private lands that served as habitat for endangered species. The authors provided an element of public attitudes in this research by including landowner opinions of aquatic conservation. Cooperation from private landowners to practice conservation methods on their land is an essential part of habitat protection because private land ownership classifies over half the land ownership in the United States (Chambers, Baldwin, Baldwin, Bridges, & Fouch, 2017). They accomplished this by distributing a 27-question mixed-method survey to 409 landowners, of which they received 70 completed responses. Surveys can be a very vital help to managers in understanding the perceptions of the private landowners they work with.

The researchers found that in this area of the country, there tends to be a stronger feeling of anti-government attitudes. Although this was the case, due to spatial analysis, the study showed that aquatic areas and wildlife are valued by landowners and have influence in their decisions. Those who responded to the survey showed concern for threats of pollution from runoff and siltation. The authors were able to show the importance of conservation to private landowners, no matter their opinion on government involvement. The point the researchers made about facilitating better outreach and communication for more successful implementation of conservation practices was very valid and represented in their study (Chambers et al., 2017). This is very applicable to any public land managers seeking out public interest on conservation practices by utilizing surveys or other forms of public outreach. The more rural setting of this study lends itself to being a useful resource in the case of Marion site, where the majority of the upstream landscape is privately owned and used for agricultural purposes.

Another article conducted in Australia highlights the uprising of conservation programs over the last several decades. While sustainability is not a new idea, new approaches to sustainability and the value of it in people's eyes is ever-changing. The authors placed prominence on the role that social contexts play in shaping private land conservation (PLC) outcomes. Their research identified how creating an inclusive policy-making process can reduce conflict between conservation agencies and landowners (Cooke, Langford, Gordon, & Bekessy, 2011). One of the main focuses of the private land conservation practices was to protect sensitive habitat areas where threatened or endangered species might live.

This study can teach the reader about the direct correlation between landowner's participation in conservation programs and the health of an environment. The authors point out that the influence landowners can have on the environment is not given enough attention. The success of any managed natural resource hinges on the willingness of stakeholders and users to not overwhelmingly degrade these resources. Stakeholder input and participation is something that could be more utilized at the Marion County Park and Lake.

Lastly, a study was done in the Deerfield River Watershed in western Massachusetts, identifying a comparison between public and private efforts to mitigate flood hazards and other issues related to successful adaptation to climate risks. The private landowners have a perspective that is based on local concerns to protect their own land from flood impacts. On the other end of the spectrum, public adaptations look at a more broad area. Both private and public adaptations can affect either interest group

and create flood impacts across the watershed. The authors had landowners respond to the effectiveness of these adaptations and how they fit in with the social setting of the area.

The researchers were able to conclude that in areas where public and private interest groups share responsibility and in areas with high geo-physical connectivity, the input of all stakeholders must be considered and combined to achieve the best cumulative outcomes (Milman & Warner, 2016). The authors pointed out that while their study focused on flooding, this research about the interactions between public and private environmental adaptations is applicable to a wide range of climatic impacts. The information that is to be gained from this research can be used in taking preventive measures in any watershed against potentially harmful effects like flooding, sediment and nutrient overloading, and other damaging ecosystem problems. The dynamic of involving both public and private interest is something that would also have to be applied at the Marion site.

Whether the land or water is public or private, the way it is managed can have a significant effect on the environment. This is why it is extremely important for public land managers to collect input from both the stakeholder who only uses the resource and the upstream landowners whose management practices can affect the public land and water. In the case of managing water quality at the Marion County Park and Lake, the managers could conduct more outreach to landowners to determine their perceptions and understandings on the management practices used at the lake. Managers could then gauge their interest in being involved with certain sustainable land and water management programs.

Identifying Stakeholder Management Preferences

The final step in initiating the involvement of the stakeholders in natural resource management is understanding their preferences for combating public land and water issues. Management does not always have to follow these preferences, but having this input can help inform their decisions. By knowing stakeholder preferences and making decisions based on them, the managers will likely gain more support for these decisions and help for sustaining the natural resource.

An article looking at the immediate pressures and potential impacts of climate change on the coast of Christchurch Bay on the south coast of England and the Orkney Islands off the north coast of Scotland identified the importance of stakeholder opinion when determining managerial actions to be taken toward environmental issues. The technique used by the authors for involving stakeholders in management processes was centered on the scenario-based stakeholder engagement novel method. Using this method, “which brings together stakeholder analysis, climate change management scenarios, and deliberative techniques, the necessary trade-offs associated with long term coastal planning are explored” (Tompkins, Few, & Brown, 2008, p. 1580).

The authors were able to discover a wide distribution of conflicting preferences that are held by important stakeholders on the ideal management structures to combat the effects of climate change on different areas of the coast. They also found that importance needed to be placed on the stakeholder’s perception of the trade-offs that would have to be made to accomplish the management of the environmental issues such as the cost of taking action versus the actual risks of doing little to nothing. The authors concluded that the locals knew these areas the best (especially much better than government

officials who never or rarely have visited these sites) and, therefore, could play a major factor in determining what would be best for their management.

This article made the important point that for managerial decisions to not face backlash and be accomplished quicker, the decisions need the support of the local stakeholders. This study was presented in a way that truly expresses the significant value of stakeholder input and involvement in environmental management. Managers that are aware of their stakeholder's preferences can make more informed decisions about what will not only benefit the resource but the public as well. The management team at the Marion County Park and Lake could easily implement these strategies to reach greater consensus on tough natural resource management decisions from passionate and involved stakeholders.

Managing Water Quality Issues with Stakeholders in Mind

After a natural resource manager is able to understand why their stakeholders value the resource, their perceptions of the management practices, how they are willing to contribute on their own land, and their preferences of management, the manager can then work towards how to involve them in the management decisions. The manager must evaluate all the roles and uses that the land and water serves for the stakeholders, wildlife, and the overall ecosystem. Once managers identify the varying interest groups and their uses of the natural resource, they can make decisions on how to involve the public. When managing water quality issues like sedimentation, it is vital for the managers to determine how to utilize the full potential of involving their stakeholders.

Stakeholders can be included in the management of a natural resource on many different levels. It is important for the manager to know how involved and how much power to give the stakeholders before including them in the decisions. After the involvement level is decided, the manager can then focus on the effective ways of engaging stakeholders in the decisions and practices of natural resource management and sustainability. Managers need to critically look at what the stakeholders value in order to get them interested in participating. Finally, managers can evaluate the benefits of involving stakeholders and can potentially reward stakeholders for their help. For instance, if an upstream landowner is willing to implement conservation practices on their land to help protect water quality, the managers could enroll them in a program that helps to pay for the cost of up keeping these practices. Examples of how the Marion managers could do this at their site are discussed later on in the report. Managers and stakeholders can mutually benefit from being involved in cohesive environmental management.

Managing for Areas with Multiple Uses

Managers of environmental resources deal with the challenges of managing the land and water for a wide range of use. The managers at the Marion County Park and Lake must plan for recreational use, flood control, water quality use, and agricultural use in the surrounding areas. With this wide spectrum of use, it can be hard to know what interest groups to prioritize when having to make tough natural resource decisions about sedimentation prevention for example.

The authors of a research article looked at the challenges of managing water and nearby land resources for multiple uses, including wildlife habitat, recreation, and agriculture. The writers identified

the dynamic use and the nature of the Conesus Lake in New York. This article discusses the planning structures used by the area managers and agencies to accomplish their watershed management goals while trying to involve stakeholders in the process. A crucial part of this study was looking at the current water quality conditions, ecological impairments, and the perceived roadblocks to successful management (Moran & Woods, 2009).

The article was able to represent both the organizational structure for the implementation of the Conesus Lake Watershed Management Plan and the actual adopted organizational structure (Figure 11 and 12). The organizational structure and levels of stakeholder involvement will be mentioned again later in this report. During the development of the plan, they were able to outline the vision and goals that they had for the project (Figure 13). This approach to developing a management plan by involving stakeholders facilitates plans that are supported by both the managers and the lake users. This kind of structure could be used by the managers at the Marion County Lake and Park to determine the interest groups and their level of involvement.

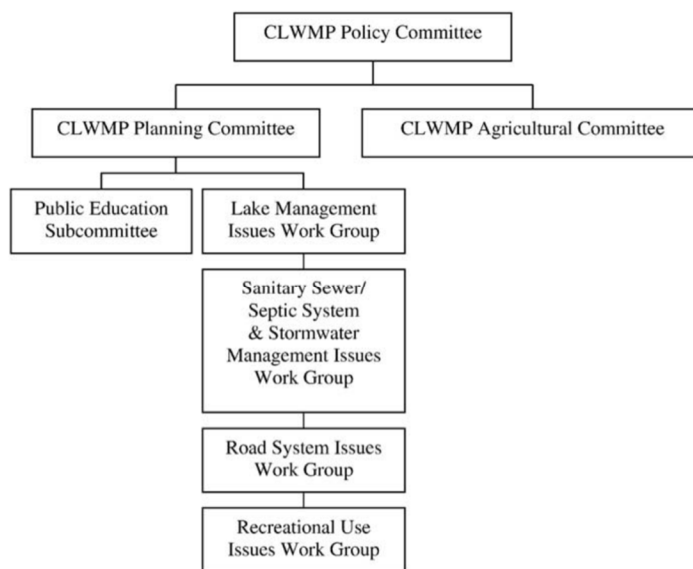


Figure 11. Organizational structure adopted for the Conesus Lake Watershed Management Plan (retrieved from Moran & Woods, 2009, p. 12).

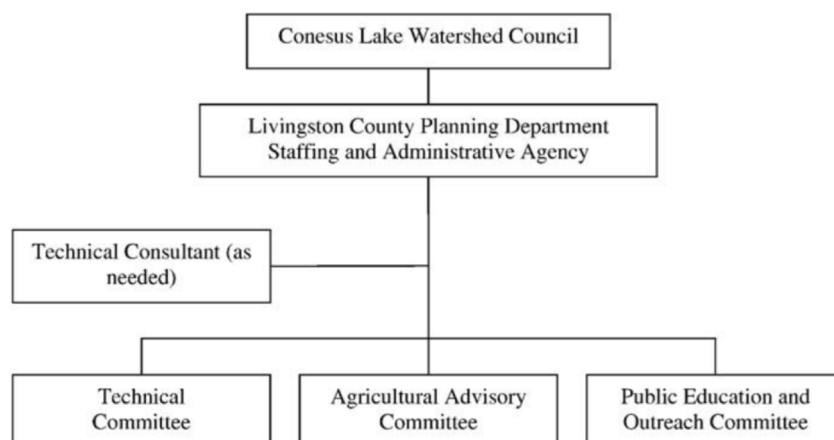
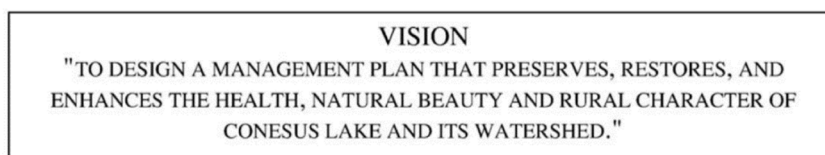


Figure 12. Organizational structure adopted for the Conesus Lake Watershed Management Plan (retrieved from Moran & Woods, 2009, p. 13).



What is the objective of the Conesus Lake Watershed Management Plan?

To ensure the sustainability of designated uses for Conesus Lake and its continued role as a positive influence on the social and economic well being of watershed communities.

What are the goals for water quality of the lake?

To improve water quality conditions in Conesus Lake to ensure its continued use as a water supply and make it more attractive for water contact recreation.

How does the plan view ecosystem management?

The plan includes actions designed to restore Conesus Lake to a diverse ecosystem composed primarily of native species of plants and animals.

What part does the community plan in the plan?

For the plan to succeed, it must promote cooperation of all stakeholders at the local level to develop a comprehensive approach that seeks to build collaboration and balance diverse concerns.

How does the plan address the specific concerns of agriculture?

The plan recognizes the value of high quality agricultural practices in meeting its goals. The plan seeks to promote the viability of agriculture and best management practices in land use.

How does the plan affect residents of the watershed?

The plan seeks to provide necessary services to all watershed residents while preserving the natural beauty and rural character of the countryside.

Figure 13. Summary of the community's vision and goals for Conesus Lake and its watershed (retrieved from Moran & Woods, 2009, p. 13).

Levels of Stakeholder Involvement

Managers of natural resources need to determine how much power they want to give the stakeholders when involving them in the management decision process. One example of involving stakeholders at different levels was an article that sought to explain the connection between sediment management and stakeholder involvement. This study was conducted under the policies of the European Union in the Netherlands, with some look into American policies. The significance of the European Union policies is that they demand societal participation, especially in decisions of the management of environmental problems, which are becoming progressively complicated. The authors looked at identifying who the stakeholders are, why they should be involved, what role they can play, and the diversity of stakeholders. The management of Marion site and its upstream well-being also demands participation from the surrounding stakeholders and landowners to combat sedimentation and other water quality issues that could worsen over time.

As for the role that stakeholders can play in sedimentation management, the authors described them as being involved on different levels. These levels included providing information to the stakeholders, consulting them on what to do, having them advise and give recommendations, involving them in the policy-making process, and finally, involving them in everything previously mentioned and giving them decision-making power (Slob, Ellen, & Gerrits, 2007). The authors wrote about a real-life example in Rotterdam, the Netherlands, where the citizens had to be involved in the management process where sediment remediation and improving water quality was crucial for the immediate health of the resource. The large city lake had to be dredged and, therefore, was going to cost the stakeholders in both spatial disturbances and financially. This is a prime example of communication with stakeholders being necessary for project success and support. This example focuses on sedimentation, just like this report, but the difference is that bank erosion from upstream sites at the Marion County Park and Lake does not appear to be a serious issue yet. Wise management of monitoring sediment and nutrient loading in combination with stakeholder and landowner involvement can help to prevent a situation like this example.

Including stakeholders in ecosystem management processes can be risky when not all parties involved can have the same advantages to gain, or a solution can not be reached due to differences of ideas. The authors countered these pitfalls by establishing the basic needs for public opinion and investment in natural resource projects. Stakeholders that care and feel involved are more likely to take care of the natural resources they use. The managers at the Marion County Park and Lake can determine the levels of involvement and then decide the best way of engaging them in the management of their natural resources based on how much these decisions may affect them.

Methods to Engage Stakeholders in Natural Resource Protection

Managers who are trying to engage stakeholders in their management decisions need to determine their interests and values. The United States Environmental Protection Agency produced a report outlining recommendations about how to get stakeholders interested in watershed management processes. According to the US EPA, “about 40 percent of our nation’s waters do not meet their water quality goals

because of runoff from streets, farms, mines, yards, parking lots and other nonpoint sources of pollution” (United States Environmental Protection Agency, 2013, p. 1).

This report discusses the importance of stakeholders, how to develop a framework for their involvement, how to build the interest group, develop the processes, and outline the responsibilities of the plan managers. The most useful information in this report, when applying it to other watersheds, like the Marion County Park and Lake, is the section about “building your stakeholder group.” This report highlights how to conduct outreach, invite stakeholders to participate, build an operating plan, and educate stakeholders. It teaches the reader how to keep the stakeholders engaged and feel as if they all have a shared responsibility in the management plans so that they have a passion and drive to see the plans become successful. This report goes in-depth about different levels of contacting your stakeholders, the scale on which they can be involved, and how to keep their investment sustained.

Examples of tips from the report:

Steps in the watershed planning process (United States Environmental Protection Agency, 2013, p. 10):

1. Build partnerships.
2. Characterize the watershed to identify problems.
3. Set goals and identify solutions.
4. Design an implementation program.
5. Implement the watershed plan.
6. Measure progress and make adjustments

Possible roles and responsibilities for stakeholders include the following:

(United States Environmental Protection Agency , 2013, p. 24):

- Clarify overall project goals and objectives.
- Ensure all relevant interests are adequately represented.
- Provide input on watershed problems.
- Help develop evaluation criteria for analyzing management options.
- Provide input on the preferred management strategies.
- Provide review and comments on reports or watershed plans.
- Help conduct community education and outreach throughout the process.

Questions to ask when identifying potential stakeholders:

(United States Environmental Protection Agency, 2013, pp. 27-28):

- What are the problems affecting the watershed, from the community’s perspective?
- Who has the potential to help protect the watershed?
- What are the political, cultural, and economic factors in the community?
- What are the demographics of the community?
- How is your organization perceived in the community?
- Who are the influential leaders—religious, civic and business?

Top 12 tips to move the process forward:

(United States Environmental Protection Agency, 2013, pp. 45-49):

1. Involve stakeholders as soon as possible.
2. Be honest.
3. Listen.
4. Communicate clearly and often.
5. Don't leave out stakeholders because they're difficult.
6. Maintain strong leadership.
7. Focus on their issues.
8. Establish mini-milestones.
9. Commit the resources needed to achieve your objectives.
10. Call a meeting only when it's absolutely necessary.
11. Give feedback and praise.
12. Make it fun.

This in-depth knowledge can be applied to any watershed management plan development that is seeking to involve crucial stakeholders in their conservation decisions. For example, private landowners upstream at the Marion site need to be involved in the management of their water access points so as to not destroy the resources downstream. One issue that this report on Marion highlights is sedimentation and using the above suggestions of engaging stakeholders and landowners can be utilized to combat sedimentation and other water quality issues. This report establishes engagement actions that can be taken towards these management collaborations.

Management Improvements and Stakeholder Incentives

After involving stakeholders in natural resource management processes, managers will find that they will benefit from this additional source of input and help. Stakeholders can feel empowered by having the opportunity to have a say in the management of their natural resources. Landowners also get this benefit and could even have the opportunity to receive financial incentives for implementing sustainable land and water use practices on their land. A literary work on a watershed located in south-central Kansas between Wichita, Kansas and agricultural producers in the Little Arkansas River Watershed seeks to discuss the processes involved with integrating watershed management across land with multiple uses, including urban and rural settings. The researchers claim that these opportunities for partnerships to improve water quality management would work using off-site best management practices (BMP) (Moore, Sheshukov, & Graber, 2019).

The study found that relationships between urban stakeholders, extension specialists, and rural producers are essential for the successful implementation of water quality programming. This can positively increase the impact of best management practices on the environment. The most applicable part of the study also analyzed the possibility of rewarding stakeholders that implement these practices with financial support to maintain the practices. This would provide advantages for both the producer financially and from a land conservation standpoint. It would also benefit other stakeholders in the watershed because it may prevent having to pay for damages to the watershed that may become hard to remediate and much costlier than providing the producers with financial support to now implement the

best management practices. This research is useful as an outline for what can be done in other watersheds, such as the Marion County Park and Lake, to get more producers and stakeholders invested in their natural resources. The emphasis the researchers place on the critical relationships between the interest groups is vital to know about when planning watershed management in any area.

In order to get landowners and stakeholders to adopt conservation methods it is important to explain how they can benefit. It is important to target the behaviors that bar them from adopting these methods. Based on information from the studies mentioned earlier, people respond well to conservation communication and it is needed. Correct conservation communication methods will vary based on a person-by-person basis. This report group believes that based on information gained from the literature they have mentioned that communicators will have to identify the exact behavior they want to change. Then, communicators can craft their message to resonate well with them. Most landowners would be interested in programs or grants that would aid in implementing conservation methods. Showcasing how to combine conservation methods all while still being able to use the land for agricultural use. There may be cost-share options available through the Kansas Conservation Districts. That will be up to the landowner, their county conservation district and potentially extension agent to find a plan perfect for the situation. There are a variety of strategies that could work for education purposes. From workshops to articles that could be disseminated, landowners are typically going to be interested in knowing their options. An effective way to educate the landowners on conservation methods would be to use face-to-face interaction and to utilize a variety of communications strategies. The other strategy that might work would be social norm. By having certain landowners who implement these conservation practices go out and show the other landowners that it is normal to use these methods, more landowners would be more likely to adopt conservation practices because it would seem normal. Although these are generalizations for potential lake managers to create plans and conservation methods for the adjacent landowners, conducting a survey would help create plans that are specialized for the landowner's specific needs.

The survey that would be created would cover important considerations for landowners. It would pinpoint what is important to them, their current understanding of conservation methods and terms and what would make them a viable option for landowners to implement. The survey would save the lake manager's time. They could find what landowners want right away and get to work on methods that people are really interested in. Lake managers need to consider before they create the survey what exactly they want to do with their results, how detailed do they want the results to be and how they can make the survey understood and user friendly. The success of surveys can be seen in the previous studies mentioned in this report. The managers at the Marion County Park and Lake can utilize surveying to gain multitudes of valuable information from their stakeholders and landowners. The points about incentivisation and identifying significant programs are all applicable to the Marion site.

Summary

Conservation methods and getting people to adapt means scientists have to go after their target audience via their behaviors and their belief system. The stakeholders and landowners in many of the studies mentioned earlier in this report show an increased interest and pressure to be sustainable, profitable and efficient with natural resource utilization. The public is becoming more interested in what is going on private property and how it impacts public lands and recreational areas. This shows that people respond well to conservation communication and it is needed. Communication methods will also

vary depending on who the receiver is. The target audience and their behavior will be important to pay attention to in conveying and disseminating information and surveys. In order to better communicate with the target audience, subgroups to further specialize our information is an effective avenue. This is all helpful for the project and landowner survey because landowners beginning to consider adopting conservation methods onto their operation is a goal of this Marion site study. After understanding stakeholder needs and preferences, watershed conservation practices can be planned and implemented. The next section provides additional information on what conservation practices might be effective in the Marion County Park and Lake Watershed which could utilize stakeholder and landowner participation.

Recommended Conservation Practices for Marion County Lake and Its Watershed

As previously discussed in the “Marion County Lake Site Description” section, Marion County Lake has issues with algal blooms in the summer, which is caused by excess nutrients in the water. These nutrients can come from places like crops, pastures, and lawns. Excess nutrients in runoff is a major problem. Since the watershed is mostly herbaceous- covered, possible rangeland management conservation practices that could be implemented include access control and stream crossings. The site that was surveyed allowed cattle full access to the stream that drained into the Marion County Lake. Based on field observation of full cattle access in the stream that was surveyed (see “Streambank Erosion Monitoring” section), it is assumed that this practice is likely occurring through the watershed in other pastures. Cattle grazing on or near streambanks can increase the shear stress on streambanks (Trimble, 1994). While they graze they trample the ground and cause compaction, which decreases the infiltration of the soil and leads to more water flow in the stream. An NRCS practice that could be implemented would be access control (NRCS, 2019), where people, animals, and equipment are kept out of a place, like a stream. This would require some fencing around the stream to keep cattle off of the streambanks.

Another practice that could be implemented in pastures around Marion County would be Stream Crossing (NRCS, 2019) which makes a crossing for livestock, people, and equipment. This reduces streambank and streambed erosion. The stream can be fenced off from livestock and this crossing provides them a section of the stream to drink from and wade through. Having most of the stream sectioned off from cattle limits their excretions in the water.

There are other options for conservation practices besides pasture and rangeland that could help reduce nutrients and sediments in the lake. Riparian buffer strips are vegetated areas planted along streams that catch runoff from fields. Water infiltrates the grassed areas and filters out nutrients and sediments, improving water quality (NRCS, 2014). Planting native species with deep roots can stabilize streambanks. Stabilizing streambanks can prevent erosion and reduce sedimentation in reservoirs. Landowners within the watershed can place riparian buffer strips along their land to benefit the Marion County Lake downstream of them.

Popular conservation practices such as no-till, conservation tillage, and cover crops all work to reduce soil erosion in cropland. Keeping a cover on the surface minimizes the raindrop impact on soil which reduces erosion. Cover crops, keeping a living root in the soil, can capture nutrients (NRCS, 2017) which would reduce the amount of nitrogen and phosphorus entering Marion County Lake. Protecting the soil with a cover of residue or vegetation will reduce sedimentation and the silting in of reservoirs and lakes.

If sedimentation and further stream bank erosion is not prevented, there are solutions to resolving these problems in the future. One method that could apply to the site for remediation might include flushing of lakes. This method has been proven to be useful in a few different scenarios both on United States soils and overseas. In the "Feasibility of Flushing Sedimentation from Reservoirs" study was to show quantitatively how flushing can help or hinder reservoir sedimentation. Flushing is a process where sediments are removed using low-level outputs. It only works on a very select few reservoirs. The reservoirs must be narrow with a place for large volumes of water to pass through, and the reservoir needs to be emptied. The costs of flushing include compromising the sedimentation levels downstream and the potential need for new infrastructure. The primary benefit is the restored water quality of the reservoir once it is refilled with water. If flushing is successful, reservoirs reported they were restored to either long-term full or majority effectiveness. Flushing of reservoirs is not an appropriate solution for all sedimentation problems, but in cases where the reservoir meets these certain standards flushing can be the most effective option. This study looked at a wide variety of reservoirs in a variety of different countries to see which ones worked and which ones did not. They had to create their own criteria for how to flush and when it works best to do so. They concluded that it was not the best thing to do for all reservoirs but in the cases where the reservoir matches the criteria it is a great solution (Haregeweyn, Nigussie n.d).

Flushing has also been a method practiced in Ethiopia. One reservoir that supplied a village with water started to see sediment levels rise significantly. This decision had to be made after considering a cost-benefit analysis and toxicological risk assessment. One way helped lead Ethiopians to a conclusion was doing a Multicritical decision analysis which handled multiple important factors related to coming to a sedimentation solution. They evaluated sedimentation excavation. This would cost \$4.375 million (in U.S. Dollars) and about 500,000 workdays to clean up the reservoir. This effort would provide lots of jobs, the reservoir would be allowed to be used again, and thanks to few pollution points, this considerably clean water source would help rehabilitate the community. Bottom outlets are an infrastructure that not many other reservoirs have. This one does have it. It only works if the runoff to level ratio is low. This reservoir did not fit the bill for that criteria. This method would still involve some dredging, so it is not saving much time or money. There was also discussion over building new dams or making the current reservoir taller. They concluded this reservoir should be dredged and then a new watershed management plan be created. (Haregeweyn, Nigussie n.d). While flushing offers one solution, it is critical to research all possible options to resolve water quality issues. Part of this research includes presenting data gathered from the problem site to the stakeholders and landowners that way they can develop solutions to gain everyone's support.

Conclusion

From the cross section surveys, it was estimated that streambank erosion was happening along channels that lead into the Marion County Lake. The retreat rate was estimated to be 0.61 feet per year based on the comparison between the 2020 and 2018 data. Understanding where erosion is occurring and what is causing water quality issues can help lake managers create strategic plans and promote conservation practices to cut down on sedimentation and excess nutrients that jeopardize the natural resources. Natural resource managers constantly face decisions that impact public land and waters as these resources are sustained for the use of current and future generations. It is no easy task to take on

managing outdoor spaces and it can become even more complicated when surrounding uses of the land and water come into play. By involving stakeholders and landowners in the management process, these decisions become more supported, and the public feels more invested in the well-being of their natural resources. With a more invested public, conservation practices will be more accepted and understood why they should be implemented. A passionate stakeholder is a powerful resource management tool, and together, managers and stakeholders can sustain the useful and restorative qualities of nature. The Marion County Park and Lake Managers can use monitoring practices to research water quality issues and share this data with the stakeholders that these problems affect. This will create a harmonious basis for management collaboration and cooperation through surveying and outreach, providing a setting for an overall healthier environment through solutions like incentivised conservation practice implementation.

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