

A publication of the North American Lake Management Society

LAKELINE

Volume 37, No. 3 • Fall 2017



Recreation

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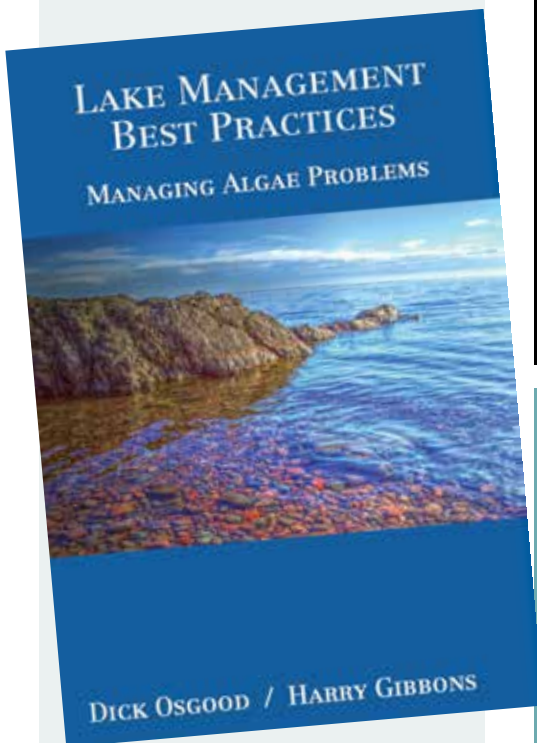
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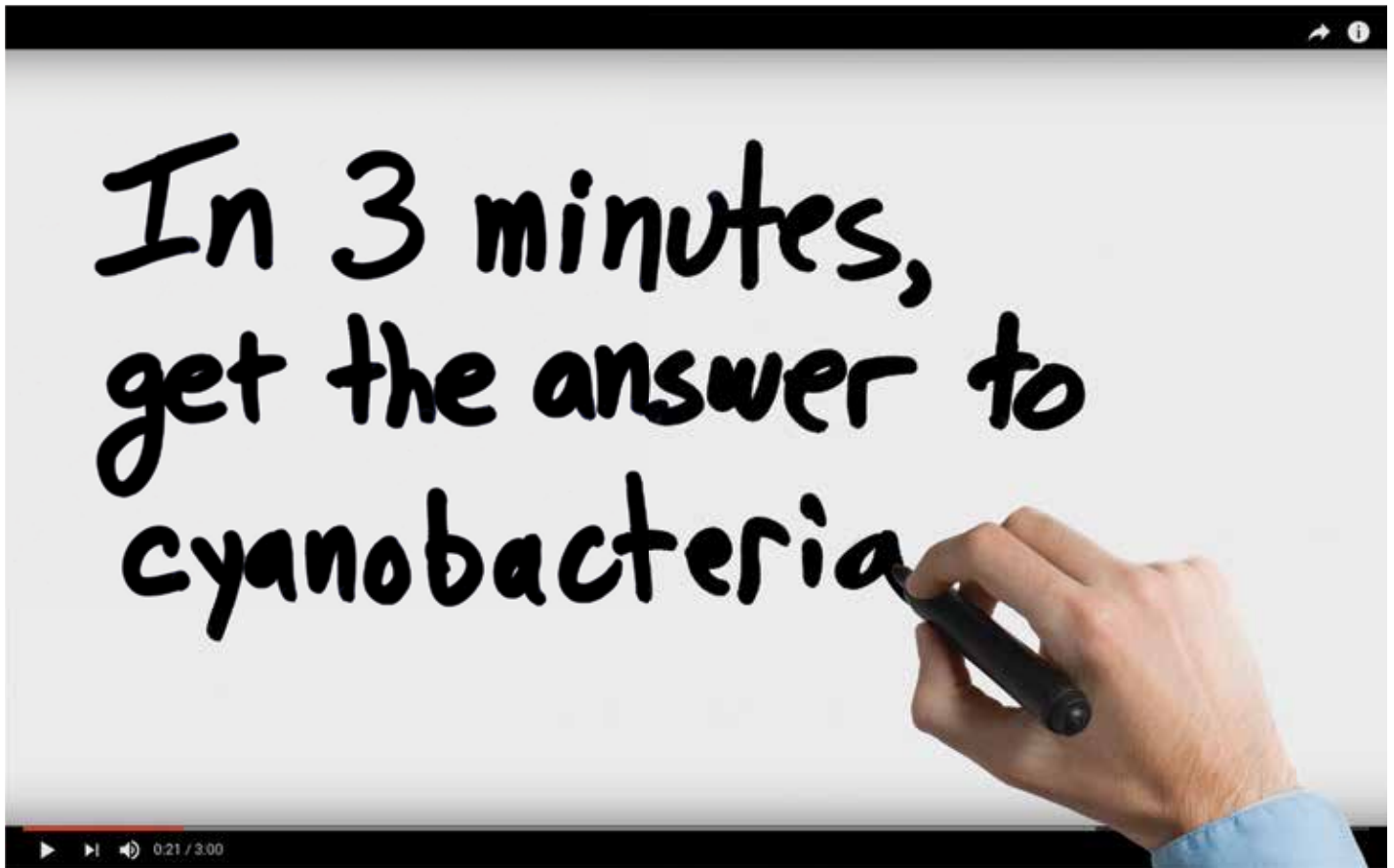
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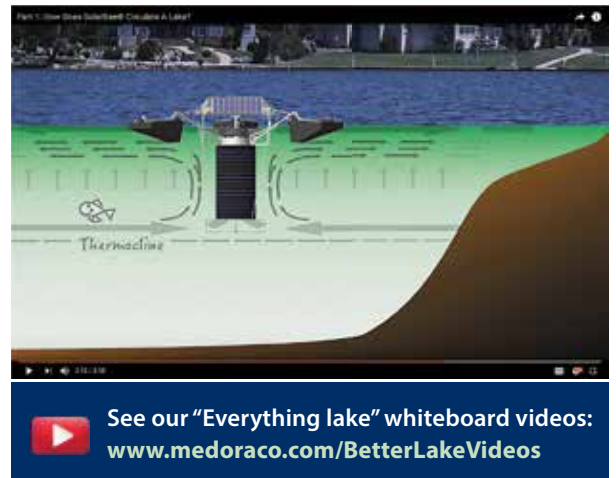
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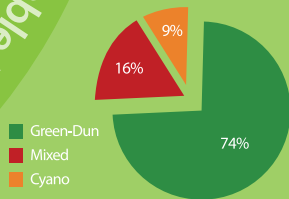
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Production: Parchment Farm Productions
Printed by: Metropolitan Printing Service Inc.

ISSN 0734-7978
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Lake Management Society
P.O. Box 5443 • Madison, WI 53705
(All changes of address should go here.)
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On the cover:

Lake Trout in northeast Minnesota.
Photographed by Jeff Spence and
submitted to the 2014 NALMS Photo
Contest.

From Bill Jones the Editor

We last covered water recreation, issues and management, in successive issues of *LakeLine*



(Vol. 24, Nos. 3 and 4) in 2004. In those issues, we discussed best boating practices to avoid conflicts, recreational carrying capacity, motorboat noise, physical impacts of boats on

lakes, personal watercraft management, competitive sport fishing, freshwater SCUBA and large floating objects (trampolines, rafts, slides). I've long thought of again having recreation as a *LakeLine* theme but what new topics are there? After talking with my friend and NALMS member, Lyn Crighton of Lake Tippecanoe in N. Indiana, I had the inspiration I was looking for. Lyn told me about the phenomena of wake boats, the high-horsepower, ballast-loaded, stern-heavy, plodding boats that create a supersized wake large enough to surf on. I had never heard of these watercraft. As I became informed during my research, I discovered yet more water recreational pursuits that can impact our aquatic environments.

For example, it is common for young male drivers to customize their cars with undercarriage colored LED lights that reflect off the road underneath the auto, casting an eerie glow upon the road. Much to my surprise, I've learned that people do a similar thing to customize their boats and piers (Figure 1)! I've even seen wake boats with powerful lights for nighttime wake surfing (Figure 2). I wonder what the fish and aquatic invertebrates make of this? Do these lights interfere with resting or diurnal activities of aquatic organisms? Have we gone too far with the impacts



Figure 1.



Figure 2.

of our toys and presence upon lakes? I'll leave it for you to decide after reading and pondering the articles in this issue.

From all indications, the demand for aquatic recreation continues to increase each year. The *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, is one of the oldest and most comprehensive continuing recreation surveys in the U.S., conducted every five years or so since 1955. The results from the 2011 survey show that the number of anglers increased 34 percent between 2006 and 2011, to 33.1 million participants. Freshwater anglers accounted for 27.5 million of this total, having fished for 443 million days on 354 million trips.

The *National Survey on Recreation and the Environment* (NSRE) is conducted every 10 years, and while I could only find published results for the 1999 – 2003 survey, the results are relevant and participation is likely higher today. Table 1 shows results for water-based recreation. Note that stand up paddle boarding isn't represented since it wasn't prevalent 15 years ago. This also illustrates how new water-based recreation activities have a cumulative effect as more people are drawn to water-based recreation by new activities.

With this as a preface, let's turn to this issue of *LakeLine*. We begin with an article by **Doug Keller** of the Indiana DNR that describes the features of wake boats, some of their impacts, and management actions to reduce those impacts. Next we hear from someone on the front lines dealing with wake boats. **Heather Harwood** of the Wawasee Area Conservancy Foundation discusses their approach to managing wake boats and their impacts on Indiana's largest lake through education and lakeshore BMPs. **Lisa Borre** then introduces us to another rather new water recreational trend – stand up paddleboards (SUP). She looks at three lakes in the Northeast and how they accommodate them...SUP yoga anyone?

Larry Butler and **Nicki Bellezza** work at the Reston Association, a 50-year old planned community in the Washington, D.C., area containing four lakes. At times, the lakes can't meet the demand for water recreation so they have policies to help avoid conflicts and to keep the water safe for all uses. In our last

Table 1. Percent and number of people 16 years and older in the U.S. participating in water-resource-based outdoor activities, 1999-2003.

ACTIVITY	Percent of Population 16 and over	Number in Millions
BOATING/FLOATING/SAILING		
Sailing	5.2	11.1
Canoeing	9.6	20.5
Kayaking	3.7	7.9
Rowing	4.3	9.2
Motor Boating	24.3	51.8
Water Skiing	8.0	17.1
Jet Skiing	9.5	20.3
Floating, Rafting	9.7	20.7
Sailboarding/Windsurfing	0.8	1.7
Surfing	1.7	3.6
FISHING		
Freshwater	29.1	62.0
Coldwater	13.3	28.3
Warmwater	22.4	47.7


recreation-themed article, **Sadie Dainko** and **Adam Phelps**, waterfowl biologists with the Indiana DNR, tell us the many ways that waterborne recreation can disturb waterfowl populations. Waterfowl nesting, rearing, feeding, and resting can all fall victim to water-based recreation.

In the "Student Corner," **Jack McLaren**, a graduate student at Indiana University's School of Public and Environmental Affairs, describes his research at Idaho's Island Park Reservoir. He studied how drought-induced water shortage can affect reservoir water temperatures and the temperature of waters released downstream. He offers several examples of creative management to mitigate the impacts.

Our NALMS President, **Frank Wilhelm**, is nearing the end of his one-year term. In his "From the President" column, he reflects on several of the many changes in our Society during 2017. He

also asks us to remember those in Texas, Louisiana, and other Gulf areas that have experienced the power of too much water due to Hurricane Harvey. Amen to that.

We conclude this issue, as usual, with "Literature Search." Enjoy!

William (Bill) Jones, is *LakeLine*'s editor and a former NALMS president, and clinical professor (retired) from Indiana University's School of Public and Environmental Affairs. He can be reached at: 1305 East Richland Drive, Bloomington, IN 47408; joneswi@indiana.edu. 

LakeLine encourages letters to the editor. Do you have a lake-related question? Or, have you read something in *LakeLine* that stimulates your interest? We'd love to hear from you via e-mail, telephone, or postal letter.

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To The Editor:

Kudos for last issue of *LakeLine* focusing on HABs. The issue contained helpful and timely articles on this critical issue. In their article, McCarthy et al. stated that reducing external nutrient loads was the “only way” to permanently break internal nutrient cycles and urged the use of best management practices (BMPs), especially in agricultural watersheds. I disagree.

I agree reducing nutrient loads to lakes is important. However, one can argue that accomplishing the needed nutrient reductions by relying on BMPs, as I have (Osgood in press), is inadequate.

The authors use edge-of-field buffers as an example claiming they intercept nutrients before they reach the lake, but do not quantify the reductions. While buffers and other BMPs most like reduce nutrients downstream, it is not clear the reductions are adequate in most cases. The application of BMPs (or any mitigation strategy) ought to occur following an assessment of the critical nutrient reduction required, and evaluate the feasibility and cost of all mitigation approaches – and not apply these uncritically.

We know (USEPA 2009; Oliver et al. 2017) that despite years of effort and billions in investment, there has been no change in the condition of the nation’s lakes. Furthermore, there are significant increases in the detection of microcystins and significant decreases in oligotrophic lakes between 2007 and 2012 (USEPA 2016; Stoddard et al. 2016). These trends are troubling in light of the fact that our predominant lake management paradigm relies on nonpoint source nutrient control using BMPs.

If HABs in lakes pose serious, immediate, and actionable problems, and if watershed BMPs are not adequate to address these problems, there are two logical approaches. We can adapt to these impacts, as Baulch et al. (2017) recommends or we can apply more effective, timely remedies (see Osgood

and Gibbons 2017 and the entire issue 33[2] *Lake and Reservoir Management*).

Waiting and adapting is impractical and possibly unethical, especially for what is being portrayed as a world-wide public health crisis. Lathrop and Carpenter (2013) found no significant nutrient reductions after four decades of BMP implementation and Rissman and Carpenter (2015) estimate a time lag of >250 years for Yahara Lakes (Madison, WI) to recover following watershed nutrient reductions.

There are feasible and effective nutrient mitigation strategies available, often lower costs compared to nonpoint source controls (see issue 33[2] *Lake and Reservoir Management* and numerous additional sources). Precipitants (most commonly alum) can be used to intercept incoming phosphorus, low doses can be applied as a maintenance action to strip phosphorus from the water or large doses can be applied to inactivate internal phosphorus cycling. Other precipitants (e.g., iron or lanthanum) or other chemical and engineering approaches have been used to accomplish critical nutrient reductions in lakes.

Some may be troubled by the prospect of adding materials or dodging the underlying causes in these remedies. However, it is time we recognize that intensive agricultural and urban land development is hard-wired into the landscape and relying on BMPs has been largely ineffectual. If HABs are serious enough to be actionable, there are management options at hand.

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Dick Osgood, CLM
Lake Advocates

From Frank Wilhelm the President

Where has the time gone? Bill's e-mail to extract this column from me was emphatic that the fall issue was my last one as president! You'll be hearing from Frank Browne next after he and I transition at the symposium in Denver. Please extend a warm welcome to him as he takes over the reins of NALMS.



As well, if you have not yet booked your pilgrimage to Denver, make sure you do, you don't want to miss the latest in lake management science and a chance to catch up with old friends and make new ones.

While this issue's theme is recreation related to water, recent delivery of it to parts of the Gulf States in astronomical quantities will prevent those individuals from enjoying it. Our thoughts are with them as they move through the challenges facing them.

I'll use this column to provide a recap of what has transpired during my time at the helm. There was a high expression for retirement or at least reduction of involvement in NALMS activities by key individuals, Jeff Schloss is seeking to step back from his heavy involvement in conference planning; this year also marks Al Sosiak's end of current editorship for *Lake and Reservoir Management*; and Bill Jones, our *LakeLine* Editor, is looking to undertake some longer travels that would prevent the timely production of *LakeLine*. All of these individuals have given selflessly to the well-being and smooth operation of their facet of NALMS. Please join me in thanking them for a job well-done (and by no means are we planning to let them go cold turkey).

Ken Wagner will be the next editor of *LRM* effective January 2018; he is no stranger to this position, having held it in the past when the journal transitioned to the electronic review system, and he has been an associate editor during Al's tenure. Al and Ken have worked out a plan to ensure a seamless transition for all involved including authors, reviewers, and associate editors.

For planning future conferences, we formed a planning committee led by board member George Antoniou and released a call for proposals. Those are being evaluated currently to identify a suitable individual or entity to lead our symposia. Depending on visions, financial needs, or restrictions, we may see some changes in our annual symposium. I encourage the membership to embrace whatever these may be. Jeff is still hard at work planning our 2018 symposium in Cincinnati, so the boat won't rock too much for a bit yet.

For Bill's replacement, the publications committee is also currently evaluating applicants received in response to our call for editor; we'll inform you of the selection as soon as it's made – keep an eye on NALMS Notes.

Speaking of NALMS Notes, due to some unforeseen changes in personnel in the "real world work life" of Terry McNabb, he has decided to reduce his involvement, and NALMS Notes will now be edited by office staff. Thank you for your efforts, Terry. If you have interesting stories or happenings in your area, please feel free to pass the material or articles on to Philip Forsberg for publication in the Notes.

As part of efforts to keep abreast of the rapid changes proposed at the federal level regarding aquatics and to make our voice heard, we joined CASS – the Consortium of Aquatic Science Societies.

Diane Lauritsen, our Region 4 director, has ably represented us. Some of the early involvement has been to comment on and alert members to the efforts to repeal and replace the Waters of the U.S. rule or WOTUS. Expect to hear more about how you can comment or get involved as future changes in the aquatics arena are considered in D.C.

We are already planning the annual Board of Director's meeting held ahead of the annual symposium in Denver to consider the future trajectory of NALMS. By the time you read this, elections will be open, please vote, as member participation makes for a strong society. As always, if you have any concerns, please let the board know, either through your regional director, or contact myself or Frank Browne directly. I thank you for the opportunity to be your president, and look forward to seeing many of you in Denver shortly.

Frank Wilhelm is an associate professor of limnology at the University of Idaho in Moscow, Idaho, where he teaches courses in limnology and in the introductory sequence of natural resources course. He has an active research program focused broadly on limnology including cyanobacteria, invasive species, nutrient cycling, and foodweb dynamics. He has been an active member of NALMS, having served on various committees and as Region 10 director previously. 🐼

Low-Speed Boating . . .

Managing the Wave

Doug Keller

Remember the old days when the “cool” boats were the ones that glided across the water at such high speeds that they seemed to barely touch the surface of the water? A low wake was what slalom skiers desired as they skipped from side to side behind the boat. Oh, how times have changed. Now boats that plod along at a low rate of speed, deeply plowing through the water, throwing a large wake for wakeboarding and surfing are all the rage. I like to term this type of boating as “low-speed boating” and it comes with its own set of concerns regarding the health of a body of water.

Today’s “wake boats” are designed to increase wave height. To accomplish this, the hull is shaped to achieve maximum wake and many have a hydrofoil device that lowers the stern when the boat is under power. Most wake boats also have built-in ballast tanks that can be filled with lake water to increase the weight in the back of the boat, causing more water to be displaced and larger waves created (Figure 1).

Problems with Increased Wake Height

As wave height increases, so do adverse effects that go along with waves. The larger the wave, the deeper it can churn sediment in the shallows of a lake. Larger waves also deliver more energy against the shoreline, exacerbating erosion of natural shorelines and islands. If the shoreline is a hard regular face like a concrete or sheet-pile seawall then the energy from waves is deflected back toward the center of the lake, which, again, disturbs sediment in the shallow areas of the lake.

Because of the shape of the boat and the means of lowering the stern of the boat through ballast placement or mechanical means, ultimately the



Figure 1. A typical, stern-heavy wake boat creates a large surferable wake. Photo from Pinsdaddy.

propeller is deeper in the water. This can result in direct contact of the propeller with the lake bottom. However, even if the prop does not contact the bottom directly, the turbulence from the propeller can reach as deep as 10 feet. In either scenario, the end result is disturbance to the bed of the lake.

Whether it is propeller-induced or the result of boat-induced wave action, sediment and nutrients can become re-suspended due to low-speed boating. After a weekend of heavy boating, lake residents have surely noticed that the lake is not as clear as it was right before the weekend because of the disturbance of the sediment. Depending on how fine the bottom sediments are, it can take 24 hours or more to return to the clarity it was prior to an intense boating period. Sediment

in suspension means nutrients like nitrogen and phosphorus have also been kicked-up. These nutrients in suspension are now available to interact with the biotic community in the water column. Often times these available nutrients fuel a planktonic algae bloom, which can contribute to additional water clarity problems. In the worst-case scenario, a harmful algae bloom can lead to water safety issues.

The deeper the propeller, the more chance there is to uproot or fragment aquatic vegetation. This can lead to the destruction of desirable native species, many of which do not reproduce via fragmentation. Invasive plant species, however, commonly use fragmentation as a means of propagation. Therefore, boats chopping up plants can facilitate the

proliferation of aquatic invasive plants, which can lead to their spread and crowd out native species.

Speaking of invasive species, the ballast tanks that assist in creating the large waves for surfing behind wake boats can facilitate the spread of detrimental species. Zebra mussel larvae, fish pathogens, or invasive plant fragments could be pumped into the ballast tanks. While the tanks would typically be de-watered when the boat is loaded on the trailer to go home, the tanks are never able to completely dry. Unwanted “hitchhikers” could remain viable in the tanks and could be expelled into the next lake that is visited.

Wake Boat BMPs

There are a number of best management practices (BMPs) that could be employed by low-speed boaters and lake residents to lessen the impacts from this style of boating. No one action can save a lake; rather, improved lake management could involve adopting many different practices.

The suspension of sediment and nutrients is arguably the greatest concern with wake boats because it can speed eutrophication of lakes. Boaters should consciously seek water 10 feet or deeper to operate wake boats since by design the propeller is much deeper underwater than boats that are not intentionally trying to create a large wake. While few if any wake boats are fitted with depth finders, there is other information available to guide recreational boaters toward deeper water. With today’s technology, it is much easier than before for state agencies or other entities to gather lake depth data and produce maps showing depth contours. Check with your state’s Natural Resources agency to see what lake maps may be available.

Another reason for wake boat operators to avoid shallow water is to minimize contact with aquatic vegetation. This will protect native vegetation from damage and will lessen the fragmentation and spread of invasive plant species. Vegetation fouling the propeller is certainly a nuisance to boaters and should cause wake boat operators to want to avoid these areas anyhow. For the sake of the health of the lake, the answer is not to perform more weed control in shallow

water; the solution is for boaters to move to deeper water to avoid plants.

When wake boat owners move from one body of water to another, the greatest risk is the movement of aquatic invasive species. All boaters, not just wake boaters, should adopt practices to stop the movement of aquatic hitchhikers. Simple steps such as draining water from all parts of the boat, removing aquatic vegetation from the boat and trailer, and drying or decontaminating all parts of the boat that came in contact with the water are reasonable procedures to reduce the likelihood of transporting unwanted organisms. Unfortunately, the drying and decontaminating step can be problematic when dealing with the enclosed ballast tanks of wake boats. Check with the boat manufacturer to determine a method to treat the ballast tanks before visiting a different body of water.

It is not simply incumbent on wake boat operators to lessen the negative impacts of higher waves created; lake residents also play a key role. Flat-faced, vertical, bulkhead seawalls deflect most of the wave and its energy back toward the center of the lake causing additional lakebed erosion and suspension of sediment and nutrients. Irregular or natural surfaces actually dissipate wave energy. Lakefront owners can greatly improve the health of a lake by installing

living, bioengineered shorelines that utilize native plant materials to protect shorelines. Other options providing some improvement over concrete or sheet-pile seawalls would include the installation of glacial stone seawalls or placing glacial stone on the face of a vertical seawall.

Another action shoreline owners can take is to maintain some submergent and emergent vegetation in the shallows of the lake. Aquatic vegetation does a remarkable job at dissipating waves, protecting shorelines, stabilizing sediment, and locking up nutrients. Low-speed, high-wake boating is the rage and certainly will continue. We just need to learn how to manage the wave all the way from the wake boat driver to the shoreline property owner in order to reduce the negative impacts of this boating style to protect our lakes.

Doug Keller is the Aquatic Habitat Program Manager with Indiana DNR – Division of Fish and Wildlife. In his 28-year career with the Division he has also had roles as a district fisheries biologist and the Aquatic Invasive Species Coordinator. 🐟



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Protecting Water Quality & Resuspension Caused by Wakeboard Boats

Heather Harwood

A Conservancy's View

As a lake area conservancy charged with protecting and maintaining good water quality, the Wawasee Area Conservancy Foundation (WACF) has installed pollution and erosion control projects for over 20 years. Projects include streambank stabilization, wetland restoration, sediment basins (allowing sediment to settle out), and agricultural projects keeping topsoil on the fields. With the help of willing landowners and many partners including the IDNR Lake and River Enhancement, the Elkhart River Restoration Association, and the Great Lakes Commission, we have kept over 40,000 tons of sediment out of lakes and streams in our watershed.


But with all that effort, sediment still gets into our lakes and streams, and over the years has accumulated. This bottom sediment is now our biggest challenge. These days, instead of thinking about projects upstream, we are thinking about the sediment already in the lake, thus the current focus: keeping sediment out of the water COLUMN. Stirring up sediment clouds turbidity and releases phosphorus from the lake bed. Our goal: to leave that sediment alone as much as possible.

Responsible Boating Campaigns

The first line of defense on stirring: *responsible boating*. Being aware of the shallow areas, and staying in deep areas while wake boarding and surfing. This has a huge impact on slowing resuspension in the lake, helping turbidity, and keeping algae blooms down. Included in Figure 1 are examples of our efforts to spread the word at local marinas and public launch ramps.

Wawasee, Indiana's largest natural lake (3,060 acres) has large shallow areas

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- **DON'T USE IT!**
- Seaweed uses phosphorus to grow.
- Tell your local supplier or lawn care provider that you only want zero phosphorus fertilizer.
- Once released into the lake it stays in the sediment.

PRESERVE OUR LAKE BOTTOM

- Stirring lake bottom suspends the phosphorus.
- Accelerating in shallow water creates sediment plumes.
- Shallow water is highlighted above in blue.
- Wakeboard and surf in deeper water (you will have a larger wake anyway).
- Begin pulling skiers and tubers in deep water.

DIMINISH WAVE ACTION

- Consider Glacial Rock in front of your seawall.



PLEASE RESPECT BUOYS AND PROTECTED AREAS

Figure 1. WACF's signs and refrigerator magnets stressing the importance of avoiding stirring the lake bottom (and including a bathymetric on the magnet).

susceptible to stirring. Up to half of the lake's surface area is less than 10 feet deep. We encourage deep draft boats to stay in the deep areas for wake boarding and surfing (Figure 2). Our campaign: "Be Wake Cool" (Figure 3).

Under Indiana law, a person may not operate a motorboat at a speed greater than 10 mph on a lake having less than 300 surface acres. This law is intended to provide safe boating speeds on small lakes and to protect small lakes from excessive boat wakes. However, since wakeboats operate at less than 10 mph, these small lakes will not be protected from excessive wakes or the lake bottom scouring and shoreline erosion that can occur.

We absolutely do not discourage boating on Lake Wawasee – but we do encourage *smart boating*. By publishing the bathymetric maps regularly (Figure 4) and providing these maps as reminders, we hope to continue to have an impact on boating awareness. Our long-term goal is to add a boating education center on site at our Lake & Watershed Education Center.

Deep drafting ballast boats are more and more common on Lake Wawasee and



Figure 3. "Be Wake Cool" campaign sign.

other Indiana lakes. Directing boats to the best places to wake board and surf in the lake will be key to protection of the bottom. Damage has already occurred. Prop scarring of the lake bottom is visible in aerial images (Figure 5).

Regulated Ecozones

Another tool WACF has used to encourage smart boating is the establishment of ecozones. Ecozones were established by the State of Indiana in 2000 to protect significant ecological areas within lakes where the use of



Figure 2. Typical surfing wave.

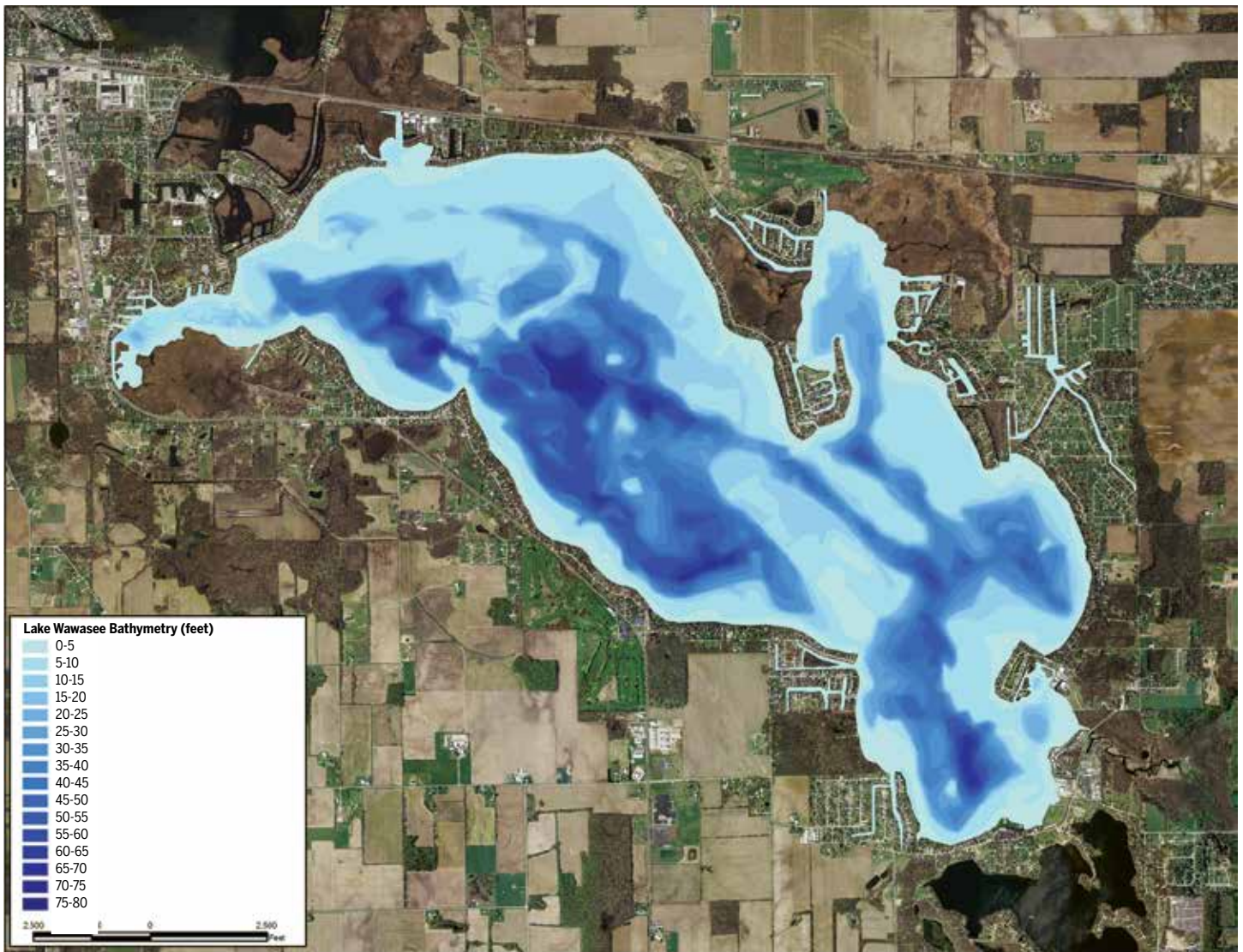


Figure 4. Wawasee's bathymetric map.

watercraft may be limited or prohibited for fish, wildlife, or botanical resource management, or for the protection of users. Wawasee was the first lake in Indiana to establish ecozones. In four areas where perimeter wetlands are contiguous, WACF has special designated and regulated ecozones defined by white "Idle Only" buoys (Figure 6). These wetlands are vital to the health of our lake and a healthy sustainable fishery. These buoys are installed and removed by volunteers in the spring and the fall of each year.

As we gain more experience with wake boats, we will continue to examine and identify more options to relieve the pressure from deep drafting ballast boats and the waves they create. The WACF is committed to working together with recreational lake users and encouraging

good lake stewardship. WACF completed a Carrying Capacity Study in 2004 to measure the magnitude of effect from motor boating activity. Dudiack (2004) suggested that a conservative estimate of a lakes' motor boat carrying capacity is around 15-20 acres of usable lake area per boat. On most given days, that is easy to meet. But on a busy weekend, Lake Wawasee can become over-crowded, resulting in some of these wave action and bottom scarring stresses on the lake.

Healthy Shorelines

Wake boarding and surfing create larger waves that, as a result, create a greater demand for shoreline protection and seawalls. WACF encourages natural shorelines and glacial stone seawalls to help break up the wave action. With every permit application for concrete

seawalls around the lake, WACF contacts the applicant and explains advantages of stone seawalls and sends out our "Stop the Chop" brochure on the advantages of glacial stone to absorb the wave action. Glacial stone can absorb wave action better than concrete seawalls, improving swimming areas and back wash that scrubs the bottom of the lake.

So – "Stop the Chop" and "Be Wake Cool"!

Heather Harwood,

ASLA, is a landscape architect and has been executive director of the Wawasee Area Conservation Foundation for 20 years. 🌿



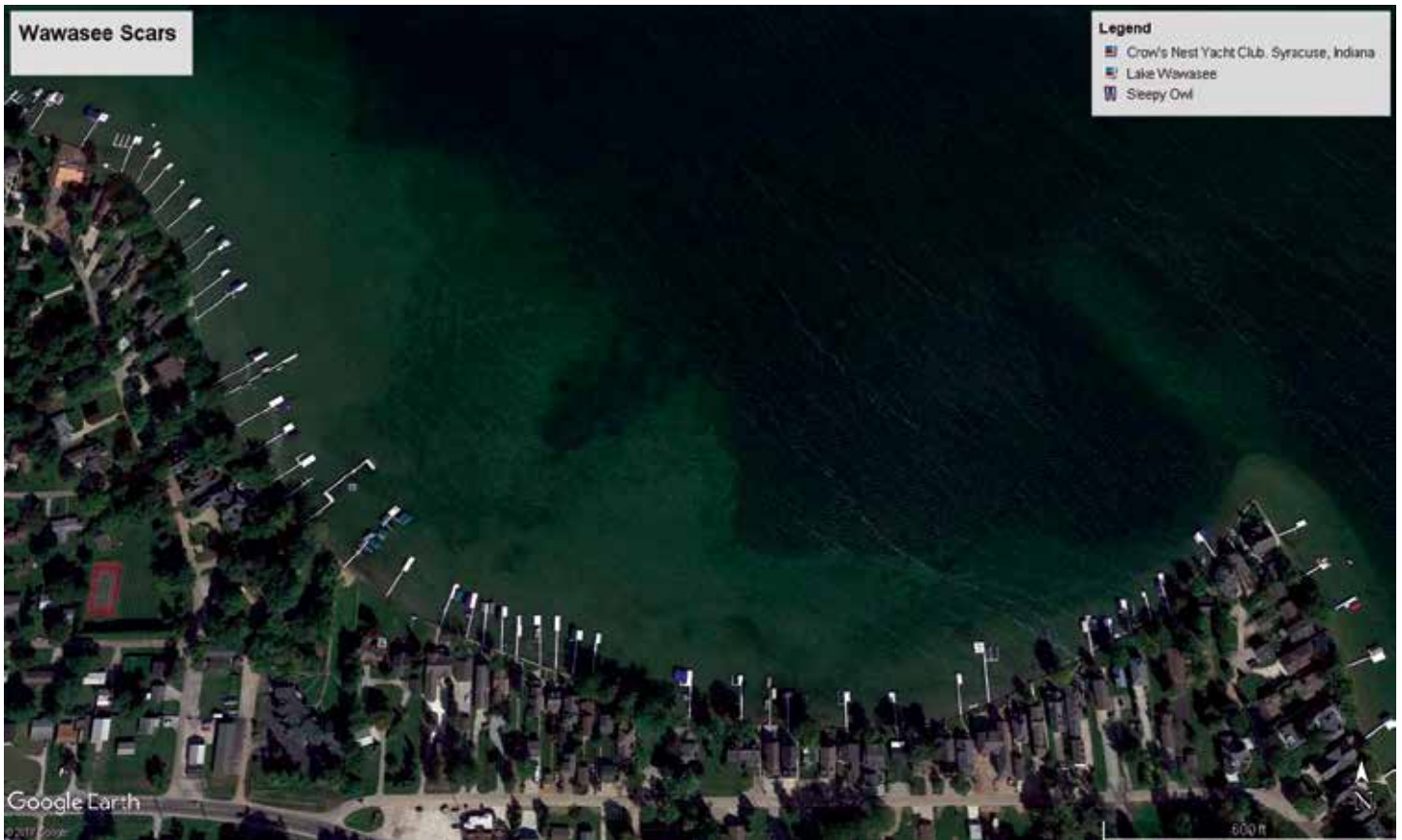


Figure 5. Propeller scarring on the bottom of Lake Wawasee are seen as thin, straight lines.



Figure 6. Eco-Zone buoy.

What'SUP with Lake Recreation in the Mid-Atlantic Region?

Lisa Borre

Stand up paddle boarding growing in popularity

When a call went out for articles on the recreation theme for this issue of *LakeLine*, the responses from NALMS Region 3 highlighted the many ways we recreate on lakes and some of the challenges lake managers face. Lake recreation in the mid-Atlantic region of the U.S. ranges from reservoirs managed for drinking water where recreational use is banned or restricted, to private lakes where paddle sports reign, to popular resorts where recreational use and user conflicts abound on busy summer weekends.

Many lakes in the region are man-made and face problems associated with sediment and contaminant accumulation. The threat of aquatic invasive species (AIS), an abundance of submerged aquatic vegetation (SAV), algal blooms, beach closures and other water quality concerns further impair recreational use and enjoyment. Climate change exacerbates some of these problems and further complicates lake restoration and management efforts, as described in a previous *LakeLine* article (Vol. 36, No. 2, Summer 2016). Despite these concerns, lake recreation continues to thrive.

Of the trends in lake recreation in our region, one stands out: stand up paddle boarding, or SUP. It has become one of the fastest growing non-traditional sports on land or water (*SUP Magazine* 2016). This article explores why the act of standing on a long board and using a paddle to move through the water is growing in popularity and what the trend means for lake recreation and management by examining case studies in three locations: (1) Lake Wallenpaupack, PA, (2) Reston Lakes, VA, and (3) Spa Creek in Annapolis, MD, a relevant

example from the author's hometown on the Chesapeake Bay.

Lake Wallenpaupack, Pennsylvania

Lake Wallenpaupack, located in the heart of the Pocono Mountains' lake region, is a popular recreation destination for boating, fishing, swimming, snowmobiling, and other activities. With 52 miles of shoreline and an overall length of 13 miles, Lake Wallenpaupack boasts 5,700 acres of open water, making it the third-largest lake in Pennsylvania.

Lake Wallenpaupack is within a day's drive of many major metropolitan areas, making it a prime vacation destination for millions of inhabitants of the Mid-Atlantic States (LWWMD 2017).

Maggie Lehrian, owner of Roots Yoga Studio in Hawley, PA (<http://rootsyogahawley.com>), teaches SUP yoga classes twice a week during the summer on Lake Wallenpaupack, one in the evening near sunset and the other on Saturday mornings (Figure 1). She also hosts SUP yoga group sessions and private parties, including bachelorette parties. Limited by the number of boards



Figure 1. SUP yoga classes on Lake Wallenpaupack, PA. Photo courtesy of Maggie Lehrian, Roots Yoga.

available to her at a local marina, her classes typically have three to seven people. “Everyone who tries SUP yoga loves it,” said Lehrian.

Lehrian first heard of paddle boarding in 2012 while on honeymoon in Rehoboth Beach, a popular beach resort on the Delaware shore. She got the idea for SUP yoga when someone requested that she offer a class. She had been involved with yoga for a long-time – it’s her life’s passion – and grew up on the water at a smaller lake near Wallenpaupack. “It was a perfect fit for me,” she said, “so I reached out to others in the yoga community to learn more about it.” Lehrian ended up organizing a SUP yoga teacher’s training on Lake Wallenpaupack, put on by Bliss Paddle Yoga (<http://blisspaddleyoga.com/teacher-training/>), a company based in California that offers teacher training around the country and sells their own line of paddleboards specifically designed for SUP yoga. About 15 other teachers attended.

“Practicing on the water takes yoga to another level,” she explained. “Balancing on a paddleboard forces your body and mind to be connected. It forces you to be in the present moment without distractions like text messages or dinner plans.” This reinforces the principles of what she teaches in her yoga practice. People don’t realize how much exercise they get while practicing SUP yoga, Lehrian says. Some of her students are nervous at first about trying yoga on the water. “Paddleboards are more stable than you might think. Very rarely do people fall in.”

Other than a lake-use permit Lehrian needed for the teacher training session, there are no restrictions for SUP yoga on the lake. For her classes, she prefers quiet water and uses a cove in the marina, but she says paddle boarding is not restricted to calm water. So far they have had no complaints from other recreational users, but occasionally they need to move to allow a boat to get in or out of its slip in the marina. With paddle boarding becoming more popular, the Lake Wallenpaupack Watershed Management District (LWWMD) informally advises paddlers to avoid busy weekends.

Reston Lakes, Virginia

Reston Association (RA) is a not-for-profit corporation that serves a community

of about 60,000 people in Reston, VA and is one of the largest community associations in the United States (www.reston.org). Reston’s four human-made lakes (Lake Anne, Lake Thoreau, Lake Audubon, and Lake Newport) cover 125 acres and provide recreation and storm-water management for the community. Swimming and ice skating are not permitted, but fishing, boating, wildlife watching, and lakeside picnicking, and walking on the pathways near the lakes are available to RA members and their guests (Reston Association 2017).

The types of recreational uses on Reston’s lakes are more limited than the other examples in this article, and the lakes themselves are privately managed in accordance with a community management plan. The Association restricts gas motors and only allows electric motors no more than three horsepower, eliminating most of the user conflicts and recreation management challenges experienced on other lakes. RA works in partnership with Surf Reston (<https://www.surfreston.com>), a local business that offers SUP sessions guided

by certified instructors, including special sessions for SUP yoga, yoga acrobatics, parties, whitewater, and race training. Surf Reston maintains insurance and requirements to RA’s specifications and contributes 10 percent of their revenue to the association every year. In addition, Surf Reston supports the annual Lake Cleanup, the Lake Swim and Reston Triathlon with paddleboards for the lifesaving team (Figure 2).

Surf Reston is a part-time endeavor for Steve Gurney, who is also publisher/founder of *Retirement Living Sourcebook* magazine and an adjunct professor at University of Maryland Baltimore County (UMBC) School of Aging Studies. Gurney was introduced to paddle boarding by Surf Reston founder Chris Higgins, who worked with him on weekends as a snowboard instructor at Liberty Mountain Resort. Gurney was “hooked” and took over the business after Higgins was relocated due to his full-time job.

“I love being outside and introducing a healthy activity to Reston residents,” said Gurney. “Paddle boarding is not difficult, but like all sports there are



Figure 2. Surf Reston supplies paddleboards for volunteers to participate in the Reston Association’s Annual Lake Cleanup. Photo courtesy of Surf Reston.

some key fundamentals that can make it safer and more enjoyable. I am proud that everyone who paddles with us has gone through our introduction to the sport, which provides a good overview of safety, equipment, and technique. We feel like we are building a community of responsible paddlers.” After leading most of the on water sessions in the first few years, the Surf Reston team has grown to nearly a dozen certified instructors, most of whom are current or former RA lifeguards or Reston swim team coaches. Gurney is particularly proud of Sabrina Grove, one of their instructors who recently entered her first paddleboard race and won first place overall, beating all the men, too.

From June to August, about 10 paddlers participate in several sessions per day on Saturdays and Sundays (Figure 3). Every Thursday night there is a concert at Lake Anne, so a group paddles down and listens to the music on the water. Paddle boarding in Reston is intentionally not a full-time operation to avoid interfering with other ways of enjoying the lakes and balance commercial usage. “Paddle boarding is great for family and friends to enjoy a healthy activity and experience Reston’s lakes from a new perspective,” said Gurney.

Spa Creek, Annapolis, MD

Annapolis is the center of Maryland’s recreational boating scene and has long been known as “America’s Sailing Capital.” Maryland’s capital city and home to the U.S. Naval Academy sits on the shores of the Severn River and four creeks, including Spa Creek, Back Creek, College Creek, and Weems Creek, all tributaries of the Chesapeake Bay. In the midst of its rich maritime history and yachting culture, stand up paddle boarding is growing in popularity, with entrepreneurs like Brian Meyer and Kevin Haigis of Capital SUP (<http://capitalsup.com>) leading the way.

Operating from a marina on Spa Creek, just across the bridge from historic downtown Annapolis, Capital SUP offers rentals, lessons, guided tours, special events, corporate wellness, race training, and SUP yoga (Figure 4). As fitness enthusiasts, their vision is to create a “gym on the water experience” and share their passion for SUP, the outdoors



Figure 3. Paddle boarding on Lake Anne, one of the Reston Lakes in VA. Photo courtesy of Surf Reston.



Figure 4. SUP yoga class led by Capital SUP on Spa Creek, Annapolis, MD. Photo courtesy of Capital SUP.

and a healthy lifestyle. They opened the business in 2014 and have experienced steady growth from 3,000 people on the water in their first year to 8,000 in 2016. On a busy day, they will get 50-100 people on paddleboards. From a business standpoint, Meyer sees great opportunity for continued growth. In addition to his own business, he noted several other area SUP businesses and 12-15 SUP races in the Delmarva (DE-MD-VA) region alone. There is even talk of SUP racing becoming an Olympic sport in 2028.

Capital SUP is going “full throttle” to get as many people on the water as they can by offering a range of SUP classes and events, including dance class, yappy hour for people and their dogs, and SUP yoga. They organized events to watch the 4th of July fireworks (Figure 5) and 70 people joined them on the water to watch the solar eclipse in August.

Meyer grew up in Salisbury, MD and was introduced to paddle boarding while at college in Hawaii. He is a surfer who also took up outrigger paddling. He got into SUP racing, becoming a professional

racer and traveling the world. It’s a great “total body” work-out, even at a leisurely pace, he noted. Meyer no longer races professionally, but paddle boarding remains the main part of his fitness program. “I’m in the best shape of my life,” he said. In addition to SUP racing, yoga, surfing, and whitewater, a new trend in the sport is SUP foiling, paddling downwind on hydrofoil boards.

With the growing popularity of SUP on the busy waterways in Annapolis, Capital SUP business partners have heard some complaints about their programs causing congestion on Spa Creek, a designated no-wake zone. They are committed to educating customers about safety and rules of the waterway, says Haigis, who also points out that anyone could go out on the water without any briefing at all. They run classes outside of the main channel and feel that paddlers may be getting unfairly singled out by shoreline property owners and boaters who would prefer to keep others from using the public waterway. Meyer has started to attend city meetings when

waterway issues are being discussed to make sure that SUP interests have a voice in any decisions that affect their business.

Capital SUP’s business model is to open locations in urban areas. Last year they expanded to a new location in Washington, D.C., and they have plans to open another location in Baltimore, in 2019. Their main target audience is a younger generation that enjoys the outdoors, but programs are offered for all ages, including race training for ages 13 to 60-plus. They are also targeting people who otherwise might not have opportunities to get out on the water. In the Chesapeake Bay region, access to the water is limited for people who don’t own waterfront homes, live in water-privileged communities, or own their own boat.

Haigis, who is from Annapolis and serves on the board of the Spa Creek Conservancy, sees another opportunity. “It creates more access to the water and a deeper connection with the environment when people get out on a paddle board or kayak,” he said. Meyer added, “Once you create communities of paddling



Figure 5. Paddling event to see the Fourth of July fireworks in Annapolis, MD. Photo courtesy of Capital SUP.

enthusiasts, you have a group of people who are more likely to become clean water advocates and volunteer to protect the waterbodies they enjoy.” At a recent trash pick-up event at their D.C. location, volunteers collected 34 bags of trash.

Because of the potential for paddlers to fall in the water, Haigis asked local officials, “Is it safe to swim?” He found out that no one could really answer the question and started a weekly monitoring program for the creek. As a result, they don’t allow paddling for 48 hours after a rainstorm (and 72 hours after rain in DC) due to high bacteria levels. “Although we lose out on a little bit of business, safety comes first,” he said.

Summary

Both high-speed water sports such as wake surfing and quieter activities such as paddle boarding are reported to be on the rise in the Mid-Atlantic region. While there is a hint that these trends may create the potential for recreational user conflicts on some lakes, the growing popularity of SUP activities is widespread. The sport has the potential to increase access to water-based recreation in ways that are low impact to the environment and provide fitness and wellness benefits for SUP enthusiasts. Paddle boarding also has the potential to get a younger generation and people who might not otherwise have access to water sports out enjoying the water, and in the process, becoming more aware of water quality and other environmental issues. Business owners

and watershed groups are finding that SUP enthusiasts gain more awareness about the waterbodies they enjoy and are also more likely to volunteer for water clean-up programs. Stand up paddle boarding has experienced a growth trend in the water sports industry, and in the case studies examined for this article, lake and watershed management programs welcome the trend.

Acknowledgments

Thanks to Maggie Lehrian of Roots Yoga, Brian Meyer and Kevin Haigis of Capital SUP, and Steve Gurney of Surf Reston for sharing their experience and for providing photos. Thanks also to NALMS members Nick Spinelli and Nicki Bellezza for contributing information about lake management on Lakes Wallenpaupack and Reston Lakes, respectively, and providing contact information for SUP enthusiasts in NALMS Region 3. The author wishes to acknowledge Mark Lewandowski (MD DNR), Barbara Beelar (Friends of Deep Creek Lake), Bob Hoffman (Property Owners Association of Deep Creek Lake) and David Rosenthal (Virginia Lakes and Watersheds Association) for sharing perspectives about lake recreation in the region. Although a case study about Deep Creek Lake, MD was not included in this article, plans are underway to share lake management experience from this recreational treasure in a future issue of *LakeLine*.

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Lakes on the Urban Fringe: Recreation Challenges in a Growing Community

Larry Butler and Nicki Bellezza

As more and more people move back to the nation's revitalizing and walkable cities, many communities on the peripheries of those cities are also seeing their own renewals. One of those communities is Reston, Virginia, a more than 50-year-old planned community 23 miles west of Washington, D.C. With the opening of the Silver Line, part of the DC Metro area's rail system, Reston, and Tysons to its east, has seen a huge boom in development interest. Soon, many new residents will call Reston home.

Most of this development will be in the rail corridor, leaving the bulk of Reston's nearly 12-square miles close to its original planned design, including its extensive open space and park system with lakes and ponds, recreational facilities and miles of trails connecting all parts of the community. It is no secret in the DC Metro area that places like Reston, located on the urban fringe and becoming more urban, are attractive places to live, work, and play. It is the play part that gives Reston Association (RA), the community service organization that owns and operates the extensive recreation and natural resource system in the community, the biggest challenges as the community enters its second half-century.

Reston is home to four lakes: Anne, Thoreau, Audubon, and Newport, ranging in size from 12.5 to 45 acres. These multi-use impoundments serve as stormwater management facilities, backdrops for expensive real estate, fish and wildlife habitat, and, most importantly, a water-based playground for Reston's residents and their guests. Also, let us not forget the many non-residents who ply their trespassing trade under the guise of being actual residents!

On the Water

As one might expect, the most popular lake-based recreation activity is boating. Not unlike most planned communities, RA has governing documents that outline its covenants, conditions and restrictions (CCRs), and one of the oldest continuous restrictions is an 18-foot length limit on boats, along with no gasoline motors. What is amazing is how frequently these restrictions are ignored, thus setting up a sometimes old western movie-style showdown between an owner and the covenants or legal committee of the association. Just this summer a resident challenged the 18-foot covenant on the hope that a Board of

Director's vote would permit the owner to keep it on the lake. Fortunately, the Board agreed with the Covenants Committee and the owner will now have to shorten the boat or remove it from the lake.

Over the past few years the RA Board of Directors, the governing body for the association, has passed resolutions permitting interpretations on the types of vessels that may be used on the lakes, including sailboards and most recently, stand-up paddleboards, or SUPs, covered in great detail elsewhere in this issue of *LakeLine*. RA utilizes a contractor to teach SUP lessons as well as provide some revenue back to the association (Figure 1). This is a similar set-up to



Figure 1. SUP yoga has been a popular addition to recreational opportunities at the Reston Association. Photo by Jim Kirby, used with permission.

the canoe and kayak instruction that has been operating for several years on Reston's lakes. This is an opportunity for residents who do not live on or near a lake to enjoy the benefit of the resource they help maintain through their annual assessments. As this article was being written RA received its first complaint about SUPs and the paddlers' apparent disregard for the difficulty in stopping a pontoon boat headed in their general direction (Figure 2)!

In the Water

One of the difficulties RA has is the lack of open water in the DC Metro area for water-based recreation. Most lakes are private, or in the case of the few public lakes, are inconvenient to be used casually or on the spur of a moment especially in northern Virginia's notoriously bad traffic. Local park organizations have lake access points for fishing on lakes and local tributaries to the Potomac River but none are close to Reston. The mighty Potomac River is nearby, with two reasonably close access points, but the size, current and relatively frequent high water makes it less attractive to the more timid recreation seekers.

While on the subject of open water, swimming by both residents and non-residents is a constant problem. As a not-for-profit corporation, RA is in the private insurance market and does not allow swimming except for three Board of Directors-approved events



Figure 2. Occasionally there has been congestion on the waters. Photo by Jim Kirby, used with permission.



Figure 3. Participants eagerly begin one of Reston Association's sanctioned swimming events. Photo by Jim Kirby, used with permission.

(Figure 3). Unlike most municipalities, RA is not covered by a sovereign immunity statute, and while those statutes are not fool-proof it is one means of defense not afforded to private entities.

The three swimming events include a Polar Dip held in February, the Reston Triathlon, one of, if not the, oldest triathlon in the Commonwealth, and one of the oldest annual open water

swim competitions in the state, the Jim McDonnell Lake Swim (JMLS). These have been conducted each year for 33 and 29 years respectively (Figures 3 and 4). Outside of a clinic held before each of the marquee events, no open water swimming is permitted. This is one of the most frequent requests RA receives each year as triathletes and swimmers who want to hone their skills only have a single venue on the Potomac River to practice. Given this fact it is easy to see why so many trespass onto Reston's lakes to swim under the stealth of near darkness and when association staff is less likely to confront them!

E coli testing is done before the two swimming events per the requirements of the sanctioning organizations, and two times the swim portion of the Reston Triathlon has been canceled due to poor water quality and debris in the lake. On one occasion the JMLS was moved to another lake due to poor water conditions.

From the Water

While on the subject of organisms in the water, no article on lake-based recreation would be complete without discussing fishing! Ahh... fishermen! Both authors are fisher-people and yet some of the most mean-spirited conversations we have encountered have been with other anglers. Whether the timing of a dredging project, the use of aquatic herbicides for invasive aquatic plant control, or kicking them off one of the lakes for not being a Reston resident, a season rarely goes by without a good tongue-lashing. Lake access is the *single* recreation access privilege of Reston membership that cannot currently be bought into, as is the case with non-resident pool and tennis court access or program participation (Figure 5).



Figure 4. Swimmers cross open water under the watchful eye of a paddle boarder. Photo by Jim Kirby, used with permission.



Figure 5. Fishing is a recreational opportunity provided to RA residents only. Photo by Jim Kirby, used with permission.

Part of the reason for this is the expense of maintaining these facilities – whether dam maintenance, dredging, water quality monitoring, aquatic plant control, shoreline stabilization, and litter pick-up etc. – all supported by the annual assessment. Will it be this way in the future as more people living close to Reston’s lakes increase these pressures to open access up to non-residents? What might be their willingness to pay for such privilege? This is a policy discussion that would ultimately be decided by the Board of Directors and no doubt greatly influenced by the voices of many lakefront and lakeside owners.

The attraction to water is summed up well in this quote by Michael Faraday, where he states “Water is to me, I confess, a phenomenon which continually awakens new feelings of wonder as often as I view it.” Reston’s lakes are just such an attraction, and with many more people realizing the accessibility to their shorelines, and though sometimes not legally, to their surfaces, Reston’s

lakes will continue to be a management challenge into the future (Figure 6).

These challenges are certainly not unique to Reston. In those areas where large bodies of water with multiple public access points exist, the pressures may be less. One measure might be the lake surface area to population ratio. In Reston there are approximately 62,000 residents and 125 acres of accessible surface waters, or 480 people per acre. As the population grows, so too will the pressures on these community resources.

Larry Butler is the senior director for parks, recreation, and community resources at Reston Association (RA). He has a master’s degree in urban and environmental planning from the University of Virginia and a bachelor’s degree in wildlife management from West Virginia University. He



has held various positions at RA over the past 35 years and is a NALMS past president and Region 3 director.


Nicki Bellezza is RA’s watershed manager, a position she has held for 11 years. She has a master’s degree in environmental science and management from Duquesne University and is responsible for monitoring, managing and maintaining Reston Association’s lakes, ponds, and streams. She is a past NALMS Region 3 director. 



Figure 6. The attraction of RA’s lakes will require continued vigilance by recreational managers. Photo by Jim Kirby, used with permission.

Recreational Boating and Waterfowl

Sadie Dainko and Adam Phelps

Changes in season bring people outdoors for a variety of recreational activities. On our lakes, spring and summer invite fishing and boating. However, something many people might not consider while cruising around the lake is the disturbance caused by boating to wildlife, particularly waterfowl. Waterfowl and other water-dependent birds are breeding during spring and raising broods during summer. For water-based recreation, people rely on the same habitats that waterfowl require

for these critical stages of their life cycle. This can cause disturbance to the birds from which they may have difficulty recovering.

Most waterfowl species can suffer negative impacts from water-borne recreation, but some species are more sensitive to disturbance than others. Canvasbacks have been found to flush from boats passing 300 yards away, whereas other species, such as American coots, may be relatively unaffected by the presence of boats and anglers (Figure 1).

Wildlife managers are not immune to these concerns. The Stillwater – North Fork Waterfowl Resting Area, adjacent to Lake Monroe in Bloomington, Indiana, is managed for a variety of wildlife, primarily waterfowl. Many sections of the property are closed off throughout fall and winter (during waterfowl migration) to decrease disturbance to the birds during this critical time. During the spring and summer months, these areas are open for boating, camping, hiking, and other recreational activities. We band wood



Figure 1. Diver ducks depicted above (Lesser scaup pair on the left, redhead pair on the right) are typically more vulnerable to human and boating disturbance. Since this group is typically only seen in large numbers during migration, their stopover is critical to refuel along the way. Disruption in feeding or resting during this time could obstruct their energy requirements to make this long journey. Photo credit: Joe Bailey.

ducks in summer in this area, and spend a lot of time moving through their habitats, both in boats and on foot. We have flushed wood ducks several times while kayaking or walking. One evening around dusk we flushed a family of wood ducks out of a patch of button bush, forcing them to seek new shelter as it was getting dark. We had seen raccoons in the area, and heard coyotes, leading us to wonder whether we had driven the ducks out of cover and into becoming an evening snack.

Disturbances caused by boating and other water-based recreation to waterfowl can take many forms. Simply the sight of a boat or person can be enough to drive a bird off in some cases, and adding the sound of a gasoline engine may multiply that effect. Mud motors, which are essentially the four-wheel drive of motor boats, in particular can be very destructive to habitat (vegetation as well as substrate).

These engines are designed for easy access through less navigable wetlands and to withstand heavy vegetation, fallen logs and debris, rocks, and mud. Birds may even be directly harmed by boat-related causes, especially litter, like discarded fishing line.

A primary consequence of disturbance is the interruption of feeding. A bird frequently pushed away from its nest may not return, or its eggs may be exposed to excessive chilling or predation. In addition, flushing birds increases flight time, which frequently leads to decreased feeding time. Reduced feeding time results in lower caloric intake, which may reduce energy reserves available to help birds through periods of harsh weather. Waterfowl try to maximize feeding time while minimizing flight time, particularly during migration, so they can store fat reserves for their long journey. However,

when disturbed from a feeding area, birds may be forced to flee and abandon the feeding opportunity, thus using energy that would have been better stored as fat (Figure 2). Birds can also be forced into less-suitable habitat, depending on the frequency and location of disturbance, which can cause energy deficits and increase chances of predation.

A study in Great Britain showed that one species of goose spent about one percent of their time flying on a typical day, but during the weekends (when recreation activity was highest), time spent in flight could increase up to seven times. Feeding was prevented nearly 12 percent of the time during the weekends. A study in the Upper Mississippi River calculated an average of 17 boats passed through the study site every day, causing 5.2 disturbances per day, each of which resulted in a minimum four minutes of



Figure 2. Wood ducks are among the most sensitive to disturbance. When spooked, they tend to let out a shrill cry, usually causing others nearby to flee with them. I've flushed wood ducks from about as far as 100 meters and they tend to not come back for hours. With enough disturbance, they would stop coming back to certain areas all together (or in fewer numbers) because it's not worth the energy loss. Photo credit: Joe Bailey.

additional flight time. In the same study, feeding areas were limited due to boating, which caused 90 percent of the waterfowl population to concentrate on 28 percent of the study area (Korschgen and Dahlgren 1992). As few as two disturbances per hour can cause energy deficits that cannot be made up (Belanger and Bedard 1990).

In most areas, the peak of recreational boating does not occur at the same time as the bulk of migration. However, the boating peak does coincide with egg incubation, hatch, and brood-rearing. Considering the energy required for chicks to fledge, it is apparent that recreation-related disturbances can have a major impact on the survival of juvenile birds. In addition to energetic concerns, one study showed predation on ducklings by gulls increased 200-300 percent with an increase in boat activity in the area (Ahlund and Gotmark 1989). The severity of disturbance is variable and is dependent on the type of species, flock size, frequency of disturbance, and type of disturbance (Figure 3). Larger groups of birds tend to be disrupted more easily than a small group. In the Upper Mississippi study, a group of 2,500 migrating tundra swans completely abandoned one of their prime feeding areas, apparently just because of two fishing boats.

Of course, there are other problems that boating recreation can cause for waterfowl and their habitats. Some of these include: habitat disturbance, degradation, or alteration; pollution from boats, in terms of toxic byproducts of engines or litter; and soil impacts (erosion) to shorelines from wakes. In addition, direct injury to birds from discarded fishing line and lures can be significant. During waterfowl banding, we regularly remove fishing line from the legs of birds, where it wraps tightly, tangles, cuts into the leg and can get badly infected, even leading to death. We have also removed fish hooks from waterfowl. Most of these impacts can be mitigated with a little awareness on the part of the public. It is important to consider all of these factors on top of the (less tangible) impact of generalized disturbance.

Case Study

The issue of the disturbance of waterfowl by boaters did not get much attention until the 1970s, when Ruby



Figure 3. Canada geese are perhaps the most tolerant to disturbance depending on the area. These geese were pushed out of the water with kayaks but they were molting at the time making them more vulnerable thus easier to disturb. The kayakers were able to get within a few meters of the gaggle before they went ashore. Photo credit: Martha Fox.

Lake National Wildlife Refuge (NWR) in Nevada was sued because of the boating disturbance occurring on the refuge (Bouffard 1982). Ruby Lake NWR was established as a migratory breeding bird area in 1938 with 37,600 acres of wetland habitat. Nevada has lost a significant amount of wetland habitat, thus making Ruby Lake one of the most important areas in the state for waterfowl and other migratory water birds. However, it also became one of the few destinations for recreational boating. The refuge's South Marsh unit holds about 7,000 acres of open water and wetland habitat. While 85 percent of the canvasback and redhead population at the refuge nest in the South Marsh, 80 percent of boating and fishing activities also occur in this unit.

While the Refuge Recreation Act of 1962 allows for boating and recreation in all NWRs, it does so as long as recreational uses do not interfere with the area's primary purpose. In the case of Ruby Lake NWR, that primary purpose is to provide habitat for waterfowl and other migratory birds. However, boating

activities at Ruby Lake apparently were not well regulated, and recreational activities peaked during the waterfowl breeding season. By the 1960s it was becoming apparent that lake recreation was taking a toll on the quality of the wetland habitat. In 1974 the Defenders of Wildlife (DOW) threatened to sue the U.S. Fish and Wildlife Service (USFWS) in an attempt to toughen boating regulations because of its wildlife impact. A temporary restraining order against FWS was issued to stop boats with gasoline motors from using the lake. After litigation, the boating regulations for the South Marsh unit were rewritten to include no boating January 1-June 14 and electric motors only June 15-July 31. Outboard gasoline motors no larger than 10hp are allowed August 1-December 31. These regulations are still in effect.

The Ruby Lake case was one of the first cases of its kind, forcing USFWS and refuge managers to consider how to manage the growing negative impacts of recreation on wildlife. It also forced managers to consider events such as

migration, breeding, and timing of other life cycle segments that are critical to the survival of waterfowl and other species when writing regulations.

Management

Conflicts between the public's desire for water-based recreation and the need to maintain living space for waterfowl during the breeding season are growing. However, we all enjoy a day out on the lake. Observing wildlife adds to these experiences. Respecting the needs of wildlife does not mean that recreational activities need to be banned outright.

There are a variety of techniques available to managers that can be applied to limit the disturbance so that waterborne recreation can still be enjoyed without causing excessive disruption to wildlife (Table 1). However, for the general public, education on the issue is the most important component. By being aware of the impacts recreation can have on wildlife, we can use this information to make better judgment calls when recreating. We might choose to boat down a different channel instead of using the same area each time, thus disrupting the same duck family, or rent a kayak instead of a motorboat. Understanding the basis for these rules and regulations may help people respect them and encourage people to protect the resource by following them.

Managing the balance between the recreational use and protection of natural areas can be a challenge. Recreational activities need not be incompatible with wildlife. With an understanding of bird behavior and needs, we can use education where possible and management techniques where necessary to continue to enjoy water-based recreation as well the wildlife these natural areas sustain.

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Table 1. Management techniques for reducing impacts to waterfowl from waterborne recreation.

Issue	Solutions
<p>Direct breeding season impacts</p> <ul style="list-style-type: none"> • Nest and brood disruption • Increased predation • Nest abandonment • Habitat abandonment/moving into less suitable habitat • Residing in less suitable habitat <p>Indirect breeding season impacts</p> <ul style="list-style-type: none"> • Boating disturbance • Noise disturbance • Habitat degradation • Boating-related injuries 	<ul style="list-style-type: none"> • Place trails and access predominantly in less preferred waterfowl habitat • Limited access until average ducklings are over three weeks old • Primary nesting areas off limits during peak nesting • Artificial nest boxes or nesting areas away from human access • Special use permits in primary habitat • Seasonal/limited access roads • Limited/seasonal fishing regulations to avoid peak nesting and brood rearing • Special use permits/restricted entry for accessing optimal habitat areas • Limit boat size and horsepower seasonally or year-round, as appropriate • Specified boating areas • Non-motorized boat access in more areas to reduce motorized boat activity
<p>Non-breeding season impacts</p> <ul style="list-style-type: none"> • Migration disruption • Noise disturbance • Habitat degradation • Disrupted feeding/increased energy use 	<ul style="list-style-type: none"> • Public education on wintering and migratory requirements • Screened or hidden observational platforms • Large areas closed off as resting area during migration • Increase quantity and quality of food availability • Lease private land as food source areas • Special use permits and limited hunting access • Limit or eliminate access to feeding and roosting sites • Designated parking areas and rerouted roads during migration months away from resting sites

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Sadie Dainko has been the waterfowl technician with the Indiana Division of Fish and Wildlife for two years. She primarily handles wood duck banding in the Stillwater – North Fork Waterfowl Resting Area, an area heavily used by both wood ducks and the public.



Adam Phelps has been the waterfowl research biologist with the Indiana Division of Fish and Wildlife for 12 years. He has statewide responsibility for management of all waterfowl species. 🐦



Jack McLaren

Student Corner

Reservoir profiles uncover mechanism behind warming waters in the Henry's Fork

Introduction: Study Location

Island Park Reservoir (IPR) serves as an irrigation storage reservoir on the Henry's Fork of the Snake River in southeastern Idaho (Figure 1). It is a relatively shallow reservoir with a $1.67 \times 10^8 \text{ m}^3$ (135,205 acre-foot) capacity and a mean depth of just over 5 m (16 ft.). IPR's exclusive purpose is irrigation storage; the patterns of water storage and release are driven by need to supply

valuable downstream agriculture during the summer irrigation season.

Like other large irrigation storage reservoirs in the western U.S., IPR releases water into its tailwater from the deepest part of the reservoir, cooling and moderating river water temperature to the benefit of cold-water sport fish (Olden and Naiman 2010) (Figure 2). In part because of consistent water supply and moderated water temperatures, IPR's tailwater, the

Henry's Fork River, supports a world-class fishery known for its excellent macroinvertebrate hatches and large population of fast-growing and hard-fighting rainbow trout (*Oncorhynchus mykiss*). The fishery attracts fly-fishermen from around the world, adding \$29 million and 851 jobs to the local economy (Loomis 2006).

The Henry's Fork Foundation (HFF) is a conservation organization focused on

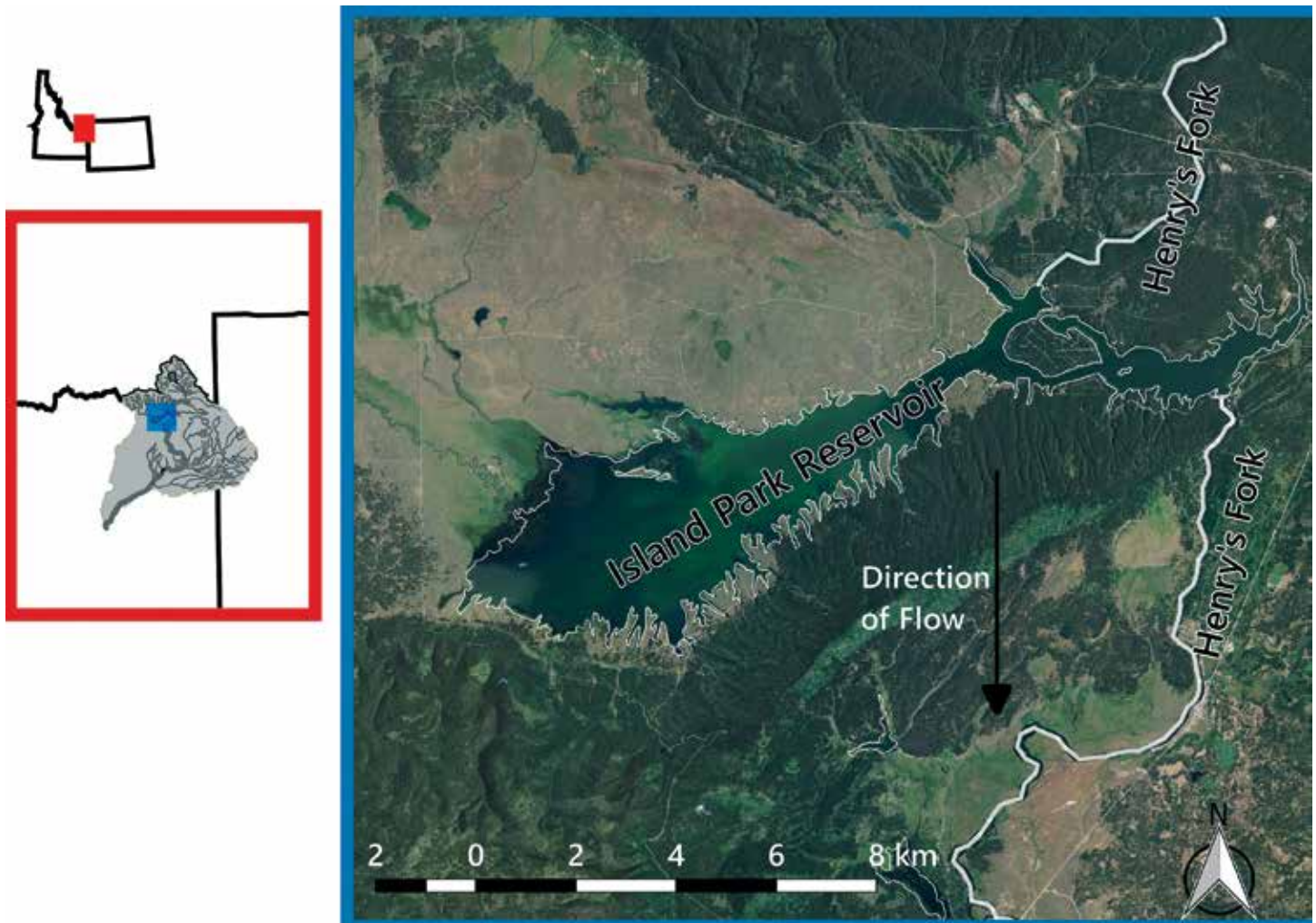


Figure 1. Aerial imagery showing Island Park Reservoir within the Henry's Fork watershed in Idaho and Wyoming (USDA 2011).



Figure 2. Island Park Dam (background) and the Henry's Fork River (foreground), showing the USBR hypolimnetic outlet on the lower-left part of the dam. Picture was taken on July 22, 2015, during peak irrigation delivery.

wild trout protection in the Henry's Fork basin. Because water temperature controls fish and macroinvertebrate growth and development, the Henry's Fork Foundation's science program monitors river water temperatures using a network of water-quality monitoring sondes. HFF's sonde data indicates a larger-than-expected between-year variation in water temperature over the last 20 years immediately below IPR (Figure 3). If reservoirs are supposed to moderate water temperatures, why do water temperatures in the Henry's Fork vary so much?

To understand the reason behind water temperature variation downstream of IPR, I developed my thesis in conjunction with Dr. Todd Royer at Indiana University's School of Public and Environmental Affairs and Dr. Rob Van Kirk with the HFF. My thesis seeks to understand the drivers of water temperature variation in IPR's tailwater. One potential driver is limnological processes within the reservoir. By

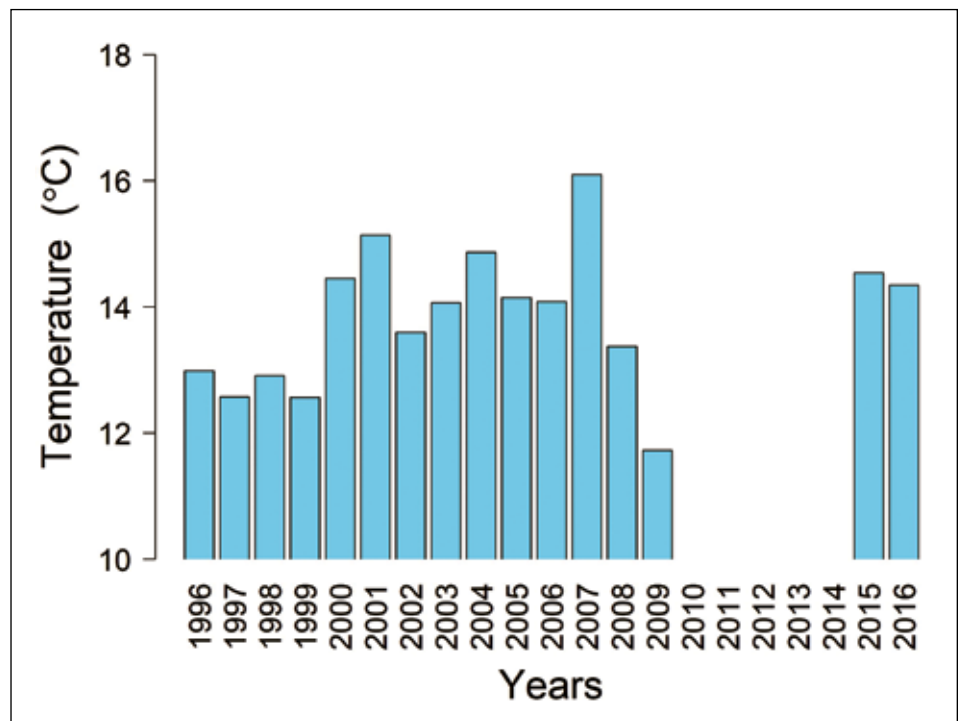


Figure 3. Averaged May to August water temperatures (°C) from 1996 to 2016 in the Henry's Fork River immediately below Island Park Reservoir, ID.

collecting weekly reservoir temperature profiles during the drought year of 2016, I hope to determine the mechanisms for higher water temperature in the Henry's Fork River.

Methods

Water temperature data for the Henry's Fork immediately downstream of IPR for 1996-2009 were collected by Fall River Rural Electric Cooperative, which operates a hydropower plant on the IPR dam. The hydropower facility does not control reservoir outflow but rather generates electricity from the flow released for irrigation storage and delivery. As a condition of operating the hydropower plant, Fall River Rural Electric Cooperative is required to monitor water quality in the Henry's Fork. Water temperatures were recorded hourly approximately 200 m downstream of IPR dam at a US Geological Survey

(USGS) stream gauge site (Figure 4). In 2015 and 2016, water temperature data was recorded every 15 minutes with data loggers provided by the HFF.

For my research, I recorded reservoir profiles weekly using an EXO-II sonde (Xylem Incorporated, Yellow Springs, OH) beginning June 15, 2016 at the US Bureau of Reclamation gates, which at 21 m is the deepest location in the reservoir. This sampling location is where outflow not passed through the power plant leaves IPR (Figure 4).

Results

Temporal progression of water temperature downstream of the dam reflects evolution of temperature gradients in the reservoir (Figure 5A-H). The profile taken on June 15 was similar to what is expected in an average dimictic lake: a thermally stratified water column with warm epilimnetic water at about

20 °C above a layer of hypolimnetic water around 10 °C (Figure 5B). As the summer progressed and outflow increased to meet downstream irrigation demand, the hypolimnion was quickly depleted. By July 1 temperatures at the deepest point in IPR increased to 16°C as warm epilimnetic water replaced cold hypolimnetic water that had passed through the IPR outflow (Figure 5D). The result was a 7 °C increase in water temperature in the tailwater in less than three weeks (Figure 5A). A decrease in water temperature in mid-July (Figure 5A) was caused by a week of cool, wet weather that increased cool-water inflow to the reservoir, temporarily reestablishing the hypolimnion (Figure 5F). This bank of cool water was quickly used up as warm temperatures and high irrigation delivery continued in late July and early August, resulting in a return to high temperatures (Figure 5A).



Figure 4. Sampling locations for reservoir profiles (designated as IPR Gates) and data logger temperature monitoring in Island Park Reservoirs tailwater on the Henry's Fork River (USDA 2011).

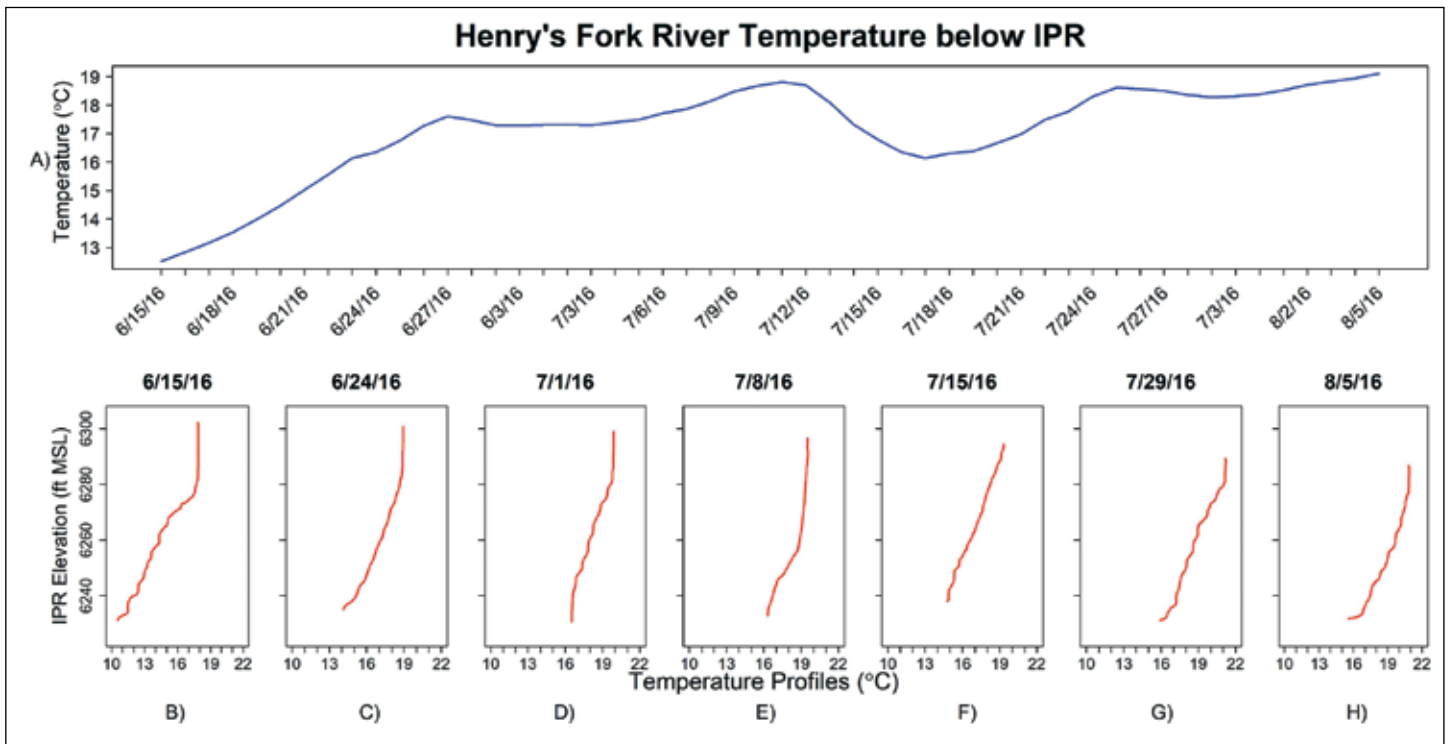


Figure 5. 5A shows water temperature (°C) trends collected in the Henry's Fork River from June 15 to August 5, 2016. 5B-H show water temperature profiles collected at IPR Gates. Note in figures 5B-H the top of each profile starts at a lower elevation as the summer progresses, reflecting reservoir draft

Discussion

My research to date indicates that drought-induced water shortage may change the expected water temperature regime in IPR and similar reservoirs, resulting in higher-than-expected water temperatures downstream. 2016 was a severe drought year; low snowpack and low summertime precipitation result in low natural flow (Figure 6), necessitating high delivery of storage water from IPR relative to inflow. As a result, IPR was drafted much lower than the median (Figure 7). The high draft appears to have released all available hypolimnetic water, resulting in the release of epilimnetic water, resulting in higher river water temperatures.

Water shortages in the West are predicted to become more severe due to climate change (Woodhouse et al. 2016). Creative management may be needed to preserve water quality for sport fishing while simultaneously providing the allotted water for irrigators. A first step towards developing creative management solutions involves finding which climactic and hydrologic factors predict tailwater temperatures. During the 2017 field season, I am developing a bathymetric

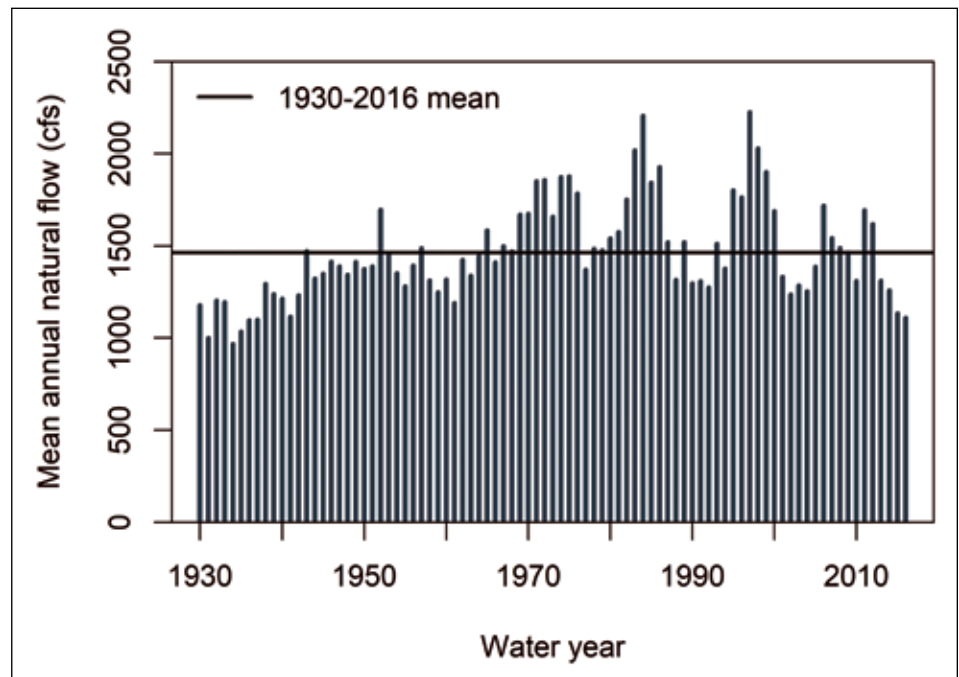


Figure 6. Mean yearly watershed yield, a measure of natural flow, for the entire Upper Henry's Fork watershed from 1930 to 2016. Note 2016 is well below the 1930-2016 mean, and is the lowest since the severe drought of the dust bowl years in the mid-1930s

map for IPR. With a depth-volume curve developed from this bathymetric map coupled with temperature monitoring and hydrologic data, I plan to develop

an accurate heat model for IPR. Knowing how heat – and therefore water temperature – flows through IPR, we could alter the timing and amounts of

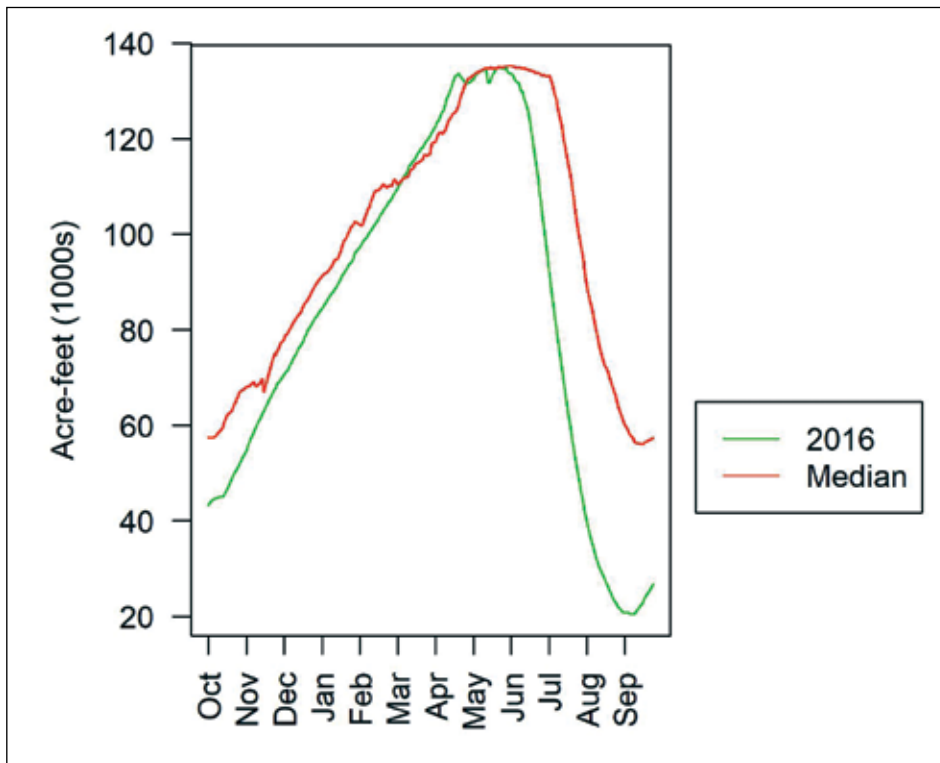


Figure 7. Island Park Reservoir volume comparison between the 2016 water year and median of 1939-2016.

releases to simultaneously meet irrigators' needs while keeping water temperatures in the optimal range for trout and macroinvertebrate growth and survival.

Other more dramatic examples of creative management could include infrastructure changes. A selective withdrawal system, which is a movable outflow gate that can withdraw water from any vertical point in the reservoir, would allow managers to manipulate water temperature in the river below the dam. The system could be used to draw epilimnetic water in the spring and early summer when epilimnetic water temperatures are cool, reducing hypolimnetic releases early in the year and preserving cool water for later in the summer. Another infrastructure change could include increasing the size of IPR by raising the height of the dam, storing more water to benefit irrigators while increasing the volume of the hypolimnion as a side benefit.

Short of infrastructure improvements, a new water market system in Idaho could allow the HFF to pay irrigators to use less water during the irrigation season. The saved water would no longer need to be withdrawn from IPR in the summer, reducing usage of the hypolimnion and

keeping water temperatures cooler in the Henry's Fork River. These and other creative solutions will be needed both at IPR and across the West to mitigate the impact of climate-change-driven drought and preserve water supply, quality, and sustain fish populations.

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Master in Environmental Science-Master in Public Affairs student at Indiana University's School of Public and Environmental Affairs advised by Dr. Todd Royer. His research interests involve how limnology and climate influence water quality in the Upper Henry's Fork River system in Island Park, Idaho. 🐟



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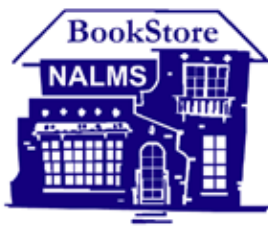
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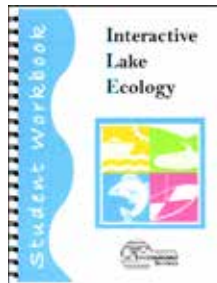
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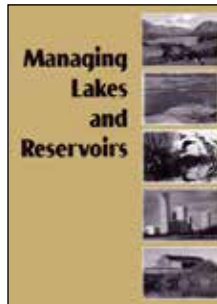
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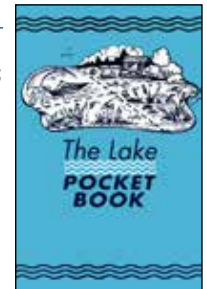
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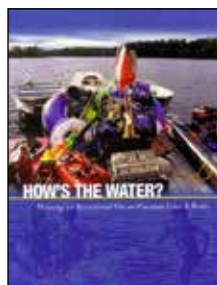
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