Fisheries

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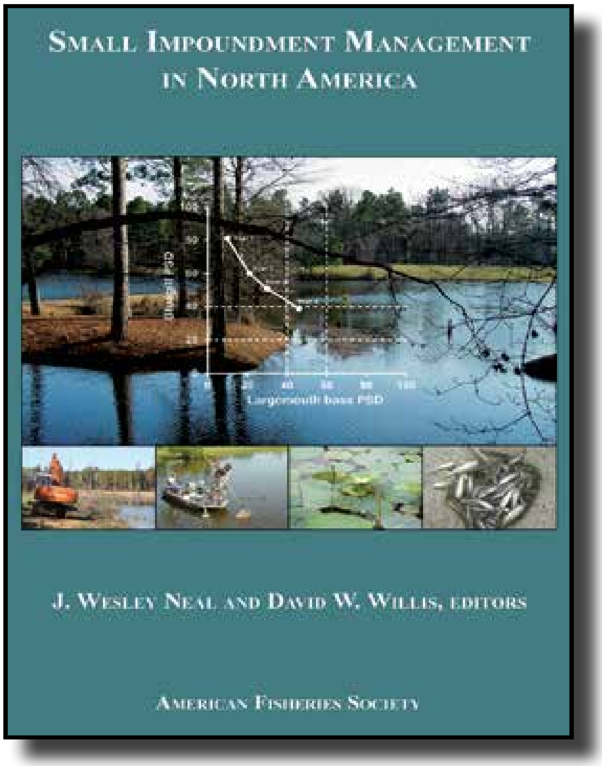
Small Impoundment Management in North America



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This book is an in-depth overview of biota, habitat, and human management in small water bodies up to approximately 40 ha in surface area. Authors were selected to cover the wide geographic diversity of ponds and pond management throughout North America.

The first section (*Introduction and History*) defines small impoundments, provides a concise history of pond management, overviews pond resources in the USA and world, and discusses the importance of small impoundments. Section Two (*Pond Environment*) addresses proper construction considerations, explores the physical and chemical characteristics of these waters, discusses productivity, and examines methods to manipulate environmental conditions in small waters. Section Three (*Fish Management*) describes current stocking practices and species selection, addresses the importance of proper harvest and assessment, and explores mechanisms involved in population dynamics and the occurrence of crowded predator or prey populations. Section Four (*Problem Troubleshooting*) addresses problems that can arise in small impoundments and provides solutions. Section Five (*Opportunities*) provides a platform for topics that previously had received limited treatment in the educational literature. Thorough discussions of fee fishing and community fishing opportunities for small impoundments are provided, as is an overview of careers in private sector pond management and extension/outreach. Finally, the technical aspects of managing small impoundments for wildlife are described in detail.

A primary use for this book will be university classes on pond or small impoundment management for advanced undergraduate or graduate students. Practicing fisheries professionals should also find substantial value in the depth of information provided by the book. Finally, private pond owners will find the book to be useful as they seek to learn more about ponds and pond management.

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Cover: Tarpon (*Megalops atlanticus*). Photo credit: Steve Williams and Fin Foundation Images.

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The American Fisheries Society (AFS), founded in 1870, is the oldest and largest professional society representing fisheries scientists. The AFS promotes scientific research and enlightened management of aquatic resources for optimum use and enjoyment by the public. It also encourages comprehensive education of fisheries scientists and continuing on-the-job training.

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Iron Triangles and Fisheries

Bob Hughes, AFS President

COLUMN
President's Commentary

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In his January 1961 farewell address, President Dwight Eisenhower warned of the unwarranted and growing influence of the military–industrial complex on governments. However, this relationship was not new. Samuel Colt's assembly line supplied arms to the Confederate and Union armies during the U.S. Civil War in the 1860s; in the 1880s, Alfred Krupp's firm sold cannons to the Prussian, Russian, and Turkish armies. Government contracts and warfare made these companies and others like them very profitable and influential, with powerful military–industrial complexes developing in England, France, and Germany and contributing to World War I. However, for military–industrial complexes to persist, they require government budgetary support (in the United States this amounted to an estimated $800–900 billion in 2006 and 2013, respectively; Higgs 2007; Hellman and Kramer 2013)—thus the iron triangle, and at least one reason the United States is considered the greatest threat to world peace (Worldwide Independent Network of Market Research and Gallup International 2013). Iron triangles develop to ensure economic growth, which also leads to declines in fish and fisheries (Limburg et al. 2011), or they may focus on interests such as environmental protection, religion, or retirees.

Iron triangles are everywhere, driven in large part by our increasingly technological societies and persisting regardless of who is president, prime minister, or premier. In Western republics at the federal level, the angles of the triangle are represented by congress/parliament members, civil servants (executive branch, congressional/parliament, and university staff), and an industry or interest group likely to profit from the relationship. Typically, various members from each group form long-term, mutually beneficial relationships—both financial and intellectual. In some nations, such as Brazil, these bonds (the sides of the triangle) are strengthened by joint industry–government-owned major industries and federal universities. In other nations, such as the United States, the bonds are strengthened by lobbyists, who spent $2–3 billion per year over the past 10 years (in addition to campaign contributions) to influence congress and federal agencies (Open Secrets 2013).

In the natural resource and environmental policy arenas, iron triangles have proven immensely valuable for scientifically driven management and decision making. Because of the scientific information produced from federal–university–industry research, management of agriculture, forests, rangelands, wildlife, and fisheries have moved from highly destructive methods to potentially sustainable methods in the short term, if not the long term (Hughes 2014a, 2014b). For the past six years I have participated in such a collaborative research triangle involving the Brazilian government, two federal universities, and a major power corporation (Callisto et al. 2013). Another example of collaborative federal–university–industry research—and subsequently improved management—is the National Acid Precipitation Assessment Program (e.g., Burns et al. 2011).

However, iron triangles in the mining, oil, and gas industries have produced, and continue to produce, undesirable conditions, particularly for fish, fisheries, and aquatic and marine ecosystems (Hughes et al. 2013). In the United States, hard rock mining is regulated by a law passed by Congress in 1872 that effectively gives mineral wealth on public lands to mining corporations and cleanup responsibilities to taxpayers (Woody et al. 2010). The Office of Surface Mining has oversight for coal mining in the United States, but coal mining on private lands is governed by state legislatures and regulators, which are usually much more easily influenced by the regulated industries. The frequency of disastrous spills and fish kills are some of the products of this iron triangle. When its IXTOC I well spilled in 1979, PEMEX, a Mexican national company, paid no fines because governments do not fine themselves. A recent classic example is the April 2010 Deepwater Horizon oil spill, in which the U.S. Congress provided subsidies for oil and gas production and the Interior Department's Minerals Management Service was deemed mismanaged and corrupted by industry influence (Lipton and Broder 2010).

Iron triangles in the mining, oil, and gas industries have produced, and continue to produce, undesirable conditions, particularly for fish, fisheries, and aquatic and marine ecosystems.

Although the iron triangles developed for mineral and oil and gas extraction are problematic for fish and fisheries, they seem like less of a factor than the iron triangles developed for water development. The U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers, various congressional committees and subcommittees, and the dam building industries (e.g., Bechtel-Kaiser, Morrison-Knudsen) have greatly modified the rivers of the western United States, mostly for hydropower and irrigation (Reisner 1993). Nearly all major U.S. rivers are dammed, approximately 90% of the extracted water is used for irrigation, and water rights are overallocated (Reisner 1993). These changes have been especially problematic for western fish taxa, with many being listed as threatened or endangered (Jelks et al. 2008) and entire faunas being altered basin-wide (Rinne et al. 2005). Thousands more dams are projected worldwide, especially in Africa, Asia, and South America, with the World Bank sometimes serving as the funding source (Perkins 2004; RiverWatch 2013).

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COLUMN

Letter from the Executive Director

The Value Proposition Challenge of AFS

Doug Austen, AFS Executive Director

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It has come up time and again during discussions with members, former members, and prospective members of AFS. It's also the truth that more than a few people have approached me somewhat sheepishly over the past couple of months to let me know that their membership has lagged, maybe even for the past couple of years. They admit that it just sort of happened. No real reason, not a protest, not a position that AFS has taken that they object to. No other reason than the troubling issue of a membership in AFS not being seen as a positive value proposition. Just to be honest with you, I'm guilty of this as well. While working in an administrative role several years ago, I simply didn't have time to read the journals, wasn't able to make the meetings, and found little of interest to entice me to put my credit card to work. I let my membership slip. Somewhat embarrassing, yes, but also far too familiar given the stories that have been shared with me. So what gives? How do we make the mental math work out so that AFS regains its role as an important part of the lives of fisheries and aquatic conservation professionals? I need your help in better understanding this as we go about addressing this challenge. Here are some observations, data, and thoughts to get the conversation started. Please check out my LinkedIn page and the AFS Facebook page to get more information and provide your thoughts and comments.

The membership numbers tell part of the story. For the past 10 years or so we've varied from a little over 7,000 to slightly over 9,000 members. To a certain extent, this fluctuation appears to be linked to Annual Meeting size. With Seattle in 2011, our largest meeting, we also experienced our largest membership bump. Prior to that, relatively small meetings in Nashville and Pittsburgh were associated with membership numbers in the 7,000s. So one of the problems is our inability to retain these members. Individuals appreciate the Annual Meetings but don't see a long-term value in membership during the intervening years.

It's important to realize that we're not alone in experiencing this challenge. Scientific societies and social organizations as a whole need to address a changing constituency that is constantly reevaluating membership, finding ways to connect with each other that simply were not available in the past, and accessing needed information in a variety of ways that don't depend on the professional society or trade association. In fact, far too often it's the trade associations or scientific societies that are the last to recognize these shifts and they are then caught flat-footed.

Let's explore two issues. The first is member acquisition of information relevant to successfully accomplishing their job, clearly a fundamental role of AFS. This could be a fishery management biologist working in a state agency field office, graduate student developing a thesis, faculty members working on a proposal, or any one of a number of other AFS member profiles. We certainly hope that AFS is a primary source of providing you the information needed to make the resource decisions of importance to you. This can be in the traditional form of our six journals, more than 180 books, conferences, continuing education courses, or other means. We certainly also know that the tools for searching, obtaining, sharing, and conveying this information are changing and there are more options out there than ever before. What we don't know is how well AFS is doing in meeting these changing needs. Is it the right information, packaged to meet the needs of a varied constituency, and delivered using the methods that you desire? AFS works with phenomenal publishing partners to put out our journals and they are constantly evaluating the journal marketplace and technology to find new approaches. However, I doubt that they wake up in the morning concerned about ensuring that a district fisheries management biologist has access to the right information being delivered in the most effective way to help fully understand the best science available and apply it to his or her fisheries management challenge. AFS needs to be doing that. AFS needs to be the solution to that challenge and many more that our members face as they go about the business of fisheries management and aquatic conservation. We'll be asking you how to best meet these needs and would greatly appreciate your thoughts on how to better address this problem.

The second challenge is the role of AFS in developing members as professionals. Jim Martin, conservation director for Pure Fishing and former fisheries chief for Oregon, puts this challenge quite clearly. He asks, "Who is going to be the best advocate for your professional growth?" The answer is generally not the agency that you work for (although some do a great job with this). The agencies are often already stretched thin and overwhelmed in dealing with the immediate resource management challenges, pressing budget issues, and politics of survival that too frequently put staff development at the bottom of the priority list. The answer to Jim's challenge, of course, is that each person needs to take this on as an individual responsibility; we each own our own future.

It is the professional society, AFS in our case, that can and should be a primary source of advice, content, training, mentorship, and leadership development that will help each member grow as a professional. How are we doing with this? What more can be done and how should AFS, at all levels, help meet this critical need? Let's figure out better answers to these questions and evolve AFS in a dynamic and responsive way to meet these needs.

COLUMN
Policy

Aquatic Blue Carbon

Thomas E. Bigford, AFS Policy Director

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Carbon is a critical element. Life requires it, but too much of a good thing can be harmful. Climate change literature tells us that when present in elevated concentrations, and when mixed with the wrong particles, carbon-based molecules can be one of the primary causes of global warming. Our industrial society has already pumped sufficient carbon into our atmosphere to warm the globe for decades. To control warming, society absolutely must move away from its fossil fuel diet while also sequestering the carbon-based molecules that drive this unwanted atmospheric transformation. This challenge has special meaning for us because warming almost certainly will affect fish populations on a massive scale. Though fish lovers may be counting on chemists, politicians, and others to chart a path toward sanity, we in the fish community can play a major role.

You've probably heard of inventive ideas to control carbon dioxide, methane, or other such gases—deep-well injection, intergalactic orbit, and the like. And each futuristic remedy comes with an unsigned promissory note from our children stating their commitment to invent the technical and financial wherewithal to prevent leaks for eternity. Or, just because it makes preeminent sense, we could bypass wishful thinking and simply take advantage of the carbon storage tanks that have served us since our knuckles scraped the Rift Valley muds. The newly understood option will not solve all of our woes, but its proven success is undeniable. It must be part of our long-term societal plan. Beginning now—before the option is removed from the equation.

Though life is rarely simple, the scientific logic behind this ecological option is inescapable. The plain fact is that aquatic environments from lake shorefronts to salt marshes offer far greater sequestration potential than we could ever expect from forests or the Rube Goldbergian options on the table (Mcleod et al. 2011). The very places that support fish also pose huge benefits to society. And those nearshore environs represent a mere fraction of the total acreage of the upland ecotones often mentioned as the most logical "sinks" for excess carbon. Simply put, the aquatic edge between shore and shallows offers society a great benefit. To redeem its value we need only to let nature run its course.

Rather than elaborate scrubbers atop power plant stacks, the latest and best carbon sink is commonly camouflaged as wetlands, mudflats, peat bogs, mangroves, etc. Even waters such as rivers, lakes, and reservoirs also serve a vital role. This unanticipated ecological service was discovered in the past decade, is only now being recognized in natural resource plans, and is not yet reflected in regulatory decisions. Cole et al. (2007) described how freshwater aquatic systems help to store, transform, and transport terrestrial carbon and thereby affect global carbon budgets.

Let me clarify the environs at the heart of this option. Carbon sequestered in shore-side sediments and plants represents a contribution to ecological sinks. The same carbon dissolved in oceans can acidify our seas, perhaps to the demise of critters who depend on calcium and other elements that will fare poorly if pH levels decrease. This is undoubtedly more complex than the preceding sentences, but coastal habitats can serve a far greater role than envisioned.

From headwaters to the Great Lakes and our oceans, the concept of "coastal carbon" is adding value to our work. A quick skim through some recent literature reveals that the very habitats that nurture most of our fish (and birds of economic value and nonconsumptive pleasures) are extraordinarily adept at storing carbon. Pendleton et al. (2013) described the seemingly unique role of coastal ecosystems in the global climate equation. Coastal ecosystems store carbon at unprecedented rates, adding justification to habitat protection and restoration efforts formerly based on cost–benefit ratios and associated criteria. Now, without the addition of a single legislative mandate or additional staff, society has the opportunity to address a crying need with an additional variable in a simple equation. If we conserve shallow-water habitats we will retain the ecological services that benefit fish and fish lovers plus the newfound and enormous capacity of those same environments to sequester carbon. If those special places are lost to development, natural or human-driven catastrophe, or even the chronic ravages of climate change, we will lose the capacity of those environments to store carbon. Worse still, society will also suffer from the release of the very carbon those places have sequestered from the global atmosphere.

These new realizations promise to shift debate in the many management, science, and regulatory arenas that touch aquatic ecosystems. Pendleton et al. (2013) offered nonthreatening steps toward change. Sutton-Grier et al. (2014) provided additional detail on incorporating these types of ecosystem services into natural resource management. Those authors have connected the physics to ecology. AFS members and other fish folk need to connect the option to reality.

The timing is opportune as many nations have expressed growing interest in a fuller consideration of ecosystem services in their regulatory decisions. Now, with climate services added to the debate, it would seem that the odds have tilted toward conserving places that remain at risk. Whether you approach this conundrum from a watershed, ecosystem, parochial, or political perspective, the concept of blue carbon should deepen your commitment to conserve aquatic places.

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COLUMN
Digital Revolution

RIP XP

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Thom Litts

Jeff Kopaska

If you work for an agency or university, it has happened to you. The computer police called and said it is the end of the line for your XP machine. Get signed up for a new computer, and hand the XP one over to us. Everything will be fine. Thank you.

You heard it, you experienced it, and now it is done (or will be soon). But everything is not fine. At work, this means that a number of common tools used by fisheries professionals (e.g., FAMS, FishBC) will not function like they used to on your new computer. In fact, they may not function at all. At the office, we are also trying to get the new machines to operate external devices (microscopes, survey scanners) that were originally set up for use with XP machines. It is not going well, and there is not much support for these "peripheral problems." Sure, we'll get some help with these "problems" from our respective IT staffers, but they are not going to solve them all. We can help each other by utilizing the FITS blog site to pose questions needing answers and by sharing good solutions.

It is interesting to note, even with all the efforts to eradicate XP machines and with Windows XP's end-of-life at hand, that XP is still a fairly prevalent OS. Consider that a website Thom administers was accessed, in the last month (January 2014; >250,000 unique visits) predominately by computers running Windows 7 (first, 32%), but followed by Windows XP (third, 7%), Windows Vista, and 8.0 (fourth and fifth, 4% each), and Windows 8.1 (ninth, 2%) according to Google Analytics.

If you work at a place with an IT department, this is supposed to get handled. But what do you do if you work for a small company, or what about at home, where *you* are the IT person and rely on an XP box as your primary computer?

Well, if you're wed to a Microsoft OS, the obvious option is to buy a new computer with a supported Windows OS such as Windows 7 or Windows 8(x). Extended support for these OSs run into the next decade, so you're safe on that front. But beware—if you are hoping to land a new computer with Windows 7—though it is still possible (verified via a 3 February 2014, visit to a popular PC builders website)—the options are limited and fading. The good news is that if you opt for a new computer, you will likely find that prices are considerably lower than you paid years ago for a lesser machine.

If your XP box is relatively new (2–3 years old), you might also be able to upgrade to Windows 8. Microsoft offers a freely downloadable tool that you can run locally and assess the potential of your existing machine for upgrade. Just key in "xp end of life" to your favorite search engine and poke around on the returned Microsoft.com pages for more info.

If you're frugal, and/or broke (like us), you might also look to an auction house run by a major computer vendor and buy a refurbished computer. This is how we've operated over the last decade or so. Yeah—they're refurbished, but so far we've had good luck—and at this point in the game we've both come to think of computers as a disposable/recyclable product. So for dimes on the dollar, and Windows 7 as an option (albeit the 32-bit version, a discussion for another day), this is one avenue to consider.

If you're downright stingy, destitute, or simply tired of Microsoft, you can convert your XP machine to a Linux box for exactly: $0.00. There are many flavors of Linux to choose from and you can even get by running Linux off a bootable USB stick for Internet access (and more), while keeping XP installed to run your favorite Microsoft software—though you may want to disconnect from your Wifi or Ethernet before booting to the latter.

If you're downright stingy, destitute, or simply tired of Microsoft, you can convert your XP machine to a Linux box for exactly: $0.00.

It is important to note that on 9 April 2014, your XP box will boot up as it did the day before. Just be aware that Microsoft no longer supports the OS—at all—XP mode included! Specifically, and most important, this means no more security updates! However, Microsoft will still provide malware protection through Security Essentials (if you've downloaded and installed it prior to April 8, 2014) for some period of time, and there are also third-party options on this end of the equation. Just be warned, hackers and malware providers love to hate Microsoft—so if you decide to make a go of it with XP, you do so at your own risk!

For additional information and useful links, visit this installment of the Digital Revolution at: www.fishdata.org/blog/digital-revolution-rip-xp.

Do you have suggestions for topics or questions that need answering? Please write to Jeff at Jeff.Kopaska@dnr.iowa.gov

COLUMN
The Communication Stream

New Toy Mania and Manageable Bytes

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New toy mania. Most of us have probably experienced it at one point or another. We just couldn't resist the urge to have the latest and greatest "thing." I'm guilty of it. I love gadgets, electronics, and doodads, and I pretty much try on most new communication trends for size. The thing is, not all of them fit. Nor do I try them all on in one craze-filled fitting session. Rather, experts suggest trying things out in manageable "bytes" and with a strategic focus in mind. This will help your organization and its members find that perfect balance between the "new toy" and the "old shoe." Not to mention save you a fair bit of anxiety from being spread too thin.

You are not alone in trying to find that delicate equilibrium. Many are struggling with figuring out what "social media" really is and how it fits within their organization or personal lives. You may be on the leading edge with adopting social media or not quite there yet. That's OK. What's important is figuring out (or remembering) what you or your organization are trying to achieve and maintaining that consistency in your communications. When you stay true to your original goals, adopting communication strategies that are a perfect complement to your existing ones becomes a painless and much more fruitful exercise.

As you deliberate on which new communication "toys" might be the right fit for you and your organization, keeping these seven things in mind will help you minimize unnecessary heartburn.

1. **Start with a strategy** (it bears repeating). Adopting social media without specific goals is a surefire way to build frustration (and often confusion) about the value of your organization's communication efforts. If you work within your personal or business's existing strategy, you'll find it much easier to accomplish your communication objectives and justify the necessity of maintaining your online presence.
2. **Do a little research.** To borrow from Neil Armstrong, research is investigating something that you do not know or understand. There are many new communication tools—too many to possibly adopt them all. Each has been tried by countless others. Read their reviews. Dig into comments left by users. You will quickly get a sense for each tool's utility. Furthermore, your audience already knows what it wants. Make sure you have their pulse. If you do not, conduct some surveys. The American Fisheries Society recently did just this, surveying AFS unit leadership (Chapters, Divisions, Sections, Subunits) on their current (or intended) use of social media and the types of communication assistance they'd like to see. Knowing the ins and outs of the various tools *and* your audience's interests will make adoption of new communication tools a snap.
3. **Adopt new tools a few at a time.** Several years back author Clay Shirky, in his book *Here Comes Everybody*, advised readers against letting a thousand flowers bloom at one time. Rather, he suggested adopting things in manageable chunks by letting "seven flowers bloom." If trying on seven new communication tools at a time seems daunting (it was for me), start with two or three. Either way, taking manageable "bytes" will allow you to quickly evaluate their usefulness to your overall communication strategy. Then cut what *clearly* is not working and try new tools in their place. For those that *might* be working. …
4. **Tinker and experiment.** As with any goal, success is not necessarily static, nor does it come from simply adopting the goal. Rather, success is often a morphing target that constantly needs assessment and adjustment. A tool that once was helpful in reaching your goal may lose (or change) its utility and no longer serve its original purpose. It is better to revisit the utility of your current communication tools and experiment with new ones than simply sticking with the comfortable "old shoe."
5. **Distribute your portfolio.** This old investment adage also holds for adopting new communication tools. Just because you found one or a few tools that work does not mean you should stop there. Technology is volatile (floppy disk drives anyone?). Don't put all your eggs in one basket. It is better to continually experiment and adopt new tools than get stuck with tools that have lost their public appeal or utility. Invest wisely.
6. **Build around leadership.** Chances are that you already have someone in your organization (maybe it's you) that has the passion and skills for communicating using some of the new social media tools. Capitalize on that. Bring them into the fold. Incorporate it into their job description. If you get support from the right people, you'll be surprised how quickly their influence leads the way to adoption of the new tools across your organization. Empower the assets you already have.
7. **Provide training opportunities.** Encountering speed bumps is inevitable when adopting any new technology. But don't let the technological hiccups keep you from embracing them. Demonstrate leadership by incorporating these tools into your normal business routines. Provide learning opportunities to encourage participation across the enterprise. Once people see the utility and value, others will follow suit.

Strategy, good listening, flexibility, diversity, and leadership: a recipe for successful communication strategies.

Global Inland Fisheries Conference: Theme 2—Economic and Social Assessment

The global conference "Freshwater, Fish, and the Future: A Cross-Sectoral Conference to Sustain Livelihoods, Food Security, and Aquatic Ecosystems" convening in Rome in January 2015 includes four main themes. The **Biological Assessment** theme will explore and develop new approaches to assess the production and status of inland fish stocks and their fisheries. The **Economic and Social Assessment** theme will explore and develop new approaches to provide monetary and nonmonetary value to fisheries, including their importance to human health, personal well-being, and societal prosperity. The **Drivers and Synergies** theme will identify synergies between the services that can be made to increase societal gain while maintaining ecological integrity and allowing for the protection of aquatic biodiversity and fisheries production. Finally, the **Policy and Governance** theme will develop methods to assure that governance decisions take into account the contribution inland fisheries make to food security, human well-being, and ecosystem productivity. Each theme will conclude with a **Future of Fisheries** discussion forecasting various scenarios, along with recommendations for achieving the conference vision of a sustainable fisheries future.

THEME 2: ECONOMIC AND SOCIAL ASSESSMENT

The Economic and Social Assessment theme panel chair is Eddie Allison of the University of Washington. David Coates of the Secretariat of the Convention on Biological Diversity is acting as panel facilitator. Below are some of the questions that this theme will address.

What are the economic and societal values of inland fisheries? Decisions about management of inland waters and fisheries production systems often do not include the economic and societal values of inland fisheries to society. In instances where there is some estimate of value of these fisheries, valuation has often ignored the important contribution of fish to nutrition, livelihoods, leisure, societal well-being, and the intrinsic value associated with religious and cultural uses of fisheries resources.

The goal of this theme is to explore and develop new approaches to provide monetary and nonmonetary value to fisheries, including their importance to human health, personal well-being, and societal prosperity. Value assessments will need to include the use of monetary and nonmonetary approaches such as shadow pricing, replacement value, willingness-to-pay, human nutrition and health, employment, and cultural use of fishes. The availability of improved estimates of the economic and social worth of inland fisheries will promote the role of inland fisheries in individual well-being and societal prosperity and stability. The increased understanding of the value of these fisheries will help provide a common metric for evaluating alternative uses of these resources and habitats.

CALL FOR PAPERS—ABSTRACT SUBMITTAL NOW OPEN

Abstract submission is now open for the Global Inland Fisheries Conference. Please see the guidelines and instructions at www.inlandfisheries.org. All abstracts are due by 10 August 2014.

Keep up with all of the conference news on Facebook (www.facebook.com/inlandfisheries), LinkedIn (www.linkedin.com/groups/Global-Inland-Fisheries-Conference-7402542), and Twitter (@inlandfisheries).

ESSAY

More Than Mucus: The Hidden World of the Fish Microbiota

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All living organisms maintain a diverse community of microbes that live in association with mucus-covered surfaces including the digestive, respiratory, and urogenital tracts. These microbial communities are known as “microbiota.” We grow up viewing microbes as disease-causing organisms, but most of those associated with our surfaces are harmless or even beneficial to our health. Studies on the gut microbiota have indicated that microbes aid in proper development and function of the digestive tract and immune system, help obtain energy from food, and act as a barrier against potential disease-causing microbes. These roles have also been demonstrated in fishes, all of which have microbiota associated with the gills, skin, and gut: the primary entry routes of pathogenic organisms.

Currently, investigations are underway to determine the impacts of the Deepwater Horizon oil spill on the skin microbiota of the Gulf Killifish, an economically significant bait fish species.

Under ordinary circumstances, a fish maintains a healthy, normal microbiota that forms a protective barrier on the mucosal surfaces, preventing infection from potential pathogens. Normal fluctuations in the microbial community structure are expected due to changes in environmental factors such as season, location, water quality (including temperature, salinity, and oxygen content), and presence of organic matter (for example, carbohydrates and amino acids). However, not all changes are harmless and deviations from the normal microbiota (also known as dysbiosis) may lead to higher susceptibility to infection. These more serious changes may arise from a combination of factors including unfavorable diet, dramatic changes in environmental factors, limited resources, pollution, and disease. Dysbiosis is often observable prior to physical signs of disease and thus may serve as a warning sign of disease-favoring conditions.

In order to understand the connection between dysbiosis and disease, the normal healthy microbiota of a fish must be described. Although the exact bacterial community structure varies by individual and environmental conditions, the Aquatic Microbiology Lab at Auburn University is exploring the existence of a relatively stable portion of the community that is fish species specific. Our lab is testing the hypothesis that each fish species maintains a normal healthy microbiota that is distinguishable from other species (i.e., the microbiota of a healthy Red Snapper can be distinguished from that of a healthy Pinfish) that can also serve as a baseline for monitoring dysbiosis.

We have already demonstrated species specificity in the microbiota of recreational coastal fishes including Atlantic Croaker, Striped Mullet, Pinfish, and Sand and Spotted Seatrout, as well as the economically significant Red Snapper. These studies analyzed the bacteria associated with fish skin and mucus, developing a minimally invasive yet descriptive method for analyzing these communities. Although primarily focused on marine species, we have also provided characterization for the gut microbiota associated with Channel Catfish, Largemouth Bass, and Bluegill in Alabama to provide a starting point for monitoring the bacterial communities of these species.

Due to the influence of microbiota structure on fish health, we are also interested in how the external environment effects the microbiota composition. This includes not only natural factors such as temperature and salinity but also pollutants. Currently, investigations are underway to determine the impacts of the Deepwater Horizon oil spill on the skin microbiota of the Gulf Killifish, an economically significant bait fish species. Gulf Killifish are commonly used in pollutant studies due to their sensitivity to toxins. Pollution can potentially impact the microbial community structure through direct interaction with the bacteria on the fish surface or indirectly through suppression of the immune system. Deviations from the normal microbiota of these fish may be a first indication of negative impacts on the health of the fish. Thus, this study aims to determine the makeup of the healthy microbiota, as well as whether oil exposure alters the bacterial community structure.

Studies are also underway to characterize the healthy microbiota associated with fish gills, digestive tract, and blood. It is generally assumed that the blood of healthy organisms is sterile; however, new methodologies have challenged this belief in sharks and humans. A recent study performed by our group demonstrated the presence of bacteria in the internal organs of apparently healthy Red Snapper. Current studies are attempting to determine whether the presence of bacteria in the blood is the exception or the rule as well as characterizing the bacterial species associated with the primary entry routes (gill and intestine) of pathogens. As the normal microbiota forms a barrier to resist entry of pathogenic organisms, dysbiosis in these tissues may have major implications for fish health.

Deviations from a normal microbiota may indicate changes in fish health or other environmentally significant parameters. Thus, it is important to characterize these communities and the factors that influence their structure. It is our hope these studies will improve long-term health monitoring of species valuable to U.S. fisheries.

Importance of Understanding Landscape Biases in USGS Gage Locations: Implications and Solutions for Managers

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ABSTRACT: *Flow and water temperature are fundamental properties of stream ecosystems upon which many freshwater resource management decisions are based. U.S. Geological Survey (USGS) gages are the most important source of streamflow and water temperature data available nationwide, but the degree to which gages represent landscape attributes of the larger population of streams has not been thoroughly evaluated. We identified substantial biases for seven landscape attributes in one or more regions across the conterminous United States. Streams with small watersheds (<10 km²) and at high elevations were often underrepresented, and biases were greater for water temperature gages and in arid regions. Biases can fundamentally alter management decisions and at a minimum this potential for error must be acknowledged accurately and transparently. We highlight three strategies that seek to reduce bias or limit errors arising from bias and illustrate how one strategy, supplementing USGS data, can greatly reduce bias.*

La importancia de comprender el sesgo inducido por el paisaje en el posicionamiento de sensores USGS: implicaciones y soluciones para los administradores

RESUMEN: *la temperatura y flujo de agua son propiedades fundamentales de los ecosistemas fluviales, sobre los cuales se toman diversas decisiones de manejo en cuanto a recursos dulceacuícolos. Los sensores del Estudio Geológico de los Estados Unidos de Norte América (EGEU) son la fuente disponible más importante de datos de flujo de agua y temperatura a nivel nacional, pero el grado al cual los sensores son representativos de los atributos paisajísticos de una población más grande de ríos, no ha sido analizado a profundidad. Se identificaron sesgos sustanciales en siete atributos paisajísticos en una o más regiones a lo largo de las zonas limítrofes de los Estados Unidos de Norte América. Los ríos de cauce pequeño (<10 km²) y aquellos localizados en regiones elevadas no estuvieron adecuadamente representados, y los mayores sesgos se observaron en los sensores que miden la temperatura del agua y en las regiones áridas. Los sesgos tienen el potencial de alterar de manera fundamental las decisiones de manejo, y como mínimo este error tiene que reconocerse de forma precisa y transparente. Se plantean tres estrategias que buscan tanto reducir el sesgo o limitar los errores que surgen de dicho sesgo, como ilustrar cómo una estrategia, suplementando los datos EGEU, puede reducir el sesgo de manera importante.*

INTRODUCTION

Streamflow and water temperature are fundamental properties of fluvial systems that structure aquatic communities, determine environmental services, and are susceptible to human activity and climatic processes. Streams are often characterized by flow regime (Poff et al. 1997), which determines the movement of energy within stream channels (Leopold et al. 1964), connectivity to floodplains (Tockner et al. 2000), availability and diversity of instream habitats (Jowett and Duncan 1990), and ultimately the structure of lotic communities (Poff and Allan 1995). Water temperature is a key determinant of ecological processes, such as stream metabolism (Demars et al. 2011) and organism bioenergetics (Kitchell et al. 1977), and plays a primary role in influencing distributions of aquatic organisms due to varied thermal tolerances of individual species (Magnuson et al. 1979).

Just as streamflow and water temperatures influence distribution and abundance of fluvial fishes, flow and temperature regimes are themselves influenced by both natural and anthropogenic landscape attributes (Frissell et al. 1986; Poff et al. 1997). Climatic and landscape attributes that influence streamflow and temperature regimes include precipitation and air temperature, catchment area, soil and bedrock permeability, valley constraint, catchment aspect and elevation, and vegetative cover over multiple spatial extents (Isaak and Hubert 2001; Morris et al. 2009; McManamay et al. 2011). Similarly, anthropogenic activities can confound influences of natural controls, and their effects on streamflow and temperature have been widely documented (e.g., Paul and Meyer 2001; Poole and Berman 2001; Poff et al. 2006).

Management of stream and river ecosystems and fisheries, along with their interconnected lake and reservoir systems, often relies on our ability to characterize both streamflow and temperature regimes throughout regions of interest. To achieve this end, streamflow and water temperature data must be monitored using a statistically valid sampling strategy that ensures representation of regional variation in natural and anthropogenic landscape attributes (e.g., U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program, USEPA 2010), if the goal is to characterize hydrologic and thermal properties of all streams in a region of interest. However, this goal may be difficult to achieve in many regions, because streamflow and water temperature data are rarely collected in such a systematic manner.

The stream gage network of the U.S. Geological Survey (USGS) is the main source of nationally available standardized data for characterizing streamflow and temperature regimes. The USGS gage network was designed to collect continuous streamflow data to serve a number of purposes, which include water management, flood monitoring, recreation, and scientific studies (National Hydrologic Warning Council 2006). Water temperature is also monitored at a smaller subset of gages. Although water temperature data are often collected by other agencies or researchers, those data are often not readily available, because they must be compiled into standardized formats (e.g., Isaak 2011). Though USGS gages provide data that characterize large numbers of streams throughout a variety of large spatial units (e.g., basins, entire states, and ecoregions), the gage network was not designed to support statistically valid, regional inferences. For example, at the national scale, gages are disproportionately located near dams, in areas dominated by human influences, and on larger rivers (Poff et al. 2006; Falcone et al. 2010). Such biases in gage locations may compromise opportunities to extrapolate from gage data to all streams in a region. However, these *landscape biases* have not been formally quantified for USGS gage locations and there has been little systematic discussion of related implications for research and management.

To address these challenges and facilitate the use of streamflow and water temperature data across large regions, we assess and quantify landscape biases for the complete USGS gage network within the conterminous United States. Our decision to focus on the conterminous United States stems from a growing federal interest in identifying and prioritizing management actions to address landscape-scale changes (e.g., National Fish Habitat Partnership, www.fishhabitat.org; U.S. Fish and Wildlife Landscape Conservation Cooperatives, www.fws.gov/landscape-conservation/lcc.html). We also assess landscape biases among different ecoregions. We then discuss implications for using gage data to make inferences in a research and management context in light of landscape biases. Finally, we highlight three strategies to address landscape bias and demonstrate how one of these strategies, compiling supplemental data, can greatly reduce landscape bias.

METHODS—IDENTIFYING BIASES

We assessed the distribution of USGS gages throughout the conterminous United States (national extent) and within the nine ecoregions of Herlihy et al. (2008): Coastal Plains (CPL), Northern Appalachians (NAP), Northern Plains (NPL), Southern Appalachians (SAP), Southern Plains (SPL), Tall Grass Plains (TPL), Upper Midwest (UMW), Western Mountains (WMT), and Xeric West (XER; Figure 1). These physiographically diverse ecoregions were selected for use in this study because they have been used in prior investigations to characterize the current condition of lotic fish habitats (Esselman et al. 2011) as well as an ongoing investigation to identify potential effects of climate and land use changes on these habitats (FHCLC 2011). We used the 1:100,000 NHDPlusV1 as the base spatial layer or "census population" for data management and analyses, where the finest spatial unit was the individual stream reach (USEPA and USGS 2005). Data sets linking stream reaches to physical or anthropogenic landscape attributes were previously compiled as part of the National Fish Habitat Partnership–National Fish Habitat Assessment (Esselman et al. 2011). Landscape attributes were summarized at the watershed scale, which includes all land area draining to a given stream reach.

The locations of USGS gages were obtained in October 2010 from the National Water Information System (http://waterdata.usgs.gov/nwis). Water temperature gages for the nation and nine ecoregions were the subset of USGS gages with recorded water temperatures. We included all gages where streamflow or water temperature data have ever been collected. It is important to note that our results may not reflect current landscape bias in USGS gages because some gages included in our study are no longer operational. However, historic gage data are still used for some objectives and including all gages enables our study to provide a baseline assessment of bias that is likely lower than all other subsets (e.g., currently active gages).

We selected three physical landscape attributes to describe natural variation among stream reaches: watershed area (km^2), mean watershed elevation (m), and mean watershed slope (degree; Table 1). We also selected three percentage measures of land cover as metrics of human disturbance: natural (as sum of forest, grassland, and shrubland), agricultural, and urban (Table 1). These physical and land cover metrics can influence water temperature, streamflow, and distributions of fishes (e.g., Brenden et al. 2008), macroinvertebrates (e.g., Tsang et al. 2011), and algae (e.g., Cao et al. 2007) throughout the conterminous United States. We followed methods in Wagner et al. (2008) to identify potential sampling biases for each of the landscape attributes by comparing cumulative frequency distributions (CFDs) of the sample of reaches containing streamflow or water temperature

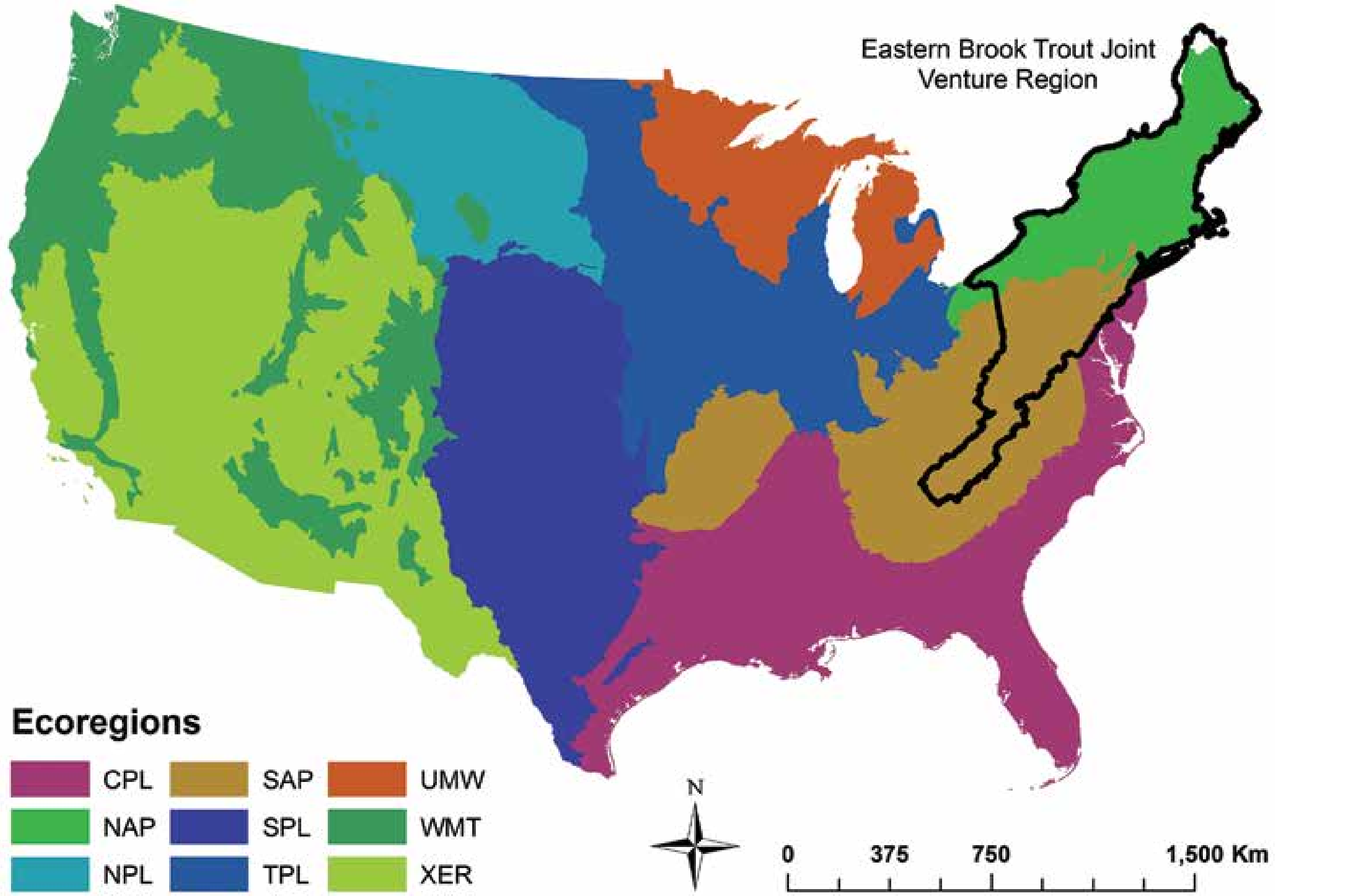

Figure 1. Map of the conterminous United States showing the nine ecoregions and one focused management region used in analyses: the Coastal Plains (CPL), Northern Appalachians (NAP), Northern Plains (NPL), Southern Appalachians (SAP), Southern Plains (SPL), Tall Grass Plains (TPL), Upper Midwest (UMW), Western Mountains (WMT), Xeric West (XER), and the Eastern Brook Trout Joint Venture region.

Table 1. Names and sources of natural and anthropogenic landscape attributes that were used in analyses. The land cover code column lists the reference numbers from the source data set used to calculate land cover types used in our analyses.

Attribute	Resolution	Units	Source	Land cover code
Watershed area	1:100,000	km^2	Calculated using NHDPlusV1[1]	NA
Mean slope	30 m	degrees	National Elevation Dataset[2]	NA
Mean elevation	30 m	m	National Elevation Dataset[2]	NA
Urban land cover	30 m	% of network catchment	NLCD 2001 Version 1[3]	21 + 22 + 23 + 24
Agricultural land cover	30 m	% of network catchment	NLCD 2001 Version 1[3]	81 + 82
Natural land cover	30 m	% of network catchment	NLCD 2001 Version 1[3]	41 + 42 + 43 + 52 +71

[1] USEPA and USGS (2005).
[2] USGS (2006).
[3] Homer et al. (2007).

gages to those of the census population of all stream reaches in each region. We performed statistical analyses and created plots within the R programming environment (R Development Core Team 2012).

The interpretation of sampling bias from CFD curves is as follows: (1) generally unbiased samples have a CFD that matches closely with the census population CFD; (2) sample CFD deviations above the population CFD represent oversampling; and (3) CFD deviations below the population CFD represent undersampling. Sample CFDs may begin at higher or end at lower values of a landscape attribute than the census population, which signifies that some values of the attribute are not represented by USGS gages (i.e., these extreme attribute values are entirely unsampled). Erratic, step-like CFDs result whenever the addition of one or a few gages results in a large increase in cumulative frequency and are usually associated with a small number of gages.

For each landscape attribute, we assessed the magnitude of biases for streamflow and water temperature gages. First, we calculated the maximum difference in cumulative frequency between the population and the sample for each landscape attribute (i.e., the greatest vertical difference between population and sampling CFDs). We then summarized the magnitude of bias by classifying the maximum difference using arbitrarily defined cutoffs: "low" (maximum difference between population and sample CFDs < 0.1), "moderate" (maximum difference between population and sample CFDs ≥ 0.1 and < 0.3), and "high" (maximum difference between population and sample CFDs ≥ 0.3). Second, we identified CFDs where the sample range was less than 90% of the population range and refer to these as "notably unsampled."

We found that the greatest landscape bias existed for watershed area.

RESULTS—IDENTIFIED BIASES

Of the 2,607,304 census population stream reaches in the conterminous United States, USGS gaging stations monitored streamflow for 20,362 (0.78%) reaches and water temperature for 1,673 (0.06%) reaches. The UMW had the greatest percentage of stream reaches with streamflow gages (2.66%) and the SAP had the lowest (0.25%). The percentage of stream reaches with temperature gages was much lower, with the SPL having the highest (0.13%) and the NPL the lowest (0.02%). Landscape characteristics of all census population stream reaches, including gaged reaches, are provided in Table A1 for the national extent and all ecoregions (see http://fisheries.org/appendices).

We present a subset of CFDs to illustrate typical biases for each landscape attribute; the full set of CFD plots for each attribute and all regions is available online (Figures A1–A6, see http://fisheries.org/appendices). Streamflow and water temperature sampling CFDs indicated that small (i.e., <10 km^2) and intermediate (i.e., ≥10 and <500 km^2) sized watersheds were highly underrepresented or notably unsampled at the national extent and in most ecoregions (Figure 2a, Table 2). Large watersheds (i.e., >10,000 km^2) were well represented in all regions (Figure A1, see http://fisheries.org/appendices), and biases were higher for water temperature gages than for streamflow gages in all regions.

Mean watershed elevation was generally better represented than watershed area for both streamflow and water temperature gages (Table 2; Figure 2b). However, relatively higher elevations were notably unsampled by streamflow gages in all regions, except the national and TPL, and by water temperature gages in all regions (Table 2). For example, the NPL had the highest magnitude of biases for both streamflow and water temperature gages, and high elevations (>2,200 m) were notably unsampled by water temperature gages (Figure 2b).

Urban land cover CFDs for streamflow gages showed moderate biases in nearly all regions and high bias in only the XER ecoregion, whereas biases for water temperature gages were high in four ecoregions (Table 2). Biases in most regions were due to undersampling of all but the highest percentages of urban land cover, and this tendency was greater for water temperature gages (see national, Figure 2c). The magnitude of undersampling was lowest in the NPL, but intermediate to high urban land cover was notably unsampled by streamflow and water temperature gages in this ecoregion (Figure 2c).

Biases for natural land cover were moderate in most regions for both streamflow and water temperature gages (Table 2). No region had low bias for streamflow gages, but the UMW had low bias for water temperature gages. The most common bias was oversampling areas with relatively high natural land cover, but the magnitude differed among regions. For example, at the national extent, streamflow gages oversampled natural land cover greater than 80%, whereas in the SAP streamflow gages oversampled natural land cover greater than 20% (Figure 2d). In contrast, only natural land cover greater than 85% was oversampled in the SPL, while almost all of the range was undersampled (Figure 2d).

Most regions had low or moderate landscape bias for agricultural land cover for streamflow gages and moderate or high bias for water temperature gages (Table 2). Biases in most regions were due to oversampling across a wide range of intermediate to high agricultural land cover (e.g., SPL), undersampling low agricultural land cover (e.g., XER), or a combination of these two (e.g., national; see Figure 2e). Stream reaches with higher values of agricultural land cover (>80%) were notably unsampled by streamflow gages in the NAP ecoregion and by water temperature gages in four ecoregions (e.g., SPL; Figure 2e).

DISCUSSION

Our analyses identified substantial landscape biases in streamflow and water temperature gages across several landscape attributes in one or more regions. Landscape biases were lower for flow gages than for temperature gages across all landscape attributes, partly because streamflow data are collected at more USGS gages than water temperature data. Biases were also generally greater within arid ecoregions of the western United States, where a lower percentage of streams were gaged. We found that the greatest landscape bias existed for watershed area, and this bias toward sampling larger rivers has been previously noted (e.g., Poff et al. 2006; Falcone et al. 2010). Higher elevation streams were entirely unsampled in some regions (e.g., NPL), which may be particularly important because shifts in air temperature and precipitation resulting from climate and land use changes may have pronounced effects on small, high elevation stream systems (Beniston et al. 1997). Large biases in the arid ecoregions of the western United States (e.g., XER) are also concerning because many of these streams contain endemic fishes of conservation concern and are already impaired from dams, water extraction, and nonnative fishes (Olden and Poff 2005).

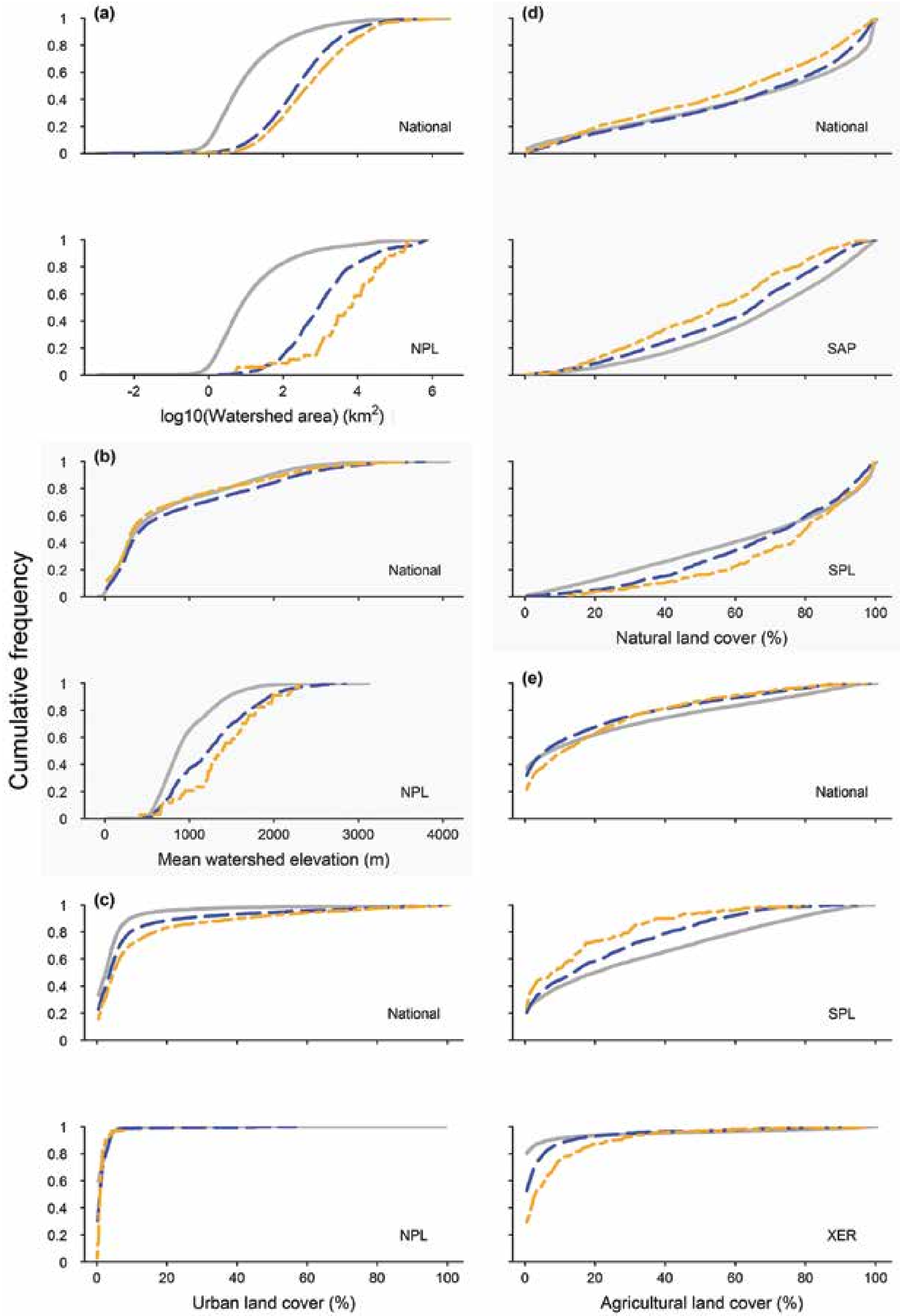

Figure 2. Cumulative frequency distributions for the national extent and selected ecoregions illustrating typical landscape biases for (a) watershed area (log10 (km^2)), (b) mean elevation (m), (c) urban land cover (%), (d) natural land cover (%), and (e) agricultural land cover (%). The solid grey line represents the population of stream reaches, the dashed blue line represents reaches with streamflow gages, and the orange dash-dot line represents reaches with water temperature gages.

Table 2. Summary of the landscape biases observed for each landscape attribute by region for streamflow and water temperature gages. We calculated the magnitude of bias as the maximum difference in cumulative frequency across all values in the sampling data and classified bias as low (maximum difference between population and sample CFDs < 0.1), moderate (maximum difference between population and sample CFDs ≥ 0.1 and < 0.3), and high (maximum difference between population and sample CFDs ≥ 0.3). Regions are listed in order of increasing bias for each landscape attribute. Bold font denotes regions where the landscape attribute sample range was < 90% of the population range.

Landscape attribute	Landscape bias		
	Low	Moderate	High
Streamflow data			
Watershed area	None	None	**UMW, CPL, NAP, WMT,** National, **SAP, XER, TPL, SPL, NPL**
Mean elevation	**NAP, UMW, WMT,** National, TPL, **SAP, CPL**	**SPL, XER, NPL**	None
Mean slope	**SAP, CPL, WMT, NAP, TPL, UMW**	**SPL, National, XER, NPL**	None
Natural land cover	None	SPL, UMW, SAP, National, CPL, NAP, TPL, NPL	WMT, XER
Urban land cover	SPL	**NPL**, National, UMW, WMT, NAP, TPL, SAP, CPL	XER
Agricultural land cover	SAP, National, CPL, UMW	WMT, SPL, NAP, TPL, **NPL, XER**	None
Water temperature data			
Watershed area	None	None	**UMW, SAP, NAP,** National, **CPL, TPL,** WMT, **SPL, XER, NPL**
Mean elevation	National, SAP	XER, SPL, WMT, UMW, NAP, TPL	CPL, NPL
Mean slope	National, WMT	SAP, TPL, SPL, UMW, CPL, XER	NPL
Natural land cover	UMW	TPL, National, **NAP,** SPL, **CPL,** SAP	**NPL,** WMT, XER
Urban land cover	None	**NPL,** SPL, TPL, National, **WMT, NAP**	CPL, SAP, UMW, XER
Agricultural land cover	SAP	**NAP,** CPL, UMW, National, WMT, SPL, **TPL**	**NPL, XER**

Are Biases Relevant?

Our results show that streamflow and water temperature data from USGS gages do not adequately represent key landscape attributes throughout the nation and in one or more ecoregions. The resulting landscape biases will be relevant to research and management efforts that attempt to characterize streamflow or water temperature within ungaged streams (i.e., to extrapolate from gaged to ungaged streams). If inferences are restricted to gaged streams, then the landscape biases reported here are irrelevant. However, many research and management efforts seek to draw inferences regarding large regions, and these inferences can be fundamentally altered by landscape bias.

When landscape biases are determined to be relevant, the next step is to assess the magnitude of biases for landscape attributes of interest. We have provided an example of how CFDs and selected landscape attributes can be used to characterize landscape bias in a rigorous and quantitative manner. However, we caution that our results may not be representative of other regions or of other landscape attributes.

Addressing Bias

At a minimum, landscape biases and their potential for introducing error must be acknowledged accurately and transparently when gage data are used to inform management decisions. However, a simple acknowledgement of bias may not always be sufficient. Thus, we also discuss three approaches that seek to reduce biases or limit associated errors in light of existing biases.

1. *Limit or qualify inferences.* The first strategy for addressing biases in USGS gage data is to limit or qualify inferences for regions or types of streams with large landscape biases. To illustrate this strategy, consider the biases and CFDs for agricultural land cover (Figure 2e). For example, landscape biases in water temperature data may be considered "too great" for the entirety of the NPL and XER ecoregions, and analyses could be limited to other ecoregions where data are more representative of agricultural land cover. Alternatively, inferences in the NPL and XER regions could be qualified to incorporate potential errors arising from bias in these regions. Similarly, this strategy can also be employed within a single region to limit or qualify inferences to subsets of streams based on magnitudes of bias. For example, in the XER ecoregion one may decide that water temperature gage biases are too great for streams with less than 30% agricultural land cover (Figure 2e) and either qualify inferences for this subset of streams or limit inferences to streams with more agricultural land cover.

2. *Compile supplemental data.* The second strategy is to compile supplemental streamflow and water temperature data from sources other than USGS gages. These supplemental data will help to reduce landscape bias when additional landscape variation is represented. Potential sources of supplemental data include Federal Energy Regulation Commission–licensed hydropower projects, National Pollutant Discharge Elimination System permit compliance monitoring data, U.S. EPA STORET, universities, watershed organizations, and state agencies. To illustrate the use of supplemental data, we appended the USGS water temperature data with data from federal, state, university, watershed organization, and two previously published (Gardner et al. 2003; Martin and Petty 2009) sources for a focused management region, the Eastern Brook Trout Joint Venture region (EBTJV; Figure 1). We included all

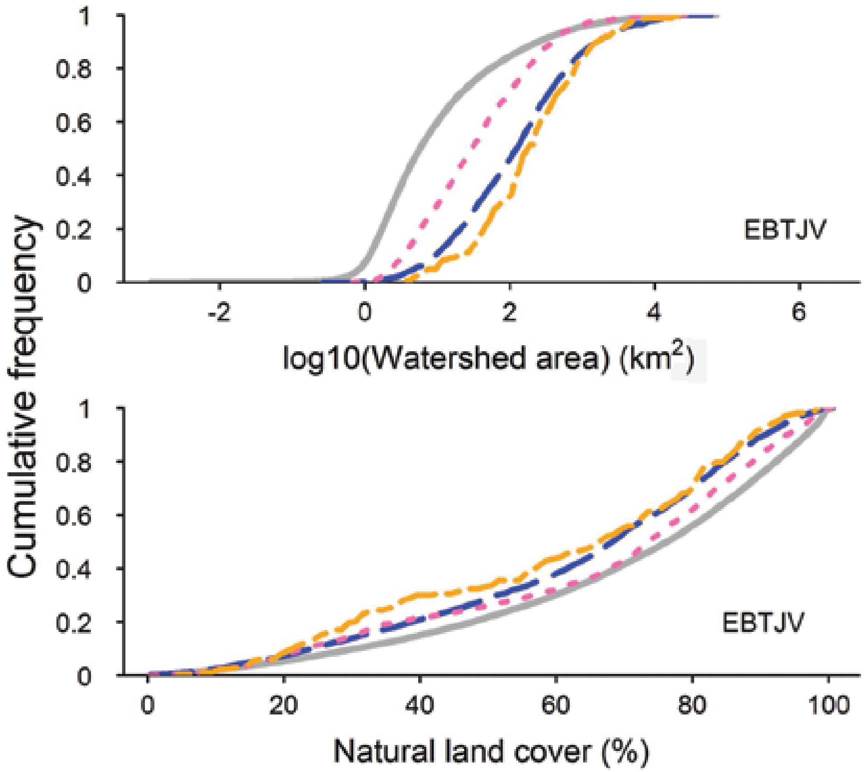

Figure 3. Cumulative frequency distributions illustrating the influence of including supplemental data on landscape biases for watershed area (km²) in the Eastern Brook Trout Joint Venture (EBTJV) region. The solid grey line represents the population of stream reaches, the long dashed blue line represents reaches with streamflow gages, the orange dash-dot line represents reaches with water temperature data from USGS gages only, and the short dashed pink line represents reaches where supplemental temperature gages were included in addition to USGS gages.

water temperature sampling locations where data were collected at a repetitive, systematic interval (hourly, bi-hourly, etc.) and used the same methods described above to create new CFD plots. A total of 1,480 additional stream reaches with temperature data were available for the EBTJV, and landscape biases for some landscape attributes were greatly reduced (e.g., watershed area; Figure 3).

3. *Modeling.* The final strategy is to use correlative, spatial, or mechanistic models in place of empirical streamflow and water temperature data. These models can then be used to support resource management decisions for many or all streams throughout a given region. Correlative models have been used widely to predict streamflow (e.g., Vogel et al. 1999) or water temperature (e.g., Mohseni et al. 1998; Wehrly et al. 2009) at unsampled locations based on empirical relationships with variables that are known and typically easy to measure (e.g., precipitation, air temperature). Spatial models incorporate distance and spatial connectivity between sample locations to predict streamflow or water temperature and may also include correlative relationships with other predictors (e.g., Peterson et al. 2007). For example, a spatial stream temperature model may accurately generalize to undersampled headwater reaches by interpolating upstream temperatures based on data from downstream gages. Finally, mechanistic (also referred to as deterministic or process-based) models may reduce landscape bias by predicting streamflow or water temperature based upon physical relationships with landscape attributes and other controlling factors (e.g., Soil & Water Assessment Tool, Arnold et al. 2012; heat budget analysis, Johnson 2004). Each of these types of models can, in some instances, be a powerful tool for estimating flow and/or temperature in ungaged stream reaches. However, it is important to note that landscape bias may be retained in model predictions if biased gage data are used for model calibration or validation purposes. Further, sufficient streamflow and/or water temperature data may not always be available to develop models that can generate accurate predictions in unsampled streams. In such cases, models that use climatic and/or landscape attributes as surrogates of water temperature and/or streamflow can inform management decisions in place of gage data. For example, thermally suitable habitat for Trout has been estimated from correlative models using mean July air temperature in Wyoming (Keleher and Rahel 1996) and elevation in the southern Appalachians (Flebbe et al. 2006) as surrogates of water temperature.

Strategies to Reduce Bias

Acknowledging and addressing existing landscape biases are only temporary, objective-specific solutions for using USGS streamflow and water temperature data sets. In the long term, a strategy to increase the representativeness of landscape attributes is needed to increase the utility of available data for addressing pressing objectives, such as predicting climate and land use change effects on stream hydrologic and thermal regimes. Construction of additional USGS gages is unlikely to greatly reduce landscape bias because financial resources are limited and gage locations are usually not selected solely to capture variation in landscape attributes. However, if the construction of new or redistribution of existing USGS gages becomes feasible, underrepresented streams identified herein could be targeted as one way of reducing landscape bias. A more cost-effective way to reduce landscape biases in available water temperature data is to expand water temperature monitoring to a greater proportion of existing USGS gages. A second cost-effective way to reduce landscape bias and increase the utility of available data is to coordinate supplemental data collection efforts and offer these data in standardized formats. Efforts of this type are already underway for water temperature data in some regions (e.g., Isaak 2011) and can greatly reduce landscape biases as we demonstrated in the EBTJV region.

CONCLUSIONS

We found that streamflow and water temperature data from USGS gages do not adequately represent key landscape attributes throughout the conterminous United States or within select ecoregions, which can lead to errors when attempting to infer or predict hydrologic or thermal properties of all streams in a region of interest. The greatest source of bias was undersampling of small (i.e., <10 km^2) to intermediate sized (i.e., ≥10 and <500 km^2) watersheds, but all landscape metrics showed large biases in one or more regions. Biases in USGS gage data were generally greater in arid regions of the Western United States and were almost always greater for water temperature data than streamflow data, in part because fewer USGS gages monitor water temperature. Our study provides a useful overview of landscape bias throughout the conterminous United States but likely underestimates landscape biases in currently active USGS gages because we used all gages where any streamflow or water temperature data had ever been collected. More restrictive subsets (e.g., currently active gages) are likely to have greater biases, and these biases must be quantified on a case-by-case basis. Reducing landscape biases in USGS data will require a comprehensive strategy, and our results suggest that making data from supplemental sources available in standardized formats can reduce biases and could be one part of this strategy. Despite inherent landscape biases, uniformly collected and reported USGS data remain the most valuable source of streamflow and water temperature data for the United States and will continue to be used widely to support resource management efforts. Nevertheless, landscape biases can fundamentally alter inferences and must be acknowledged as a potential source of error when gage data are used to support management decisions.

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The Status of Environmentally Enhanced Hydropower Turbines

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ABSTRACT: *Environmentally enhanced hydroelectric turbines have been developed to reduce injury and mortality of downstream-migrating fishes and to improve downstream water quality. Significant progress has been made in the past decade in the development of such turbines and in the methods to evaluate their biological and power generating performance. Full-scale demonstrations have verified the performance of Voith Hydro's minimum gap runner turbine, which maintains high survival rates for fish while producing more power than conventional designs. Despite a promising pilot study and subsequent design enhancements, similar full-scale demonstrations of the fish-friendly Alden turbine have yet to be conducted. Furthermore, the tools with which to predict and evaluate the performance of new turbine designs are available and are continually being improved. This article provides a status update of advances in this field over the past decade.*

El estado de las turbinas hidroeléctricas ambientalmente mejoradas

RESUMEN: *las turbinas hidroeléctricas ambientalmente mejoradas se desarrollaron para reducir los daños y mortalidad en los peces migratorios en los ríos y para mejorar la calidad del agua en éstos. Se ha logrado un progreso significativo en la última década en el desarrollo de las turbinas y de los métodos de evaluación de su desempeño en cuanto a generación de poder e impacto biológico. Demostraciones a escala real han servido para verificar el desempeño de una hidroturbina Voith de mínimo distanciamiento, la cual mantiene altas tasas de supervivencia en los peces al mismo tiempo que produce mayor cantidad de poder en comparación a los diseños tradicionales. Pese al prometedor estudio piloto y a las subsecuentes mejorías en el diseño, aún están por realizarse demostraciones similares en escala real de la turbina Alden "ictiológicamente-amigable". De hecho, las herramientas con las que se predice y evalúa el desempeño de nuevos diseños de turbinas, ya están disponibles y se encuentran en un continuo proceso de mejoramiento. Este artículo muestra una actualización del estado y avances en este campo durante la última década.*

INTRODUCTION

The advancement of hydroelectric power as a means to generate environmentally friendly, renewable energy depends in part on the success of newly developed technologies for addressing the principal environmental concerns. These concerns include the survival and condition of fish passing through turbines as well as the water quality downstream of hydro projects. In recent years, significant progress has been made in the development of environmentally enhanced conventional hydro turbines. Research and development (R&D) completed to date has considerably increased the hydropower industry's understanding of how fish are affected when passing through turbines. The R&D in this area has contributed to improvements in turbine design and operation that are expected to result in reduced fish injury and mortality; in addition, the employment of new aerating turbine designs has improved downstream water quality by increasing dissolved oxygen concentrations (Electric Power Research Institute [EPRI] and U.S. Department of Energy [DOE] 2011a).

Cada (2001) provided a comprehensive summary of the development of advanced hydroelectric turbines and research on fish injury mechanisms at the time. We present herein a status update of recent advances in the design and evaluation of so-called fish-friendly hydroelectric turbines. In addition to a summary of advancements in turbine design, we include a review of the biological, physical, and numerical investigations that have been conducted to better define the fish injury and mortality mechanisms associated with turbine passage.

ADVANCED TURBINE RESEARCH AND DEVELOPMENT

U.S. Department of Energy

The U.S. DOE, the EPRI, and the Hydropower Research Foundation, Inc., established the Advanced Hydropower Turbine Systems (AHTS) Program in 1994 to support the development of environmentally friendly turbine technologies. Specifically, the AHTS Program aimed to advance the development of turbines that minimize injury and mortality of fish, maintain satisfactory downstream water quality, and produce energy efficiently (Odeh 1999). During the program's life, it funded various R&D efforts that met the DOE's objectives and, most notably, initiated the development of two advanced turbine designs: the Alden turbine and the Voith Minimum Gap Runner (MGR). The DOE Hydropower Program was closed in 2005 due to lack of funding (Sale et al. 2006) but was reinstituted 4 years later as the DOE Water Power Program.

Despite the end of the DOE's original Hydropower Program in 2005, development and testing of advanced turbines continued in various arenas. The DOE's Pacific Northwest National Laboratory (PNNL) continued to conduct research on injury and mortality mechanisms associated with turbine passage. The U.S. Army Corps of Engineers (USACE), through its Turbine Survival Program (TSP), conducts research to improve the knowledge of the turbine passage environment and its impact on fish. The TSP provides the framework to optimize turbine operations for safer fish passage and improve future turbine designs for fish passage (Medina and Shutters 2011). The EPRI has supported further R&D of the fish-friendly Alden turbine through both numeric modeling and biological evaluations to improve the power generation and biological performance of the unit. Since its return in 2009, the DOE Water Power Program has begun to revitalize hydropower through resource assessments, demonstration projects, and engineering and environmental R&D (U.S. DOE 2014).

Pacific Northwest National Laboratory

A clear understanding of the stresses acting on fish passing through turbines and their responses to those stresses is critical to designing turbines that are fish-friendly. To that end, the PNNL has been conducting controlled laboratory research on the effects of known injury and mortality mechanisms in the turbine passage environment. PNNL biologists and engineers have focused on the effects of shear, pressure, and gas supersaturation on salmonids passing through turbines. The responses of fish exposed to these injury mechanisms in the laboratory can be combined with computational fluid dynamics (CFD) simulations that can predict the levels of these stresses in the turbine environment. By coupling biological response data from the laboratory with predicted stress levels generated from CFD simulations, scientists are able to predict injury and survival of turbine-passed fish under various conditions (Richmond 2011).

Most recently, the PNNL has focused its laboratory research on determining the effects of barotrauma on fish passing through turbines (Brown et al. 2009, 2012a, 2012b; Colotelo et al. 2012). Using computer-controlled hyper/hypobaric chambers researchers expose fish to simulated turbine passage pressure changes and assess injury and survival. Results indicated that the injuries sustained during rapid decompression mainly result from swim bladder rupture rather than from gas dissolution from the blood (Brown et al. 2012b). In addition, Brown et al. (2012a) concluded that the principal factor affecting mortal injury of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) during simulated turbine passage was the ratio between a fish's acclimation pressure and the lowest pressure to which it was exposed (nadir). The PNNL has also demonstrated that the presence of surgically implanted telemetry transmitters (used to track movements of downstream migrating smolts) negatively affects turbine passage survival of juvenile Chinook Salmon (Brown et al. 2009; Carlson et al. 2010, 2012). In response to these results, the PNNL has been developing neutrally buoyant, externally attached transmitters for use in turbine passage studies (Deng et al. 2011) in order to minimize the risk of bias resulting from this artificial source of mortality.

Releases of "sensor fish" through turbines at hydro projects have also provided a means to characterize the hydraulic signature of the turbine passage environment (Deng et al. 2010). The sensor fish is a PNNL-developed tool that has shed light on the hydraulic characteristics of flow passing through turbines. It is a cylindrical, polycarbonate instrument roughly the size of a juvenile salmon and can be used to sense changes in pressure, angular rate of change in position, and linear accelerations during turbine passage. The PNNL is comparing hydraulic field data (such as those provided by the sensor fish) with results of CFD simulations and predictions of injury risk in order to develop a comprehensive method for predicting the biological performance of turbines—the PNNL's Biological Performance Assessment (Richmond 2011). Because field-based biological evaluations of newly installed turbines can be expensive, the Biological Performance Assessment method represents a cost-effective means to bridge the gap between fish evaluations in the laboratory and post-installation field evaluations.

U.S. ARMY CORPS OF ENGINEERS TURBINE SURVIVAL PROGRAM

The USACE established the TSP in 1997 in response to the request of the Northwest Power Planning and Conservation Council and the National Marine Fisheries Service (NMFS) to increase the survival of out-migrating salmonids in the Columbia River (Medina and Shutters 2011). The goals of the TSP are to (1) improve the understanding of the turbine passage environment and its impact on downstream migrating juvenile salmonids, (2) optimize operations of existing turbines for safer fish passage, and (3) improve future turbine designs for safer fish passage. The TSP is a collaborative effort between the USACE Walla Walla and Portland Districts, the Hydroeletric Design Center (HDC), the Engineering Research and Development Center (ERDC) and the NMFS.

The USACE is currently in the process of redesigning replacement turbines for the 603-MW Ice Harbor project on the lower Snake River in Washington State. This work is being conducted collaboratively with Voith Hydro and was formulated as a unique iterative design process with an overall goal of providing safer fish passage for salmon smolts (Nelson and Freeman 2011). The design process progresses from CFD simulations to performance (physical) model testing to the testing of an observational (physical) model at a 1:25 scale. The observational models are constructed at the ERDC of acrylic to allow visualization of streamlines created by the passage of dye and small, neutrally buoyant beads (Figure 1, left). Laser Doppler velocimetry is used to quantify flow characteristics in the models. The objective of the new turbine design is to minimize risks posed by mechanical strike, shear, turbulence, and pres-

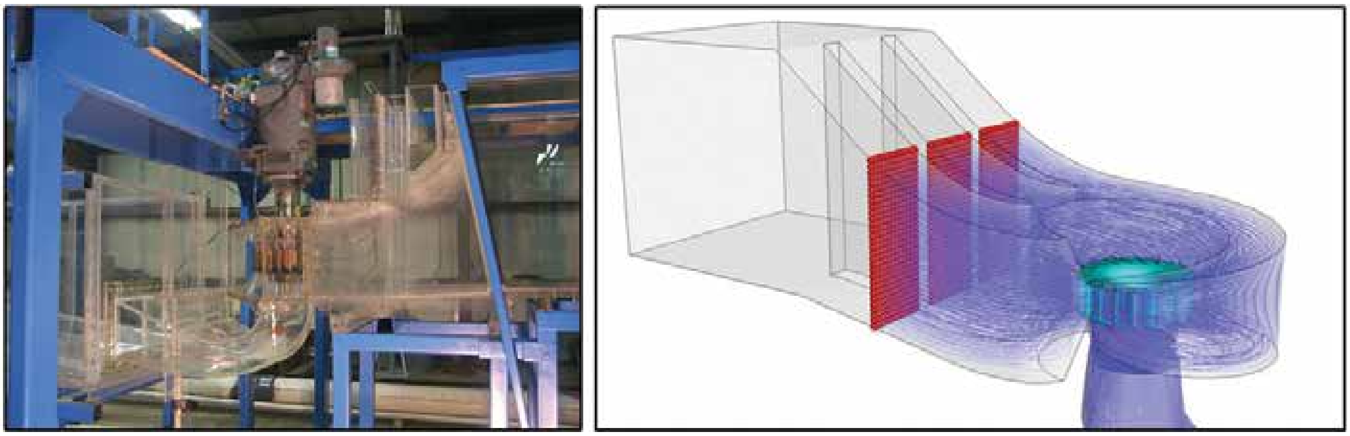

Figure 1. Left: U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC) hydraulic observational turbine model (1:25 scale) for the Ice Harbor runner replacement project. Photo credit: USACE. Right: Computational fluid dynamics (CFD) model used to predict the probability of fish passage through various regions of the turbine. Photo credit: USACE.

sure change (Nelson and Freeman 2011). Installation of the new runner for Unit 2 is projected to be completed by the summer of 2016 with biological testing to occur the following year.

The USACE is also using CFD to predict the characteristics of the flow field in the turbine runner environment (Figure 1, right). This numerical simulation approach has been used to support a pressure risk analysis for salmon smolts passing through the Kaplan units at the John Day Powerhouse on the Columbia River. Comparison of the pressure regimes predicted by the CFD model to the pressures documented with sensor fish passage indicates that CFD is a viable tool for assessing the risk of exposure to nadir (lowest) pressures (Kiel and Ebner 2011). This information can be combined with acclimation distribution and pressure mortality relationships to predict a mortality risk due to pressure (Trumbo et al. 2013).

Industry

The hydropower industry has also made significant strides in advancing the science of environmentally enhanced turbines. Fisheries biologists continue to rely on release–recapture methods to assess turbine passage injury and survival in the field with balloon tags (aka Hi-Z Turb'N tags). Balloon tag studies are considered the industry standard and have been used for evaluating injury and survival of fish passed through environmentally enhanced turbines at various projects, including Bonneville Dam First Powerhouse on the lower Columbia River (Normandeau Associates et al. 2000), Wanapum Dam on the mid-Columbia River (Normandeau Associates et al. 2006), the Box Canyon Hydroelectric Project on the Pend Oreille River (EES Consulting 2011), Kelsey Station on the Nelson River in Manitoba, and at a French hydro project on the Rhine River (Heisey and Avalos 2011). Carlson and Richmond (2011) noted that balloon-tagged fish may not be neutrally buoyant before release, making it difficult to parse the effects of rapid decompression from other injury mechanisms on overall turbine passage survival. In addition to the field-based evaluations, private industry contributes heavily to the advancement of environmentally friendly hydropower through laboratory and CFD evaluations of critical turbine aspects that influence injury and mortality of entrained fish, such as leading-edge blade geometry (EPRI 2007a, 2008, 2011).

NEW TURBINE TECHNOLOGIES

Fish-Friendly Turbines

Alden Turbine

The Alden turbine is a relatively new hydro turbine runner design with fish-friendly characteristics. It was conceptualized and tested at a pilot scale in the laboratory under the former DOE AHTS Program for fish survivability (Cook et al. 2003). More recently, the EPRI (2007a, 2007b, 2008, 2009; EPRI and DOE 2011b) has overseen the laboratory and numerical modeling R&D of the Alden turbine with a goal of optimizing its biological and power generating performance.

The Alden turbine was initially developed using two- and three-dimensional CFD models (Cook et al. 1997, 2003; Lin et al. 2004; Hecker and Cook 2005), later being refined with additional three-dimensional CFD simulations (EPRI 2007a, 2009; EPRI and DOE 2011b).

As part of the development of the Alden turbine, the EPRI (2007a, 2008, 2011) conducted laboratory evaluations of the parameters that affect fish survival due to blade strike. Trials were conducted with a representative bony fish (Rainbow Trout, *Oncorhynchus mykiss*) and a representative cartilaginous fish (White Sturgeon, *Acipenser transmontanus*). Results generally indicated that the ratio of fish length to blade thickness is an important factor, with survival increasing as the ratio decreases. Survival also increased with decreasing strike velocity for trout, with velocities of about 5 m/s or less causing no mortality for any of the fish length–to–blade thickness ratios that were tested (up to a ratio of 25). Notably, survival of sturgeon was greater than that of trout, indicating that physical characteristics of sturgeon (e.g., cartilaginous skeleton, tough integument, and more robust scales, which are also referred to as "scutes") result in less injury from blade strike. This observation was also consistent with the results of the pilot-scale biological evaluation of the Alden turbine (Cook et al. 2003), which demonstrated that White Sturgeon had statistically higher passage survival than the bony fish that were tested (Rainbow Trout, Alewife [*Alosa pseudoharengus*], Coho Salmon [*Oncorhynchus kisutch*], and Smallmouth Bass [*Micropterus dolomieu*]). Results of the blade strike experiments were incorporated into the redesign of the Alden turbine (i.e., incorporation of a thicker blade leading edge) and also hold potential for improving the design of other turbine types (Amaral and Hecker 2011).

Most recently, the Alden turbine underwent mechanical engineering and physical model testing by Voith Hydro (Figure 2), resulting in a commercially available unit predicted to yield fish passage survival rates of 98% or greater for fish less than 20 cm (8 in.) in length and a maximum best efficiency point efficiency of about 94% (EPRI and DOE 2011b). Hecker et al. (2011) have also verified that the CFD model developed for evaluation of the Alden turbine agrees well with the physical model testing done by Voith Hydro. This indicates that the internal runner hydraulics, which were designed to specific biological criteria for safe fish passage, are predicted accurately by the CFD model.

However, the fish survival predictions of the Alden turbine remain to be validated at a full scale in the field. To that end, the EPRI and Alden are actively seeking a demonstration site for a full-scale Alden turbine (Perkins and Dixon 2011). In 2011, the DOE Water Power Program offered its support of this effort, and although the initially selected demonstration site project has since been withdrawn by the power company, the DOE has continued to express its support in identifying an alternate demonstration site for the Alden turbine.

Minimum Gap Runner

The MGR is a modification of a Kaplan turbine in which the gaps between the adjustable runner blade and the hub, and

Figure 2. Alden turbine physical model (1:8.7 scale) used for performance testing by Voith Hydro. Photo credit: Alden Research Laboratory.

Figure 3. Voith Hydro Minimum Gap Runner (MGR) during installation at Wanapum Dam on the Columbia River in Washington State in 2005. Photo credit: Grant County Public Utility District.

between the blade tip and the discharge ring, are minimized at all blade positions (Cada 2001; Figure 3). In addition, there is no overhang of the trailing part of the wicket gate. It has been suggested that these modifications would decrease the fish injury and mortality caused by grinding (fish are injured passing through the narrow, sharp-edged gaps) and the locally high shear stresses, turbulence, and cavitation in the fluid flow created by the gaps. These modifications were also expected to result in efficiency improvements (Odeh 1999). A team of organizations led by Voith Hydro is credited with having developed the MGR under the former DOE AHTS Program, and other manufacturers (e.g., Alstom, Andritz Hydro) have since developed turbines with similar features. MGRs are a product of numerous studies supported by the DOE and USACE TSP. They have been installed and tested at three projects in the Pacific Northwest.

The first installation of an MGR was at the Bonneville Dam First Powerhouse on the lower Columbia River. The MGR turbine was put into commercial operation on 27 July 1999. Survival of juvenile Chinook Salmon through the MGR turbine was subsequently tested between November 1999 and January 2000 (Normandeau Associates et al. 2000). Direct survivals through the new MGR Unit 6 were estimated for three release locations (designed to direct fish toward the hub, mid-blade, and blade tip of the runner) and various power levels (operating efficiencies) and compared to those for the standard Kaplan Unit 5. Turbine passage survivals for the MGR were highest for fish directed toward the hub, intermediate for fish directed toward mid-blade, and lowest for fish directed toward the blade tips. No statistically significant correlations were found between fish passage survival and turbine operating efficiency for either turbine type. Fish passage survival through the MGR was equal to or better than survival through the standard Kaplan, especially for fish directed toward the blade tip; near the hub, survival probabilities were generally greater than 98% for both types of turbines. Overall, significant differences in passage survival were observed between release locations (fish directed toward the tip versus fish directed toward the other two blade locations) but not between turbines (Normandeau Associates et al. 2000). Ploskey et al. (2007) concluded that the Unit 6 MGR did not provide substantive improvement in fish survival over the relatively high survivals already occurring with the existing, standard Kaplan turbine installed in Unit 5.

In addition to good fish passage survival, the new MGR turbines are more efficient and the Bonneville First Powerhouse is expected to produce 15% more electricity with the new turbines. Because of the combined benefits of good fish passage survival and increased power production, replacement of all 10 of the old Kaplan turbines with MGRs continued at the Bonneville First Powerhouse (USACE 2008). Commissioning of the last turbine replacement occurred in January 2011.

The MGR has also been evaluated at the Wanapum Dam in Washington State. Wanapum Dam is one of two dams that comprise the Priest Rapids Project on the mid-Columbia River, Washington. The Wanapum dam had 10 conventional Kaplan turbines that had been operating for over 40 years and were reaching the end of their useful life. In 2005, Public Utility District No. 2 of Grant County began replacing all 10 Kaplan turbines at Wanapum Dam with advanced MGR turbines that were developed with support from the DOE AHTS Program. Compared to the existing Kaplan turbine, the MGR turbine was predicted to have lower values for several potential fish injury mechanisms: shear stress, turbulence, cavitation, and grinding. On the other hand, the MGR has more blades (six vs. five) and more wicket gates (32 vs. 20) than the existing Kaplan turbines at Wanapum, which might increase the potential for strike injuries.

Installation and preliminary engineering performance testing of the MGR at Wanapum Unit 8 were completed by mid-February 2005. Fish survival tests using balloon-tagged and passive integrated transponder–tagged fish were carried out in February, March, and April 2005 (Skalski et al. 2005). Tagged fish were passed through two turbines (the new MGR in Unit 8 and the conventional Kaplan turbine in Unit 9), all three intake bays in each turbine, two intake release depths (3 m [10 ft] and 9 m [30 ft]), and five turbine flows (255, 311, 425, 481, and 524 m^3/s [9,000, 11,000 15,000, 17,000, and 18,500 ft^3/s]). Releases of a total of 8,960 balloon-tagged fish were used to quantify direct mortality associated with turbine passage. Further, 1,000 releases of the sensor fish (Carlson and Duncan 2003) provided information on passage conditions (velocities, accelerations, and water pressures) within the turbines and draft tubes. Over the range of turbine discharges and release depths, 48-h survivals ranged from 94.04% to 99.56% for the MGR and from 95.23% to 99.23% for the existing Kaplan (Skalski et al. 2005). The overall weighted mean survival for the MGR of 97.8% was not significantly different from that of the existing Kaplan of 97.7%.

Because of good fish passage survival and increased power production, Public Utility District No. 2 of Grant County had replaced eight of the Kaplans with MGRs by 2011 and plans to have all 10 turbines replaced by 2014. Other than the initial tests carried out on the first MGR in 2005, no other fish studies have been conducted to date. Under the terms of the new project license (Federal Energy Regulatory Commission 2008), additional fish testing is planned upon completion of the Wanapum turbine replacement project.

The Pend Oreille PUD is in the process of replacing the four existing turbines at the Box Canyon Hydroelectric project on the Pend Oreille River in northeast Washington State with more fish-friendly units manufactured by Andritz Hydro. The new units are expected to improve turbine passage survival while increasing power production. Compared to the existing Kaplan turbines at Box Canyon, the new turbines have fewer blades (four vs. five) and minimum gaps at the blade tips and runner hubs (EES Consulting 2011). A balloon-tag study was carried out in late 2011 to compare the direct injuries and mortalities among juvenile and adult Rainbow Trout that passed through a new MGR turbine and an existing Kaplan turbine (Normandeau Associates 2012). Rainbow Trout were released at three locations to direct them toward the hub, mid-blade, and tip regions of the runners. The most common injuries (decapitation or severed bodies) were indicative of mechanical strike and were more frequent among adults than juveniles. The 48-h survival probabilities for juvenile Rainbow Trout were 96.5% for both the original Kaplan turbine and the new MGR. The 48-h survival probabilities for adult rainbow trout were 83.8% for the original Kaplan and 84.9% for the MGR. For both juvenile and adult Rainbow Trout, there were no statistically significant differences between the MGR and the Kaplan in terms of 1-h and 48-h survival estimates. The nameplate electrical output of the new MGR unit is 30% greater than the Kaplan at the Box Canyon Project (22.5 MW vs. 17.25 MW, respectively). Replacement of all four units is estimated to be complete by 2014 (Atyeo 2010).

Low Head Turbines

With resurgence of interest in the development of renewable hydropower resources, several low-head turbine designs have been recently developed for use at non-powered dams or small dams with decommissioned or abandoned power facilities. Some of these designs have also been described as being fish-friendly and some developers have indicated that turbine passage survival rates will be high due to design and operational parameters that will result in low injury rates. A hydraulic head of 20 m (66 ft) or less is considered low head; very low head is considered 3 m (10 ft) or less.

Very Low Head Turbine

The very low head (VLH) turbine design, which incorporates a Kaplan runner with eight blades, has been developed by MJ2 Technologies (Leclerc 2008). The VLH turbine is designed for heads between 1.4 and 4.5 m (5 and 15 ft) and flows between 10 and 30 m^3/s (353 and 1,059 ft^3/s). The VLH design is described as having an integrated generating set that prevents the need for sophisticated intake and discharge civil structures.

This allows the turbine to be installed in sluiceway-type passages from which it can be easily removed with a crane (Leclerc 2008). The VLH turbine design is considered fish-friendly by the developer; Lagarrigue and Frey (2011) cited the following fish-friendly design characteristics: a large diameter runner (4.5 m [14.8 ft]) with large spaces between blades, low runner speed (approximately 40 cpm [40 rpm]), water velocity inside the runner less than 2 m/s (6.6 ft/sec), small pressure variations, and minimization of gaps.

Turbine passage survival tests were completed by the manufacturer's consultant, Etudes et Conseils en Gestion de l'Environnement Aquatique (ECOGEA), and the results have been made available via the company's periodic newsletters and the consultant's reports. Initial turbine passage survival tests were conducted in 2008 at a site in Millau, France, with a prototype VLH turbine using Atlantic Salmon (*Salmo salar*) smolts (Lagarrigue et al. 2008). Tested smolts measured 147 to 240 mm (5.8 to 9.4 in.) long and weighed between 34 and 150 g (1.2 to 5.3 oz.). Fish were injected at the runner periphery, mid-blade, and at the hub. Overall immediate turbine passage survival was 96.9% for smolts (Lagarrigue et al. 2008) with fish released at the periphery, mid-blade, and hub having survivals of 94.5%, 98.6%, and 99.0%, respectively. Extended survival for all release groups combined (72 to 96 h) averaged 98.6%. However, extended survival for control groups averaged 97.9%; therefore, latent effects of passage were dismissed as negligible.

Additional fish passage tests were completed with the VLH turbine in 2008 with 150 European eels (*Anguilla anguilla*; Leclerc 2008). When the data were averaged, the overall survival rate for passage of adult eels (0.7 to 1.2 m [28 to 47 in.] long and 0.8 to 2 kg [1.8 to 4.4 lb.]) through the VLH turbine was 95%, though there is no documentation of whether this was immediate or extended survival. Survival varied based on injection location, with the highest survival rates documented for fish injected near the hub (100%) and the lowest for fish injected near the blade tips (84%). No information was provided about the statistical significance of these differences (Leclerc 2008).

Additional turbine passage evaluations were conducted with a modified VLH turbine design in 2010 on the Moselle River in France with 200 yellow and silver phase eels (0.6 to 1.0 m [23.6 to 39.4 in.] long and 0.6 to 2.0 kg [1.3 to 4.4 lb.]; Lagarrigue and Frey 2011). More recent tests were conducted in May and June of 2013 with hatchery-reared Rainbow Trout, Common Carp (*Cyprinus carpio*), and Tench (*Tinca tinca*) at the La Glaciere plant on the Tarn River. Results indicate that overall survival was between 95.6% and 100% for all species and sizes tested (Lagarrigue 2013).Though these data are encouraging, data on passage survival of other species would be valuable.

Archimedes Screw Turbine

Archimedes screw turbines are considered to be fish-friendly due to their very low rotational and tip speeds (about 30 rpm and 3.8 m/s [12.5 ft/s], respectively), lack of significant pressure changes or damaging shear forces, and minimal number of blades (typically three or fewer). Archimedes screw turbines typically have diameters between 1.5 and 3.5 m (4.9 to 11.5 ft) and are appropriate for sites with a head of 10 m (33 ft) or less (Figure 4). Evaluations of injury and mortality of fish passed through Archimedes screw turbines have been conducted with a variety of species and size classes (Spah 2001; Fishtek Consulting 2007, 2008, 2009a, 2009b) and indicate that adult European eels, sea-run Brown Trout (*Salmo trutta*), and Atlantic Salmon kelts experience minimal or no injury and no mortality.

More recently, Bracken and Lucas (2013) assessed the potential impact of an Archimedes screw turbine on downstream migrating larval and juvenile River Lamprey (*Lampetra fluviatilis*) in northeast England (River Derwent). Drift netting in the turbine discharge documented no mortality and low injury rates (1.5%); however, the authors noted that the full turbine discharge was not completely sampled.

SUMMARY

The R&D of environmentally enhanced turbines continues to evolve in response to increased demand for renewable energy generation with minimal environmental impacts. Since Cada (2001) first reported on the development of advanced hydroelectric turbines designed to protect fish in 2001, the science of safely passing fish through turbines has expanded considerably. The use of CFD, for instance, has become much more prevalent and more widely accepted for identifying areas of concern in the turbine passage environment. Similarly, the use of three-dimensional acoustic telemetry tags and sensor fish has provided much greater resolution on the behavior of fish approaching turbines and the stresses they experience during passage. These advanced tools give researchers the ability to fine-tune the engineering design and flow characteristics of hydropower projects, particularly within the complex turbine environment, to improve passage survival. Table 1 provides a summary of the characteristics of the fish-friendly turbines discussed above.

The application of advanced turbine designs such as the MGR has resulted in increased power production (up to 30% at the Box Canyon Project) without concurrent increases in fish

Figure 4. Archimedes screw turbine installed on the River Dart in the UK. Photo credit: Fishtek Consulting.

injury or mortality—more power with no greater impact to fish. With passage survival estimated at 98% and greater, the Alden turbine may represent an alternative to other conventional approaches for safely passing fish downstream, with the added benefit of generating power from flows that would otherwise be spilled or bypassed around turbines.

A host of groups (federal, nonprofit, and private) are actively applying the latest tools to design and redesign turbines to make them more environmentally friendly. For example, the USACE is currently working with Voith Hydro on the redesign of the replacement runners for the Ice Harbor Project. The contract mechanism is vastly different from typical federal hydropower contracts in that the goal is to work collaboratively using all available tools to develop a turbine with improved fish passage survival, rather than simply emphasizing power performance.

With an aging fleet of hydropower turbines and undeveloped hydropower resources at existing non-powered dams in the United States (estimated to have the potential to increase hydropower capacity by 15%; Hadjerioua et al. 2012; Figure 5), there is an opportunity to reap environmental benefits of new turbine designs while concurrently increasing the contribution of hydropower to the domestic renewable energy portfolio.

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Table 1. Summary of fish-friendly turbine characteristics: premise of development, application ranges, operational details, and fish passage survival.

		Application range						
Fish-friendly turbine type	Premise of development	Flow range (ft³/s)	Head range (ft)	Number of blades	Speed (rpm)	Passage survival	Notes	Reference
MGR	Reduce gaps in a conventional Kaplan unit to minimize potential for injury and increase power output	6,200 to 18,500[1]	41 to 77[1]	4 to 6[1]	75 to 100[1]	Bonneville: 93.9 to 98.2%; Wanapum: 97.8% (overall weighted mean); Box Canyon: 96.5% (extended) for juveniles and 84.9% (extended) for adults	In each case, passage survival was not significantly different from conventional Kaplan units, though MGRs produced more power comparatively	for Bonneville: Normandeau et al. (2000); for Wanapum: Skalski et al. (2005); for Box Canyon: Normandeau (2012)
Alden	Design new turbine runner using known fish injury mechanism thresholds as design criteria	600 to 11,500	30 to 120	3	≤ 120	98% (predicted)	Survival is predicted; not yet field validated	EPRI and DOE (2011b)
VLH	Modify a Kaplan unit to target very low head; minimize civil engineering costs	353 to 1,059	5 to 15	8	≤ 40	Millau 2008: 98.6% for Atlantic aalmon smolts (overall extended); Frouard 2010: 100% for eels (extended); Millau 2013: 95.6 to 100% for Rainbow Trout and Carp	2008 testing was with a prototype unit; later tests were with modified units	for Millau 2008: Lagarrigue et al. (2008); for Frouard 2010: Lagarrigue and Frey (2011); for Millau 2013: Lagarrigue (2013)
Archimedes	Adapt ancient pumping technology for power generation at very low head	4 to 353	3 to 33	3 to 5 (typically 3)	≤ 40	River Dart: 100% for eels and salmon kelts; River Derwent: 100% for all species	Small sample sizes were used for most species	for River Dart: Fishtek Consulting (2008); for River Derwent: Fishtek Consulting (2009a)

[1] Operational ranges based on installations at Bonneville, Wanapum, and Box Canyon.

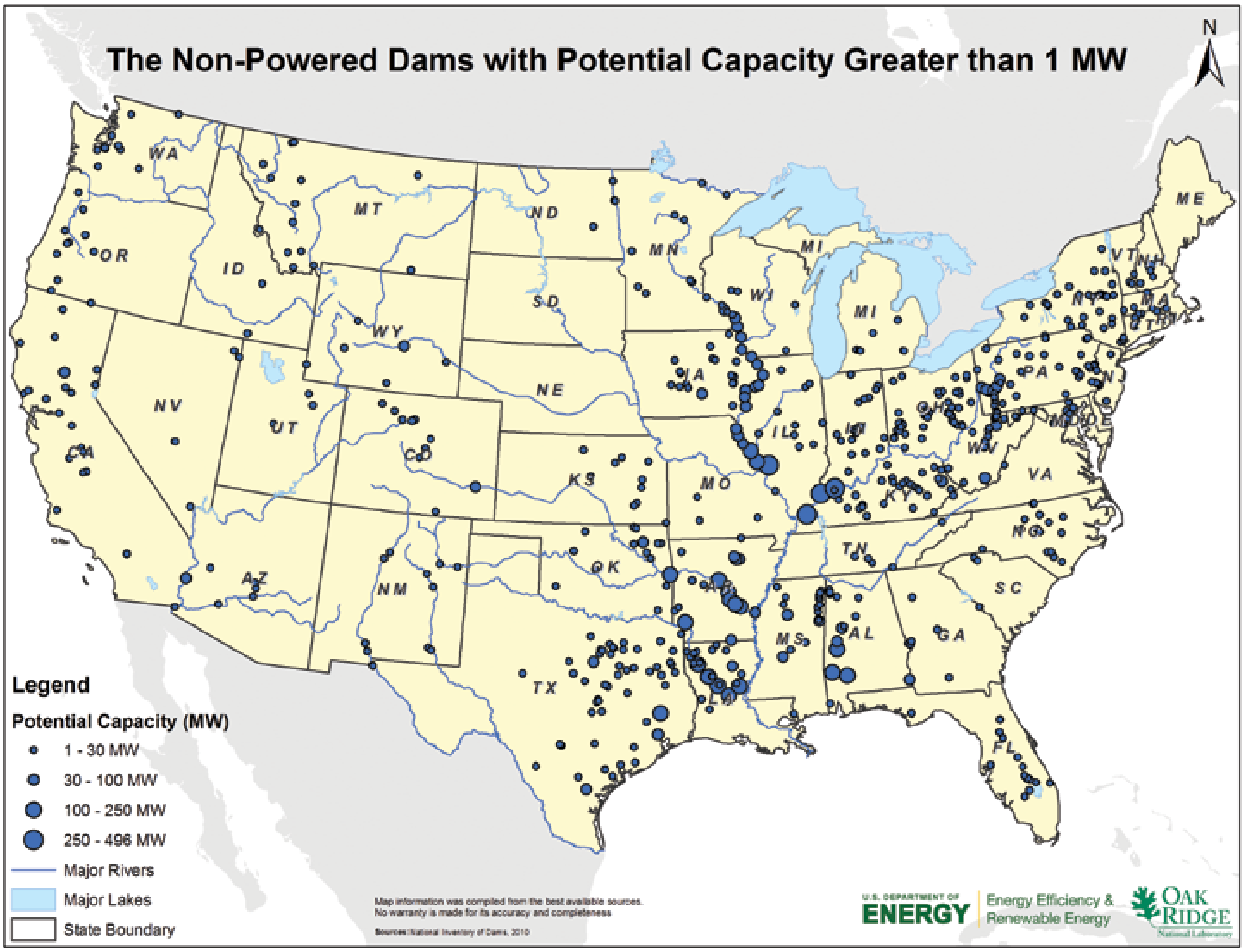

Figure 5. Location of the top non-powered dams in the United States with potential capacities greater than 1 MW.

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90 YEARS AGO - FROM THE ARCHIVES

On May 16th of this year a Conference was called of representatives from every out-of-door section of the country, including everything from Child Welfare to the Conservation of the Forests Fish and Game. This was the first message, so to speak, from the President of the United States to all the people of the United States that out-of-door recreation was of prime importance. The Conference was an exceedingly comprehensive one. It was attended by five or six hundred delegates, and President Coolidge in his opening address, which did not take more than twelve or fifteen minutes, made a clarion call that rang all over the world—it was a wonderful thing.

F. C. Walcott (1924): Report of committee to attend the President's Conference on Outdoor Recreation, *Transactions of the American Fisheries Society*, 54:1, 17.

Validating and Improving Life History Data in FishBase

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ABSTRACT: *Life history parameters of fish stocks are central to ecological research and management, including the fields of macro-ecology, fisheries science, and ecosystem modeling. The need for such information has led to several life history databases being developed to support and disseminate this information publicly. However, there has been little independent evaluation of the precision and accuracy of the life history values in these databases. This article summarizes a recent evaluation of FishBase, one of the largest and oldest life history databases, by distinguishing biases among seven life history parameters, two types of information available in FishBase (i.e., Entered vs. Generated data), and two taxa (i.e., Teleost vs. Chondrichthyan). In general, the study shows that certain types of information like data "entered" by experts are relatively accurate and precise, while empirically "generated" were not. We conclude with some ideas on how American Fisheries Society members can improve upon the data already available within FishBase.*

Validación y mejoramiento de datos de historia de vida en FishBase

RESUMEN: *los parámetros de la historia de vida de los stocks de peces son parte fundamental de la investigación ecológica y del manejo, lo que incluye a disciplinas como la macroecología, la ciencia pesquera y la modelación ecológica. La necesidad de conocer estos aspectos ha impulsado la creación y desarrollo de distintas bases de datos de historia de vida con el fin de mantener y difundir públicamente esta información. Sin embargo, ha habido pocas evaluaciones de carácter independiente acerca de la precisión y exactitud de los valores de historia de vida en dichas bases. En este artículo se sintetiza una evaluación hecha recientemente a FishBase, una de las bases de datos más grande y antigua de historias de vida, en la que se hizo una distinción de sesgos entre siete parámetros de historia de vida, entre dos tipos de información disponible en FishBase (i.e. capturada vs. datos generados) y entre dos taxa (i.e. teleósteos vs. condrictios). En general, el estudio muestra que ciertos tipos de información como datos "capturados" por expertos son relativamente precisos y exactos, mientras que aquellos "generados" empíricamente no lo fueron. Se concluye con algunas ideas sobre cómo los miembros de la Sociedad Americana de Pesquerías pueden mejorar los datos disponibles en FishBase.*

INTRODUCTION

In the late 1980s, FishBase began cataloging key life history parameters of the world's fish species (Froese and Pauly 2000). Some 20 years later, FishBase is an important online resource that now contains information on over 30,000 fish species and receives approximately 1 million web page downloads and half a million visitors per month (R. Froese, FishBase, personal communication). The success of FishBase can be attributed to its ability to fill a critical gap in fisheries science—the need of life history information on individual species to contribute to such things as:

- trade-off analysis of management actions (e.g., Magnusson and Hilborn 2007; Cope and Punt 2009);
- vulnerability assessments (e.g., Musick 1999; Hobday et al. 2011);
- stock assessments (e.g., Jennings et al. 2001; Caswell 2006);
- meta-analyses of life history theory (Zhou et al. 2012); and
- large marine ecosystem models (e.g., Pauly et al. 1998; Worm et al. 2009).

Yet despite the large number of published articles citing FishBase (Stergiou and Tsikliras 2006), skepticism by fellow colleagues, journal peer reviewers, and science committees of fishery management councils and commissions remains when a scientist mentions that his or her research relies on life history values reported in FishBase. At the forefront of this skepticism are questions of accuracy and precision in FishBase information. For example, life history parameters for different populations of the same species may differ due to inherent population specific differences in life history traits (Cope 2006), and thus parameters derived from geographically distant populations may be less precise for local applications than locally derived parameters. Life history parameters may also be imprecise if there is large sampling error associated with their estimation in any given field study. In this case, multiple studies are likely to result in highly different estimates of a given life history parameter, and we treat the resulting variability among studies as "imprecision." In addition, the variety of sources and thus differing quality of information in FishBase may allow biases to occur (e.g., if mortality values for mildly harvested populations are entered as natural mortality estimates for a given species). However, we believe a major reason that some scientists question the validity of FishBase information is because they may be uninformed or confused about the two ways life history information is offered in FishBase.

FishBase offers two ways to access basic life history information: (1) entered values and (2) generated values. Entered values are accessed through the species main page, under the section “More information,” which contains a variety of life history traits whose values are from published species-specific studies. Generated values allow scientists to estimate the life history characteristics of species when entered values are lacking. Generated values are accessed through the species main page, under the section “Tools” and then under “Life history tool.” The life history tool contains several parameter values that are estimated from empirically derived relationships (summarized in Table 1). The user can either accept the default values or reestimate the life history parameter values based on values they input. The default values of the life history tool are also summarized as a “species ecology matrix” spreadsheet, which can be found on FishBase’s homepage under the sections “Information by Family,” “Country/Island,” or “Ecosystem.” It is these generated data that we believe are most questioned by users, because the life history data are based on empirical relationships unfamiliar to researchers and reviewers or based on meta-analyses that may not hold true for certain species.

Table 1. Explanation of how values are estimated by the FishBase life history tool.

Parameter	Primary	Secondary
L_{max}	Largest reported size	NA
L_∞	Median of reported values	L_{max}[a]
k	k and L_∞[b]	L_∞, L_{mat}, A_{mat}, A_{max}, t_0[c]
M	L_∞, k, and T[c,d]	L_∞, T[c]
L_{mat}	L_{max}[a]	NA
A_{mat}	L_{mat}[c]	NA
A_{max}	k and t_0c	NA

[a]Froese and Binohlan (2000).
[b]Pauly et al. (1998).
[c]FishBase: http://FishBase.org/manual/key%20facts.htm.
[d]Pauly (1980).

VALIDATING FISHBASE DATA

To test the validity of FishBase data, Thorson et al. (2014) recently assessed the precision and accuracy of “entered” and “generated” FishBase data against life history parameters they obtained from regional experts who maintained independent databases of life history parameter estimates for their fisheries research. They did not assume that regional experts had “perfect knowledge” but only that they had obtained on average unbiased estimates of life history traits for their regions of expertise

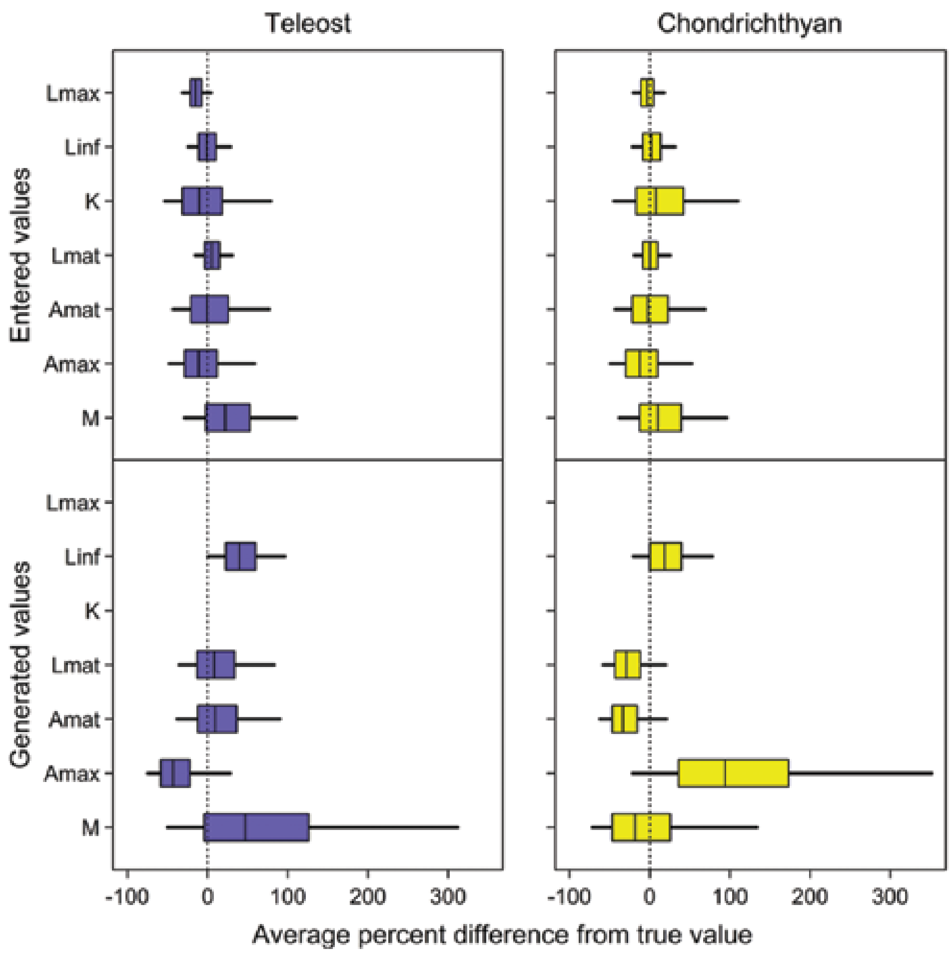

Figure 1. Distribution of the percentage error for a given parameter categorized by taxa and information type.

(i.e., that the experts had a value that was randomly distributed around the "true" but unknown value). Thorson et al. (2014) then used a Bayesian error-in-variables model to estimate biases that might occur among seven life history parameters and two taxa (Teleost and Chondrichthyan fishes). The seven life history parameters were maximum length (L_{MAX}); asymptotic maximum length (L_{INF}); the von Bertalanffy growth coefficient (K); length at maturity (L_{MAT}); age at maturity (A_{MAT}); maximum age (A_{MAX}); and the instantaneous natural mortality rate (M).

Overall, Thorson et al. (2014) collected data on 156 finfish species, including 109 Teleost and 47 Chondrichthyan species. Here, we briefly summarize their findings in terms of percentage error, which is the relative error [(i.e., (true value − observed value)/(true value)] multiplied by 100 to be expressed as a percentage. The distribution of percentage errors for each parameter was then plotted as a box plot using the 25th and 75th percentiles for the box distribution, and the whisker is the 5th and 95th percentiles.

Values entered into FishBase proved more accurate and precise than values generated by the life history tool. The range of median percentage errors varied from −18% to 25% for entered values versus −45% to 195% for generated values, for both Teleost and Chondrichthyan species (Figure 1). For entered FishBase values, L_{MAX}, L_{INF}, and L_{MAT} were generally the most accurate (i.e., unbiased) and precise (i.e., low variance) estimates, whereas other life history parameters were either accurate but not precise (i.e., K, A_{MAT}) or neither accurate nor precise (i.e., A_{MAX}, M).

Regarding generated data, the random effects model used by Thorson et al. (2014) required confidence intervals of life history values, so L_{MAX} and K had to be excluded from the analyses because FishBase does not provide this information. Of the remaining five life history parameters evaluated for generated data, L_{INF} was the most precise but not accurate, whereas L_{MAT} and A_{MAT} were the most accurate for Teleost species but not so for Chondrichthyan species (Figure 1). Furthermore, there was no general trend observed between Teleost and Chondrichthyan species, other than L_{INF}, which was skewed slightly higher for both fish types. For example, L_{MAT}, A_{MAT}, and K are skewed high for Teleost species and low for Chondrichthyan species. Similarly, A_{MAX} is skewed extremely low for Teleost species and extremely high for Chondrichthyan species.

IMPROVING FISHBASE DATA AND THE AMERICAN FISHERIES SOCIETY

Even though the Thorson et al. (2014) study has shown that certain types of information in FishBase are relatively accurate and precise, scientists should continue to strive to improve these data by entering their life history data into FishBase. The biases and imprecisions observed here from entered and generated data are unlikely to be unique to the species we evaluated, as Bienen (2006) noted that, worldwide, gaps in biological information for important species still need to be filled, data contribution and expert verification must continue, and linkages with other data sources need to be increased. As information content expands and improves, we expect the accuracy and precision of entered values to improve. It is also likely that, as more expert-verified information is entered into FishBase, better models for empirically deriving relationships can subsequently be developed, and values generated from the life history tool will improve accuracy and precision.

FishBase offers two ways to access basic life history information: (1) entered values and (2) generated values.

Administrators of FishBase have been advocating for such data expansions since the 1980s and, though the database has grown, much more is needed (Beinen 2006). The hurdle of course is taking the time to go through your life history data, organizing it in an understandable format, and submitting it to FishBase when time is a premium, the action is voluntary, and there is no immediate benefit to the submitter. One solution to this problem is requiring authors to submit their life history information to FishBase before articles will be published in an American Fisheries Society (AFS) journal. Such is the practice of several popular genetics journals (e.g., *PLOS Genetics*, *Molecular Biology and Evolution*, *Genetics*, etc.) that require authors to deposit their genetic data into GenBank (a publicly available genetic sequence database managed by the National Institutes of Health) and to list an accession number that references where the genetic data can be found in GenBank. Opportunities to include raw data (e.g., individual length, weight, and maturity data), as opposed to just summary data, directly into FishBase are also being explored and may be an additional option in the future (R. Froese, FishBase, personal communication). Archiving of raw data is already required for some publications; for example, both the Ecological Society of America (e.g., *Ecological Monographs*) and the British Ecological Society (e.g., *Journal of Animal Ecology*) use online systems to maintain raw data.

Such an approach is simple because it makes what was once a voluntary action that had no immediate benefits to the submitter a scientific duty. We expect that such a change in the submission process for AFS may be met with some aversion at first, because change is rarely a welcomed guest, but over time it will become a common practice when submitting a manuscript for publication. Maybe the first step toward this practice need not be so formal, and instead of requiring an accession number be listed within the text of the manuscript, it could begin with a template document being submitted to the editor (e.g., similar to the ethics in publishing document) showing that relevant life history data has been deposited into FishBase. Regardless of how big a step we take at the beginning, we think that this is a step worth taking, especially for AFS members, to further support and promote the dissemination of fisheries science.

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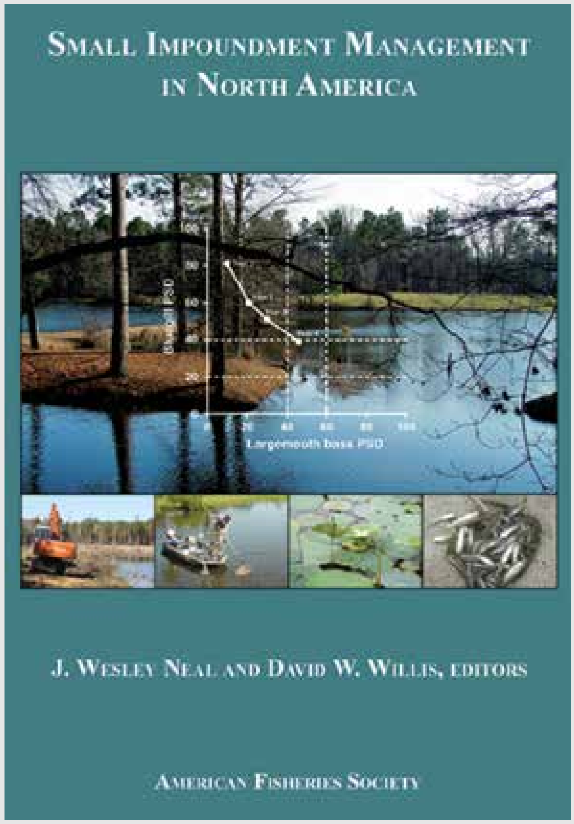
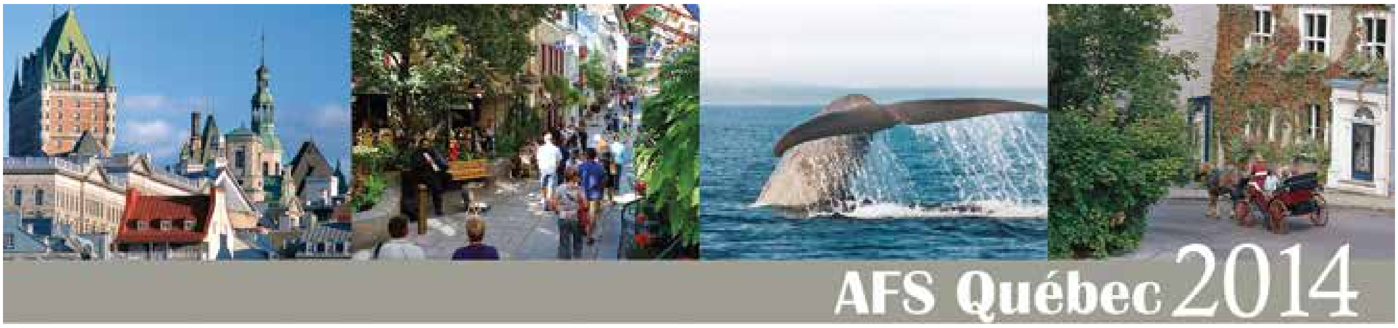




Meeting Update

Student Activities

TO SHARE AND LEARN ABOUT AQUATIC SCIENCES

The Best Student Paper/Poster Competition is a fantastic way to share your research and receive feedback from professionals and peers, engage in scientific discussions, and create partnerships for future collaborative projects. This year's meeting features a Student Colloquium. Learn about skills and qualifications needed to achieve a successful scientific career. Talk directly with invited mentors and ask all your questions.

TO FIND A JOB

A Career Fair will take place at the Student Colloquium. Look for employment opportunities and get tips on how to obtain a job in fisheries or aquatic sciences. Make sure to bring your résumé!

TO HAVE FUN

The Student Networking Event on Tuesday the 19th will be the time to relax and have fun while engaging in networking activities. This event will take place at the Ninkasi du Faubourg, located on famous St-Jean Street, where music, food, and beverages will be offered.

ACCOMMODATIONS

Low-cost housing, including breakfast and free WiFi, has been arranged at Laval University. Rooms are near all commodities and located less than 15 minutes away by bus from the Québec City Convention Centre. Book now at www.residences.ulaval.ca/en/short_term_accommodation

For more details contact us by e-mail at students.afs2014@gmail.com

Scheduled Symposia
Québec, August 17–21, 2014

*Symposium includes international participation from outside North America.

38TH ANNUAL LARVAL FISH CONFERENCE*
Organizers: Pascal Sirois and Dominique Robert

A RETROSPECTIVE OF FISHERIES ADVANCES EMANATING FROM THE QUEENS UNIVERSITY BIOLOGICAL STATION
Moderator: David Philipp
Chairs: David Philipp and Steven Cooke
Organizers: David Philipp and Steven Cooke

ARE WE STILL FISHING DOWN THE FOOD WEB?
Moderators: Sean M. Lucey and Steven X. Cadrin
Chair: Sean M. Lucey
Organizers: Sean M. Lucey, Steven X. Cadrin, and Richard Beamish

BIG DATA SCIENCE AND ITS IMPACTS ON FISH CONSERVATION AND MANAGEMENT
Moderators: Marlis R. Douglas and Michael E. Douglas
Chairs: Marlis R. Douglas and Michael E. Douglas
Organizers: Marlis R. Douglas and Michael E. Douglas

CHALLENGES IN MANAGING UNITED STATES MARINE & ESTUARINE RECREATIONAL FISHERIES
Moderators: Steve Meyers and Derek Oner
Chair: Paul Perra
Organizers: Paul Perra, Steve Meyers, and Derek Oner

CHANGES IN MANAGEMENT REGIMES IN NORTH ATLANTIC FISHERIES AND THE EFFECTS THEY'VE HAD ON ABUNDANCE, PRACTICES, AND THE SOCIO-CULTURAL SYSTEMS OF FISHERMEN AND FISHING COMMUNITIES*
Organizers: Sean Janson and Peter Fricke

COMMON CHALLENGES AND OPPORTUNITIES FOR GLOBAL FISHERIES: AN INTERNATIONAL PERSPECTIVE*
Organizers: Douglas Vaughan, Shuichi Satoh, John Pinnegar, and Sungchul C. Bai

COMMUNITY ECOLOGY AND TROPHIC INTERACTIONS OF FISHES
Moderator: Ron Heintz
Chair: Jason Link
Organizers: Ed Farley, Anthony Overton, and Richard McBride

DAM IMPACTS ON FISHERY RESOURCES*
Chair: Margaret H. Murphy
Organizers: Laura Wildman and John A. Sweka

DEVELOPING A NATIONAL FISHERIES DATA EXCHANGE STANDARD
Moderators: Andrew Loftus, Thomas Litts, and Andrea Ostroff
Chairs: Andrew Loftus, Thomas Litts, and Andrea Ostroff
Organizers: Andrew Loftus, Thomas Litts, Andrea Ostroff, Jeff Kopaska, and Rebecca Krogman

ECOSYSTEM SERVICES: BRIDGING NATURAL AND SOCIAL SCIENCES TOWARD SUSTAINABLE POLICIES
Organizers: Joel Nohner, T. Douglas Beard, and Devin M. Bartley

ENGAGING THE RIGHT PARTNERS: MULTIDISCIPLINARY APPROACHES TO PROPAGATION TO SUPPORT CONSERVATION AND MANAGEMENT
Moderators: Bruce A. Barton, Steve Lochmann, and Carl Kittel
Chairs: Carl Kittel, Bruce A. Barton, and Steve Lochmann
Organizer: Carl Kittel

ENVIRONMENTAL DNA: A NEW TOOL FOR AQUATIC CONSERVATION AND FISHERIES MANAGEMENT
Chairs: Anaïs Lacoursière and David M. Lodge
Organizers: Anaïs Lacoursière and Louis Bernatchez

FIRE MANAGEMENT AND AQUATIC SYSTEMS: PAST, PRESENT, AND FUTURE
Moderators: Rebecca Flitcroft and Jeffrey Falke
Organizers: Rebecca Flitcroft and Jeffrey Falke

FISH MIGRATION AND OCEAN TRACKING NETWORK
Chairs: Mélanie Béguer-Pon, Julian Dodson, Sara Iverson, and Frederick G. Whoriskey
Organizers: Mélanie Béguer-Pon, Martin Castonguay, Julian Dodson, Sara Iverson, and Frederick G. Whoriskey

FISHING GEAR SELECTIVITY AND SELECTIVE FISHING: MEANS, METHODS, AND IMPLICATIONS*
Chairs: Michael Pol, Pingguo He, and Petri Suuronen
Organizers: Pingguo He, Michael Pol, and Petri Suuronen

FRESHWATER FISHERIES IN CANADA: HISTORICAL AND CONTEMPORARY PERSPECTIVES ON THE RESOURCES AND THEIR MANAGEMENT
Organizers: Steven A. Cooke and Jack Imhof

FUTURE OF FISHERIES: PERSPECTIVES FOR EMERGING PROFESSIONALS
Organizers: Marissa Hammond, Abigail J. Lynch, Nancy Leonard, and William W. Taylor

GAINING BETTER UNDERSTANDING OF RESOURCES AND RESOURCE USERS THROUGH THE APPLICATION OF EMERGING TECHNOLOGIES
Chairs: Tom Lang, Joanna Whittier, and Julie Defilippi
Organizers: Julie Defilippi, Joanna Whittier, and Tom Lang

GENOMIC TOOLS FOR FISHERIES MANAGEMENT AND CONSERVATION: PROMISES AND CHALLENGES
Moderator: Louis Bernatchez
Chair: Scott A. Pavey
Organizers: Shawn R. Narum and Ben Hecht

GLOBAL WATER ISSUES AND SOLUTIONS FOR FUTURE WATER SUSTAINABILITY
Chair: Kimberly Ann Elkin
Organizer: Kimberly Ann Elkin

INTEGRATED PEST MANAGEMENT APPROACHES FOR COMBATING AQUATIC NUISANCE SPECIES
Organizers: Patrick M. Kocovsky, Mark P. Gaikowski, David Glover, Marybeth K. Brey, and Becky Cudmore

INTEGRATING ECOSYSTEM THRESHOLD RESPONSES INTO LIVING MARINE AND AQUATIC RESOURCE MANAGEMENT
Moderators: Gavin Fay, Scott Large, and Mary Hunsicker
Chairs: Gavin Fay, Scott Large, and Mary Hunsicker
Organizers: Gavin Fay, Scott Large, and Mary Hunsicker

INTERNATIONAL EEL SYMPOSIUM 2014: ARE EELS CLIMBING BACK UP THE SLIPPERY SLOPE?*
Moderators: Laura Lee, Russell Poole, Kate Taylor, Ron Threader, Guy Verreault, and Alan Walker
Chairs: Laurent Beaulaton, David Cairns, John Casselman, Martin Castonguay, Martin de Graaf, Willem Dekker, and Paul T. Jacobson
Organizers: Laurent Beaulaton, David Cairns, John Casselman, Martin Castonguay, Martin de Graaf, Willem Dekker, and Paul T. Jacobson

JAWLESS FISHES OF THE WORLD
Organizers: Alexei M. Orlov and Gordon A. McFarlane

LINEAR DEVELOPMENTS ACROSS WATERBODIES AND THEIR POTENTIAL EFFECTS ON FISH AND FISH HABITAT
Chair: Nicole Pilgrim
Organizers: Kerry Brewin and Nicole Pilgrim

MARINE MAMMAL AND FISHERIES INTERACTIONS: MANAGEMENT CHALLENGES IN A CHANGING WORLD
Organizer: Lyne Morissette

OUT OF SIGHT, NOT OUT OF MIND: ESTIMATING AND REDUCING RELEASE MORTALITY IN COMMERCIAL AND RECREATIONAL FISHERIES
Moderators: Noëlle Yochum and David Rudders
Chairs: Noëlle Yochum and David Rudders
Organizers: Noëlle Yochum, David Rudders, Lee Benaka, and Derek Orner

PELAGIC FISH STOCKS ON THE MOVE AND IN THE NEWS: COLLAPSE, RECOVERY, OR SOMETHING ELSE?*
Chairs: Anna Olafsdottir and Erin Carruthers
Organizers: Anna Olafsdottir and Erin Carruthers

POPULATION DYNAMICS AND SUSTAINABLE FISHERIES FOR HIGHLY-MIGRATORY LARGE PELAGIC SPECIES
Moderators: Jon Brodziak and Patrick Lynch
Chairs: Jon Brodziak and Patrick Lynch
Organizers: Jon Brodziak and Patrick Lynch

PRACTICAL APPLICATIONS OF STURGEON RESEARCH
Moderators: Ryan Koenigs, Cam Barth, Matthew Balazik, and Ronald M. Bruch
Chairs: Ryan Koenigs, Cam Barth, Matthew Balazik, Ronald M. Bruch, Rene Dion, Yves Paradis, and Tim Haxton
Organizers: Ryan Koenigs, Cam Barth, Matthew Balazik, Ronald M. Bruch, Rene Dion, Yves Paradis, and Kenneth Sulak

PROTECTING FISH AT COOLING WATER INTAKES: ADVANCING SCIENCE TO SUPPORT CLEAN WATER ACT §316(B) COMPLIANCE
Moderators: Bill Dey, Tom Englert, Robert H. Reider, Charles C. Coutant, and Terry Cheek
Chairs: Douglas A. Dixon and Jonathan Black
Organizers: Bill Dey, Tom Englert, Robert H. Reider, Charles C. Coutant, and Terry Cheek

RECHERCHE ET INNOVATION POUR UNE PÊCHE DURABLE DANS L'ESTUAIRE ET LE GOLFE DU SAINT-LAURENT
Moderators: Julie Boyer, Daniel Boisvert, Ginette Levesque, Jean-Michel Poulin, Rabia Siga Sow, and Maité Chavez
Chair: Meggie Desnoyers
Organizers: Bernard Sainte-Marie, Bernard Morin, Jean-Paul Gagné, Jean-Pierre Couillard, O'Neil Cloutier, Léonard Poirier, and Julie Lavallée

REPRODUCTIVE BEHAVIOR AND RECRUITMENT IN MARINE FISHES: EMERGING UNDERSTANDING AND FUTURE NEEDS*
Chair: Susan K. Lowerre-Barbieri
Organizers: Susan K. Lowerre-Barbieri, Mandy Karnauskas, Mark Dickey-Collas, Pierre Pepin, Claire Paris, and Yvonne Sadovy de Mitcheson

RIVER HERRING: TOWARDS A HOLISTIC UNDERSTANDING
Chairs: Barbara Arter, Adrian Jordaan, Karen Wilson, and Janet Nye
Organizers: Barbara Arter, Adrian Jordaan, Karen Wilson, and Janet Nye

ROADS AND RIVERS: RECONCILING ACCESS TO LAND AND INTEGRITY OF RIVERINE ECOSYSTEMS
Organizers: Elsa Goerig, Doug Peterson, and Laura Wildman

SIZE-BASED MODELS OF AQUATIC ECOSYSTEMS: THEORY AND PRACTICE—A SYMPOSIUM IN HONOUR OF ROB PETERS
Chairs: Brian J. Shuter and Henrique Giacomini
Organizers: Brian J. Shuter and Henrique Giacomini

SPATIAL ECOLOGY OF OPEN SYSTEMS*
Chairs: Daniel E. Duplisea, Michael Frisk, and Verena M. Trenkel
Organizers: Daniel E. Duplisea, Michael Frisk, and Verena M. Trenkel

STANDARD METHODS FOR SAMPLING FRESHWATER FISHES: OPPORTUNITIES FOR INTERNATIONAL COLLABORATION*
Moderators: Scott A. Bonar, Wayne Hubert, and Norman Mercado Silva
Chairs: Scott A. Bonar, Wayne Hubert, and Norman Mercado Silva
Organizers: T. Douglas Beard, Göran Dave, Jan Kubecka, Nigel P. Lester, David W. Willis, and Ian Winfield

SUSTAINABLE SOLUTIONS TO OPTIMIZE HYDROPOWER ENERGY DEVELOPMENT AND BENEFITS FOR FISHERIES AT A BASIN SCALE
Moderator: Gary E. Johnson
Chair: Ryan A. McManamay
Organizer: Mark S. Bevelhimer

TELEMETRY ON THE ATLANTIC COAST: TAGGING LOCALLY AND OBSERVING GLOBALLY
Organizers: John F. Kocik, James P. Hawkes, Gayle Zydlewski, Heather Haas, and Gordon Waring

THE NEXT GENERATION OF FISH STOCK ASSESSMENTS
Moderators: Patrick Lynch and Tara Dolan
Chairs: Patrick Lynch and Tara Dolan
Organizers: Patrick Lynch and Tara Dolan

UNDERSTANDING FISH AND THEIR ECOSYSTEMS IN CHALLENGING ENVIRONMENTS
Chair: Haley Viehman

THE MISSOURI CHAPTER—STILL HOOKED AFTER 50 YEARS

John L. Funk organized a meeting of Missouri fisheries professionals in February 1963 to discuss forming a Missouri Chapter of the American Fisheries Society (MOAFS). Officially chartered on 10 March 1964, MOAFS held its first official meeting on 19 February 1965. The Missouri Chapter recently celebrated its 50th anniversary in conjunction with the Missouri Natural Resources Conference (MNRC) at Osage Beach, Missouri, on 6 February 2014. The Chapter banquet was attended by 143 members and a special guest, AFS Executive Director Doug Austen. A brochure, including classic photographs and a timeline outlining the history of the Chapter with important events and accomplishments, was handed out to all attendees. The Chapter has much to be proud of in its 50-year history. MOAFS has produced four AFS presidents and six North Central Division (NCD) presidents, established a $100,000 student support trust fund, supports four Student Subunits (located at the University of Missouri, Missouri State University, University of Central Missouri, and Southeast Missouri State), established a disabled angler fishing program, hosted two AFS Annual Meetings (the 96th meeting in 1966 and 130th in 2000), and is scheduled to host the 146th in 2016 at Kansas City, Missouri.

After dinner, past-officers, committee chairs, life members, and 25-year members were recognized. Two attendees garnered special recognition: Joe Dillard and Lee Redmond. Dillard and Redmond attended the original meeting to discuss Chapter formation and have remained active ever since. Both served as president of the Chapter, NCD, and AFS and have been honored with the AFS Distinguished Service Award as well as the Chapter's highest honor—the John L. Funk Award of Excellence. Redmond has also received the Meritorious Service Award from AFS.

Later that evening at the MNRC awards reception, MOAFS presented its two highest awards to deserving Chapter members. The John L. Funk Award of Excellence was given to Marlyn Miller for his efforts towards providing angler and boating access, coordinating Federal Aid reimbursements for fisheries-related activities, and working with local communities to provide close-to-home fishing opportunities. The A. Stephen Weithman, Jr. Leadership Award was presented to James A. Civiello for over 28 years of service to the Missouri Department of Conservation (MDC) aquaculture program. Civiello currently oversees activities related to MDC's four warmwater and five coldwater hatcheries. Overall, the night was a resounding success, with everyone looking forward to making the next 50 years even more successful than the first.

Doug Austen, AFS executive director, addresses the MOAFS at the 50th anniversary banquet. Photo credit: Cliff White.

Bill Turner, MOAFS past president, sets the record straight. Photo credit: Bob Temper.

Founding MOAFS member Joe Dillard entertains the crowd with Jason Persigner. Photo credit: Cliff White.

Ron Dent, former MOAFS president, addresses the crowd. Photo credit: Bob Temper.

Founding MOAFS member Lee Redmond honored by the crowd. Photo credit: Cliff White.

25TH ANNUAL MEETING OF THE NORTH CAROLINA CHAPTER

The 25th Annual Meeting of the North Carolina Chapter was held in Durham, North Carolina, 18–19 February 2014, and one of the highlights of the meeting was congratulating Rich Noble with a Golden Membership. This was on the heels of other awards—Noble won the AFS Excellence in Fisheries Education Award in 1996, and in 2002, the North Carolina Chapter determined that, in recognition of his outstanding commitment and career contributions to fisheries student education, and through his dedication to teaching and mentoring students, the Best Student Paper Award of the NC AFS Chapter should be known as the Richard L. Noble Best Student Paper Award.

John Boreman presents Rich Noble (right) with the Golden Membership Award.

VIRGINIA CHAPTER 2014 ANNUAL MEETING WRAP UP

"Virginia is for Fish Lovers" was the theme of the 2014 Annual Meeting of the Virginia Chapter Meeting, held in Fredericksburg, 11–13 February. Despite the arrival of winter storm Pax, attendance was good for technical sessions, business meeting, and two continuing education workshops. Colin Shea and Greg Anderson taught Occupancy Modeling and David Crosby taught Fish Health. Technical sessions provided a mix of updates on species of concern, including Redbellied Dace, crayfish, Atlantic Sturgeon, freshwater mussels, American Shad, and Roanoke Logperch, as well as progress for road-crossings, acid-sensitive streams, liming, environmental flow, Walleye, and safety management.

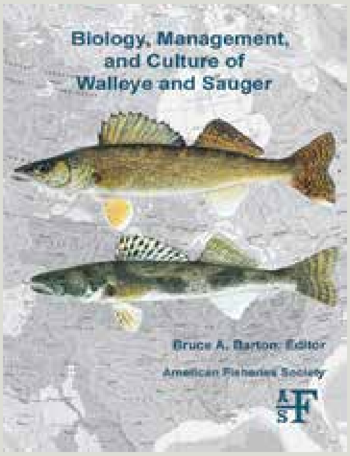
David Crosby, Virginia State University, teaches a session on Fish Health. Photo credit: Donald Orth.

Mike Isel, Dawn Kirk, and John Copeland received Certificates of Appreciation for their service as officers. New officers of the chapter are Don Orth, president, Eric Hallerman, president elect, John Harris, treasurer, and Christine May, secretary.

Best student paper awards were presented to Bonnie Jean Myers, Virginia Tech, and Lindsey House, James Madison University. Robert Ross Scholarships were awarded to Brandon Peoples, Virginia Tech, and Kristen Anstead, Old Dominion University, and Robert E. Jenkins scholarships were awarded to Jessica Dodds, Virginia Tech, and Casey Pehrsons, George Mason University.

Chapter awards were presented to Ned Yost, Citizen Conservationist, and John Copeland, Surber Professional Fisheries Biologist. Photo credit: Donald Orth.

BOOK REVIEW



Biology, Management, and Culture of Walleye and Sauger

Edited by Bruce A. Barton. American Fisheries Society, Bethesda, Maryland. 2011. 600 pages. US$79.00

Why would a group of fisheries scientists and managers take it upon themselves, under the auspices of the Walleye Technical Committee of the North Central Division of the American Fisheries Society, to write this 600-page reference book? We learn in the preface and introduction that a revision of the 1979 *FAO Synopsis of Biological Data on Walleye* was long overdue and there is a wealth of information produced in the recent decades on congenerics (Sauger, Saugeye hybrids, and Zander) to report and summarize. The widespread popularity of this group of fishes and the huge numbers of Walleyes, Saugers, and their hybrids produced and stocked in the United States and Canada also argue for a book that provides one-stop shopping for up-to-date references and information for anyone and everyone (undergraduates, graduate students, management and research biologists, academicians) working with *Sander* spp.

All of the topics relating to biology and management are covered in detail by 33 authors of 13 stand-alone, well-referenced chapters that review and discuss systematics, zoogeography, genetics, habitat, life histories, reproduction, environmental biology, feeding ecology, population dynamics, harvest and regulations, sampling, marking, and culture of *Sander*. I found it very easy to read those chapters that discussed topics outside my field of expertise (e.g., molecular systematics [Chapter 3] and population genetics [Chapter 4]), as well as those chapters discussing more familiar topics, especially Chapters 5 (habitat) and 7 (life histories). If you just hired a graduate student or entry-level biologist who will work with *Sander* spp., give them a copy of this book and say, "Read this and get back to me when you're done." The authors and the editor have done much of the heavy lifting associated with writing a thesis proposal, pitching a research topic to a supervisor, or learning how to do a better job of rearing, stocking, sampling, or managing *Sander* populations, their habitat, and those who exploit them.

Those interested in Sauger might be disappointed that some chapters, or sections of chapters, are devoted wholly to Walleye, which reflects the simple fact that for every peer-reviewed paper on Sauger biology or management, there are probably 30 (or 40? 50?) Walleye manuscripts, agency reports, and theses published. The relative paucity of Sauger research presented in this heavily-referenced text will motivate anyone sitting on unpublished Sauger data to contribute to the literature.

Production quality was very high and I have but a few negative comments. Black-and-white photographs in Chapter 13 (culture) were poorly reproduced and in stark contrast to the excellent line drawings and figures throughout the book. I question the inclusion of a chapter on phylogenetic analysis of Percidae using osteology (Chapter 2). It was one of the longest chapters at 40 pages—that narrowly-focused (albeit scholarly) material was jarringly out of place in this book and might have found a better home in a journal monograph series. Finally, only Chapter 13 (culture) ended with "Suggestions for Future Research." Suggestions in other chapters were implied, as in, "We found no study that looked at this-or-that…" Ending all chapters with explicit suggestions for future research would have been a nice touch.

I agree with Peter Colby, who wrote the introduction and produced the 1979 FAO Synopsis, when he stated that it would be ideal to turn this publishing effort someday into a living (virtual) document, one that could be easily updated and refined. I also agree with him that, "this book is not only a useful reference, but a new beginning!"

Phillip W. Bettoli

U.S. Geological Survey, Box 5114, Cookeville, TN 38505

Korean Federation of Fisheries Science and Technologies Annual Meeting

Sungchul C. Bai

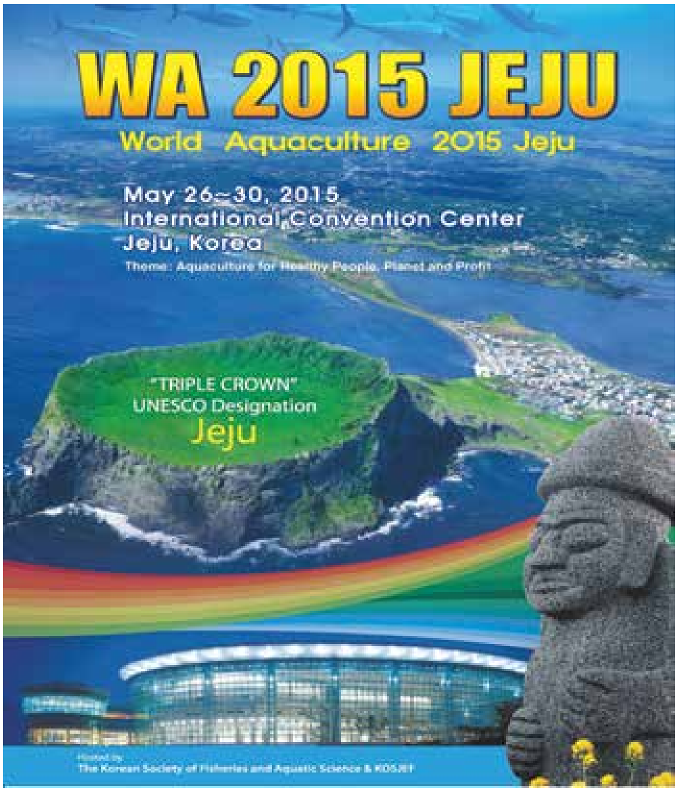
President, Korean Society of Fisheries and Aquatic Science (KOSFAS)

For the 21st century, one of the most important challenges of the fisheries and aquaculture industries around the world is climate change and the shortage of high quality aquatic products. Experts around the world have been working to strengthen global fisheries and aquaculture to cope with the consequences. Therefore, the Korean Federation of Fisheries Science and Technologies (KOFFST), Korean Society of Fisheries and Aquatic Science (KOSFAS), Ichthyological Society of Korea, Korean Society of Fish Pathology, Korean Society of Fisheries Technology, and the Malacological Society of Korea organized and hosted the 2013 international conference on "Climate Change and Trends in Demand and Supply of Aquatic Products" on 22 November 2013 at the Bexco Conference Center in Busan, Republic of Korea. The meeting was attended by 1,000 participants, including domestic and internationally known policy makers, researchers, and scientists from 28 different countries. This international conference provided an excellent platform to exchange innovative ideas and share international fisheries and aquaculture perspectives. The conference was organized in conjunction with the 13th Busan International Seafood and Fisheries Expo (BISFE), which was held 20-23 November and attracted a historic record number of 14,816 visitors. At BISFE, 372 domestic and multinational seafood trading companies at 738 exhibition booths explored the opportunities of the seafood trade and trade agreements.

PLENARY SESSION

The plenary session included three talks. Son Jae Hak, vice-minister of the Ministry of Oceans and Fisheries, Republic of Korea, presented "The Direction of Ocean and Fisheries Policies in the Era of Climate Change." He expressed concern about the slow recovery of fisheries resources and the shortage of appropriate aquaculture farming areas, leading to the consequent loss of opportunities for Korea to prepare for the global shortage of aquatic products. He emphasized Korean government policies including the head-start fisheries resources management plan, new target aquaculture species development projects, and the expansion of eco-friendly, low-carbon emission fisheries, all of which are aimed at adapting to global climate change.

"Bioassessment in Water Resources Management to Study Global and Regional Status and Change" was presented by Robert M. Hughes, president of the American Fisheries Society. He emphasized the importance of ecological monitoring as a key link between the fields of landscape ecology and ecological modeling. He also discussed the importance of determining the appropriate level of sampling effort, methods for determining reference conditions, and the value of existing fish databases for long-term studies.



A presentation entitled "The Status, Challenges, and Prospects of the Mariculture Industry in China" was given by Wang Qingyin, Yellow Sea Fisheries Research Institute, Chinese Academy of Fisheries Sciences. He described the sizable aquaculture industry in China and emphasized ways such as integrated multitrophic aquaculture (IMTA) to build a sustainable and more efficient mariculture industry.

INVITED SPEAKER SESSION

Se-Kwon Kim, Pukyong National University, Busan, Korea, presented "Development and Application of Bioactive Substances from Marine Organisms." He discussed opportunities to explore the functional properties of several marine organisms for use in the biopharmaceutical industry. Ari Purbayanto, Bogor Agricultural University, Indonesia, discussed the "Status of Distance Water Fisheries and Resources Conservation in Indonesia." He stressed the importance of participating in regional fisheries management organizations to boost tuna and other fisheries. Naoki Itoh from Japan talked on "Pathogenic Parasites in Commercially Important Bivalves." He discussed past events of parasitic disease in bivalve aquaculture and recommended approaches to prevent future disease outbreaks.

ORAL AND POSTER PRESENTATIONS

A total number of approximately 400 oral and poster presentations were given. The research on "Effects of Acute and Chronic Administration of Phlorotannins on Sleep-wake Profile in C57BL/6N Mice" by Minseok Yoon and colleagues, Korea Food Research Institute, received the Grand Award for Research. They demonstrated that phlorotannins from marine brown algae have the potential to be used as medicine for insomnia. The research team headed by Jun-Hyeong Choi, Pukyong National University (PKNU), Busan, received the Excellence Award for their research demonstrating the efficacy of sargachromenol as a neuraceutical candidate for treating neuroinflammation in neurodegenerative diseases. The research group of Eun Hye Lee and Su-young Song from PKNU, Busan, were also recognized for their research on "Anti-bacterial Activity of Phlorotannins from *Eisenia bicyclis* against *Propionibacterium acnes* and Anti-inflammatory Activity of Phlorotannins on *P. Acnes*-induced Inflammation" and "A Pentameric Peptide Isolated from Marine Microalgae *Pavlova lutheri* Inhibit Matrix Metalloproteinase-2 and -9 under Migration in Human Fibrosarcoma Cells."

The poster presentation entitled "Preparation and Characterization of Multi-layered Poly (3-caprolactone)/chitosan Scaffolds Fabricated with a Combination of Melt-plotting/ in situ Plasma Treatment and a Coating Method for Hard Tissue Regeneration" by Chandika and Jung received the Excellence Award. Research groups from around the world demonstrated that a multi-disciplinary approach is imperative to prepare global fisheries and aquaculture to cope with the challenges of climate change.

KOSFAS will host the 2015 World Aquaculture Congress, 26-30 May, in Jeju, Korea, and we invite you to attend.

90 YEARS AGO - FROM THE ARCHIVES

Dr. Emmeline Moore presented the report of the Vice-President, Division of Aquatic Biology and Physics. Mr. President: This is the first time a formal report of this division has been presented to the Society. When elected to the office last year I was somewhat at a loss to know how the Division should function. On looking up the records I found that this Vice-Presidency, and the other four, were created in 1910 by constitutional amendment, with duties suggested in the titles. "For instance," to quote from the author of the amendment, "The vice-president of fish culture will push his line, the vice-president of biology will push his line and on."... Mr. President, I am not submitting a report of my work, for as chairman of this Division I have done nothing. I find myself in the predicament of the theological student who was weak in his examination. When asked to distinguish between the major and the minor prophets, he answered, "Far be it from me to distinguish between the major and minor prophets. Here follows a list of the kings."

E. Moore (1924): Report of divisions, *Transactions of the American Fisheries Society,* 54:1, 15–16.

90 YEARS AGO - FROM THE ARCHIVES

At the last annual meeting I took it upon myself, in view of the financial condition of the Society, to recommend that the officers serve without salary. We had been paying the secretary $300 a year for quite a few years and then paying his assistant for doing some of the work. Not being present at the session when the election of officers took place I had the secretarial honor thrust upon me, and I was sport enough to take it for the year, to serve without honorarium.

J. W. Titcomb (1924): Report of the executive secretary, *Transactions of the American Fisheries Society,* 54:1, 10–11.

We need your help and that of your Section members

We currently have several policies needing revision.
(VISIT: fisheries.org/resource-policy-status)

We need knowledgable people from your Section to review one or more of the existing policies and help the RPC update them. These Policies summarize the Society's position on particular issues and they represent one of the principle mechanisms by which the Society advocates on behalf of fish, fisheries professionals, and aquatic resources. They are used to inform public policy (e.g., our climate change policy was used to comment on the National Climate Change Assessment), to inform regulatory authorities (e.g., our fish sedatives policy initiated a dialogue with the Food and Drug Administration about changes to the process of aquatic animal drug approvals), or to inform the public and our membership.

Please distribute this list to your Section members, along with a request to aid the RPC in updating our Policies. Interested members can contact Jesse Trushenski directly, and she will help them tackle the Policy of their choosing.

Again, thank you for your service, and we hope that you can help us. If you cannot do so, we would appreciate suggestions for persons who might.
Sincerely,

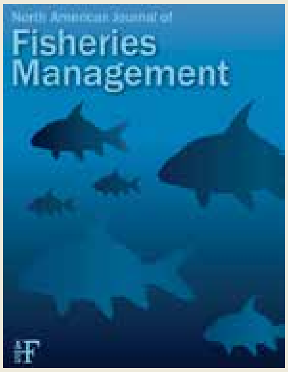
Jesse Trushenski
Chair, AFS Resource Policy Committee

Bob Hughes
AFS President

Donna Parrish
AFS President-elect

JOURNAL HIGHLIGHTS

North American Journal of Fisheries Management
Volume 34, Number 1, February 2014



The Relationship between Interannual Climate Variability and Juvenile Eastern Oyster Abundance at a Regional Scale in Chesapeake Bay. *David G. Kimmel, Mitchell Tarnowski, and Roger I. E. Newell. 34:1–15.*

Using Ecopath Modeling to Describe Historical Conditions for a Large, Boreal Lake Ecosystem prior to European Settlement. *Andrea M. McGregor. 34:16–29.*

[Management Brief] Evaluation of Calcein and Photonic Marking for Cultured Delta Smelt. *Gonzalo Castillo, Jerry Morinaka, Robert Fujimura, Jason DuBois, Bradd Baskerville-Bridges, Joan Lindberg, Galen Tigan, Luke Ellison, and James Hobbs. 34:30–38.*

[Management Brief] Habitat Selection and Movement of Adult Humpback Chub in the Colorado River in Grand Canyon, Arizona, during an Experimental Steady Flow Release. *Brandon Gerig, Michael J. Dodrill, and William E. Pine III. 34:39–48.*

Evaluation of Catch-and-Release Regulations on Brook Trout in Pennsylvania Streams. *Jason Detar, David Kristine, Tyler Wagner, and Tom Greene. 34:49–56.*

American White Pelican Predation on Cui-ui in Pyramid Lake, Nevada. *G. Gary Scoppettone, Peter H. Rissler, Mark C. Fabes, and Donna Withers. 34:57–67.*

[Management Brief] Retention of PIT and T-Bar Anchor Tags in Blue Catfish. *Kristopher A. Bodine and Paul Fleming. 34:68–71.*

Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery. *Joseph H. Anderson, George R. Pess, Richard W. Carmichael, Michael J. Ford, Thomas D. Cooney, Casey M. Baldwin, and Michelle M. McClure. 34:72–93.*

Climate Change, Migration Phenology, and Fisheries Management Interact with Unanticipated Consequences. *A. C. Peer and T. J. Miller. 34:94–110.*

Automated Detection and Tracking of Adult Pacific Lampreys in Underwater Video Collected at Snake and Columbia River Fishways. *Cristi Negrea, Donald E. Thompson, Steven D. Juhnke, Derek S. Fryer, and Frank J. Loge. 34:111–118.*

Summer Thermal Thresholds of Fish Community Transitions in Connecticut Streams. *Mike Beauchene, Mary Becker, Christopher J. Bellucci, Neal Hagstrom, and Yoichiro Kanno. 34:119–131.*

Evaluation of Statistical River Temperature Forecast Models for Fisheries Management. *Merran J. Hague and David A. Patterson. 34:132–146.*

Growth and Smolting in Lower-Mode Atlantic Salmon Stocked into the Penobscot River, Maine. *Joseph Zydlewski, Andrew O'Malley, Oliver Cox, Peter Ruksznis, and Joan G. Trial. 34:147–158.*

Evaluating the Performance of Two Salmon Management Strategies using Run Reconstruction. *Justin M. Carney and Milo D. Adkison. 34:159–174.*

Genetic Pedigree Reconstruction Detects Bias in Largemouth Bass Nest Sampling Procedures. *Jan-Michael Hessenauer, Mary Tate Bremigan, and Kim T. Scribner. 34:175–183.*

Monitoring Stock-Specific Abundance, Run Timing, and Straying of Chinook Salmon in the Columbia River Using Genetic Stock Identification (GSI). *Jon E. Hess, John M. Whiteaker, Jeffrey K. Fryer, and Shawn R. Narum. 34:184–201.*

Bull Trout Trends in Abundance and Probabilities of Persistence in Idaho. *Kevin A. Meyer, Edward O. Garton, and Daniel J. Schill. 34:202–214.*

90 YEARS AGO - FROM THE ARCHIVES

I have taken an inventory of all our publications and find that the Society has not one complete set of its own publications. There are many years where we are short; for some years we have none at all, and for other years we have a great number of copies. I tried to obtain for the Society, either through gift or sale, the numbers that we were short. I had an opportunity to sell a complete library of the Transactions, which would have brought us in about $200 had it been possible to furnish a complete set. The members as a whole do not appear to appreciate the value of this publication. Perhaps they will when they see that they now costs $3 a volume. The Transactions for 1923 are sold at $3; 1906 to 1922 at $2, and 1876 to 1906 at $3.50.

J. W. Titcomb (1924): Report of the executive secretary, *Transactions of the American Fisheries Society,* 54:1,11.

NEW AFS MEMBERS

Aaron Adams
Elysha Agne
James Aiken
Megan Altenritter
Matthew Anderson
Jessica Andrade
Derek Apps
Matthew Bach
Danielle Bailey
Jacob Ball
Emily Ball
Alexa Ballinger
Tony Barada
Robert Barta
Shannon Bayse
Peter Bisson
Evan Boone
Bryant Bowen
Scott Brack
Jacob Bransky
Jon Paul Brooker
Jason Buckley
Drake Burford
David Buys
Stephanie Caballero
Aaron Chapman
Anthony Chatwin
Kuan-Yu Chen
Helen Cheng
Steven Clark
Brian Clark
Claire Coiraton
Will Collier
Robert Colombo
Susan Colvin
Jason Connor
Pierre-Marc Constantin
Morgan Corey
Leslie Crawford
Rebecca D'Agostino
Steve Davison
Kim De Mutsert
David DeKrey
Doug Demko
Lauren Dimock
Adam Dodge
Trenten Dodson
Tara Dolan
Bud Downs
Spencer Dumont
Michael Eastman
Jamison Ellington
Terry Ellison
Lindsey Fenderson
Daniel Ferons
Tom Finnegan
Max Fish
David Foltz
Jennifer Gardner
Sarah Gaughan
Cassidy Gerdes
Trisha Giambra
Hilary Goodwin
Molly Gorman
Jennifer Granneman
Ruth Haas-Castro
Travis Haber
Brian Ham
Mark Haro
Christopher Harper
Johnathan Harris
Hans J. Hartmann
James Hawkes
Tiffany Hedrick-Hopper
Michael Hendricks
Christopher Holt
Darryl Hondorp
ATANAS Irinchev
Stephen Jacquemin
Andrea Jolley
Krista Jones
Michelle Jones
Austin Klais
Cory Kovacs
Jeffrey Kozlowski
Michelle Krall
Ryan Kreiner
Betsy Krier
Eric Krumm
Megan Lay
Juan Pablo Lazo
Austin Lee
Jennifer Lee
Joe LeMoine
Wally Macfarlane
John MacMillan
Tom Maier
Kaitlyn Manishin
Kate Mansfield
Benjamin Marcy-Quay
Travis Marella
Sara Marriott
Ryan Mayfield
George Maynard
Michael Mazur
Bryce Mecum
Glenn Merritt
June Mire
Jolvan Morris
Chris Mott
Barbara Muhling
Timothy Mulligan
Christina Murphy
Matt Nicholl
Tye Nichols
Staci Orr
Katherine Osborn
Aitza Pabon
Justin Pawlik
David Pearson
Jessica Pease
Tiffany Penland
Heather Penney
David Petry
Naomi Pleizier
Jim Prescott
Jefferson Ramalho
Jared Reese
Cameron Reyes
Jamie Reynolds
Josey Ridgway
Alex Roath
Eli Robinson
Nathan Roueche
Idelfonso Ruiz
Austin Rundus
Roberta Ryan
Cory Sauve
Michelle Scharer
Matthew Schrum
Douglas Sigourney
Jack Sleeper
Jennifer Smiley
Steven Smith
Carl Smith
Alex Sotola
Ramona Swenson
Sara Tanis
Christopher Taylor
Colin Tierney
Ben Titus
Robert Titus
John Urquhart
Jed Varney
Katherine Wakefield
John Walter
Stephanie Watson
Nathan Welker
Jason Westlund
Don Whitney
Dustin Wichterman
Ben Williams
Philip Willink
Christopher Winslow
Thomas Wissing
Kayce Workman
Brooke Wright

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Water projects and their maintenance create obvious iron triangles that affect the perspectives of the scientists and managers involved; however, more insidious iron triangles exist in many of the institutions in which we AFS members are employed. U.S. regional fishery management councils may subvert the public interest to the degree that their memberships or individual perspectives are biased toward a particular interest group or another, particularly exploitation (Grimes 2001; Pew Oceans Commission 2003). And those of us employed by, or receiving grants or contracts from, industries or the industry-regulating agencies may be reluctant to jeopardize continued employment, promotion, or funding by publishing or stating results contrary to the industry–agency paradigm. Of course, this sort of direct or self-censorship subverts the free exchange of scientific information. The American Fisheries Society can serve as a place where such information can be exchanged and peer reviewed through its meetings, journals, books, policy statements, and official letters.

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You have probably heard about the perils of declining habitats for fish, birds, large mammals, and the like. There is a strong coastal signature in those trends, not the least of which is the continued loss of coastal wetlands (Dahl and Stedman 2013) while the inland wetland footprint expands. Second homes, unusual storms, and a burgeoning human population are among the drivers affecting the national health of aquatic habitats. Now the reasons to engage extend from fish to society, from an avocation to the future of humanity. I don’t mean to get preachy, although I can’t help but be passionate, but it is not often that an issue connected to fish and their habitats becomes a larger factor in the grander plan.

This opportunity is reflected in the National Ocean Policy’s implementation plan (National Ocean Council 2013)—incorporate carbon sequestration into coastal habitat conservation. Action to achieve that objective must involve all sectors—industry and environmental, public and private, individual and corporate. Aquatic blue carbon cannot reverse the damage we are doing to our atmosphere but it most certainly can be part of the solution. Certainly, that is, if we wean ourselves off fossil fuels, conserve the places that provide these ecosystem services, and remain vigilant about adjacent places such as open waters that may acidify rather than sequester. Professional fish people will need to work with the politicians, physicists, and others to succeed.

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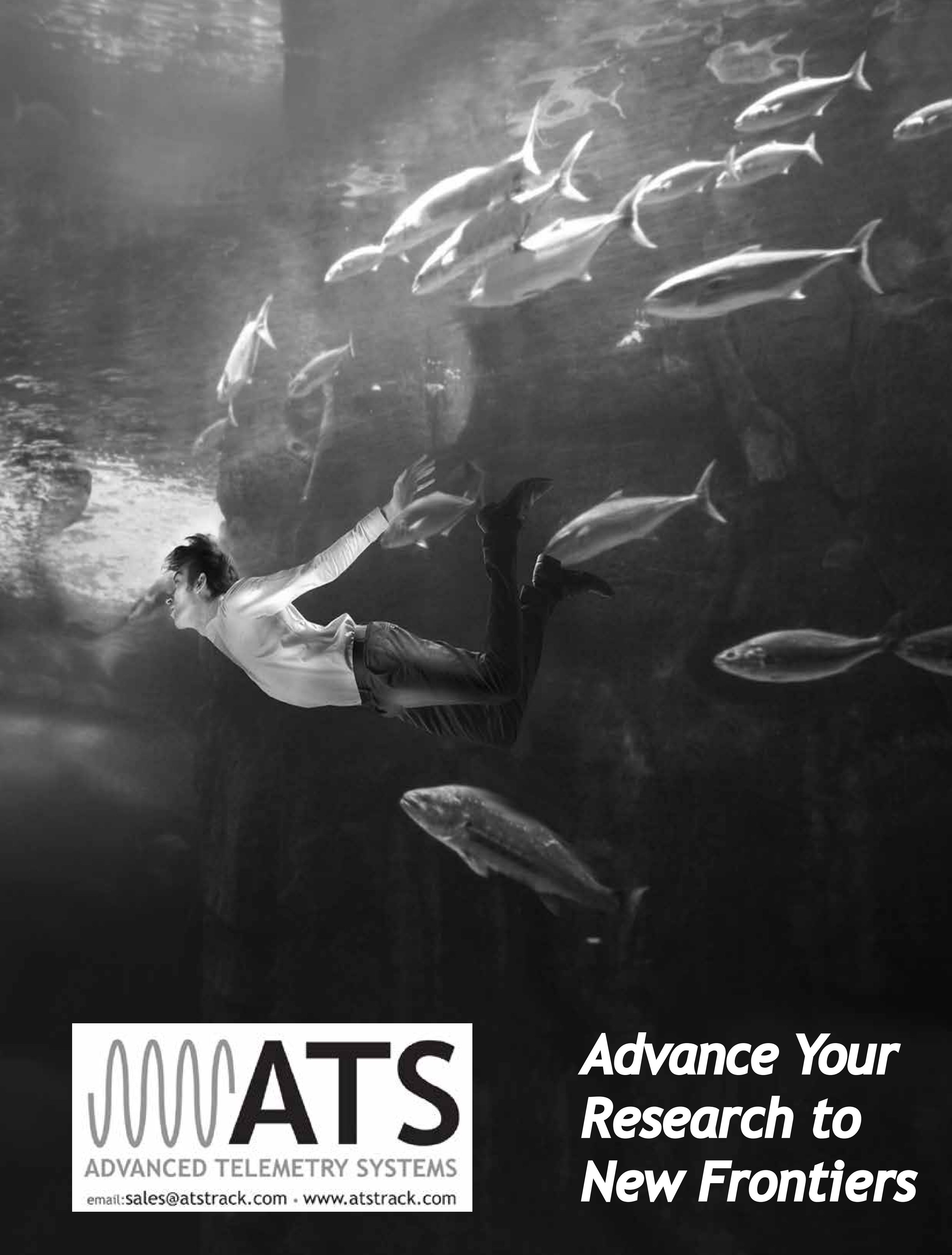
CALENDAR
Fisheries Events

To submit upcoming events for inclusion on the AFS web site calendar, send event name, dates, city, state/province, web address, and contact information to sgilbertfox@fisheries.org.

(If space is available, events will also be printed in *Fisheries* magazine.)

More events listed at www.fisheries.org

DATE	EVENT	LOCATION	WEBSITE
May 19–23, 2014	AFS Piscicide Class	Logan, UT	fisheriessociety.org/rotenone/Piscicide Classes.htm or sjohnston@fisheries.org
June 7–11, 2014	World Aquaculture Adelaide 2014	Adelaide, South Australia	www.was.org
June 24–27, 2014	Iberian Congress of Ichthyology	Lisbon, Portugal	sibic.org/jornadas/2014/inicio_en.html
July 7–10, 2014	Fisheries Society of the British Isles Meeting & Call for Papers-Integrated Perspectives on Fish Stock Enhancement	Hull, England	fsbi.org.uk
July 30–August 3, 2014	American Society of Ichthyologists and Herpetologists Annual Conference	Chattanooga, TN	asih.org/meetings
August 3–7, 2014	International Congress on the Biology of Fish	Edinburgh, United Kingdom	icbf2014.sls.hw.ac.uk
August 16–20, 2014	AFS Annual Meeting 2014	Québec City, Canada	afs2014.org
August 16–20, 2014	38th Annual Larval Fish Conference (AFS Early Life History Section)	Québec City, Canada	larvalfishcon.org
August 31–September 4, 2014	AFS-FHS – International Symposium on Aquatic Animal Health (ISAAH)	Portland, OR	afs-fhs.org/meetings/meetings.php
January 26–30, 2015	Global Inland Fisheries Conference	Rome, Italy	inlandfisheries.org
February 19–22, 2015	Aquaculture America 2015	New Orleans, LA	
May 26–30, 2015	World Aquaculture 2015	Jeju Island, Korea	
August 16–20, 2015	AFS Annual Meeting	Portland, OR	
February 22–26, 2016	Aquaculture 2016	Las Vegas, NV	
February 19–22, 2017	Aquaculture America 2017	San Antonio, TX	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