Hurricane Impacts to Lake Okeechobee: Altered Hydrology Creates Difficult Management Trade Offs

Surveying Professional Opinion to Inform Bull Trout Recovery and Management Decisions
Tagging Rare Species

Visible Implant Elastomer (VIE) tags provide the solution for many researchers when an externally visible, but benign tag is needed. The tags are implanted beneath transparent or translucent tissue and remain externally visible. VIE is a biocompatible, medical-grade material that is injected into an animal as a liquid and then cures to a pliable solid. These tags have been successfully applied to many species of fish, cephalopods, crustaceans, reptiles, and amphibians and are often suitable for animals that are too small for other tagging methods.

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NMT is pleased to announce that Visible Implant Elastomer is now available in a new formula that is mixed in a 1:1 ratio. Because very small quantities can be mixed, it makes it more convenient and cost effective for projects where only a few animals are tagged at a time. NMT is proud to contribute to these programs. Please contact us if we can help with yours.

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Surveying Professional Opinion to Inform Bull Trout Recovery and Management Decisions

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Robert Al-Chokhachy, Wade Fredenberg, and Shelley Spalding

COVER: Bowman Lake in Glacier National Park looks like pristine habitat but bull trout here have largely been replaced by nonnative lake trout.

CREDIT: Robert Al-Chokhachy

Dues and fees for 2008 are $76 in North America ($88 elsewhere) for regular members, $19 in North America ($22 elsewhere) for student members, and $38 ($44) retired members. Fees include $19 for Fisheries subscription. Nonmember and library subscription rates are $106 ($127). Price per copy: $3.50 member; $6 nonmember. Firearms (ISSN 0363-2415) is published monthly by the American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814-2199. Copyright 2008. Periodicals postage paid at Bethesda, Maryland, and at an additional mailing office. A copy of Fisheries Guide for Authors is available from the editor or the AFS website, www.fisheries.org. If requesting from the managing editor, please enclose a stamped, self-addressed envelope with your request. Republication or systematic or multiple reproduction of material in this publication is permitted only under consent or license from the American Fisheries Society. Postmaster: Send address changes to Fisheries, American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814-2199.
A New AFS Open-Access Journal to Explore and Advance Marine and Coastal Fisheries Science

The American Fisheries Society has been publishing scholarly journals since the late 1800s, and while the delivery of high-quality scientific information on fisheries research and management is a long-standing tradition in AFS, all of our journals were conceived as print media. Today, electronic publications are flourishing and traditional print journals are typically offered as either print or electronic subscriptions. AFS members may elect to receive either the print or online version of all five AFS publications—*Fisheries*, *Transactions of the American Fisheries Society*, *North American Journal of Fisheries Management*, *Journal of Aquatic Animal Health*, and the *North American Journal of Aquaculture*.

Shedding the constraints of the print medium, newly-established scientific publications are appearing as e-journals, and many of these have adopted a very different business model—that of the open-access scholarly publication. While these changes are beneficial to professionals seeking scientific information because more information is now available free of charge, these changes also represent significant challenges to nonprofit organizations that publish scientific content. The proliferation of open-access online journals presents somewhat of a different challenge to users—that of ascertaining the quality of the published information.

Two years ago at the mid-year meeting of the Governing Board, AFS leaders embraced the challenges of a purely electronic publication and began to explore a new opportunity in e-publishing, one that signals a sea change for AFS. This year, AFS will begin publishing a new open-access, e-journal entirely devoted to marine and coastal fisheries. The need for such a journal was first articulated by presidents from the AFS Marine Fisheries Section and the AFS Estuaries Section, and the idea won the support of the AFS leadership. The new journal will be called *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, and as its name implies, the journal will publish scientific contributions encompassing the research necessary to understand the dynamics and management of single-species fisheries science, as well as novel approaches and research that contribute to building the foundation of ecosystem-based fisheries science. Since the inception of this idea several years ago, the Publications Overview Committee (POC), under the leadership of Steve Cooke, has been thoroughly involved in the process of bringing this new journal to fruition. The plan to launch the new journal included the identification of a development editor early in the process; this was to ensure that the scope and niche of the journal, as well as the editorial board, would reflect not only the vision of the POC and the two AFS Sections, but also the insights and innovations of the development editor. Late last year, Donald Noakes was named the development editor for the journal.

One of the exciting features of this new endeavor is the possibility of publishing scholarly contributions that depart from the conventional manuscript contributions of print journals. Thus, the new e-journal will publish multi-media contributions and will also include a Fisheries Forum section to provide an opportunity for readers to engage in discussion and debate about topical issues in near-real time. The hallmark of this journal will be its high-quality scientific content, which will be ensured through the peer-review process and the high standards to which all AFS publications adhere. Although free to AFS members and nonmembers alike, this new e-journal will maintain the quality for which AFS publications are known among fisheries and aquatic science professionals.

What can fisheries and aquatic science professionals expect to find in the electronic “pages” of this new journal? The *Marine and Coastal Fisheries* journal will publish original and innovative research that synthesizes and integrates information on biological organizations across spatial and temporal scales to promote ecologically sound fisheries science and management. This international venue devoted to marine, coastal, and estuarine fisheries will have a strong emphasis on understanding the performance and response of species to environmental perturbations and will promote the development of ecosystem-based fisheries science and management. Contributors will be asked to identify and address challenges in population dynamics, assessment techniques and management approaches, human dimensions and socioeconomics, and ecosystem metrics to improve fisheries science in general and to make informed predictions and decisions. Reflecting the broad range of ecosystems, issues, and perspectives that are included in the scope of the journal, the development editor and subject editors will seek contributions that are inclusive and interdisciplinary. Major themes to be addressed by the journal will be described and posted to the web page of the journal. A Guide for Authors is under development, and a search for scientists to serve as subject editors for the journal is currently underway. We aim to have the first issue of the new journal available online this summer. In the meantime, should you have any questions about the new e-journal, I invite you to contact me (mfabrizio@vims.edu), Don Noakes (dnoakes@tru.ca), or AFS Publications Director Aaron Lerner (alerner@fisheries.org).
Studying Route Specific Passage

Nestled in the geographic center of Washington State are two vital hydroelectric plants: Rocky Reach and Rock Island dams. Rocky Island Dam, the first to span the Columbia River, is located 12 miles (19 km) downstream from the city of Wenatchee. Rocky Reach Dam sits 7 miles (11 km) upstream from Wenatchee. Both projects have been nationally recognized for their environmental efforts.

As the operator of both dams, Chelan County Public Utility District (PUD) is committed to improving fish survival. For example, Rocky Reach Dam has the first-of-its kind fish bypass system to aid juvenile salmon and steelhead passage on their way to the ocean. In order to help refine the bypass system, Chelan Co. PUD contracted with HTI to employ acoustic tag 3D telemetry. For the past 10 years, HTI has been using acoustic tags to monitor the fine scale, 3D swimming paths of juvenile salmonids approaching the powerhouse and spillway of the dam. Pacific salmon species evaluated have included steelhead, chinook and sockeye. Primary objectives have included estimation of:

- Fish survival,
- Bypass effectiveness, and
- Fine scale 3D behavior.

To date, tens of thousands of downstream migrating smolts have been surgically implanted with HTI’s Model 795 Acoustic Tags and monitored at both Rocky Reach and Rock Island dams. HTI’s Model 290 Acoustic Tag Tracking Receivers were then used to remotely track tagged fish in 3D with sub-meter position resolution, yielding each fish’s location every 3 seconds. Resulting tag positions were plotted in 3D revealing the fine scale movement of each tracked fish. According to Andrew Grassell, a Fisheries Biologist Project Leader for Chelan County PUD, “The 3D information we have collected using acoustic tags has provided a great value to Chelan PUD as we strive to meet the objectives of our habitat conservation plan for salmon and steelhead.”

HTI’s acoustic tag tracking technology continues to help Chelan Co. PUD evaluate fish behavior and improve dam operations, which improves the protection of downstream migrating fish. HTI is proud to work with Chelan County PUD. For more about the equipment and techniques used, visit us online at HTIsonar.com or call us at 206-633-3383.
Smart Gear Competition winner announced

A team of Rhode Island inventors was awarded the grand prize in the International Smart Gear Competition for a fishing gear innovation that could save thousands of fish and other sea creatures from dying accidentally in fishing nets each year, announced the World Wildlife Fund and its partners, including the American Fisheries Society. The grand prize winning team consists of University of Rhode Island Fisheries Center researchers and AFS members Laura Skrobe and David Beutel and fishermen Jon Knight, Phil Rhule, Sr., Phil Rhule, Jr., and Jim O’Grady. Their invention—aptly named “The Eliminator”—captures haddock while reducing the accidental netting of other marine species. The device works by taking advantage of the haddock’s tendency to swim upward but not over the headrope when encountering the large mesh net invention, instead of swimming downward where they can escape the net, which is the tendency of other fish. The Grand Prize winners beat out more than 70 other contenders from 22 countries.

Two other inventors won runner up prizes of $10,000 each for their inventions to help reduce bycatch. Argentinian Diego Gonzalez Zevallos studied the accidental death of seabirds as they dive for food and are struck by trawling warp cables, dragged under the water, and drowned. His device, a simple plastic cone attached to the warp cable, has dramatically reduced seabird deaths while not affecting the profitability of fishermen. The other runner-up prize winner, AFS member Glenn R. Parsons of the University of Mississippi, created a nested cylinder device that greatly reduces bycatch of a number of species and was widely tested on red snapper in the Gulf of Mexico.

A special UK prize of £5,000 was won by Andy Smerdon of Aquatec Group Ltd. of Hampshire, England, for a device called the Passive Porpoise Deterrent. The winning design, which draws on the mammal’s echo-location system, combines passive acoustic reflectors that have several wavelengths, with a small number of active pingers, and alerts porpoises to the presence of fishing nets.

NOAA Endangered Species Activities

An assessment of the health of white marlin (Tetrapturus albidus) populations indicate that the species is not in danger of extinction throughout all or a significant portion of its range, nor is it likely to become so in the foreseeable future. NOAA Fisheries’ White Marlin Biological Review Team have analyzed the best scientific and commercial data available and have concluded that Atlantic white marlin does not meet the Endangered Species Act definition of an endangered or threatened species and that the listing of Atlantic white marlin under the ESA is not warranted. A number of conservation measures have been implemented in recent years to improve white marlin conservation, including the required use of circle hooks in Atlantic billfish tournaments. A copy of the status review document is available at: http://sero.nmfs.noaa.gov.

After completing a status review of black abalone (Haliotis cracherodii), NOAA Fisheries has proposed listing the species as endangered. Black abalone once supported a commercial fishery in California, but their numbers have been declining since the 1980s when populations were reduced by the bacterial disease known as withering syndrome. Other impacts on black abalone include poaching and natural predation. The species is also threatened by suboptimal water temperatures and reduced genetic diversity. Public comments on this proposal must be received by 10 April 2008—see the Federal Register notice for 11 January 2008.

Invasive mussels found in Colorado and California

Two western states have confirmed the presence of zebra mussels. In Colorado, the species was found in November in Lake Pueblo—a reservoir about 100 miles south of Denver that feeds the Arkansas River and eventually the Mississippi River. Larvae were also found. In January, California Department of Fish and Game officials confirmed the presence of zebra mussels in San Justo Reservoir, which is connected to California’s central waterways. The shellfish found in California and Colorado were the first confirmed zebra mussels west of Oklahoma.

Meanwhile, the Los Angeles Times has reported that the quagga mussel, first detected in California in January 2007, has surged across the state’s southern counties, stirring concern that its spread will inflict costly damage to public water systems and fisheries statewide. Its rapid invasion from Lake Mead southwest through the Colorado River Aqueduct to San Diego is alarming water officials in a region that heavily depends on imported water moved through a vast network of pipelines and canals. The quagga already has infested five San Diego County reservoirs and two of the three largest reservoirs in Riverside County operated by the Metropolitan Water District, which supplies Los Angeles with most of its water.
The Geometry of Longline Fishing
With increasing scrutiny on commercial longline fishing practices and their effects on populations of top-level marine predators, standardized data collection is crucial for providing accurate population assessments. Depth is an important factor in longlining, as different hooks depth allow different species to be targeted. Scientists usually calculate the depth of longline hooks using a catenary geometry equation developed in Japan in the 1950s, which estimates the sag of the longline between the surface floats. In a recent article in the North American Journal of Fisheries Management, scientists from the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences and NOAA's Southeast Fisheries Science Center used temperature-depth recorders to measure the actual depth of the hooks deployed by vessel longlining for swordfish in the Caribbean. They found that the equation usually overestimated the actual depth of the hooks, and that hooks in similar positions on a longline often had quite different depths. The researchers recommend further research to build a database of actual hook depths under different conditions and uncover the factors that influence longline hook depth. Use of Catenary Geometry to Estimate Hook Depth during Near-Surface Pelagic Longline Fishing: Theory versus Practice, by Patrick H. Rice, C. Phillip Goodyear, Eric D. Prince, Derke Snodgrass, and Joseph E. Seafy. North American Journal of Fisheries Management 27:1148-1161. Rice can be contacted at patrick.rice@noaa.gov.

Investigating Intersex Fish
The discovery of intersex fish—those with characteristics of both sexes, such as males with egg cells in their testes—has caused some concern over the level of estrogen compounds in water supplies around the world. One of these discoveries was in smallmouth bass from the Potomac River following a fish kill and fish found with lesions. In a recent article in the Journal of Aquatic Animal Health, scientists from the U.S. Geological Survey, Army Corps of Engineers, and Virginia and West Virginia state agencies microscopically examined dozens of smallmouth bass gonads from the Potomac and Shenandoah rivers, along with out-of-basin waters, over three years to see if there was any relation between the water conditions that cause fish kills and the incidence of intersex fish. The investigation first required developing a rating system for the severity of the number of egg cells in the gonads. The researchers found wide variability in the prevalence and severity of testicular oocytes but noted a seasonal pattern with a higher prevalence in the spring during the pre-spawning and spawning season. The percentage of affected fish also seemed to relate to land-use patterns, with higher human population and agricultural use possibly being a factor, although further research is needed. Intersex (Testicular Oocytes) in Smallmouth Bass from the Potomac River and Selected Nearby Drainages, by V. S. Blazer, L. R. Iwanowicz, D. D. Iwanowicz, D. R. Smith, J. A. Young, J. D. Hedrick, S. W. Foster, and S. J. Reeser. Journal of Aquatic Animal Health 19:242-253; Blazer can be contacted at vblazer@usgs.gov.

Where Do Bull Trout Go at Night?
Habitat issues are thought to be the main impediment to the recovery of bull trout, an imperiled species found in the western United States. Decisions made in large-scale habitat restoration programs have effects down to the microhabitat level, including such factors as water velocity, depth, substrate, and cover. Determining how a fish that occurs at naturally low densities actually uses its habitat is challenging. In a recent article in the North American Journal of Fisheries Management, scientists from the U.S. Geological Survey's Utah Cooperative Fish and Wildlife Unit at Utah State University performed snorkeling surveys both during the day and at night at three rivers in eastern Oregon. Habitat measurements were also taken. The researchers found that bull trout used deep, slow-water habitats with cover, which offer bull protection from predators and conserve swimming energy. Adult trout were found even deeper than younger trout, and at night bull trout shift to slower moving water but still stay under cover. Although attempts to create a model to predict bull trout habitat use were unsuccessful, the findings may help in setting benchmarks for restoring bull trout habitat since their habitat use was consistent in different river systems. Summer Microhabitat Use of Fluvial Bull Trout in Eastern Oregon Streams, by Robert Al-Chokhachy and Phaedra Budy. North American Journal of Fisheries Management 27:1068-1081. Al-Chokhachy can be contacted at robertal@cc.usu.edu. ©


A Comparison of Point Abundance and Continuous Sampling by Electrofishing for Age-0 Fish in a Channelized Lowland River. Michal Janáč and Pavel Jurajda, pages 1119-1125.


Influence of Motorboat Use on Thermal Refuges and Implications to Salmonid Physiology in the Lower Rogue River, Oregon. Ian S. Reid, pages 1162-1173.


Genetic Evidence for Relict Atlantic Sturgeon Stocks along the Mid-Atlantic Coast of the USA. Isaac Wirgin, Cheryl Grunwald, Joseph Stabile, and John Waldman, pages 1214-1229.


Preferences, Specialization, and Management Attitudes of Trout Anglers Fishing in Tennessee Tailwaters. Clifford P. Hutt and Phillip W. Bettoli, pages 1257-1267.


An Efficient Smolt Trap for Sandy and Debris-Laden Streams. Justin G. Sace, Benjamin H. Letcher, and John Noreika, pages 1276-1286.

The Effect of Chemical Treatments on Red-Rim Melanina (Melanoides tuberculata), an Exotic Aquatic Snail That Serves as a Vector of Trematodes to Fish and Other Species in the USA. Andrew J. Mitchell, Melissa S. Hobbs, and Thomas M. Brandt, pages 1287-1293.

Generating River Bottom Profiles with a Dual-Frequency Identification Sonar (DIDSON). Suzanne L. Maxwell and April V. Smith, pages 1294-1309.


Selection of Spawning Sites by Coho Salmon in a Northern California Stream. Kristin E. Mull and Margaret A. Wilzbach, pages 1343-1354.


Comparison of Methods Used to Age Spring-Summer Chinook Salmon in Idaho: Validation and Simulated Effects on Estimated Age Composition. Timothy Copeland, Matthew W. Hyatt, and June Johnson, pages 1393-1401.
The new edition of *Introduction to Wildlife and Fisheries* marks the return of the first and only book to integrate both wildlife and fisheries into a single textbook. Thoroughly updated, with an inviting new design, the Second Edition offers the most current and accessible coverage of essential biological concepts and their applications, principles of resource management and conservation, and contemporary and public policy issues affecting today’s scientists and resources.

**In the New Edition**

**More Balanced Coverage**
The authors balance the book’s cover of sport wildlife and fisheries with substantial new information on the conservation of nongame organisms and an increased focus on community and ecosystem management.

**Cutting Edge Topics,** including
- advances in Geographic Information Systems (GIS), global positioning (GPS) and telemetry
- chronic wasting disease (CWD)
- avian flu
- West Nile virus
- whirling disease in fishes
- Pacific salmon stock sustainability
- adaptive management
- community evaluation and management
- ecosystem management
- harismatic mega fauna
- effect of nonindigenous (invasive) species

**New Design and Photo Program**
The new open modern look and vivid images make the text more visually appealing to the today’s student.
**UPDATE: LEGISLATION AND POLICY**

Elden Hawkes, Jr.
AFS Policy Coordinator Hawkes can be contacted at ehawkes@fisheries.org.

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**Ocean Acidification Measure**

On 12 December 2007, the Senate Committee on Commerce, Science, and Transportation approved the “Federal Ocean Acidification Research and Management Act of 2007” (S.1581), which was cosponsored by Committee Vice Chairman Ted Stevens (R-AK). Ocean acidification, which is caused by rising levels of carbon dioxide in the atmosphere, could negatively alter marine ecosystems and affect fisheries. S.1581 would authorize an interagency committee to develop a comprehensive research and implementation plan to deal with the emerging problem of ocean acidification; a program within the National Oceanic and Atmospheric Administration (NOAA) to implement activities consistent with the plan, including a competitive grant process; and appropriations of $100 million for fiscal years 2009–2013. This authorization would be split with 40% going to NOAA and the remaining 60% to other agencies.

“Ocean acidification threatens our fisheries and other marine resources,” said Stevens. “It is important that we understand the effects of ocean acidification and implement management strategies that will help protect the oceans and the creatures that live within them.”

**Congress Approves Provision on IUU Fishing**

On 19 December 2007, the U.S. Congress approved a provision authored by Senator Ted Stevens and Senator Daniel Inouye (D-HI) that would create a list of fishing vessels and vessel owners engaged in illegal, unreported, and unregulated (IUU) fishing. The measure was included as part of a comprehensive omnibus appropriations bill (H.R. 2764). The provision would also allow the United States to take appropriate action against listed vessels and owners, in accordance with federal and international fisheries and trade laws.

Currently, NOAA does not maintain a list of IUU vessels, even though many international fisheries management organizations compile such lists. The goal of the Stevens-Inouye provision is to raise awareness about IUU vessels and ensure that the United States has the authority to take action against such vessels.

“This provision will boost our nation’s efforts to combat destructive global IUU fishing,” said Stevens. “It will also ensure that America’s fishing industry can quickly and easily identify IUU ‘blacklisted’ vessels. These illegal, unreported, and unregulated fishing practices threaten to deplete important fish stocks not only in the United States, but around the world.”

**USGS Climate Change Briefing**

On Friday, 30 November, the U.S. Geological Survey (USGS) held a briefing entitled “Climate Change Science: Helping Wildlife, Water, and Energy Managers Respond.” The briefing was moderated by Scott Sutherland of Ducks Unlimited. The briefing featured presentations by Sue Haseltine, USGS associate director for biology; Dave Schad, Minnesota state fish and wildlife director; and Lynn Scarlett, deputy secretary of the Department of the Interior.

Haseltine’s presentation was entitled “Climate Change: Impacts on Natural Systems” and she highlighted some observed effects of climate change thus far. She cited examples of global atmospheric and ocean temperature increases, and decreases in arctic ice and snowfall. Haseltine went on to illustrate the ecological consequences of these changes on an array of highly vulnerable natural systems, including lower soil moisture leading to more frequent fires, vegetation die off due to drought, shoreline erosion due to sea level rise, increased salinity, and changes in species phenology and distribution. Haseltine concluded her presentation by detailing some examples of potential adaptations of climate change that resource agencies can implement, including reducing non-climate stresses on habitats, adjusting harvest of fish and wildlife, establishing corridors for migration, changing management prescriptions for habitats to allow more flexibility, and using adaptive management with strong monitoring strategies.

The second presentation, “Climate Change and Fish and Wildlife: State Perspectives,” was given by Dave Schad. The presentation began by giving insight into how climate change has impacted three aspects of Minnesota’s natural resources: prairie potholes (90% of wetlands could be lost by 2080), coldwater fisheries (potential median water temperature increase of 80%), and moose populations (populations have vanished in northwestern Minnesota in the last 10–20 years). The presentation demonstrated four areas that resource managers could implement in response to climate change. First, the use of adaptive programs such as monitoring, research, and modeling were recommended. Secondly, managing for resiliency was suggested. This includes focusing on other habitat stressors (i.e., invasive species, disease, water quality, etc.), and by developing and maintaining existing state wildlife action plans, federal/state partnerships, and conservation delivery mechanisms. Schad concluded by explaining how partnerships and tools (specifically through public education and information), and working cooperatively can be used to offset the effects of climate change.

The final presentation given by Lynn Scarlett was entitled “Climate Change: The Effect on Federal Lands and Waters.” Scarlett focused on the Department of Interior’s (DOI) efforts to adapt to the results of climate change. Stating that DOI manages 500 million acres of U.S. land and 45 million acres of coastal shelf, Scarlett highlighted the following challenges to climate change: understanding climate dynamics, monitoring changes, anticipating effects, and employing adaptive management.

In response, DOI has created a climate change task force. This task force includes subcommittees on legal and policy issues, land and water management, and climate change science. The committee will address the need for information on the areas of greatest vulnerability, increased monitoring (particularly in regards to water demand and flow), more interagency and public/private collaboration in monitoring, and modeling development on a regional level.
Hurricane Impacts to Lake Okeechobee: 
Altered Hydrology Creates 
Difficult Management Trade Offs

ABSTRACT: Human modifications to ecosystems can exacerbate effects of natural disturbances, but interactions between disturbance and altered hydrology are rarely assessed. Lake Okeechobee, Florida, was impacted by four large hurricanes in 2004–2005 that caused large lake-wide reductions in the coverage and biomass of aquatic macrophytes. We quantified dramatic changes in the aquatic plant and littoral fish assemblage after hurricanes, including decreased fish richness, diversity, and biomass, and large reductions in the species that support important fisheries. Human-induced hydrologic changes prevented the lake from expanding to the historically connected floodplain during and following hurricanes, which likely exacerbated impacts to aquatic plant and fish communities. Altered hydrology has complicated management scenarios for returning the lake to pre-hurricane conditions because policy options that will initiate recovery at Lake Okeechobee (i.e., lower water levels) will exert negative impacts on east and west coast Florida estuaries. Anthropogenic modifications raise difficult trade-offs for ecosystem restoration.

Mark W. Rogers and Micheal S. Allen

Rogers is an alumni fellow and Allen is an associate professor at the Department of Fisheries and Aquatic Sciences, University of Florida. Rogers can be contacted at mrogers@ufl.edu.

Impactos de huracanes en el Lago Okeechobee: 
alteraciones en la hidrología 
dificulta las tareas de manejo

RESUMEN: La modificación antropogénica de los ecosistemas puede exacerbar las perturbaciones naturales, sin embargo la interacción entre estas perturbaciones y las alteraciones en la hidrología son raramente evaluadas. El Lago Okeechobee, Florida, fue afectado por cuatro huracanes entre 2004 y 2005 que causaron reducciones drásticas y extensivas en la cobertura y biomasa de macrofitas acuáticas. Después del paso de los huracanes, se cuantificaron cambios sustanciales en las plantas acuáticas y las asociaciones de peces a lo largo del litoral; cambios que incluyen disminución de la riqueza específica, diversidad y biomasa de peces así como reducciones importantes en las especies sujetas a explotación. Los cambios de origen humano sobre la hidrología impidieron que el lago se expandiera y conectara con las planicies de inundación durante y después de los huracanes, lo cual muy posiblemente exacerbó los impactos sobre las comunidades de plantas y peces. Las alteraciones hidrológicas han complicado los escenarios de manejo en cuanto a la reversión de las condiciones hacia las observadas antes del paso de los huracanes, ya que las opciones políticas que se aplicarán para recuperar el Lago Okeechobee (bajos niveles de agua) ejercerán un impacto negativo sobre las costas este y oeste de los estuarios de Florida. Las modificaciones antropogénicas generan dificultades en cuanto al balance de prioridades para la restauración de los ecosistemas.

Impoundment and channelization operations present some of the greatest threats to aquatic ecosystem structure and function (Richter et al. 1997), but how these human-induced hydrologic changes interact with natural disturbances to influence aquatic communities is rarely quantified. We used a unique natural experiment to evaluate hurricane effects on a freshwater ecosystem and described how human-induced hydrologic manipulations magnified negative hurricane impacts. Lake Okeechobee, Florida, is the second largest natural lake in the United States (area ~ 1,730 km²), and is extremely shallow (mean depth 2.7 m, maximum depth 5 m) and eutrophic (Havens 2005). The lake supports large recreational fisheries for black crappie (Pomoxis nigromaculatus), largemouth bass (Micropterus salmoides), and sunfish (Lepomis spp.), and commercial fisheries for catfish (Ictalurus spp. and Ameiurus spp.) with a combined value over U.S. $200 million. (Furse and Fox 1994). The lake also serves as a water supply to cities in south Florida and provides important habitat to a wide range of plants and animals in the region (Johnson et al. 2007). The quality of all of these resources is closely tied to lake water levels and their influence on habitat quality and quantity (Havens et al. 2005; Johnson et al. 2007).

Modifications to the lake's hydrology have substantially changed the lake's surface area and connectivity to the watershed. Initial changes were made to facilitate agriculture by draining portions of the Everglades, and the Herbert Hoover Dike and lock system was constructed around the lake in the early twentieth century to prevent catastrophic hurricane impacts to humans. The final dike and lock system was finished in the 1960s and resulted in 143 miles of levee, including multiple culverts and water control structures. Regulated water levels occurred after completion of the dike system, which restricted the vegetated littoral marsh to about 400 km² within the levee, dominated by submergent and emergent aquatic plants and organically rich sediments (Havens 2005). Pesnell and Brown (1977) reported that the levee system resulted in extreme alterations to the biomass and distribution of shoreline terrestrial vegetation, aquatic macrophyte communities, and the distributions of littoral and limnetic habitats relative to pre-levee construction conditions. The levee system substantially reduced the maximum surface area of the lake and restricted the littoral vegetation community to within the levee system (Pesnell and Brown 1977), but surface area data prior to levee construction are not available. The levee also altered system responses to environmental effects such as pulse rain events by holding the lake surface area within the levee and preventing water expansion into the historically connected floodplain.

Construction of the levee system altered water outflows from the lake compared to
historical conditions. Prior to the levee system, lake water outflow occurred over a large area to the south via sheet flow through the Everglades to Florida Bay. The hydrologic alterations included large new connections to the east (St. Lucie Canal) and west (canal to the Caloosahatchee River), so that most water from Lake Okeechobee was discharged to estuaries on the east and west coasts of Florida (Steinman et al. 2002; Figure 1). Discharges from Lake Okeechobee through these altered water pathways caused lower salinity and elevated nutrient levels relative to estuary conditions prior to the levee system (Steinman et al. 2002), and created new policy implications for Lake Okeechobee that require consideration of estuarine resources for lake management operations (discussed below).

During 2004–2005, Lake Okeechobee was impacted by four large hurricanes (Figure 1) that resulted in large changes to littoral habitats. Lake Okeechobee's shallow depth and long fetch (up to 56 km) facilitated wind-induced wave energy and sediment disturbances in this system (Bachmann et al. 2000; Havens et al. 2001; Chimney 2005). Direct hurricane effects resulted in physical uprooting of macrophytes, and indirect effects included resuspension of sediments that attenuated light penetration and increased water levels that potentially weakened plant structures. Resuspension of sediments was facilitated by the fluid mud layer (i.e., flocculent sediments) that covered much of the lake bed (Mehta 1996; Bachmann et al. 2005) and resulted in persistent turbidity. We measured changes to the littoral fish community following hurricane-induced habitat changes, and addressed how anthropogenic manipulations to the system magnified hurricane impacts and created new challenges to ecosystem restoration.

METHODS

We sampled a 25 km² area in the northwest region of Lake Okeechobee, which was typical of the littoral aquatic plant community found at the lake. We sampled fish communities during the summers of 2003 and 2004 (pre-hurricanes) and 2006 (post-hurricanes). A block net (3.2-mm knotless nylon mesh) was deployed in a 10 m x 10 m square (total area = 0.01 ha) and liquid rotenone (Prenfish® 5% active ingredient) was applied at 3 mg/L. Samples were collected in the shallow (~ 1 m) littoral zone and sample sites were selected to be representative of available habitat types (i.e., vegetation types) including remaining macrophytes in the post-hurricane period. We sampled within the same large littoral area during both time periods (n = 24 and 20 net-sets during pre- and post-hurricane periods, respectively). At each net, all fish were collected by 3–4 wading investigators until fish did not continue to surface (i.e., approximately one hour per net), and the net was then moved to another location and set again. We quantified aquatic macrophyte biomass by removing and weighing all above-ground vegetation growing within 3 randomly placed 0.25 m² plastic squares in each block-net during both periods. The block net gear collects fish less than 200 mm total length, and thus, is an effective sampling gear for juvenile and small-bodied fishes (Timmons et al. 1978; Rogers and Allen 2005).

All collected fish were placed on ice and returned to the laboratory. Subsamples of 50 individuals per species were measured to TL (mm) and weighed (nearest 0.01 g) for each block net. Average individual weight for each species was used to extrapolate the total catch for each net, which provided relative density and biomass estimates for each species in each block net.

We evaluated the following community metrics for differences between the pre- and post-hurricane time periods: total aquatic macrophyte biomass, fish species diversity, fish species richness, fish species evenness, and total fish biomass. Species diversity was estimated using the Shannon-Wiener index, and species evenness was estimated using Simpson’s index (Krebs 1999). We also considered species groups including omnivore/obligate planktivore biomass (i.e., brook silversides Labidesthes sicculus, inland silversides Menidia beryllina, gizzard shad Dorosoma cepedianum, and threadfin shad D. petenense), centrarchid biomass (i.e., bluegill...
Lepomis macrochirus, dollar sunfish L. marginatus, warmouth L. gulosus, redear sunfish L. microlophus, spotted sunfish L. punctatus, bluespotted sunfish Enneacanthus gloriosus, black crappie and largemouth bass), and fundulid/poecilid biomass (i.e., bluefin killifish Lucania goodei, eastern mosquitofish Gambusia holbrooki, golden topminnow Fundulus chrysotus, least killifish Heterandria formosa, sailfin molly Poecilia latipinna, and Seminole killifish Fundulopanchax seminolis). The omnivore/obligate planktivore group was considered separately because their abundance is often inversely related to habitat quality and trophic state (Vanni et al. 2005). The centrarchid group was considered because they exhibit a wide range of feeding strategies and support important recreational fisheries at the lake, and the fundulid/poecilid group was evaluated because these species are associated with dense aquatic macrophytes in Florida (Hoyer and Canfield 1994).

All metrics were estimated for each block net during each period. We used a resampling procedure (Poptools, www.cse.csiro.au/poptools/) in Excel® to draw 1,000 random samples with replacement from the data. The resampling procedure created expected parameter distributions (e.g., distribution of mean total fish biomass) for the pre- and post-hurricane time periods.

### EFFECTS OF HURRICANES ON THE LAKE ECOSYSTEM

Hurricanes caused lake-wide losses to the vegetated littoral zone (Figures 2, 3) and resulted in a near absence of submerged aquatic vegetation (Havens 2005). Lake-wide changes in aquatic macrophyte densities were reflected in our samples by large reductions in average total aquatic macrophyte biomass (Figures 2, 3, 4a). Prior to the hurricanes, the aquatic plant community consisted of a diverse group of floating (e.g., fragrant water lily Nymphaea odorata and pondweeds Potamogeton spp.), emergent (e.g., maidencane Panicum hemitomon, spikerush Eleocharis spp., and bulrush Scirpus californicus), and submersed (e.g., eel grass Vallisneria americana, coontail Ceratophyllum demersum, and southern naiad Najas guadalupensis) macrophytes. After the storms, macrophyte biomass was greatly reduced (Figure 4a), and aerial coverage was reduced by over 75% lake-wide (C. Hanlon, South Florida Water Management District, pers. comm.) compared to the pre-hurricane conditions.

![Figure 2. Examples of the Lake Okeechobee littoral zone in pre-hurricane (2004, top panel) and post hurricane (2006, bottom panel) time periods. Both photographs were taken from the same location in the northwest region of the lake.](image-url)
and fundulid/poecilid abundance (Figure 4f, g), which support popular fisheries and high fish richness and diversity in Florida, to high abundance of omnivorous and obligate planktivorous species (Table 1, Figure 4h), which often dominate fish communities in eutrophic systems with low habitat complexity (Vanni et al. 2005). Members of the centrarchid and fundulid/poecilid families utilize aquatic plants and associated invertebrates for food resources and protection from predation, and loss of aquatic macrophytes resulted in dramatic functional shifts in the fish community at Lake Okeechobee (as per Tilman et al. 1997).

Individual species shifts followed the trends observed for fish families. Bluefin killifish exhibited the highest density in our samples before the storms, and this species was not collected in post-hurricane samples (Table 1). Similarly, juvenile largemouth bass were abundant before the storms and absent from our samples afterwards, and other species of centrarchid and fundulid/poecilid families showed large declines after the storms. All obligate planktivores (e.g., threadfin shad, gizzard shad, and silversides) increased in catches after the macrophytes were reduced. Thus, the individual species trends mirrored the family analyses showing large changes in fish community composition and abundance after the hurricanes.

Tropical storms have long impacted south Florida ecosystems, but modifications to the system’s hydroscape likely exacerbated hurricane damage to the lake’s flora and fauna. Historically, hurricane and high water events would have resulted in a vast surface area expansion of the lake and natural sheet flow to the Everglades. Modern water control structures hold the lake’s surface area within the levee system and water levels rise during hurricane events, which increase wind and wave damage to plants within the levee (Havens 2005). The levee system likely also magnified seiches and wave energy effects during hurricane events relative to historical lake conditions, when winds would have been dampened by connected wetlands (Chimney 2005; Havens 2005). For example, the difference in lake stage between the northern and southern end of the lake was 3.5 m during one of these storms (Hurricane Jeanne), and wave energy compiled against one side of the lake and then shifted to the other as the storm passed, instead of extending into historically connected marshes (Chimney 2005). We found large changes in the littoral fish community composition after loss of littoral macrophytes, and the constraint of the levee prevented the lake from expanding to surrounding floodplain habitats. This scenario revealed an urgent need for management actions that accelerate the lake’s return to a macrophyte-dominated system.

**POLICY IMPLICATIONS**

Ecosystem restoration is usually constrained by social and/or economical factors, and is further complicated if anthropogenic modifications alter system thresholds of stability (Scheffer et al. 2001). Management

![Figure 3. Jason Bennett and Mark Rogers identify aquatic plants in front of a vegetated island located in the littoral zone of Lake Okeechobee in the pre-hurricane time period (2004, top panel). The same location is shown in the post-hurricane time period (2006, bottom panel).](image-url)
responses to restore plant and fish communities at Lake Okeechobee require low water levels for germination of emergent aquatic vegetation within the levee system (Steinman et al. 2002; Havens 2005; Johnson et al. 2007). Johnson et al. (2007) suggested that maintaining lake levels below 4.6 m MSL (mean sea level) would foster growth of a diverse aquatic plant community in Lake Okeechobee's littoral zone. High lake water levels (i.e., > 4.6 m MSL; Johnson et al. 2007) reduce light availability directly through sediment-induced turbidity, and indirectly by bringing water with high nutrient levels into the lake's littoral zone, resulting in algae blooms, lowered light availability, and reduced macrophyte coverage (Havens 2005). Thus, large water discharges following high periods of rainfall are required to reduce the lake level and promote restoration of aquatic plant communities.

Large water releases required to reduce lake levels cause substantial negative effects on sea grasses, oyster reefs, and fishes in now-connected Florida estuaries due to nutrient increases and salinity depressions (Steinman et al. 2002; Havens 2005). Doering et al. (2002) identified maximum desired flows in the Caloosahatchee River estuary based on shoal grass (Halodule wrightii) distribution and salinity tolerance. They reported little shoal grass growth at salinities between 6 and 12 ppt, and mortality occurred at salinities below 6 ppt. The connection to Lake Okeechobee increases the frequency and duration of low salinities in the Caloosahatchee Estuary (Steinman et al. 2002).
Table 1. Average number per hectare (standard error) of fish species captured in littoral zone blocknets at Lake Okeechobee, Florida, before (n = 24 nets) the 2004–2005 hurricane seasons.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Pre-hurricane</th>
<th>Post-hurricane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>needlefish</td>
<td>Strongylura marina</td>
<td>4 (4)</td>
<td>35 (11)</td>
</tr>
<tr>
<td>Blue tilapia</td>
<td>Oreochromis aurea</td>
<td>63 (41)</td>
<td>50 (21)</td>
</tr>
<tr>
<td>Black acara</td>
<td>Cichlasoma bimaculatum</td>
<td>154 (109)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Black crappie</td>
<td>Pomoxis nigromaculatus</td>
<td>4 (4)</td>
<td>10 (7)</td>
</tr>
<tr>
<td>Bluefin killifish</td>
<td>Lucania goodei</td>
<td>20,575 (9,575)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Bluegill</td>
<td>Lepomis macrochirus</td>
<td>1,171 (248)</td>
<td>565 (110)</td>
</tr>
<tr>
<td>Bluespotted sunfish</td>
<td>Enneacanthus gloriosus</td>
<td>3,742 (1,696)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Brook silverside</td>
<td>Labistes siculus</td>
<td>50 (109)</td>
<td>325 (121)</td>
</tr>
<tr>
<td>Brown bullhead</td>
<td>Ameiurus nebulosus</td>
<td>71 (33)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Brown hoplo</td>
<td>Hoplosternum littorale</td>
<td>0 (0)</td>
<td>125 (41)</td>
</tr>
<tr>
<td>Channel catfish</td>
<td>Ictalurus punctatus</td>
<td>0 (0)</td>
<td>75 (42)</td>
</tr>
<tr>
<td>Clown goby</td>
<td>Microgobius gulosus</td>
<td>125 (116)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Chain pickerel</td>
<td>Esox niger</td>
<td>179 (73)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Dollar sunfish</td>
<td>Lepomis marginatus</td>
<td>975 (359)</td>
<td>20 (12)</td>
</tr>
<tr>
<td>Eastern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mosquitofish</td>
<td>Gambusia holbrooki</td>
<td>3,858 (2,560)</td>
<td>20 (12)</td>
</tr>
<tr>
<td>Florida gar</td>
<td>Lepisosteus platyrhincus</td>
<td>4 (4)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Flagfish</td>
<td>Jordanella floridæ</td>
<td>217 (159)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Gizzard shad</td>
<td>Dorosoma cepedianum</td>
<td>4 (4)</td>
<td>2,215 (1688)</td>
</tr>
<tr>
<td>Golden shiner</td>
<td>Notemigonus crysoleucus</td>
<td>1,067 (289)</td>
<td>90 (71)</td>
</tr>
<tr>
<td>Golden topminnow</td>
<td>Fundulus chrysotus</td>
<td>671 (250)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Inland silverside</td>
<td>Menidia beryllina</td>
<td>75 (60)</td>
<td>1,565 (414)</td>
</tr>
<tr>
<td>Lake chubsucker</td>
<td>Enimyzon sucetta</td>
<td>604 (217)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Least killifish</td>
<td>Heterandria formosa</td>
<td>275 (106)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Largemouth bass</td>
<td>Micropterus salmoides</td>
<td>1,192 (587)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Mayan cichlid</td>
<td>Cichlasoma urophthalmus</td>
<td>0 (0)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Pugnose minnow</td>
<td>Opsopoeodus emiliae</td>
<td>775 (472)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Redear sunfish</td>
<td>Lepomis microlophus</td>
<td>1,433 (236)</td>
<td>10 (7)</td>
</tr>
<tr>
<td>Sailfin molly</td>
<td>Poecilia latipinna</td>
<td>321 (287)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Seminole killifish</td>
<td>Fundulus seminolis</td>
<td>75 (36)</td>
<td>20 (16)</td>
</tr>
<tr>
<td>Spotted sunfish</td>
<td>Lepomis punctatus</td>
<td>113 (45)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Suckermouth catfish</td>
<td>Hypostomus plecostomus</td>
<td>725 (721)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Swamp darter</td>
<td>Etheostoma fusiforme</td>
<td>467 (197)</td>
<td>50 (28)</td>
</tr>
<tr>
<td>Tadpole madtom</td>
<td>Noturus gyninus</td>
<td>4 (4)</td>
<td>40 (20)</td>
</tr>
<tr>
<td>Tailt identification not clear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threadfin shad</td>
<td>Dorosoma petenense</td>
<td>13 (13)</td>
<td>275 (89)</td>
</tr>
<tr>
<td>Unidentified cichlid</td>
<td>Cichlasoma spp. or Tilapia spp.</td>
<td>0 (0)</td>
<td>2,110 (1065)</td>
</tr>
<tr>
<td>Warmouth</td>
<td>Lepomis gulosus</td>
<td>667 (208)</td>
<td>20 (20)</td>
</tr>
<tr>
<td>White catfish</td>
<td>Ameiurus catus</td>
<td>0 (0)</td>
<td>10 (7)</td>
</tr>
</tbody>
</table>
Similarly, Chamberlain and Hayward (1996) showed that the connection to Lake Okeechobee has substantially increased fluctuations in salinity, dissolved oxygen, and nutrient concentrations for the St. Lucie Estuary on Florida's east coast. Low freshwater flows from Lake Okeechobee were necessary to approximate historical water quality conditions for this system (Chamberlain and Hayward 1996). Estuarine impacts of freshwater inflows from Lake Okeechobee are a direct effect of anthropogenic alterations, because water is released to estuaries that were previously not openly connected to the Lake Okeechobee drainage. Human-induced changes have therefore created trade-offs, because restoration efforts for the lake system will impose extensive costs to other components and users of the ecosystem.

Policy decisions require evaluating trade-offs among system states (Carpenter et al. 2001) and associated resource uses and values. Because many aquatic ecosystems are heavily modified, policy makers need to acknowledge that optimal solutions for all components of the ecosystem (including human users) can be difficult or impossible to achieve (Walters and Martell 2004). Exposing trade-offs in resource priorities will be a strong research need in the future, but implementation of policies where all resources cannot be optimized will require difficult management decisions. Disturbance is an integral component of ecosystem structure and function, and the potential for anthropogenic activities to magnify effects of disturbances presents new challenges to ecosystem management and restoration. ☞

ACKNOWLEDGEMENTS

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REFERENCES


FEATURE: ENDANGERED SPECIES

Surveying Professional Opinion to Inform Bull Trout Recovery and Management Decisions

ABSTRACT: Increasing concerns about management and recovery of the threatened bull trout (Salvelinus confluentus) prompted the Bull Trout Committee of Western Division American Fisheries Society to survey scientists working most closely with bull trout in Pacific Northwest drainages of the contiguous United States. We solicited scientific and judgment-based assessments regarding current status and future trends, limiting factors, effectiveness of restoration strategies and regulatory mechanisms, and information gaps. The survey was sent to 235 biologists, with the majority of the responses coming from Montana, Oregon, and Washington. Respondents indicated fish passage, forest management practices, and nonnative species interactions are the primary factors limiting bull trout populations, and these issues were identified as the primary recovery challenges in the foreseeable future. Survey results indicated large information gaps in our understanding of bull trout population dynamics, monitoring and evaluation, and community interactions. Finally, survey respondents across demographic groups identified the listing under the Endangered Species Act as the single most important regulatory action benefitting bull trout. We conclude online surveys of professional opinions can be useful for guiding future management decisions, identifying research needs, understanding the relative importance of potential limiting factors, and evaluating the effectiveness of different regulatory mechanisms.

INTRODUCTION

Bull trout (Salvelinus confluentus) is a native char found in rivers and lakes of the Pacific Northwest, ranging historically from northern California to northern British Columbia and Alberta. The bull trout is a top-level piscivore that is unique among western native trout because of its potentially large size (to 15 kg), high longevity (commonly 13 years or more), and adaptable life history patterns (fluvial, adfluvial, anadromous, and resident forms). Bull trout that reside within freshwater habitat tend to be more migratory than most other non-anadromous salmonids, with spawning, foraging, migrating, and overwintering movements up to 250 km in large interconnected systems (Fraley and Shepard 1989).

In the late 1980s, fisheries scientists recognized the unique attributes of bull trout and expressed concern that this was a species at risk (Howell and Buchanan 1992). The increased scientific focus led to expanded research throughout its range (e.g., Mackay et al. 1997; Rieman et al. 2007). The increased scientific focus led to expanded research throughout its range (e.g., Mackay et al. 1997; Rieman et al. 2007).
Because of widespread reductions in abundance, distribution, and genetic diversity from historical levels, the bull trout was listed under the U.S. Endangered Species Act (ESA) as a threatened species in U.S. states and portions of the Columbia River basin in 1998 (USFWS 1998), a listing which was expanded throughout the coterminous 48 states in 1999 (USFWS 1999). Declines are largely attributed to habitat degradation and fragmentation, interactions with nonnative salmonids, and overexploitation (Rieman et al. 1997). Draft Bull Trout Recovery Plans were published in 2002 and expanded in 2004 (USFWS 2002 and 2004), and critical habitat was formally designated in 2005 (USFWS 2005). In 2004, the U.S. Fish and Wildlife Service (USFWS) initiated a formal five-year status review, which is yet to be completed.

In the spring of 2005, following a request by its Species of Special Concern Committee, the Montana Chapter of AFS (MTAFS) formally requested the WDAFS Bull Trout Committee survey bull trout biologists to assess the effectiveness and progress of bull trout restoration and recovery efforts. The MTAFS request to WDAFS specifically noted that: “Uncertainty about the effectiveness and implementation of regulatory mechanisms, including state and tribal recovery plans and the Endangered Species Act processes, somewhat cloud future prospects for bull trout recovery. Given those elements of uncertainty and concern that policy decisions regarding future protection for bull trout and their habitat may not adequately consider the science necessary to fully support bull trout recovery....” Following discussion, the WDAFS Executive Committee endorsed and initiated the survey in November 2005.

METHODS

To meet the objectives set out by the MTAFS and WDAFS to develop a robust and objective survey, a Bull Trout Survey Subcommittee which included the authors was formed. The subcommittee included biologists from state and federal governments, hydropower utilities, non-governmental organizations, and academia (see Acknowledgments). We used terminology provided in the Draft Bull Trout Recovery Plan (USFWS 2002, 2004) for designing the survey, because of its general use and acceptance for describing bull trout populations. The plan is organized around a hierarchical approach to population units and describes 121 bull trout core areas across the range in the 5 western states where bull trout occur. Core areas described in the plan constituted the basic units upon which bull trout recovery is to be gauged (USFWS 2002, 2004). To standardize the survey approach throughout the range and to avoid potential ambiguity associated with various population terms (local populations, meta-populations, subpopulations, etc.), we designed questions that addressed bull trout population units at the core area level as described in the plan. Because some respondents would likely be familiar with multiple core areas, respondents were allowed to complete a maximum of five separate surveys for questions related to different core area populations.

SURVEY DETAILS

The survey developed by the subcommittee contained six components: respondent background, status and trend of bull trout populations and habitat, limiting factors, effectiveness of restoration strategies, effectiveness of various regulatory mechanisms, and information gaps. In total, we asked 19 questions (see Appendix), several of which had 2 parts.

The background information component included questions regarding the professional and geographic experience, expertise, and educational background of the biologist. The purpose of the background questions was to assess qualifications of respondents as a group (not individually) and to potentially account for variability in the responses to the survey.

The second component of the survey included two questions related to the status and trends of bull trout populations. The first question asked if the bull trout population in the individual core area considered by the respondent had increased, decreased, remained stable, or if the trend was unknown over the most recent decade. The second question asked whether the quantity of habitat in the core area had increased, decreased, remained the same, or if the trend was unknown over the most recent decade. There was no attempt to assess habitat quality, as the subcommittee viewed that as too subjective to be adequately quantified in this survey.

For these and some subsequent questions, respondents were asked to qualify their answers according to the level of information they used to generate each response. Four categories were used to assess the level of information quality on which responses were based, from most rigorous to least: (1) peer-reviewed empirical trend data, (2) short term or incomplete empirical data (e.g., redd counts every other year), (3) scientific observation not backed by empirical data (e.g., some evidence, but not statistically rigorous), and (4) anecdotal information.

The third component of the survey focused on the variability of factors limiting a particular bull trout core area population. Respondents were asked to rank the five most important categories of management activities they felt could induce limiting factors, and to rank those limiting factors relative to their contribution to the current status of bull trout (Table 1). There were two separate components for each question: one related to historical management activities (most recent
decade) and the other to future activities (next 10 years). Ten years was used as a temporal frame of reference, as it approximates two bull trout generations and the subcommittee viewed it as representative of the context in which many biologists would consider past and future assessments related to this fish.

### Table 1. A list of potential factors limiting bull trout populations.

- Agricultural practices
- Angling or harvest (legal and illegal)
- Dewatering
- Entrainment (hydropower and diversions)
- Fish passage issues (barriers to migration)
- Forest management practices and forest roads
- Introduced species (fish or other organisms)
- Livestock Grazing
- Mining (including oil and gas)
- Residential development and urbanization
- Transportation networks (e.g., major highways, railroads, etc.)
- Water quality impairment from non-specific or multiple sources
- Currently no apparent limiting factors
- Other (specify)

The fourth component of the survey used questions to assess the effectiveness of various strategies at facilitating bull trout restoration or protecting existing status in each core area. Respondents were asked to rank the 5 most important categories of restoration strategies for their relative potential to contribute to the healthy status of bull trout populations over the next 10 years (Table 2).

### Table 2. A list of potential restoration strategies for bull trout core areas.

- Agricultural practice improvements
- Angling regulation and angler education
- Fish passage improvement/removal of barriers
- Forest management practice improvements
- Grazing practice improvements
- Long term habitat protection (e.g., wilderness, National Park)
- Habitat restoration (watershed based or site-specific)
- Improved water quality (e.g., TMDLs)
- Improved water quantity (e.g., instream flow requirements)
- Nonnative species control
- Reduced forms of mortality (e.g., incidental or illegal harvest)
- Other

The fifth component assessed professional opinions regarding which regulatory mechanisms have been historically most effective and are likely to continue to be effective in the next 10 years in furthering the restoration and/or protection of the bull trout population in a given core area. There were 2 separate questions in this component: respondents were asked to rank the top 5 regulatory mechanisms (Table 3) based on their past and current effectiveness in contributing to bull trout population status and to assess the same regulatory mechanisms for their likely effectiveness in the next 10 years. Sixth component focused on the state of our knowledge regarding bull trout biology and management strategies. Respondents were asked to identify up to 5 categories where the largest information gaps occur and, if given the opportunity, where respondents would allocate the most resources over the next 10 years. Bull trout research categories included (in alphabetical order): angling and fishery management, biology and physiology, genetics, habitat relationships, migratory patterns, movement and tracking, population dynamics (e.g., demographics, vital rates), population monitoring and evaluation (basic abundance and distribution), species and community interactions (e.g., nonnative species), and other.

### Table 3. A list of regulatory actions potentially affecting bull trout.

- Clean Water Act (TMDLs and 303d lists)
- ESA Threatened listing (1998...)
- ESA Section 7 Consultations (1998...)
- ESA Critical Habitat proposed and final rule (2005)
- FERC licenses or agreements
- Forest plans
- HCP’s, Safe Harbor Agreements, and other voluntary strategies
- PaFish, InFish, or similar “watershed” protection strategies
- State or tribal bull trout management plan(s)
- Other (specify)

This survey was intended to include as many bull trout biologists as possible, and to collect as much information across broad landscape and demographic lines as was feasible, thus allowing for a comprehensive assessment of the variability of biologists’ opinions. To prevent potential bias associated with biologists’ employment affiliation, we made considerable effort in the design of questions and survey protocol to ensure anonymity of respondents. For example, in order to allow evaluation of the variability in responses by geographic region, respondents were asked to identify the location by state (Oregon, Washington, Montana, Idaho, or Nevada) of the particular core area they were addressing in the survey, but names of specific core areas were not requested.

We developed state-by-state lists of prospective respondents through information obtained by members of the bull trout subcommittee, augmented by additional resources at our disposal (e.g., professional meetings). Prior to being released, the survey was reviewed by a select group of biologists who were familiar with fisheries terminology and in some cases bull trout issues, but were outside our survey pool (e.g., Canadian collaborators), and by an external reviewer with expertise in designing survey questionnaires.

In April 2006, we distributed a cover letter describing the background of the survey and instructions for access to the survey (via a commercial website, SurveyMonkey.com) through e-mail from WDAFS to 235 bull trout biologists in U.S. portions of the Pacific Northwest. We encouraged biologists to forward the survey to coworkers who may have been missed, including those who had past experience with bull trout and had maintained an active interest in bull trout research, monitoring, or management. The subcommittee asked participants to complete the survey within two weeks and provided instructions on how to decline the survey to those who considered themselves as unqualified or where participation was otherwise problematic. We encountered difficulties in reaching some potential respondents due to Internet spam blockers; however, we forwarded the contact letter through multiple channels to maximize the number of qualified scientists surveyed. We extended the survey period for participants who received late notification, and closed the survey after about one month of gathering responses. Additionally, a final opportunity for participation in the survey was provided at a professional meeting (i.e., WDAFS Annual Meeting), although very few responses were received at that late juncture.
DATA ANALYSIS

We performed summary statistics for each question in the survey. With questions involving a rank of answers (e.g., 1 through 5), we calculated a weighted estimate and reported the relative importance for each category based on the following equation:

\[ R_i = \frac{\sum n_i}{R_{\text{max}}} \]

where \( R_i \) is the relative importance, \( i \) is the category for a particular question, \( n_i \) is the number of responses for each ranking (1 through 5), and \( R_{\text{max}} \) is the category with the highest response value; thus, categories with the highest ranking (1) were given the most weight (5).

We summarized the survey data at two levels. First, we partitioned the data at the state level to allow analyses of similarities and differences across geographic regions. Because Nevada represents such a small portion of the bull trout range (single Jarbridge River core area), we grouped this core area with adjacent Idaho. Next, because bull trout are listed under the ESA at the species level, we calculated similar metrics for all responses with no partitioning by state (United States only; hereafter referred to as range-wide), which provided a comprehensive summary of biologist opinions.

RESULTS

We received completed surveys from 87 respondents, which represented a 37% response rate to the original distribution list for the survey. Some respondents chose to answer only certain questions; hence, sample sizes were not the same for every question. Montana, Oregon, and Washington had the most respondents with 33, 24, and 21 survey participants, respectively; Idaho/Nevada had the fewest respondents with 8, and 1 respondent did not report a location. The majority of the respondents were affiliated with federal agencies, state agencies, and academic institutions (41%, 22%, and 11%, respectively). AFS membership was not required to take the survey, although 77% of respondents indicated they were AFS members. Because some respondents provided input for more than one core area, we received a total of 103 core area characterizations. Of the core areas that were characterized, the highest number were in Montana (\( n = 33 \)), followed by Oregon (\( n = 27 \)), Washington (\( n = 23 \)), and Idaho/Nevada (\( n = 9 \)); and 12 responses failed to include this information. This article presents and discusses primarily the range-wide results, with regional interpretation where it is particularly valuable or informative. More detailed results are provided in the Appendix (Tables A1 through A5).

Results for the second component of the survey, population trends, indicated that range-wide the highest number of responses were based on short-term or incomplete data (39%), 31% percent of responses were either uncertain or based on nonempirical scientific observations or anecdotal information, and only 28% of the core area population trend determinations were based on the most rigorous category of peer-reviewed empirical data (Figure 1a). Overall, there was no apparent pattern suggesting a particular range-wide trend in population abundance (e.g., increasing vs. decreasing) at the core area level.

When survey results for population trends were analyzed by geographic location of the core area, there was variability among states in both the source of information used to generate responses and in the direction of core area population trends (Table A1). Opinions regarding the current trend of core area populations in Idaho (albeit small sample size) and Montana had a higher proportion of responses based on peer-reviewed, empirical data (47% and 38%, respectively; Table A1). Oregon (18%) and Washington (19%) had substantially fewer responses based on rigorous information (peer-reviewed empirical trend data and short term or incomplete empirical data). When the level of information on which the survey responses were based was disregarded, there was significant variability in the range of responses by state in identifying increasing population trends (from 16 to 30%), stable trends (from 31 to 60%), and decreasing trends (from 13 to 36%), but no particular direction to the overall trend in each state was apparent.

Range-wide responses (United States only) indicated even fewer empirical data exist for assessing trends in habitat quality at the core level than observed for population trends (Figure 1b). Responses to habitat trend for 16% of core areas were based on the most rigorous peer-reviewed empirical data and for 19% short-term or incomplete empirical data were used. Nearly two-thirds (66%) of the habitat trend determinations were either uncertain, or were based on non-rigorous scientific observations.
or anecdotal information. When the level of information used to inform the survey responses was disregarded (i.e., no delineation of empirical and less-rigorous responses), there was no apparent pattern regarding the range-wide trend of habitat quantity; 37% of the responses suggested increasing trends, 30% stable trends, and 26% decreasing trends.

In analyzing responses based on geographic location of the respondent, the pattern regarding information used to describe habitat trends was similar to the range-wide results (Table A1). Few responses were based on empirically-based, peer-reviewed data (from 0 to 16%) and short-term or incomplete empirical data (from 26–39%), while 50–77% of the responses were based on non-empirical scientific observations, anecdotal information, or "uncertain". When information used to generate responses was not included, the majority of the responses suggested that habitat conditions were stable across states (from 47–67%), while there was little difference between the percent of responses indicating increasing (from 7–34%) and decreasing trends (from 13–22%).

Nonnative species, forest management strategies, and fish passage issues were considered the top factors limiting bull trout populations at the range-wide level. The results were similar for factors affecting historical and current population status (Figure 2a) as well as when considering future limiting factors (Figure 2b). In the geographic analysis of responses, there was substantial variability across states as to the relative rank of each management activity; however, similar to the range-wide responses, nonnatives, forest management activities, and fish passage issues were generally the highest ranking factors (Table A2).

Range-wide rankings (United States only) of the importance of various restoration activities generally paralleled those limiting bull trout populations. Nonnative species control, fish passage improvements, and habitat restoration received the highest rankings for their relative potential to contribute to the healthy status of bull trout populations over the next 10 years (Figure 3). When responses were analyzed by state, fish passage improvements and habitat restoration were consistently ranked highly (Table A3); however, there was substantial variability among states relative to the importance of different restoration strategies.

The ESA listing of bull trout as threatened was identified by most respondents, both at the state level and range-wide, as being the most effective regulatory mechanism for the current and future protection and recovery of bull trout (Figure 4; Table A4). ESA Section 7 consultations received the next highest rankings range-wide and relatively high rankings across states.

Finally, range-wide responses identifying research fields where the greatest information gaps for bull trout occur were uniformly highest for population dynamics (including demographics, vital rates, and modeling), population monitoring and evaluation, and species and community interactions (e.g., nonnative species; Figure 5). Analysis of responses by geographic area (Table A5), indicate considerable variability in ranking among states.

**DISCUSSION**

We found a professional opinion survey can be a useful, cost-effective and informative tool to assess areas where scientifically-based differences of opinion occur. This was demonstrated in our survey of diverse scientists working to restore bull trout populations in the U.S. portions of the Pacific Northwest. This survey was
Figure 4. Rangewide responses of the relative importance of different regulatory mechanisms or guidance documents that may have assisted in current (a) and future (b) protection and restoration of bull trout populations.

Figure 5. Rangewide responses of the relative rank of pre-selected categories where information gaps are known to occur regarding bull trout biology, population structure, and management, and where biologists would choose to allocate resources over the next 10 years. Categories are: (a) angling and fishery management; (b) biology and physiology; (c) genetics; (d) habitat relationships; (e) migratory patterns, movement and tracking; (f) population dynamics; (g) population monitoring and evaluation; and (h) species and community interactions.
conducted by a volunteer effort of WDAFS members, with minimal financial outlay.

The survey results, as with any poll, should be considered to represent the opinions of those included as respondents, as well as the information available to those individuals. Furthermore, the nonrandom design and geographically uneven response rate means that it is statistically nonrepresentative of all who would consider themselves bull trout biologists. However, the value of the results was increased by the design of the questions and the considerable planning and foresight incorporated to ensure that quality input was received. We consider the respondent sample size (n = 87) and relative consistency of responses to have provided a useful and rapid assessment of opinions of professional bull trout biologists in the U.S. portion of the species range.

Sullivan et al. (2006) note there are positive and negative attributes of various sources of scientific information. Expert opinion, the method used for our bull trout biologist survey, is categorized as “highly reliable, especially when it is based on the experience of multiple experts who collectively function as peer reviewers of a sort.” Expert opinion is further characterized as: “… the only form of scientific knowledge available for some crucial policy issues.” Sullivan et al. (2006) also indicated that expert opinion has an advantage over published literature based on field research, in being timely and providing “immediate” feedback, an attribute that was effectively demonstrated by the implementation of this survey.

However, such opinion surveys have shortcomings as well. Yoder and Rankin (1995) reported that qualitative assessments of fish assemblage condition tended to be more optimistic than quantitative assessments. Paulsen et al. (1998) found that nonrandom surveys tended to overestimate water body and coho salmon (Oncorhynchus kisutch) status because of nonrandom site selection being biased toward less disturbed sites. An alternative, albeit far more expensive and time consuming approach is to conduct rigorous field surveys through use of a probabilistic survey design (e.g., Paulsen et al. 1998; Dambacher and Jones 2007; Whittier et al., in press).

Nonetheless, as the electronic age advances, rapid feedback is becoming a more important part of our culture, from news to weather to the arts and science. As fisheries scientists, we should actively embrace opportunities to use new and different methods not previously available, such as the online survey employed here. A survey of this type allows an occasional “check on the pulse” of the scientific community and a determination of whether expert practitioners closest to the subject believe the intersection of science and policy translates into meaningful protection and restoration of species. The inclusive and controlled method by which this survey evolved and was administered through WDAFS protocol and guidance, combined with the high level of professionalism embodied by the respondents, separates a professional opinion survey of this nature from random public opinion polls.

Specific to bull trout, we have gleaned important messages about restoration efforts from this survey of professional opinions. First, and not surprisingly, the results (Figure 1) suggest that real population or habitat trends from the cross-section of bull trout core areas we surveyed are not yet evident. These findings may conflict with public perception, often on a localized scale, that bull trout populations are either fully recovered and not in need of protection, or conversely,
are spiraling rapidly downward toward extinction. Bull trout are relatively long-lived and widely-distributed salmonids which naturally occur at low densities, often disproportionately distributed in inaccessible backcountry areas and headwater habitats (Al-Chokhachy 2006). The biological attributes of the species (fall spawning and reliance on cold, clean water) may make bull trout particularly susceptible to natural or human-caused habitat and climatic changes (e.g., Rieman et al. 2007). Thus, a decade may be an insufficient amount of time to detect trends, even with good scientific data (Staples et al. 2005; Al-Chokhachy 2006). Furthermore, the survey results indicate fishery scientists do not currently place high confidence in the adequacy of existing empirical data upon which to base core area population and habitat trend assessments (see data quality ratings in Figure 1). These results are consistent with responses from another portion of the survey (see Figure 5) indicating population and habitat monitoring and evaluation are high priorities for further research emphasis.

A second important finding of this survey was the consistency in the opinions of biologists that fish passage, forest management practices and roads, and nonnative species interactions as the primary historical, current, and likely future limiting factors for bull trout (Figure 2). Along with habitat restoration, these three areas were also rated as the most important target areas for future restoration efforts (Figure 3). While many existing mitigation and protection activities emphasize these factors, the migratory nature of bull trout makes it even more critical that restoration activities be coordinated at the larger basinwide scale (typically synonymous with core area) to be most effective.

Finally, there is clear and overwhelming agreement from respondents to this survey, regardless of their background, jurisdiction, or affiliation, that the single most important regulatory action benefiting bull trout is its ESA listing status as a threatened species (Figure 4). Second most important are Section 7 consultations, the regulatory review of Federal projects carried out under the ESA. Respondents assigned lower, but substantially important benefits to the Clean Water Act, Draft Bull Trout Recovery Plan, forest plans, PacFish/Infish standards, and state and tribal management plans.

Results from this survey are consistent with many of the themes of a similar professional survey conducted in Alberta (Brewin 2004). That survey also found there was insufficient monitoring data to comprehensively evaluate population trends and concluded that long-
FUTURE CONSIDERATIONS

Obtaining information related to the status, trend, and gaps in current research can be extremely difficult for species such as bull trout that occupy broad spatial patterns. While surveys may not provide empirical assessments of factors such as population status and trend, they can be extremely helpful in collectively assessing information from the scientific community, bridging communication gaps existing across different entities, and helping guide research and management. The results of this survey indicated consistency in the perceived factors limiting bull trout, the effectiveness of different regulatory actions, and data limitations and research needs. However, despite these consistencies, there is some uncertainty as how specific components of management and regulatory actions have detrimental/positive effects on bull trout populations. For example, forest management practices were noted as a historic, current, and future factor limiting bull trout. The concept of “forest management” includes a wide variety of actions not delineated in this survey; thus, future research may be necessary to help identify the effect of different management and recovery actions on bull trout status and trends. As such, we urge consideration of these results as we move forward in understanding the ecology and designing effective management strategies for this species.

Despite the relative success of this survey, there were limitations in our survey that can be improved in future efforts. First, we experienced difficulties in distributing this survey to intended reviewers as a result of e-mail filters within different state/federal agency offices. We were able to include additional venues to reach out to respondents through professional meetings, but future surveys should consider as many resources as possible and potential setbacks to reach the intended respondents. Next, although not conducted here, future surveys of professional opinion might consider a means to ground-truth or validate responses, where synthesized opinions are compared against empirical data. Here, we were not able to conduct this type of validation effort due to our lack of resolution in our responses to relevant population units (i.e., core areas), which resulted from our efforts to keep respondent’s opinions anonymous. For future surveys, this validation may be particularly important where questions and responses relevant to the survey differ substantially across relevant spatial scales. In lieu of these limitations, this survey can be used by AFS, both at the Western Division and local Chapter levels, as a blueprint to guide future involvement in meaningful policy dialogue about bull trout restoration issues. Further, we consider our approach a useful tool to aid governmental, tribal, and non-governmental entities in evaluating complex resource concerns across broad spatial and political scales.
ACKNOWLEDGMENTS

Other members of the WDAFS Bull Trout Subcommittee contributed immeasurably to helping design and streamline the survey, including Chris Frissell (Pacific Rivers Council), Don Ratliff (Portland General Electric), Frank Shrier (PacificCorp), Kate Walker (U.S. Forest Service), and Steve Yundt (Idaho Fish and Game). Kerry Brewin, formerly with Trout Unlimited Canada, provided a prototype for the survey and valuable review. Clint Muhlfeld, past president of the MTAFS, pushed for initiating the survey and reviewed the manuscript. Bob Hughes, current WDAFS President, also provided valuable review, insight and motivation to complete this project.

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___. 1999. Endangered and threatened wildlife and plants; determination of threatened status for bull trout in the coterminous United States; Final rule. Notice of intent to prepare a proposed special rule pursuant to Section 4(d) of the Endangered Species Act for the bull trout; proposed rule. Federal Register 64(210)58910-58936. Washington, DC.


___. 2005. Endangered and threatened wildlife and plants; Designation of critical habitat for the Bull Trout; Final rule. Federal Register 70(185)56212-56311. Washington, DC.


Appendix 1.

Table A1. State by state comparisons of results indicating the trend of bull trout abundance and quantity of habitat at the core area level, and the quality of information used to evaluate trends.

<table>
<thead>
<tr>
<th>Trend</th>
<th>Core area population trend</th>
<th>Habitat trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WA OR MT ID</td>
<td>WA OR MT ID</td>
</tr>
<tr>
<td>Increasing peer-reviewed empirical trend data</td>
<td>0.06 0.13 0.07 0.13</td>
<td>0.00 0.05 0.02 0.00</td>
</tr>
<tr>
<td>Increasing short term or incomplete empirical data</td>
<td>0.13 0.08 0.09 0.00</td>
<td>0.10 0.05 0.02 0.07</td>
</tr>
<tr>
<td>Increasing scientific observation not backed by empirical data</td>
<td>0.03 0.08 0.00 0.07</td>
<td>0.13 0.13 0.11 0.00</td>
</tr>
<tr>
<td>Increasing anecdotal information</td>
<td>0.03 0.03 0.00 0.00</td>
<td>0.00 0.11 0.07 0.00</td>
</tr>
<tr>
<td>Stable peer-reviewed empirical trend data</td>
<td>0.09 0.05 0.20 0.27</td>
<td>0.00 0.03 0.11 0.00</td>
</tr>
<tr>
<td>Stable short term or incomplete empirical data</td>
<td>0.16 0.28 0.18 0.13</td>
<td>0.19 0.16 0.27 0.20</td>
</tr>
<tr>
<td>Stable scientific observation not backed by empirical data</td>
<td>0.06 0.08 0.02 0.13</td>
<td>0.19 0.21 0.20 0.33</td>
</tr>
<tr>
<td>Stable anecdotal information</td>
<td>0.00 0.03 0.02 0.07</td>
<td>0.13 0.08 0.02 0.13</td>
</tr>
<tr>
<td>Decreasing peer-reviewed empirical trend data</td>
<td>0.03 0.00 0.11 0.07</td>
<td>0.00 0.00 0.02 0.00</td>
</tr>
<tr>
<td>Decreasing short term or incomplete empirical data</td>
<td>0.13 0.13 0.16 0.07</td>
<td>0.10 0.05 0.09 0.07</td>
</tr>
<tr>
<td>Decreasing scientific observation not backed by empirical data</td>
<td>0.06 0.00 0.09 0.00</td>
<td>0.10 0.08 0.00 0.00</td>
</tr>
<tr>
<td>Decreasing anecdotal information</td>
<td>0.03 0.03 0.00 0.00</td>
<td>0.03 0.00 0.02 0.13</td>
</tr>
<tr>
<td>Uncertain (specify)</td>
<td>0.19 0.13 0.07 0.07</td>
<td>0.03 0.05 0.02 0.07</td>
</tr>
</tbody>
</table>
Table A2. State by state comparisons of the relative importance of different management activities that can induce limiting factors in the current and historical and future status of bull trout populations.

<table>
<thead>
<tr>
<th>Management activity</th>
<th>Current and historical status</th>
<th>Future status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WA</td>
<td>OR</td>
</tr>
<tr>
<td>Agricultural practices</td>
<td>0.29</td>
<td>0.49</td>
</tr>
<tr>
<td>Angling or harvest (legal and illegal)</td>
<td>0.59</td>
<td>0.32</td>
</tr>
<tr>
<td>Dewatering</td>
<td>0.25</td>
<td>0.38</td>
</tr>
<tr>
<td>Entrainment (hydropower and diversions)</td>
<td>0.41</td>
<td>0.36</td>
</tr>
<tr>
<td>Fish passage issues (barriers to migration)</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>Forest management practices and forest roads</td>
<td>1.00</td>
<td>0.63</td>
</tr>
<tr>
<td>Introduced species (fish or other organisms)</td>
<td>0.37</td>
<td>0.50</td>
</tr>
<tr>
<td>Livestock grazing</td>
<td>0.06</td>
<td>0.21</td>
</tr>
<tr>
<td>Mining (including oil and gas)</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Residential development and urbanization</td>
<td>0.35</td>
<td>0.27</td>
</tr>
<tr>
<td>Transportation networks (i.e. major highways railroads etc.)</td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>Water quality impairment from nonspecific or multiple sources</td>
<td>0.43</td>
<td>0.46</td>
</tr>
<tr>
<td>Currently no apparent limiting factors</td>
<td>0.15</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Table A3. State by state comparisons of the relative importance of restoration strategies for their relative potential to contribute to the healthy status of bull trout populations over the next 10 years (i.e., short term).

<table>
<thead>
<tr>
<th>Restoration activity</th>
<th>WA</th>
<th>OR</th>
<th>MT</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural practice improvements</td>
<td>0.40</td>
<td>0.55</td>
<td>0.08</td>
<td>0.10</td>
</tr>
<tr>
<td>Angling regulation and angler education</td>
<td>1.00</td>
<td>0.23</td>
<td>0.62</td>
<td>0.87</td>
</tr>
<tr>
<td>Fish passage improvement/removals of barriers</td>
<td>1.00</td>
<td>0.92</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Forest management practice improvements</td>
<td>0.96</td>
<td>0.29</td>
<td>0.81</td>
<td>0.93</td>
</tr>
<tr>
<td>Grazing practice improvements</td>
<td>0.11</td>
<td>0.28</td>
<td>0.27</td>
<td>0.10</td>
</tr>
<tr>
<td>Habitat protection—long-term (e.g. legislative or statutory such as wilderness National Park)</td>
<td>0.96</td>
<td>0.17</td>
<td>0.73</td>
<td>0.40</td>
</tr>
<tr>
<td>Habitat restoration (watershed based or site-specific)</td>
<td>1.00</td>
<td>0.80</td>
<td>0.85</td>
<td>1.00</td>
</tr>
<tr>
<td>Improved water quality (e.g. TMDLs)</td>
<td>0.44</td>
<td>0.34</td>
<td>0.58</td>
<td>0.20</td>
</tr>
<tr>
<td>Improved water quantity (e.g. instream flow requirements)</td>
<td>0.56</td>
<td>0.63</td>
<td>0.77</td>
<td>0.40</td>
</tr>
<tr>
<td>Nonnative species control</td>
<td>0.58</td>
<td>0.53</td>
<td>1.00</td>
<td>0.93</td>
</tr>
<tr>
<td>Reduced forms of mortality (e.g. incidental or illegal harvest)</td>
<td>0.33</td>
<td>0.22</td>
<td>0.65</td>
<td>0.23</td>
</tr>
<tr>
<td>Other</td>
<td>0.16</td>
<td>0.25</td>
<td>0.04</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Table A4. Relative importance of different regulatory mechanisms or guidance documents that may have assisted in previous and future protection and restoration of bull trout at the state level.

<table>
<thead>
<tr>
<th>Regulatory action</th>
<th>Current and historical population status</th>
<th>Future population status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WA</td>
<td>OR</td>
</tr>
<tr>
<td>Clean Water Act (TMDLs and 303d lists)</td>
<td>0.18</td>
<td>0.30</td>
</tr>
<tr>
<td>ESA Threatened listing (1998...)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>ESA Section 7 Consultations (1998...)</td>
<td>0.50</td>
<td>0.45</td>
</tr>
<tr>
<td>ESA Draft Recovery Plan (2002)</td>
<td>0.43</td>
<td>0.30</td>
</tr>
<tr>
<td>ESA Critical-Habitat proposed and final rule (2005)</td>
<td>0.16</td>
<td>0.08</td>
</tr>
<tr>
<td>FERC licenses or agreements</td>
<td>0.30</td>
<td>0.18</td>
</tr>
<tr>
<td>Forest plans</td>
<td>0.36</td>
<td>0.30</td>
</tr>
<tr>
<td>HCP’s Safe Harbor Agreements and other voluntary strategies</td>
<td>0.18</td>
<td>0.05</td>
</tr>
<tr>
<td>PacFish InFish or other similar “watershed” protection strategies</td>
<td>0.34</td>
<td>0.32</td>
</tr>
<tr>
<td>State or tribal bull trout management plan(s)</td>
<td>0.44</td>
<td>0.23</td>
</tr>
<tr>
<td>Other</td>
<td>0.14</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table A5. State by state comparisons of the relative rankings of information gaps regarding bull trout biology, population structure, and management, and where biologists would allocate resources over the next 10 years.

<table>
<thead>
<tr>
<th>Component of bull trout biology or management</th>
<th>WA</th>
<th>OR</th>
<th>MT</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angling and fishery management</td>
<td>0.08</td>
<td>0.05</td>
<td>0.11</td>
<td>0.13</td>
</tr>
<tr>
<td>Biology and physiology of bull trout</td>
<td>0.05</td>
<td>0.07</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Genetics</td>
<td>0.12</td>
<td>0.07</td>
<td>0.09</td>
<td>0.08</td>
</tr>
<tr>
<td>Habitat relationships for bull trout</td>
<td>0.12</td>
<td>0.12</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Migratory patterns movement and tracking</td>
<td>0.20</td>
<td>0.14</td>
<td>0.13</td>
<td>0.09</td>
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<td>0.21</td>
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<td>0.16</td>
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<td>Species and community interactions (e.g. nonnative species)</td>
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COLUMNS:
GUEST DIRECTOR’S LINE

Thermal Workshop Revives
Interest in Water Temperatures

Temperature is rising! A foremost issue for fisheries in late 1960s to mid-1980s was temperature effects, or “thermal pollution.” I was perpetually “in hot water” as our teams studied heated discharges in the Columbia River and Tennessee reservoirs and I participated in establishing science-based thermal criteria. Section 316(a) on thermal discharges of the U.S. 1972 Clean Water Act sent teams of biologists seeking a “balanced indigenous population” at nearly every power plant thermal discharge. Although the political and scientific “heat” and the fisheries employment surge subsided in the mid-1980s, temperature is now rising to the top again.

In October 2007, I met with over 100 people in Westminster, Colorado, for the Second Thermal Ecology and Regulation Workshop to exchange technical, regulatory, and legal information on §316(a). This section provides for a variance from both technology-based limits and temperature standards if the thermal discharge “will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water.” The workshop was co-sponsored by the Electric Power Research Institute (EPRI) and the host, Tri-State Generation and Transmission, Inc. It intentionally complimented the thermal symposium held at the 2007 AFS Annual Meeting in September.

As prefaced by Bob Goldstein, organizer and EPRI program manager, “Water issues, such as thermal discharges, impingement and entrainment, total maximum daily loads, effluent guidelines, water availability, and climate change, are converging.” Climate change ran through many presentations.

I was privileged to give the keynote, an overview of 60 years of trying to set temperature criteria and standards to protect aquatic life, including the community-based §316(a) approach. Steve Jinks (ASA Analysis and Communication) elaborated on §316(a) biological criteria for determining “balance” while Kristy Bulleit (Hunton and Williams) provided legal perspectives. Recent experiences with revising thermal standards were shared for Colorado (Lareina Wall, Geotechnical Engineers Inc. [GEI] Consultants), Wisconsin (Mike Wenholz, Wisconsin Department of Natural Resources), and the Ohio River (Erich Emery, Ohio River Valley Water Sanitation Commission). All noted a desire for better thermal response data and coordination of efforts.

An Environmental Protection Agency (EPA) official, Deborah Nagle, provided the agency’s perspective on thermal discharge variances. She discussed requirements of a §316(a) variance, and indicated that states are not implementing §316(a) consistently. Thus, EPA expects to update their 1977 §316(a) technical guidance document (of which I was an author) next year. A major topic was an update on scientific research for characterizing biotic thermal responses. Chris Yoder (Midwest Biodiversity Institute) presented an ordering scheme for aquatic organism sensitivity. Rob Reash (American Electric Power) discussed laboratory versus field tolerances for fish. Mark Bevelhimer (Oak Ridge National Laboratory) presented lab results indicating fish recover from short-term thermal stress in fluctuating thermal environments. Tamara Pandolfo (North Carolina State University) discussed thermal sensitivity of freshwater mussels and how a toxicant increases it. Modeling by John Schaefer (Great Lakes Water Institute) demonstrated thermal effects on interactions between benthic algae and mussels. State-of-the-art tools for evaluating thermal discharge effects on fish, e.g., telemetry, were reviewed by Tim Brush (Normandeau Associates).

One-third of the presentations focused on specific sites. Terry Cheek (Geosyntec Consultants) described Georgia Power Company’s decision to retrofit cooling towers on three riverine plants to prevent fish kills under low-flow conditions (because of reduced dissolved oxygen in heated water). David Lee (WE Energies) shared the §316(a) demonstration used for the Oak Creek Expansion Project’s Wisconsin discharge permit application. Informative case studies in New Hampshire (Mark Hutchins, Normandeau Associates), Rhode Island (Tom Englert, HDR/LMS engineering consultants), Florida (Sharon Good, Tampa Electric Co.), the Ohio River (Greg Seegert, EA Engineering), and the Tennessee Valley (Dennis Baxter, Tennessee Valley Authority) gave good geographic insights.

Chuck Coutant
AFS Past President Coutant is retired from Oak Ridge National Laboratory and can be contacted at ccoutant3@comcast.net.
North Pacific International Chapter Meets in Tacoma, Washington

The North Pacific International Chapter (NPIC) held its annual meeting at the Landmark Convention Center in Tacoma, Washington from 6–8 June 2007. Total attendance was 160 and included students from the University of Washington and Peninsula College in Port Angeles. The theme of the meeting was “Fisheries and Development: Can They Co-exist?” Fisheries technical sessions covered a wide range of contributed papers and posters, and featured three tracks—“Salmon Ecosystem Recovery and Management,” “New Fisheries Science,” and “Adapting to a Developing World.” A concurrent poster and trade show was held for the entire meeting and provided an excellent location to network, visit, and tell fish stories without disrupting the sessions.

On Wednesday Mike Fraidenburg started the meeting with a free continuing education module, “Conflict Resolution.” This module was followed by keynote speakers who presented their inspirational messages in the Temple Theatre of the former Masonic Hall. Keynote speakers included Jeff Koenings, director of the Washington Department of Fish and Wildlife (WDFW); Ron Sims, King County executive; and Aaron Adelstein from the Washington Master Builders’ Built Green Program. The featured keynote speaker at lunch was John Stein of NOAA, speaking about “Fisheries, Development and the North Pacific—AFS and PICES.” Each of the keynote speakers addressed how fisheries and development can and must co-exist.

Highlights of the annual business meeting on Thursday included an address by Jennifer Nielsen, AFS president, urging the Chapter members to think big in many ways, including possibly hosting the Annual Meeting in a few years. Chapter President Keith Underwood spoke to Chapter business urging membership participation in the Executive Committee and leadership roles.

A social was held at Tacoma Metro Park’s Point Defiance Aquarium on Thursday evening, where we dined in the presence of many fishes, sharks, and invertebrates representing the diversity and faunal beauty of Puget Sound. The food was good and the conversation lively as we discussed the many challenges facing fisheries in Washington and British Columbia.

By the conference end, over 90 papers were presented. The presented papers impressed attendees with their scientific rigor and novelty. If you would like to access the abstracts from the meeting, please go to www.npic-afs.org.

The 2007 conference was concluded with a field trip to Tacoma Water’s Green River watershed where we toured several projects demonstrating how people are co-existing with fish. Overall, the conference reminded us of the important role NPIC plays in improving our fisheries and fisheries professionals.

—Jim Shannon
South Dakota State University Student Subunit Hosts Kids Fishing Clinic

The South Dakota State University Student Subunit (SDSU AFS) hosted a kids fishing clinic for three local Cub Scout troops in September 2007 at a local pond in Brookings, South Dakota. The scouts were first taught fishing basics by visiting four instructional stations involving knot tying, casting, fish biology, and tackle.

After learning the basics, scouts were given an opportunity to fish under the watchful eye of SDSU AFS members. Many of the scouts were able to catch largemouth bass, and the day was extra special for those who were able to catch their first fish ever! One highlight was a “surprise” 8-lb. northern pike caught by one of the scouts. Because of the event, the scouts were able to qualify for a special belt loop for learning about fish and fishing.

SDSU AFS has hosted a variety of activities and events this year. The fall semester got off to a great start with a fish fry social that welcomed new and returning undergraduate and graduate students in the Department of Wildlife and Fisheries Sciences at SDSU. Other fall/winter activities included an annual ice fishing tournament, chili feed, and a fundraising raffle held at the Dakota Chapter’s annual meeting. The raffle proceeds fund scholarships that provide financial support to undergraduate fisheries students to attend the Dakota Chapter meeting. SDSU AFS also hosts continuing education activities such as under-ice sampling, biotelemetry, and an annual resume workshop/job fair.

SDSU AFS enjoys a tradition of inviting guest speakers to SDSU. These guest lectures provide a great venue for members to learn about current fisheries research and to meet with fisheries professionals in a more informal setting. Howard Fullhart (Minnesota Department of Natural Resources [MN DNR]), Brian Murphy (Virginia Tech), and Dave Lucchesi (South Dakota Department of Game, Fish and Parks) provided guest lectures this past year. Fall presenters included Tim Goeman (MN DNR Hiring and Recruitment) and Bob Lusk (editor, Pond Boss magazine).

SDSU AFS officers for 2007 include Tom Bacula (president), Andy Jansen (vice president), Bethany Galster (secretary), and Steve Ranney (treasurer). More information about SDSU AFS can be found at http://dakotaafs.sdstate.org/SDSUAFS_webpage/index.htm.

—Andrew Jansen
The American Fisheries Society is seeking nominations and applications for several 2008 awards. Award recipients will be honored at the Annual Meeting in Ottawa, Canada, in August 2008. Nominations typically require a candidate’s name, full contact information, biographical information, and/or history of service to the Society. Some awards require additional nomination materials; please see the AFS website at www.fisheries.org. For more information on how to nominate an individual or organization, see descriptions below or contact the award chair. For more information you may also contact Gail Goldberg, AFS awards coordinator, at ggoldberg@fisheries.org, or 301/897-8616 x201.

**Award of Excellence**

The highest honor of the Society, presented to an AFS member for original and outstanding contributions to fisheries and aquatic biology.

**Nomination deadline:** 1 April 2008

**Contact:** Margaret H. Murphy
Quantitative Environmental Analysis, LLC
290 Elwood Davis Rd.
Liverpool, NY 13088
**Phone:** 315/453-9009
**Fax:** 315/453-9010
**E-mail:** mmurphy@qeallc.com

**Carl R. Sullivan Fishery Conservation Award**

Presented to an individual or organization for outstanding contributions to the conservation of fishery resources. Eligibility is not restricted to AFS members, and accomplishments can include political, legal, educational, scientific, and managerial successes. Nominations should include a synopsis of fishery conservation contributions; a description of the influence of those contributions on improved understanding, management, or use of fishery resources; and at least one additional supporting letter.

**Nomination deadline:** 16 April 2008

**Contact:** William G. Franzin
1006 Kilkenny Drive
Winnipeg, MB, Canada, R3T 2N6
**Phone:** 204/269-1950
**Fax:** Call ahead
**E-mail:** franzin@shaw.ca

**Distinguished Service Award**

Recognizes outstanding contributions of time and energy for special projects or activities by AFS members. The number of recipients may vary.

**Deadline:** 9 February 2008

**Contact:** William G. Franzin
1006 Kilkenny Drive
Winnipeg, MB, Canada, R3T 2N6
**Phone:** 204/269-1950
**Fax:** Call ahead
**E-mail:** franzin@shaw.ca

**Excellence in Public Outreach**

Presented to an AFS member who goes the “extra mile” in sharing the value of fisheries science/research with the general public through the popular media and other communication channels.

**Nomination deadline:** TBD, see website

**Contact:** Kevin Pope, Chair
Nebraska Cooperative Fish and Wildlife Research Unit
University of Nebraska Lincoln
103 Miller Hall
Lincoln, NE 68583-0711
**Phone:** 402/472-7028
**Fax:** 402/472-2722
**Email:** k pope2@unl.edu

**Honorary Membership**

Presented to individuals who have achieved outstanding professional accomplishments or have given outstanding service to the Society. Honorary Members must be nominated by at least 100 active members and elected by a 2/3 majority of active members online.

**Contact:** Gail Goldberg
American Fisheries Society
5410 Grosvenor Lane, Suite 110
Bethesda, MD 20815
**E-mail:** ggoldberg@fisheries.org

**Meritorious Service Award**

Presented to an individual for loyalty, dedication, and meritorious service to the Society throughout the years and for exceptional commitment to AFS’s programs, objectives, and goals.

**Nomination deadline:** 1 May 2008

**Contact:** Carolyn Griswold
National Marine Fisheries Service
28 Tarzwell Drive
Narragansett, RI 02882
**Phone:** 401/782-3273
**Fax:** 401/782-3201
**E-mail:** carolyn.griswold@noaa.gov

**Outstanding Chapter Award**

Recognizes outstanding professionalism, active resource protection, and enhancement programs, as well as a strong commitment to the mission of the Society. Three awards are given: one for small Chapters, one for large Chapters, and one for a Student Subunit of a Chapter. Chapters should submit an application to their Division presidents to be considered. Division presidents must nominate two best Chapters from their Divisions, one with less than 100 members and another with 100 members or more. Applications can be obtained soon from the AFS website.

**Nomination deadline:** TBD, see website

**Contact:** J. F. Heitman
American Aquatics, Inc.
P.O. Box 32748
President’s Fishery Conservation Award

Presented in two categories: (1) an AFS individual or Unit or (2) a non- AFS individual or entity, for singular accomplishments or long-term contributions that advance aquatic resource conservation at a regional or local level. The award is administered by the Past President’s Advisory Council. A nomination package should include a strong and detailed letter describing the nominee’s contribution and the evidence for accomplishment at a regional or local level. If the nomination is for an individual, include a CV if possible. Nominations may be supported by multiple individuals by signing one nomination letter, or by submitting supporting letters in addition to the main nomination letter. Include the nominee’s title and full contact information (address, e-mail, phone).

Nomination deadline: TBD, see website
Contact: Jennifer Nielsen, Past President
USGS/ Alaska Science Center
1011 East Tudor Rd
Anchorage, AK 99503
Phone: 907/786-3670
Fax: 907/786-3636
E-mail: jnielsen@usgs.gov

Retired Members Travel Award for the AFS Annual Meeting

The American Fisheries Society has established this travel award to encourage and enable retired members of the Society to attend Annual Meetings, particularly those members who may play a more active role in the meeting. The Society recognizes that some retired members who desire to participate in the Annual Meeting might be inhibited for financial reasons. Retired members may not have travel funds that were available to them while employed. Therefore, this award is meant for those members who truly have a need for financial assistance. The Society has neither means nor desire to verify financial need, so your request for support is based on a honor system. However, you must be a dues-paying retired member of the American Fisheries Society to apply. You may request up to $1,500 for reimbursable expenses. Please send applications to Jennifer Nielsen, Chair, Past President’s Advisory Council.
Deadline: TBD, see website
Contact: Jennifer Nielsen, Past President
USGS/ Alaska Science Center
1011 East Tudor Rd
Anchorage, AK 99503
Phone: 907/786-3670
Fax: 907/786-3636
E-mail: jnielsen@usgs.gov

Student Writing Contest

Recognizes students for excellence in the communication of fisheries research to the general public. Undergraduate and graduate students are asked to submit a 500- to 700-word article explaining their own research or a research project in their lab or school. The article must be written in language understandable to the general public (i.e., journalistic style). The winning article will be published in Fisheries.

Nomination deadline: TBD, see website
Submission deadline: TBD, see website
Contact: Kevin Pope, Chair
Nebraska Cooperative Fish
and Wildlife Research Unit
University of Nebraska Lincoln
103 Miller Hall
Lincoln, NE 68583-0711
Phone: 402/472-7028
Fax: 402/472-2722
E-mail: kpopec2@unl.edu

AWARDS ADMINISTERED BY SECTIONS

Education Section: Excellence in Fisheries Education Award

The American Fisheries Society (AFS) Excellence in Fisheries Education Award was established in 1988. The award is administered by the Education Section and is presented to an individual to recognize excellence in organized teaching and advising in some aspect of fisheries education. Nominees may be involved in extension or continuing education, as well as traditional college and university instruction. Nominees must be AFS members, have been actively engaged in fisheries education within the last 5 years, and have had at least 10 years of professional employment experience in fisheries education. Two or more people may act as nominators, but at least one nominator must be an AFS member. The nominator(s) is responsible for compiling supporting material and submitting the application. The suggested format for applications can be found on the Education Section website. Application materials should be sent to Michael Quist (mcquist@iastate.edu) in digital form.

Contact: Michael Quist
Department of Natural Resource Ecology and Management
Iowa State University
339 Science II
Ames, IA 50011
Phone: 515/294-9682
Fax: 515/294-2995
E-mail: mcquist@iastate.edu
Education Section:

John E. Skinner Memorial Fund Award

The John E. Skinner Memorial Fund was established in memory of John Skinner, former California-Nevada Chapter and Western Division AFS president. The fund provides monetary travel awards for deserving graduate students or exceptional undergraduate students to attend the AFS Annual Meeting. The 2008 meeting will be held in Ottawa, Canada, 17–21 August.

Any student who is active in fisheries or related aquatic disciplines is eligible to apply. Awardedes are chosen by a committee of the AFS Education Section. Selection is based on academic qualifications, professional service, and reasons for attending the meeting. Travel support (final amount is yet to be determined, but at least up to $800 per award) will be made available to successful applicants. Award winners will also receive a one-year paid membership to the American Fisheries Society.

Limit all answers to the space provided. Additional material will not be considered in evaluating applicants. Please check the AFS website for more information and an application when it becomes available.

Application deadline: 9 May 2008

Contact: Craig Paukert
205 Leisure Hall, Division of Biology
Kansas State University
Manhattan, Kansas 66506
Phone: 785/532-6522
Fax: 785/532-7159
E-mail: cpaukert@ksu.edu

Equal Opportunity Section:

J. Frances Allen Scholarship Award

The American Fisheries Society (AFS) is pleased to announce that applications are being accepted until 7 March 2008 (postmark date), for the J. Frances Allen Scholarship for a female doctoral fisheries student. The Allen Scholarship was established in 1986 to honor Allen, who pioneered women’s involvement in the AFS and in the field of fisheries. The scholarship fund was established with the intent of encouraging women to become fisheries professionals.

Eligibility: The qualified applicant must be a female Ph.D. student who was an AFS member as of 31 December 2007. The applicant must be conducting aquatic research in line with AFS objectives, which include “all branches of fisheries science, including but not limited to aquatic biology, engineering, fish culture, limnology, oceanography, and sociology.”

Application: To apply, submit items A through D in the same package:
A. Resume (10 copies) with information in the following format:
• educational history: degrees, grade point average for each degree (overall and in major), relevant courses taken;
• professional experience: positions held, level of position, years of experience at each level;
• publications: separated into refereed and other;
• presentations: “first author” implies you presented it, “second author” assumes you did not, specify if otherwise; and,
• AFS participation: year joined, meeting attendance and participation, committee involvement, presentations at AFS meetings.
B. Transcripts (10 copies) from all institutions of higher education attended; include enrollment in Ph.D. program. High quality photocopies are acceptable. Please include transcripts—do not have them sent separately.
C. Dissertation research proposal (10 copies): not to exceed four single-spaced pages (excluding separate title page, abstract, and references). The proposal must be submitted in the following single-spaced format with headings:
• Title page with project title, area of research (e.g., genetics, ecology, modeling), applicant’s name, university, and department;
• Abstract, not to exceed one half-page, describing research proposed;
• Introduction of project with background and project justification;
• Problem statement with specific objectives or hypotheses;
• Summary of procedures and methods with justification for choices, including preliminary testing, literature references;
• Expected and preliminary results;
• Significance of research or anticipated application of findings; and,
• Literature cited (follow format for Transactions of the American Fisheries Society).
D. Three letters of recommendation, one of which must be from the applicant’s major advisor. One letter must be from an AFS member. Each letter should address the (1) applicant’s promise as a fisheries scientist, (2) potential of applicant to complete their proposed work, and (3) significance of the applicant’s proposed research to the advancement of fisheries science.

Send applications and recommendations (in one mailing), postmarked by 7 March 2008 to:
J. Francis Allen Scholarship
American Fisheries Society
5410 Grosvenor Lane, Ste. 110
Bethesda, MD 20814-2199

An application will not be reviewed if any part is missing, or if it is received after the deadline.

Criteria for Selection: Selection will be made by the J. Frances Allen Scholarship Committee of the AFS Equal Opportunity Section, www.fisheries.org/units/eos/.

Proposal reviews by scientists in appropriate fields will be solicited by the committee. The awardee will be selected on a competitive basis with emphasis placed on research promise, scientific merit, and academic achievement. Submission of an application acknowledges the applicant’s acceptance of the committee’s decision as final.

Public Announcement and Notification: Public announcement of the recipient of the J. Frances Allen Scholarship will be made at the 2008 AFS Annual Meeting in Ottawa, Canada. In addition a written announcement will appear in Fisheries and the recipient will receive an official letter of award. The recipient is encouraged to present the results of her research at an Annual Meeting of the Society. It is expected that the research findings will be published in an appropriate fisheries journal upon project completion, at which time the support from this scholarship and AFS will be acknowledged.
# CALENDAR: 2008 CHAPTER AND DIVISION MEETINGS

**MEMBERS:** Be sure to mark your calendars now, so you don’t miss these important local events!

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<td>California-Nevada</td>
<td>April 3-5</td>
<td>Tahoe City</td>
<td>Brad Cavallo, <a href="mailto:bcavallo@fishsciences.net">bcavallo@fishsciences.net</a></td>
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<td>Colorado-Wyoming</td>
<td>Mar 3-6</td>
<td>Plains Hotel, Cheyenne</td>
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<td><a href="mailto:Michael.hawkins@dnr.iowa.gov">Michael.hawkins@dnr.iowa.gov</a></td>
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<td><a href="mailto:dcfulton@umn.edu">dcfulton@umn.edu</a></td>
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<td>Montana</td>
<td>Feb 12-15</td>
<td>Crowne Plaza Hotel, Billings</td>
<td>[Carter Krause, <a href="mailto:carter.kruse@retranches.com">carter.kruse@retranches.com</a>](mailto:Carter Krause, <a href="mailto:carter.kruse@retranches.com">carter.kruse@retranches.com</a>)</td>
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<td>Nebraska</td>
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<td><a href="mailto:weber@nebraskaafs.org">weber@nebraskaafs.org</a></td>
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<td>New York</td>
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<td>Northeastern Division</td>
<td>Apr 27-30</td>
<td>Marriott Seaview, Galloway, New Jersey</td>
<td><a href="mailto:scott.decker@wildlife.nh.gov">scott.decker@wildlife.nh.gov</a></td>
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<tr>
<td>North Carolina</td>
<td>Feb 18-20</td>
<td>Pinehurst, (tentative)</td>
<td>[Christian Waters, 919/989-7058, <a href="mailto:waterscr@earthlink.net">waterscr@earthlink.net</a>](mailto:Christian Waters, 919/989-7058, <a href="mailto:waterscr@earthlink.net">waterscr@earthlink.net</a>)</td>
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<td>Ohio</td>
<td>Feb 1</td>
<td>Fawcett Center, Columbus</td>
<td>[Andy Burt 740/928-7034, <a href="mailto:andrew.burt@dnr.state.oh.us">andrew.burt@dnr.state.oh.us</a>](mailto:Andy Burt 740/928-7034, <a href="mailto:andrew.burt@dnr.state.oh.us">andrew.burt@dnr.state.oh.us</a>)</td>
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<td>Oklahoma</td>
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<tr>
<td>Ontario</td>
<td>Aug 17-21</td>
<td>Ottawa</td>
<td>Joint with AFS 2008 Annual Meeting</td>
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<tr>
<td>Oregon</td>
<td>May 4-9</td>
<td>Portland</td>
<td>[Neil Ward, 503/229-0191, <a href="mailto:neil.ward@cbfwa.org">neil.ward@cbfwa.org</a>](mailto:Neil Ward, 503/229-0191, <a href="mailto:neil.ward@cbfwa.org">neil.ward@cbfwa.org</a>)</td>
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<td>Pennsylvania</td>
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<tr>
<td>Potomac</td>
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<td>TBA</td>
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<tr>
<td>Southern Division</td>
<td>Feb 28-Mar 2</td>
<td>Wheeling, West Virginia</td>
<td>[Pat Mazik, general chair, <a href="mailto:pmazik@wvu.edu">pmazik@wvu.edu</a>](mailto:Pat Mazik, general chair, <a href="mailto:pmazik@wvu.edu">pmazik@wvu.edu</a>)</td>
</tr>
<tr>
<td>Southern New England</td>
<td>Jan 9</td>
<td>Doyle Conservation Center, Leominster, Massachusetts</td>
<td>D.Taylor, <a href="mailto:dtaylor@rvu.edu">dtaylor@rvu.edu</a> (mailto:D.Taylor, <a href="mailto:dtaylor@rvu.edu">dtaylor@rvu.edu</a>)</td>
</tr>
<tr>
<td>Tennessee</td>
<td>Mar 11-12</td>
<td>Fall Creek Falls State Park</td>
<td><a href="http://www.tr-afs.org/events/2008meeting_announc.html">www.tr-afs.org/events/2008meeting_announc.html</a></td>
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<tr>
<td>Texas</td>
<td>Jan 17-19</td>
<td>Texas Tech University-Junction</td>
<td><a href="http://www.sdfas.org/tidewaterannualmeeting.html">www.sdfas.org/tidewaterannualmeeting.html</a></td>
</tr>
<tr>
<td>Tidewater</td>
<td>Mar 6-8</td>
<td>VA Institute of Marine Science, Gloucester</td>
<td><a href="http://www.fisheries.org/units/aznm">www.fisheries.org/units/aznm</a></td>
</tr>
<tr>
<td>Utah</td>
<td>Feb 25-27</td>
<td>Moab</td>
<td><a href="http://www.fisheries.org/units/aznm">www.fisheries.org/units/aznm</a></td>
</tr>
<tr>
<td>Virginia and Virginia Tech</td>
<td>Feb 5-7</td>
<td>Blacksburg</td>
<td><a href="http://faculty.virginia.edu/vcafs/">http://faculty.virginia.edu/vcafs/</a></td>
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<tr>
<td>Western Division</td>
<td>May 4-9</td>
<td>Portland, OR</td>
<td>Joint with Oregon</td>
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<tr>
<td>West Virginia</td>
<td>Feb 28-Mar 2</td>
<td>Wheeling, West Virginia</td>
<td>Joint with Southern Division</td>
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<tr>
<td>Wisconsin</td>
<td>Feb 5-7</td>
<td>Wausau</td>
<td>Joint meeting AFS and TWS, John Kubisiak, <a href="mailto:JohnF1.Kubisiak@Wisconsin.gov">JohnF1.Kubisiak@Wisconsin.gov</a> (mailto:Joint meeting AFS and TWS, John Kubisiak, <a href="mailto:JohnF1.Kubisiak@Wisconsin.gov">JohnF1.Kubisiak@Wisconsin.gov</a>)</td>
</tr>
</tbody>
</table>
## CALENDAR: 2008 FISHERIES EVENTS

To submit upcoming events for inclusion on the AFS Web Calendar, please send event name; dates; city, state/province; and web address or contact information to cworth@fisheries.org. (If space is available, events may also be printed in Fisheries magazine.)

To see more event listings go to www.fisheries.org and click on “Calendar of Events.”

### DATE  
**EVENT NAME**  
City, State  
FOR MORE INFORMATION

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Name</th>
<th>City, State</th>
<th>For More Information</th>
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<tbody>
<tr>
<td>Feb 9-12</td>
<td>Aquaculture America</td>
<td>Lake Buena Vista, Florida</td>
<td><a href="http://www.was.org">www.was.org</a></td>
</tr>
<tr>
<td>Feb 24-28</td>
<td>Advances in Tagging and Marking Technologies in Fisheries Management and Research</td>
<td>Auckland, New Zealand</td>
<td><a href="http://www.fisheries.org/units/tag2008">www.fisheries.org/units/tag2008</a></td>
</tr>
<tr>
<td>Feb 28-Mar 2</td>
<td>Southern Division of the American Fisheries Society and West Virginia Chapter of AFS</td>
<td>Wheeling, West Virginia</td>
<td><a href="http://www.sdafs.org/meetings">www.sdafs.org/meetings</a></td>
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<tr>
<td>Feb 29-Mar 2</td>
<td>Catfish Farmers of America Annual Convention</td>
<td>San Diego, California</td>
<td>662/887-2699</td>
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<tr>
<td>Mar 2-7</td>
<td>2008 Ocean Sciences Meeting</td>
<td>Orlando, Florida</td>
<td><a href="http://aslo.org/meetings/orlando20081">http://aslo.org/meetings/orlando20081</a></td>
</tr>
<tr>
<td>Mar 5-8</td>
<td>26th Annual Salmonid Restoration Conference</td>
<td>Lodi, California</td>
<td><a href="http://www.calsalmon.org">www.calsalmon.org</a></td>
</tr>
<tr>
<td>Mar 13-15</td>
<td>Seventh Biennial Conference on University Education in Natural Resources</td>
<td>Oregon</td>
<td><a href="http://uenr.forestry.oregonstate.edu/index.htm">http://uenr.forestry.oregonstate.edu/index.htm</a></td>
</tr>
<tr>
<td>Apr 6-13</td>
<td>National Shellfisheries Association and 37th Annual Benthic Ecology Meeting</td>
<td>Providence, Rhode Island</td>
<td><a href="http://www.shellfish.org">www.shellfish.org</a></td>
</tr>
<tr>
<td>Apr 27-30</td>
<td>AFS Northeast Division Annual Meeting</td>
<td>Marriott Seaview, Galloway, New Jersey</td>
<td>Scott Decker, <a href="mailto:scott.r.decker@wildlife.nh.gov">scott.r.decker@wildlife.nh.gov</a>, 603/271-2491</td>
</tr>
<tr>
<td>Jul 7-11</td>
<td>11th International Coral Reef Symposium</td>
<td>Fort Lauderdale, Florida</td>
<td><a href="http://www.nova.edu/ncri/11/11crs">www.nova.edu/ncri/11/11crs</a>, Nancy Copen, <a href="mailto:ncopen@faseb.org">ncopen@faseb.org</a>, 301/634-7010</td>
</tr>
<tr>
<td>May 4-8</td>
<td>Western Division of the AFS and the Oregon Chapter of the AFS Annual Meeting: Human Population Growth and Fisheries—The Western Challenge</td>
<td>Portland, Oregon</td>
<td><a href="http://www.wdafos.org">www.wdafos.org</a></td>
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<tr>
<td>May 12-16</td>
<td>River Management Society Meeting</td>
<td>Portland, Maine</td>
<td><a href="http://www.river-management.org/symposium.asp">www.river-management.org/symposium.asp</a></td>
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<tr>
<td>May 19-23</td>
<td>International Conference on Echohydrological Processes and Sustainable Floodplain Management: Opportunities and Concepts for water Hazard Mitigation, and Ecological and Socioeconomic Sustainability</td>
<td>Lodz, Poland</td>
<td><a href="http://www.erce.unesco.lodz.pl">www.erce.unesco.lodz.pl</a></td>
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<tr>
<td>May 19-23</td>
<td>PICES Symposium: Effects of Climate Change on the World's Oceans</td>
<td>Gijon, Spain</td>
<td><a href="http://www.pices.int/meetings/international_symposia/2008/symposia">www.pices.int/meetings/international_symposia/2008/symposia</a></td>
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<tr>
<td>May 21-24</td>
<td>Interactions between Social, Economic, and Ecological Objectives of Inland Commercial and Recreational Fisheries and Aquaculture</td>
<td>Antalya, Turkey</td>
<td><a href="http://www.fao.org/si/eifac.htm">www.fao.org/si/eifac.htm</a></td>
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<tr>
<td>Jul 14-18</td>
<td>HydroVision 2008</td>
<td>Sacramento, California</td>
<td><a href="http://www.hcipub.com/hydrovision/abstracts.asp">www.hcipub.com/hydrovision/abstracts.asp</a>, <a href="mailto:techpapers@hcipub.com">techpapers@hcipub.com</a></td>
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<tr>
<td>Jul 23-28</td>
<td>American Society of Ichthyologists and Herpetologists Conference</td>
<td>Montreal, Canada</td>
<td><a href="http://www.asih.org/annualmeetings">www.asih.org/annualmeetings</a></td>
</tr>
<tr>
<td>Jul 25-27</td>
<td>Seventh International Conference on Recirculating Aquaculture</td>
<td>Roanoke, Virginia</td>
<td><a href="http://www.cpe.vt.edu/aquaculture/">www.cpe.vt.edu/aquaculture/</a> Terry Rakestraw, <a href="mailto:aqua@vt.edu">aqua@vt.edu</a>/aquaculture/, 540/231-6805</td>
</tr>
<tr>
<td>Sep 28-Oct 2</td>
<td>Pathways to Success 2008 Conference: Integrating Human Dimensions into Fisheries and Wildlife Management Increasing Human Capacity for Global Human-Wildlife Coexistence</td>
<td>Estes Park, CO</td>
<td><a href="http://www.warner.cn.colostate.edu/nrt/hdfw/partners.html">www.warner.cn.colostate.edu/nrt/hdfw/partners.html</a> <a href="mailto:eduke@warner.cn.colostate.edu">eduke@warner.cn.colostate.edu</a></td>
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<tr>
<td>Oct 20-24</td>
<td>Fifth World Fisheries Congress 2008</td>
<td>Pacifico Yokohama, Japan</td>
<td><a href="http://www.5thwfc2008.com">www.5thwfc2008.com</a>, <a href="mailto:wfc2008@ics-inc.co.jp">wfc2008@ics-inc.co.jp</a>, +81-3-3219-3541</td>
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**2009**

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<th>Date</th>
<th>Event</th>
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<th>Website/Contact Information</th>
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<tr>
<td>Aug 30-Sep 3</td>
<td>American Fisheries Society 139th Annual Meeting</td>
<td>Nashville, Tennessee</td>
<td><a href="http://www.fisheries.org">www.fisheries.org</a>,</td>
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Study Abroad: Fisheries in a Global Environment

Last summer I had the fortunate opportunity to embark upon an overseas study abroad program, “Environmental Policy in the Eastern Mediterranean Basin.” I began my graduate school experience at Michigan State University a semester before, expecting my life to be consumed by research and coursework. Little did I realize that it would be filled with novel opportunities for professional and personal growth. While overseas travel was not new to me, having served two years in Africa in the Peace Corps, traveling in my capacity as program assistant was a first, not to mention a bit daunting. Nonetheless, there was an air of excitement at the prospect of seeing and learning about another part of the world. It was a chance to assume a more professional role: providing tutelage to undergraduate students while working side by side with both academics and professionals in the scientific community. It was exhilarating to be directly involved in educating and promoting awareness of ecological issues which focused on the coupled human and natural systems related to fisheries and the interface between land and water resources.

Universities nationwide offer their students the opportunity to engage in study abroad programs. Michigan State University (MSU) is regarded as having the largest single-campus university study abroad program in the nation, with programs offered in more than 200 different countries. The study abroad program “Environmental Policy in the Eastern Mediterranean Basin,” offered by the MSU Department of Fisheries and Wildlife and James Madison College, covered a range of environmental and natural resources topics. The program focused on regional, national, and international policy and policymaking concerning environmental health, productivity, stewardship, and fisheries resource conservation with extensive lab and field-based components, including on-site water collection and analysis, fish identification, and fisheries sampling. The goal was to provide an understanding of the integrated nature of biological and social systems. This was achieved by exploring how the structure and function of biological systems can be altered by local and global environmental, social, and political activities.

Summer 2007 was the first year this study abroad program was offered. The program spanned four weeks, two weeks in Greece and two weeks in Turkey. Students had the opportunity to earn eight credits, equivalent to two campus classes, in an intensive four-week time period. To the students, participating in this study abroad program was time effective and created a long-lasting impression as the intense immersion allowed them to really focus on the topics covered and experience the breadth and depth of resource governance and management.

In this era of globalization, most students rely on the Internet to link themselves to other nations, but this does not allow for a personal understanding of the underlying socio-political-ecological issues and attitudes within those nations. In this program, students and faculty interacted, face-to-face, with experts from a multitude of disciplines from both nations, including water quality and water management, fisheries management, marine biology, GIS, and political science. To learn from local experts, to interact with local culture and people, and to witness firsthand the environmental issues at play was deemed by all the students as the “ultimate educational experience,” overshadowing the typical on-campus classroom routine they were accustomed to. Senior Nate Giddings described his 2007 experience as having “…allowed me to gain the type of cultural perspective that can’t be read in a book or obtained in a classroom.”

The diversity among the students was high in terms of their scholastic and personal experiences and provided for a unique learning experience not frequently encountered in campus courses targeting specific majors. Their majors spanned several disciplines, from engineering and international relations to economics and fisheries and wildlife. Despite this, all the students shared a common interest—the sustainability of our natural resources—and from this common interest they learned what each of their disciplines could contribute towards seeking solutions to natural resources challenges. The importance of students learning to communicate and work with others from different disciplines is an invaluable skill set that could only be achieved through constant interaction. Environmental and fisheries issues are becoming increasingly complex and global in scale and the industry and profession is ripe for professionals with a dynamic education that allows them to communicate and exchange these complex ideas with professionals from other disciplines, as well as the public. Despite the current differences in their academic interests and majors, these students may one day find themselves working as professionals on cross-disciplinary projects. This study abroad program begins the formation of a solid framework, so when the time comes, the students will be able to effectively analyze, understand, and address key global environmental issues from their respective disciplines.

For most of the students, the study abroad experience was not without its share of adversity. An immediate and
apparent barrier was communication. Words were not enough; body language and expressions became important in successfully communicating their thoughts. Patience was imperative in listening and understanding what was being said. What emerged was an understanding of the many challenges of international collaboration. Throughout the trip, the adversity was embraced and it built leadership skills and group ethic, promoted friendships and understanding, and allowed for true engagement of diverse values and beliefs. Students were surprised by the fact that people, despite different cultures and languages, are really not all that different. They soon understood that countries face similar environmental problems and strive to find solutions to those problems. In this context, students and instructors returned with the reinforced message that it only makes sense to strive towards working collectively on such complex environmental and biological issues. From the message emerged the importance of thinking locally to then act globally.

For freshman Leighanna Beach, the study abroad experience forced her to be more enterprising. “Traveling with a study abroad provides a chance to gain a drastically contrasting viewpoint while also providing that familiar tinge, safety, and prestige of Michigan State University. Traveling is enlightening because it takes you out of yourself, and forces you to see things you might have lost sight of in familiar surroundings.”

Junior Natassja Markham commented, “The experience has allowed me to realize what I find important in a career and what I am really interested in.” For this student, the study abroad program has helped to alleviate some of the uncertainty about life after college that plagues many undergraduates, not to mention graduate students and professors.

I found that the opportunity to be involved a program assistant in this course challenged me personally and professionally, as it did the students. The course provided a renewed sense of purpose and acted as a revitalizing force during a demanding time in life that familiar tinge, safety, and prestige of Michigan State University. The application process is also open to non-MSU students.

For faculty members, involvement in study abroad courses enriches the breadth and depth of their research and teaching programs. These often lead to the development of joint-international research projects, locations for future sabbatical leave, and lifelong personal and professional colleagues. For students, this provides a learning experience that prepares them to be better global citizens as well as enhancing their professional network. Participation in these courses allows for a better understanding of interconnections of the global fisheries supply chain and differing values. This knowledge provides for a more informed and skilled professional in the years to come.

For natural resources professionals, the global understanding of natural resource management prepares them to more effectively address challenges arising from this increasingly globalized world. What occurs in a local community is no longer divorced from the global community. As such, natural resource management agencies need to recruit employees who understand the complexity of the global environment. For instance, it would be impossible to imagine the effective management of insidious threats of such things as invasive species and diseases without a global context. To be effective, managers and policymakers of the future must be cognizant that fisheries are coupled human and natural systems based on diverse cultural values and needs.

In summary, study abroad courses give rise to new and effective international and inter-disciplinary collaborations which contributes to the better global management of natural resources. Participating in a study abroad program will provide for better professionals and a more highly valued and sustainable fisheries resources.
MISSION STATEMENT

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Although peer-reviewed and frequently cited, *Fisheries* is not considered an AFS journal. Lengthy, specialized, or highly technical research articles should be submitted to one of the four AFS journals. Some types of articles which are suitable for *Fisheries* include fishery case histories, review or synthesis articles covering a specific issue, policy articles, perspective or opinion pieces, essays, and current events or news features. Short research articles may be considered if the research has broad implications or applications and the article can be readily understood by professionals of a variety of backgrounds. We also encourage articles that will expose our members to new backgrounds. We also encourage articles by professionals of a variety of backgrounds. We also encourage articles by professionals of a variety of backgrounds. We also encourage articles by professionals of a variety of backgrounds.

REVIEWED ARTICLES

Features and Perspectives

We encourage submission of topical manuscripts of broad interest to our readership that address contemporary issues and problems in all aspects of fisheries science, management, and policy. Articles on fisheries management; aquatic resources; economics; educational/administrative concepts, controversies, techniques, philosophies, and developments; and other general interest, fisheries-oriented subjects will be considered. Policy and issue papers are welcome. Papers are judged on scientific and professional merit, relevance, and interest to fisheries professionals. Features and perspectives should not exceed 4,500 words (excluding references and tables) and should not cite more than 40 references. Please consult the senior or managing editor PRIOR to submission for a length or reference limit exemption for articles of Society-wide significance.

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What to Submit

- Assemble manuscript in this order: title page, abstract page, text, references, tables, figure captions, Tables may included at the end of the article file or may be submitted as separate files. Figures should not be embedded in the article file and should be submitted separately.
- Authors are strongly encouraged to submit a word processing file in either Word, Word Perfect, or Text formats. Figures/images should be in TIF or EPS formats and tables should be in Excel or Word formats.
- The cover letter should explain how your paper is innovative, provocative, timely, and of interest to a broad audience. It should also include a list of colleagues who have seen the manuscript in draft. The cover letter can also be used to provide further explanation if part of the information has been published or presented previously.

General Instructions

- Consult current issues for additional guidance on format.
- Manuscripts should be double-spaced, including tables, references, and figure captions.
- Leave at least a 1-in margin on all sides. Indent all paragraphs. Number pages sequentially.
- Please number lines for use as reference points by the reviewers. In Word, this feature is found in the File menu under Page Setup.
- Use dictionary preference for hyphenation. Do not hyphenate a word at the end of a line. Use Chicago Manual of Style, 14th edition, to answer grammar or usage questions.
- The first mention of a common name should be followed by the scientific name in parentheses. Our standard is Common and Scientific Names of Fishes from the United States, Canada, and Mexico, 6th edition.
- Cite each figure and table in the text. Organize text so each is cited in numerical order.
- Use metric units of measure. Imperial equivalents may be given in parentheses.
- Define abbreviations the first time they are used in the text.
- Spell out one-digit numbers unless they are units of measure (e.g., four fishes, 3 mm, 35 sites). Use 1,000 instead of 1000; 0.13 instead of .13; % instead of percent.
- Use the name-and-year system for references in the text as follows:
  1. One author: Jones (1995) or (Jones 1995);
  2. Two authors: Jones and Jackson (1995) or (Jones and Jackson 1995);
  3. Several authors: Jones et al. (1995) or (Jones et al. 1995). But include author names in references.
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4. Manuscripts accepted for publication but not yet published: Jones and Smith (in press) or (Jones and Smith in press).
5. Personal communications: (J. Jones, Institute for Aquatics, pers. comm.).
6. Within parentheses, use a semicolon to separate different types of citations (Figure 4; Table 2), (Jones and Smith 1989; Felix and Anderson 1998). Arrange lists of citations chronologically (oldest first) in a text sentence.
   • DO NOT cite more than three references for a specific point.
   • For quotations include page number (Jones 1996:301).
   • Institutional authors may be cited as acronyms in the text but must be defined in the reference list.

Title Page

• Type the title near the middle of the page, centered, in caps and lowercase.
• Keep the title short, preferably less than seven words; it should accurately reflect the paper’s content. Use common names.
• Below title, include author(s) name(s) and title(s). In multi-authored works, indicate which author is responsible for correspondence.

Abstract Page

• Type the abstract as one paragraph. You can copy and paste this into the online form.
• Do not cite references or use abbreviations in the abstract.
• Ensure that the abstract concisely states (150 words maximum) why you did the study, what you did, what you found, and what your results mean.

Text

• See “General Instructions.”
• Set all type at left. Boldface primary subheads and italicize secondary subheads.
• Insert tabs—not spaces—for paragraph indents.
• Italicize any words that should appear in italics.
• Avoid footnotes by including the information in the text.

References

• Double-space between each reference entry but do not indent text. References will be formatted during the production process.
• Alphabetize entries first by the surnames of senior authors and the first word or acronym of corporate authors; second, by the initials of the senior authors with the same surname; and third, by the surnames of junior authors.
• List multiple works by the same author(s) chronologically, beginning with earliest date of publication.
• Distinguish papers by the same author(s) in the same year by putting lowercase letters after the date (1995a, 1995b).
• Use a long dash when the author(s) is/are the same as in the immediately preceding citation.
• “In press” citations must have been accepted for publication, and the name of the journal or publisher must be included.
• Insert a period and space after each initial of an author’s name.
• Do not abbreviate journal names. Verify all entries against original sources, especially journal titles, accents, diacritical marks, and spelling in languages other than English.

Tables

• Tables may be included with the article or submitted as separate files.
• Double-space everything, including the table title and column headings.
• Use single horizontal lines to separate column heads and to indicate the end of the table—other horizontal lines are not needed. Never use vertical lines.
• Use sentence-style captions for tables, not fragments.
• Capitalize only the first letter of the first word in each column and row entry (except initial caps for proper nouns).
• Tab between column items—DO NOT “space” between columns.
• Type “NA” (not applicable) where no entry applies in the table body. Do not add filler dashes.
• Label footnotes with lowercase, superscript letters, starting from the beginning of the alphabet (a, b, c).
• Redefine, in the table’s caption or in a footnote, any acronyms that are used in the table but are mentioned only infrequently in the text.

Illustrations

Illustrations are photographs, drawings, or figures. All illustrations will print in black-and-white unless an extra payment is made for color. Consult the editor about color costs if interested. Prepare illustrations using professional standards, and consult issues of Fisheries for examples.

• For review on the manuscript tracking system, we prefer digital photos (or scans). However, original film photos and slides can be used for final production. The managing editor or production editor will contact you after acceptance and let you know when to send original photos.
• Identify all people who appear in photographs, and identify photographer or agency responsible for photo. Caption must be in sentence, not fragment, form. Photos are not considered figures and do not need to be referenced in the text.
• Electronic photos should have good contrast, a size of at least 4 x 6 inches, at least 300 dots per inch (dpi) resolution, and be saved in EPS, TIF, or JPG formats. For black-and-white figures and graphs, please use a resolution of 1,200 dpi. We cannot accept PowerPoint files. Camera ready copy also must be submitted for production purposes after acceptance.

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ESSAYS

Essays are thought-provoking or opinion articles based upon sound science. Essays may cover a wide range of topics, including professional, conservation, research, AFS, political, management, and other issues. Essays may be submitted in conjunction with a full feature article on the same topic. Essays range from 1,200–1,400 words, may include photographs or illustrations, and should not cite more than eight references. However, essays should provide scientific documentation, unlike unreviewed editorials (below). Essays are peer-reviewed based on the following criteria: contribution to the ongoing debate, logical opinion based on good science, persuasiveness, and clarity of writing. Reviewer agreement with the opinion of the views expressed is not a criterion. Essays do not have page charges or abstracts. Essays should be formatted and submitted online as above.

UNREVIEWED ARTICLES

Unit News and Other Departments

AFS members are encouraged to submit items for the Unit News, Member Happenings, Obituaries, Letters to the Editor, and Calendar departments. Dated material (calls for papers, meeting announcements, nominations for awards) should be submitted as early as possible, but at least eight weeks before the requested month of publication. AFS Unit News and Letters should be kept under 400 words and may be edited for length or content. Obituaries for former or current AFS members may be up 600 words long. Do NOT use the online manuscript tracking system to submit these items—the text and 300 dpi electronic photos for all departments except the Calendar should be e-mailed to the managing editor at bbeard@fisheries.org or mailed to the address below. Calendar items should include the date, event title, location, and contact information, and should be sent to the production editor at cworth@fisheries.org. For information about submitting a Students’ Angle column, please contact Student Subsection President Melissa Wuellner at Melissa.Wuellner@sdstate.edu.

Fisheries News

Brief items for the Fisheries News section are encouraged. Typical items include conservation news, science news, new programs of significance, major policy or regulatory initiatives, and other items that would be of interest to Fisheries readers. News items for the section should be no more than a few paragraphs; please consult the managing editor about submitting longer news articles.

Fisheries Forum (formerly Guest Editorials)

Authors are encouraged to submit most opinion pieces about fisheries science or management as essays for peer review. Occasionally, editorials about professional or policy issues may be inherently unsuitable for a scientific review. Sometimes these pieces are submitted by a committee, agency, or organization. Editorials should be 750–1,500 words, may be edited for length or content, and referred for outside review or rebuttal if necessary. A disclaimer will accompany all Fisheries Forum editorials.

Book Reviews

Please contact Book Review Editor Francis Juanes at 413/545-2758, juanes@forwild.umass.edu, if you want to be added to the list of potential book reviewers. New books (preferably two copies) submitted for review should be sent to Francis Juanes, Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA 01003-4210.

QUESTIONS?

Contact Managing Editor Beth Beard; AFS; 5410 Grosvenor Lane, Suite 110; Bethesda, MD 20814-2199; 301/897-8616, ext.220; bbeard@fisheries.org. Detailed instructions for using the online manuscript tracking system are available at http://fisheries.allentrack.net. Also see the Fisheries Guidelines for Reviewers and the Guidelines for Case Studies at www.fisheries.org.
Bigheaded Carps: A Biological Synopsis and Environmental Risk Assessment

Cindy S. Kolar, Duane C. Chapman, Walter R. Courtenay Jr., Christine M. Housel, James D. Williams, and Dawn P. Jennings

The book is a detailed risk assessment and biological synopsis of the bigheaded carps of the genus Hypophthalmichthys, which includes the bighead, silver, and largescale silver carps. It summarizes the scientific literature describing their biology, ecology, uses, ecological effects, and risks to the environment.

Includes information on taxonomy and distinguishing characteristics, hybrids, native and introduced ranges, temperature and salinity tolerances, fecundity, sexual maturity and mating behavior, spawning, early development, feeding habits, growth rate and longevity, response to physical stimuli, associated diseases and parasites, human uses, environmental effects, potential range, population control measures. Summarizes United States federal and state regulations, and assesses the risk posed by these species in the United States.

204 pages, hardcover, index
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The Hutton Junior Fisheries Biology Program is a summer mentoring program for high school students sponsored by the American Fisheries Society (AFS). The principal goal of the program is to stimulate interest in careers in fisheries science and management among groups underrepresented in the fisheries professions, including minorities and women. Application to the program is open to all current sophomore, junior, and senior high school students regardless of race, creed, or gender. Because the program seeks to increase diversity within the fisheries professions, preference is given to qualified women and minority applicants.

Students selected for the program are matched with mentor professionals and enjoy an eight-week, hands-on fisheries science experience in a marine and/or freshwater setting. Assignments are made with participating organizations within reasonable commuting distance from the students. Each student receives a $3,000 scholarship and a complimentary student membership in AFS.

Selection to the program has become very competitive. From 156 eligible student applications, the Hutton Evaluation Panel selected 35 students for the Class of 2007. The students were matched with professional mentors in state and federal agencies, at universities, tribal facilities, and private organizations throughout 20 states. Minorities made up 60% of the class, and 58% of all selected students were female.

At the end of the summer, students and mentors submit a final report to AFS evaluating their experience, their mentor or student, and the program. The students respond to questions about their future education and career plans. The immediate success of the program is defined by the
number of students who make a positive statement in their final reports about their experience and whether or not they plan to study or are considering studying fisheries or a related field when they enter college. Of the 35 students in the Class of 2007:

- 7 are currently enrolled in college, and of those students:
  - 4 are studying fisheries or biology;
  - 1 plans to study fisheries or biology;
  - 1 is undecided on a major, but is considering fisheries or biology as an option; and
  - 1 is studying a related non-science.
- 27 are planning to attend college, and of those students:
  - 20 plan to study fisheries or biology when they enter college;
  - 6 are undecided on a major, but are considering fisheries or biology as an option; and
  - 1 student did not respond.

These reports verified that participation in the Hutton Junior Fisheries Biology Program significantly benefits students in many ways. All of the students had the experience of working in a professional setting and learning what is required to be successful in the field. They learned about fisheries issues in their local area and the importance of conservation and education to the future of the resource.

One more statistic worth mentioning is the percentage of Hutton scholars planning to study fisheries or biology when they enter college has risen to 57% from 27% in 2006. This percentage increase of students interested in fisheries is not only a testament to the quality of Hutton mentors, but it is a hopeful sign for the future of the fisheries resource as well.

SURVEYS

AFS surveys the parents of each class for their evaluation of the program and suggestions for improvement. A survey of the parents of the Class of 2007 received a good response with 20 completed surveys collected to date. All of the responses were very positive with respect to evaluation of the program and benefit to the students. The most commonly repeated suggestion for improvement was to make the program more widely available with more publicity and increased funding. Other suggestions for improvement included the option to extend the program beyond eight weeks and the creation of an advanced program for undergraduate students. One father even mentioned, “If angling is involved, dads should be included!”

The long-term results of the program will continue to be monitored by the Annual Hutton Alumni Survey to determine how the Hutton experience affects the educational plans and career choices of Hutton alumni. Ultimately, the success of the program will be measured by the number of minority and female Hutton alumni who choose a career in fisheries science or natural resource management. AFS staff spent several months conducting the Annual Hutton Alumni Survey of students in classes 2001–2007. It was completed in December 2007, with 152 responses, generating a 57% response rate. According to the survey results:

- 115 (76%) are studying or considering studying fisheries, biology, or environmental science;
- 12 (8%) have undergraduate degrees in fisheries or biology;
- 4 (3%) are pursuing advanced degrees in fisheries or biology;
- 7 (5%) are working in fisheries or biology;
- 4 (3%) are studying or planning to study related non-sciences;
- 7 (5%) are either studying or planning to study other sciences;
- 16 (11%) are studying or working in an unrelated field.

OVERSIGHT AND EVALUATION

The Hutton Oversight Committee monitors and evaluates the Hutton Junior Fisheries Biology Program. This is a special AFS committee composed of AFS members appointed by the Society’s President.

PARTNERS

Supporters of the 2007 Hutton Junior Fisheries Biology Program include the National Oceanic and Atmospheric Administration, USDA Forest Service, U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, Wisconsin Department of Natural Resources, many AFS members, and several AFS Units, including the North Central Division, Northeastern Division, Michigan Chapter, Minnesota Chapter, Montana Chapter, and the Wisconsin Chapter.

Co-sponsors of the Hutton Program include the Fish and Wildlife Division of the District of Columbia Government, Mississippi-Alabama Sea Grant Consortium, National Association of Biology Teachers, and the University of Arkansas at Pine Bluff.

LOOKING FORWARD

Since the number of student applicants accepted into Hutton has dropped drastically over the past few years due to limited funding, we hope to bring the numbers back up from 35 (2007) to 65 (2004) and beyond, in order to extend this exciting opportunity to more students.
The AFS 2008 organizing committee is planning a week of social events that will make the Ottawa conference “one to remember.” Upon your arrival, there will be an “ice-breaker” party on the terrace of the Congress Centre, overlooking the Rideau Canal and Parliament Hill, the Canadian capital. Warm summer nights in Ottawa are magical with all the city has to offer and the terrace at the Congress Centre is a perfect location to view the sights and sounds of the city, to greet old friends, and to make some new ones. Ottawa is well known in Canada for its hip musical scene, and our events will be complemented with musical entertainment.

We are planning events throughout the week to make your conference in Ottawa fun, including a student social, a Tuesday evening event called “Savour Ottawa,” and a farewell to Ottawa social to wrap things up on Thursday. The signature event of all AFS conferences is the Wednesday evening social and 2008 will be no different—except for everything! We have the entire facility at the Canadian Museum of Civilization in Gatineau, Quebec, which is only a short walk or bus ride across the bridge from the Westin/Congress Centre. The Canadian Museum of Civilization is Canada’s largest and most popular cultural institution, attracting over 1.3 million visitors each year. Located on the shores of the Ottawa River, the museum offers a spectacular view of the Parliament buildings across the river.

Designed by Native-Canadian architect Douglas Cardinal, the Canadian Museum of Civilization is considered one of the most striking architectural masterpieces of the twentieth century. The award-winning building, with its dramatic, curved lines, attracts admirers from all over the world and is considered essential viewing for anyone visiting Ottawa.

Within the museum, there are several permanent exhibitions which will be open to our delegates, including the Grand Hall, a stunning gallery focusing on the Native peoples of the Northwest Coast, with 43 authentic totem poles; the Canada Hall, which recounts 1,000 years of Canadian history, and the First Peoples Hall, exhibition showcasing the history and cultures of Canada’s Native peoples.

Sound like fun? We look forward to seeing you in Ottawa. Our planned social events and the vast array of outdoor/indoor bars, restaurants, and entertainment venues downtown and in the Byward Market area which you can visit on your own make the 2008 AFS Annual Meeting one not to miss.
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A 1.1 m Chinook salmon, one of less than 500 in an 8-week run on the Coweeman River.

Courtesy of Dan Rawding, Washington Department of Fish and Wildlife

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Fish Habitat Specialist (Manager of Environmental Resources), Kings River Conservation District, Fresno, California.

Responsibilities: Serve as manager of environmental resources. Plans, organizes, and supervises staff involved in the district’s environmental program and policy; directs and coordinates activities relative to the fisheries management program and related objectives for environmental enhancement of the Kings River; works with governing bodies to ensure that the regulatory requirements of the District are addressed; and provides effective management and operation of the district’s environmental obligations and commitments.

Qualifications: B.A. or B.S. from accredited college or equivalent to graduation in wildlife management, fishery biology, zoology, or similar biological science and 6 years increasingly responsible professional experience in a large public or private entity, with 4 years in a supervisory capacity. Salary: $5,107-6,537 per month. Closing date: 15 February 2008. Contact: For general information, contact Louie Long, Resource Analyst:, 559/237-5567 x122, llong@krcd.org.

M.Sc. and Ph.D. Assistantships in Fish Ecology, Fish Ecology and Conservation Physiology Laboratory, Carleton University, Ottawa, Canada.

Responsibilities: Work on projects that are typically interdisciplinary, ranging from basic (e.g., energetics of parental care, the relationship between physiological stress and population level processes) to applied (e.g., hydropower impacts, catch-and-release science). All projects involve substantial field work and collaboration with a diverse team of stakeholders and scientists.

Qualifications: Interest in the behavior and physiology of freshwater and marine fish. Ideal candidates will be creative, self-motivated, and have exceptional problem solving abilities. Superior communication skills are essential.

Start date: May or September 2008. Closing date: 15 February 2008. Contact: Send a CV, letter of interest, and unofficial summary of grades to Steven Cooke, Biology Department, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada K1S 5B6; Steven_Cooke@carleton.ca; 613/867-6711; www.carleton.ca/feclpl.

Seasonal Native Fisheries Technician, Utah Division of Wildlife Resources Field Station, Moab.

Responsibilities: Assist with various field projects involving native and endangered species of fish on the Green, Colorado, and San Juan rivers. Primary duties include monitoring of native and nonnative fish populations.

Qualifications: Ability to paricipate in multi-day field trips on rivers in remote locations. Must work well with others, and have a degree in biological sciences, ecology, zoology, wildlife or fisheries management, or a closely related field. Preference may be given to applicants with boating experience (motor / rowed).

Salary: B.Sc. $11.27 per hour and M.Sc. $11.90 per hour. Closing date: 28 February 2008. Contact: For additional information and job description see www.nr.utah.gov/hr/list.htm or e-mail project leader.

To apply send cover letter and resume to Patrick Goddard, Project Leader, Utah Division of Wildlife Resources, Moab Field Station, 1165 South Highway 191, Suite 4, Moab, Utah 84532; patrickgoddard@utah.gov; 435-259-3781; fax 453-259-3785.

Assistant Professor (Tenure-track), (Wildlife and Ecological Restoration concentration), Department of Applied Biological Sciences, Arizona State University at the Polytechnic Campus, School of Arts and Applied Sciences.

Responsibilities: Teach and conduct research in the field of wildlife biology with specific emphasis on habitat management. Teaching responsibilities may include introductory courses in biology and wildlife management. Develop undergraduate and graduate course work related to their area of expertise. Establish and conduct a vigorous extramurally funded research program.

Qualifications: Required—must at the time of appointment have a Ph.D. in wildlife biology or related field with evidence of teaching and research experience. Applied research in the fields of fisheries, herpetology, or ornithology, as related to riparian ecology and demonstrated knowledge and experience in working with management agencies is highly desirable. Commitment to providing undergraduate and graduate students and education emphasizing applications of the biological sciences and advancing knowledge in chosen fields of study. Commitment to teaching through practical experience, including substantial laboratory, and field experience, with the result being extensive hands-on interaction between faculty and students.

To see more job listings go to www.fisheries.org and click Job Postings.
Ph.D. Assistantship, Purdue University/West Lafayette, Indiana.

Responsibilities: Conduct research related to themes in lab, including, but not limited to, evaluating/modeling stream ecosystem responses to landscape change, evaluating stream conservation success, elucidating mechanisms underlying the displacement of native aquatic species by introduced aquatic nuisance species, and evaluating the ecology and life history of native freshwater mussels.

Qualifications: M.S. degree, GPA >3.3, and upper 50th percentile GRE scores. Extensive field, laboratory, and writing skills necessary.

Closing date: 1 March 2008.

Contact: Send a letter or e-mail of intent, including statement of research/career interests, resume, names/addresses of 3 references, GRE scores, and transcripts to Reuben Goforth, Department of Forestry and Natural Resources, 195 Marstellar Street, Purdue University, West Lafayette, IN 47907; 765-494-0009; rgoforth@purdue.edu. See www.fnr.purdue.edu/faculty/goforth/index.shtml. EA/EO/AAEP.
Professor of Aquatic Ecology (Tenure-track), Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings

Responsibilities: Teach, advise, research, and fulfill service responsibilities. Contribute to an applied research program but also obtain competitive funding to address basic ecological questions.

Qualifications: Completed Ph.D. in Aquatic Ecology or closely related area by application deadline. Strong research background in stream ecology, with an emphasis in conservation biology of fishes and/or landscape ecology. Participate in institutional governance/service, professional service, and outreach activities. Demonstrated record of research and scholarly activity. Appropriate oral, written, and interpersonal communications skills.

Salary: Commensurate with experience.

Closing date: 7 March 2008.

Contact: For further information see http://wfs.sdstate.edu/. To apply see http://YourFuture.sdbor.edu, search for the position, and follow the electronic application process. For questions on the electronic employment process, contact SDSU Human Resources at 605/688-4128. AA/EEO employer.

Fishery Biologist, Gulf of Mexico Fishery Management Council, Tampa, Florida.

Responsibilities: Assists in preparation, review, and coordination of fishery management documents. Responsible plan amendment development, analysis, review, and monitoring. Presents analyses to various groups. Compiles and analyzes biological and other data.

Qualifications: B.S. with major study in biology, fishery science, or related studies and at least seven years of experience or a M.S. and at least three years experience. Professional experience is desirable in the preparation of technical publications. Preference will be given for knowledge of population dynamics, technical writing, Gulf fisheries, and the Magnuson-Stevens Act.

Salary: $63,417-75,414 per year, negotiable.

Closing date: 7 March 2008.

Contact: Send a complete resume, references, and writing examples related to the subjects enumerated above to Wayne Swingle, Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607.

Seasonal Fisheries Technician, University of Wyoming, based out of Landerg.

Responsibilities: Assist on a project studying abundance and diversity of burbot population in lakes and reservoirs. Field methods will include trammel netting, habitat assessment, and data collection.

Qualifications: A student who is pursuing or has completed a degree in fisheries or biological field. A desire to work with unique native fish, willingness to work in adverse weather, experience with boat operation and trailering a necessity, and ability to carry 50 lbs. of equipment. A valid driver’s license and clean driving record.

Salary: $10.50 per hour, plus free housing.

Closing date: 12 March 2007.

End date: May 11–18, 2008.

Contact: For further information see http://wfs.sdstate.edu/. To apply see http://YourFuture.sdbor.edu, search for the position, and follow the electronic application process. For questions on the electronic employment process, contact SDSU Human Resources at 605/688-4128. AA/EEO employer.

Post-doctoral Researcher—Fish Ecologist/Ecological Modeler, Ohio State University’s Aquatic Ecology Laboratory.

Responsibilities: Develop and apply models to help understand how hypoxia affects coastal food webs/fisheries, and use modeling and field data to compare ecological responses to hypoxia in Chesapeake Bay, the northern Gulf of Mexico, and Lake Erie.

Qualifications: Ph.D. in ecology, fisheries science, or related field, and strong quantitative and written skills. Modeling experience is highly desired.

Salary: $37,500-$42,000 per year for 2 years of support.

Closing date: 15 March 2008.

Contact: Apply at the university’s career website, www.jobsatosu.com/, job posting #335591—post doctoral researcher. In addition to the OSU Employment Application, submit a cover letter, CV (resume), college transcripts, and names/contact information 3 references to Stuart Ludsin, ludsin.1@osu.edu, the Aquatic Ecology Laboratory, Room 232 Research Center, 1314 Kinnear Road, Columbus, Ohio 43212.
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