Fisheries

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VOL 37 NO 2
FEB. 2012

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The **American Fisheries Society Student Writing Contest** recognizes students for excellence in the communication of fisheries research to the general public.

Undergraduate and graduate students are encouraged 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.***

Students may write about research that has been completed, is in progress, or is in the planning stages. The papers will be judged according to their quality and their ability to turn a scientific research topic into a paper for the general public and will be scored based upon a grading rubric. Check the AFS Web site (www.fisheries. org) awards page for the grading rubric.

Fisheries

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67 Photograph of Sanctuary Pond showing natural shoreline cover and proximity to residential areas. Photo credit: James Bland

COVER: Left three panels, starting at the top: blacknose shiner *Notropis heterolepis* , Iowa darter *Etheostoma exile*, banded killifish *Fundulus diaphanus.* Right panel: blackchin shiner Notropis heterodon. **CREDIT:** All photos by James Bland

Fisheries

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

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The Value of Meetings

Bill Fisher, President

AFS President Fisher may be contacted at: william.fisher@cornell.edu

In my January Hook, I told my story of why I joined AFS and what being a member has meant to me over the past 30 years. Most of the high points of my time with AFS have come at meetings of all sorts. The reason is I met new people, interacted with old friends or acquaintances, and learned something about them I didn't know. We shared ideas, talked about concerns, sought solutions, laughed, and joked. My point is that meetings, and particularly face-to-face ones, provide one of the greatest values of being a member of AFS, and in my opinion is one of the primary reasons the Society thrives. This point really hit home during the past several months, and below I share two of my meeting experiences with you. In fact, I would argue that meetings are the glue that holds our Society together. Our strategic plan, AFS Vision 2020, supports this. The plan lists nine ways for AFS to become the premier organization of fisheries-related professionals, and one of them is the importance of providing forums (i.e., meetings) for effective discourse contributing to the identification of science-based solutions to local, national and global fisheries-related issues. The Society literally holds hundreds of meetings every year when you include our annual meeting and those of divisions, chapters, student subunits, and sections and all of the committees therein. Each of these meetings brings members face-to-face (or at least in voice or written contact) and help us get to know and understand one another.

I would argue that meetings are the glue that holds our Society together. Our strategic plan, AFS Vision 2020, supports this.

Student subunit meetings typically provide an interesting array of topics flavored by the unique and often fun character of the students. I am the advisor to the Cornell Student Subunit of the New Chapter of AFS. The Cornell Subunit was formed two years ago (actually re-formed; a Cornell Chapter was established in 1980 but dissolved about a decade later), and the students have hosted a variety of activities including a statewide student colloquium, a professional development workshop for undergraduates, fishing trips (open water and ice) and community outreach events. The Cornell students recently organized a faculty spotlight event in which they invited fisheries and aquatic science faculty from across the campus to give a brief synopsis of their research, teaching and how they involve students. Cornell has over twenty faculty and staff that are associated with fisheries and aquatic sciences, ranging from fisheries management to limnology and stream ecology to marine science. There was a large turnout of undergraduate and graduate students at the event, and they were treated to an amazing diversity of faculty research project and courses offered on campus. As with many large universities, fisheries and aquatic faculty and staff are distributed across departments and field stations, and we often don't get a chance to see or hear what other folks are doing or have done. The point is that student subunits are providing a wonderful service to students, faculty and staff, and the public by providing meetings and forums to discuss fisheries education and research across a broad range of geographic regions and topics.

AFS presidents typically attend the four division meetings and as many chapter meetings as possible to interact with leaders of these units and provide an update of what is happening at the Society level. Each division meeting has their own traditions. Some divisions meet with their wildlife counterparts while others are fisheries only. I recently attended the 72nd Midwest Fish and Wildlife Conference in Des Moines, Iowa. Nearly 400 people were at the conference, including students and professionals. I had the opportunity to interact with many former acquaintances and friends and meet several new ones. This meeting was rich with content that reflected regional concerns and issues. As with most division and chapter meetings, it started with a plenary session, the topic of which was reconnecting people and natural resources. Former AFS President Don Jackson, a professor at Mississippi State University, began the session by recounting his connections with natural resources. Many of you know that Don is an avid fisher, hunter and trapper and has a unique talent for telling a story and stirring emotions through his passion for the outdoors. Through a collage of stories and photos, Don took us around the world and through time as he recounted the experiences that shaped his outlook on fisheries and wildlife conservation and management. He drew a loud and prolonged ovation. Mark Duda, executive director of Responsive Management, was next and drew inferences from research he has conducted to ascertain attitudes toward and knowledge of fish and wildlife management. He focused on the importance of conservation, credibility, cooperation, and communication by agencies. Mark's talk provided convincing evidence that we need to implement new ways of working with constituents and the public. Finally, Dick McCabe, formerly with the Wildlife Management Institute, asked "Where's Aldo?". Dick reflected on the past century of advances in wildlife science and the need to remember the lessons learned as we tackle natural resource and environmental challenges in the future. Following the plenary session were the usual paper sessions, symposia, socials and,

Continued on page 89

CANDIDATE STATEMENT
Second Vice President

Robert L. Curry

All AFS members will receive an email with instructions on how to vote online. (Only current members can vote. To become a member, visit fisheries.org/afs/membership.html)

BACKGROUND

Robert L. Curry is the chief of inland fisheries for the North Carolina Wildlife Resources Commission. He received his B.S. in biology from Augusta College and his M.S. in fisheries and wildlife science from the University of Tennessee. Curry began his career in 1984 as a technician and two years later he became the statewide warmwater fish production coordinator. Curry was promoted to assistant chief in 1994; 10 years later he was promoted to division chief.

Curry spent much of his field time sampling reservoirs and small lakes. He quickly transitioned into warmwater fish production and orchestrated the transfer of the state's warmwater production program from a 15-surface acre facility constructed in the 1920s to a modern facility with 43 ponds totaling 45 surface acres. As assistant chief, he managed the division's research, survey, management, and angler access programs. Most recently, Curry has focused on developing a comprehensive plan for implementing fish and wildlife conservation information, education, and outreach across all elements of the North Carolina Wildlife Resources Commission.

AFS INVOLVEMENT

Curry is an active member of the North Carolina Chapter, chaired its Education Committee, and later served as Chapter president. He served on the Southern Division's Striped Bass Committee and was the registration chair for the 2003 mid-year Southern Division meeting. Curry was president of the Southern Division and chaired the AFS Disaster Relief effort that provides assistance to AFS members and agencies impacted by natural disasters. At the Society level, Curry served on several AFS committees, including: Local Arrangements, Outstanding Chapter Award, Time and Place, Nominating, Membership Concerns, and AFS Management Committee. He is a member of the AFS Executive Director Succession Committee and he currently chairs the Meritorious Service Award Committee. Curry was the general chair of the 1999 AFS Annual Meeting in Charlotte, North Carolina. He is a member of the Education and Fisheries Management Sections and he is currently past-president of the Fisheries Administration Section. An AFS member since 1979, Curry received the AFS Distinguished Service Award in 2007 for his part in initiating and overseeing the AFS Disaster Relief Effort.

VISION

The American Fisheries Society is the world's oldest scientific organization dedicated to advancing fisheries science, strengthening fisheries professionals, and conserving fishery resources. Our rich and diverse history demonstrates our commitment to accomplish our mission effectively by providing many forums for the exchange of high-quality science, including world-renowned publications; promoting professional development through a variety of membership services; mentoring future fishery professionals; and providing sound, science-based recommendations to improve the sustainability of aquatic ecosystems.

We need to continue to evaluate our strategies identified in the Society's Strategic Plan and be prepared to adapt to rapidly changing environments. As we face the onslaught of significant physical and economic changes, we and our successors need to address global climate change, exponential population growth, and significant loss of critical aquatic habitats. One of the Society's greatest strengths is our commitment to mentoring future leaders—our young professionals and students—who will be crucial to ensuring sound, science-based management and conservation of aquatic resources and habitats. The Society should not neglect its responsibility to take the lead in preparing these future leaders. Rather, we should continue to encourage their active involvement in the Society and enhance their professional development. We must also continue to provide quality services to our professional membership by maintaining high quality publications, meeting forums, and other opportunities for professional growth.

The Society's greatest asset is its Unit structure; those members who volunteer to lead the Sections, Divisions, and Chapters are the heart of AFS. Society officers must nurture our Units, provide them with the tools necessary to advance our mission, and empower them to move forward at the local level. They are vital to implementing strategies that will conserve and protect aquatic habitats and ensure viable and sustainable fishery resources into the future.

AFS is known throughout the world as a leader in fisheries science and in communicating information through peer-reviewed scientific publications, workshops, and meetings. We most often share our science and recommendations with those we are comfortable dealing with—other scientists. We should investigate opportunities to expand our relevance beyond just the fisheries community. The Society has done a remarkable job in the past few years engaging Congressional leaders and informing them about critical aquatic resource issues; we must continue that effort.

We can improve our involvement and engagement with other natural resource conservation organizations, such as the Association of Fish and Wildlife Agencies (AFWA) as well as industry partners. State agency directors are actively involved with AFWA and rely on it to represent states' fish and wildlife interests in Congress. By re-engaging our relationship with AFWA, we can ensure that critical aquatic resource issues receive the attention of state directors who make resource management decisions and allocate funding to support aquatic resource management.

I am truly humbled to have an opportunity to give back to the organization that has given so much to me. If elected, I pledge my commitment to represent our membership and our profession to the best of my ability.

CANDIDATE STATEMENT
Second Vice President

Ronald J. Essig

All AFS members will receive an email with instructions on how to vote online. (Only current members can vote. To become a member, visit fisheries.org/afs/membership.html)

BACKGROUND

Considering the rich lineage of past American Fisheries Society (AFS) leaders, I am truly humbled to be considered as a candidate for Second Vice President. I was one of those atypical kids who knew what profession I wanted to pursue early on. Growing up camping with my family along the Atlantic Coast and fishing with my dad were major influences on this decision. Then a National Science Foundation summer program in marine biology, oceanography, and mathematics at Humboldt State College for high school students sealed the deal. I went on to earn a B.S. in Biology from Rutgers University in 1976 and a M.S. in Fisheries Biology from the University of Massachusetts in 1979. After a series of temporary appointments with the National Marine Fisheries Service (NMFS) stock assessment team in Woods Hole, MA (1979-1980), I worked for the Georgia Department of Natural Resources, Coastal Resources Division in Brunswick, GA as Chief of the Data Management Section (1980-1984). Then I rejoined NMFS as a statistician working on the Marine Recreational Fishery Statistics Survey in Washington, DC (1984-1991). In 1991, I started as a Fishery Biologist with the Federal Aid Program in the Northeast Region of the U.S. Fish and Wildlife Service where I have been administering Sport Fish Restoration and other grants to state fishery agencies for the past 21 years. My current position is Chief of the Fisheries Program of the Division of Wildlife and Sport Fish Restoration in Hadley, MA. A common theme throughout my State and Federal agency career has been facilitating partnerships to accomplish important fisheries goals.

AFS INVOLVEMENT

I have been an AFS member since 1975, becoming a Life member and Certified Fisheries Professional in 1984. I have been involved at all AFS levels through which I have given a total of at least eight scientific presentations and been senior author of three peer-reviewed publications. At the Chapter level, I was President of the Potomac Chapter (1990-1991), started the Southern New England Chapter (SNEC) newsletter as Editor (1992-1994), and served as SNEC President (1995-1996). At the Division level, I chaired the Continuing Education Committee (1991-1994), was Secretary-Treasurer (1997-2001), and was President of the Northeastern Division (2003-2004). I am a long-time member of several Sections and am currently Past President of the Fisheries Management Section. I have been a member of several AFS committees including the Hutton Oversight Committee, Award of Excellence Committee, and Distinguished Service Award Committee. Regarding Society governance, I served two terms on the Management Committee and Governing Board (2002-2004 and 2008-2010).

VISION

AFS is truly a world-class professional organization that places a premium on dissemination of scientific information for the betterment of aquatic resources. This is reflected in the current AFS Strategic Plan that provides a vision to 2020 and beyond with goals for global fisheries leadership, education, and values of membership. Effective governance and efficient operations are needed to make progress in implementing the Plan. Several areas of Society operations that I believe need careful attention in the future fall in the general categories of finances, communications, and new initiatives.

Regarding finances, strong budgets coupled with member volunteerism are essential for AFS viability. The AFS business model, where the lion's share of revenues comes from printed journals, has served us well over time and the move to Taylor and Francis publishing our journals continues that tradition. However, we will need to pursue other positive revenue approaches for the sustainable financial footing needed to accomplish the important work ahead. AFS should seek grant funding where appropriate to further its mission. Moving carefully toward fee-based electronic information dissemination also seems like a logical direction for AFS.

It's obvious that effective communications need to be maintained for AFS to be relevant and maximize member benefits. Chapters do this well, but more can be done, particularly at the Society level. Any strategies that enhance the ability of members to exchange ideas and be heard are positive, particularly as AFS moves more to electronic voting. We will need to take more advantage of all electronic communications tools to do this since the ability of members to travel to AFS meetings is increasingly difficult. I'm in favor of sharing scientific information in easily understood summary formats as appropriate for the benefit of busy members and for outreach purposes. A final communications tenet is transparency in all aspects of Society governance. The President's Hook column within Fisheries could be a vehicle to explain several of the finer aspects of AFS business as appropriate.

The third pillar of this vision for AFS involves new initiatives. AFS has countless enthusiastic members who provide new ideas and approaches to aquatic resource issues and professionalism. We need to provide a supportive environment that will facilitate success. This means being willing to try new things even if they take us a little out of our comfort zone. If this philosophy continues to be the norm at all AFS levels, then members will want to continue to volunteer their efforts and other fisheries professionals will want to become members. This would be a true win-win for AFS and aquatic resources.

I have benefited immensely from my AFS involvement over the past 35-plus years. From my shaky first scientific presentation at the 1979 annual meeting of the Northeastern Division in Providence, RI to my keynote address at the 2009 annual meeting of the Institute of Fisheries Management in Leeds, England, AFS has provided me with countless opportunities for personal and professional growth. I would be honored to play a role in continuing this tradition and to give back as an AFS officer. With your trust and help, we can continue the fine legacy of AFS work to improve aquatic resources and the fisheries profession.

Fisheries and Hard Rock Mining: AFS Symposium Synopsis

Sarah O'Neal

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Robert M. Hughes

Department of Fisheries & Wildlife, Oregon State University and Amnis Opes Institute, Corvallis, Oregon

The 2011 annual AFS meeting in Seattle included a one-day Fisheries and Hard Rock Mining symposium (sponsored by Trout Unlimited, the Pebble Limited Partnership, and the AFS Water Quality Section) that covered diverse topics and disciplines, including aquatic ecology, copper toxicity, mine waste mitigation, and mining regulation. Because of widespread concerns about the potential effects of mining on fisheries, we provide a brief synopsis of the session for *Fisheries* readers.

In addition to impairing gill function, Cu can be acutely toxic through effects on the peripheral nervous system

Five talks focused on the effects of metal mines on aquatic ecosystems. In several case studies from North and South America, mine effects led to increased incidence of diatom structural anomalies and percent tolerant individuals; decreased diatom and macroinvertebrate taxa richness, biofilm, and fish percent intolerant individuals; and altered fish, macroinvertebrate, and diatom assemblage structure at local and catchment scales. Another study concluded that metal contamination of streams remains in the mining district in Idaho's N.F. Coeur D'Alene River Basin more than 100 years after mining began; even where metal concentrations are below water quality standards, poor physical habitat structure, elevated sediment levels, and high temperatures still limit fisheries. Researchers in Canada found otolith microchemistry was useful for evaluating the extent of metal contamination and the locations and timing of fish migration. Two presenters discussed the Bristol Bay drainage of Alaska, where 12 million acres of state land were reclassified by state government from habitat and recreation uses to a mining use despite a high water table, waters of low acid neutralizing capacity, active geologic faults, and salmonid presence in 75% of headwater streams surveyed (159 stream km). Because of those environmental conditions, development of the proposed Pebble Mine — a 10.8 billion ton copper (Cu) prospect in the Bristol Bay drainage — could threaten the world's largest, most valuable sockeye salmon fishery and the people who depend on salmon for income and subsistence.

Five presenters discussed Cu toxicity to salmonids and water quality criteria. In addition to impairing gill function, Cu can be acutely toxic through effects on the peripheral nervous system (e.g., olfaction, lateral line). For example, in low ionic-strength water, olfactory inhibition occurs as low as 2 ppb above background, and 70% olfactory inhibition occurs after 10 minutes at 10 µg Cu/L (ppb). A 1-h exposure to 44 µg Cu/L caused significant loss of olfactory neurons and Cu avoidance response by juvenile Chinook salmon. If they can, fish will avoid exposure to copper. However, detection of copper is (likely) chemosensory; fish no longer avoid copper after exposure to copper at concentrations and durations that are neurotoxic to the peripheral system of fish, potentially affecting their ability to reproduce, feed, avoid predators, and migrate. Water chemistry has an important influence on Cu bioavailability and toxicity. In particular, increasing dissolved organic carbon (DOC) concentrations can provide protection against olfactory impairment. One presenter showed instances where the USEPA's biotic ligand model (BLM)-based criterion for Cu, which incorporates a number of water quality variables (temperature, pH, alkalinity, DOC, and the major inorganic cations and anions), was more consistently protective against olfactory impairment in salmonids than hardness-based Cu criteria using 20% inhibition concentrations (IC20s) and published fish toxicity studies. Salmonid olfaction was not impaired below BLM-based Cu criteria in this study. Only a few states are currently considering use of the BLM to derive regulatory criteria for Cu. Hardness-based criteria were sometimes deemed under-protective or over-protective, depending on water hardness.

Mine waste mitigation and disposal was the focus of ten speakers. A 2009 U.S. Supreme Court decision upheld the disposal of Kensington Mine tailings into a lake in Alaska. Schedule 2 in Canada exempted water bodies from Fisheries Act protections. The cost savings of using a natural lake for waste disposal will likely lead to increased use of lakes for such purposes in both countries. In both nations, there is a need to limit such practices to clean fill and to isolate mine wastes hydrologically from ground and surface waters. The Fraser River basin has a 150 y history of mining, with 50 active mines; mitigation procedures focus on separating tailings and mines from waters, subaqueous waste disposal, and tailings covers. Careful planning for mine closure can mitigate fisheries impacts.

Capture and treatment of natural (pre-mining), metal-laden surface waters, coupled with isolation and treatment of mining effluents has decreased metal concentrations and allowed salmonid range expansion in Red Dog Creek, Alaska; however perpetual, costly treatment and maintenance will be required to maintain this condition in perpetuity. Removal of the Milltown Dam, Montana (driven by both public health and ecological impacts), cost at least $106 M, took 7 years, and resulted in the removal of a dam/reservoir and 2.2 M cubic yards of contaminated sediments; further rehabilitation and redevelopment is estimated to raise the costs to $150 M. Rehabilitation of the S.F. Coeur d'Alene River Basin is estimated to cost $1 B. Although abandoned mines may have substantial negative environmental and economic legacies, similar problems have been identified at some active mines. Water quality at mining sites is often worse than that predicted in environmental impact statements and environmental assessments. Water quality standards/criteria were exceeded at 74% of mines analyzed in one study, and at 93% of mines with close proximity to groundwater and moderate to high contaminant leaching potential. Acid drainage occurred at 36% of mines studied, yet 89% of the pre-mining assessments for those mines predicted that acid drainage would not occur. Water quality exceedances are associated with inadequate pre-mining hydrologic and geochemical characterization and failures in the performance of installed mitigation measures. Another study concluded that the major limiting factors for fishes at an Arizona mine were inadequate flows caused by excessive water withdrawals and naturally variable flows. Approximately 40% of western USA headwaters are affected by abandoned hard rock mines. However, there are insufficient funds for mine clean-ups, especially if effluents are non-toxic (e.g., excess sediments and temperature, inadequate flows, and physical habitat structure) and if salmonids are not potentially present. Mitigation is more successful if the entire ecosystem is considered and involves diverse stakeholders.

Legal and educational issues were discussed by three speakers. A two-day course on mining-fisheries conflicts and resolutions presented at an annual miners' convention in Alaska drew considerable interest by — and thoughtful exchanges from — miners, indicating the value of public education on mining issues. Legal liability is a major hindrance to reclaiming abandoned mines. Under current laws, a second party assumes liability for the site when it implements rehabilitation or restoration. Legislation to provide Good Samaritan protections for conservation groups interested in mine clean-up could aid in the rehabilitation of abandoned mine lands. The USEPA ability to regulate and remediate mine wastes is limited under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which established Superfund. Funding for Superfund is no longer provided through taxes on industries; rather, it is provided by uncertain Congressional appropriations, and the burdens of cleanup are borne by taxpayers rather than pollution-producing industries—although some mining companies do pay for cleanups themselves. One solution proposed is for mine owners to post bonds sufficient to cover the true costs of potential human and ecological liabilities resulting from mining, although these are extremely difficult to accurately estimate in advance. Additional work by USEPA directed toward clean-up and compliance includes new mining regulations, guidance documents, and permit restrictions concerning mine waste disposal.

In light of the information presented in Seattle regarding Fisheries and Hard Rock Mining, we recommend a number of policy changes to hard rock mining law and regulations, though not all the session participants might agree with every recommendation. Those include:

- Establish clear environmental standards, including biological use designations; quantitative chemical, physical, and biological criteria; and quantitative engineering standards with appropriate safety factors.
- Fund increased research on chronic metal toxicity, and evaluation and improvement of mitigation measures.
- Allow federal land managers to balance mining with other uses of public lands rather than giving primacy to mining.
- Designate sensitive lands and waters as off-limits to hardrock exploration and development.
- Restore fish and wildlife habitat to pre-mining or reference conditions, or incorporate compensation into estimates of financial assurance.
- Prohibit mines likely to result in perpetual water pollution and/or requiring perpetual water treatment.
- Prohibit mine discharges to surface or ground waters that degrade water quality.
- Improve mine oversight, monitoring, and enforcement of regulations.
- Increase pre-mining financial responsibility of permittees.
- Create funds and Good Samaritan legislation to aid clean-up of abandoned mines.
- Increase education of miners concerning the potential effects of mining on terrestrial and aquatic life, and methods for mitigation.

See also: the Op-Ed piece written by Robert M. Hughes (AFS First Vice President) and Carol Ann Woody that ran in The New York Times: www.nytimes.com/2012/01/12/opinion/a-mining-law-whose-time-has-passed.html

Invasive Species

Killing Trout to Save Trout

Yellowstone Lake.
Photo credit: nps.gov

At Yellowstone Lake, a government funded research team is using surgically altered lake trout with implanted radio transmitters to help find where invasive lake trout breed. The Judas Fish Program's goal is to find where the invasive species breeds via an electronic signal so that the eggs can be killed before they hatch. Introduced into the region by fishermen decades ago, lake trout are killing off the native trout species—the cutthroat—which provides prey for bears, egrets, eagles, and martens, among others animals. This is only one of many efforts being used to save the cutthroat and restore Yellowstone's natural ecosystem.

Read more: Gresswell, R. E. 2011. Biology, status, and management of the Yellowstone cutthroat trout. North American Journal of Fisheries Management 31:782-812.

AFS Policy Statement #15—Introductions of Aquatic Species:
"Introduction of any species into a novel environment may alter community trophic structure, and the nature and extent of such changes are complex and unpredictable. There is little doubt that when an introduced fish exhibits explosive population increases, substantial changes in native communities must occur. Documentation of predation by introduced species on native species serves as the most definitive example of impacts on communities . . . ."
fisheries.org/afs/docs/policy_15s.pdf

Research

Groundbreaking Study Used to Track Bonefish Migration

Photo credit:
Joseph Cunningham

University of Massachusetts researcher and AFS Science Editor, Andy Danylchuk and colleagues have been able to tag and track the migration of sixty bonefish for a two year program using ultrasonic transmitters. Bonefish—one of the most popular fish among thousands of anglers off the Caribbean coast—aggregate twice a month from October and May to waters of more than 1,000 feet deep to spawn in the dark. Danylchuk stated that "one possible benefit of bonefish migrating to offshore locations to spawn is that it increases the dispersal of their fertilized eggs, especially with the high tides that happen with the new and full moons. This is the first time movement patterns of bonefish to deep water have been formally described." This new understanding of bonefish movement and spawning aggregations has significant implications for their conservation.

Legislation

Funds for Fish Mitigation Hatcheries

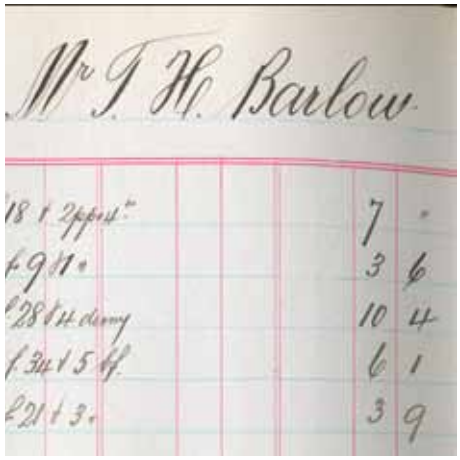


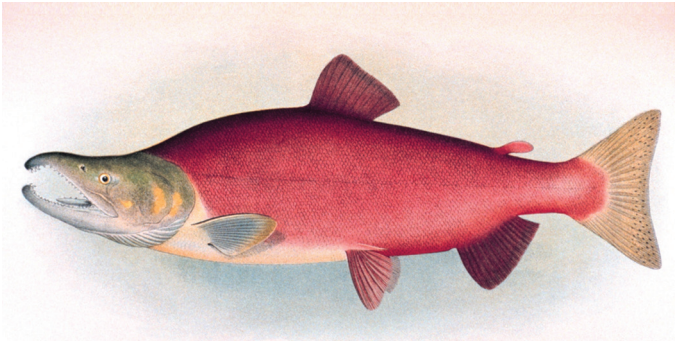
Photo credit: M. Tolson

Congress has approved the FY2012 Budget and it includes $7.2 million for the nine fish mitigation hatcheries that were defunded for the U.S. Fish and Wildlife Service (USFWS) in previous budget requests. Congress specifically directed that:

1) All of the mitigation hatcheries will be fully funded in 2012.
2) Congress supports the efforts by the Service to recover mitigation costs from other Federal partners.
3) The amount of reimbursable funding must be sufficient to fully operate and maintain the mitigation hatchery program.
4) Each reimbursable must be in place before the Service moves forward to eliminate Service funding for the mitigation hatcheries.
5) Since the mitigation hatcheries are fully funded there should not be any operational or maintenance disruption at any of the hatcheries.

The president of one fish hatchery stated, "This is really good news for hatchery employees and all of those that depend on the [fish] hatcheries for their source of income."

Ban on Pesticides Near Salmon Habitat Upheld



Red salmon, breeding male. In: "The Fishes of Alaska." Bulletin of the Bureau of Fisheries, Vol. XXVI, 1906. P. 360, Plate XXXIV. Photo credit: NOAA

A Maryland U.S. District judge ruled against pesticide manufacturers who tried to overturn a 2008 decision in favor of the National Marine Fisheries Service (NMFS) that limited where three organophosphate pesticides (chlorpyrifos, diazinon, and malathion) could be sprayed in Oregon, Washington, Idaho, and California. The Court upheld the NMFS's more controversial restrictions that require the Environmental Protection Agency (EPA) to prohibit ground application of these chemicals within 500 feet of salmon habitat and aerial application within 1,000 feet. The pesticide manufacturers argued insufficient scientific basis existed to conclude that the pesticides harm the salmon, while environmental groups countered that the pesticides damaged juvenile fish that fall under the Endangered Species Act (ESA).

AFS Policy Statement #6—Effects of Toxic Substances in Surface Waters:
"The persistence and accumulation of hazardous substances such as pesticides and recalcitrant organics have resulted in the need for new and useful manufacturing containment and waste treatment procedures that will help protect aquatic life from the problems associated with materials such as DDT, PCBs, and kepone. It is some significance to note that the initial indications of adverse ecological effects of many of these global pollutants came from the aquatic environment." fisheries.org/afs/docs/policy_6f.pdf.

Overfishing

Menhaden Catch Sharply Reduced

Often called "the most important fish in the sea" due to the critical role they play as forage fish in the marine ecosystem, Atlantic menhaden are caught more than any other fish in the eastern coastal waters. Due to overfishing, however, the species has fallen to less than 10% of historic levels. Therefore, the Atlantic States Marine Fisheries Commission (ASMFC) took bold action to save the menhaden from reaching the critical point where reproduction would become impossible by voting to reduce the menhaden harvest by as much as 37 %.

Read more: Lynch, P. D., M. J. Brush, and R. J. Latour. 2011. Simulated short-term impacts of the Atlantic menhaden reduction fishery on Chesapeake Bay water quality. North American Journal of Fisheries Management 31:70-78.

The bounty of the Chesapeake - bushel baskets of blue crab - *Callinectes sapidus* - and a profusion of Atlantic menhaden - *Brevoortia tyrannus* - on the deck. Photo credit: Michael Dowgiallo, Coastal Ocean Program, NOAA

AFS Policy Statement —#27 Conservation of Imperiled Species and Reauthorization of the Endangered Species Act of 1973: "The major causes of aquatic species endangerment include habitat degradation, introduction of non-native species, and overfishing." fisheries.org/afs/docs/policy_27f.pdf.

Oil Spills

First Offshore Drilling Lease Approved since the BP Spill

A charred fire boom collects oil in the Gulf of Mexico. The U.S. Coast Guard working in partnership with BP PLC, local residents, and other federal agencies conducted the "in situ burn." Photo credit: Department of Ecology, State of Washington/NOAA

In November 2011, the federal government announced the first oil and gas lease sale in the Gulf of Mexico since the oil explosion in April 2010. Despite the clear environmental effects to the entire Gulf marine ecosystem caused by the BP spill that impacted fish, sea turtles, dolphins, whale sharks, etc., the government claims that drilling in water ranging from 16 to more than 10,975 feet is "environmentally sound." The new sale opens up 21 million acres to drilling from nine to 250 miles offshore. Environmental groups studying the impact of the BP spill on marine life decry the sale as "caving into industry . . . [and] giving the green light to offshore drilling [that] has the potential to kill marine life and the coastal communities that depend on it," said Deirdre McDonnell, an attorney with the Center for Biological Diversity.

Read more: McCrea-Strub, A., K. Kleisner, U. R. Sumaila, W. Swartz, R. Watson, D. Zeller, and D. Pauly 2011. Potential impact of the Deepwater Horizon oil spill on commercial fisheries in the Gulf of Mexico. Fisheries 36:332-336.

AFS Policy Statement #6 —Coping With Point Source Discharges: "At certain concentrations, point source discharges can alter biological community and ecosystem diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity and species richness and evenness. Some ecosystems may recover very rapidly following disturbance and even be dependent upon a certain frequency of perturbation in order to maintain associated biological communities (e.g., periodic flooding of certain types of wetlands). Other ecosystems may be highly resistant to perturbations but, once altered in either structure or function, may require very large amounts of time, often many human generations, to recover. Even this lengthy recovery or rehabilitation may never result in an ecological condition nearly identical to the original." fisheries.org/afs/docs/policy_8f.pdf.

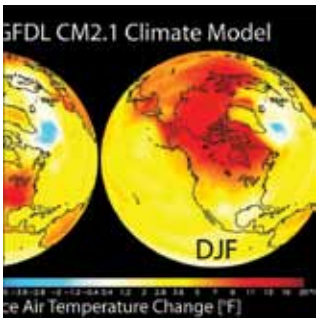


Photo credit: NOAA

Some Marine Species Left Adrift

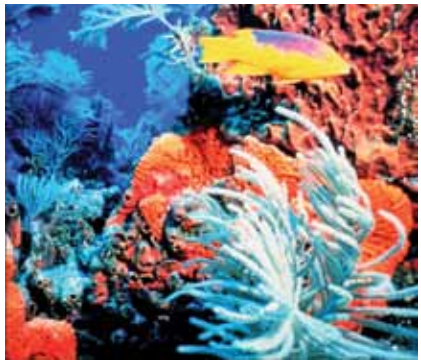
New research shows that rising water and ocean temperatures caused by climate change is forcing some marine species to move to other regions, which may eventually leave some aquatic species without a home. When ocean temperatures rise, some species can move to cooler spots. However, that is not the case for many marine species that live at or near the ocean's surface and can become trapped when there are no cooler places to migrate.

Read more: Rose, K. A. J. I. Allen, Y. Artioli, M. Barange, J. Blackford, F. Carlotti, R. Cropp, U. Daewel, K. Edwards, K. Flynn, S. L. Hill, R. HilleRisLambers, G. Huse, S. Mackinson, B. Megrey, A. Moll, R. Rivkin, B. Salihoglu, C. Schrum, L. Shannon, Y.-J. Shin, S. L. Smith, C. Smith, C. Solidoro, M. St. John, and M. Zhou. 2010. End-to-end models for the analysis of marine ecosystems: challenges, issues, and next steps. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:1, 115-130.

AFS Policy Statement — #33 Climate Change:
"As a result of global climate change, fisheries that have sustained us in the past (whether through recreational, commercial, or subsistence means) will likely be different from the fisheries that will sustain us in the future. Vulnerability assessments will be required to understand which species, communities, and habitats are at risk so that appropriate adaptation measures can be designed."
fisheries.org/afs/docs/policy_33f.pdf.

Human and Environmental Stressors Harm Florida Keys Ecosystem

NOAA scientists have confirmed that ongoing stressors such as increasing coastal populations, marine debris, overfishing, poaching, and climate change continue to threaten the health of the Florida Keys National Marine Sanctuary ecosystem. The findings documented in NOAA's Condition Report 2011 for Florida Keys National Marine Sanctuary suggest that a series of measures must be taken to reduce the stress, which include sustained management efforts and increased regulatory compliance to mitigate the effects of climate change.



Spanish hogfish at reef.
Photo credit: Florida Keys National Marine Sanctuary

AFS Policy Statement #31a—Protection of Marine Fish Stocks at Risk of Extinction:
"The major causes of aquatic species endangerment include habitat degradation, introduction of non-native species, and overfishing." fisheries.org/afs/docs/policy_31a.pdf

Coal Miners in Pennsylvania
Photo credit: National Archives

AFS has honored Trout Unlimited

Trout Unlimited has received the President's Fishery Conservation Award, for its Eastern Abandoned Mine Program (EAMP). Since the initial cleanup of the Kettle Creek coal mine in north central Pennsylvania, Trout Unlimited has completed close to 12 similar projects targeting abandoned mine drainage, and has provided technical assistance throughout the Appalachian region impacted by historic coal mining. Amy Wolf, EAMP Director, said, "Receiving this award is a tremendous honor. Our close collaboration with many AFS members, government agencies, and other grassroots organizations has helped us to advance cleanup of streams polluted by abandoned mine drainage throughout the West Branch Susquehanna watershed and beyond. This is certainly a team effort."

Population Characteristics of AFS Membership: Special Focus on the Millennial Generation of Fisheries Professionals

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ABSTRACT: *The survival of scientific societies depends on recruitment and retention of members. The importance of this strategy is underscored by the impending retirement of the Baby Boomer generation. Recent trends indicate alarming declines in many scientific societies—including the American Fisheries Society (AFS)—particularly as students transition into young professionals. Despite increased efforts to incentivize membership, overall membership losses continue to accrue annually. In order to address this issue, AFS needs to know more about the motivations of and perceived challenges that may limit the next generation of scientists. We describe an informal survey of student and young professional AFS members that was discussed during the plenary session of the 2010 AFS annual meeting. Ten questions were posed to students and young professionals to identify factors related to recruitment and retention of AFS membership, describe potential future challenges, and provide views on the direction of AFS and the fisheries profession. We relate these results to additional research on how the "Millennial generation" (those born after 1980) will change the workplace. By identifying common themes, we hope AFS members and governance at multiple levels will use this information in planning recruitment and retention initiatives aimed at the next generation of fisheries professionals.*

Características de la población de miembros de la Sociedad Americana de Pesquerías: la Generación del Milenio de profesionales en pesquerías

RESUMEN: *la existencia de las sociedades científicas depende del reclutamiento y permanencia de sus miembros. La importancia de esta estrategia es subrayada por el inminente retiro de la generación Boomer. Las tendencias recientes indican una alarmante disminución en muchas sociedades científicas –incluyendo la Sociedad Americana de Pesquerías (SAP), particularmente a medida que los estudiantes se convierten en jóvenes profesionistas. Pese a los crecientes esfuerzos para incentivar la membrecías, las pérdidas continúan acumulándose anualmente. Con el fin de atender este problema, la SAP requiere contar con información acerca de los motivos y retos que pudieran limitar a la siguiente generación de científicos. En la presente contribución se describe un sondeo informal aplicado a estudiantes y jóvenes profesionistas miembros de la SAP, el cual se discutió durante la sesión plenaria en la reunión de la SAP en el 2010. Se hicieron diez preguntas a estudiantes y jóvenes profesionistas para identificar aquellos factores relacionados al reclutamiento y permanencia de los miembros de la SAP, que describen potenciales retos para el futuro y proveen una perspectiva tanto de las directrices de la SAP como de las profesiones afines a las pesquerías. Aquí se relacionan estos resultados con investigaciones adicionales sobre cómo la "Generación del Milenio" (aquellos nacidos después de 1980) modificará el ambiente de trabajo en su sentido más amplio. Mediante la identificación de temas comunes, se espera que los miembros y gobernanza de la SAP a distintos niveles, se valgan de esta información para planificar las iniciativas relativas al reclutamiento y permanencia de sus miembros, con especial énfasis en la siguiente generación de profesionales en pesquerías.*

Populations of scientific societies are regulated by dynamic rate functions similar to those which affect fish populations (Fisher 1999). Sustainability requires continuous addition of younger members ("recruitment") and retention of existing members as older members cease participation ("mortality"). Oftentimes it is assumed that once a member joins a scientific society, he or she becomes vested into the group for at least the remainder of his or her working years. However, recent trends indicate this model may not be true. In fact, many scientific societies may be "poised on the precipice of oblivion" due to an imbalance between recruitment and mortality (Schwartz et al. 2008).

Concerns have arisen during the past decade regarding changes in the dynamics and demographics of membership within the American Fisheries Society (AFS). Students and young professionals have not remained members long enough to replace current professionals as they retire. Annual recruitment in AFS was, in fact, *negated* by the loss of about 100 members per year between 1999 and 2003 (Franzin 2009). Recent increases in student memberships have helped sustain or slightly increase overall membership numbers in the parent society. Consequently, it was postulated that declines in membership were due largely to the loss of students after graduation (Franzin 2009). Dues were subsequently reduced 50% for this membership category as one way to incentivize participation of young professionals. Despite continued efforts to recruit and retain the younger members in AFS, membership lapses fre-

quently occur during the transition from student to young professional (Franzin 2009).

To determine the best courses of action for recruiting and retaining the younger generation, it is important to understand their values and beliefs and the challenges they will likely face as they enter the workforce. Much speculation has been made regarding how the next generation—commonly known as the "Millennial generation" (those born after 1980)—will affect education and the workplace (see a recent review of Millennial characteristics by Millenbah et al. in the June 2011 issue of *Fisheries*). Often the commentary is contradictory or does not describe all individuals of a generation adequately (Hoover 2009). A better understanding of Millennial members is important to help sustain AFS. We address the following objectives:

1. Describe the factors that influence recruitment and retention as well as the future outlook of students and young professionals in AFS.
2. Compare Millennial members of AFS against other research on this generation.
3. Identify common themes that have implications for effective recruitment and retention initiatives.

We used informal surveys of student and young professional AFS members and attempted to reconcile those results with other research on motivations and perceptions of the Millennial generation. Here, we describe a more in-depth summary of information presented by the first author during the plenary session for the 2010 AFS annual meeting in Pittsburgh, Pennsylvania.

SURVEY METHODS

Brief informal surveys were administered to current student and young professional (YP) members of AFS in March 2010. We assumed that the majority of student and young professional members were of the Millennial generation. Surveys were created using SurveyMonkey, a free but limited Internet-based survey program. Similar but separate surveys were created for students (see http://www.surveymonkey.com/s/8NCC7RK to view student survey) and YPs (see http://www.surveymonkey.com/s/8N7JRQH to view YP survey). In both surveys, 10 questions were asked to identify factors related to recruitment and retention of AFS membership, describe potential future challenges, and assess the outlook of students and YPs regarding the direction of AFS and the fisheries profession in general (see Table 1). The types of questions were varied; some items allowed respondents to provide more than one answer, rank or score several factors, or provide open-ended responses (Table 1). In an attempt to survey as many students and YPs as possible, survey links were e-mailed to the student member listserv maintained by the student subsection and the distribution list of current YP parent society members. In all, 20 students and 100 YPs responded to the survey. Survey results were tallied in July 2010; responses to open-ended questions were categorized by one author (Wuellner) to identify common themes. No attempts were made to stratify responses based on gender, age, or other demographics because such questions were not asked on the survey.

TABLE 1. Questions posed to student and young professional members of AFS during an online survey conducted from March to July 2010. Superscript letters denote the type of question asked (a = single answer; b = more than one answer; c = ranking or scoring questions; d = open-ended questions).

Student Questions	Young Professional Questions
1. Who influenced your decision to join AFS at any level?[b]	1. Were you a member of AFS at any level as a student? (If yes, then proceed to next question. If no, then skip the next question.)[a]
2. Besides personal interest, what factors influenced your decision to join AFS?[b]	2. What factors influenced your decision to retain your membership in AFS at any level after you became a professional?[b]
3. What benefits have you already received or utilized as part of your membership in AFS?[b]	3. Besides personal interest, what factors influenced your decision to become a member of AFS as a young professional?[b]
4. What other benefits would you like to receive as part of your AFS student membership?[d]	4. Why do you think membership in AFS may lapse as members transition from students to young professionals?[d]
5. How likely are you to retain your membership in AFS at any level after graduation?[a]	5. How do you think the parent society can best help young fisheries professionals?[c]
6. What factors will influence whether you retain your membership in AFS in any level after graduation?[c]	6. How do you think the state or regional units of AFS can best help fisheries and young professionals?[c]
7. What do you think is the biggest challenge you will face as you make the transition from student to fisheries professional?[d]	7. Do you think AFS is headed in a positive direction?[a]
8. Do you think the fisheries profession is headed in a positive direction?[a]	8. What do you think is the biggest challenge AFS will face in the next 20 years?[d]
9. What do you think is the biggest challenge the fisheries profession will face in the next 20 years?[d]	9. Do you think the fisheries profession as a whole is headed in a positive direction?[a]
10. What do you think is the biggest challenge AFS will face in the next 20 years?[d]	10. What do you think is the biggest challenge the fisheries profession will face in the next 20 years?[d]

SURVEY RESULTS

Factors Influencing Recruitment of Students and Young Professionals

The influence of other AFS members and the attraction of AFS-related benefits were important factors for recruiting younger members into the society. Most students reported that their decision to join AFS at any level (subunit, state, division, parent society) was influenced by an advisor (70%) or other AFS member (30%). However, some students indicated that self-motivation (15%), an employer (10%), or a friend (5%) influenced their decision to join AFS.

Membership benefits incentivized students to join AFS more than the influence of other AFS members (Table 2). Networking opportunities were the most important factor drawing student members, followed by self-development and improvement opportunities and the types of additional activities offered by AFS (Table 2). Costs of membership and the relative time commitment required of AFS membership was of less importance in influencing AFS memberships. Two students identified a sense of professional duty as an additional factor influencing their society membership.

Students reported taking advantage of several membership benefits. A majority of students indicated that they used their free access to AFS journals (80%) or took advantage of networking (70%) or travel (65%) opportunities. Half of them received education benefits as part of their society membership, whereas fewer report receiving scholarships (40%) or employment opportunities (25%). Only 10% of students described professional certification as a benefit of their membership. Students did not suggest any additional benefits that they would like to receive as part of their AFS membership.

Early involvement in the society was high among YPs; most (83%) reported being a student member. For those YPs who were not AFS members as students, the most important incentive for joining the society was access to relevant scientific information afforded by membership (Table 2). Networking and self-development opportunities followed by other types of AFS activities were also notable enticements to join. Costs of membership and the influence of other AFS members were of less importance. Two respondents identified a sense of professional duty as one factor motivating their membership.

Retention of Membership during the Transition from Student to Young Professional

A majority of students surveyed indicated that they were either highly likely (80%) or somewhat likely (15%) to retain their membership in AFS after completing their terminal degree. Students rated having continued access to relevant scientific information as the single most important factor influencing their decision to retain their membership in AFS post-graduation and continued opportunities for self-improvement ranked

TABLE 2. Rankings of the factors that most influenced students and young professionals who were not members of the society as a student (referred to as first-time young professional members) to join AFS. Responses were those given for question 2 in the student survey and question 3 in the young professional survey listed in Table 1. Factors are listed in order from most to least important (1–6).

Students	First-time young professional members
1. Networking opportunities	1. Having access to relevant scientific information
2. Self-improvement and development opportunities/types of other activities offered by AFS (tied)	2. Networking opportunities/self-improvement and development opportunities (tied)
3. Cost of membership	3. Types of other activities not offered by AFS
4. Other time commitments (e.g., membership in other professional societies; personal commitments)	4. Cost of membership
5. External forces (e.g., advisor, employer)	5. External forces (e.g., employer)
6. Other (e.g., professional duty)	6. Other (e.g., professional duty)

TABLE 3. Rankings of the factors that influence retention of AFS membership post-graduation from the terminal degree among students and young professionals who were AFS members as students. Responses were those given for question 6 in the student survey and question 2 in the young professional survey listed in Table 1.

Students	First-time young professional members
1. Having access to relevant scientific information	1. Having access to relevant scientific information/self-improvement and development opportunities (tied)
2. Self-improvement and development opportunities	2. Self-improvement and development opportunities
3. Employer incentives for membership	3. New opportunities to work within AFS
4. New opportunities to work within AFS (e.g., leadership, AFS-specific projects)	4. Cost of membership
5. Other time commitments (e.g., membership in other professional societies; personal commitments)	5. Employer incentives for membership
6. Cost of membership	

second among the factors influencing retention (Table 3). Employer incentives for membership rated third among students as a motivation for post-graduation membership retention; the cost of membership ranked sixth in importance.

Young professionals who were members of the society as students indicated that the most important factors influencing their decision to remain members after graduation were related to having access to relevant scientific information and opportunities for self-improvement afforded through AFS (tied; Table 3). The cost of membership ranked fourth among the factors that influenced membership, though a few respondents expressed concern that they may not be able to afford full AFS membership dues once their 3-year YP membership window expired. A sense of professional duty was noted by a handful of respondents as a motivating factor for continued membership. Thirty percent of respondents noted that their employer offered no incentives (e.g., pay raises, bonuses) for AFS membership or participation.

Questions asked of both groups regarding the challenges of making the transition from students to professionals yielded interesting results related to potential limitations to membership retention. Among students, 70% expressed concern in being able to find long-term, meaningful employment. The remaining 30% described some apprehension in understanding and executing the responsibilities of a fisheries professional or in establishing a suitable work–life balance. Surveys were not sent to YPs whose membership had lapsed because no current database existed for these individuals; however, YPs who responded to the survey provided some insight as to why these lapses might occur. Ninety percent of YPs believed that a lack of long-term or relevant employment in fisheries and the increased cost of membership largely influenced why memberships were dropped among their student and young professional colleagues; a lack of membership benefits for YPs was also cited as a possible factor (10%).

Young professionals identified several ways in which the parent society and local units of AFS (chapters, divisions) could best assist YPs in making the transition. Assistance with job placement was desired by YPs at the society and local levels (Table 4). Young professionals also wanted reduced costs for or travel grants to annual meetings, inexpensive continuing education opportunities, and more networking opportunities from the parent society. At the local level, the priorities of YPs changed somewhat; YPs ranked mentoring programs and networking opportunities above other benefits offered by AFS (Table 4).

Outlook on the Futures of the Profession and the Society

Students and young professionals provide unique insights on the future of the fisheries profession in general and AFS in particular. Among students, 40% agreed that they believe that the fisheries profession is headed in a positive direction and 45% were unsure. The views of YPs were more positive: 66% agreed that the profession is headed in a positive direction. However, 21% of the respondents expressed some uncertainty. Students believed that the greatest challenge facing the fisheries profession in the next 20 years was maintaining sustainable fisheries in the face of climate change, water scarcity, or competing societal demands (identified by 75% of respondents). Economic concerns as they relate to funding of fisheries research or retention of agency jobs ranked second (15% of respondents). Among YPs, maintaining the relevance of fisheries science to the public or managing resources in the face of complex issues (e.g., climate change, changing societal demands) ranked highest among potential challenges identified for the fisheries profession over the next 20 years. A small percentage of both students and YPs (<10%) also believed that issues of continuity and retention of institutional knowledge in light of anticipated personnel turnover is another important issue facing the fisheries profession.

Among YPs, 49% believed that AFS is headed in a positive direction and 44% expressed some uncertainty when asked this question. Both students and YPs believed that the biggest challenge facing the society in the next 20 years was maintaining relevancy in the face of shifting professional demands (45% of respondents). Avoiding stagnation (35%) as well as retention and recruitment of members (20%) were also important issues identified for the near future.

DISCUSSION

Every generation has a unique identity often shaped by major events and trends that occur during the lifetimes of its mem-

TABLE 4. Rankings by young professionals of further opportunities desired by local (chapter, division) AFS units and the parent society. Responses were those given for questions 5 and 6 in the young professional survey listed in Table 1. Opportunities are listed in order from most to least important (1–9).

Local	Parent Society
1. Assistance with job placement	1. Assistance with job placement
2. Partnering young professionals with AFS mentors	2. Reduced costs to participate in annual meetings
3. More networking opportunities	3. Travel grants for young professionals
4. Travel grants for young professionals	4. Inexpensive continuing education opportunities
5. Reduced costs to participate in annual meetings	5. More networking opportunities
6. Inexpensive continuing education opportunities	6. Partnering young professionals with AFS mentors
7. AFS leadership opportunities	7. AFS leadership opportunities
8. Recognition of young professionals via awards	8. Recognition of young professionals via awards
9. Assistance with research funding	9. Assistance with research funding

bers. This identity shapes the workforce and affects continuity of professions. The Millennial generation differs in many ways from Generation X (those who were born between 1965 and 1980) and the Baby Boomer generation (those who were born between 1946 and 1964) who comprise the majority of working professionals today. Much press has described how the Millennials will alter education and the workplace (see Millenbah et al. [2011] for discussions on Millennials in fisheries education and conservation). Overly negative or positive commentary on this generation can make it difficult to predict changes at work or in professional societies with any degree of accuracy. Some of the "facts" presented regarding the younger generation have been gleaned from only a few observations, whereas other findings have been based on more rigorous surveys. Commentary on the Millennial generation is often conflicting or creates false stereotypes (see Hoover [2009] for examples). Teasing out differences among individuals *within* a generation can be even more difficult than discerning differences *between* generations (Hoover 2009). However, major themes identified in other research on Millennials are congruent with findings identified in this survey and can provide some insight for AFS at all levels as to how the society can guide the next generation of fisheries professionals. Four major themes are discussed below.

Though membership benefits may be able to draw the younger individuals to the society initially, lasting membership may require more meaningful benefits and purpose, particularly at the young professional level.

Recruitment and Retention

Millennials have more choices among professional societies and advocacy groups than any previous generation. Thus, it is important to demonstrate why AFS membership is particularly beneficial to the younger generation. Schwartz et al. (2008) stated that in order for scientific societies to survive in the 21st century, they "must mean more to members than simply the source of a journal or meeting." Presently, AFS provides many membership benefits beyond journals and meetings, particularly at the student level (e.g., the student reviewer database hosted by the student subsection; best student paper or poster awards at annual meetings; scholarships and travel grants; various activities of student subunits; special student representatives in various AFS sections; see Colvin and Kopaska [2009] and Duong and Roberts [2010], for example). Such practices should be continued.

Though membership benefits may be able to draw the younger individuals to the society initially, lasting membership may require more meaningful benefits and purpose, particularly at the young professional level. Perhaps assumptions are made that once a student is recruited into the society he or she will stay. This assumption may be true as indicated in the results of this survey: 95% of students indicated they were likely or somewhat likely to retain membership in the society after graduation and 83% of young professionals in the survey reported being AFS members as students. Research shows that retention of Millennials in the workforce is tied to the transparency of the mission or core values of a company, and early integration with "the big picture" creates a sense of loyalty (Center for Research on Employment and the Workforce [CREW] 2010). All levels of AFS could consider outreach and integration of young professionals. Those AFS members who work with or mentor YPs can help guide the newer members, demonstrate how AFS fulfills its mission in various ways, discuss why they themselves joined the society, and try to integrate the YPs in various AFS activities at different levels. Natural resources agencies could attempt to "cultivate a culture of participation" in AFS by encouraging active engagement of YPs in the society (Lauber et al. 2009). Communications (e.g., newsletters, websites, and newsfeeds) might describe how younger members can be involved in activities related to the AFS strategic plan. The purpose and value of AFS certification could be made more transparent to younger members as well. Efforts to connect and integrate the younger generation within AFS should be increased (Connelly and Brown 2009).

Importance of Economic Considerations

Arguably, the Millennials have witnessed more economic catastrophes in their lifetime than any other generation prior—the Dotcom Bust, the 2002 Stock Market crash, and the multiple crises resulting from the Great Recession (CREW 2010). The younger generation has been promised a wealth of employment opportunities once they came of age due to the impending retirements of the Baby Boomers. Entry of the Millennials into the workforce has been delayed compared to previous generations. Roughly 37% of 18- to 24-year-olds were unemployed in 2010, which is the highest share among this age group in three decades (Pew Research Group [PRG] 2010). Many students who responded to this survey expressed the concern that they would not be able to obtain long-term, meaningful employment. A majority of YPs cited employment issues as a potential reason why many of their colleagues dropped their AFS memberships after graduation. As a consequence of the changing economy and the resulting impact on the fisheries profession, AFS may need to consider that some loss of members is inevitable as the Baby Boomers retire and are not being replaced by many state or federal natural resources agencies.

Millennials have not lost hope, however. Research has demonstrated that this generation holds some positive attitudes in spite of the economic challenges; many believe that the economy will improve in time (PRG 2010). Positive outlooks on the future of AFS and the fisheries profession were still found among a substantial proportion of students and YPs in this survey. Tapping into that positive spirit can build morale and momentum and promote retention in the profession (CREW 2010).

Continuous Opportunities for Learning and Improvement

Millennials are on track to become the most educated generation in history (PRG 2010). In 2008, a record share of 18- to 24-year-olds was enrolled in college, and roughly 54% of all Millennials reported having at least some college education (PRG 2010). Thus, it is not surprising that this generation values advanced learning and professional development opportunities while on the job (CREW 2010), particularly because the soaring cost of higher education and a lack of time often preclude this generation from returning to college for further training (PRG 2010). The value of continuing education (CE) was reflected in responses of YPs because many of them wanted some financial assistance for annual meetings or increased opportunities for low-cost CE from the parent society.

The Education Section recently launched the YP Travel Award (similar to the Skinner Memorial Award), and the Continuing Education Committee is exploring some opportunities to provide inexpensive distance education opportunities to benefit *all* AFS members. The elevated value of education among Millennials may also be an important reason to strengthen and promote the AFS certification program. Current enterprises to include greater participation of YPs in annual meetings and CE demonstrate steps in the right direction, and all levels of AFS should consider similar programs.

The Value of Mentors

Millennials do value the opinions of older generations and look to their mentors to provide continuous feedback on their professional development (CREW 2010). Further, mentoring has been described as one way of promoting a "productive and valued workplace" (Millenbah et al. 2011). The value of mentorship to the younger members of AFS was evident in this survey. Students are recruited into AFS often because of a mentor's guidance, and YPs cited mentoring and networking programs as high-priority initiatives that could be addressed by local levels of AFS.

Transitioning from student to YP status can be a time of uncertainty, but mentorship can assist the younger generation in addressing their concerns and retaining those members in AFS. Many natural resource agencies and professional societies have initiated mentorship programs targeting Millennial employees. Recently, the governing board of AFS started a mentoring program for those YPs interested in governance of the society (AFS 2010). However, YPs in our survey seem to desire opportunities for mentorship at local AFS levels as well. Increased mentorship opportunities for the younger generation at all levels of AFS would benefit the society by guiding and retaining future professionals.

RECOMMENDATIONS

The Millennial generation is the future of the fisheries profession and AFS, and the continuance of the society and its work hinges on the recruitment and retention of younger members. All levels of AFS should consider a variety of initiatives to guide and support students and particularly YPs using information gleaned from this survey and other research on Millennials. However, the survey described in this study and the implications of the results should only be considered an early step in a long process. Certainly this study is more descriptive than scientific in nature. More valuable information could be gleaned through continuous careful surveying of the younger members of AFS and evaluation of current and future recruitment and retention initiatives. Efforts could be made to try to contact those whose membership did lapse after graduation to more fully understand the nature of retention issues. To be successful, it will take the work and cooperation of AFS subunits, chapters, divisions, sections, committees, and the governing board to understand and assist the Millennials as they develop into fisheries professionals.

ACKNOWLEDGMENTS

We thank Eva Przygodzki for providing access to contact information for young professional members of the society and to the Student Subsection of the Education Section of AFS for distributing surveys to student members. We are deeply indebted to the students and young professionals who provided information used to guide this article whether through survey responses or casual conversations. A previous draft of this article was improved through spirited discussion with the graduate students of the Ecology Discussion Group in the Department of Natural Resource Management at South Dakota State University and comments provided by two anonymous reviewers.

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Use of a Stormwater Retention System for Conservation of Regionally Endangered Fishes

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ABSTRACT: *Maintaining aquatic biodiversity in urban or suburban areas can be problematic because urban landscapes can be nearly devoid of aquatic habitats other than engineered basins for storm water management. These areas are usually of questionable value for fish, but we examined a case study in which five regionally imperiled fish species were reintroduced into an artificial storm water detention pond and subsequently thrived. Although not a formal experiment, postintroduction survey data suggested that three of the five species maintained high population densities for 10 years after initial stocking, and two persisted in lower numbers. Success was likely due to a combination of unique design features and prior habitat preparation that resulted in clear water conditions that supported dense vegetation. Stocked fish persisted despite occasional bouts of low dissolved oxygen and increased chloride levels resulting from road salt application within the watershed. Transplanted fish served as a source population for both research and further reintroduction experiments. We suggest that, for some fish species, habitat preservation has a middle ground between natural habitats and completely artificial environments that require constant husbandry and that storm water systems could be used to create engineered sanctuaries within the human landscape that have many potential benefits for both humans and fish.*

Uso de Sistemas de Retención de Aguas Pluviales para la Conservación Regional de Especies Amenazadas de Peces

RESUMEN: *el mantenimiento de la biodiversidad acuática en áreas urbanas y suburbanas representa un problema dado que los paisajes citadinos pueden ser desprovistos de hábitats acuáticos casi en su totalidad, con excepción de las cuencas erigidas para manejo de aguas pluviales. Estas áreas normalmente tienen un valor cuestionable como hábitat para peces, sin embargo en este trabajo se examina un caso de estudio en el cual cinco especies amenazadas de peces se reintrodujeron en un estanque artificial de retención de aguas pluviales, y subsecuentemente proliferaron. Si bien no se trata de un experimento formal, los datos recabados después de la introducción sugieren que tres de las cinco especies mostraron densidades poblacionales elevadas durante diez años tras la estabulación inicial y dos más persistieron en densidades comparativamente más bajas. Esto seguramente se debió a una combinación única entre diferentes factores y a la condición previa del hábitat que resultaron en condiciones de agua limpia y transparente, generando así una vegetación densa. La población de peces persistió a pesar de disminuciones ocasionales en el oxígeno disuelto e incrementos en los niveles de cloro como consecuencia de la introducción de sal en el estanque. Los peces trasplantados sirvieron de población testigo tanto para investigaciones como para experimentos de reintroducción. Se sugiere que, para ciertas especies de peces, la preservación del hábitat posee un nivel intermedio entre un sistema virgen y uno completamente artificial que requiere cuidados constantes, y se sugiere que los sistemas de retención de aguas pluviales pueden ser utilizados para crear santuarios dentro de los paisajes urbanos con beneficios potenciales para los peces y para los humanos.*

INTRODUCTION

Fisheries managers have become increasingly concerned with fish–habitat relationships (Margraf 2009), and there has been a proliferation of tools available for preservation and restoration. For preservation, fisheries scientists now have quantitative techniques to classify both fish communities and habitats to prioritize conservation efforts (Sowa et al. 2007). Likewise, damaged habitats can be restored via reestablishment of riparian corridors (Carline and Walsh 2007), placement of large woody debris (MacInnis et al. 2008), dam removal (Catalano et al. 2007), repatriation of lost species (Schute et al. 2005), control of exotics (Weedman et al. 2005), and even placement of anadromous fish carcasses to mimic historical nutrient inputs (Michael 2003). However, preservation efforts tend to focus on pristine habitats, and because ecological complexity is difficult to replicate, restorations tend to occur in ecosystems that are at least partially intact and where managers can provide the key structures, linkages, or functions that were lost. Unfortunately, this

Success was likely due to a combination of unique design features and prior habitat preparation that resulted in clear water conditions that supported dense vegetation.

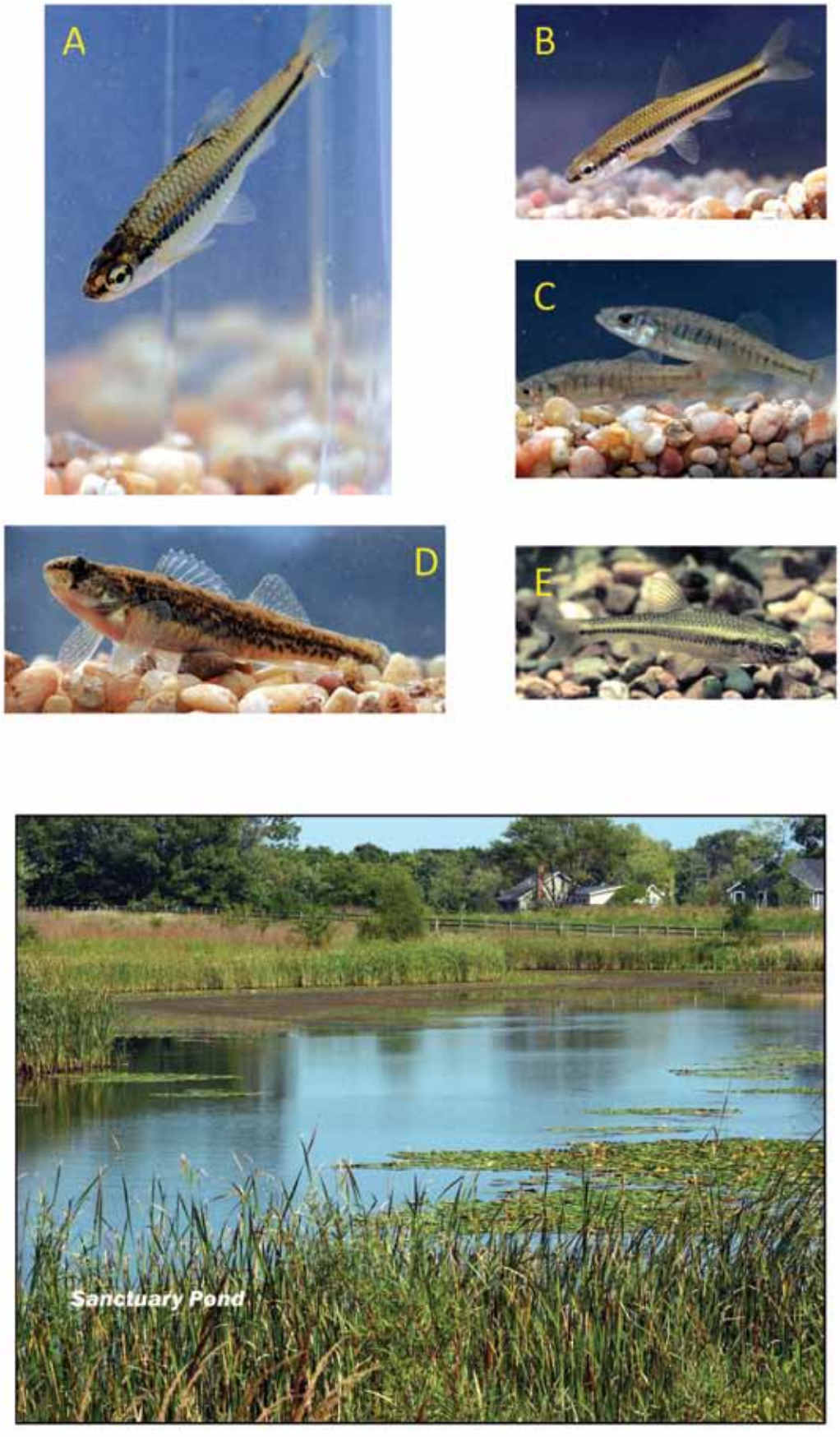

Figure 1. Top panel: Photographs of five species introduced into Sanctuary Pond: (A) blackchin shiner, (B) blacknose shiner, (C) banded killifish, (D) Iowa darter, and (E) pugnose shiner. Pugnose shiner photograph courtesy of Konrad Schmidt, other photographs by James Bland. Bottom panel: photograph of Sanctuary Pond showing natural shoreline cover and proximity to residential areas. Photograph courtesy of James Bland.

leaves out much of the human landscape, especially for aquatic habitats within urban or suburban environments. Developed habitats are especially problematic for conservation because they are increasing in area (Brown et al. 2005), and urban landscapes can lack even remnants of any original habitat (McIntyre and Hobbs 1999).

The practice of creating aquatic habitats has been occurring for over a century in the form of artificial ponds that have become a dominant landscape feature. Smith et al. (2002) estimated conservatively that there are between 2.6 and 8 million artificial impoundments within the coterminous United States. They have vast potential for supporting fish and wildlife but are managed primarily for game fishes, particularly largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*; Dauwalter and Jackson 2005). Largemouth bass predation can reduce diversity and abundance of small-bodied non-game fishes (Jackson 2002), so ponds are unlikely to play a role in conservation.

More recently, aquatic habitats have been created in the form of detention ponds designed to retain storm water. Detention ponds are designed to hold runoff from impervious surfaces and reduce stream flooding by ameliorating peak flows (Roy et al. 2008). They may be the only aquatic feature in urban landscapes and can be vital for amphibians (Brand and Snodgrass 2009). However, their utility for fish has been questionable. Storm water retention systems are often designed to dry between rainfall events to prevent mosquitoes (Metzger et al. 2008), and those that retain water have often required mosquito control via chemical treatment or introduction of nonnative larvivorous fish, particularly mosquitofish (*Gambusia* spp.; Hunt et al. 2006). Storm water systems can also have contaminant issues (Bishop et al. 2000).

We contend that storm water systems can be used to conserve aquatic biodiversity in urban landscapes and present a case study that successfully reestablished five regionally rare fishes within a detention pond in the Des Plaines River watershed in northern Illinois: the blackchin shiner (*Notropis heterodon*), blacknose shiner (*Notropis heterolepis*), banded killifish (*Fundulus diaphanous*), Iowa darter (*Etheostoma exile*), and pugnose shiner (*Notropis anogenus*; Figure 1).

The five fish species represent a group of freshwater habitat specialists that have declined in substantial portions of their U.S. or Canadian ranges. All were formerly widespread throughout the Great Lakes States, and all but the pugnose shiner ranged northward into inland Canadian waters (Scott and Crossman 1973; Trautman 1981). However, within their range all five species were confined to habitats having high water clarity and dense aquatic vegetation, especially glacial kettle lakes (Scott and Crossman 1973; Trautman 1981) and vegetated Great Lakes shorelines (Trautman 1981). Iowa darters are still widespread with locally abundant populations, but banded killifish and the three shiners have been extirpated from large portions of their U.S. range. In Ohio, most shiner populations disappeared by the 1940s, and banded killifish showed the greatest decrease in abundance of any species during surveys performed in Ohio during 1920–1950 (Trautman 1981). Similar declines were observed in most other Great Lakes States, and the species are often listed as imperiled (Natureserve 2009) or listed by individual states as endangered, threatened, or of special concern (Table 1). In particular, the pugnose shiner is noted as having become rare in every state or province within its global range. And though these species are usually protected from harvest, relatively little habitat preservation has been accomplished to secure remaining populations.

TABLE 1. State and provincial protective and conservation status for five glacial relict fish species occurring in the Laurentian Great Lakes region.

	State or Province Protective Status								
	ON	MN	IL	IN	OH	PA	NY	WI	MI
Blackchin shiner	–	–	T	–	E	E	–	–	–
Blacknose shiner	–	–	E	–	E	–	–	–	–
Blacknose shiner	–	SC	E	SC	X	–	E	T	E
Banded killifish	–	–	T	–	E	–	–	–	–
Iowa darter	–	–	T	–	SC	E	–	–	–

	State or Province Protective Status								
	ON	MN	IL	IN	OH	PA	NY	WI	MI
Blackchin shiner	S4	SNR	S2	S2	S1	S1	S1	S4	S5
Blacknose shiner	S5	SNR	S2	S3	S1	SX	S3	S4	S4
Pugnose shiner	S2	S3	S1	S1	SX	–	S1	S2	S3
Banded killifish	S5	SNR	S1	S4	S4	S5	S5	S3	S4
Iowa darter	S5	NR	S2	S3	S3	S1	S2	S4	S5

Protective status: E=endangered, T=threatened, SC=special concern. Conservation status ranges from S1 (critically imperiled) to S5 (secure). SNR=species not reported, SX= extirpated, NR= not ranked, - indicates incomplete data. Protective status data from State of Minnesota (2009), State of Illinois (2009), State of Indiana (2009), State of Ohio (2009), State of Pennsylvania (2009), State of New York (2009), State of Wisconsin (2004), State of Michigan (2009). Conservation status data from Natureserve (2009).

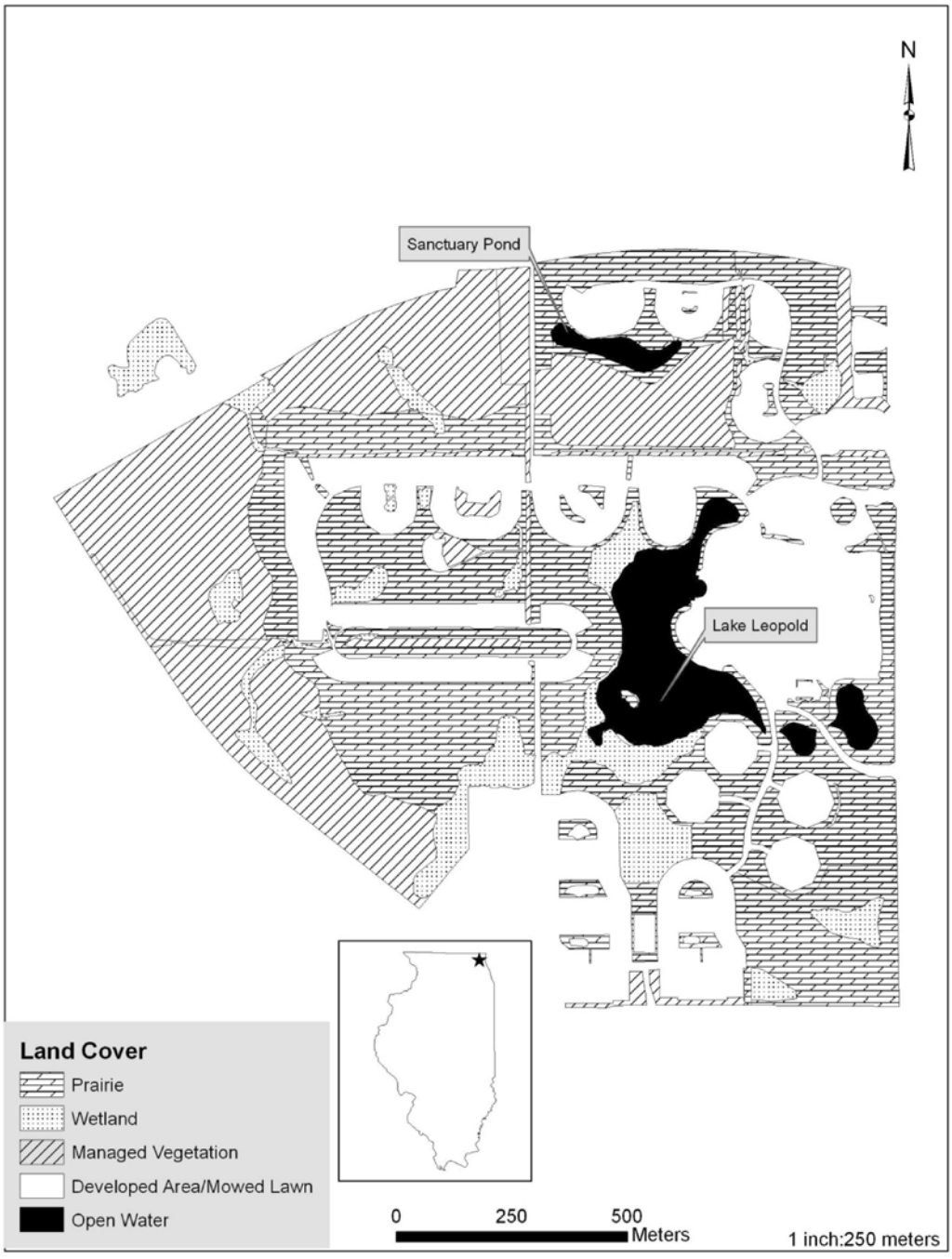

Figure 2. Map of Prairie Crossing, I, showing Sanctuary Pond and Lake Leopold. Managed vegetation includes farm fields, hedgerows, pasture, and orchard, and developed land includes single-family residences with mowed lawns.

In this article, we examine how new populations of five regionally rare fish species were introduced into a detention pond, retrospectively evaluate the reestablishment process, and discuss implications of the project within the context of engineering habitats for imperiled species.

METHODS

Prairie Crossing (latitude 42°19′39″, longitude 88°00′40″) is a 274 ha conservation community near Grayslake, Illinois, that incorporates housing, land preservation, and resident services (Figure 2). Community design minimized impervious surfaces, and storm water is managed by routing runoff through grassed swales, prairies, wetlands, and retention ponds that ultimately drain into Lake Leopold, a 13 ha lake managed for sport fishing. Lake Leopold supports largemouth bass, tiger muskellunge (*Esox masquinongy* × *Esox lucius*), bluegill, and black crappie (*Pomoxis nigromaculatus*).

Sanctuary Pond is a 1.3 ha retention pond that was excavated and filled during 1995, with a mean depth of 1.5 m and maximum depth of 2.5 m. Sanctuary Pond drains into Lake Leopold but is separated from the lake via an intermittent channel and a

vertical overflow that prevents upstream fish movement. Community restrictions on landscape practices and fertilizer result in exceptional water clarity and dense aquatic vegetation in both systems. Extensive stands of submersed macrophytes included native musk grass (*Chara* spp.), pondweeds (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*), and nonnative exotics including Eurasian milfoil (*Myriophyllum spicatum*).

Annual water quality monitoring began immediately after pond construction and included dissolved oxygen (DO)/temperature profiles, pH, alkalinity, turbidity, conductivity, chlorides, nitrogen (Kjeldahl, nitrite/nitrate, and ammonia), total dissolved and volatile solids, chlorophyll a, iron, and sulfates.

Reintroduction of the regionally endangered species occurred during the summer of 1998. Prior to reintroduction, the pond was treated with rotenone to remove completely a dense green sunfish (*Lepomis cyanellus*) population that had become established during 1995–1998. A bioassay using fathead minnows (*Pimephales promelas*) was performed 2 weeks after treatment to insure no residual toxicity. Source populations of the rare fishes came from two nearby lakes: Deep Lake (latitude 42°25′, longitude 88°04′) and Cedar Lake (latitude 42°25′, longitude 88°05′) in the Fox River drainage, Illinois. For transfer, collections of up to 200 individuals of each species were made using seines (3.2 mm mesh). Number of fish stocked was based on limiting seining damage to vegetated habitats in the source lakes to about 3–5% of the undeveloped shorelines. Individual source fish were dipped from the seine's bag in a bowl and identified individually. Captured fish were transported to the release site in coolers, acclimated, and then released into Sanctuary Pond.

The reintroduced Sanctuary Pond fish populations were monitored by seining four times a year from 1999 through 2007 to confirm survival and reproduction. Only presence/absence data were collected during 1999, but after 2000 total catches and estimates of effort were recorded in all years but 2004. Effort during 2004 was similar to other years. Seine lengths varied from 3 to 9 m, and seining occurred for 30 min until enough fish had been collected to develop a size distribution. Field personnel verified that all species were still present and measured all captured individuals (mm). Multiple modes within a species length frequency indicated the presence of both juveniles and adults. Field personnel also noted the presence of fish schools visible from shore but out of reach of seines.

In 2000, up to 200 individuals of each species from Sanctuary Pond were introduced into Lake Leopold to determine whether they could survive in a larger lake with game fish populations. Lake Leopold was sampled during 2004–2006 using hoop nets, seines, and minnow traps. As with Sanctuary Pond, collection effort and methods differed among years, with most emphasis on confirming species presence and examining size distributions.

RESULTS

Seining of Sanctuary Pond during 1999 revealed both adults and age-0 individuals of all four reintroduced species, indicating that all species had reproduced successfully that year. Large numbers of shiners and banded killifish were observed offshore, and most fish sampled were blackchin shiner, blacknose shiner, and banded killifish. Only three adult Iowa darter were collected, but several larval Iowa darter were also observed. Annual sampling during 2000–2007 indicated that all four species persisted through 2007. Catches were dominated by blackchin shiner and banded killifish (Figure 3). Blacknose shiner were less abundant but were collected during 7 of the 8 years of sampling. Iowa darters never exceeded 10% of all fish collected, and absence of Iowa darters from collections during 2006 and 2007 was likely due to the presence of unusually dense vegetation that reduced seine efficiency. Shore observations during 2000–2007 always resulted in sightings of schools of shiners and banded killifish.

One surprising result during 2003 was discovery of a fifth rare species, the pugnose shiner. This species had most likely been included accidentally in the original source populations from Deep Lake and was subsequently found in both Sanctuary Pond and Lake Leopold. No additional fish species were found through 2007.

Seining of Lake Leopold during 2001–2003 revealed that the second introduction of fish from Sanctuary Pond was also successful. Thousands of shiners and banded killifish were observed visually or seined, and several Iowa darters were collected. More systematic surveys during 2004–2006 suggested that four of the five species persisted in Lake Leopold through 2006. Surveys in Lake Leopold were designed primarily to assess game fish using hoop nets and captured large numbers of centrarchids (mostly bluegill; Figure 3). Less effort was devoted to seining, but blackchin shiner, blacknose shiner, banded killifish, and Iowa darter were captured. Pugnose shiner were also collected in Lake Leopold during both 2002 and 2003 in a separate study (Burr et al. 2005) and presumably entered that system from Sanctuary Pond.

Water quality data suggested that Sanctuary Pond had generally high water quality, although occasional bouts of low (<0.1 mg/L) dissolved oxygen were observed occasionally near the substrate. Sonde data collected during winter confirmed that DO values were nominal during that season; nevertheless, the low DO values did not seem to impact survival of any of the species during the subsequent springs. High N/P ratios suggest that the pond was phosphorus limited and received relatively low nutrient inputs due to land use characteristics of the watershed (Figure 4). Chloride concentrations increased consistently due to application of winter road salt. Secchi depth increased temporally; clear water conditions allowed for development of a dense macrophyte community composed primarily of coontail and Eurasian water milfoil. Though no coverage estimates were made, visual observations suggested that macrophyte densities remained high and covered much of the pond's surface. Over time, Sanctuary Pond remained a clear-water, heavily vegetated habitat despite road salt inputs.

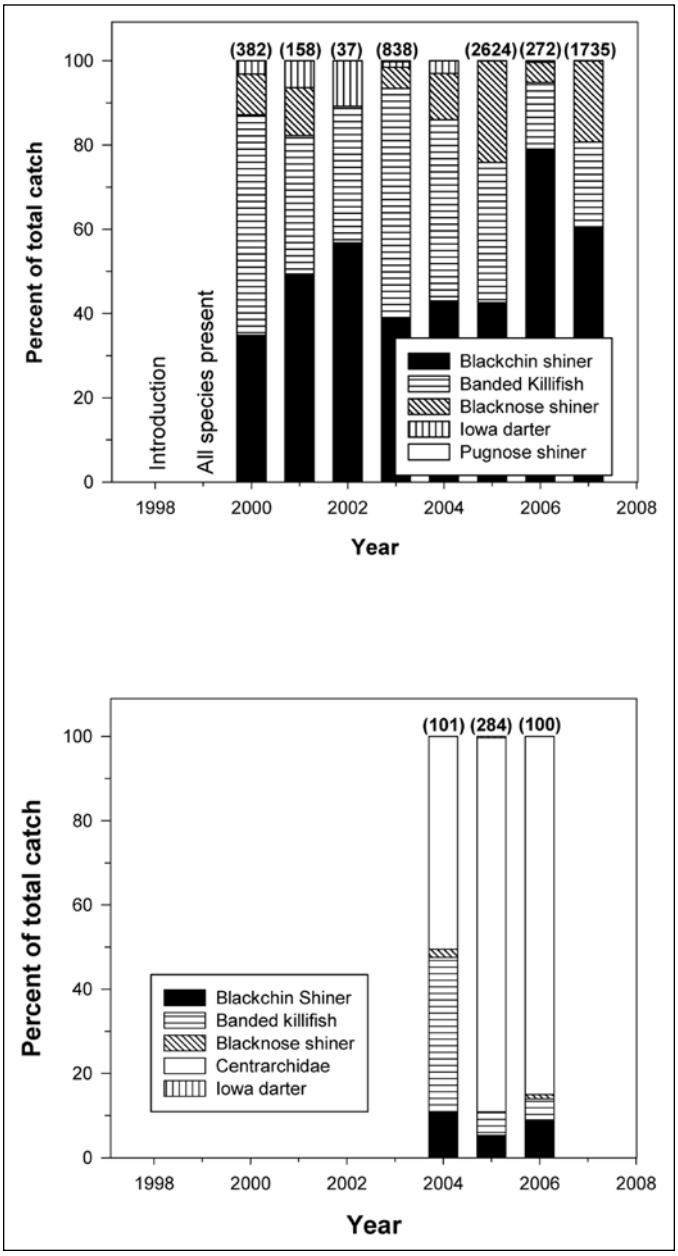

Figure 3. Percentage of total catch of five fish species taken during one to four seining surveys in Sanctuary Pond (top panel) and Lake Leopold (bottom panel), Prairie Crossing, Illinois, 1998–2007. Numbers in parentheses represent the total number of individuals taken in all samples. Sample size was not available for Sanctuary Pond in 2004. Small numbers of pugnose shiners collected in 2003 (Sanctuary Pond) and Iowa darters collected during 2006 (both lakes) not visible.

DISCUSSION

Prairie Crossing demonstrated the viability of providing sanctuaries for rare fishes within a well-designed storm water system. Blacknose, blackchin, and pugnose shiner; banded killifish; and Iowa darters thrived and reproduced in Sanctuary Pond despite moderate eutrophication, occasional bouts of low dissolved oxygen, and increases in chloride from road salt. They were also able to persist after reintroduction into Lake Leopold despite the presence of piscivores and putative competitors. Although age structure of blackchin shiner, banded killifish, Iowa darter, and pugnose shiner populations have been poorly described, ageing of blacknose shiners suggested that they have a maximum age of 2 years (Roberts et al. 2006); thus, their continued presence in Lake Leopold suggested that most individuals would have been fourth-generation post-release when data collection ended in 2007. Assuming similar longevity, populations of other species likely were comprised solely of individuals recruited after reintroduction.

We think of the Prairie Crossing project as an example of reconciliation ecology (Rosenzweig 2003) with an aquatic focus. Reconciliation is defined as a modification of the human landscape to sustain biodiversity and is effective in cases where (1) a particular species can thrive in proximity to human activity, (2) lack of a key resource is the only factor preventing the species from thriving, and (3) the resource can be provided by humans in way compatible with existing human activities. The most common application of this technique is likely provision of nest boxes for bluebirds, which thrive in urban landscapes as long as nest cavities are available. In this case, the habitat modification was creation of an excavated pond with a heavily vegetated watershed composed of prairie grasses.

Prairie Crossing was actually conceived and implemented prior to discussion of reconciliation as a conservation approach. The idea originated with Page (1991), who suggested stocking rare and endangered species, and Prairie Crossing was identified by coauthor James Bland as an opportunity to see whether it might actually work. The project's success led us to examine the data retrospectively and consider them in the broader context of conservation within developed landscapes and especially storm water systems.

Development of refuges for rare fish species has taken several forms. Most management efforts have been performed in headwater streams where mangers create downstream barriers to exclude nonnative species and then physically or chemically remove nonnatives above the barrier (Weedman et al. 2005). In other cases, artificial habitats have been created that mimic desert spring pools (Baugh and Deacon 1988). Still other approaches used semi-natural refugia: a shallow channel adjacent to an irrigation canal was developed for the Comanche Springs pupfish (*Cyprinodon elegans*) and Pecos gambusia (*Gambusia nobilis*; Winemiller and Anderson 1997), and artificial pools were excavated adjacent to springs supporting populations of the endemic barrens topminnow (*Fundulus julisia*; Goldsworthy and Bettoli 2006). Sanctuary Pond used a newly created habitat that was isolated from existing glacial lakes, but it could be considered more natural than the zoo habitats constructed for desert fishes (Baugh and Deacon 1988) because it required no husbandry or maintenance.

Sanctuary Pond differed from some other reintroductions because it was rendered fishless through a rotenone treatment prior to reintroduction. In two other studies fish species were present prior to reintroduction, but their presence yielded contrasting results. Winemiller and Anderson (1997) concluded that the presence of Mexican tetras (*Astyanax mexicanus*) and Largespring gambusias (*Gambusia geiseri*) had little impact on

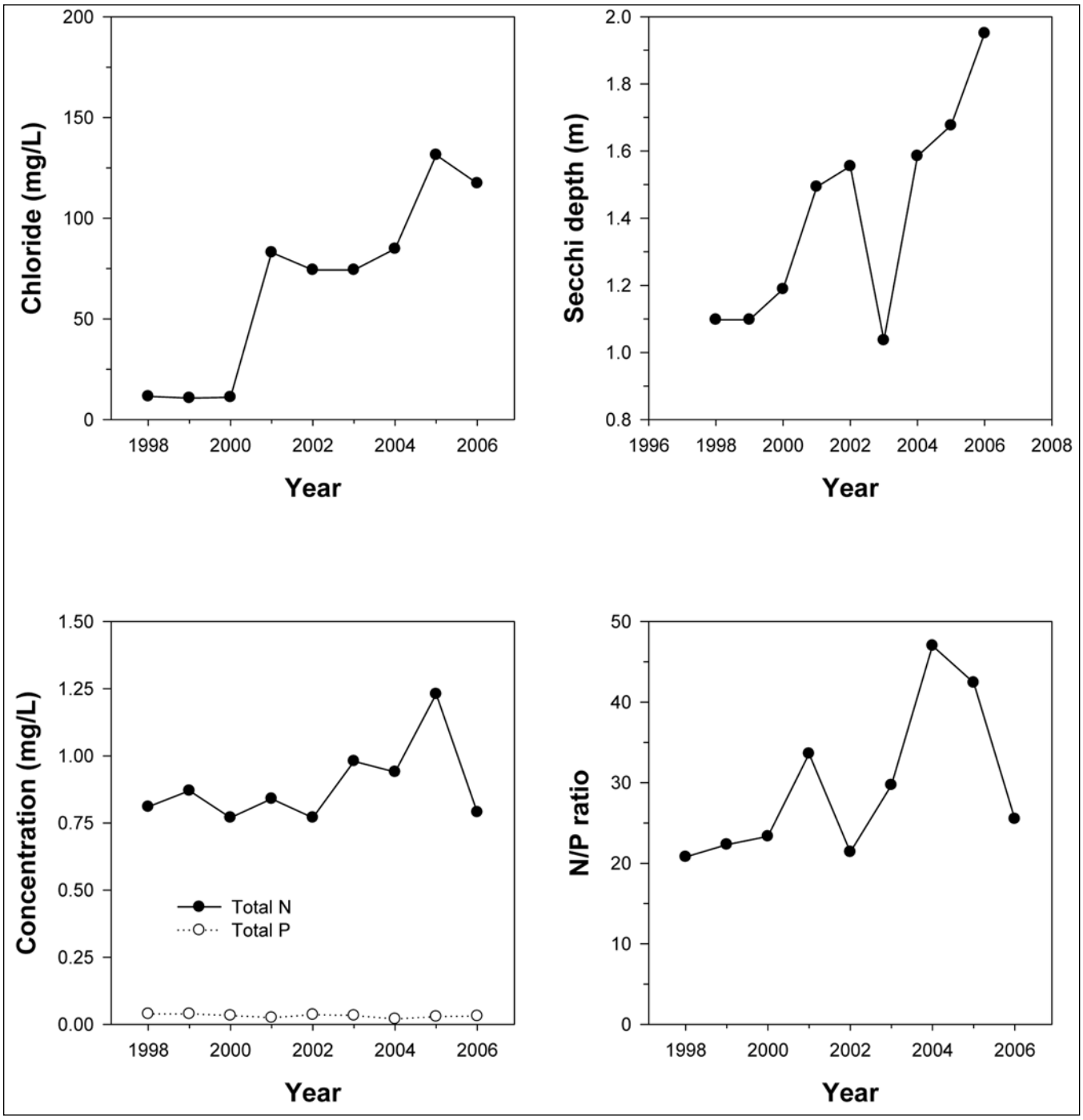

Figure 4. Mean annual water quality parameters, Sanctuary Pond, Prairie Crossing, Illinois, 1998–2007. Mean values developed from three to seven seasonal samples.

the reintroduced Comanche Springs pupfish or Pecos gambusia, but Goldsworthy and Bettoli (2006) found that presence of nonindigenous mosquitofish (*Gambusia affinis*) prevented reestablishment of barrens topminnows. Sanctuary pond likely benefited from prior removal of green sunfish because they can dominate small lentic habitats (Scott and Crossman 1973), but the issue of existing fish species at reintroduction sites appears to be complex and may require site-specific evaluation.

Sanctuary Pond was not a formal experiment, but it should have been, and there are many things that we would do differently were it repeated. First, we would examine the project in terms of newer, more extensive reintroduction guidelines (George et al. 2009). We would also examine each individual fish more closely to insure that only planned species were actually introduced. This failure led to a paradox: the pugnose shiner was the most globally imperiled species to benefit from the project, yet its inclusion was unplanned. Adult pugnose shiners were included accidentally because they closely resemble small blackchin shiner (Scott and Crossman 1973). The species had not been collected previously in either Deep or Cedar lakes, and the species is so rare regionally that no one expected

their presence. Pugnose shiners remained rare in collections in both Sanctuary Pond and Lake Leopold, but this was also true for source populations. Burr et al. (2005) later found pugnose shiner in Deep Lake and examined the introduced Lake Leopold population during 2002 and 2003. In both lakes, numbers were low (1–16 individuals), and captures occurred at only one site within each lake. Burr et al. (2005) believed that pugnose shiner may have localized distributions within a lake, and the species may be difficult to detect due to its close association with dense vegetation. Though its inclusion was consistent with Rosenzweig's (2003) advice to always take advantage of happy accidents, the experiment could have easily gone less well had the accidental inclusion been mosquitofish or largemouth bass.

It is a slippery slope, and the existence of populations in engineered habitats could reduce the incentive to protect remaining natural ones.

Many observations regarding population size and reproduction were qualitative. Annual fish sampling was designed only to (1) verify presence/absence and (2) capture enough individuals to verify in situ recruitment. If the project was repeated, actual population estimates would be beneficial. We would also assess ecological interactions among the five species. Though they all co-occurred in western Lake Erie (Langlois 1954; Trautman 1981), in a pond their ecological interactions could have been different and led to differential survival and inadequate numbers of each species. Winemiller and Anderson (1997) found complex interactions among four species within a refuge that may have affected carrying capacity, but full understanding of interactions was gained only after extensive sampling of both fish and habitat, and sacrificing individual fish was required. Likewise, Goldsworthy and Bettoli (2006) found that mosquitofish predation on larval barrens topminnows was the most likely explanation for failure to maintain reintroduced populations. It is also likely that genetic studies would be performed prior to introduction and we would be likely to consider a source population with distinct genetics. We might lean toward peripheral populations near the edge of their native range because these populations are often distinct genetically and especially worthy of conservation (Lesica and Allendorf 1995).

However, several aspects of the project were well planned. The design of both ponds allowed them to be isolated from downstream immigration, and the Prairie Crossing community cooperated by not introducing other fish species into Sanctuary Pond. The habitat was prepared beforehand so that rare species were introduced into a fishless habitat with clear water and profuse vegetation. Translocated fish were examined individually to the extent that species such as bluntnose minnows were excluded. Most important, both fish and water quality were monitored annually for 10 years post-introduction—an action that we believe is not included in many restorations.

Sanctuary Pond provided additional benefits beyond its original goal of repatriation of rare native species. First, it demonstrated that, given appropriate habitat, all species could coexist in lakes managed for game species. Second, Sanctuary Pond served as a source of individuals for life history studies that could not be undertaken previously due to their rarity. Those studies revealed that blacknose shiners may be vulnerable to extirpation because their life span is short and steady recruitment is required to maintain populations (Roberts et al. 2006). Third, Sanctuary Pond and Lake Leopold provided source populations that led to subsequent downstream emigration and recolonization of sites within their historic range within the Des Plaines River watershed. Fourth, Sanctuary pond provided fish for at least three additional reintroduction attempts and an educational display (J. Bland, unpublished data). Though some were not successful, those efforts were precluded until Sanctuary Pond populations became available. Even if Sanctuary Pond had none of the aforementioned benefits, it would still represent a "backup" population (Becker 1983) that would allow Illinois populations to persist if the original glacial lake populations were lost.

We suggest that well-designed storm water systems such as Prairie Crossing can play a role in biodiversity conservation, especially in urban landscapes that would support no aquatic biodiversity otherwise. Such sanctuaries would be artificial in the sense that they would be engineered, but engineering would result in a mesocosm that would support species sustainably with little or no subsequent human intervention. Obvious sites might be city, regional, or state parks where populations could be protected, monitoring could be facilitated, and visitor education could be incorporated. Another possibility is business parks that have potential for conversion back to habitat (Snep 2009). We also note that artificial engineered habitats may be especially valuable in the southeastern United States where isolated springs support endemic darters and reproductively specialized minnows (Goldsworthy and Bettoli 2006). And though our interest was in fish, detention ponds can also provide habitat for amphibians (Brand and Snodgrass 2009) and native invertebrates (Foltz and Dodson 2009).

Urban or suburban landscapes that are devoid of habitat receive no ecosystem services yet can benefit from them (Boland and Hunhammer 1999). The detention ponds at Prairie Crossing were designed to provide storm water management and maintain water quality in downstream areas, and fish likely provided mosquito control. Though mosquito control could have been achieved with another species, the use of regionally threatened species provided cultural benefit, with the ultimate benefit of improving human quality of life in an urban habitat. Prairie Crossing was atypical because it provided an attractive water feature with generally high water quality and an interesting fauna. Not all storm water systems share those attributes, but they can be designed or redesigned for sustainability even in densely developed areas (Cairns and Palmer 1995; Roy et al. 2008); the key may be to eliminate direct conduits between impervious surfaces and catchments.

We caution that engineered approaches are distinct from habitat protection and should not be considered mitigation. Winemiller and Anderson (1997), in an elegant discussion, raised the issue that artificial habitats for desert fishes could be considered a halfway technology that was a poor substitute for restoration (Meffe 1992). We share their concerns regarding the issue. It is a slippery slope, and the existence of populations in engineered habitats could reduce the incentive to protect remaining natural ones. We also heed Conant's (1988) warning that translocations can result in rapid evolution that alters both genotype and phenotype. Most important, storm water systems are unlikely to allow species to persist over millennia. However, alteration of the human landscape in the form of aquatic sanctuaries may be the only short-term hope for some species or populations.

In closing, we reiterate that using storm water systems (no matter how well designed) is not a substitute for habitat protection or restoration. However, these two approaches leave out many landscapes that have been altered to the extent that they no longer support any significant aquatic biodiversity, and there are currently few tools available to resource managers who want to repatriate non-game native species within their historic range. We view provision of aquatic habitats via well-designed storm water systems as a concept worthy of exploration, and this approach may increase interest in and awareness of native fish and provide the needed source populations for research and repatriation.

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From the Archives

During the seasons under review both fish and eggs were remarkably free from diseases, whether merely due to chance or because of the healthful living conditions will be established later. During the hot summer months there is always a certain mortality of stock fish, confined almost entirely to the old hens. On the stripping table 1 to 2 percent of the hens will produce dead eggs mixed with a mess of bloody ovarian fluid: the cause is unknown. In the hatching house as indicated in previous tables, a proportion of the eggs die, due either to initial infertility or to organic weakness. These eggs turn white and must be removed daily. If they are not removed threads of Saprolegnia sp. appear by the second day and spread to the surrounding eggs.

D. Hey, p. 77, Seventy-Seventh Annual Meeting, Transaction of The American Fisheries Society, 1947

Improving the Learning Process for Both Instructor and Student Using Assessments

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ABSTRACT: The objective of this article is to describe the theory and types of commonly used assessments and how they relate to course objectives and the learning process in higher education. Using a fisheries course example, I argue that quality assessment techniques occur continuously, are aimed at both instructor and student, are not always used to assign grades, and improve the quality of instruction in the classroom. Properly used, assessments can transform institutions of higher education from a place where instruction is given to one where learning takes place.

INTRODUCTION

The concept of assigning grades has haunted both students and instructors for nearly as long as the educational process has existed. For students, grades reduce how much they know (or don't know) to the context of alpha or numeric values. These values have direct bearing on their self-confidence, future success in gaining admission to graduate schools, finding pertinent and gainful employment, and, for some, receiving honors and awards. For instructors, the process of assigning grades is one of the most arduous and least understood pedagogical tasks (Bott 1996; Walvoord and Johnson Anderson 1998). Instructors are often uneasy over the accuracy of grades as a measurement tool, because they know the influence that grades have on the future of each student. Unfortunately, too few students and instructors understand or have been offered guidance regarding the grading process, which is an important component of assessment.

Assessment elicits evidence of performance (Wiliam and Black 1996) and is composed of several facets (Committee on Science Education Standards and Assessment, National Research Council 1995). In addition to grading, assessment provides a mechanism by which instructors and students determine how much and what kind of learning has occurred and how to improve the learning process (Angelo and Cross 1993; Brookhart 1999). Assessment starts when the course begins and does not finish until grades are assigned and evaluations are complete. Assessments are driven by the course objectives, which also serve as the guiding directive in the learning process. Assessments should not simply measure student learning but also pedagogy. Although some assessment activities, such as assigning final grades, are episodic, assessment is a process (Walvoord and Johnson Anderson 1998) and is best conducted along a continuum (Angelo and Cross 1993).

Unfortunately, not all instructors and students fully understand or implement quality assessments in their courses. Consequently, the purpose of this article is to provide guidance on the use of assessments with the intention to show how assessments can be used to both improve the quality of the instruction and accurately measure student learning. First I will clarify assessment types and theory of use, including how learning styles may influence outcome. Next I will progress through a commonly taught concept in some life science courses—fish identification—as the teaching example to demonstrate the assessment process. Throughout this article, I hope to outline an assessment model that can be modified for all instructional settings, because good pedagogy is not limited by subject content or location.

ASSESSMENT TYPES AND THEORY OF USE

Assessments can be broken into two major classifications: formative and summative (Bloom et al. 1971). Formative assessments are used to evaluate the learning process (Bell and Cowie 2001) with the intent to provide feedback used to alter behavior that advances learning (Boston 2002). These assessments can range from instructor observation of understanding, such as simple questioning in class, to formal and extensive written testing. A variety of specific assessment techniques can be employed (see Angelo and Cross 1993; Brown et al. 1996) that facilitate advancement toward the course (learning) objectives. As an example, very early in my teaching career I gave a lecture to a general biology class on neuron firing. I left the lecture questioning whether the students had grasped the concept—one of the learning objectives for the class. Based on the glassy eyes, the nodding heads, puzzled looks, and my own self-doubts—forms of formative assessment—I was sure that they had not. I sought help on how to remedy the situation from my teaching mentor. His paraphrased response was simple: "Go back in during the next lecture, tell them you screwed up, and reteach the material in a different way." I complied. In retrospect, this made a good story because it ended as you might hope. However, at the time I was an anxious, unconfident, untenured, and a nervous wreck. Before or since, I have never spent so much time preparing for a lecture. Did formative assessment alter my behavior? Did formative assessment from the students and me improve the learning process? Did formative assessment move the students closer to meeting the course learning objectives? The affirmative response for all three questions gives credence to Black and Wiliam (1998), who argued that formative assessments raise classroom standards of learning.

Since that eventful lecture, I have used a number of varied techniques that promote formative assessments (feedback). One of my favorites is to give each student a 3 × 5 card (see Angelo and Cross 1993) that is used to elicit a response. The responses may be answers to explicit questions (e.g., What is the taxonomic difference between smallmouth and largemouth bass?), concept understanding (explain the Bohr effect), evaluations (What went wrong with the stocking process?) or serve to provide feedback on a lecture (What part of today's lecture is fuzzy in your mind and you would like me to reteach?). Cards have the advantage in that they provide a response (written) from every student in the class—something that is often lacking with verbal questioning. The more recent use of electronic audience response tools, such as i-clickers, provide similar feedback but have the advantage of summarizing responses instantaneously, providing the instructor with some pedagogy advantages in the classroom. Regardless of the technique, the intent of these formative assessments is to create a form of communication that details the student's level of understanding. In response, the instructor can structure future learning activities.

However, the intent of formative assessments is to evaluate the learning process, whereas summative assessments tersley state how much the student learned. Understanding the distinction between these assessment techniques and their intended use is critical in structuring the learning process.

Summative assessments, in contrast, are typically used to validate a level of accomplishment and are often used for the purpose of assigning grades (Bloom et al. 1971). Tests, assignments, quizzes, and term papers all quantify a student's proximity to meeting course objectives, assuming that the measurement device correlates well with the instructional intent (Walvoord and Johnson Anderson 1998). Summative assessments are also used for school entrance exams (e.g., SAT, GRE), graduate school progression (e.g., preliminary exams, thesis defense), or even academic credentialing of institutions of higher learning.

The distinction between summative and formative assessments is not always clear, because overlap in measurement techniques does exist (Wiliam and Black 1996). However, the intent of formative assessments is to evaluate the learning process, whereas summative assessments tersely state how much the student learned. Understanding the distinction between these assessment techniques and their intended use is critical in structuring the learning process.

FORMULATING A PLAN OF INSTRUCTION

An educational plan begins with one or more objectives, typically defined in a syllabus. Their establishment does not differ from good objectives found in a scientific study with which we may be more familiar—clear, concise, measurable, and attainable. Educational objectives include dimensions of "who, what, time frame, under what conditions, in what amount, and measured by what method" as described by Bott (1996). In short, educational objectives tell us where we are going, how we are going to get there, and when we have arrived. Using a hypothetical ichthyology course example, one objective might be that students will be able to use the taxonomic keys provided in class to identify successfully any unknown fish found in our state to family by the end of the semester (Table 1). Without explicit and well-defined objectives, instructors will not know where to take students. The objectives must also be explicitly presented to the students in order for them to comprehend instructional expectations and to know whether they have met stated learning objectives. Poor objectives, such as identify fish by sight or be competent with your fish key (Table 1), are too ambiguous and fail the assessment process for both parties.

TABLE 1. Examples of poor and better (good) course objectives for a hypothetical ichthyology course addressing fish identification skill.

Objectives	
Poor Quality	**Better Quality**
1. Be competent with your fish key	Students will be able to use the taxonomic keys provided in class to identify successfully any unknown fish found in our state to family by the end of the semester
2. Identify fish by site	Students will be able to identify the 40 species of fishes listed on the handout by sight using both common and scientific names by midterm
3. Know your local minnows	Students will be able to identify the 15 minnow species found in the White River watershed by the next test (give date)

Because each student has a specific learning style and personality type (see Felder [1996] for a detailed description of these), failure to accommodate these preferences will ultimately result in failure to reach course objectives. Students exposed to a variety of teaching methods perform better when compared to those exposed to singular educational approaches, particularly when instructors use active and cooperative techniques (Felder 1995; Felder et al. 1998). Furthermore, multiple and varied teaching methods ensure that most, if not all, students are exposed to the type of instruction to which they can best relate. It is quite possible that some students can learn fish identification while simply reading a description of the fish. However, I would argue that fish identification skills additionally improve when students have been given instruction in fish anatomy; when students have access to physical specimens (live and preserved) to see, hold, touch, turn, inspect, and ponder; when students have been given oral and visual instruction on similarities and differences among fishes; or when students are simply exposed to a variety of taxonomic keys that theoretically do the

same thing but take difference approaches. I agree with Dunn et al. (1989), who concluded that the inability of students to learn may not be in their cognitive abilities or efforts but, rather, the style (conditions) in which the material was presented.

TEACHING METHODS AND ASSESSMENTS

Teaching methods must be designed to attain course objectives. In the case of our hypothetical ichthyology class, anecdotal evidence suggests that too many students have simply been given a bucket of fish and a taxonomic key with instructions to "go for it" during labs. More problematic is that after several of these classes, the instructor often tests students on their taxonomic competency (i.e., a summative assessment) with the assumption that learning has occurred. A number of pedagogical violations occur when using this approach, beginning with the first lab and ending with the ID test. Let us take a look at a better strategy.

Students learning to use a taxonomic key should use curriculum sequencing (Brusilovsky 1999; Brusilovsky and Vassileva 2003)—a process whereby the most basic skills are mastered before progressing to more advanced activities. If we want students to effectively use a taxonomic key, then we must ensure that they progressively build the skills necessary to accomplish the task. In this case, the instructor may create a behavioral sequence based on the course objective. Steps 1–6 in Table 2 are intended to give the student the foundation to effectively use a taxonomic key to identify an unknown fish to family. Students would typically start with step 1 and then move up in order to step 6, working at each level until mastery occurs and offers a more logical sequence for learning. The intent is to prepare students for summative testing (grading), typically related to a course objective. For example, students may be faced with making a choice in the dichotomous key where the term "axillary process" is used. If they are unfamiliar with this anatomical feature (step 4), they would not be able to proceed confidently, stifling the effort. Similarly, students may be unable to define key components (e.g., how to properly count fin rays), resulting in a low proficiency in identifying fish.

TABLE 2. Hypothetical ichthyology course sequencing steps that should be sequentially mastered prior to the assessment of the course objective.

Sequencing Steps
1. Students will be able to state the intended purpose of the taxonomic key.
2. Students will be able to describe how the key is organized.
3. Students will be able to use (in this example) a dichotomous key.
4. Students will be able to describe the anatomical terms used in a fish key.
5. Students will be able to compare and contrast key expressions.
6. Students will be given practice using the key, including testing procedures
Course Objective
Students will be able to use the taxonomic keys provided in class to identify successfully any unknown fish found in our state to family by the end of the semester.

Steps 1–6 (Table 2) may not formally be used to assign grades but must be included in the assessment process. The instructor must get some feedback from the students to determine whether mastery of each step has been achieved. This can be accomplished using observation, pretesting, question–answer sessions in class, quizzes, group responses using 3 × 5 cards or electronic clickers, attitude testing using a Likert scale (Likert 1932), or key creation using inanimate items. Angelo and Cross (1993) provided a number of assessment techniques that are simple, straightforward, and helpful in this capacity. If deficiencies are identified by the instructor, remedial actions should be taken by both the instructor and the students, which may require using a different learning style. Student-centered learning techniques are generally considered the most effective learning style in this situation (Nicol and Macfarlane-Dick 2006). Unfortunately, this may require instructors to change or alter their teaching methodology. For example, if a deficiency in step 4 is identified, the instructor may hold additional sessions focused on anatomy or employ different teaching approaches (e.g., online references, PowerPoint explanations, one-on-one with a graduate student). The instructor may finish by assessing the student's knowledge and understanding using various formats until the student achieves an acceptable level of competency. Only then can the student move forward to the next step in the learning process. The assessments used to determine mastery would be termed "formative" and are typically not used for course grading. Rather, formative assessments are designed to determine whether the student has the skills necessary to achieve the course objective in taxonomical key proficiently and to provide guidance to the instructor on teaching methodology.

Testing for mastery of the course objectives at the end of the teaching period is referred to as a "summative assessment." This kind of assessment measures how much students have learned but is not without controversy. Mager (1973) stated that objectives should be clear and concise, and testing should be directly associated with those objectives. If we wanted the class to be able to identify families of fish commonly encountered in Indiana, then our testing should not include fish found only in California or questions asking students to identify fish to species. This mismatch in testing does not identify how much learning has taken place as it relates to our objectives but creates consternation and discord. Imagine the student's dismay when he or she knew how to use a key to successfully take a lake trout *Salvelinus namaycush* to the family Salmonidae only to find that your test question asked to specify the difference between said fish and a brook trout *Salvelinus fontinalis*. Although it is clearly acceptable for students to exceed expectations, summative assessment is not a tool that is used for this purpose.

Ultimately, proper assessment improves the learning process and determines the extent of leaning that has occurred (Mager 1973; Bloom et al. 1981; Brookhart 1999), but assessment is among the least understood of pedagogical tasks (Bott 1996). The complexities associated with assessment (Walvoord and Johnson Anderson 1998) must be understood by both instructors and students before effective learning can occur. As-

sessment must also be a daily and ongoing practice (Angelo and Cross 1993; Stiggins 2002) that continually moves instructors and students toward learning objectives. Moreover, this process must place more emphasis on student-centered learning in which they become self-regulated learners (Nicol and Macfarlane-Dick 2006). Only when the full array of assessment techniques is implemented can a paradigm shift in higher education transform a process where instruction is given to one where learning takes place (Barr and Tagg 1995).

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Recruiting the Next Generation of Fisheries Professionals

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INTRODUCTION

Fishes are an invaluable resource for myriad reasons. In the United States, they support important commercial (National Marine Fisheries Service [NMFS] 2011), recreational (Southwick Associates 2007), and subsistence (Reis and Hibbeln 2006) fisheries, all of which provide employment, a variety of economic impacts, high-quality protein, and cultural identity. As a result of their importance, understanding and managing fish resources is critically important to ensure sustainable fisheries in the future. To accomplish this goal, fisheries professionals from a wide variety of scientific and humanist specializations are necessary to study and manage the cultural and scientific aspects of fisheries. However, in the near future, it is predicted that the United States will experience a shortage of trained social (Ocean Studies Board, National Research Council 2000) and fishery scientists, especially stock assessment experts (U.S. Department of Commerce and U.S. Department of Education 2008). Therefore, it is necessary to attract, educate, and train future fisheries professionals by recruiting youths to college and university fisheries programs where they can begin their education and training experiences in fisheries.

RECRUITING TRENDS

Recruitment of college and university students has undergone a recent transformation. Historically, higher learning recruitment efforts relied on in-person events such as college fairs and mail and telephone communications targeting junior- and senior-level high school students. These recruitment efforts typically relied on a quantity, rather than quality, approach to finding potential college and university enrollees because a large number of individuals, ranging from potentially interested to completely uninterested in higher education, was targeted.

These recruitment techniques have come under scrutiny over the past few decades as students in the United States have fallen behind their peers from developed countries in science (such as fisheries), technology, engineering, and mathematics (STEM) fields (Jeffers et al. 2004). To address the concern of the quality of STEM education in the United States, many colleges and universities are attempting to reverse this trend through new outreach efforts designed to recruit more students to their programs (Laursen et al. 2007).

These outreach efforts have transformed into an interactive recruitment process that starts in elementary school and then provides stepwise stimulation and connection through the end of high school. Outreach and recruiting programs can take a variety of forms, one of which is exposing students in grades K–12 to the expertise and enthusiasm of practicing professional scientists (Jeffers et al. 2004). The most common model is the "scientist in the classroom" approach (Laursen et al. 2007); other approaches include science camps, activities at schools, on-campus activities, academic competitions, volunteer and internship opportunities, college fairs, and even professional development programs for K–12 teachers. The ultimate goal of a these approaches is to stimulate student interest and learning, increase science literacy, and urge consideration of science careers to maintain a strong and diverse workforce (Laursen et al. 2007).

CASE STUDY IN RECRUITING AND OUTEACH ACTIVITIES IN A UNIVERSITY FISHERIES PROGRAM

The School of Fisheries and Ocean Sciences (SFOS) at the University of Alaska Fairbanks (UAF) offers undergraduate (B.S., B.A., and minor) degrees in fisheries. Several years ago, it was recognized that the undergraduate fisheries program needed to be strengthened to adequately serve Alaskan residents and the commercial and sport fishing industries, which are some of the largest private-sector employers in the state. A number of initiatives were developed to strengthen the Fisheries program (Seitz and Sutton 2010), one of which was to increase enrollment through outreach and recruitment. To accomplish this goal, a full-time recruitment and retention coordinator was hired in 2006 to lead the recruitment and outreach efforts. With assistance from fisheries and marine sciences faculty and staff members, outreach efforts aimed at K–12 students encompassed a broad variety of activities throughout the state, which are subsequently described.

Summer Science Camps

Fisheries Division faculty, with support from the recruitment and outreach coordinator, have instructed two summer science camps. The first science camp was based at the UAF and was part of the Alaska Summer Research Academy (ASRA), an intensive, 2-week summer science camp for students with an interest in STEM fields. Students study one subject in a course module and work in small teams participating in project-based learning in a college-like environment. The fisheries module had eight students (ages 14–16) who participated in several field trips in a variety of freshwater habitats and learned how to sample fishes and characterize their environment. After field outings, the students processed samples and analyzed data, which were summarized and presented at a research colloquium at the end of the course. Students received one university credit for their participation in the ASRA module.

The second summer science camp was held in a rural village in the eastern Bering Sea on Nunivak Island, Alaska. The goal of this science camp was to encourage high school students from the Yukon–Kuskokwim Delta to consider a career in STEM fields and to pave their way toward an academic education. The 2-week class exposed seven Yukon–Kuskokwim high school Native students to fisheries field and laboratory methods and covered a variety of topics, including basic descriptions of fisheries science and fish biology and ecology.

On-Campus Educational Activities

Each year, the SFOS Fisheries Division participates in several educational outreach activities in which K–12 students are brought to the UAF campus. Typically, these outreach activities are organized by the UAF Office of Admissions and are part of a campus-wide effort conducted several times throughout the year aimed at educating young students and raising awareness about programs at UAF. To accomplish this goal, each department conducts relatively short (approximately 1 hour) outreach activities several times throughout the day and groups of students cycle through each department's activities. In the Fisheries Division, these activities typically feature a brief mock lecture by a faculty member followed by a hands-on laboratory or field exercise led by graduate students demonstrating aspects of fisheries science.

In addition to outreach activities organized by UAF, one of the flagship days of on-campus outreach, called "Outdoor Days," is coordinated by U.S. Fish & Wildlife Service and the Bureau of Land Management. This all-day, multi-agency outdoor educational outreach event features instructors from natural resource management agencies, university students and educators, and scientists from the private sector and nonprofit groups. This event attracts approximately 700 sixth graders annually who cycle through a diverse array of 30-minute activities, giving them hands-on lessons in a variety of natural sciences, including fisheries, from national environmental curriculum studies.

Scientist in the Classroom

In addition to students visiting the UAF campus, the recruitment and outreach coordinator and faculty members frequently visit K–12 students in their classrooms. These visits may be at the request of a teacher or may be part of a recruitment trip, in which several cities, towns, and villages may be visited. The purpose of classroom visits varies from solely informing students, such as upper-level high school students, about the fisheries program at UAF to providing a guest lecture/activity about a fisheries topic to students of any age, but typically these visits involve elements of both. School visits may be logistically challenging, yet extremely gratifying, in Alaska, where road access to schools can be very limited and one-room schools are common in rural villages.

College Fairs

College fairs are another venue where high school students who are potentially interested in studying fisheries have been reached. These are one of the most traditional forms of recruitment and are typically organized by national associations or by high school guidance counselors. College fairs are usually held during the school day and students from surrounding areas are bused in, making them high-traffic events for interacting with college-bound and interested students. Often the college fair schedule will also incorporate a lunchtime, weekend, or evening event that allows parents and nontraditional students to attend. Typically, recruiters from a variety of career paths including trades, military branches, 2-year colleges, and 4-year universities are given a booth in a large exposition area and hand out printed information to high school students.

Academic Competitions

Interest in higher education may be generated in academic competitions, of which several nationwide competitions exist. The flagship academic competition sponsored and conducted by the UAF SFOS and Alaska Sea Grant College Program staff and faculty is the Tsunami Bowl, which is part of the National Ocean Science Bowl (NOSB). The NOSB is a nationally recognized high school academic competition that consists of two parts, providing a forum for students to test their knowledge of the marine sciences, including fisheries and biology. The first part is the quiz competition, in which four-person teams each representing a high school compete against each other in a timed quiz match. The second part is the research component of the competition in which the teams prepare a 20-page research paper and present their findings in a 20-minute oral presentation at the Tsunami Bowl, both of which are evaluated by a panel of experts. The team with the highest overall score wins an all-expenses-paid trip to the national competition, featuring teams from each of the 25 NOSB regions.

In addition to NOSB, faculty and staff from UAF SFOS have participated in the Alaska Statewide High School Science Symposium (ASHSSS) as judges and research mentors. The ASHSSS is a regional competition in which high school students from around the state conduct mentored research, submit written papers about their projects for technical review and revision, and then present their project to a panel of expert judges from the UAF. Winners are eligible for a variety scholarships and "cash-in-fist" prizes, as well as advancement to a national competition, the National Junior Science and Humanities Symposium.

Volunteer and Internship Opportunities

Students interested in pursuing an education and potentially a career in fisheries may opt to learn more about this field by volunteering or completing an internship in a research lab. Volunteer and internship opportunities may be established informally through high school guidance counselors or formally through established programs, such as the Hutton Junior Fisheries Biology Program sponsored by the American Fisheries Society. In either case, high school students work under the guidance of a fisheries mentor and assist with an existing project or undertake an independent research project. These projects may segue into a high school science fair project or even a journal publication.

Professional Development Programs for K–12 Teachers

In addition to reaching out directly to students, outreach may be conducted indirectly, via grade K–12 teachers, who then pass on information to their students. One effective method of educating teachers is during annual professional development programs, in which teachers are typically required to participate. Professional development programs may be organized by schools themselves or by an extension program, such as a cooperative extension or Sea Grant. Professional development programs may consist of lecture and activity-based learning followed by questions and discussion. All of this information is then summarized by each individual teacher and presented in his or her respective classroom. In addition to professional development programs, a wide variety of fisheries-related material and grade-appropriate lesson plans are made available to teachers by extension programs.

RESULTS AND DISCUSSION

Since outreach and education efforts started in 2006, undergraduate student enrollment in the UAF fisheries program has nearly tripled (Figure 1). During the first 2 years (AY 2006–2007 and AY 2007–2008), there was a lag in enrollment because the first recruitment efforts targeted high school juniors during the fall semester, who needed sufficient time (approximately 1.5 years) to graduate high school and enroll at UAF. Since this cohort of students entered the program during the third year of active outreach and recruiting efforts (AY 2008–2009), enrollment in the undergraduate fisheries has increased at approximately 35–40% annually.

This increase is likely the result of a combination of effective outreach and recruitment efforts by staff and faculty in the fisheries program, as well as the hiring of new faculty, creation of new facilities, development of new courses and curricula, and increased offerings of distance-education courses (Seitz and Sutton 2010). However, we are not able to quantitatively determine to what extent each factor is responsible for the increased enrollment or which outreach and recruiting strategies are most effective. Evidence suggests that in-person events and face-to-face conversations are among the most effective outreach and recruitment practices (Noel-Levitz, Inc. 2009). Given the relatively short timeframe of this study, the frequent in-person and face-to-face outreach efforts, and anecdotal evidence from student entrance and exit questionnaires, we believe that a considerable proportion of the increased enrollment in the UAF fisheries program is the direct result of outreach and recruitment efforts aimed at high school students in Alaska. Specifically, many of these students have stated that they joined the UAF fisheries program because a dedicated staff member was available to answer their questions and persistently contacted them throughout the application to enrollment cycle.

RECOMMENDATIONS

Outreach and education can be a very rewarding endeavor, particularly if a few simple recommendations are considered. Foremost, when designing and planning an outreach activity, it is helpful to coordinate your activities with high school teachers and counselors, college and university admission counselors, extension specialists, governmental and nongovernmental

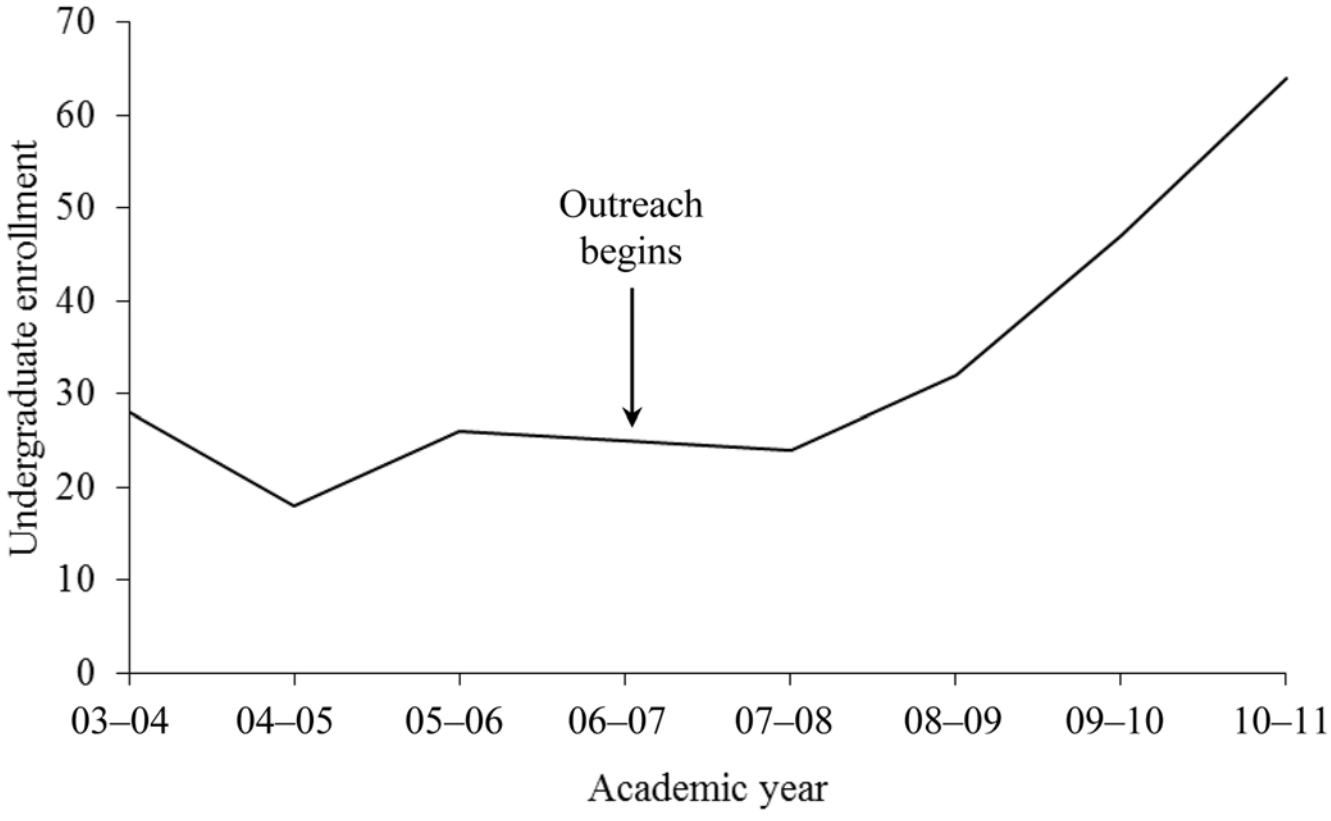

Figure 1. Undergraduate enrollment in the fisheries program at the University of Alaska Fairbanks School of Fisheries and Ocean Sciences.

agencies, and/or colleagues because they may have broader initiatives into which your ideas may fit. If it is possible to include your activities within a broader initiative, it will save time, money, and frustration in the planning process. Additionally, coordination of university outreach and recruiting with other entities, especially potential employers, makes university programs appear more cohesive to the student by directly demonstrating the pathway from education to career and collaboration among universities and employers. In the UAF fisheries program, the majority of the outreach activities are part of larger outreach efforts arranged by the university and other organizations.

When planning the content of the activity, it is imperative to know your audience and the facilities available to determine how to make the information most appealing and to generate maximum interest.

When planning the content of the activity, it is imperative to know your audience and the facilities available to determine how to make the information most appealing and to generate maximum interest. Coordinating with other people during the planning process allows them to provide information necessary to understanding your audience and facilities. For example, a favorite activity of high school students is dissecting fish and if visiting a local high school, a biology laboratory may be used to conduct this activity.

In order to generate maximum interest, hands-on activities should be the focus of the outreach efforts, rather than lectures that rely on PowerPoint slides. As scientists, it is the norm to prepare a PowerPoint presentation, stand in front of a group of peers and present for 15–20 minutes, and then answer questions. Young students lose interest in this method of conveying information; therefore, it is extremely important to design and conduct interactive, hands-on activities to generate and maintain the target audience's interest. If presenting to teachers in continuing education classes, demonstrate a hands-on activity that they can lead in their own classrooms.

Finally, after finishing an outreach activity, it is important to provide contact information to your audience and follow up with individuals who are interested in your fisheries program. This suggestion is especially true for high school juniors and seniors who face a steady barrage of recruiters during the last 2 years of high school. Adding a personal touch to outreach and education efforts frequently leads to successful recruitment of students.

CONCLUSIONS

In the UAF undergraduate fisheries program, we conduct a variety of outreach activities to generate student curiosity and interest in pursuing a higher education in fisheries. Evidence from surveys and our experience suggests that the most successful outreach programs typically involve hands-on activities and face-to-face interaction among professional scientists and K–12 students. As a result of our outreach, we believe that these activities are invaluable tools for increasing enrollment in college and university fisheries programs, which should increase the quality and quantity of trained specialists entering the workforce. These trained specialists will become critical to understanding and sustainably managing the nation's and the world's fish resources.

ACKNOWLEDGMENTS

The revitalization of the UAF undergraduate fisheries program would not be possible without the diligent outreach and recruitment efforts by the faculty, staff, graduate students, and administrators and the generous support of the Rasmuson Foundation and the University of Alaska Fairbanks.

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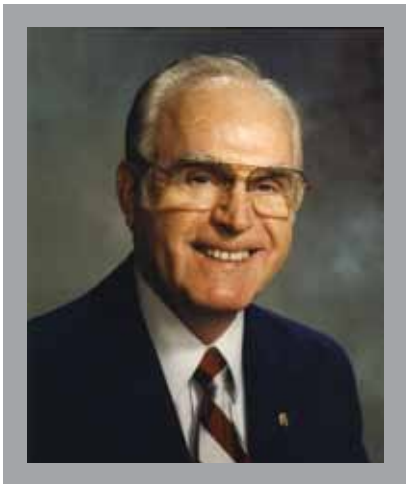
IN MEMORIAM
Dr. Theodore R. Rice



Dr. Theodore R. Rice died on June 3, 2011, in Morehead City, North Carolina. He was 92 years old.

Dr. Rice grew up in eastern Kentucky and graduated from Berea College in 1941. He entered the U.S. Army during World War II, served 4 years in the Chemical Warfare Corps, and attained the rank of major.

After leaving military service, Ted received his Ph.D. in marine ecology from Harvard University and joined the U.S. Bureau of Fisheries Laboratory on Pivers Island in Beaufort, North Carolina, in 1949. From then, until his retirement in 1985, he rose to international prominence as both a scientist and laboratory director.

In his early years at Beaufort, Ted established himself as a quality research scientist while describing the cycling of radionuclides and nutrients in phytoplankton. As his career progressed, he became a research manager who strived to address the information needs of a frequently changing bureaucratic structure and evolving societal concerns. In 1963, Ted Rice became director of the radiobiological program at Beaufort. The program was soon elevated to laboratory status, which resulted in the creation of two separate laboratories at Beaufort. Additional staff was hired and a new research building was constructed.

In 1969, the two Bureau of Commercial Fisheries laboratories were combined and Dr. Rice was appointed as director. From 1970 until Ted's retirement in 1985, he guided the laboratory through difficult financial times and ever-changing agency priorities. In the 1970s, the conservation of estuarine wetlands and other essential coastal marine fish and shellfish habitats was becoming of increasing concern due to rapid human development in coastal areas. In response to this need, Dr. Rice focused research on priority coastal habitats, including salt marsh and seagrass ecology and restoration, toxic metal effects, and the importance of coastal habitats to the survival and growth of estuarine-dependent fishes.

Additionally, the Beaufort Laboratory initiated research on the offshore snapper/grouper reef communities, which provided essential information to the Southeast and Gulf of Mexico Fisheries Management Councils. During these years, the Beaufort Laboratory continued to gather important information on the Atlantic and Gulf of Mexico menhaden fisheries.

During his years as laboratory director, Dr. Rice provided assistance to the National Oceanic and Atmospheric Administration and others on marine radiobiological issues. He was a member of the National Research Council's Committee on Radioactivity in the Marine Environment and the National Academy of Sciences Committee on Water Quality. In addition to his research papers, he published a number of book chapters and review articles on marine radioecology. Ted also was a longtime member of the American Fisheries Society and Association for the Sciences of Limnology and Oceanography, where he served on the editorial board.

His contributions to science were not related only to marine radioecology. He served on the National Aeronautics and Space Administration's Lunar Quarantine Operations Team and the federal committee that established a marine scientific exchange program with the Soviet Union in the 1970s. Closer to home, he served on the Governor's Marine Science Council.

For his many accomplishments, Dr. Rice received several awards. In 1972, he was chosen as the National Oceanic and Atmospheric Administration's Outstanding Marine Scientist for that year. In 1984, he was selected as the National Marine Fisheries Service's Outstanding Employee of the Year and also received the North Carolina Distinguished Service Award.

Ted Rice had vision and compassion. Not only was he an excellent scientist in his own right but he took pride in hiring and developing young scientists. He recruited staff fresh out of graduate school and provided them with the opportunity to conduct fundamental research on relevant issues. In other words, he invested in human capital. Such an investment paid off as the Beaufort Laboratory rose to a position of national and international prominence.

Ted believed in giving his staff the opportunity to pursue their own ideas as long as the research was relevant to agency needs. He encouraged his staff to publish in the open refereed literature and to present their research findings at scientific meetings. Ted worked hard to ensure that his staff had capable scientific equipment and a first rate library. He also encouraged and supported his staff to further their education or to spend a sabbatical at another laboratory. Ted had the vision to know that the loss of a year of productivity at the lab to better oneself would pay dividends down the road, and it did.

Another priority of his was to have close ties with universities. In 1963, he developed a relationship with the Zoology Department at North Carolina State University in Raleigh, where graduate students interested in marine science could use the facilities at the lab to conduct their research, and Ted and several staff had adjunct faculty appointments at the university.

Though many of Ted's goals and priorities for his staff are commonplace today, this was not the case for many federal marine laboratories in the 1960s and 1970s. His contributions to marine research, as both a scientist and a manager, were exceptional. His compassion for his staff and desire for them to be all they could be still serves as a template for any aspiring laboratory director.

Ford "Bud" Cross and David S. Peters

AFS 2012 Minneapolis – Saint Paul: Where waters meet, people greet, and networks are born

Photo Credit: Visit Saint Paul

Being green will be easy for AFS 2012. RiverCentre and the Crowne Plaza Hotel both support green initiatives. RiverCentre uses biodegradable service ware and paper towels in public areas. Crown Plaza's green initiatives include going paperless, providing reusable service for banquets, and filtering city water for bottling. Both venues provide recycling bins, compost food waste and are committed to conservation and sustainable energy.

RiverCentre has achieved this by adding rooftop solar panels, upgrading 1,087 lights to florescent and utilizing energy for heating and air conditioning from District Energy St. Paul, which derives 70% of its energy from renewable biomass. The Crowne Plaza has made a commitment to acquire 25% of its energy from renewal resources.

Our part: We have committed to going as paperless as technology allows. We hope that the only paper you need to carry will be your drink tickets! The program and schedulers will be online for download. In the works are electronic boards to display schedules outside meeting rooms. Local sustainable fish are on the menu. The Spawning Run and Thursday farewell social are both within easy walking distance. Event t-shirts will be "green" fabrics. Look for energy conscious choices when you register!

Professional

Ecological Social

Twin Cities - 2012

What you can do:

- Make eco-friendly choices for your hotel stay. Share a room. Request less frequent room cleaning and linen changes. Conserve energy by shutting blinds, turning off lights, and turning down the air conditioning when rooms are vacant.
- Bring a water bottle. Minimize use of other disposables.
- Go vegetarian to reduce more energy and resource use.
- Consider alternatives to air travel or take direct flights. Use public transportation or carpool. Walk or bike when possible. Consider purchasing carbon offsets.
- Travel to and from the airport using light rail and bus connections to downtown St. Paul. Bus 54 from MSP is even more direct. Plan your trip on Metro Transit: www.metrotransit.org.
- For more information about AFS 2012 green initiatives, visit www.afs2012.org and "friend" the American Fisheries Society 2012 Facebook page.

AFS Facilitates Development of Ecologists without Borders

Eric Knudsen, Larry Dominguez, and Cleve Steward

Cofounders, Ecologists Without Borders, and AFS Members

This is a story of how the American Fisheries Society (AFS) helped turn a dream into reality. It starts with three AFS members—us—who shared a vision of harnessing the expertise, creativity, and altruistic impulses of their colleagues to benefit present and future generations by donating their abilities to solve environmental problems around the world. As longtime fisheries biologists with international consulting experience, we were acutely aware of the intractability of many of these problems. Moreover, the most egregious impacts occur in countries that lack the resources to address them. All too often decisions are made, actions taken, and opportunities are foregone without the benefit of ecological expertise and input.

What would happen if we eliminated the hassle and provided you with a vehicle to contribute your specialized knowledge or skills toward solving ecological problems around the world?

Realizing that we could not tackle the world's problems alone, we brainstormed and expanded on the concept—originally conceived by Larry—of forming a nonprofit organization to facilitate the transfer of ecological knowledge and expertise to developing areas of the world. The organization is Ecologists Without Borders (EcoWB, http://ecowb.org/).

Great idea, but how are we to turn this dream into reality? *One ecologist at a time!* Many of you would like to lend a hand but may not know where or whom to help or be unprepared to deal with the logistical hassle associated with working overseas. What would happen if we eliminated the hassle and provided you with a vehicle to contribute your specialized knowledge or skills toward solving ecological problems around the world?

You have probably heard of Doctors Without Borders—the international organization that enables medical specialists to provide emergency aid in response to international disasters. Another "Without Borders" organization—Engineers Without Borders—takes a more project-oriented, small-scale approach by funding the travel of engineers to help build local infrastructure in developing countries. EcoWB aspires to use both program delivery approaches, working with other experts and organizations to provide ecological assistance when and where needed, whether the need is immediate or long term. EcoWB will stimulate change by facilitating the exchange of ecological knowledge and resources wherever it is culturally and socially appropriate. We want to empower people through education and technical assistance so that they can address problems that affect them directly.

So, how has AFS helped? The synergy of EcoWB can be traced back to our professional relationships—now friendships—that formed through AFS involvement over the years. We have each been active AFS members, participating in numerous AFS activities at many levels. Most recently this culminated in Cleve and Larry serving as general cochairs of the 2011 AFS Annual Meeting in Seattle. Eric chaired the fundraising committee. In organizing the Seattle conference, we were fortunate to work with AFS staff and many dedicated AFS volunteers. The result was a quality meeting attended by over 4,300 people, the largest turnout ever for AFS.

In planning for the 2011 Annual Meeting, AFS agreed to a creative arrangement where, if the governing board–approved fundraising targets were met, additional funds raised could be allocated to a special project. The targets were exceeded, thanks to generous donations from many AFS 2011 sponsors. The Parent Society, Western Division, and Washington–British Columbia Chapter all shared in the extraordinary fundraising revenue. The Washington–British Columbia Chapter recommended EcoWB as the special project and, after gaining AFS approval, seed money was donated to EcoWB for startup costs.

AFS has been a catalyst for EcoWB in several other important ways. First and foremost, a large number of our colleagues have generously volunteered to support and assist EcoWB. We presented EcoWB publicly for the first time at the International Fisheries Section meeting in Pittsburgh at the 2010 AFS Annual Meeting. The response was very encouraging, so we developed a business plan, met with AFS leaders, and began laying the groundwork for future activities. We organized a special symposium on international fisheries assistance projects at the 2011 AFS meeting and sponsored an informal reception afterwards to further introduce EcoWB. This meeting, which was attended by over 50 representatives from foreign countries, AFS elected officers, researchers, managers, and students, convinced us that AFS was behind us.

AFS is also supporting EcoWB by sponsoring the symposium we have organized for the 6th World Fisheries Congress in Edinburgh, Scotland, in May 2012 (http://www.6thwfc2012.com). The symposium is entitled "Enabling Small-Scale Fisheries and Aquaculture to Achieve Sustainability through the

Transfer of Technology and Knowledge." The AFS International Fisheries Section has graciously offered to underwrite travel costs for several symposium presenters from developing countries.

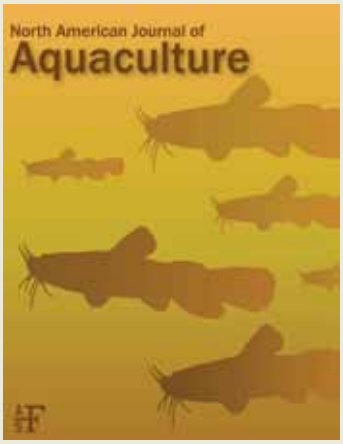
We are also pleased to have two on-the-ground projects underway. One is a sustainable aquaculture project in northern Cambodia; the other is a collaborative, AFS-stimulated fisheries/mangrove ecosystem research and conservation project on the Pacific Coast of Mexico. These are but two of dozens of ecologically sensitive projects conceived by AFS members that we hope to implement in the near future.

Volunteers are needed to keep EcoWB moving in the right direction. We invite you to help organize and implement specific projects, connect with other organizations, build our organizational infrastructure, and raise funding. We are relying mainly on grants and private donations to support our projects and provide EcoWB ecologists with the resources they need to do their jobs. Please visit http://www.ecowb.org to volunteer, support, or donate to EcoWB.

We offer this story as an example of the remarkable influence that AFS exerts on its members. More important, we hope that it has stimulated you to consider ways in which AFS can support you not only professionally but also by lending its voice and prestige to your favorite causes. AFS enjoys a well-deserved reputation for supporting important fisheries-related initiatives such as the North American Fisheries Habitat Plan, the Fisheries Conservation Foundation, and the World Council of Fisheries Societies. These and many other programs were launched by individual AFS members who envisioned a world with diverse and healthy fish communities, habitats, and fisheries. Whether your vision is for a local project or a global program, we urge you to network and brainstorm with your AFS colleagues. We can change the world, *one ecologist at a time!*

Members who attended the Ecologists Without Borders inaugural Advisory Committee meeting in June, 2011 were, from the left, Bill Dunning, Jack Hulsey, Roger Palm, Cleve Steward, Larry Dominguez, Eric Knudsen, Mark Pedersen, Christina Iverson, Matt Love, and Barry Gall. Photo credit: Eric Knudsen

JOURNAL HIGHLIGHTS
North American Journal of Aquaculture, Volume 73, Number 4



Growth, Survival, and Body Composition of Sunshine Bass after a Feeding and Fasting Experiment. *John Bowzer, Konrad Dabrowski, Kyle Ware, Teresa Ostaszewska, Maciej Kamaszewski, and Monica Botero.* 73: 373–382.

Evaluation of the Viability and Growth of Walleye Embryos and Larvae after Antiviral Iodine Treatment. *John Bowzer, Konrad Dabrowski, Marta Jaroszewska, Kyle Ware, and Karolina Kwasek.* 73: 383–392.

Predictors of Walleye Growth and Survival in Michigan Hatchery Ponds. *Marcy R. Knoll and Tracy L. Galarowicz.* 73: 393–402.

[Communication] Interpretation of pH, Acidity, and Alkalinity in Aquaculture and Fisheries. *Claude E. Boyd, Craig S. Tucker, and Rawee Viriyatum.* 73: 403–408.

Transitioning Coho Salmon Broodstock to a Docosahexaenoic Acid (DHA)-Rich Diet during Vitellogenesis: Effects on Egg Composition and Embryo and Fry Quality. *Ronald B. Johnson, Eric L. Kroeger, Cameron S. Carter, William L. Reichert, and Michael B. Rust.* 73: 409–417.

Quality Assessment of Wild Atlantic Sturgeon Semen under Conditions of Short-Term Storage. *Kathryn M. Dorsey, H. David Guthrie, Glenn R. Welch, Jerre Mohler, Daniel D. Theisen, Frank Siewerdt, Bryan T. Vinyard, and L. Curry Woods III.* 73: 418–425.

[Communication] Water Quality in Tilapia Transport: From the Farm to the Retail Store. *John Colt, Tracey Momoda, Rob Chitwood, Gary Fornshell, and Carl Schreck.* 73: 426–434.

Growth Performance and Tissue Fatty Acid Composition of Largemouth Bass Fed Diets Containing Fish Oil or Blends of Fish Oil and Soy-Derived Lipids. *Jérôme Laporte and Jesse Trushenski.* 73: 435–444.

[Technical Note] Genetic Variation Analysis in Wild and Cultured Subpopulations of Small Abalone *Haliotis diversicolor* Estimated by Microsatellite Markers. *Weiwei You, Xin Zhan, Dexiang Wang, Weidong Li, Xuan Luo, and Caihuan Ke.* 73: 445–450.

[Technical Note] Rapid Estimation of Gonad-to-Body Ratio in Eastern Oysters by Image Analysis. *Roberto Quintana, Wesley M. Burnside, John E. Supan, John W. Lynn, and Terrence R. Tiersch.* 73: 451–455.

Efficacy of Common Aquaculture Compounds for Disinfection of *Aeromonas hydrophila, A. salmonicida* subsp. *salmonicida*, and *A. salmonicida* subsp. *achromogenes* at Various Temperatures. *Mary E. Mainous, David D. Kuhn, and Stephen A. Smith.* 73: 456–461.

[Technical Note] The Critical Thermal Maximum of Juvenile Red Drum Reared for Out-of-Season Stocking in Texas. *Dusty L. McDonald, Paul D. Cason, and Britt W. Bumguardner.* 73: 462–467.

Growth Performance, Tissue Fatty Acid Composition, and Consumer Appeal of Rainbow Trout Reared on Feeds Containing Terrestrially Derived Rendered Fats. *Jesse Trushenski, Justin Rosenquist, and Brian Gause.* 73: 468–478.

[Communication] Sperm Metabolism and Biochemical Characteristics in First-Time and Second-Time Spawners of Farmed Atlantic Cod. *Dounia Hamoutene, Lynn Lush, Kimberly Burt, Stephanie Samuelson, Dwight Drover, and Andy Walsh.* 73: 479–483.

[Communication] Effects of Stargrass Hay Supplementation on Growth and Survival of Juvenile Redclaw Crayfish *Cherax quadricarinatus.* *Antonio Garza de Yta, D. Allen Davis, David B. Rouse, I. Patrick Saoud, and Joly Ghanawi.* 73: 484–488.

[Communication] The Role of Activated Lignite Carbon in the Development of Head and Lateral Line Erosion in the Ocean Surgeon. *Jay Hemdal and R. Andrew Odum.* 73: 489–492.

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The Effects of *Myxobolus cerebralis* on the Physiological Performance of Whirling Disease Resistant and Susceptible Strains of Rainbow Trout. *Eric R. Fetherman, Dana L. Winkelman, George J. Schisler & Christopher A. Myrick.* 23: 169-177.

A Real-Time Polymerase Chain Reaction Assay for Quantification of *Edwardsiella ictaluri* in Catfish Pond Water and Genetic Homogeneity of Diagnostic Case Isolates from Mississippi. *Matt J. Griffin, Michael J. Mauel, Terrence E. Greenway, Lester H. Khoo, and David J. Wise.* 23: 178-188.

Intersex Condition of Shoal Bass in the Flint River, Georgia. *Dallas R. Ingram, Debra L. Miller, Travis R. Ingram, and Josh E. Tannehill.* 23: 189-194.

[Communication] Modified Live *Edwardsiella ictaluri* Vaccine, AQUAVAC-ESC, Lacks Multidrug Resistance Plasmids. *Benjamin R. LaFrentz, Timothy J. Welch, Craig A. Shoemaker, John D. Drennan, and Phillip H. Klesius.* 23: 195-199.

[Communication] Genotyping of Infectious Pancreatic Necrosis Virus Isolates from Mexico State. *Magda Barrera-Mejía, Simón Martínez, César Ortega, and Raúl Ulloa-Arvizu.* 23: 200-206.

Detection of Viral Hemorrhagic Septicemia Virus by Quantitative Reverse Transcription Polymerase Chain Reaction from Two Fish Species at Two Sites in Lake Superior. *Emily R. Cornwell, Geofrey E. Eckerlin, Rodman G. Getchell, Geoffrey H. Groocock, Tarin M. Thompson, William N. Batts, Rufina N. Casey, Gael Kurath, James R. Winton, Paul R. Bowser, Mark B. Bain, and James W. Casey.* 23: 207-217

[Communication] Concentration of Infectious Aquatic Rhabdoviruses from Freshwater and Seawater Using Ultrafiltration. *Amelia A. M. Grant, Eva Jakob, Jon Richard & Kyle A. Garver.* 23: 218-223

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breaks, all of which provided many opportunities for interactions and exchanges among meeting attendees.

The meetings I described left an impression on me and illustrate how important it is that we gather to listen, talk, discuss, debate, and socialize. I look forward to attending the Southern, Western and Northeastern Division meetings, our New York Chapter meeting, the Governing Board Midyear Meeting, the 6th World Fisheries Congress, and of course the Annual Meeting in St. Paul-Minneapolis. These will all provide wonderful opportunities to exchange ideas about fisheries and aquatic science and management and related policy issues. They will also allow me and others the opportunity to extend our professional network. I hope to meet and talk with many of you at these upcoming meetings and hope all of you can experience the value of an AFS meeting this year.

From the Archives

As the years advance it becomes more evident that fish culture is undergoing a metamorphosis. The current emphasis on fishery management requires the hatchery operator to be responsible for his fish until they reach the creel. Before the beginning of the previous decade, fish-culturists in general were content to rear their fish and stock the streams in accordance with local pressure and requests. It is not at all strange, in the light of our present-day knowledge, that the conscientious efforts of the fish-culturist did not always pay dividends. We can see now that promiscuous stocking was only a stopgap measure.

O. Lloyd Meehean, p.289, Seventy-Seventh Annual Meeting, Transaction of the American Fisheries Society,1947

Although smelt are believed to be very abundant in the Canadian waters of the Great Lakes, an intense, well organized fishery has not been developed and potential production is still unknown.

N. S. Baldwin, p. 176, Seventy-Eighth Annual Meeting, Transaction of The American Fisheries Society, 1948

NEW AFS MEMBERS

Julie Alexander
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Seema Balwani
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Janet Bavilla
Jessica Beecher
Carolina Behe
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Adam Cross
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Christopher Downs
Michael Drexler
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Cristopher Salazar
Natalie Scheibel
Katie Straub
Christina Stuart
Win Taylor
Lynn Wright
Thomas Zabotny

RECENTLY APPROVED CERTIFIED FISHERIES PROFESSIONALS

The American Fisheries Society's professional certification program provides a way for fisheries professionals who achieve specific standards of professional competence to be recognized.

Congratulations to the following individuals who were recently approved as certified professionals.

Approved January 5, 2012

Certified Fisheries Professionals-FPC:
Jeffrey D. Crosby
Erich B. Emery
Ron Kegerries
Carl J. Kittel
Keith Lockwood
Michael R. Meador
Christy M. Mower
Mark Porath
Tracy J. Richter
Jacob W. Riley
Tamara Smith
David Ward
John R. Young

Associate Fisheries Professionals-FPA:
Kyle Mosel
William E. Smith

Early Bird Reservation

AFS St. Paul Booth Reservation Request

August 19-23 2012

Please complete this application in its entirety.
Please print or type all information.

Company Name _____

Address_____

City _____State _____ Zip _____

Phone _____ Fax _____

Company Contact_____Email _____

Please email your company's description (75 word max) as you would like it to appear in the meeting program guide; please also include your company's address, phone and web-link to ***sjohnston@fisheries.org*,**

BOOTH FEES

• AFS member firm*: $1,500.00 per 10 x 10 booth
• AFS nonmember firm: $1,650.00 per 10 x 10 booth
*Crafters/Non-Profit: $550.00 per 10 x 10 booth

**** To qualify for member rate, the exhibiting company must hold a sustaining, official, or associate membership with AFS. Please include your membership number_____.***

Number of Booths **Total Cost**

_____ _____

We would **like to be located near**

_____

We would **rather not be located near**

_____

AFS reserves the right to assign an alternative choice based on availability.
We agree to abide by the AFS 2012 Annual Meeting Booth Reservation Terms and Conditions specified on this booth reservation form, which are made part hereof by reference.

_____
Signature

PAYMENT

Send request with your 50% deposit of the full exhibit fee for space required. Make checks payable to **AFS 2012 Annual Meeting**. The balance will be due by June 1, 2012**.** Applications submitted after June 1, 2012 must be accompanied by full payment.

Cancellations received on or after April 15, 2012 and prior to June 1, 2012 will be assessed a cancellation fee equal to 50% of the total exhibit space rental fee. Cancellations received after June 1, 2012 will be assessed a cancellation fee equal to 100% of the total exhibit space rental fee.
CHECK:

Amount enclosed: $_____

CREDIT CARD (Circle One): Visa Amex MasterCard

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Name as it appears on card

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Exp. Date 3-digit Security Code

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RETURN COMPLETED FORM WITH DEPOSIT TO

American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814, Attn: Shawn Johnston

Questions about the Trade Show? Please contact Shawn Johnston, AFS Trade Show Coordinator, 301-897-8616 x 230, ***sjohnston@fisheries.org* Fax 301-897-8096**

AMERICAN FISHERIES SOCIETY
APPLICATION FOR COMMITTEE APPOINTMENT

As a small organization, AFS depends on volunteers for many tasks related to the science and the profession. Committees at all levels of the American Fisheries Society (AFS) provide many ideas that shape the future of the Society, and they are excellent avenues for members to begin or continue volunteer service to AFS. We encourage new members to contact their Chapter, Division, and Section officers to volunteer their services. We encourage experienced members, including students, to apply for AFS Committee appointments. (AFS committee terms are considered by the incoming AFS President for appointment starting in September) By volunteering at one or more of these levels, a member gains experience and leadership skills

Please number, in order of priority, no more than two (2) Committees on which you would like to serve:

____ Associate Editor on a Journal
____ Awards
____Ballot Tally
____Board of Professional Certification
____Continuing Education
____Endangered Species
____Ethics and Professional Conduct
____External Affairs
____Hutton Junior Fisheries Biology
____Investment
____Meetings Overview
____Membership
____Membership Concerns
____Names of Aquatic Invertebrates
____Names of Fishes
____Program
____Publications Award
____Public Policy Guidance
____Publications Overview
____Resolutions
____Resource Policy
____Task Force on Fishery Chemicals
____Time and Place
____Web Advisory
____Other _____

I AM NOW SERVING ON THE FOLLOWING COMMITTEE(S):
(Please indicate level--Chapter, Division, Section, Society)

.....

.....

I HAVE HAD EXPERIENCE ON THE FOLLOWING COMMITTEE(S):
(Please indicate level--Chapter, Division, Section, Society)

.....

.....

I CAN CONTRIBUTE TO THE COMMITTEE(S) INDICATED ABOVE BECAUSE (optional):

.....

.....

(Continue on back if more space is needed)

NAME: ..... **DAYTIME PHONE**: .....

ADDRESS: .....

CITY: ..... **STATE, ZIP:** .....

COUNTRY:..... **FAX**:.....

AFS MEMBERSHIP #:..... **E-MAIL**: .....

CURRENT EMPLOYER:.....

☐ Self-employed, ☐ retired, ☐ undergrad, ☐ M.S, ☐ Ph.D. student, or ☐ postdoc at the following university: .....

SIGNATURE: .....

Please complete and return form for consideration to:
Unit Services Coordinator
American Fisheries Society
5410 Grosvenor Lane, Suite 110
Bethesda, MD 20814-2199
e-mail: ggoldberg@fisheries.org

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

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

More events listed at www.fisheries.org

CALENDAR
Fisheries Events

DATE	EVENT	LOCATION	WEBSITE
March 7–10, 2012	Idaho Chapter Annual Meeting	Coeur d'Alene, Idaho	www.idahoafs.org/meeting.php
March 8–10, 2012	Tidewater Chapter's 26th Annual Meeting	Beaufort, NC	http://www.sdafs.org/tidewater/AFSTidewater/Annual_Meeting.html
March 26–March 29, 2012	Colorado/Wyoming Chapter Annual meeting	Jackson, WY	fisheriestn.wordpress.com
March 28–March 31, 2012	46th California-Nevada Chapter Annual meeting	San Diego, CA	www.afs-calneva.org/events.php
May 7–11, 2012	6th World Fisheries Congress	Edinburgh, Scotland	www.6thwfc2012.com
May 15–May 18, 2012	Beyond Borders 2012	Victoria, BC, Canada	www.ser.org/sernw/Conference_2012.asp
May 21–25, 2012	Planning and Executing Successful Rotenone and Antimycin Projects	Utah State University, Logan, UT	http://www.fisheriessociety.org/rotenone
May 27–May 31, 2012	Canada's First National Fish and Wildlife Conservation Congress	Ottawa, ON, Canada	www.afs-oc.org/events.htm
June 5–7, 2012	National Conference on Engineering and Ecohydrology for Fish Passage	Amherst, Massachusetts	http://www.umass.edu/tei/conferences/FishPassage
July 15–July 19, 2012	10th International Congress on the Biology of Fish	Madison, WI	conferencing.uwex.edu/conferences/icbf2012/index.cfm
August 19–23, 2012	142nd Annual Meeting of the American Fisheries Society	Minneapolis-St. Paul, MN	www.afs2012.org

The American Fisheries Society Annual Meeting in the Twin Cities 2012 provides a great opportunity for groups to host workshops, alumni gatherings, technical work groups and other meeting in conjunction with the main conference.

To host an event or gathering at Twin Cities 2012 between August 18 to 23, you need to register with conference planners no later than July 6th. Events will be scheduled on a first come, first served basis.

To register and request information contact: Henry Van Offelen, **henry.vanoffelen@gmail.com**

Or visit the AFS2012 website at **www.afs2012.org** and click "Associated Meetings" for a registration form.

Employers: to list a job opening on the AFS online job center submit a position description, job title, agency/company, city, state, responsibilities, qualifications, salary, closing date, and contact information (maximum 150 words) to jobs@fisheries.org. Online job announcements will be billed at $350 for 150 word increments. Please send billing information. Listings are free (150 words or less) for organizations with associate, official, and sustaining memberships, and for individual members, who are faculty members, hiring graduate assistants. if space is available, jobs may also be printed in *Fisheries* magazine, free of additional charge.

Aquatic specialist/technician
ATAC llc Pond Management Specialists, Lebanon, OH
Permanent

Salary: $30,000 to $40,000 - dependent on experience and education

Closing: Until filled

Responsibilities: Apply Aquatic herbicides and algaecides. Assist biologist in solving aquatic weed problems. Assisting customers pond side. General maintenance of equipment, facility and land Water analysis DO, pH, ammonia etc. Completion of daily log sheets. Assist other departments as needed cleaning fountains and aeration maintenance as well as the fish hatchery, and any other assigned duties. Good people/communication skills. Knowledge in basic pond management, and fish production a plus. A.T.A.C. is an equal opportunity employer..

Qualifications: AS / Aquaculture, Fish Management, Aquatic Biology, Ag science. Horticulture, Biology, Zoology or similar Natural Resource Major. Must obtain a pesticide license with in 90 days.

Contact: Richard A. Rogers, P.O. Box 1223, Lebanon, OH 45036; fax resumes to 1-513-932-9706.

Link: http://www.atac.cc

Email: rick@atac.cc

Faculty Positions in Atmospheric Sciences
Stony Brook University, Stony Brook, NY
Professional

Salary: DOE

Closing: 7/3

Responsibilities: Stony Brook University s School of Marine and Atmospheric Sciences SoMAS invites applications for three tenure track positions, one in Atmospheric Sciences (F-7098-12-01), one in Physical Oceanography (F-7099-12-01), and one in Fisheries Ecology (F-7100-12-01), to begin as early as Fall 2012. We welcome applicants in all areas of Atmospheric Sciences, Physical Oceanography, and Fisheries and Fish Ecology. Successful candidates are expected to develop an independent externally funded research program, to teach and direct research at both the undergraduate and graduate levels, and participate in School and University service. All candidates must have a Ph.D. in a relevant field, and have demonstrated excellence in research and a strong commitment to teaching. The positions are expected to be filled at the Assistant Professor level, but exceptional candidates at other ranks will also be considered.

Qualifications: Candidates should submit a State employment application, CV, a letter of introduction which conveys the candidate s teaching philosophy and proposed research plans, and the names and contact information of three references electronic submission in one PDF document is strongly preferred . and continue until the position is filled.

Link: http://www.somas.stonybrook.edu/about/empopps.html

Special Projects Manager
Cook Inlet Aquaculture Association, Kenai, AK
Permanent

Salary: $52,493 - 74,046 starting salary is negotiable including medical, HSA, employee 403b plan, vacation and sick leave.

Closing: Until filled

Responsibilities: Directs and supports field projects associated with salmonid enumeration adult and smolt , habitat improvement and invasive species Northern Pike. Assists in developing new projects to develop various assessment projects associated with salmonids i.e., creel surveys . Responsible for assuring that permits and progress reports are accurate and completed. Secure and manage grants to support various projects.

Qualifications: Must hold a BS/BA degree in biology or related field and a minimum of 5 years experience as a Fisheries Biologist working with salmonids. Must be comfortable working around boats and in remote location. Supervision experience a necessity. Must be well organized and have excellent time management skills. Must be able to work in inclement weather, operate fish and water quality sampling gear. Familiarity with grant writing, personal computers and software packages. The ability to communicate effectively written and oral with other entities government, NGOs is a necessity.

Link: http://ciaanet.org

Email: gfandrei@ciaanet.org

Supervisory Biologist or Supervisory Fisheries Biologist
US Geological Survey, Seattle WA
Permanent

Salary: Competitive Salary at the GS-15 level

Closing: 3/2

Responsibilities: Science Center Director, Molecular to ecosystem scale fisheries research throughout the western US six laboratory locations support genetic, conservation, habitat, climate change and other investigations.

Qualifications: Job advertised under multiple series and will be open to both status applicants and all qualified U.S. citizens. Go to the link to view and apply for position

Link: http://www.usajobs.gov (Title: Western Fisheries Research Center Director, GS 15- 0401/0482)

Policy and Grants Development Coordinator
American Fisheries Society
Bethesda, MD
Permanent

Salary: We offer an excellent benefit package including paid vacation, medical/dental, and metro subsidy.

Closing: Until filled

Responsibilities: Small nonprofit Scientific Society in Bethesda, MD seeks team motivated person to work as a Policy Grants Development Coordinator.

Qualifications: Candidate must possess a B.A. or B.S. degree. Technical skills , social media expertise, and Web content development are important. Experience in programs that relate to policy development, government advocacy, and grant writing are desirable. Experience and education in aquatic sciences/ecology is preferred. Needs the ability to multitask in a fast-paced environment and should be familiar with and adept with electronic media applications PowerPoint, Excel, Web, Video

Contact: Send cover letter w/resume and salary requirements to below email or fax to: 301-897-8096. American Fisheries Society, 5410 Grosvenor Lane Ste. 110 Bethesda, MD 20814.

Link: http://www.fisheries.org/afs

Email: dspencer@fisheries.org

MS Graduate Research Assistant
Dept. of Natural Resource Management, SD State University
Student

Salary: $17,200 includes out-of-state tuition waiver

Closing: 3/1

Responsibilities: Seeking a highly motivated student interested in fish ecology. Goals of the study are to quantify population characteristics, diet and bioenergetics of lake trout and northern pike in the Black Hills, South Dakota. Interest or experience in fish ecology, diet analysis and bioenergetics modeling are desired. The student is expected to work closely with state research biologists. Remote field work is required and summer housing will be provided in the Black Hills.

Qualifications: B.S. degree in fisheries science or related field strong written and oral communication skills interest/experience with fish sampling competitive GPA 3.2 and GRE scores 1,100.

Contact: Submit a letter of interest, resume, names and contact information of three references, copies of academic transcripts and GRE scores to: Steve R. Chipps, USGS South Dakota Cooperative Fish Wildlife Research Unit, Department of Natural Resource Management, NPBL 2140B, South Dakota State University, Brookings, SD 57007

Email: Steven.Chipps@sdstate.edu

California Sea Grant Extension Advisor, Academic Coordinator (Two Positions)
CA Sea Grant, Scripps Institution of Oceanography at UC San Diego
Professional

Salary: Salary is competitive and is based upon UCSD pay scales, commensurate with a candidate's experience, but is expected to range between $44,400 and $63,816 annually.

Closing: 3/1, or until filled

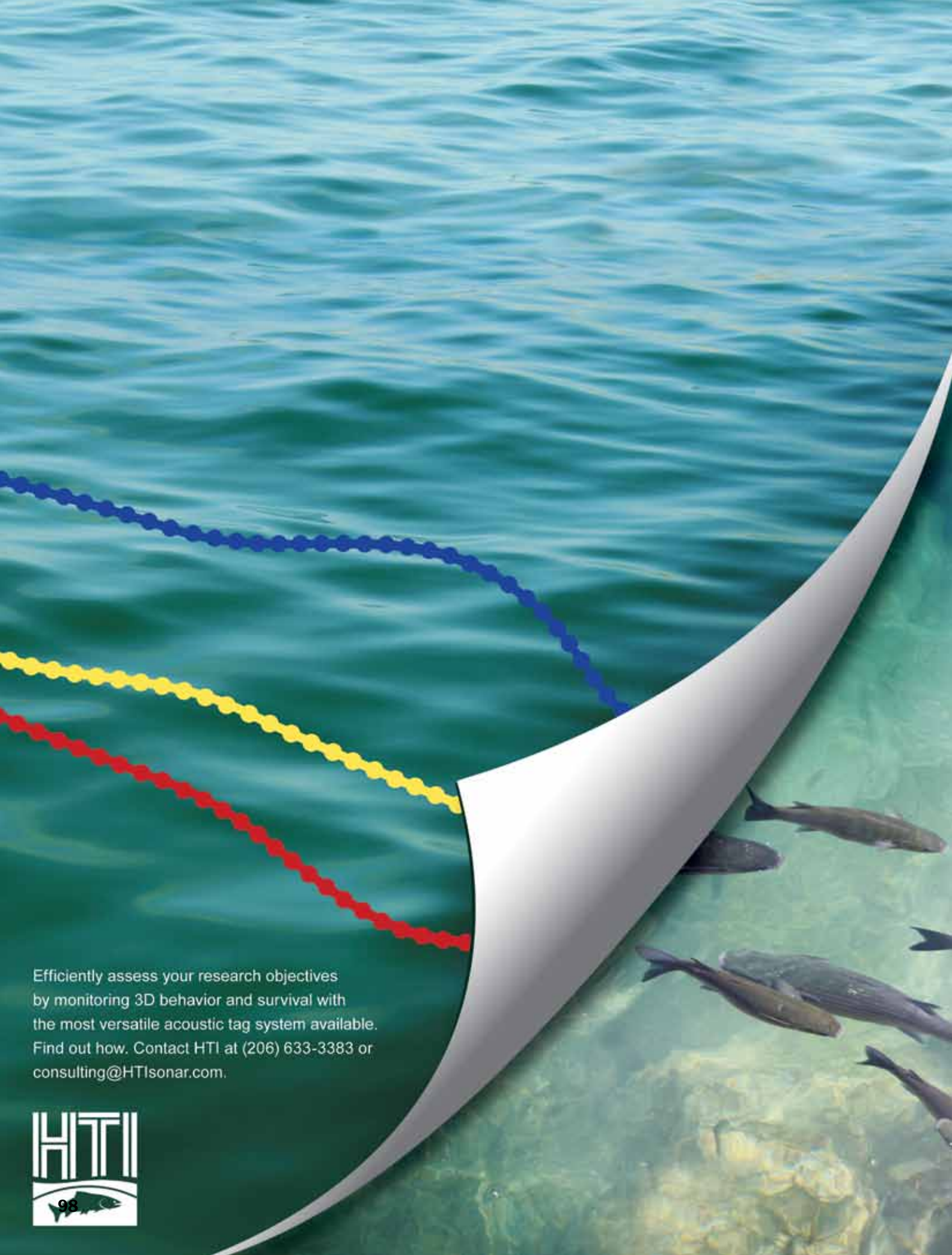
Responsibilities: One position will be based in San Diego or Orange County, CA and one position will be based in Eureka, CA in either case the Advisor will be an employee of SIO/UCSD hired in the Academic Coordinator series. UCSD is an Equal Opportunity/Affirmative Action Employer with a strong institutional commitment to excellence through diversity. The Univ of CA prohibits discrimination against or harassment of any person employed by or seeking employment with the University on the basis of race, color, national origin, religion, sex, gender identity, pregnancy, physical or mental disability, medical condition cancer-related or genetic characteristics, ancestry, marital status, age, sexual orientation, citizenship, or service in the uniformed services as defined by the Uniformed Services Employment and Reemployment Rights Act of 1994 . Advisor is to develop solutions to high-priority coastal and marine issues, and disseminate information through diverse extension methods. Extension Advisors utilize research as an outreach and education tool. Advisors also organize symposia, workshops, and meetings to help local, regional, state, national, and international audiences identify resource problems and then engage community leaders, industry, academics, and agency staff in collaborative projects that lead to better-informed public decisions. Successful candidates will be expected to develop collaborations with other researchers, organizations, industries, and educators to conduct integrated research, education, and outreach projects. Please go to web site below for complete description.

Qualifications: Extension Advisors will have a background and will provide research-based information and leadership in one of the targeted areas of aquaculture, marine fisheries, coastal resource or coastal community sustainability, climate change, invasive species or similar fields. Advisors will be expected to obtain external support grants or contracts that can contribute to the CASG Extension Program budget. Advisors will report through the CASG Extension Director to the CASG Director. Review of applications will begin 3/1and continue until the position is filled. Candidates are strongly encouraged to submit complete application packages before 3/1

Contact: The package should be submitted in electronic format to below email. Package details are included on our web site. For additional information, contact either Rick Starr Extension Program Director at RickStarr@ucsd.edu or 831-771-4442 or Jim Eckman CASG Director at jeckman@ucsd.edu or 858-534-4440.

Link: http://ca-sgep.ucsd.edu

Email: csgdirrecruit@ucsd.edu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