Fisheries

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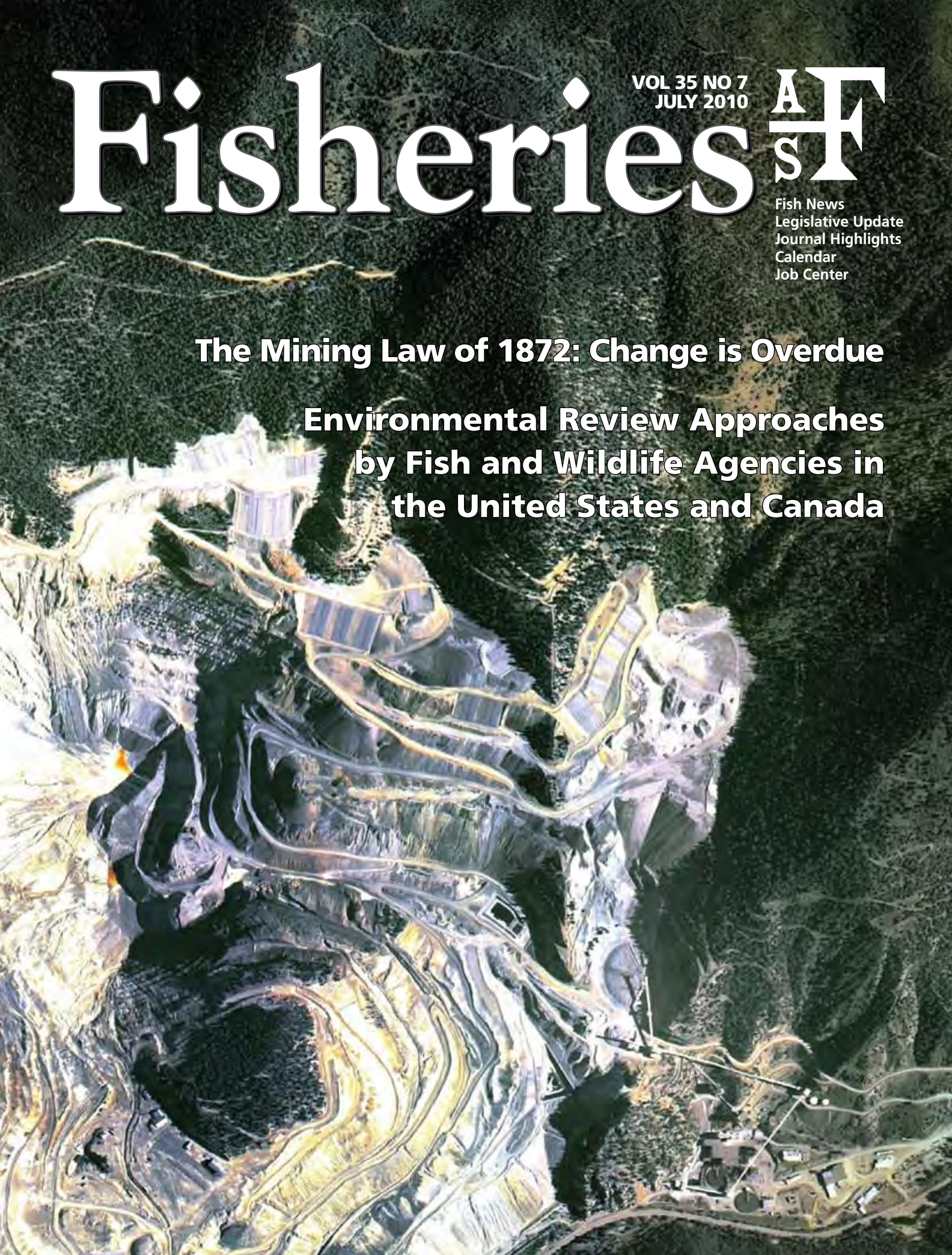

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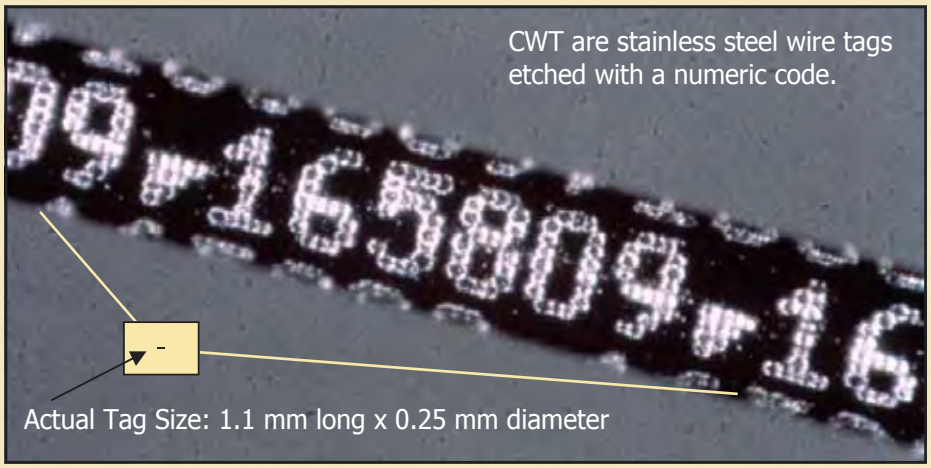

Millions of aquatic animals have been tagged with NMT's Coded Wire Tags™ (CWT). CWTs are unique in their nearly universal high retention rates, even through molts and metamorphosis. Retention for the life of the animal is the norm, and tags have been recovered 24 years after release.

Left: CWTs are implanted hypodermically. Because they are so small, CWTs have little effect on the host and can be used with life stages and species too small for other types of tags.

Right: CWTs are detected electronically, and then the code must be read under a microscope. Tags are usually removed from dead animals, (e.g. adult salmonids returning to spawn), but benign recovery is often possible. When sorting animals of wild or hatchery origin, detecting the presence or absence of the CWT may give all the data needed.

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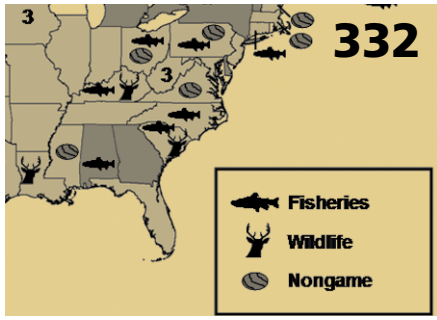

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CREDIT: Google Earth satellite image

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Addressing the Oil Spill in the Gulf of Mexico

The magnitude and impacts of the British Petroleum *Deepwater Horizon* tragedy in the northern Gulf of Mexico are virtually incomprehensible. The loss of life; the specter of oil drifting across the Gulf, washing onto beaches and barrier islands, and into bays, marshes, and estuaries; the resulting changes to ecological diversity and functions; and the associated social, cultural and economic impacts are horrific. Commercial, recreational, artisanal, and subsistence fisheries are already closed, or are likely to be closed, in vast areas of the Gulf, and potentially beyond the Gulf. Throughout the region, communities that were just recovering from the impacts of major hurricanes now face a menace that threatens core elements of life and livelihoods. Gulf Coast states are in a state of shock and that shock is rippling across a nation and into the rest of the world. It is a tragedy that transcends disaster. This is a catastrophe.

OK, now what? Well, as AFS president, here's my guidance. First of all, let's remember the Deep South's definition of "class": grace under pressure. This is not a time to wilt, weep, and slink back into shadows full of grief for treasures lost. This is not a time for anger, vindictiveness, or profiteering. This is not a time to engage in comfortable isolationism. It is, rather, a time to gather our collective forces, engage cool minds, generate clear thoughts, and envision a new reality…a new future…to make decisions on how to address that future and then get to work. We may shake our heads when we see images of individuals wiping oil off of a blade of marsh grass, scooping oil and tar balls off of a mud flat or sandy beach, or washing a bird. Down here we say, "That's like cutting a man's leg off with a chainsaw and then handing him a band-aid." But the reality is that people throughout the region, and many from beyond, are on the Gulf Coast working hard to address the spill, doing what they can with the resources that they have—even if all they have is an absorbent towel, a shovel, a bottle of drinking water, and the internal drive to keep slogging ahead.

The American Fisheries Society is absolutely engaged with the issue. As a professional scientific society our job is to make sure that there is timely exchange of science-based information. That's what we do. That's who we are. That's our identity. That's how we address issues. That's how we best support professionals in our ranks and beyond.

We have opened and are maintaining communication with colleagues in leadership positions who are working with the oil spill at the highest levels of government. We are offering our services to assist with scientific review of proposals and other documents, and identification of and linkages with AFS members and others who have the expertise and experience necessary to address the myriad issues that are and will be associated with the oil spill. As the issues become more comprehensively framed, there will likely be legislative action. As legislative action evolves, AFS will engage the process via congressional briefings, ensuring that science, as related to fisheries, is firmly positioned within that framework.

It is my intention that you be fully informed about issues regarding the oil spill. Accordingly, Jane Lubchenco, U.S. Undersecretary of Commerce for Oceans and Atmosphere and administrator of the National Oceanic and Atmospheric Administration (NOAA), will be one of the speakers during the Plenary Session of the AFS Annual Meeting in Pittsburgh, Pennsylvania (Monday morning, 13 September 2010). I am arranging a briefing on the oil spill that will be presented during the AFS annual business meeting (Tuesday afternoon, 14 September 2010). I have also asked the AFS Annual Meeting program chair (Pat Mazik) to open a special session to address the spill (Thursday afternoon, 16 September 2010). I am in charge of that session. We have developed and are maintaining a special link on the AFS website, in partnership with sister organizations in the Coalition of Natural Resource Societies (CNRS), so that you can be connected with the latest information on the oil spill.

This is a time of great testing, a time for action, and a time for professionalism of the highest order. It is a time for AFS to come forward to serve where needed with its leadership as the oldest and largest science-based fisheries organization in North America. We have done this before. We will do it again this time…with dignity and good order.

Aquatic life declines at early stages of urban development

The number of native fish and aquatic insects, especially those that are pollution sensitive, declines in urban and suburban streams at low levels of development — levels often considered protective for stream communities, according to a new study by the U.S. Geological Survey (USGS). The USGS studies examined the effects of urbanization on algae, aquatic insects, fish, habitat, and chemistry in urban streams in nine metropolitan areas across the country: Boston, Massachusetts; Raleigh, North Carolina; Atlanta, Georgia; Birmingham, Alabama; Milwaukee-Green Bay, Wisconsin; Denver, Colorado; Dallas-Fort Worth, Texas; Salt Lake City, Utah; and Portland, Oregon.

"When the area of driveways, parking lots, streets and other impervious cover reaches 10% of a watershed area, many types of pollution sensitive aquatic insects decline by as much as one-third, compared to streams in undeveloped forested watersheds," said Tom Cuffney, USGS biologist. "We learned that there is no 'safezone,' meaning that even minimal or early stages of development can negatively affect aquatic life in urban streams."

These USGS studies also show that land cover prior to urbanization can affect how aquatic insects and fish respond to urbanization. For example, aquatic communities in urban streams in Denver, Dallas-Fort Worth, and Milwaukee did not decline in response to urbanization because the aquatic communities were already degraded by previous agricultural land-use activities. In contrast, aquatic communities declined in response to urbanization in metropolitan areas where forested land was converted to urban land, areas such as Boston and Atlanta.

Comparisons among the nine areas show that not all urban streams respond exactly the same. This is mostly because stream quality and aquatic health reflect a complex combination of land and chemical use, land and storm-water management, population density and watershed development, and natural features, such as soils, hydrology, and climate.

A tale of two atolls

To gain new insights on the ecology of coral reef fishing, Fiorenza Micheli, a professor of biology at Stanford University's Hopkins Marine Station, and a team of Stanford researchers are taking advantage of an ongoing "natural experiment" at two isolated Pacific atolls—Palmyra and Tabuaeran (or Fanning Island)—located about 1,000 miles south of Hawaii. Separated by just 250 miles of ocean, the two atolls are worlds apart in terms of fishing pressure. Palmyra, a protected U.S. wildlife refuge, is virtually uninhabited and bars fishing along its shores. But Tabuaeran, part of the island nation of Kiribati, is home to about 2,500 people who depend on the reef for food and income. Fieldwork at Palmyra and Tabuaeran began in 2007. Preliminary results from an underwater snorkeling census suggest that the two atolls host very different communities of animals.

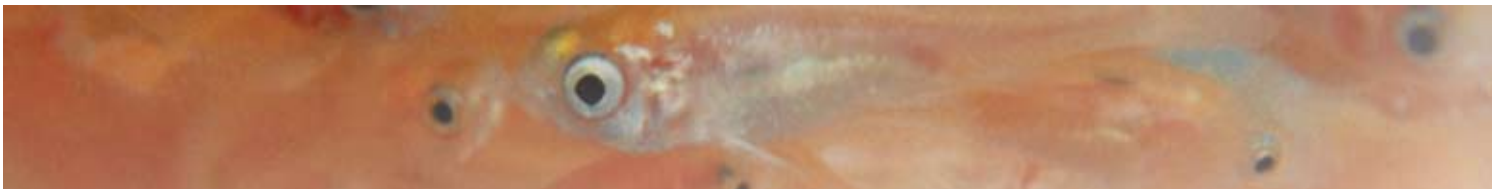
"Palmyra has some of the highest densities of sharks and other large fish of any coral reef in the world," said Douglas McCauley, a graduate student working with Micheli. "That's clear within seconds of jumping in the water there."

But at Tabuaeran, where fishing is a way of life, sharks and other large species are in short supply, McCauley said. "That was surprising, because Tabuaeran is a somewhat lightly populated island," he explained. "Most people arrived only a few decades ago, and fishing there is still very artisanal in nature."

Trophy catches like sharks and the 100-lb. bumphead parrotfish were the first to decline, he said. Highly prized by Tabuaerans, parrotfish have bottomless appetites that can alter the architecture of their coral homes. "The parrotfish's large size allows it to break off and crunch up whole branches of coral," McCauley said. "It plays a unique and important role in reef ecology that's simply not achieved by other fish species."

Sharks are also important for healthy coral reef ecosystems. But sharks tagged at Palmyra have been caught by fishermen at reefs hundreds of miles away, McCauley said. By sampling shark tissue for carbon and isotope ratios, Stanford marine scientist Rob Dunbar confirmed that these top predators have been straying far from their home reefs.

"At Palmyra, we're finding that some sharks don't stay at home like we thought, so managers can't protect them outside the sanctuary borders," McCauley said. "It seems



that effective management strategies for gray reef sharks and other similarly wide-ranging species will need to be thought out at much larger scales."

Coal ash spill fish still healthy

Fish exposed to fly ash at the site of the Tennessee Valley Authority (TVA) December 2008 coal ash spill are faring better than some expected, researchers have learned. Oak Ridge National Laboratory (ORNL) in collaboration with TVA has found that while small amounts of some contaminants from the fly ash spill have been taken up by fish in the Clinch and Emory rivers, to-date, the fish collected downstream from the spill appear healthy relative to fish from unimpacted sites.

After the spill deposited 5.4 million cubic yards of coal ash into the Emory River and an embayment adjacent to the Kingston Fossil Plant, the public was concerned that the ash and associated chemicals, particularly arsenic and selenium, could be a health hazard to local residents and also to fish and wildlife. While there are historical records from Department of Energy-sponsored studies in some locations for which to compare water quality and fish tissue concentrations pre- and post-spill, determining potential risk to the health of fish populations is more complicated.

"Fish populations can be impacted by a range of factors at this site that are unrelated to the spill, including food and habitat availability, variations in water quality characteristics, presence of historical contaminants such as mercury and PCBs, and interactions with other biota in the reservoir," said Mark Peterson, leader of ORNL Environmental Sciences Division's Ecological Assessment Team and the Aquatic Ecology Laboratory.

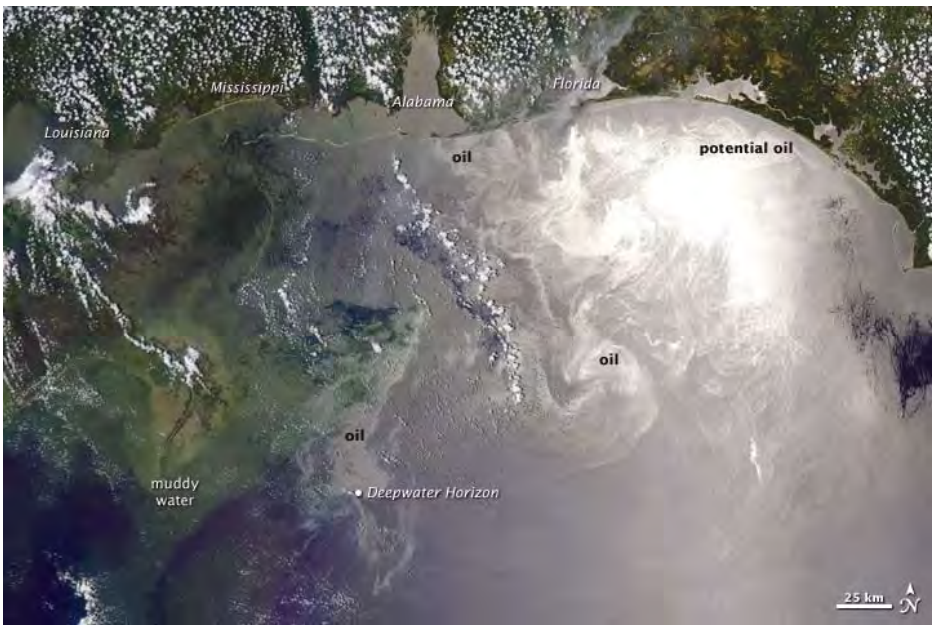
Further complicating interpretation of fish health condition is that some fly ash-related contaminants may not cause effects that can be easily measured immediately after the spill. Contaminants like selenium are accumulated via the food chain and it can take some time for fish to reach equilibrium with the environment, or for contaminant exposure to result in measurable negative impacts to fish populations. The ongoing second year of fish sampling will be especially important in assessing the longer-term environmental impacts of the spill, researchers said.

A key contaminant of concern is selenium, which at high concentrations is known to cause reproductive problems in fish, including impacts to fish early life stages. A project led by Mark Greeley will be evaluating fish embryos and larvae exposed to fly ash in large laboratory tanks. Beginning in May and extending through the summer, this study will take up a large part of ORNL's 9,000-square-foot Aquatic Ecology Laboratory and is unique in its attempt to evaluate exposure and effects over longer time scales in a controlled environment.

Oil slick captured in satellite photo

On 12 June 2010, oil from the former Deepwater Horizon well was particularly visible across the northern Gulf of Mexico when the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite captured this image at 1:55 p.m. CDT. Oil appears to have reached beaches and barrier islands in Alabama and the western Panhandle of Florida.

Close to the location of the well, the oil appears gray, but to the northeast, it is bright silver. The increased brightness does not necessarily mean the oil is thicker or more concentrated there; it may simply be that the oil is located in the sunglint region of the image—the spot where the sun's reflection would appear if the water surface was as perfectly smooth as a mirror. According to NASA, normally waves blur the sun's reflection, diffusing its brightness. Oil smoothes the water surface, making it a better mirror. When the slick appears in that part of the image, viewing conditions are ideal, and the patches and ribbons of oil are extremely bright. When the oil slick is not in the sunglint part of the image, however, it may be imperceptible against the dark background of the ocean.



JOURNAL HIGHLIGHTS: TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY

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May 2010

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[Note] **High-Resolution Melting Analysis for the Discovery of Novel Single-Nucleotide Polymorphisms in Rainbow and Cutthroat Trout for Species Identification.** Molly T. McGlauflin, Matt J. Smith, Jonathan T. Wang, Sewall F. Young, Neng Chen, Yong C. Lee, Carita Pascal, Lisa W. Seeb, Junko Stevens, and James E. Seeb, pages 676-684.

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[Book Reviews] **Atlas of Fish Histology** and **Enclosing the Fisheries: People, Places, and Power,** pages 925-928.

UPDATE: LEGISLATION AND POLICY

Elden Hawkes, Jr.

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House hearing on Gulf Coast oil spill

On 15 June 2010, the U.S. House Natural Resources Committee, Subcommittee on Insular Affairs, Oceans and Wildlife held a hearing entitled "Ocean Science and Data Limits in a Time of Crisis: Do NOAA and the Fish and Wildlife Service (FWS) have the Resources to Respond?" The hearing featured testimony from various agencies, non-governmental organizations, and academic personnel. These participants included acting NOAA Assistant Administrator Dave Kennedy, U.S. Geological Survey Director Marcia McNutt, and Merv Fingas of the Committee on Oil in the Sea.

Kennedy stated that NOAA has closed oil-impacted areas to commercial fishing in order to ensure the safety of commercial fisherman and that of consumer seafood. NOAA scientists are currently taking water and seafood samples to determine which areas are safe for commercial fishing. He further stated that the long-term effects on species and habitats will include the oil remaining on the shoreline and in wetlands and other environments for years. He elaborated that research is also needed to determine the effects of oil and dispersants that are suspended in the water column on mid-water and pelagic species, benthic habitats, as well as other communities in the ocean. He did express optimism about nature's ability to recover in the marshes, due to the oil being highly degraded by the time it makes it to the marsh areas.

McNutt stated that a wide range of data and analyses will be needed in the short term as well as in the long term to fully understand the extent and trajectory of the oil spill. These data and analyses will provide vital information on the various impacts of the oil including information on migratory birds and other fish and wildlife that might enter the oiled area. Fingas commented that the factors controlling the biological and physical processes which determine the ultimate fate of dispersed oil are poorly understood. He further stated that dispersed oil could accumulate in more significant areas, or could be consumed by plankton in the water column and enter the food chain.

The second panel of the hearing included testimony from Chris Reddy of the Coastal Oceans Institute and Christopher D'Elia, dean of the Louisiana State University School of the Coast and the Environment. Reddy stated that every day the oil content and composition are changing and moving in the surface and subsurface, and eventually once the leak is stopped, the oil will diffuse and weather to levels where it can no longer be accurately measured. This knowledge about where the oil is and how it is changed is key to understanding process acting on the oil and also estimating damages to wildlife exposed to oil.

D'Elia testified that most of the research, monitoring, and modeling that is now being conducted seems to be focused on offshore concerns pertaining to the fate and effects of oil and dispersant. However, since Louisiana's wetlands constitute 40% of the national total, and it is the second highest state in terms of seafood production, there needs to be an accelerated effort to understand the impacts of the spill on living resources from the continental shelf to coastal wetlands. All participants acknowledged short and long term study is needed to understand the full and potentially long lasting impacts of the oil spill.

NOAA Reopens Fishing Area in the Gulf

On 15 June, NOAA opened 339 square miles of previously closed fishing area off the Florida panhandle. The area was initially closed on 5 June as a precaution because oil was projected to be within the area over the next 48 hours. However, the oil did not move into the area. The reopened area which includes the northern boundary now ends at the Florida federal-state water line on the east side of Choctawhatchee Bay. At press time, the closed area represents 78,264 square miles, which is approximately 32% of Gulf of Mexico federal waters, leaving 68% of Gulf federal waters available for fishing.

Research and Aquaculture Opportunity and Responsibility Act Introduced

In May 2010, the Research and Aquaculture Opportunity and Responsibility Act (S. 3417) was introduced into the Senate by Senator David Vitter (R-LA). According to Vitter, the bill would provide relief to struggling marine ecosystems, including those threatened by the recent *Deepwater Horizon* oil spill in the Gulf of Mexico. The bill would delay the approval of plans, permits, rules, and regulations for offshore aquaculture permits for a period of three and a half years. It would also require the U.S. Secretary of Commerce to conduct a thorough report of the environmental and economic effects of open ocean aquaculture, including the environmental effects on native fish species and the economic effects on the commercial and recreational fishing industries as well as coastal communities. The bill would also require a report on the economic potential of land-based aquaculture systems. The Research and Aquaculture Opportunity and Responsibility Act has been referred to the Senate Committee on Commerce, Science, and Transportation.

PERSPECTIVE: POLICY

The Mining Law of 1872: Change is Overdue

Satellite image of the Sumpter Mine near Sumpter, Oregon (from Google Earth). This is an abandoned placer gold mine occupying 14 km of the Powder River floodplain and destroying its channel.

This article is a product of the Environmental Concerns Committee of the Western Division of the American Fisheries Society.

Carol Ann Woody, Robert M. Hughes, Eric J. Wagner, Thomas P. Quinn, Leanne H. Roulson, Lori M. Martin, and Kitty Griswold

Woody is the proprietor of Fisheries Research and Consulting.

Hughes is a senior research scientist with Amnis Opes Institute, a visiting professor in the Laboratory of Fish Biology at Universidade Federal de Lavras, and a courtesy associate professor in the Department of Fisheries and Wildlife at Oregon State University. He can be contacted at hughes.bob@epa.gov.

Wagner is a senior scientist at the Fisheries Experiment Station of the Utah Division of Wildlife Resources.

Quinn is a professor in the School of Aquatic and Fishery Sciences at the University of Washington.

Roulson is president of the Western Division of the American Fisheries Society.

Martin is president elect of the Western Division of the American Fisheries Society.

Griswold is an affiliate professor in the Department of Biological Sciences at Idaho State University.

ABSTRACT: Hardrock mining for metals has been, and is, an economically important land use in all western U.S. states. However, metals contamination associated with mining can be highly toxic to aquatic life, the composition of metal-bearing rock often leads to acid mine drainage and increased concentrations of dissolved metals, and mine-related disruptions to soil and water often produce excess fine sediments and altered stream flows. Such environmental degradation leads to large numbers of perpetually polluted streams and impaired aquatic life and fisheries. The primary U.S. law governing mining, the General Mining Law of 1872, was passed during the pick-and-shovel era to encourage economic growth; however, modern mining processes are massive in extent, highly mechanized, and incorporate additional toxic chemicals for leaching metals from ores. We provide an overview of hardrock mining impacts to aquatic life, a set of mining case studies, and suggestions for amending U.S. mining law. Our hope is that this article will lead to improved management and rehabilitation of existing mine sites and sufficient protections for the aquatic life and fisheries likely to be disturbed by future mines.

La ley de minería de 1872: un cambio retrasado

RESUMEN: la minería metalúrgica subterránea ha sido, y aún es, una actividad económicamente importante en cuanto a uso de suelo en los estados del oeste de los Estados Unidos de Norteamérica. Sin embargo, la contaminación por metales asociada a la minería puede ser altamente tóxica para la vida acuática, la composición de las rocas que contienen metales suele derivar en drenaje ácido de mina e incrementar la concentración de metales disueltos y las alteraciones en el suelo y agua relacionados con la minería pueden producir un exceso de sedimentos finos que alteran el cauce de los ríos. Tal degradación ambiental da lugar a un considerable número de cauces permanentemente contaminados, lo que pone en peligro tanto a la vida acuática como a las pesquerías. La ley directriz de minería de los Estados Unidos de Norteamérica, La Ley General de Minería de 1872, fue decretada durante la época de "pico y pala" con el fin de promover el crecimiento económico; no obstante, los actuales procesos de minería son extensivos, altamente mecanizados e incorporan químicos tóxicos para lixiviar metales a partir de minerales. En este trabajo se presenta una revisión de los impactos de la minería subterránea en la vida acuática, un grupo de minas como casos de estudio y sugerencias para modificar la Ley de Minería de los Estados Unidos de Norteamérica. Nuestra esperanza es que la presente contribución de lugar a un mejoramiento en el manejo y rehabilitación de las minas existentes y a suficientes medidas de protección para la vida acuática y las pesquerías que puedan ser alteradas por la explotación de más minas en el futuro.

Introduction

The U.S. General Mining Law of 1872 governs mineral extraction (e.g., uranium, copper, gold, etc.) on about 147 million ha of public lands in the western United States, an area equal to approximately 38% of the nation (National Academy of Sciences 1999). The 1872 law makes mining a priority use on most of these lands, guarantees priority rights for minerals extraction, and was originally intended to encourage economic growth by conveying public lands to private owners for the purpose of mineral extraction. In practice, applications to mine public lands often cannot be denied despite deleterious impacts to other resources. Under this law, a miner can purchase (patent) the surface estate and mineral rights to federal land for $1–2/ha by demonstrating the presence of a valuable mineral deposit. Currently, there is a year-to-year moratorium on new patents but this is not a permanent solution. Due diligence, i.e., $100 of annual spending on mining activity, is required, but even if millions of dollars worth of minerals are extracted from these public lands, no fees or royalties are required in return (Bakken 2008), resulting in an estimated annual loss of revenue of $160 million to the U.S. government (Pew Foundation 2009). This law remains in effect, despite serious environmental and economic issues caused by hardrock mining practices and a shift in priority use on federal lands. In addition to the Mining Law of 1872, other federal laws apply to regulate the effects of hardrock mining (e.g., Clean Water Act, National Environmental Protection Act). However, because of the magnitude of the issue and the antiquated nature and primacy of the Mining Law of 1872 a comprehensive reform of that law is needed. Our focus in this article is hardrock metal mining, the extraction of metals found in hard rock geological formations. Placer mining of alluvial deposits is also governed under the Mining Law of 1872 and is associated with damage to aquatic life (e.g., Sumpter Mine on the Powder River, Oregon), but is not a focus of this article. Related concerns also pertain to surface coal mining, which is regulated by a different under-protective law (Surface Mining Control and Reclamation Act of 1977).

Impacts to fisheries from hardrock metal mining result from both abandoned and active mines. The U.S. Environmental Protection Agency (USEPA) estimates that there are 500,000 abandoned mines in the United States; 40% of western headwater streams are polluted from mining. Clean-up costs are estimated at $32–72 billion (USEPA 2000). Under the Mining Law of 1872, mining companies are not required to provide adequate insurance for clean up and reclamation of federal lands. Perhaps more troubling, many mines slated for clean-up require long-term or perpetual water treatment (USEPA 2004). Such ongoing water contamination threatens drinking water supplies, valuable fisheries, wildlife, agriculture, recreation, tourism, human health, and industries that rely on clean water. In effect, the 1872 law shifts wealth from the United States public to mining companies, and shifts liability from those companies to the taxpayer (USEPA 2004).

Most high-grade, accessible mineral deposits in the United States are already exploited; therefore, new hardrock mining ventures generally focus on low-grade ore deposits. The Mining Law of 1872 and relatively high prices allow for low-grade ore to be marginally profitable because mining corporations are not required to purchase sufficient reclamation insurance. If there is a disaster or massive reclamation expense, they can simply abandon the site and declare bankruptcy. The quantity of waste material generated can be massive, with mine waste areas covering hundreds of hectares and containing tens to hundreds of millions of tons of spoil. For example, the proposed Pebble Mine in the headwaters of Bristol Bay, Alaska, has an estimated mineral resource of less than 1% copper, gold, and molybdenum; 99% of the estimated 7.5 billion tons to be excavated are projected to be acidic waste that will remain on site in perpetuity (www.dnr.state.ak.us/mlw/mining/largemine/pebble/index.htm). The processes used to access and extract minerals in modern mining operations create extensive ecosystem disturbance that can lead to long-term adverse effects to ground water, aquifers, surface water, aquatic resources, terrestrial vegetation, wildlife, soils, air, and cultural resources. Typical environmental effects are associated with:

Access. In remote areas, road construction and increased human activity lead to a variety of ecological effects, either directly related to the roads or the increased number of people accessing the area.

Earth disturbance. To reach and extract desired minerals, most hardrock mining operations displace massive amounts of soil and rock, either at the surface or underground.

Waste piles. Waste rock, spent ore, or tailings are generally disposed of in large heaps, ponds, or tailing impoundments, which can occupy hundreds of hectares. If these facilities are poorly designed, improperly constructed, or prematurely abandoned, their failure can lead to long-term contamination of surface and ground water.

Toxic dust. Toxic dust from dried-up tailings ponds, open pits, roads, and trucks hauling crushed ore can be carried by wind far from the mine site and contaminate surface and ground water as well as air and terrestrial vegetation.

Toxic processing chemicals. Desired metals are extracted or leached using chemicals that can be toxic if released into the environment (e.g., sodium cyanide, mercury, sulfuric acid, xanthates).

Acid mine drainage (AMD). Exposure of sulfide minerals, frequently associated with metallic ores, can create acidic conditions and leach metals into local waters. This AMD constitutes one of the most serious and common water pollution problems associated with mining (USEPA 1994; Sherlock et al. 1995); perpetual treatment may be required.

Water and soil contamination. Even without acidic conditions, metals can be discharged from mine sites and enter surface water, ground water, and soils. This can cause significant damage to aquatic life, vegetation, and terrestrial wildlife, and poses a hazard for human health. Toxic loading of stream waters can alter the assemblage structure of invertebrates (Clements et al. 2000; Maret et al. 2003), invertebrates and fish (Hughes 1985), and fish behavior (DeCicco 1990). Those toxic metals also contaminate water and sediment and bioaccumulate in fish tissues (Harper 2009), leading to reduced fitness or death (National Academy of Sciences 1999).

Flow alteration. Impoundment of water and stream diversions can lead to loss of habitat for fish spawning and rearing.

The perception that modern mining techniques are vastly improved over historic methods was recently challenged by a comprehensive study of modern U.S. mines (Maest et al. 2005; Kuipers et al. 2006). For example, the study compared predicted water quality impacts to observed impacts found at a sample of 25 U.S. mines. In summary:

100% of mines predicted compliance with water quality standards prior to operations (assuming pre-operations water quality was in compliance).

76% of mines exceeded water quality criteria as a result of mining.

64% of mines employed mitigation measures that failed to prevent water quality contamination.

Examples of mining impacts on aquatic resources

Without responsible laws and policy, and adequate reclamation and remediation, existing and future hardrock mines pose a risk to fish-bearing waters, in addition to the legacy effects of abandoned mines. Numerous examples of valuable fisheries and aquatic ecosystems harmed by hardrock mining exist across the western United States. High metals prices and demand for raw materials have created a modern minerals rush, with existing mines expanding, new claims being staked on public lands, and old mines reopening. Select case studies are presented to exemplify frequent compatibility issues existing between fisheries resource conservation and hardrock mining. These are not rare occurrences; USEPA (2004) identified 156 hardrock mining sites in the United States with past or potential Superfund liabilities of $1 million or more each.

Alaska

Red Dog Mine

The Red Dog Mine is located in northwest Alaska, near Kotzebue, and has been in operation since 1989 (www.reddogalaska.com/). It is the largest zinc mine in the world, providing 10% of the world's zinc (http://northern.org/news/epa-rescinds-key-red-dog-mine-permit-limits; Szumigala et al. 2009), and has polluted Wulik River tributaries with zinc, lead, selenium, and cyanide. The Wulik River is the drinking water source for the native village of Kivalina and the location of a subsistence and sport fishery for Pacific salmon (*Oncorhynchus* spp.), Dolly Varden (*Salvelinus malma*), and Arctic grayling (*Thymallus arcticus*). Observed shifts in overwintering sites by Dolly Varden were reported by DeCicco (1990; 1996), coincident with increased metals in 1989. Natural levels of zinc are high (approximately 10 times the state water quality standards in 1989), but rose to as much as 200 times higher once mining began in 1989. Because natural levels of minerals are high, the regulatory framework for water quality on Red Dog Mine is complex. However, tools to differentiate naturally-occurring metals vs. anthropogenic sources are available (Kelly and Hudson 2007). High levels of metals associated with dust from haul trucks were measured as highly toxic and are potentially affecting the entire watershed (Ford and Hasselbach 2001). In addition, the mine has been subject to numerous regulatory actions and currently the permit to expand the mine has been rescinded. In 1991, the mine operator was cited for 134 violations of effluent limitations for metals and pH, and spent $11 million in 1991 to route Red Dog Creek around the mine and isolate it from seepage (USEPA 1991). Dead fish from the Wulik River, approximately 40 km downstream from the mine, were discovered periodically by the public (ADNR 2004), suggesting that water chemistry samples were insufficiently protective of aquatic life, which is similar to what was concluded by Ohio EPA (1990) in its comparison of chemical and biological criteria. The mine operators paid a $1.7 million penalty for illegal discharges in 1997, and in 2008 agreed to pipe mine wastes to the Chukchi Sea or pay an additional $8–20 million penalty.

Kensington Mine

The U.S. Army Corps of Engineers approved a permit application by Coeur Alaska to deposit up to 4.5 million tons of gold mine tailings from the Kensington Mine into Lower Slate Lake, Alaska, which hosts Dolly Varden and threespine stickleback (*Gasterosteus aculeatus*). The permit was approved even though Coeur Alaska agreed in its application that these two fish species would be extirpated from the lake by the waste. The U.S. Supreme Court upheld the Corps' decision in 2009 because of conflicting and confounding laws and regulations governing when mine waste is treated as fill or as pollutant discharge (*Couer Alaska, Inc. vs. Southeast Alaska Conservation Council*). The Supreme Court decision sets a legal precedent that may allow other mining operations to avoid adherence with Clean Water Act water quality criteria by petitioning the Corps of Engineers to redefine pollutant-containing waste material as fill. This is a key issue also related to mountaintop removal and valley fill for surface coal mining in the Appalachians (USEPA 2009b).

Arizona

Pinto Valley Mine

Pinto Valley Mine, an open pit copper mine in Gila County, began operations in 1972, withdrawing water from the local aquifer and discharging to an intermittent section of Pinto Creek. Copper and zinc concentrations exceeded Arizona aquatic life criteria, metals bioaccumulated, and fine sediments buried natural substrates by an average of 15 cm, converting the reach from riffles and pools to a homogeneous run. Mountain sucker (*Catostomus platyrhynchus*) and western mosquitofish (*Gambusia affinis*) were greatly reduced in the polluted reach and 20 macroinvertebrate taxa were eliminated within 4 years. During spills and high flow events, dissolved metals were sufficient to kill fish (Lewis and Burraychak 1979).

California

Iron Mountain Mine

Iron Mountain Mine was a copper mine in operation from the 1860s through 1963 in northern California, near Redding (www.epa.gov/superfund/eparecovery/iron_mountain.html). This mine became infamous for developing the most acidic water in the world with a pH of -3.6 and it is estimated that the AMD from this site will persist for at least 3,000 years (www.epa.gov/aml/tech/imm.pdf; National Academy of Sciences 1999). Water from Iron Mountain Mine entered adjacent streams and eventually Keswick Reservoir, a run-of-the-river reservoir on the Sacramento River. Streams draining Iron Mountain Mine are devoid of aquatic life downstream of the mine. As early as 1900, the California Fish Commission investigated fish kills in the Sacramento River attributed to pollution from the mine. State records document more than 20 fish-kill events in the Sacramento River downstream of Iron Mountain Mine since 1963. AMD from Iron Mountain Mine killed 100,000 or more fish on separate occasions in 1955, 1963,

and 1964; and at least 47,000 trout died during a one-week period in 1967. The AMD from Iron Mountain Mine has harmed four runs of Chinook salmon (*O. tshawytscha*), steelhead (*O. mykiss*), and resident rainbow trout, as well as hundreds of benthic species (Hallock and Rectenwald 1990). The National Marine Fisheries Service lists the winter-run and spring-run Chinook salmon, which spawn in the Sacramento River near Redding, as endangered and threatened, respectively, pursuant to the Endangered Species Act. Iron Mountain Mine is now a Superfund site.

Leviathan Mine

Leviathan Mine began operations in 1863 on the eastern side of the Sierra Nevada (Alpine County), and from 1952 to 1962 (www.epa.gov/superfund/sites/npl/nar1580.htm) consisted of an open pit mine covering about 101 ha. Acid mine drainage developed during operations; additional contaminants include aluminum, arsenic, chromium, copper, iron, nickel, selenium, and zinc. The AMD flows into Leviathan Creek at numerous points, devastating aquatic life until Leviathan Creek joins the East Fork of the Carson River. For most of the year, roughly half of the flow in Leviathan Creek is composed of AMD (http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/84e3d3f74809433788257233007 94f02/93009e9e968d570788257007005e9445!OpenDocument). The Aspen Seep releases AMD containing elevated levels of aluminum, copper, iron, and nickel into Aspen Creek. Each of these metals has historically exceeded EPA water quality criteria for aquatic life by over 500 times. Since 1983, California has invested millions of dollars to contour the pit and surrounding waste piles, channel Leviathan Creek around the major disturbed area, and capture the most concentrated flow in a series of ponds. Leviathan Mine is now a Superfund site.

Colorado

Summitville Mine

The South Mountain mineral reserves, located in southwestern Colorado near Del Norte, were mined from 1984 to 1992 as a gold and silver open pit heap leach operation. Acid mine drainage and cyanide releases from the open-pit mine and heap leach pad were lethal to all fish and aquatic life for 29 km downstream in the Alamosa River (www.epa.gov/region8/superfund/co/summitville/). Summitville Mine was determined by the U.S. Geological Survey (USGS) to be the dominant source of aluminum, copper, iron, manganese, zinc, and acidity in the Alamosa River (http://pubs.usgs.gov/of/1995/ofr-95-0023/summit.htm#King.1995a). As of 2005, water quality criteria for aquatic life were regularly exceeded, partly as a result of contaminated ground water inputs as well as release of contaminated water from the Summitville Dam impoundment. The mine operator declared bankruptcy in 1992 and the USEPA assumed control of the site as part of an Emergency Response Removal Action. The mine was listed as a Superfund site in 1994; cleanup costs have exceeded $150 million and perpetual water treatment is required.

Idaho

Coeur d'Alene Mining District

The Coeur d'Alene Mining District is located in the panhandle of northern Idaho. This mining area has produced lead, silver, gold, and zinc from the 1880s to the present. Widespread contamination of water and soils resulted from numerous mining operations. The South Fork Coeur d'Alene River and tributaries, Coeur d'Alene River and lateral lakes, Lake Coeur d'Alene, and the Spokane River are associated with the Bunker Hill-Coeur d'Alene Basin Superfund site, a "mining megasite" (National Academy of Sciences 1999). Tributaries to the North Fork Coeur d'Alene River are also water quality impaired, associated with mining. Water quality, biological, and hydrologic conditions have been affected, and reduced native species diversity and abundance have been measured within study areas downstream of mined areas compared to non-mined sites because of metals contamination (Ellis 1940; Hoiland et al. 1994; Maret and MacCoy 2002). Metals-contaminated water also has impaired westslope cutthroat trout (*O. clarkii lewisi*) fisheries and contributed to the extirpation of bull trout (*Salvelinus confluentus*) from the Coeur d'Alene Basin upstream of Lake Coeur d'Alene. Spawning migrations of introduced Chinook salmon have also been affected, which has implications for their long-term sustainability and survival (Goldstein et al. 1999). The Idaho Department of Health and Welfare (IDHW 2003) issued a fish consumption advisory for Lake Coeur d'Alene based on lead, arsenic, and mercury concentrations in fish flesh. The advisory cites historical mining practices in the Coeur d'Alene watershed as the source of the contaminated soil and water in the area. The fishes sampled included bullhead (*Ameiurus* sp.), kokanee (*O. nerka*), and largemouth bass (*Micropterus salmoides*). Those species were chosen because they are consumed extensively by tribal anglers (IDDH 2003). Cleanup costs to the taxpayers as of 2001 were $212 million (Steele 2001). Recent analyses estimate attainment of water quality goals in just the upper basin of this mining district could take several centuries at costs of $1–2 billion (http://yosemite.epa.gov/R10/CLEANUP.NSF/9a80cd5553c69ff588256d14005074ad/97c56add3adf94678825755900771691/$FILE/Draft_Upper%20CDA%20Basin%20FFS_Report_Executive_Summary%282%29.pdf).

Blackbird Creek Mine

Blackbird Creek Mine covers approximately 336 ha of private patented mining claims and 4,047 ha of unpatented claims, all within the Salmon National Forest, Idaho. Active mining for cobalt and copper occurred from the late 1800s to the 1980s, but the mine is currently dormant. Shaft and open pit methods were used and tunnels and waste rock piles occur along 13 km of Meadow and Blackbird creeks. Waste piles include as much as 2 million m^3 of material. Acid drainage from mines and spoil, and high levels of arsenic, copper, cobalt, and nickel, have been documented downstream in both surface water and sediments; copper levels exceeded USEPA water quality criteria (www.atsdr.cdc.gov/HAC/PHA/blackbird/bla_p3.html; www.epa.gov/superfund/sites/npl/nar1369.htm). Panther Creek, downstream of Blackbird Creek Mine, once supported fish, but by 1960, steelhead and Snake River spring/summer Chinook salmon were extirpated from it. Contaminants released at Blackbird Creek Mine were indicated as causal (www.darrp.noaa.gov/northwest/black/index.html). Blackbird Creek Mine is a registered public health hazard and a designated Superfund site.

Satellite image of the Berkeley Pit and tailings pond near Butte, Montana (from NASA). The long axis of the site is 7.5 km.

Montana

The Berkeley Pit

The Berkeley Pit operated from 1955 to 1985 as an open pit copper sulfide mine in Butte, Montana. The excavated mine pit is 542 m deep and 1.4 km across the rim. The pit filled with water once mining was completed, and it now contains about 1 trillion L of acidic (pH 2.7–3.4) water and metals (aluminum, arsenic, cadmium, copper, zinc; Twidwell et al. 2006). Over 193 km of the Clark Fork River and flood plain, and Milltown Reservoir, are contaminated by approximately 5 million cubic meters of contaminated mine tailings that washed downstream from Butte and collected behind the Milltown Dam (removed in 2008). Scientists with USEPA concluded that the metals behind the dam were contaminating local drinking water wells and causing large fish kills during high water events and ice scours (http://cfrtac.org/clarkforksite.php). Silver Bow Creek, which drains Butte, is nearly devoid of aquatic life (Hughes 1985). The pit and much of the surrounding mine facilities, including the Clark Fork River, form the largest Superfund site in the United States. Reclamation and remediation are ongoing and perpetual water treatment is required.

McLaren Mine

McLaren Mine in Cooke City, Montana, operated from 1933 to 1953 to extract gold, silver, and copper through use of heap leach cyanide methods (http://serc.carleton.edu/research_education/nativelands/ftbelknap/environmental. html). In 1950, a tailings dam failure on Soda Butte Creek released about 115,000 m^3 of metal laden effluent downstream. As much as a 60-cm-deep layer of tailings were deposited as far as 8 km downstream (Ecology and Environment 1988). Copper concentrations, documented as highly toxic to aquatic life (Sorensen 1991; Eisler 2000; Hecht et al. 2007), are elevated in macroinvertebrates and fish. Greater chronic metals toxicities occur in spring runoff compared to fall base flows (Nimmo et al. 1998; Marcus et al. 2001), indicating continued leaching. Soda Butte Creek was known for "fast fishing and large trout" during the late 1800s, but fishing opportunities declined with its water quality (USFWS 1979).

Zortman-Landusky Mine

The Zortman-Landusky gold and silver mine began operation in the 1880s. Mining was extended onto lands purchased from the Fort Belknap Indian Reservation in 1895 (Klauk 2009). Modern heap leach activity began in the late 1970s, and an environmental impact statement (EIS) was completed by the state in 1979, when the mine covered 109 ha. AMD impacts resulted from several spills, including a 2,953 L leak of cyanide-tainted solution from a containment pond in 1982. A rupture in a section of piping used in the mine's cyanide sprinkling system expanded the spill, releasing 196,841 L of cyanide solution onto lands and creeks (Klauk 2009). Local tap water revealed cyanide concentration levels above drinking water standards and the community's local water system was shutdown. Over the next two years, eight separate cyanide spills occurred (Klauk 2009). In September 1986, 75 million L of treated cyanide solution were released onto 7 ha of land when a solution pond was at risk of overflowing after a heavy rainstorm. The spills have contaminated streams and ground water throughout the area. By the late 1990s, total land disturbance reached almost 486 ha with about half on Bureau of Land Management (BLM) lands. In 1998, Zortman-Landusky, now consolidated with Pegasus Gold Ltd., filed for bankruptcy. Despite a $36 million settlement from a lawsuit filed under the Clean Water Act in 1996, the agencies had to file a notice of an $8.5 million reclamation bond shortfall with the bankruptcy court (Klauk 2009). Although $1.0 million of the shortfall was eventually awarded, the bankruptcy was finalized in December 2003, and BLM and the Montana Department of Environmental Quality assumed responsibility for water storage and treatment in perpetuity (BLM 2010). The BLM (2010) estimated that it will cost approximately $528,000/y to manage the site. In addition, the state expects to spend $240,000 annually on AMD treatment through 2017, and has established a fund to pay for treatment beyond 2017.

Nevada

Caselton Mine

The Caselton Mine in Lincoln County began production in 1863 for silver, gold, lead, zinc, copper, and manganese. Part of the site continues to be marginally active, but most of it has been abandoned (IAMLET 1999). The value of metals produced was approximately $130 million, and approximately 1,147,000 m^3 of tailings remain, with an estimated cost of $11 million for on-site reclamation. That estimate does not include downstream treatment of contaminants.

New Mexico

Questa Mine

The Questa Mine Superfund site is located northeast of Santa Fe, and includes an active molybdenum mine, mill, tailings ponds, and tailings pipeline, as well as the Red River (USEPA 2010). The open pit mine opened in 1965 and the lower 13 km of the Red River were deemed "dead" by the New Mexico Water Quality Commission in 1994. Numerous pipeline breaks, AMD from the tailings ponds, aluminum, arsenic, cadmium, chromium, cobalt, fluoride, iron, lead, manganese, sulfate, and zinc have

Satellite image of the Questa Mine near Questa, New Mexico (from Google Earth). The long axis of the site is 3.4 km.

contaminated ground water and the Red River floodplain. Such contaminants threaten the Red River fisheries for brown trout (*Salmo trutta*) and cutbows (*O. clarki* x *O. mykiss*), the endangered Rio Grande cutthroat trout (*O. c. virginalis*), and a rainbow trout hatchery.

Oregon

Formosa Mine

The Formosa Mine (copper, zinc, thorium) on Silver Butte Creek near Riddle operated from 1990 to 1993. The mine has contaminated 18 miles of the Umpqua River watershed in western Oregon (USEPA 2007). The mine currently releases approximately 19 million L of AMD annually, containing up to 13,000 kg of dissolved copper and zinc, metals known to be highly toxic to fish (Dethloff et al. 1999; Baldwin et al. 2003). Consuming fish from the system poses a health risk to humans. Metals pollution is eliminating prime habitat for coho salmon (*O. kisutch*) and steelhead. Aquatic insects have disappeared from the upper reaches of the creek.

Utah

Atlas Mine

The Atlas Mine, located near Moab along the Colorado River, opened in 1952 as a uranium mine. The mine closed in 1984 but left an approximately 178 ha waste site and a 53 ha (16 million ton) tailings pile in the floodplain that leached into ground water and the Colorado River, creating a dead zone. Uranium concentrations in the dead zone are 1,660% greater than background levels. Flooding of the site had the potential of further contaminating the water supplies of millions of downriver humans. The U.S. Geological Survey observed 100% mortality of caged fish placed into the dead zone because of ammonia concentrations 750 times acutely lethal levels. The U.S. Fish and Wildlife Service considered leaching from the tailings as jeopardizing four endangered fish species: humpback chub (*Gila cypha*), bonytail (*G. elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*). The tailings removal and burial began in 2009 at a cost of approximately $1 billion and are projected to require 20 years. The mine operator had posted a $5 million reclamation bond, and filed for bankruptcy (http://healutah.org/news/; http://grandcanyontrust.org/utah/uranium_history.php).

Washington

Midnite Mine

The Midnite Mine was an open-pit uranium mine on the Spokane Indian reservation in eastern Washington, and operated from 1955 to 1981. The Dawn Mill site, just off the reservation, also processed uranium. In the 1990s, both sites were found to be leaking radioactive metals, metals, and AMD into ground water and neighboring streams, including Blue Creek, which drains to Lake Roosevelt, the Columbia River reservoir behind Grand Coulee Dam. Blue Creek is used for spawning and rearing by rainbow trout, Paiute sculpin (*Cottus beldingi*; a species of concern in Washington), and other fishes (USEPA 2009a). Midnite Mine is currently an active Superfund site.

Holden Mine

The Holden Mine, in the Okanogan-Wenatchee National Forest in Chelan County, eastern Washington, operated from 1938 to 1957. It was one of the largest copper mines in the United States, and zinc, silver and gold were also mined. The AMD and metals leach into Railroad Creek, a tributary to Lake Chelan (Johnson et al. 1997). Risks to aquatic life include degradation of surface water quality and streambed armoring. Additionally, spoil piles along stream banks pose a risk to the aquatic community. A flood in 2003 required an emergency cleanup (www.fs.fed.us/r6/wenatchee/holden-mine/flood-damage-2003.shtml). The Holden Mine is an active Superfund site.

Wyoming

Smith-Highland Ranch Mine

The Smith-Highland Ranch Mine is a uranium mine near Douglas in northeast Wyoming that began operations in 1988. In 2008, the Wyoming Department of Environmental Quality (WDEQ) issued a notice of violations to the mine operator for 80 spills over multiple years, pond leaks, well casing failures, failure to restore ground water quality, and a grossly inadequate reclamation bond. Despite those concerns with contaminating ground water, mine self-monitoring, and inadequate WDEQ oversight, the mine has been allowed to continue to operate (http://trib.com/news/state-and-regional/article_b8f9b03a-d250-51f5-a1fc-f34646cfc567.html; www.powertechexposed.com/Cameco_Wyo_mine_permit_violations.htm).

An example of possible future mining impacts

The preceding examples demonstrate fisheries impacts from mining and the poor track record for maintaining water quality suitable for aquatic life (Maest et al. 2005; Kuipers et al. 2006), leading to concerns for new mines and a continuing legacy of mineral extraction trumping all other uses of public land. For example, the Pebble Mine claim on Alaska state lands in the Bristol Bay watershed is part of a massive low-grade porphyry copper sulfide deposit also containing gold and molybdenum. Its development is projected to require an open pit mine (~6 km^2 in area and ~490 m deep), an underground mine, dams at or above 200 m high, a ~160 km long haul road and slurry pipeline, development of a port facility on Cook Inlet for fuel and concentrated mineral storage, and 1.1 billion L of water annually (www.dnr.alaska.gov/mlw/mining/largemine/pebble/2006/damaap.pdf; www.dnr.alaska.gov/mlw/mining/largemine/pebble/2006/swutorig.pdf; www.dnr.alaska.gov/mlw/mining/largemine/pebble/2006/gwsfkfinal.pdf). The region that contains the Pebble copper deposit has porous alluvial soils, abundant ground and surface water, interconnected watersheds, undefined seismic faults, significant seismic activity, little buffering, and a high concentration of sulfides that are known to produce AMD (USFS 1993; Northern Dynasty Mines Inc. 2005; HDR Alaska and CH2M Hill 2008a,b; http://earthquake.usgs.gov/eqcenter/recenteqsus/Maps/special/Alaska.php; Jennings et al. 2008).

The Pebble prospect conditions have serious implications for fisheries. Dissolved copper concentrations as low as 2–10 ug/L above background can alter the olfactory-mediated survival and migration of salmonids (Hecht et al. 2007; Sandahl et al. 2007). The waters draining the Pebble copper deposit are essential to spawning, incubating, rearing, and migrating salmon and non-salmonids, and drain into waters supporting diverse Bristol Bay fisheries. Bristol Bay is home to the world's largest wild sockeye salmon (*O. nerka*) fisheries, and sustains healthy productive fisheries of other salmonids, herring, and crab. The local seafood industry employs about 10,000 people annually; gross earnings reported in 2007 were over $100 million in international sales (www.sf.adfg.state.ak.us/Statewide/economics/). A 2007 study of sportfishing economic impacts in Alaska indicated expenditures of $1.4 billion dollars generating 15,879 jobs, of which, $989 million and over 11,000 jobs were attributed to the southcentral region which includes Bristol Bay (www.sf.adfg.state.ak.us/Statewide/economics/). The Bristol Bay exvessel commercial salmon fishery has a 20-year estimated average annual value of $125.7 million ($123.1 million for sockeye; Sands et al. 2008). National catch statistics for sockeye salmon alone (mostly from Bristol Bay) indicated an exvessel value of over $7.8 billion between 1950 and 2008 (www.st.nmfs.noaa.gov/st1/commercial/landings/gc_runc.html). Alaska Native peoples have relied on annual salmon returns to the rivers draining the Pebble copper deposit for subsistence for thousands of years; salmon still comprise 60–80% of their total subsistence harvest, which for the last 20 years has averaged over 100,000 salmon annually from the Nushagak and Kvichak drainages alone (Fall et al. 2006; Sands et al. 2008). The Pebble copper deposit lies under state land straddling both the Nushagak and Kvichak drainages, is adjacent to Lake Clark National Park and Preserve, is about 24 km upgradient of Lake Iliamna where millions of sockeye fry rear annually, and is in the headwaters of the Nushagak, a major Chinook salmon producer. The Nushagak and Kvichak river drainages have produced about 50% of all commercially harvested sockeye salmon from Bristol Bay for 125 years (ADFG 2008a,b; Fair 2003). Given the importance of sustainable fisheries in Bristol Bay and its drainages, it seems advisable to mount an ecologically and statistically defensible surveying program in the region, and to make the study designs and all data produced from surveying the region publicly available for independent peer review.

Given the history of hardrock mining documented above, the risks to fisheries like those in the Bristol Bay drainage are high. The value of these fisheries, and the livelihoods of those who

depend on them, should be considered when making decisions about land use. However, the Mining Law of 1872 still maintains mineral extraction as the highest priority use of federal lands and the BLM is considering opening 0.5 million ha of federal lands around Pebble to mining, which would further exacerbate the threat to the fishery. As Senator Lee Metcalf explained in his address to the North American Wildlife Conference in 1974, the Mining Law of 1872 is the "only law that puts the land use decision entirely in the hands of the developer" (Bakken 2008). Attempts to change the legislation in the 1990s failed due to powerful corporate interests and public apathy. An update to the Mining Law of 1872, signed by Ulysses Grant, is long overdue.

Future policy needs

Healthy sustainable fisheries support important local and national economies and depend on clean water and healthy watersheds. The examples presented, along with a wide array of other scientific evidence concerning hardrock mining, have demonstrated frequent incompatibility of hardrock mining with conservation of important fisheries resources due to outdated and inadequate regulations and policy. Although the American Fisheries Society has a surface mining policy (#13; www.fisheries.org/afs/policy_statements.html) in place, we recommend that the policy be revised to address more thoroughly the potential impacts of hardrock mining on fish and aquatic ecosystems. More importantly, and because hardrock mining is a vital industry, we recommend that the U.S. Congress revise the Mining Law of 1872 to:

1. **Establish clear environmental standards.** Specific standards for environmental protection need to be strengthened and elucidated within mining law, including:
   a. ***Reclamation.*** Mine sites should be reclaimed to sustain uses conforming to the applicable land use plan of the region, not just pre-existing, degraded conditions. Concurrent reclamation of mined lands prior to expanding onto undisturbed land can reduce overall impacts as well as provide data on the efficacy of the proposed reclamation plan. Such reclaim-as-you-go programs increase the probability that the proponent will cover the cost of reclamation before the mining operation shuts down.
   b. ***Fish and wildlife protection.*** Habitat and fish and wildlife assemblages should be restored to pre-mining conditions, at a minimum.
   c. ***Surface and ground water protection.*** Current federal law does not adequately protect ground water from mining pollution and the requirements of mine reclamation are insufficient to maintain compliance with state and federal water quality standards. Operations should minimize damage to surface and ground water resources, restore to at least pre-mining hydrological conditions, and ensure compliance with water quality standards.
   d. ***Revegetation.*** Mined areas should be reseeded and planted with sufficient vegetation and success should be measurable and monitored. Native species should be encouraged and noxious species controlled.
   e. ***Prohibition of perpetual pollution.*** Before mining ceases, mine operators should meet water quality criteria required to protect desired aquatic species without the permanent treatment of water.
   d. ***Mitigation.*** Mitigation proposals should be accompanied by clear success/failure measurement criteria and clearly defined alternative(s) that are triggered if the proposed mitigation fails. When ranking mitigation alternatives, the costs and benefits of the potential environmental impacts of each scenario should be part of the economical feasibility analysis.
2. **Protect special places.** The U.S. government currently interprets mining as the highest priority and best use for public lands based on the Mining Law of 1872. However, many places are of significant environmental value and should deserve special protections.
   a. ***Designate special lands as off-limits to hardrock exploration and development.*** Wilderness study areas, lands recommended for wilderness designation, sacred sites, areas of critical environmental concern, lands supporting highly valued or ESA-listed fish or wildlife populations, roadless areas, lands in the Wild and Scenic River System or recommended for such, and lands administratively withdrawn or segregated should be off limits to mineral exploration and development that would directly or indirectly affect them.
   b. ***Allow land managers to appropriately value mining relative to competing uses of public* land.** Land managers should be able to weigh competing land uses and consider the impacts of mining and the potential for reclamation to a desired state before mine approval. No mine should degrade the environment, public health, or public safety. Land managers should have the ability to deny permits when appropriate or to include appropriate requirements to protect the environment for approved operations.
3. **Initiate fiscal reform to increase permittee financial responsibility.** In 2000, the U.S. Bureau of Land Management estimated $982 million worth of hardrock minerals were excavated from public lands, yet the mining industry paid no royalty on those minerals. Fiscal reform is needed to aid in restoring damaged watersheds, and should include:
   a. ***End patenting.*** Under the Mining Law of 1872, an area about the size of Connecticut valued at over $245 billion dollars has been patented for far less than the land value.
   b. ***Establish royalty fees.*** Fees for new and existing mines similar to those paid by the fossil fuel industry (e.g., 8%–12.5%) should be established and used for land and water rehabilitation.
   c. ***Statutorily ensure reclamation bonding.*** Adequate reclamation bonds with clear clean-up standards are needed to protect both the environment and taxpayers. Estimated clean-up liability for operating mines is estimated to exceed $12 billion to taxpayers because of inadequate bonds.
   d. ***Establish regulatory fees.*** Fees are needed in the permitting process for effectiveness monitoring, enforcement infrastructure, and research.
4. **Create funds to clean up abandoned mines.** No dedicated federal funds currently exist to clean up abandoned mine sites. A royalty fund of $32–72 billion should be established to clean up abandoned mine sites. A program should be clearly developed and implemented to evaluate, prioritize, and fund those projects.

5. **Improve mine oversight and environmental protection.** Self-monitoring and self-reporting by the mining industry has frequently failed to protect waters and fishery resources because of irresponsible mining practices. Compliance with the Clean Water Act and state water quality standards must be achieved, including implementation of agency permit requirements and conditions, monitoring associated with National Pollution Discharge Elimination System (NPDES) permits, and other applicable regulations. Industry oversight from initial baseline studies to mine closure is needed, including:

   a. ***Independent peer review from exploration to closure.*** Annual technical reports and data should be prepared by independent mining consultants and released directly to the public as well as state and federal oversight agencies for review, critique, and improvement. Inadequacies in baseline studies and monitoring programs (including study design, site-scale design, standard methods, and indicators) should be documented and addressed (Hughes et al. 2000; Hughes and Peck 2008; Bonar et al. 2009). Agency recommendations should be considered and integrated or the status quo defended.
   b. ***Independent effectiveness monitoring.*** Independent or agency monitoring of water and sediment quality, flow regime, physical habitat structure, and biological assemblages (fish, benthic macroinvertebrates, algae, riparian vegetation) should be conducted at least during high and base flows as part of the mine permit and paid for by the permitee. Monitoring should be independent of the agencies responsible for mineral leasing, because of their roles in encouraging mining.
   c. ***Inspections.*** Unannounced inspections should be mandatory. Water quality samples should be split for independent analyses by independent laboratories, with oversight by responsible agencies for quality control. Regulatory agencies should be adequately funded to conduct rigorous and frequent inspections. In addition, the right of the public to reasonably request inspections should be guaranteed.
   d. ***Cessation of work.*** Failure to successfully address mining violations should require ceasing operations until appropriate remediation is addressed and implemented.
   e. ***Track violators.*** Operators (including firms and persons) that have a history of serious violations or are currently seriously violating laws should be ineligible for new or renewed permits and liable for criminal proceedings. Further, additional permits or permit renewals should not be considered until reclamation at other sites has been deemed appropriate and successful by the regulatory agencies and stakeholders involved.
   f. ***Right to sue.*** Citizens should have the right to file suit in federal and (or) state courts when operators or government agencies fail to implement and monitor best management practices.
   g. ***Risk analysis.*** Unanticipated events that lead to the release of metals, chemicals, dust, and debris pose serious risks to aquatic biota. Mine permitting and reclamation insurance should be developed within the context of risk assessment that takes into account landscape properties, climate, earthquake hazards, and extraction and reclamation methods.
6. **Fund research needs.** The National Academy of Sciences (1999) and USEPA (2004) recommended an aggressive and coordinated research program related to the environmental impacts of hardrock mining. A better understanding of mining practices, problems, and solutions is needed to prevent water quality degradation, guide rehabilitation of contaminated watersheds, and mitigate the effects of future hardrock mining.
7. **Follow the precautionary principle.** Time and again we have learned that it is more costly and uncertain to rehabilitate natural resources than it is to protect them. Given the inability of planners and engineers to prevent catastrophic failures, it is incumbent on the professionals that work with fisheries, wildlife, and other resources to carefully scrutinize any proposed new developments. As we write this piece, hundreds of cubic meters of oil are gushing daily from the seafloor in the Gulf of Mexico and drifting shoreward, in an event that was apparently not anticipated, and for which there were no adequate contingency plans. Recent history is replete with similar engineering shortcomings (e.g., Santa Barbara and *Exxon Valdez* oil spills, Tacoma Narrows and Minneapolis bridge collapses, Three Mile Island and Enrico Fermi nuclear plant meltdowns, *Challenger* and *Columbia* space shuttle explosions, Teton and Buffalo Creek dam collapses, Consol and Upper Big Branch mine explosions, Baie Mare and Aznalcollar mine spills). History teaches us that once initiated, mining projects continue no matter how serious the violations of permits. Therefore, the permitting process should assume that stated levels will be exceeded, and that catastrophes and spills will occur. The risks and benefits should be weighed accordingly following rigorous examination of mining and infrastructure plans, economic evaluation, ecological surveys, and peer review of all data.

Summary

The U.S. General Mining Law of 1872 allows mining operators to enter, explore, and begin the permitting process for a claim, but does not require a commitment to return the lands and waters to a state supporting aquatic life. Most mining practices require water in large quantities for some aspect of extraction, processing, or transport of the mined material and its byproducts. Therefore aquatic systems are heavily altered directly, indirectly, and cumulatively by mining. History has shown that the legacy impacts of mining are often significantly more persistent and expensive than those observed during active mining. Just as no mining company would consider it feasible to go back to nineteenth century mining practices and technology, U.S. citizens should expect mining projects to meet modern scientific standards by employing rigorous scientific assessment of all potential impacts, and by providing public access to all information gathered in those assessments in sufficient time for scientific peer review.

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Environmental Review Approaches by Fish and Wildlife Agencies in the United States and Canada

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ABSTRACT: We surveyed U.S. state and Canadian provincial fish and wildlife agencies regarding their participation and approach to environmental review (i.e., review of project permit applications or proposals for environmental impacts). Most agencies dedicated a personnel unit to environmental review ranging from 1 individual to a staff of 38, and staffs are administered within various divisions or programs. Agencies annually reviewed from 10 to 7,500 projects for environmental impact, and state and provincial agencies spent an average of 3,681 hours (state) and 700 hours (provincial) on projects monthly. An average of 1,760 hours (state) and 390 hours (provincial) was spent annually on proactive measures such as environmental education and land use planning. Most agencies viewed environmental review as very important; however, agencies generally reported limited success in influencing the outcome of reviewed projects, and many identified this as a dissatisfying aspect of the review process. State and provincial agencies have adopted a variety of approaches to accomplish environmental review. Examining the alternative strategies and approaches employed among agencies may add perspective and provide successful models to enhance other agencies' programs.

Enfoques de evaluación ambiental de las agencias de Pesca y Vida Silvestre en los Estados Unidos de Norteamérica y Canadá

RESUMEN: Se realizó un sondeo en las agencias estatales y provinciales de Pesca y Vida Silvestre de los Estados Unidos de Norteamérica y Canadá en cuanto a su participación y enfoque de evaluaciones ambientales (i.e. revisión de los proyectos para solicitar permisos o propuestas de impacto ambiental). La mayoría de las agencias designan unidades de recursos humanos para revisión ambiental que van de 1 individuo hasta 38, y el personal es administrado dentro de varias divisiones o programas. Las agencias, cada año, revisaron entre 10 y 7,500 proyectos de impacto ambiental, y las agencias estatales y provinciales invirtieron mensualmente en los proyectos, en promedio, 3,681 horas (estatales) y 700 horas (provinciales). La media anual en cuanto al tiempo invertido en definir medidas proactivas, como educación ambiental y ordenamiento de uso de suelo, fue de 1,760 horas (en agencias estatales) y 390 horas (en agencias provinciales). La mayoría de las agencias consideran la evaluación ambiental como muy importante; sin embargo, las agencias generalmente reportan un éxito limitado en cuanto a su influencia sobre los resultados de los proyectos revisados y muchos identificaron esto como un aspecto poco satisfactorio del proceso de evaluación ambiental. Las agencias estatales y provinciales han adoptado una variedad de enfoques para llevar a cabo las evaluaciones ambientales. El examen de estrategias y enfoques alternativos que se emplean entre agencias pudiera brindar una mejor perspectiva y proveer modelos exitosos para desarrollar programas en otras agencias.

Introduction

Human population demographics are changing rapidly in the United States and Canada, resulting in direct, indirect, and cumulative effects on natural resources. For example, the state of North Carolina projects a population increase of more than 4 million new individuals by the year 2030 (54.9%), and over 61% of this growth would be the result of net migration into the state (North Carolina Office of State Budget and Management 2005). Population growth will occur across the United States and is expected to be highest in the southern and western states between 2000 and 2030 (U.S. Census Bureau 2005). Overall, the U.S. population is projected to increase by 42% between 2010 and 2050 (U.S. Census Bureau 2008). As human population increases, residential, commercial, and industrial development also increases significantly, along with a corresponding decrease in aquatic and terrestrial habitat. Environmental review is one way that resource agencies protect, manage, and conserve aquatic, wetland, and upland habitats for the benefit of aquatic and terrestrial wildlife.

The National Environmental Policy Act of 1969 (NEPA) is a congressional declaration that recognizes the critical importance of restoring and maintaining environmental quality and establishes mechanisms designed to support that. Federal agencies are charged with examining the impacts and consequences of proposed projects on the environment when there is federal involvement in those projects. The NEPA process shall "utilize a systematic interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have

an impact on man's environment." Every project proposal must contain:

1. The environmental impact of the proposed action,
2. Any adverse environmental effects that cannot be avoided,
3. Alternatives to the action,
4. The relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity, and
5. Any irreversible and irretrievable commitments of resources [Sec. 102 (42 USC § 4332)].

Many states have also implemented state environmental policy acts that are modeled after NEPA. Analogously, the Canadian Environmental Protection Act of 1999 (CEPA) provides guidelines, codes of practice, and enforcement measures to ensure that alternatives are evaluated and environmental protection measures are in compliance.

Various state, provincial, and federal permits may be required to ensure compliance with particular regulations. Examples of permits that may be obtained include Clean Water Act permits (the CWA established the basic structure for regulating discharges of pollutants into the waters of the United States) and highway, energy, mining, and dam safety permits. State and provincial fish and wildlife agencies have the opportunity, if not the statutory responsibility, to review and comment on these environmental documents and permits. However, there is no established approach or protocol for agencies to follow in conducting environmental review, and procedures and perceptions vary widely among agencies.

Thus, we initiated a survey to:

1. Describe how the various fish and wildlife agencies approach environmental review (types of projects and time resources allocated to review),
2. How important this type of work is to the agency, and
3. How successful the agencies perceive they are in having their concerns addressed.

Most individuals tasked with performing environmental review within fish and wildlife agencies originally envisioned practicing the traditional roles of a biologist, such as resource management and research. Therefore, we were also interested in personal satisfaction associated with performing environmental review. A final objective of our survey was to identify where and how improvement can be made for these programs. We present our findings and recommendations for potential use by state and provincial agencies to add perspective to their environmental review programs and to provide potential models for improvement.

Methods

We contacted each of the 50 state and 13 provincial fish and wildlife agencies by phone and e-mail to determine the appropriate survey respondents and e-mailed a questionnaire to those individuals. The sample for the survey was not randomly selected, but purposive in order to obtain information from the most appropriate individuals. Respondents were selected by their respective agencies on the basis of job title and familiarity with environmental review. The 11-page questionnaire was designed and administered to four state agency test subjects during July and August 2003 and then revised and sent to all U.S. state wildlife agencies in 2004 and all Canadian provincial wildlife agencies in 2005. The basic survey design and implementation followed accepted principles and protocol based on Salant and Dillman (1994). Respondents were informed of questionnaire receipt and thanked by e-mail after returning their questionnaire. In addition to e-mail reminders to those who did not complete the questionnaire, follow-up phone calls were also made in an attempt to increase response rate.

The original survey to U.S. states contained 20 questions. An additional two questions were administered at a later date to U.S. states, which resulted in a smaller sample size for those questions. The survey administered to Canadian provinces contained all 22 questions. The survey requested general information about the individual completing the survey, and the questions consisted of queries about agency environmental review participation, permit project types (i.e., reactive approaches), proactive approaches, the success of the agency (perceived by the respondent) in influencing project outcomes, and the relative importance and satisfaction value of environmental review to the agency (as perceived by the respondent). A copy of the survey is available upon request.

Responses for questions concerning review participation, permit project types, success level, and review satisfaction were analyzed by comparison using percentages. To examine the value of permit review relative to permit and environmental assessment (EA) success, success level was assigned a number (0—not successful, 1—somewhat successful, 2—very successful), then those numbers were averaged for all of the permit types analyzed (e.g., Clean Water Act permits, transportation permits, etc.) and EAs based on their value to the respondent. Similarly, the relationship between review success and job satisfaction was examined by quantifying success (0—not successful, 1—somewhat successful, 2—very successful), and averaging for all of the permit types analyzed and EAs based on the respondents' satisfaction level.

Results

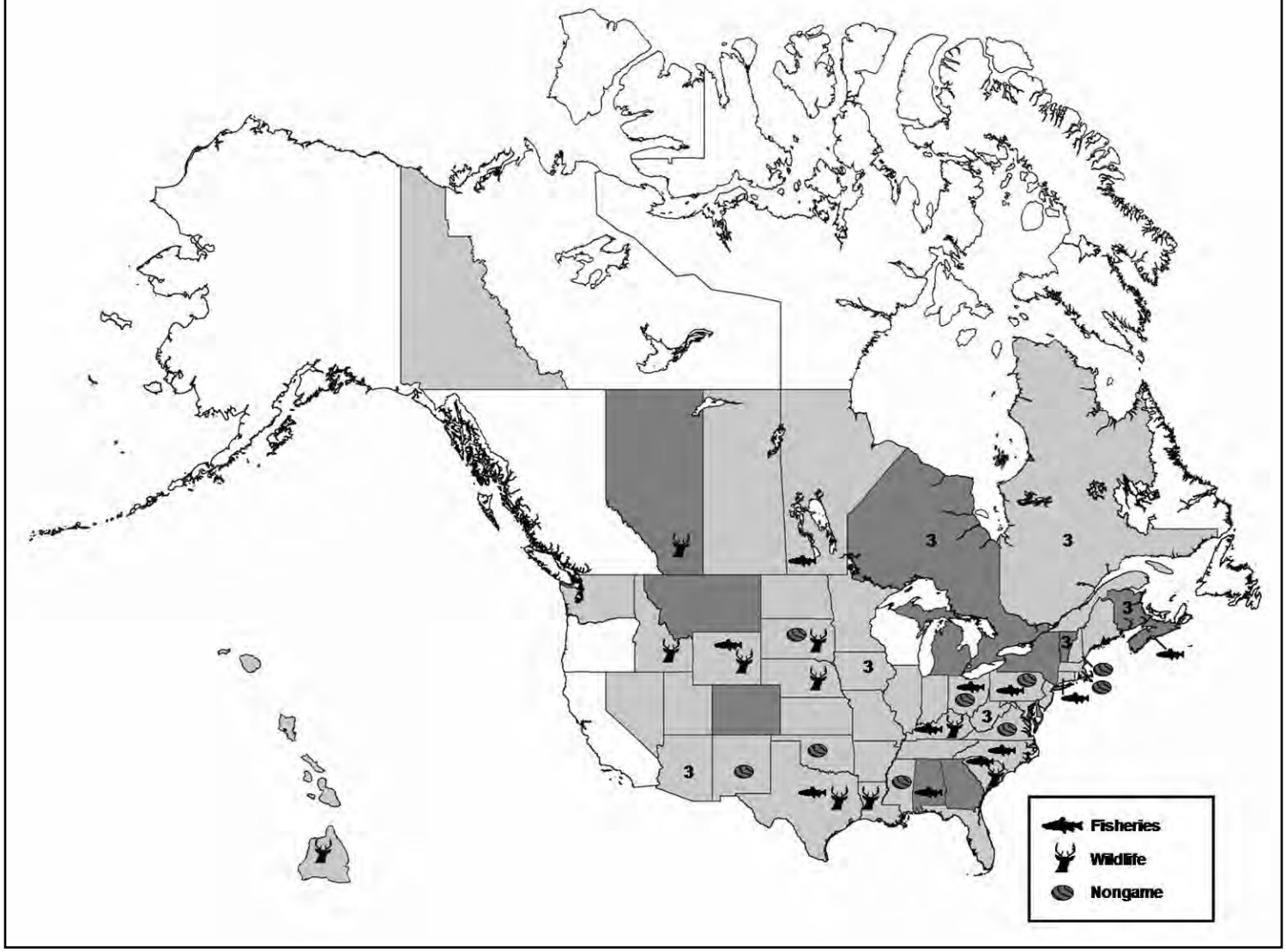
Forty-five states (90%) and eight provinces (62%) responded to the original survey. The additional two questions administered to U.S. states had a smaller response rate of 27 responses. All of the respondents indicated that they participated in environmental review to varying degrees. Thirty-six states dedicated a personnel unit comprising 1–38 personnel to environmental review (Figure 1—shaded light gray). The other nine states (Figure 1—shaded dark gray) did not formally dedicate a unit to environmental review, but commented on environmental documents by designating one or more individuals to coordinate those comments. Dedicated units or individuals occurred within fisheries, wildlife, and non-game programs, but also occurred in other programs such as environmental (planning or services), watershed services, habitat (section, program, or bureau), ecological services, and conservation section. Personnel not assigned to dedicated units also participated in environmental review.

Environmental Review Responsibilities

Reactive Projects

We stratified environmental review responsibilities into two complementary components: reactive and proactive projects. For reactive projects, agencies are responding to projects that are

Figure 1. Map of the U.S. and Canada. States and provinces not colored were non-respondents. Those in light gray had a unit dedicated to environmental review, which may consist of 1 to 38 people. Those in dark gray did not have a dedicated environmental review unit, but still commented on environmental documents and may have had someone designated to coordinate those comments. A fish symbol represents a dedicated unit or individual within fisheries, a mussel symbol represents a dedicated unit or individual within non-game, and those with a deer head symbol had a dedicated unit or individual in wildlife. Some agencies had dedicated units or individuals within two of those divisions (two symbols) and where the number three is indicated, individuals were located within all three divisions. Finally, for the states and provinces colored in light gray without a symbol, their dedicated unit was located within another division or program such as Environmental Planning, Watershed Services, or Habitat Bureau.



planned or underway (e.g., environmental permits and assessments). Most state and provincial agencies reviewed more than 600 projects per year, and agencies may expend over 3,000 h/mo on these projects. Most of the state (≥ 93%) and provincial agencies (≥ 88%) reported collaborating with other state, provincial, or national government agencies on environmental projects.

For reactive projects, most states (93%) commented on NEPA documents (i.e., EA and Environmental Impact Statements [EIS]). In addition, 38% of the states reported having a State Environmental Policy Act (SEPA) or legislation analogous to NEPA at the state level, and 94% of those that had a state act commented on those documents. Eighty-eight percent of provincial agencies commented on projects covered by the CEPA. All of the provinces surveyed had adopted provincial acts, and all of the agencies commented on those provincial documents.

Between 42% and 96% of state agencies commented on permit applications associated with legislation and regulations (Figures 2 and 3) such as CWA, highway, energy, mining, and dam safety permits. Section 404 of the CWA regulates discharge of dredged or fill material into waters of the United States, and Section 401 requires water quality certification from individual states. The National Pollutant Discharge Elimination System (NPDES) as described in Section 402 of the CWA constitutes a permitting system for any point source pollutant discharge into navigable waters. States reported having some level of regulatory authority (33% SEPA; 42% various permits), often pertaining to state threatened and endangered species, stream channel modification, or fish passage.

Some states and provinces have their own legislation to protect coastal habitats. For example, North Carolina's Coastal Area Management Act (CAMA) addresses impacts to coastal areas. Agencies were asked to respond whether they had similar coastal acts and whether they commented on permits pertaining to coastal impacts. Thirty percent of states reported having acts and

commenting on permits associated with them. Provincial agencies did not report any similar legislation.

Many of Canada's environmental legislative acts and permits are comparable to those of the United States, and 88% of provincial agencies commented on at least one type of permit (Figure 3). Examples of other projects that were reviewed by provincial agencies include those related to the Yukon Waters Act, Forests Act, timber permits, oil and gas permits, Manitoba Hydro, transportation corridors, and activities on and use of public lands and the bed and shores of water bodies. Fifty percent of provincial agencies reported having regulatory authority for some projects.

Over 85% of state agencies and more than 88% of provincial agencies reported that secondary and cumulative impacts (SCI) were assessed at least occasionally for EA, EIS, and permits (Figure 4). Most agencies also indicated that mitigation is required for SCI impacts at least occasionally (93% states; 75% provinces). Cumulative effects as defined by the U.S. Council on Environmental Quality (CEQ) are "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over a period of time" (40 CFR § 1508.7). The CEQ defines secondary (or indirect) impacts as being caused by the action and are later in time or farther removed in distance, yet are reasonably foreseeable. Indirect effects may include growth inducing effects (e.g., additional commercial development) and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems (40 CFR § 1508.8).

Proactive Projects

For proactive projects (e.g., land use planning, watershed management teams, and environmental education programs), agencies are working to incorporate protective measures into communities and habitats before projects are planned. State and provincial agencies reported participating in a variety of proactive

Figure 2. Percentage of state agencies that commented on various Clean Water Act (CWA) permits. Section 404 and 401 CWA permits, National Pollutant Discharge Elimination System permits (NPDES) (described in Section 402 of the CWA), and coastal acts such as the North Carolina's Coastal Area Management Act (CAMA).

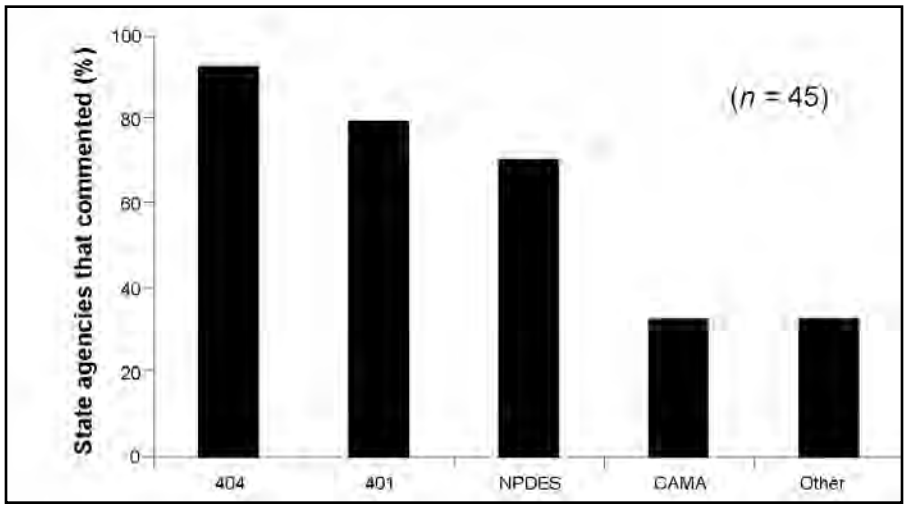


Figure 3. Percentage of state and provincial agencies that commented on local and national highway, Federal Energy Regulatory Commission (FERC), upland and instream mines, and dam safety. FERC includes hydropower projects and other energy permits. Provincial agencies responded if they had similar permits to those described and whether they commented on them.

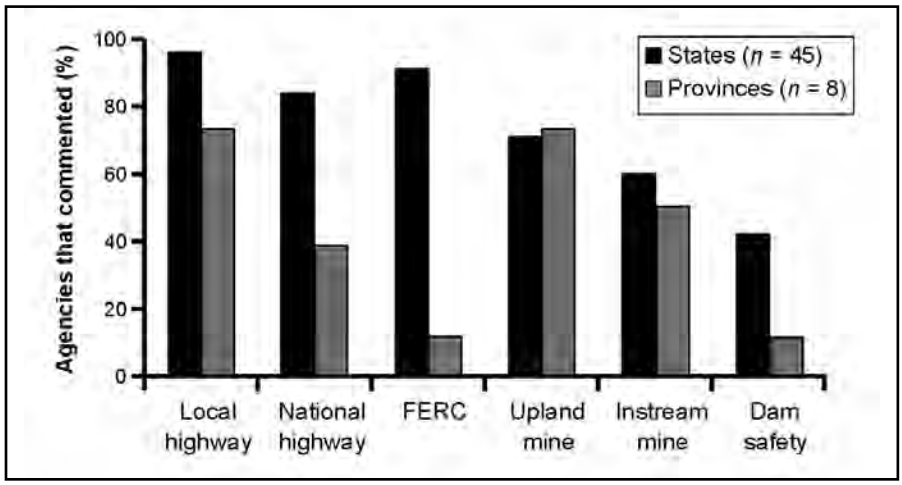
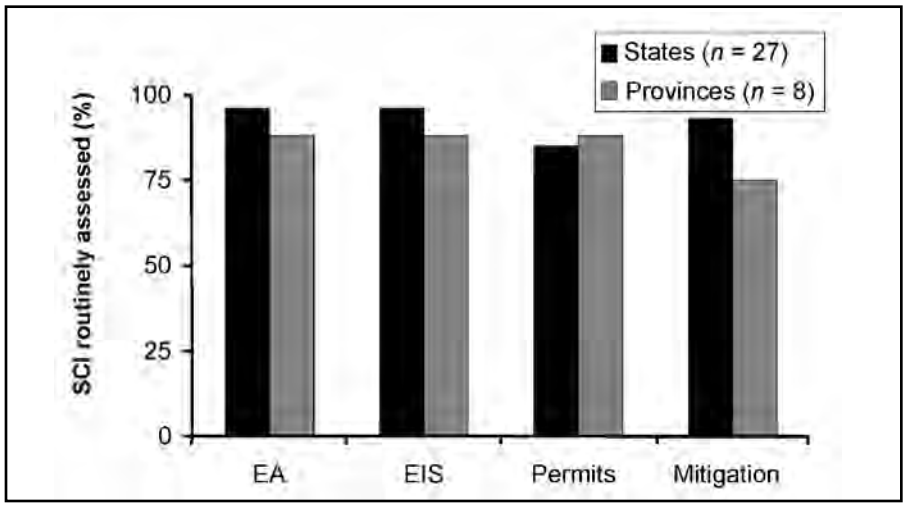
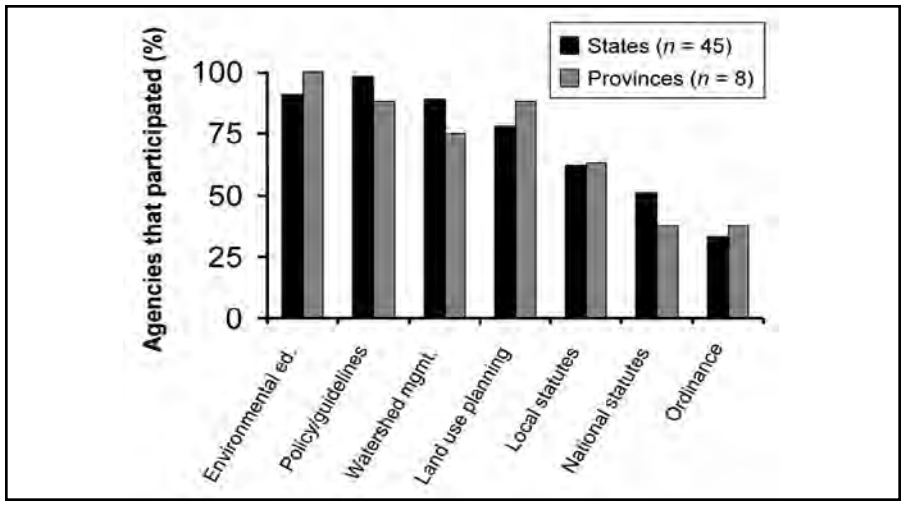


Figure 4. Percentage of state and provincial agencies that indicated that secondary and cumulative impacts (SCI) were assessed at least occasionally for environmental assessments, environmental impact statements, and permits and the percentage of those agencies indicating that mitigation was required at least occasionally for SCI impacts.



projects (Figure 5). Many of these agencies provided environmental education programs (e.g., workshops, pamphlets, and other outreach materials), participated in the development of policy or guidance documents, and participated on watershed management teams and in land use planning. Fewer participated in the formulation of local and national statutes not directly tied to an agency's duties and the development of local codes or ordinances.

Figure 5. Percentage of state and provincial agencies that participated in proactive projects such as environmental education, development of policy or guidance documents, watershed management teams, land use planning, formulation of local and national statutes not directly tied to an agency's duties, and the development of local codes or ordinances.



Value

Survey participants were asked how important various environmental review activities (permit review, environmental document review, restoration projects, and proactive projects) are to them. Most state agencies dedicated less than 10 individuals to project reviews (25 states < 10; 11 states > 10; 9 states no dedicated unit). In most cases, state agency personnel responded that environmental review activities were at least somewhat important, and in many cases these activities were considered very important (Table 1). Generally, those state agencies that dedicated more than 10 employees to environmental review activities also viewed these activities as more important than those that dedicated 10 or fewer employees. Half (4) of the responding provincial agencies dedicated from 1 to 20 individuals to environmental review. All provincial agencies responded that environmental review activities were at least somewhat important, and the majority considered them very important. There were no evident differences regarding the importance of environmental review activities among Canadian agencies that had dedicated environmental review personnel compared to those that did not dedicate personnel.

Table 1. Importance of various environmental review activities to state agency respondents.

		Importance response (%)		
		Very	Somewhat	Not at all
Number of states	Number of employees	Respondent view	Respondent view	Respondent view
		Permit review		
27	1–10	85	15	0
6	11–20	100	0	0
3	>21	100	0	0
1	Not reported	0	100	0
8	0	75	25	0
		Environmental document review		
27	1–10	78	22	0
6	11–20	100	0	0
3	>21	67	33	0
1	Not reported	0	100	0
8	0	63	37	0
		Proactive projects		
27	1–10	88	12	0
6	11–20	100	0	0
3	>21	100	0	0
1	Not reported	100	0	0
8	0	71	29	0

Success

We asked how successful participants were in influencing the outcome of various environmental permits. Approximately 60% of responding state agencies indicated they were at least somewhat successful in influencing 404 and 401 permits, 73% reported being at least somewhat successful in influencing NPDES permits, and 57% of responding coastal states reported being at least somewhat successful for CAMA permits (not applicable to states without a coast; Figure 6). Only 2% of state agencies responded that they had no success in influencing 404 permits, while 5% had no success for 401 permits, and 14% for NPDES permits. No state agency reported a lack of success in influencing CAMA permits. Approximately 50% of state agencies and 25% of provincial agencies reported being at least somewhat successful in influencing highway and mining permits and environmental documents (Figure 7). State agencies achieved highest success influencing local and national transportation projects and instream mines, with local EAs following these. Provincial agencies achieved highest success influencing local highways and local EAs. Fewer than 11% of states reported no success in influencing highway and mining permits and environmental documents. No provincial agency reported a complete lack of success on these projects.

Value versus Success

We examined the perceived value of permit reviews compared to agency success in affecting permits and environmental documents (Figure 8). On a scale of 0—not successful, 1—somewhat successful, 2—very successful, the mean of state agency success on influencing permits was 1.28 with a range of 0.43 to 2.0. Mean state agency EA success was 1.25 with a range of 0 to 2.0. Canadian permit and EA averages were 1.6 and 1.57, respectively, and the range was 1.0 to 2.0. From this comparison, it appears that agency success does not affect the value placed on performing reviews, or conversely, the perceived value of the review process does not appear to affect agency success.

Satisfaction

Survey participants were asked to rate their professional satisfaction level for permit and environmental document review and proactive activities compared to working with traditional fisheries or wildlife issues (i.e., management, outreach, and research; Table 2). State responses for permit and environmental document review were evenly split among satisfaction categories (except the strongly disagree category, which had a low response). Canadian responses for permit and environmental document review satisfaction were also relatively evenly distributed with most mildly agreeing, mildly disagreeing, or neither agreeing or disagreeing that this type of review is as professionally satisfying as traditional fisheries and wildlife roles. Responses by state and provincial agencies for proactive activities were more modal with over 60% agreeing that proactive activities are as professionally satisfying as traditional fisheries and wildlife roles.

Satisfaction versus Success

We were interested in how agency success in affecting permits and environmental documents relates to job satisfaction (Figure 9). For state agencies, respondents reporting the most success in their environmental review also reported more satisfaction with their work (r = 0.389; P = 0.009). It may also be interpreted as those less satisfied with their work also viewed their success level as low. No obvious trend appeared from the provincial responses (r = 0.418; P > 0.05); however, the sample size for those responses was small.

Figure 6. Percentage of state agencies that perceived their success level to be somewhat or very successful for Section 404 and 401 Clean Water Act (CWA) permits, National Pollutant Discharge Elimination System permits (described in Section 402 of the CWA), and coastal acts such as the North Carolina's Coastal Area Management Act.

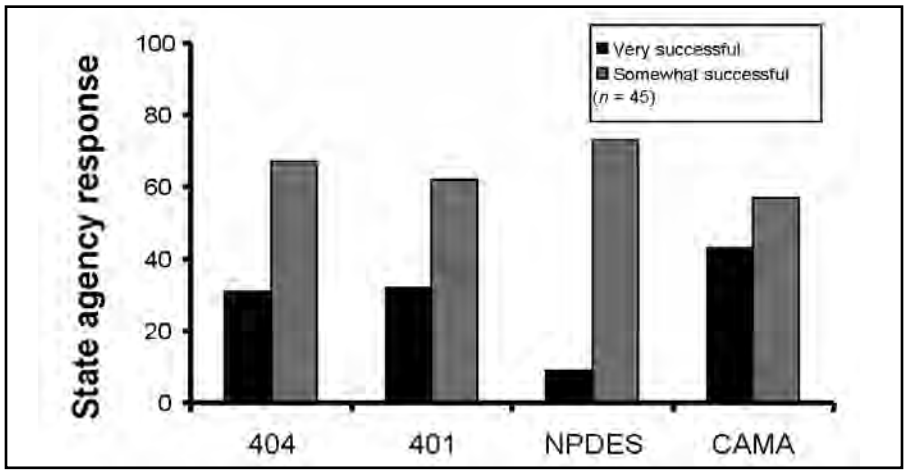


Figure 7. Percentage of state and provincial agencies that perceived their success level to be somewhat or very successful for local and national highway, Federal Energy Regulatory Commission (FERC), upland and instream mines, and dam safety (or similar permits in Canada), and local and national environmental assessments.

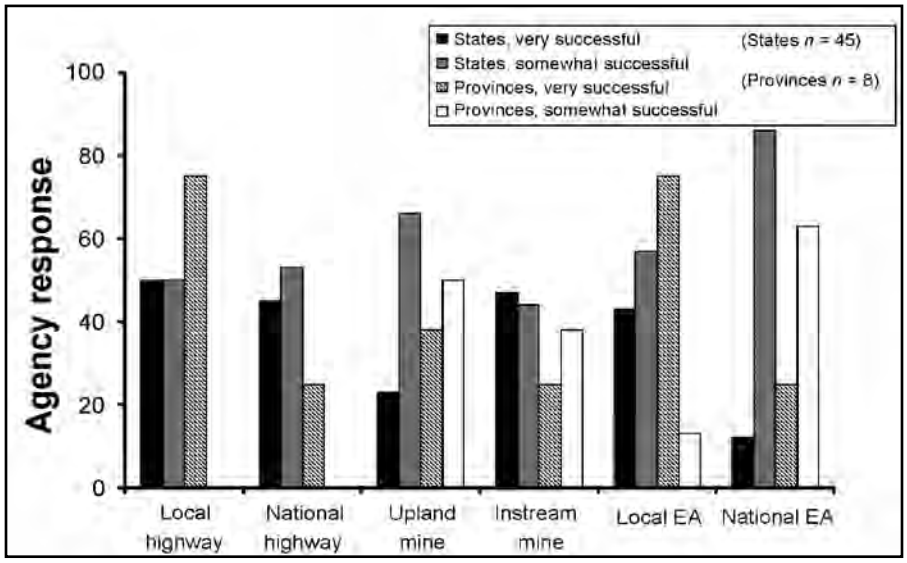


Figure 8. Value of permit review to the state and provincial agency respondents relative to agency success in affecting permits and environmental documents. Success level was assigned a 2 for very successful, 1 for somewhat successful, and 0 for not successful.

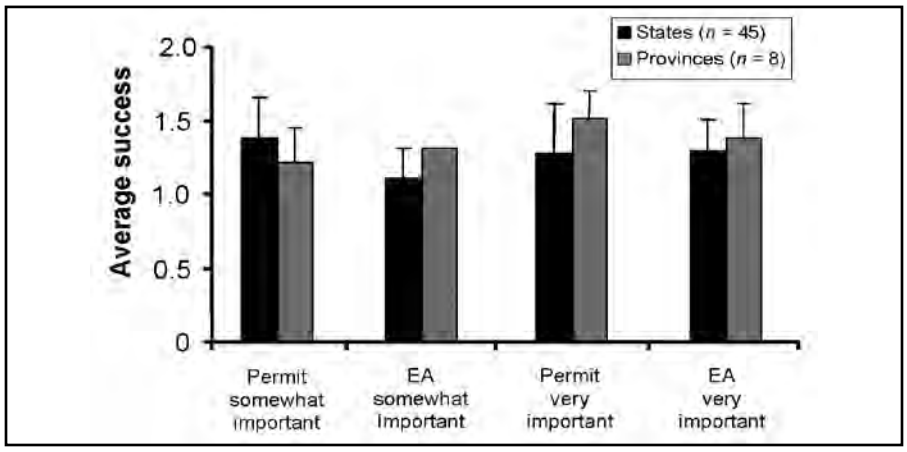
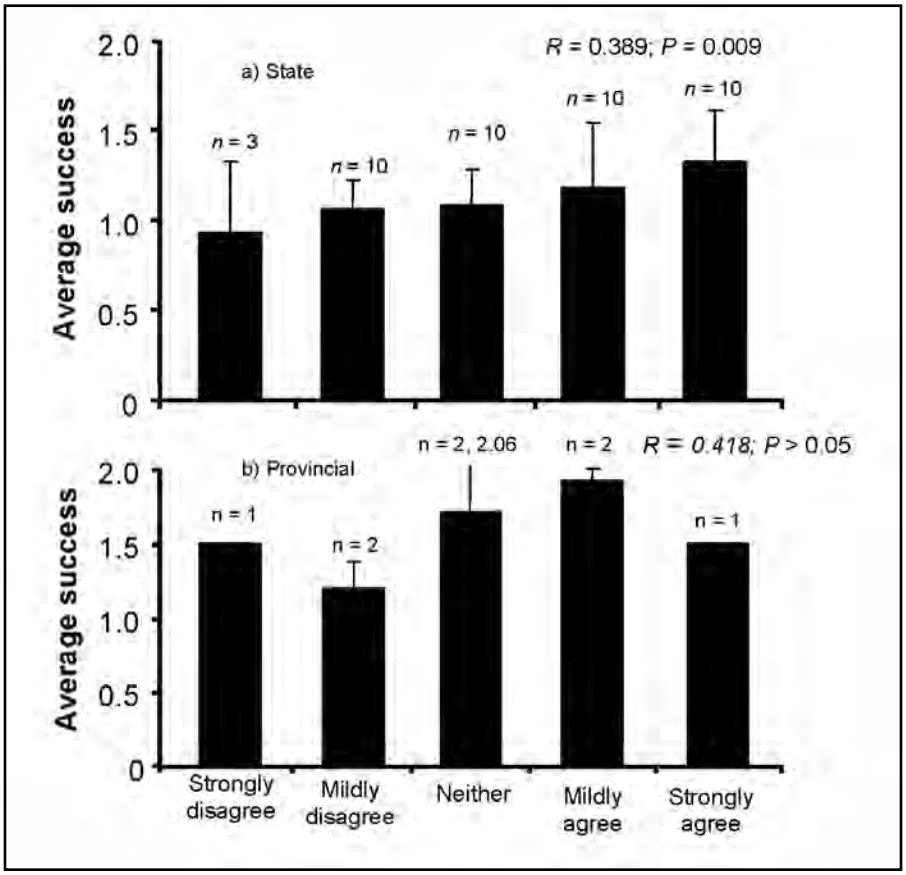


Table 2. State and Provincial agency respondents' professional satisfaction of permit and environmental document review and proactive activities compared to traditional fisheries or wildlife issues. Respondents were asked whether they agreed that environmental review was as professionally satisfying as traditional roles.

	Permit/EA review Number (percent)		Proactive activities Number (percent)	
Satisfaction level	State	Provincial	State	Provincial
Strongly agree	10(23%)	1(12.5%)	16(36%)	2(25%)
Mildly agree	10(23%)	2(25%)	12(27%)	3(37%)
Neither agree/ disagree	10(23%)	2(25%)	8(18%)	2(25%)
Mildly disagree	10(23%)	2(25%)	5(11%)	1(13%)
Strongly disagree	3(7%)	1(12.5%)	1(2%)	0
Not sure	1(2%)	0	2(5%)	0

Figure 9. State and provincial agency success in affecting permits and environmental documents relative to job satisfaction. Success level was assigned a 2 for very successful, 1 for somewhat successful, and 0 for not successful.



North Carolina: An Example Program

We include additional detail about our program in North Carolina to provide insight into a specific state's response to our survey. The North Carolina General Assembly in 1971 adopted a State Environmental Policy Act (SEPA), which requires the evaluation of direct, secondary, and cumulative impacts. The North Carolina Wildlife Resources Commission (NCWRC) had dedicated nine environmental reviewers administered within the Division of Inland Fisheries at the time of the survey. Other staff members often provided assistance in the review process, and these were located within the Division of Inland Fisheries and the Division of Wildlife Management. As with many fish and wildlife agencies, NCWRC does not have regulatory authority for environmental permits, but is consulted to participate in review of all state and federal environmental projects in North Carolina. In 2004, NCWRC dedicated staff spent approximately 800 hours per month on environmental review and reviewed 2,200 projects. In fiscal year 2006–2007, those numbers rose to approximately 1,080 hours per month on environmental review for 3,120 projects. Dedicated staff ranked environmental review and proactive projects as very important, and ranked their success level on various projects ranging from somewhat successful to very successful. NCWRC staff maintain a close relationship with other state and federal agencies in North Carolina that are afforded regulatory authority, including the North Carolina Department of Environment and Natural Resources (NCDENR) and the agencies within that department, U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. NCWRC staff have worked very closely with NCDENR staff in developing policy and guidance documents such as "Swimming with the Current~~-A~~ Guide to Help Local Governments Protect Aquatic Ecosystems While Streamlining Environmental Review" (NCWRC undated) and "NCDENR Guidance for Preparing SEPA Documents and Addressing Secondary and Cumulative Impacts" (NCDENR undated). By working with NCDENR on guidance documents, it is anticipated that these efforts will result in greater environmental protection and less review time per project, which may in turn increase reviewers' job satisfaction level.

Conclusions

Economic growth is important to all states and provinces; however, it often occurs at the expense of ecological integrity and suitable habitat for fish and wildlife resources. Some of the more substantial impacts of development, both land-based and near-water development, are related to water quality in streams and rivers. Many native aquatic species have become imperiled or extirpated as a result. Approximately 40% of North American freshwater fish species (Jelks et al. 2008) and 72% of freshwater mus-

sel species (Williams et al. 1993) qualify for classification as "endangered," "threatened," or "special concern" at the federal level, and almost 50% of crayfishes in the United States and Canada are in need of conservation recognition (Taylor et al. 2007)—and habitat loss is a primary cause. Commenting on environmental documents and permit applications is a valuable tool that state and provincial fish and wildlife agencies can use to help reduce or mitigate the impacts of development projects on wildlife resources.

All states and provinces that responded to the survey commented on environmental documents and permits. However, the number of staff committed to this work varied widely and the type of permits on which they commented also varied. The value of environmental review to U.S. and Canadian respondents did not appear to be dependent on success in affecting projects. Conversely, the success of an agency in influencing projects did not appear to affect the perceived value of conducting reviews.

Permit reviews were generally perceived as less important to those agencies with fewer than 10 dedicated reviewers. The low importance of permit review may reflect how much time the reviewers have to spend on that process. There was broad variation in how satisfied environmental reviewers were with their positions compared to traditional positions within fish and wildlife agencies. However, more respondents agreed that proactive activities were as professionally satisfying as traditional fisheries and wildlife endeavors. Many respondents perceived environmental review work to be very important, but were frustrated at the amount of success achieved. These sentiments may explain the trend of higher success corresponding to higher job satisfaction and lower success associated with lower satisfaction.

Although a general relationship was observed between the number of dedicated reviewers and the value of review, no relationship was revealed between the number of employees and their perceived success level. These results make it difficult to recommend how an agency should organize its staff. It would likely be worthwhile to examine closely each state's and province's overall organization and the environmental program's place in each organization to better determine if there is any relationship between organization and staff who rated the program as being of high importance or agencies with the largest commitment in terms of staff.

Results of this survey suggest that although environmental document and permit review is important, additional environmental success and job satisfaction may be achieved by investing more time into proactive projects, such as policy and guidance documents and education. Our survey represents an attempt to gain a broad overview of state and provincial agency environmental review processes and reviewers' views. A follow-up study that would examine in detail each state's and province's overall organization and the environmental program's place in each organization may provide additional insight into how best to organize fish and wildlife agency's environmental review program. Results from this survey may assist fish and wildlife agencies in determining strategies to improve their environmental review programs by accomplishing the dual goal of environmental document and permit success and job satisfaction.

Acknowledgments

We thank the many staff within the North Carolina Wildlife Resources Commission who provided review of the survey instrument, particularly Frank McBride, who assisted with the original survey design. We appreciate those that completed the test survey, including David Cox, Shannon Deaton, Robert Duncan, Brian Moyer, and Craig Uyeda. Appreciation is also extended to all those participants who took the time to complete the survey and provided additional information on their programs.

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ESSAY:
ENDANGERED SPECIES

Problems Associated with Assessing the Status of Populations of Atlantic and Shortnose Sturgeons in the Southeastern United States

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The anadromous Atlantic (*Acipenser oxyrinchus oxyrinchus*) and shortnose (*A. brevirostrum*) sturgeons inhabit coastal rivers along the East Coast from southern Canada to northern Florida. The latter species is listed as endangered in the United States, and the former is presently being considered for listing and is under a complete fishing moratorium in the United States. Most stocks (i.e., inhabitants of a particular river) of both species appear to be depleted or extirpated. Federal and state management agencies (and other groups such as hydropower companies and environmental organizations) often request updates on the status of either the species or of single stocks. Providing this information for the southeastern United States has been problematic for several reasons. The intent here is to briefly describe the challenges to acquiring quantitative status information for this region and to invite advice/collaboration on these issues from fisheries biologists and from others outside that field.

Figure 1. A comparison of mouth widths of juvenile Atlantic (left) and shortnose sturgeons.

First, identification to species can be difficult, even for experienced fish biologists, primarily because their morphology changes with age. In fact, until the late 1960s it was postulated that shortnose sturgeon did not even occur in South Carolina (Leland 1968). Some previously published key characters are now known to be unreliable; for example, both coloration and pre-anal shield pattern can vary, and snout length changes with age. The only reliable means of identification (except for sheer size in the case of adult Atlantic sturgeon) appears to be mouth width to interocular distance ratio (Figure 1; Moser et al. 2000).

Both sturgeons used to support valuable commercial fisheries. However, landings were reported simply as "sturgeon." Thus, there is little value in examining historical landings data to determine population trends. Further, because these fish are not presently landed in any fishery in the United States, there are no fishery dependent data to use in establishing a more recent timeline. Fishery independent studies have been conducted more-or-less continuously in at least some southern states since the 1980s. However, the goals and methodologies of the studies have varied. In studies attempting to provide abundance estimates, experience has shown that the efforts often encounter some so-far unavoidable problems.

Most southern rivers have limited or very poor visibility, being either blackwater rivers (highly tannic) or very turbid, so visual assessments using scuba divers or cameras are rarely possible. Active sampling gear such as trawls that would permit covering large areas can rarely be used effectively due to the many snags (e.g., submerged trees). Electrofishing is a common sampling method used to target other species and for whatever reason (e.g., water chemistry, generator settings, sturgeon physiology) very rarely produces sturgeon. Thus, most sampling has and continues to depend on setting either gill nets or trammel nets. However, the snags that limit trawling also plague gill nets and trammel nets. Nets can generally be set only in specific and limited locations. Fortunately, these locations are sometimes occupied by sturgeon.

Meeting the assumption of equal catchability for mark-recapture population estimation is problematic not only due to the inability to set nets in random locations, but also by the reproductive biology and behavior of the fish, and to high variation in river conditions in drought vs. flood years. Several population estimates have been generated in South Carolina, but these have not been published due to lack of confidence in their validity (Collins, pers. observ.).

Individuals of neither species spawn annually in most cases (Collins et al. 1999), and telemetry work suggests that non-

spawners may not ascend to the spawning grounds (Collins and Smith 1995; Palmer 2001). Telemetry has shown that adult Atlantic sturgeon leave the rivers for the ocean in late fall and are essentially unavailable to researchers until they return in spring (Collins et al. 2000). They then move upriver varying distances and to a large extent disperse, with some staying in the estuary and some moving well upriver. They remain in this dispersed distribution through the summer until leaving the river in the fall (Collins et al. 2000). Thus, there is no area of concentration available that would permit sampling the entire adult population.

Shortnose sturgeon generally do not leave the rivers like Atlantic sturgeon, although movement between rivers has been documented through tagging studies (personal observation; Joel Fleming, Georgia DNR, pers. comm.). From telemetry studies, in winter the adults disperse through the estuary (Hall et al. 1991). In summer, which unlike in the northern portion of their range is the most stressful season, they tend to aggregate in certain areas. However, it appears that movement is minimal, perhaps as a result of stress from high water temperatures and low dissolved oxygen. Minimal movement results in very low catch rates with passive gears like gill/trammel nets.

Thus, obtaining valid quantitative assessments of stock status for southern populations of Atlantic coast sturgeons is problematic. The assessments that are needed by the National Marine Fisheries Service and the Atlantic States Marine Fisheries Commission (e.g., Kahnle et al. 1998) are a very important part of the management process. Currently ongoing debates concerning the status of the several populations, distinct population segments, stocks, etc. for both species as they relate to the endangered/threatened status would certainly benefit if valid assessments were available. Presently, status is essentially being determined by consensus of teams of "experts" who, because all members are experienced and apparently have the best of intentions, may actually make correct decisions. However, a valid approach to obtaining quantitative population estimates for southern stocks of these fishes would certainly facilitate responsible management and restoration efforts. Unfortunately, such an approach is not currently apparent, and developing one will require innovation (and probably collaboration) on the part of scientists working in this region.

Acknowledgements

The author thanks Theodore Smith (SC), Kent Ware (SC), Gordon Rogers (GA), Joel Fleming (GA), Vincent Mudrak (GA), Joe Hightower (NC), Wilson Laney (NC) and others for their collaboration over the years. Pertinent studies were funded by the National Marine Fisheries Service, U.S. Fish and Wildlife Service, National Fish and Wildlife Foundation, Georgia Ports Authority, and South Carolina Department of Natural Resources. This is South Carolina Marine Resources Division contribution number 670.

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COLUMN:
GUEST DIRECTOR'S LINE

Fisheries Management: A Biased Look Backward— A Myopic Look Forward

Summary of a presentation made at the 2010 meeting of the Southern Division of AFS in Asheville, North Carolina.

Fred A. Harris
AFS Past President Fred A. Harris is retired as the assistant director of the North Carolina Wildlife Resources Commission, Raleigh, and he can be contacted at fahadh92@hotmail.com.

My career with the North Carolina Wildlife Resources Commission began in 1972 as a district fisheries management biologist. The early years were characterized by a strong management emphasis on reservoirs, annual increases in the number of anglers, and a proliferation of species interest groups. I saw my mission as providing anglers with an abundant and diverse assemblage of aggressive, hard-fighting game fishes, a significant portion of which would be of trophy sizes. Curtis Taylor with the West Virginia Department of Natural Resources has accurately described my early view of the aquatic community in that there were three kinds of fishes: game, potential game, and bait. This simplistic view was re-enforced by the funding that paid my salary, i.e., license sales and the federal excise tax on fishing equipment. Anglers paid my salary and I focused my management activities on populations of game species, comforted by the conviction that other species were benefiting from my good game fish management.

As the years flowed by, some rather unpleasant issues began to emerge. Aging reservoirs were not yielding the catches that were common in their younger years. The recollections by anglers of the good old days, whether real or imagined, often led to acrimonious relations between managers and anglers. The proliferation of species interest groups also led to angler-angler conflicts, which were moderated only by the groups' mutually held conviction regarding the incompetence of fisheries managers. And a growing number of biologists began audaciously proclaiming that our good game fish management was not benefiting other members of associated aquatic communities and was often detrimental to those species. Our game species approach to fisheries management was yielding neither the fishing quality nor the conservation benefits we envisioned.

In my biased view of the past, fisheries management reflected the general emphasis among other sciences on reductionism. Reductionism is the belief that the whole can be understood through an understanding of the constituent parts. During my career, fisheries managers implicitly, and often explicitly, maintained that biological communities could be understood and conserved solely through knowledge of their constituent species, particularly those species of interest to anglers. I don't think this approach will carry us far in meeting the conservation challenges of this century. Our science is moving toward more of a focus on ecosystems and landscapes. While I believe that fisheries management will, and probably should, continue to address population-level issues, I also believe that we must have a greater focus on managing and conserving biological communities. The question then becomes, how do we accomplish this change in focus?

A biological community comprises diverse, interdependent entities that adapt to their environment. Further, the community is greater than the sum of its parts due to synergistic interactions, thus a biological community has the characteristics of a complex system. One type of complex system is a network and networks appear to offer considerable promise as a conceptual approach to studying biological communities.

A network is basically a collection of objects (nodes) that are connected by links. Nodes having many links are usually referred to as hubs. For a biological community, the nodes are species or functional units made up of multiple species. Highly connected species (hubs) may function as keystone

species within a community. A network approach to community-level management therefore has the advantages of providing graphically displayed linkages between entities while lending itself to analysis by relatively simple agent-based computer models. To the extent that biological communities exhibit network-like characteristics, we should be able to enhance our management capabilities by using existing models that examine network behavior, observing responses, and evaluating those responses in the context of a biological community. Regardless of the predictive value of the models employed, we would likely gain new insights into the functioning of biological communities and the questions we should be addressing experimentally to increase our management abilities.

I believe that a community focus by fisheries management agencies should also lead to changes in agency organizational structures. Management of communities will require both a breadth and depth of knowledge of the target communities. A typical agency organizational structure maximizes the vertical flow of information and in effect discourages horizontal flow, especially among members of different administrative units. This can be seen by the emphasis on vertical lines in an organizational chart. As information moves upward in the organization it is filtered through individual biases, conventional wisdoms of the organization, and any number of other influences before reaching the level at which decisions are made. The proliferation of knowledge in recent years would seem to preclude any individual within an organization from having the needed depth and breadth of knowledge about any biological community to effectively address management issues.

A better organizational model might be one structured as a network. Here the functional unit would be a group of diverse specialists, or generalists, which would constitute a node. The specific composition of the group should be determined by the nature of the community being studied and the issues being addressed. Benefits of such an organizational structure would include a low degree of separation (network jargon for direct communications) between individuals, with a resultant increase of horizontal information flow, substantial improvements in the quality of management recommendations due to group dynamics, and more efficient operation as a result of synergistic use of funds. This last mentioned benefit should arise from the efficient application of license revenues, federal excise taxes on fishing equipment (Wallop-Breaux funds), and federal funds for non-game species (state wildlife grants) within the work group to achieve community-level conservation objectives.

Finally, I believe a community conservation orientation will affect the operation of AFS and other professional societies. Our Sections and Committees need to reflect greater disciplinary diversity in membership. The recently formed Fish Habitat Section could be a move in that direction. Future Annual Meetings and symposia could incorporate strong participation from other societies to reflect the interdisciplinary approach that will be required to accomplish conservation at the community, ecosystem, and landscape levels.

In conclusion, I believe that science is becoming more holistic, in part through recognition that in many cases the whole is greater than the sum of the parts. If we are to be effective in the conservation of aquatic resources, we must increase our focus on biological communities as a whole rather than just on their component populations. Network science provides a conceptual approach for conservation at the community level, for agency organization, and for AFS programs.

AFS CONSTITUTION AND RULES:
NOTIFICATION OF CONSTITUTION VOTE

Proposed Amendments to the American Fisheries Society Constitution

The following two amendments to the AFS Constitution were approved by a unanimous vote of the AFS Governing Board on 6 March 2010 at their mid-year meeting in Nashville, Tennessee. Proposed amendments to the Constitution, if approved by 3/4 of the Governing Board, must be published in *Fisheries* and posted to the AFS website for Society review at least 30 days ahead of a vote by Active Members of the Society. These two amendments will be on the agenda for discussion and vote at the Annual Business Meeting of the Society on 14 September 2010 in Pittsburgh, Pennsylvania. Approval of these amendments requires an affirmative vote of 2/3 of those voting, with a minimum of 50 votes.

PROPOSED additions are in bold underlined type and deletions are shown with strikethrough.

Amendment #1:

Recommended Motion: Amend the AFS Constitution Article VI to authorize electronic voting as follows:

Article VI. MEETINGS AND VOTING

5. Business and voting may be conducted via mail or electronic media instead of at Society or Governing Board meetings. An electronic vote must be approved by the President, or the Officers, or Governing Board, as appropriate for the issue being considered. All aspects of the vote (quorum, notification, length of time the vote is open) must follow the approved procedures for the type of issue being considered.

~~5.~~ **6.** (just an editorial note that #5 under Article VI becomes #6)

Background for Motion: In the sample Unit bylaws, posted on the AFS website, under "Article VI. Meetings and Voting," the following is included: "Business and voting may be conducted via mail or electronic media if approved by the Executive Committee." However, no such statement exists in the AFS Constitution. The AFS Constitution mentions electronic voting for AFS officers in Article III.3.A and then again in Article IX.2.BB under duties of the Vote Auditor. Also, the AFS Rules mention electronic voting with regard to resolutions. But there is no overall authorization of electronic voting. *Roberts Rules of Order* (10th Ed.) does not really address electronic voting to any degree and seems to discourage it. In the footnote on page 2, it says that if electronic voting is to be used, it must be "expressly authorized by the bylaws." The AFS Procedures Manual has extensive details on the electronic voting procedures, but because the AFS Constitution alludes to electronic voting without expressly authorizing it, the Constitutional Consultant and Governing Board recommends adding an authorizing statement similar to what is recommended in the sample Unit bylaws.

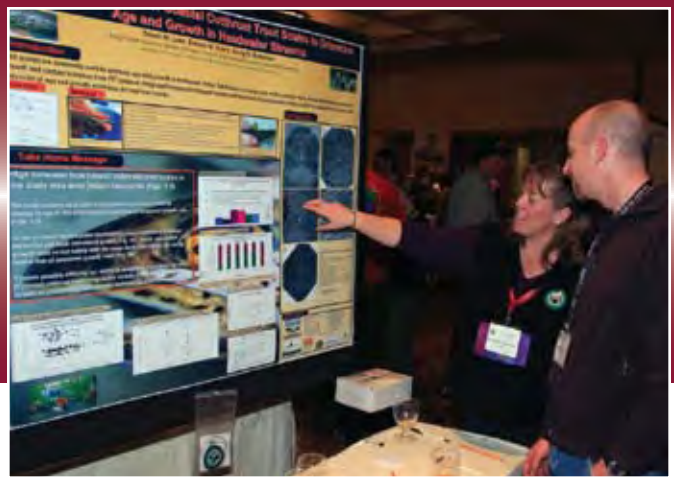
Amendment #2:

Recommended Motion: Amend the AFS Constitution Article IV to authorize representation of the Student Subsection as a non-voting member of the Governing Board as follows:

1. The Governing Board comprises the elected officers, Executive Director, Division presidents and presidents-elect, Section and Chapter presidents, **Student Subsection president,** and Constitutional Consultant.
   A. The Executive Director, presidents of Sections that had fewer than 50 members the previous year, Chapter presidents, **Student Subsection president,** and Constitutional Consultant have no vote on the Governing Board.

Background for Motion: Some years ago (date uncertain) the Governing Board voted to have the president of the Student Subsection serve as a nonvoting member of the Governing Board. However, this was never incorporated into the AFS Constitution. This amendment would incorporate that previous Governing Board decision into the AFS Constitution and give clarity to the Student Subsection's representation on the Governing Board.

Rich Grost (left) and Demian Ebert (right) visit with plenary speaker Carl Schreck (middle) at the Oregon Chapter annual meeting.



Michele Weaver discusses scale ages with David Leer at the highly successful poster session Wednesday evening.

Oregon Chapter

Holds annual meeting in Eugene

The Oregon Chapter's annual meeting in Eugene, Oregon, in February 2010 drew some 470 professionals, including 60 students, to participate in "Success Through Science and Management." The theme of this meeting reflects the reality that successful management of fisheries and aquatic resources requires translation and integration of detailed, highly technical information into management actions. Increased understanding of the science underlying natural resource processes usually leads to development of more effective management tools. This year's annual meeting challenged participants to think about the application of science and management toward achieving successful outcomes for our fisheries and aquatic resources.

Carl Schreck, professor in the Department of Fisheries and Wildlife, Oregon State University, leader of the Oregon Cooperative Fish and Wildlife Research Unit, and AFS Award of Excellence recipient, began the meeting with an inspirational and thought-provoking keynote presentation titled, "Needles in Haystacks, Haruspication, and Much Harder than Rocket Science: Perspectives on Science for Fisheries." Schreck offered his insights on the state of fisheries science and challenged the audience to think creatively and broadly. This is especially difficult when funding and peer-review processes both tend to narrow our approaches. He predicted that the science of the future will emphasize understanding how whole systems work, including connections at all levels from microscopic to macro-landscape. He urged us toward this goal through research in specialized areas such as pheromones, and also through improving our performance in providing the most basic information such as fish abundance. Throughout the meeting, many speakers referenced Schreck's address in their own talks, which is a testament to his ability to encourage broader thinking among the membership.

The volume and diversity of material presented was impressive. Twenty technical sessions accommodated 164 oral presentations and 34 posters on topics ranging from genetics, morphology, statistics, and modeling to the application of science in the fields of policy, education, aquaculture, and

Warren Leach (OR RFID) and Vince Tranquilli (ODFW) demonstrate various half-duplex antennae designs at the PIT tag workshop.

Christy Fellas (left) and Kristle Volin (right) prepare tickets for the Annual Meeting Raffle.

fisheries management. Special sessions included "Salmon in the City" and "Environmental Legacies." The least conventional session highlighted inspiring images of fish, including tips on underwater photography and video, presented by member photographers.

Three workshops preceded the meeting, enlightening 80 members. The largest, "PIT Tag Techniques and Technologies," was organized by Dave Marvin and included presentations from members with Oregon Department of Fish and Wildlife (ODFW), National Marine Fisheries Service, U.S. Geological Survey, and the Yakama Nation. Vendors participating in the workshop included OregonRFID and BioMark. This workshop covered the principles and techniques for a successful PIT tag experiment, the pros and cons of half-duplex vs. full-duplex tags, antenna theory, field detector design and testing, data management and QA/QC techniques, and live antennae demonstrations. This was the most well-attended pre-meeting workshop in recent memory. Vemco provided a free workshop on acoustic telemetry, including how the technology works, how to use Vemco equipment, and how to effectively analyze data offloaded from Vemco receivers.

The "Media Madness" workshop was presented by Oregon State University's News and Communication Services, and Extension and Experiment Station communications staff. This interactive workshop taught members how to solicit and respond to the attention of the news media. Participants reviewed news releases and video interviews, and then got their own "face time" in front of the camera for a taped and critiqued interview. There were insights on how to anticipate controversy and objectively defuse pointed questions. The workshop also provided guidance on how to translate science to help the public better understand resource and management issues.

Professional awards were managed by Mindy Simmons and the Awards Committee. Four Awards of Merit were presented to:

- Kara Anlauf (ODFW) for her outstanding dedication to rapid and effective communications for the Oregon Chapter as the Chapter's webmaster;
- Neil Ward (Columbia Basin Fish and Wildlife Authority) for his exceptional service to the Chapter, including serving on the Chapter's Executive Committee for 6 years and as the program chair for the record-setting Western Division Annual Meeting in May 2008;
- Dan Diggs (U.S. Fish and Wildlife Service) for his vision for a science-based approach to hatchery management, his insistence on high scientific standards and excellence, and his emphasis on collaboration with state, tribal, and federal agencies; and
- Brian Bangs, Paul Scheerer, and Steve Jacobs (all of ODFW) for their

Brooke Penaluna (left) and Alena Pribyl (right) receive their Student Paper and Poster Awards during the 2010 ORAFS Annual Meeting. Jayde Ferguson and Matt Stinson also won awards but are not pictured.

Student Scholarship winners (left to right): Justin Huff, Ralph Lampman, and Brooke Penaluna.

Kara Anlauf accepts her Award of Merit for her outstanding job as the Chapter's webmaster.

Neil Ward accepts his Award of Merit for his long-running service on ExCom. He was also awarded the Past President Award for his service.

Dan Diggs accepts his Award of Merit for his long service to science-based management and collaboration.

creative and tireless 20-year effort to restore Oregon chub.

The Broken Oar Award went to Don Ratliff and Jim Bartlett (both of Portland General Electric) for enduring the collapse of portions of a gigantic selective water withdrawal tower at Round Butte Dam, keeping their sanity, and persevering until the project was completed and began passing fish within the same year.

The ORAFS scholarships were awarded to: Kevin Fox (AA candidate) at Mount Hood Community College, Justin Huff (BS candidate) at Oregon State University (OSU), Ralph Lampman (MS candidate) at OSU, and Brooke Penaluna (Ph.D. candidate) at OSU. The prestigious Carl Bond Scholarship was awarded to Brooke Penaluna (Ph.D. candidate) at OSU, in support of her work on biotic interactions among native reticulate sculpin, juvenile coho, and coastal cutthroat trout in Oregon coast headwater streams. Scott Heppell and the Scholarships Committee did an outstanding job managing the scholarship process and evaluating the worthy applicants.

Best student paper honors went to Jayde Ferguson (OSU) and Alena Pribyl (OSU, runner-up), and best student poster honors went to Brooke Penaluna (OSU) and Matt Stinson (OSU, runner-up). Mike Hudson did his usual excellent job planning for these important awards.

The Student-Mentor Mixer was packed with 60 students making rapid-fire (5 to 8 minutes) "speed-dating" rounds to meet and query all 40 mentors. Despite the hectic pace, students raved about the direct exposure this

Brian Bangs, Paul Scheerer, and Steve Jacobs receive their Award of Merit for efforts to recover Oregon chub.

Don Ratliff (left) and Jim Bartlett (right) accept the Broken Oar Award for enduring the collapse of part of the selective water withdrawal tower at Round Butte Dam. Nominator Mike Gauvin stands between the recipients.

OSU undergraduates Katie Borgen (left) and Marybeth Head (right) study t-shirt designs at the sales table.

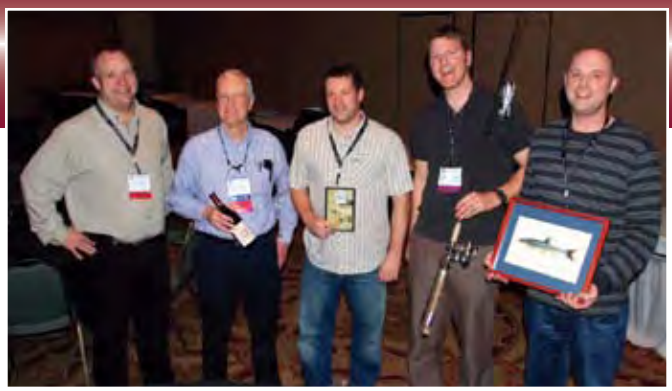
event provides to a diversity of career options, guidance, and even direct job opportunities. Shivonne Nesbitt and Brett Anderson organized and managed this event.

At the business meeting, President Rich Grost summarized the state of the Chapter as being on course to meet the goals established in the annual work plan, and within budget. He discussed the Chapter's role in continuing review of the Federal Columbia River Power System Biological Opinion and indicated that the issue had been elevated to the Western Division, where a review of the Adaptive Management Implementation Plan (AMIP) was just completed and appears timely in providing constructive comment toward improved management of the Columbia and Snake rivers. Mary Buckman (secretary/treasurer for the Western Division) provided an update on the upcoming Western Division meeting, and Bob Hughes announced his candidacy for the second vice president position of AFS. Internal Director Jason Kent announced the three education and outreach grant awardees for 2010. External Director Jeremiah Osborne-Gowey updated members on committee activities and Legislative Liaison David Moskowitz (Confluence Consulting NW) summarized opportunities to work with the state legislature. Standing committees and the Student Subunit convened for strategy sessions following the business meeting.

The raffle and auction, organized by Christy Fellas and Kristle Volin, was successful in both fun and fundraising. Amazing artwork and photographs were donated by Joe Tomelleri, Rich Grost, Mary Edwards, Ray Troll, and many others. Handmade items were donated by Laura Tesler, Michele Weaver, Paul Sheerer, and others, demonstrating the talent and creativity of some of our members. Fishing trips offered by Scott and Selina Heppell, Ian Reid, and Neil Ward were very popular. Together, over 50 individuals and businesses donated trips, items, and services to the raffle and auction.

After the banquet, two dozen card sharks plied their trade in the poker tournament and after a hard-fought game, Chad Smith emerged the overall winner. The top nine finishers were awarded a variety of prizes ranging from a Tomelleri print to fishing gear to magazine subscriptions. Tom Iverson coordinated this friendly and fun competition. The Jam Session, organized and grounded by guitarist Steve Liebhardt, brought the diverse music of some 20 member-musicians to the stage. Memorable moments include Ralph Lampman's original "Lamprey Rap," guitar licks by Jens Lovtang, mandolin riffs courtesy of Paul Sheerer, and vivacious vocals from Jeff Ziller.

Band members jam after the banquet.



Poker tournament players show off their prizes.

Oregon Chapter officers Shaun Clements, Neil Ward, Demian Ebert, Shivonne Nesbitt, Jeremiah Osborne-Gowey, Brett Anderson, and Rich Grost.

Finally, after the meeting the city of Eugene sponsored a tour of the nearby Delta Ponds Habitat Restoration Project. This is a collaborative effort with state and federal partners to restore side-channel habitat on the Willamette River. This area was once degraded and separated from the river and overgrown by invasive plants. The hydrologic connection has been restored, and it is now a thriving habitat with over 40,000 native plants and on-site use by Chinook salmon and cutthroat trout. Thanks to Eric Wold for the tour.

Overall, the 2010 meeting fulfilled expectations as the Oregon Chapter's largest and most important technical and professional networking event. Thanks are due to all who attended, assisted, presented, moderated, donated, and especially the Executive Committee for a year of behind-the-scenes planning: President Rich Grost, Past President Neil Ward, President Elect Demian Ebert, Vice President Shivonne Nesbit, Secretary-Treasurer Shaun Clements, Internal Director Martyne Reesman, and External Director Jeremiah Osborne-Gowey. This crew, and incoming President Elect Colleen Fagan, are already planning the next Oregon Chapter meeting 22-25 February 2010 at the Riverhouse Conference Center in Bend.

—Allison Evans and Demian Ebert

photos by Richard Grost

COLUMN:
STUDENTS' ANGLE

Eric R. Larson
Larson is a Ph.D. student at the University of Washington and can be contacted at lars9570@u.washington.edu.

Faculty and Graduate Student Mentoring in the Hutton Junior Fisheries Biology Program

Graduate and undergraduate students in fisheries benefit from membership and participation in the American Fisheries Society (AFS) in many ways, from leadership opportunities across the Society's hierarchy to the educational and professional benefits of attendance at conferences. However, many graduate students and their advisers may be less familiar with an AFS program that involves students in fisheries before they arrive at college. The Hutton Junior Fisheries Biology Program pairs high school students with fisheries biologist mentors for eight weeks of hands-on experience over the summer. The Hutton Program aspires to encourage interest in fisheries careers among high school students from underrepresented backgrounds in the field, including minorities and women. Junior and senior high school students are eligible to apply, and beyond an exceptional introduction to field and laboratory science, students are also compensated with a $3,000 stipend from AFS. Started in 2001, the Hutton Program now has 321 alumni, many of whom have gone on to pursue college careers in fisheries or related natural resource and biology fields. More information on the Hutton Program for both prospective students and mentors is available at www.fisheries.org/afs/hutton.html.

Kerry Ung, a 2009 Hutton Program student, measures crayfish at Mineral Lake, Washington, as part of a study documenting distributions of aquatic invasive species.

Traditionally, the Hutton Program has primarily paired high school students with mentors who are biologists and managers at state or federal resource agencies, although mentors are welcome from a wide breadth of fisheries backgrounds. University faculty and graduate students have been less frequent participants in the program. This low representation among Hutton Program mentors is unfortunate, as university faculty and graduate students may be especially well-positioned to provide insightful career guidance and diverse research experiences to students. Furthermore, universities are often located in population centers with strong applicant pools for the Hutton Program, an occasional difficulty for mentors in smaller communities.

The Hutton Program aspires to increase interest in fisheries sciences among high school students, and faculty and graduate students are ideal mentors for this purpose. As juniors and seniors in high school, many Hutton Program students are in the process of applying for or deciding on a college to attend. Faculty and graduate student mentors are well-situated to provide guidance on what to expect from college and how to navigate an undergraduate degree in the sciences. For example, faculty and graduate students can provide guidance not only on recommended classes, but also the importance of acquiring laboratory and field experience through jobs and internships, and the importance of professional contacts for future employment or admission to graduate school. University faculty are also well-versed in the expectations and demands placed on undergraduates, while graduate students have recently navigated the undergraduate experience themselves, resulting in Hutton Program mentors who can provide students with an invaluable

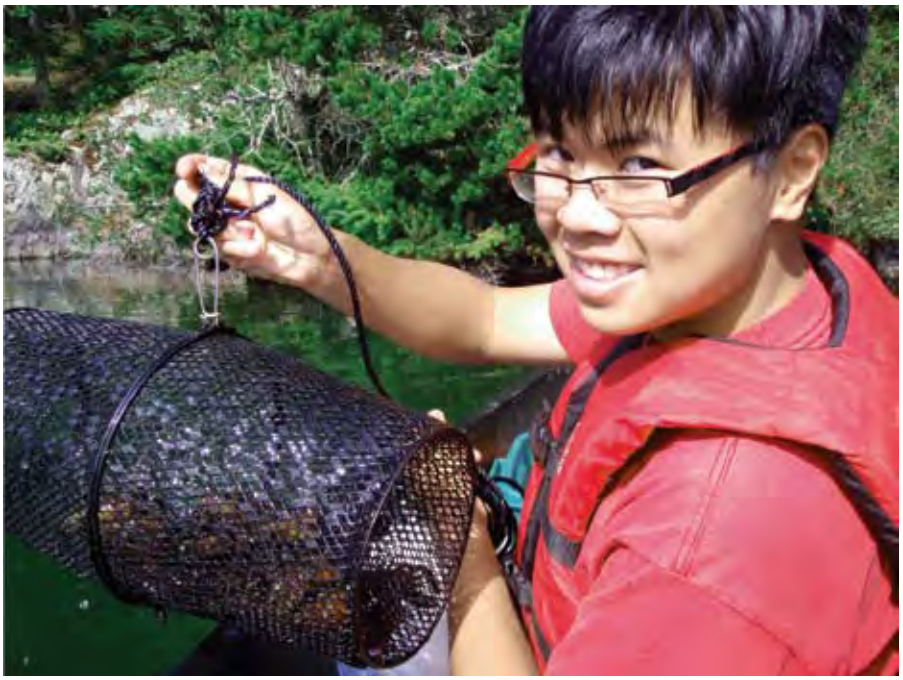
glimpse into the educational and professional world they're entering.

An additional benefit of a university setting for Hutton Program students is the diversity of research and management activities participants can experience over an eight-week period. The Hutton Program encourages co-mentoring of students to broaden the diversity of work and research exposure for participants, and universities provide an exceptional venue for this purpose. Several faculty or graduate students might co-mentor a Hutton Program student, offering exposure to a breadth of study environments, organisms, research approaches, and personalities. Such information could be extremely informative in making educational and career decisions. Although similar benefits can certainly be obtained from other prospective Hutton Program mentors (e.g., state and federal agencies), universities may be well positioned to allow Hutton Program students to work in both marine and freshwater environments, the laboratory and the field, and with scientists ranging in experience from Ph.D.-holding faculty to undergraduate technicians.

Faculty and graduate students also benefit from participation in the Hutton Program. Hutton Program students are selected from a large, talented, and motivated pool of applicants that can provide high-quality work in the laboratory and field for researchers who can often use the extra assistance. Furthermore, mentoring a Hutton Program student directly exposes a young person to issues in the environment and natural resource stewardship that will influence them and their personal decisions for a lifetime, regardless of their ultimate career path. Participation in the Hutton Program by faculty and graduate students may also feed back with outreach or citizen science efforts through community groups or schools, serving as sources for future Hutton Program applicants or means for Hutton Program students to remain engaged with their mentor following the conclusion of their time in the program. In this way, Hutton Program students may serve as a bridge between the laboratory and their school or community, facilitating interaction between university and community projects, such as habitat restoration or volunteer invasive species monitoring. It's even conceivable that the mentor and adviser relationship could extend into the future, with past Hutton Program students becoming undergraduate technicians or eventual graduate students in the lab that first exposed them to work in fisheries.

During the summer of 2009, my adviser Julian Olden and I mentored two Hutton Program students from Seattle, Washington—Francis Lin and Kerry Ung. Both students were responsible, reliable, and performed excellent work on projects evaluating the distribution and ecological impacts of freshwater invasive species in lakes of western Washington. It was enormously rewarding as a mentor to not only provide advice and encouragement on each students' college and career plans, but to also watch them develop new skills and abilities over the short expanse of a summer, from learning to paddle a canoe to identifying fish and invertebrates to acquiring basic laboratory skills. It's my hope that both students left the program not only with new skills but also with a better understanding of how to pursue a career in science and the confidence to do so. My experience as a graduate student mentor of Hutton Program students was extremely rewarding, and I would encourage other fisheries graduate students and their faculty advisers to consider participation in this valuable AFS program.

Faculty and graduate students interested in serving as Hutton Program mentors should visit the program website for additional information. The American Fisheries Society provides brochures, posters, and other promotional materials to advertise the program to schools. Prospective mentors should recruit applicants in the autumn prior to mid-winter application deadlines for both students and mentors. Although the AFS cannot guarantee pairing of students with the mentors who encouraged them to apply, advertising the program broadly is necessary to help guarantee a diverse, talented pool of prospective Hutton Program participants. Involvement in the Hutton Junior Fisheries Biology Program has enormous benefits for students and mentors alike, and I encourage other graduate students and their faculty advisers to get involved in this valuable AFS program.



Hutton Program student Francis Lin with a crayfish trap at Pass Lake, Washington, in 2009.

PUBLICATIONS:
BOOK REVIEW

Centrarchid Fishes: Diversity, Biology, and Conservation

Edited by S. J. Cooke and D. P. Philipp

Wiley-Blackwell. 2009. 539 pages. $224.

The family Centrarchidae (sunfishes) represent some of the most ecologically and economically important freshwater fishes in North America. The book is a textbook-style volume that investigates this family in a comprehensive manner, with 13 chapters written by different authors. The chapters span topics such as phylogeography, ecomorphology, reproduction and early life history, energetics, aquaculture, fisheries, and species identification. The editors did a great job of soliciting authors with much experience in each subject area, resulting in a text that is broad in its scope and at the same time detailed in its content.

Did you know that there are at least three extinct species of centrarchids, including an extinct member of the genus *Micropterus*? I didn't. The first chapter ("Species Diversity, Phylogeny, and Phylogeography of Centrarcidae") is a fascinating chronology of our phylogenetic perceptions of centrarchids. The chapter contains excellent images of fossils for various members of the family.

For researchers and fisheries managers, many of the chapters will be valuable resources. Chapter 2 summarizes hybridization within the family and describes details such as the sex ratios and degree of sterility for a range of hybrids (e.g., *Lepomis macrochirus* x *L. cyanellus*) which is an important consideration to evaluate impacts of species introductions. Chapter 7 reviews a large amount of energetics work for a wide range of centrarchid species. It includes an interesting "genealogy of largemouth bass models" showing how energetic model parameters have been borrowed and improved from one study to the next. Chapter 10 reviews culture methods for members of the group, including use of triploid technology, grow-out strategies, and nutrition requirements for each major genus. Physiology and performance metrics are summarized in Chapter 8, which represents the first synthesis of baseline values for measures such as plasma hormones, muscle enzymes, and stress responses for centrarchids. Fishery managers and researchers will find it very useful to have these parameters and studies compiled into one volume, where it will be easy to compare values across species.

...an excellent work that should be in the library of just about any professional whose work includes freshwater fishes.

The book also summarizes the ecology of Centrarchidae and puts the work in the context of broader ecological principles. Examples of competition, optimal foraging, biotic and abiotic influences on recruitment, and reproductive behaviors are described with numerous examples using a variety species within the family. Because centrarchids contain a very wide range of life history types and feeding strategies, readers will find this book useful when exploring ecological patterns for just about any freshwater fish. The book is strong enough in this area to be used as a reference in a fish ecology course.

Chapter 11 explores centrarchid fisheries and gives a solid overview of the popularity, economic implications, types of fisheries, and regulations used to manage these fisheries across their current range. Some of the information here has been published in other places, but again having it in one place for all these species will be useful.

My primary criticisms of the book are related to organization of the text and a few omissions. Some of the chapters contain content that overlaps substantially. Some of this is necessary, but the Chapter 8 "Population and Community Ecology" contains a fair amount of information that is similar to topics in Chapter 5 "Early Life History and Recruitment." Chapter 4 entitled "Alternative Reproductive Tactics" had some overlap with the chapter on hybridization. The overlap is not a major flaw but it makes the book a bit redundant in places.

Chapter 12 entitled "Contemporary Issues in Conservation and Management" could have been more explicit in separating conservation issues from management issues. For example, that chapter describes recreational fisheries broadly as a threat to centrarchid populations. Fishing influences the size and age structure of centrarchid populations, but to my knowledge there are no examples of species losses owing to fishing. The text here could do a better job of

separating the threat of population structure changes (a management problem) from the threat of species extirpations (a conservation problem).

The final chapter of the book is about 150 pages and entitled "Centrarchid Identification and Natural History." This section details the physical characteristics, size/age, coloration, range, habitat, food habits, reproductive characteristics, and other information for all 34 species in the family. Once again, it makes the book an excellent reference, and this section provides much more detail about each species than the typical "Fishes of My State" textbook. I was, however, surprised the book did not contain a set of color plates for all species in the family. Finally, the cost of the book is high, especially given the lack of color plates. This will preclude some people from acquiring the book, which is unfortunate.

In summary, this book compiles an amazing amount of information into one source that will be an important reference for a wide range of professionals working on conservation, management, culture, and ecology of this widespread family of fishes. The aforementioned misgivings aside, this book is an excellent work that should be in the library of just about any professional whose work includes freshwater fishes.

—Mike S. Allen,
School of Forest Resources and Conservation,
University of Florida,
Gainesville, Florida 32611, USA

OBITUARY: MERCER PATRIARCHE

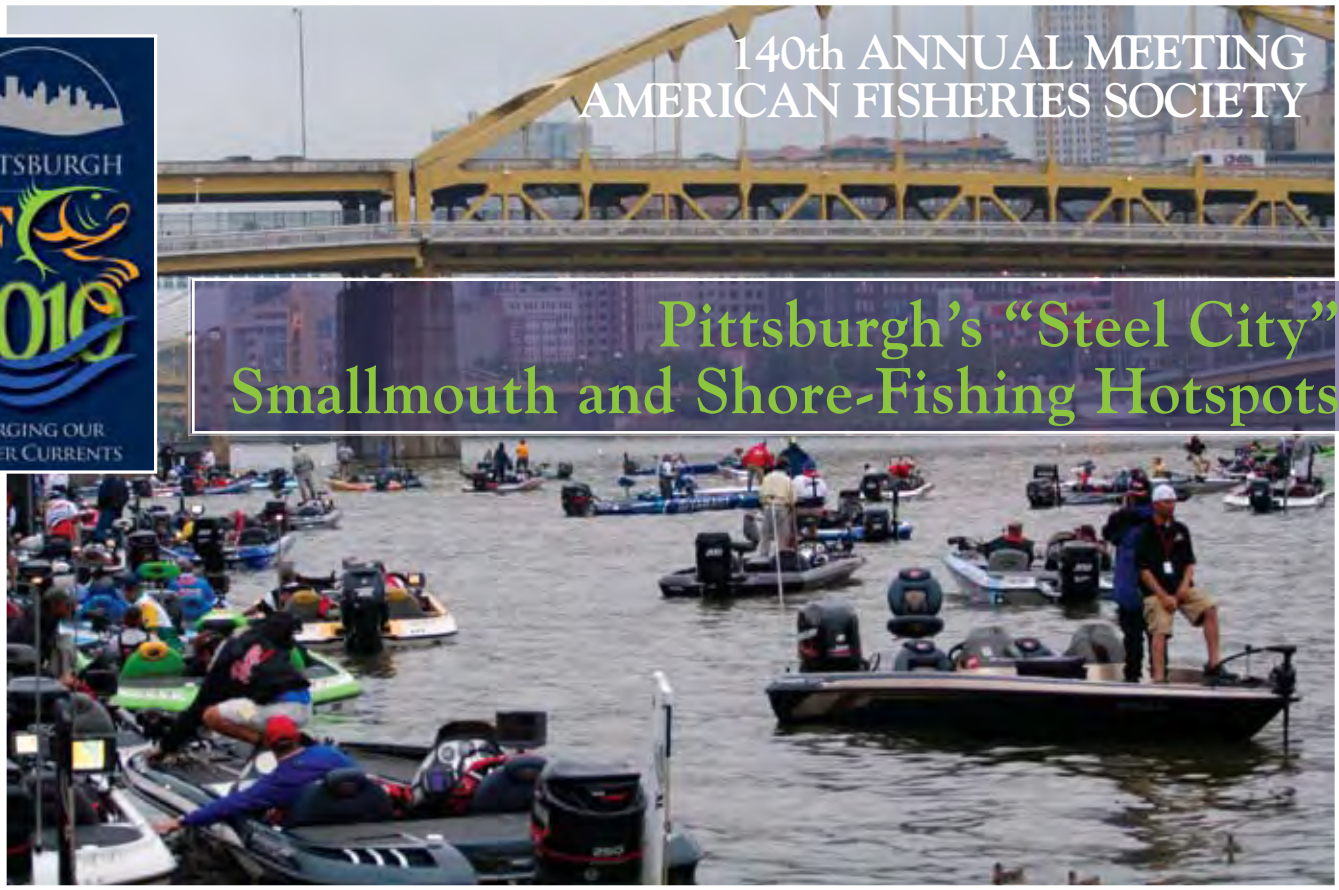
Founding Editor of the North American Journal of Fisheries Management

Mercer Harding Patriarche, 93, died at home in Ann Arbor, Michigan, on 10 April 2010. He was born in Waltham, Massachusetts, the son of Herbert and Florence Patriarche. At the age of 5, the family moved to East Lansing, Michigan, where his father became the assistant librarian at Michigan State College. Unfortunately, his father passed away the following year. His mother became the city treasurer of East Lansing and raised the family of four. Patriarche received his B.S. from Michigan State University (MSU) in 1937, and earned a M.S. from that school in 1948 after WWII. He served in the armed services in Europe in the field artillery for 32 months before being honorably discharged as a tech sergeant in 1946. He was assistant manager of MSU's State College Book Store at the time he married Melba Mickel in Grand Rapids in 1946 and they raised two children.

Patriarche took up the profession of fisheries research biologist in 1948, first moving to Columbia, Missouri, where he was employed by the Missouri Conservation commission, then returning to Michigan in 1956 to become the biologist in charge of the Rifle River Fisheries Research Station in Ogemaw County for the Michigan Department of Natural Resources (DNR). After living in West Branch for 10 years, he was transferred to the Institute of Fisheries Research in Ann Arbor. He retired from the Michigan DNR in 1981, and then was employed part-time by the American Fisheries Society as the founding editor of the Society's *North American Journal of Fisheries Management* (*NAJFM*). He worked as editor for six years. During his professional life he published several papers, served on committees of the Society, and was secretary and later president of the North Central Division. In recognition of this service, he was twice awarded the Distinguished Service Award, elected an AFS Honorary Member in 1991, and became a life member in 1996. He also received the Meritorious Service Award from the Society in 1987 and was given the Justin Leonard Award from the Society's Michigan Chapter in 1984. Furthermore, the North Central Division gave him an honorary award in 1979. In 2004, AFS established the Mercer H. Patriarche Award for the best paper published annually in the *NAJFM*. He was a member of the Society since 1947.

Patriarche was a life-long member of the Episcopal Church, serving as an acolyte in St. Paul's of Lansing as a youth and later elected to the vestries at West Branch Trinity and Ann Arbor's St. Clare's Episcopal Church. Mercer joined the Masonic organization in East Lansing in 1941 but later transferred his membership to West Branch in 1956, where he advanced through all the officer stations in the lodge except Worshipful Master, when his job transfer stopped the progression. He received his 32nd degree in Bay City in 1964 and subsequently became active in Scottish Rite Masonry in Detroit for over 35 years. Besides extensive committee assignments, he was also secretary and past president of the Washtenaw County Scottish Rite Club as well as the president of the Washtenaw Hi-12 Club, a member of Moslem Shrine Temple for several years, and was the High Priest of Washtenaw Chapter No. 6, Royal Arch Masons, in 1992–1993. Scottish Rite gave him the Meritorious Award in 1980. He also found time to participate as member of two Kiwanis clubs—Briarwood and Ann Arbor Western.

Memorials may be sent to:
The American Fisheries Society,
5410 Grosvenor Lane,
Bethesda, Maryland 20814
(www.fisheries.org/afs/donate.html)
or Washtenaw Audubon Society,
POB 130923,
Ann Arbor, Michigan 48113-0923.



Pittsburgh's "Steel City" Smallmouth and Shore-Fishing Hotspots

The waterways of Pittsburgh make it a unique and beautiful city, but most people admiring the view are not aware that the waters are teaming with life. In fact, there are more than 50 species of fish that can be found in Pittsburgh's rivers. One of the most popular gamefish there is the smallmouth bass.

The Fish

Smallmouth bass are members of the sunfish family. They are native to the Ohio River watershed which includes the Allegheny, Monongahela, and Ohio rivers. Until the mid-1800s, smallmouth bass could only be found in the Great Lakes and the Ohio River watershed.

Smallmouth bass pulled from the Allegheny River by Matt Cox.

With the industrial age and resulting pollution of the late 1800s, the number of smallmouth bass declined in the Three Rivers. Major clean-up efforts through the 1980s and 1990s resulted in a resurgence of the smallmouth bass population. Today, anglers can again enjoy the thrill of hooking a smallmouth bass.

Gear

"Steel City" smallmouth bass are great fighters, so when you fish on the rivers you will need strong line. Spool your reel with a good quality 8 to 12-lb. test line and consider a good medium action-spinning rod and reel combo. A baitcasting outfit spooled with 10-lb. test line will help you land the river's smallmouth bass.

Bait

Live bait anglers do very well with shiners in the 3-inch range and 1 to 2-inch crayfish. These live baits can be found at many area tackle shops. Circle hooks through the back will help keep shiners looking livelier and therefore will attract more strikes. Circle hooks are preferred by local anglers to catch larger fish.

For anglers who prefer artificial lures, the best advice is often "location, location, location." Locating a habitat in which your favorite artificial lure resembles the dominant food source for bass is tricky but it is the key to landing larger fish. A crankbait in a shad or fire-tiger color is an excellent lure for searching out schools of bass. Plastic baits and jigs in blue and black or dark brown are excellent baits to be used around rip-rap (partially submerged rocks) along the water's edge. The shallow flats located downstream of a shoreline point are a great place to find bass.

When to Fish

Bass season on the Three Rivers runs from the first Saturday after 11

June through 1 October. The creel limit is 6 fish that are 12-inches or larger. Be certain to check your "Summary of Fishing Regulations and Laws" before heading to the Three Rivers for current season dates. Catch-and-release angling for smallmouth bass on the Three Rivers is open year-round.

As the summer sun warms the waters past 60 degrees, bass move to deeper water and are in post-spawn mode. They may be very aggressive in early morning hours or just before dusk. When summer weather raises water temperature near 70 degrees, bass seek even deeper water, often below locks and dams. At this time, nighttime fishing is best for landing larger fish. As the water temperature cools in the fall, the bass return to more shallow water. This is the best time to land that "Big Fish."

Where to Fish

The city of Pittsburgh boat access is located off of East Caron Street at River Front Park on the South Side of Pittsburgh. River Front Park also has a handicapped fishing pier. For a list of all boat accesses on the Three Rivers, refer to the Pennsylvania Fish and Boat Commission's (PFBC) "Fishing and Boating Map" or the "Southwest Regional Guide." You can order both of these publications by contacting the PFBC at P.O. Box 67000, Harrisburg, PA 17106, or view and download the printable version online at the commission's website: www.fishandboat.com.

For shore-based anglers, easy access to the rivers can be gained by the bike trails that run parallel to the rivers. To find a printable map of the bike trails go to: www.friendsoftheriverfront.org.

Shore-fishing Hot Spots

Point State Park

Point State Park is located at the confluence of the Three Rivers in downtown Pittsburgh. Boating anglers who fish all day without a bite are often astounded to see shoreline anglers pulling bass out of the water near the point.

North Shore

Fishing the shoreline between the stadiums has produced nice bass catches but not in large numbers.

River Front Park

From June through early September, River Front Park is rarely without a shoreline angler. It is one of the most productive spots in the city.

Locks and Dams

Smallmouth bass love the consistent temperature and high oxygen levels found below the locks and dams. Fishing the lower side of any of the locks and dams can produce the largest bass in the rivers. Many of these spots are accessible by road and have designated fishing areas.

- **Emsworth Lock and Dam** on the Ohio is located just northwest of Pittsburgh off Route 65. By river, the dam is 6.3 miles downriver from the point.
- **Lock and Dam # 2** on the Allegheny River, Sharpsburg, is located northeast of Pittsburgh off Route 28. By river, the dam is 6.7 miles upriver from the point. The best fishing at this dam is on the Route 28 side, not near the lock chambers.
- **Lock and Dam # 3** on the Allegheny River, Harmar, is located northeast of Pittsburgh off Freeport Road. By river, the dam is 14.5 miles upriver from the point. The best fishing is just off Freeport Road at the dam.

Pittsburgh's status as a popular urban fishing destination continues to grow. The city hosted the Forrest Wood Cup in July 2009 with the sport's top anglers competing for a prize of $500,000.

Shore fishing is a popular activity in downtown Pittsburgh along the North Shore and at River Front Park and Point State Park.

CALENDAR: FISHERIES EVENTS

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

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

More events listed at www.fisheries.org.

Jul 7-12		Joint Meeting of Ichthyologists and Herpetologists	Providence, Rhode Island	www.dce.ksu.edu/conf/jointmeeting
Jul 24-28		Second International Sclerochronology Conference	Mainz, Germany	www.scleroconferences.de
Jul 25-30	AFS	Fisheries Society of the British Isles Conference: Climate Change and Fish	Belfast, Northern Ireland	www.fsbi.org.uk/events.htm.
Aug 1-6		95th Annual Meeting of the Ecological Society of America	Pittsburgh, Pennsylvania	www.esa.org/pittsburgh
Aug 15-20		Second International Conference on the Effects of Noise on Aquatic Animals	Cork, Ireland	www.aquaticnoise.org
Aug 22-26		National Institute of Water and Atmospheric Research	Wellington, New Zealand	www.esl.co.jp/Sympo/5th/first_announcement.pdf
Aug 31-Sep 2		Third Annual Conference of the North American Chapter of World Sturgeon Conservation Society	Chico Spring, Montana	www.wscs.info
Sep 5-9		Sixth International Symposium on Aquatic Animal Health: Global Strategies for a Changing Environment	Tampa, Florida	Andy Kane, Kane@ufl.edu
Sep 8-11		Fish Sampling with Active Methods Meeting	Ceske Budejovice, Czech Republic	www.fsam2010.wz.cz
Sep 12-16	AFS	American Fisheries Society 140th Annual Meeting	Pittsburgh, Pennsylvania	www.fisheries.org/afs10/
Sep 22		World Ocean Council: Sustainable Ocean Summit	Honolulu, Hawaii	www.oceancouncil.org
Sep 22-23		Electrofishing Class	Vancouver, Washington	www.smith-root.com
Ssep 20-24		ICES Annual Science Conference 2010	Cite des Congres, Nantes, France	www.ices.dk/iceswork/asc/2010/index.asp
Sep 27-28		Fourth International Natural Channel Systems Conference: Stream Corridors: Restoring Our Natural Infastructure	Mississauga, Ontario, Canada	www.naturalchannels.ca
Sep 28-30	AFS	Wild Trout Symposium	West Yellowstone, Montana	www.wildtroutsymposium.com
Oct 3-8		Aquatic Resources Education Association Biennial Conference	Omaha, Nebraska	www.areanet.org
Oct 10-14		Integrating Biogeochemistry and Ecosystems in a Changing Ocean: Regional Comparisons	Crete, Greece	http://imbizo-2010.confmanager.com

Oct 19		Institute of Fisheries Management 41st Annual Conference: Fisheries in Transition from Source to Sea	Portsmouth, United Kingdom	adrian.saunders@environment-agency.gov.uk
Nov 7-12		Eastern Marine Biology of Fisheries Research Institute	Taitung, Taiwan	www.tfrin.gov.tw
Nov 8-11		Alaska Sea Grant Meeting: Ecosystems 2010 Lowell Wakefield Fisheries Symposium:Global Progress on Ecosystem-based Fisheries Management	Anchorage, Alaska	http://seagrant.uaf.edu/conferences/2010/wakefield-ecosystemb/index.php
Nov 14-17		Energy Use in Fisheries: Improving Efficiency and Technological Innovations from a Global Perspective	Seattle, Washington	www.energyfish.nmfs.noaa.gov
Dec 1-2		12th Flatfish Biology Conference	Westbrook, Connecticut	www.mi.nmfs.gov/flatfishbiologyworkshop.html
Dec 10-13		Fifth Shanghai International Fisheries and Seafood Exposition—The Best Opportunity fo Explore Chinese Market	Shanghai, China	www.sifse.com
Dec 12- 15	AFS	North Central Division, joint with Midwest Fish and Wildlife Conference	Minneapolis	www.midwest2010.org

ANNOUNCEMENTS: JOBS CENTER

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.

Fisheries Biologist I, AP World Services, NOAA, National Marine Fisheries Services, Panama City, Florida.
Salary: Competitive.
Closing: Until filled.
Responsibilities: Responsibilities include but are not limited to, data entry, data proofing, field support aboard small vessels, small boat operation, processing and archiving of biological samples, coordination with co-investigators across Florida, Louisiana, Mississippi, and Alabama to facilitate Gulf sturgeon research, and recruiting and training of field volunteers. Proficient operation of small boats and trailers, laboratory and field experience, computer literate and experienced with common word processing, database, statistical, and graphics programs, knowledge of basic biological statistics, experience making oral presentations, and scientific writing skills.
Qualifications: B.S. in biology or related science or 3 years experience in related field. Must be a natural U.S. citizen or a non-U.S. citizen with at least 5 years of continuous residency in the U.S. Ideal candidates meet these minimum requirements and are flexible and easy to get along with.
Contact: Apply through the IAP World Services website www.iapws.com for the fisheries biologist I position at the Panama City, FL lab location of NOAA Fisheries.

M.S. Graduate Assistantship in Fisheries and Aquatic Ecology, Oklahoma Department of Wildlife Conservation, University of Oklahoma.
Salary: $1,545 per month plus tuition waiver.
Closing: 31 July 2010.
Starting date: 1 January 2011.
Responsibilities: Participate in Oklahoma Biological Survey monitoring and research on zebra mussels, *Dreissena polymorpha,* on Lake Texoma, Oklahoma. Research topic will likely be directed toward local life history, expansion, and management of zebra mussels.
Qualifications: B.S. in zoology or biology with preference for emphasis on aquatic ecology or related discipline.
Contact: Send cover letter, resume, copies of transcripts (unofficial OK), GRE scores (mandatory), and three letters of reference to Greg Summers, Oklahoma Fishery Research Laboratory, 500 E. Constellation, Norman, Oklahoma; 73072; gsummers@odwc.state.ok.us; 405/325-7288. See www.ou.edu/cas/zoology/graduate_degrees.htm.

Ph.D. Graduate Assistantship, University of Maine.
Salary: Fully supported 3-year research assistantship salary, plus health insurance tuition.
Closing: 1 August 2010.
Responsibilities: Work within a broad research program designed to determine the degree of demographic connectivity, immigration, and emigration and correspondence similarity or uniqueness of demographic parameters of marine and diadromous species. Responsibilities will include conducting and coordinating projects on mark-recapture and acoustic telemetry of sturgeon throughout Maine to provide a unified approach to understanding demographic connectivity and correspondence among Gulf of Maine populations. Interest in developing innovative research directions within this broader program.
Qualifications: M.S. or B.S. in biological science or equivalent. Experience with standard fisheries techniques. Excellent communication and quantitative skills preferred. GPA of 3.0 and GRE of 1100.
Contact: Send CV, transcript copies, names of references, and GRE scores to below michael.kinnison@umit.maine.edu and gayle_zydlewski@umit.maine.edu.

Postdoctoral Associate—Marine Animal Diseases, The School of Marine and Atmospheric Sciences, Stony Brook University, New York.
Salary: Depends on experience.
Closing: 1 August 2010.
Responsibilities, qualifications, and contact: See www.stonybrook.edu/job, Category K, JOBS Reference WC-S-6230-10-01-S.

Ph.D. Graduate Student Research Assistantship, Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas.
Salary: Stipend will be $18,000 plus full tuition waiver.
Closing: 15 August 2010.
Responsibilities: Develop regional ecological-flow relationships that will form the scientific framework for setting environmental flow standards and understanding impacts of global climate change. Work with a multidisciplinary team.

Starting date: Negotiable. Project is pending funding.
Qualifications: Applicants should have a B.S. and M.S. in fisheries, ecology, biology, or a related field and 3.0 GPA minimum and 1100 V Q minimum GRE. Previous research experience with fish and/or streams is preferred, but not essential.
Contact: Send a letter describing interests and career goals, resume including GPA and GRE scores, 3 names and telephone numbers of 3 references, and 4 transcripts to Dan Magoulick at danmag@uark.edu (preferred) or Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701, 479/575-5449. See http://biology.uark.edu/1397.htm.

M.S. Graduate Research Assistantship, Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas.
Salary: Stipend will be $15,000 plus full tuition waiver.
Closing: 15 August 2010.
Responsibilities: Examining population genetics and factors affecting distribution and decline of the imperiled coldwater crayfish *Orconectes eupunctus* in the Missouri and Arkansas Ozarks. Perform field work in the Ozark Mountains, experiments and observations in the lab, and ecological modelling.
Starting date: Negotiable.
Qualifications: B.S. in fisheries, ecology, biology, or a related field and 3.0 GPA minimum 1100 V Q minimum GRE. Previous research experience with crayfish and/or streams is preferred, but not essential.

ASSISTANT SPECIALIST: University of Hawaii, School of Ocean and Earth Science and Technology (SOEST). Position serves as the Program Manager for the Pelagic Fisheries Research Program (PFRP, http://soest.hawaii.edu/PFRP/) a cooperative multidisciplinary research program based in SOEST. The PFRP manager reports to the Director of the Joint Institute for Marine and Atmospheric Research (JIMAR) and is responsible for the management of all phases of the PFRP, including but not limited to identification of research priorities, evaluation of research proposals, fiscal management, organization of meetings, documentation of progress, and preparation of documents needed to ensure continuity of funding. In addition, the successful candidate is also expected to maintain an active research program in areas relevant to the PFRP and to participate in the academic life of the University. This is a non-tenure track position and is contingent on continued funding of the PFRP.

Minimum qualifications include a Master's degree with 30 credits of graduate study in fields relevant to PFRP: fisheries biology, fisheries population dynamics and behavior, fisheries oceanography, or fisheries social sciences; and three years of related experience. A Ph.D. in relevant areas is highly desirable. Preferred experience includes managing graduate level and extramural research; fisheries conservation and management decision-making; and experience in the Pacific with particular attention to highly migratory species and island ecosystems and societies. The anticipated start date is no later than August 1, 2010. Salary commensurate with qualifications and experience. Application review begins July 01, 2010.

To apply, send letter of application, resume, and list of names and contact information of three professional references to Search Committee, PFRP Mgr, c/o Dr. T. Schroeder, Director, Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa, 1000 Pope Road Room 312, Honolulu, HI 96822

Contact: Send a letter describing interests and career goals, resume including GPA and GRE scores, 3 names and telephone numbers of 3 references, and 4 transcripts to Dan Magoulick at danmag@uark.edu (preferred) or Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701, 479/575-5449. See http://biology.uark.edu/1397.htm.

Fisheries Conservation Manager, Environmental Defense Fund, Austin, Texas.
Salary: Negotiable commensurate with experience.
Closing: 16 September 2010 or until filled.
Responsibilities: Oversee and coordinate catch shares projects in the Gulf of Mexico, including Texas, Louisiana, Mississippi, Alabama, and the west coast of Florida. Partner with federal, state, and other elected officials, fisheries managers and chief scientists, catch share program administrators, council members, and local fishermen to implement these and other projects. Research and analysis of project-related information.
Qualifications: Graduate degree in science, policy, economics, or law in areas related to environmental or marine resources policy or sciences OR a minimum of 5 to 7 years equivalent professional experience. Thorough understanding of state/federal policy and political processes. Good people and project management skills. Strong written/verbal communications skills.
Contact: See www.edf.org/jobs. Contact jobs@edf.org. EOE.