APRIL 2007
VOL 32 NO 4

Fisheries

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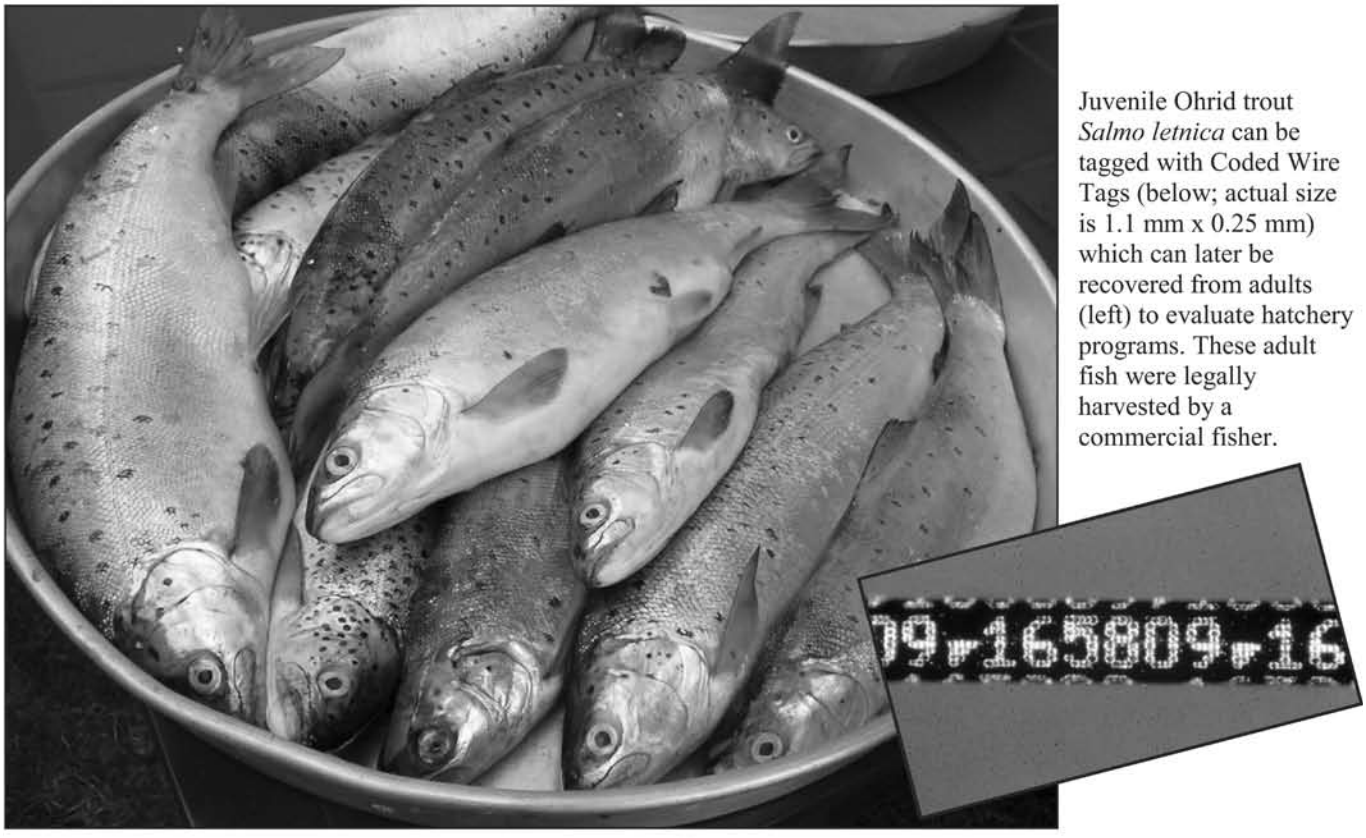
Using IKONOS Imaging to Map Wetlands in Georgian Bay

Potential Impacts of Hydrokinetic and Wave Energy Technologies on Aquatic Environments

Communicating with Oregon's Marine Recreational Fishing Community

Recovering a Unique Heritage



Juvenile Ohrid trout *Salmo letnica* can be tagged with Coded Wire Tags (below; actual size is 1.1 mm x 0.25 mm) which can later be recovered from adults (left) to evaluate hatchery programs. These adult fish were legally harvested by a commercial fisher.

Lake Ohrid is one of the oldest lakes in the world. It straddles the border between the Republic of Macedonia and Albania. Several unique species inhabit the lake, including the Ohrid trout. These trout spawn in underwater springs at depths to about 100 m. They are slow growing; while they may reach 10 kg, they take about 7 years to reach 1 kg and 3 years to attain the minimum landing size of 32 cm.

The Ohrid trout has supported an important commercial fishery, but the survival of the species is threatened by overfishing. In an effort to enhance Ohrid trout stocks, two hatcheries in Macedonia and one in Albania are producing juveniles for release. Broodstock are captured from the wild, stripped, and released. The juveniles are reared to 50-80 mm length, and about 1 million are released per year. So far, the effectiveness of the hatchery program has not been evaluated, but this is changing with the introduction of coded wire tagging for hatchery releases.

In 2005, Northwest Marine Technology helped initiate a coded wire tagging project that will evaluate the Ohrid trout stock enhancement program. Over 55,000 trout were tagged and scientists will begin an empirical assessment of their program. Success will mean the restoration of healthy stocks and a sustainable fishery, vital to the people in the region.

NMT is delighted to advise on projects and to help set up tagging programs, anywhere in the world. Please contact Biological Services if we can help with yours.

Northwest Marine Technology, Inc.

www.nmt.us

Shaw Island, Washington, USA

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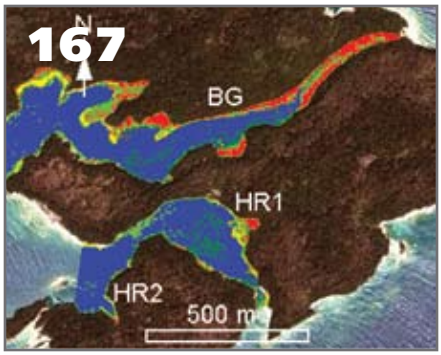
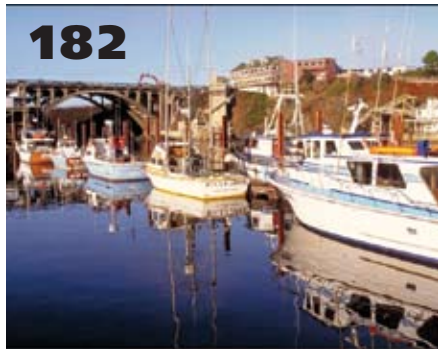
360.468.3375 office@nmt.us

Biological Services
360.596.9400 biology@nmt.us





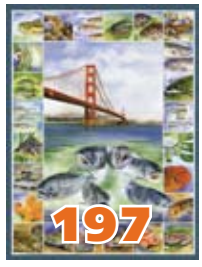
FEATURES

Cover: IKONOS image of Fathom Five National Marine Park in Georgian Bay, Lake Huron.

Credit: Anhua Wei

COLUMNS

DEPARTMENTS



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COLUMN: PRESIDENT'S HOOK

Jennifer L. Nielsen

AFS President Nielsen can be contacted at jlnielsen@usgs.gov.

Exploitation and the Conservation of Nourishing Males—Project Seahorse

It was in high school biology when I first chuckled at the idea that seahorse males became pregnant, not the females. Female seahorses transfer eggs directly to the male's brood pouch where they are fertilized and nourished until birth. The anthropomorphic associations were mind boggling to a 16-year-old girl. I recently found out that this twist of fate for many members of the genus *Hippocampus* also set the career path for one of the most effective and interesting marine fisheries conservationists active today, Amanda Vincent, director and co-founder of Project Seahorse (www.projectseahorse.org). Some time ago, Amanda and I spent time together at the University of California Berkeley studying animal behavior with George Barlow. I recently caught up with Amanda to discuss the issues of fisheries conservation, trade, and the animal culture debate for seahorses. In this President's Hook I provide an overview of our conversation.

Amanda Vincent

Male brooding and birthing are coupled with monogamy in most species of seahorse. They occupy small home ranges, swim relatively slowly, and are slow to colonize new habitats. These life history aspects and the fact that these short-lived animals (1–5 years) are generally found at low population densities or in widely dispersed dense patches (Foster and Vincent 2004) make these fish species vulnerable to overfishing, exploitation, and rapid depletion. These animals typically live in some of the most sensitive aquatic habitats in the world: coastal estuaries, seagrass meadows, mangrove swamps, and coral reefs. Global distribution throughout these rapidly disappearing habitats makes the seahorse a true bellwether species for aquatic ecosystem conservation. Based primarily on activity initiated by Amanda's team, Project Seahorse, seahorses were among the first marine fishes of commercial importance to be included in both the World Conservation Union (IUCN) Red List and the Convention on International Trade in Threatened and Endangered Species (CITES) Appendix II. But there are still enormous problems concerning sustainability and conservation for these unique animals. Indeed, Amanda considers such listings a call to action rather than a victory in themselves.

Four seahorses are native to North America, with three in the Atlantic/Caribbean (lined seahorse, *Hippocampus erectus*; dwarf seahorse, *H. zosterae*; and longsnout seahorse, *H. reidi)* and one off the west coast (Pacific seahorse, *H. ingens*; Lourie et al. 1999; www.fishbase.org). All four are included on the 2006 IUCN—World Conservation Union Red List: the first two as "vulnerable" and the latter two as "data deficient" (IUCN2006).

Commercial exploitation of seahorses and closely related pipehorses and pipefishes (all in the family Syngnathidae) supports extensive trade in many countries, primarily directed at traditional medical practices in China, Japan, Korea, and Indonesia (http://seahorse.fisheries.ubc.ca/trade.html). Trade in Asia alone has been estimated to exceed 45 tons of dried seahorses, with an estimated 24.5 million seahorses sold annually for use in traditional Chinese medicine (Vincent 1996). Incidental extraction is also a significant issue for seahorse populations in areas with fisheries using non-selective gear (Vincent 2006). Given that Project Seahorse is definitely a marine conservation team, it is rewarding that the group promotes sustainable and ecologically viable fisheries for seahorses. Indeed, its vision is a world with healthy and well-managed marine ecosystems.

Live seahorse collection also supports a growing aquarium market for education, hobby collectors (primarily targeted at the North American market), and ornamental display. Project Seahorse supports sustainable trade in syngnathids for the public aquarium market and suggests that this activity has a role to play in the conservation of seahorses and pipefishes. However, Amanda emphasized the fact that extraction for display applies considerable direct pressure on many populations around the world. Project Seahorse collaborates with the aquarium community to minimize its impacts and engage in conservation efforts directed at sustainability of wild populations (http://seahorse.fisheries.ubc.ca/positions.html). Indeed, the Zoological Society of London (UK) and John G. Shedd Aquarium in Chicago are key partners in Project Seahorse. Heather Koldewey, associate director and co-founder of Project Seahorse, is currently writing a review and analysis of seahorse aquaculture globally.

Newsletters from aquarium hobbyists' web sites frequently suggest that captive-bred seahorses are better adapted to aquarium life and may not be subject to many of the diseases and other stresses that contribute to high mortality rates in captive wild-caught animals. However, they may not realize that syngnathid aquaculture in the long term may not be sustainable, economically viable, environmentally responsible, or totally independent of wild harvest for brood stock.

Farming or culture of threatened

Continued on page 196

The Acoustic Tag Update

Project Location:
University of Hawai'i at Hilo
Hawai'i, USA

Using 3D Modeling to Present Fine-Scale Fish Tracks

This winter Chris Mott, a marine science student at the University of Hawai'i at Hilo, designed an internship to create photorealistic telemetry animations. He created a 3D hydropower dam environment showing actual fish behavior obtained from an acoustic tag tracking study conducted at a dam on Washington's Columbia River. His 3D animations provide valuable visual aids for report presentations, as well as a means to inform researchers about the behavior of fish and capabilities of acoustic telemetry.

Many fisheries biologists use 3D acoustic tag tracking systems to track fish. Typically pre-programed *Model 795 Acoustic Tags* are surgically (or gastrically) implanted into fish. The tags send out acoustic "pings" at pre-determined rates. The pings are picked up by an array of hydrophones strategically placed in the water. As a fish swims through the hydrophone array, the position of the fish is triangulated by the acoustic receiver that is connected to a computer. The computer stores the data, which can be accessed anywhere in the world by satellite. The data is used to track the fish in 3D, which can happen in real-time using the acoustic tag program *MarkTags.* The resulting 3D fine-scale track shows the path the fish took to bypass the dam.

Using the *AcousticTag* software suite permits researchers to analyze the data and export tag detections to 3D data plots.

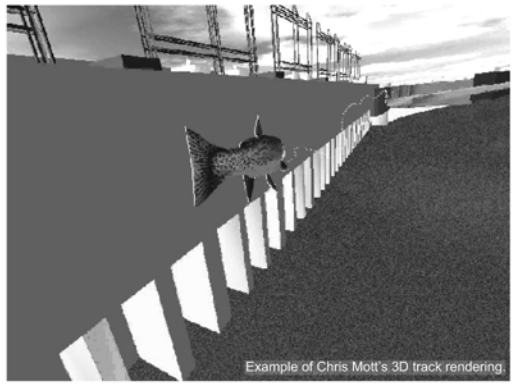

Chris and fellow classmates working on a research vessel in Hilo.

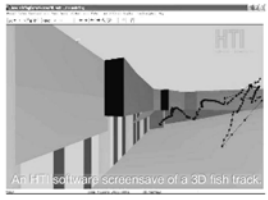
While these applications are designed to handle massive amounts of data points for thousands of fish, they do not build 3D environment models. Until recently, the acoustic tag fish tracks were drawn and animated with basic 3D lines and did not include texture-mapping, reflections, transparency, translucency, refraction, caustics, etc. For the most part, the model dam consisted of basic geometric shapes with a limited number of colors, and excluded surface textures. To show depth changes, the dot indicating each fish position changed color: red when deep and blue when shallow. Chris's newly rendered animations consist of a species-correct fish following small dots (the 3D fish track) overlaid on the specific dam environment.

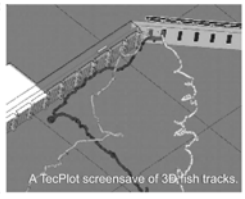
"I feel that this is needed because HTI is an industry-leading company and should present its data in the most attractive, and yet scientifically sound manner available," explained Chris. He is presently working to simplify importing different tracks into his scaled 3D environment.

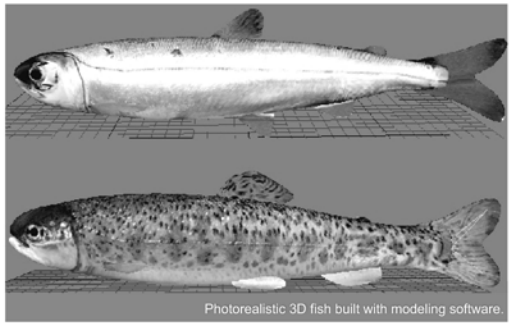
Chris built the new renderings using Lightwave 3D® software and HTI's *AcousticTag* software suite. He was able to clearly articulate the viewpoint, texture and lighting to create a simulation of the aquatic environment, the fish, and the fish's journey down the river. HTI was pleased to work with Chris and the University of Hawai'i at Hilo for this internship. For more info about his project, about *Model 795 Acoustic Tags* or *MarkTags* software, go to HTIsonar.com or call us at (206) 633-3383.

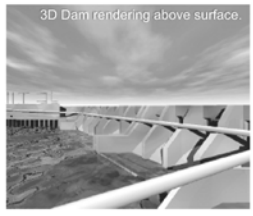
Ask Chris about his work in-person at the 137th AFS Annual Meeting in San Francisco this September

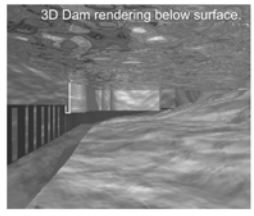

Example of Chris Mott's 3D track rendering.


An HTI software screensave of a 3D fish track.


A TecPlot screensave of 3D fish tracks.


Photorealistic 3D fish built with modeling software.


3D Dam rendering above surface.


3D Dam rendering below surface.

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Major Aquaculture Drug Approval

Florfenicol (Aquaflor®) was approved for control of mortality due to coldwater disease in freshwater-reared salmonids on 19 March 2007. The sponsor is Schering-Plough Animal Health Corporation (SPAH; Union, New Jersey). This is the first antimicrobial approved for controlling mortality due to coldwater disease in salmonids. It is also the second label claim approved for Aquaflor®, the first new antimicrobial approved for aquatic species in more than two decades. This second label claim gained designation under the Minor Use and Minor Species Animal Health Act, which entitles SPAH to seven years of exclusivity for marketing rights for a drug that is classified as a Veterinary Feed Directive drug.

This approval should greatly benefit the commercial salmonid industry and public production of any salmonid reared in freshwater. Coldwater disease causes significant losses of hatchery-reared salmonids, including losses at state and federal hatcheries producing fish for native salmonid restoration programs. Up to 50% of affected fish may be lost during disease outbreaks, with greater mortality in younger fish.

The approval of Aquaflor® is the result of a cooperative effort among the sponsor, SPAH, and federal and state researchers. The Aquatic Animal Drug Approval Partnership Program (AADAP, U.S. Fish and Wildlife Service, Bozeman, Montana) conducted and coordinated the pivotal and supportive efficacy studies. The U.S. Fish and Wildlife Service's Makah National Fish Hatchery and the Montana Department of Fish, Wildlife, and Parks' Washoe Park and Murray Springs state fish hatcheries aided AADAP in conducting the effectiveness studies. The Upper Midwest Environmental Sciences Center (UMESC, U.S. Geological Survey, La Crosse, Wisconsin) supported the effectiveness studies by providing feed analyses. SPAH used the UMESC effluent survey to support the environmental assessment for continuous-flow systems. AADAP and UMESC developed the data with financial support through base funds and the Federal-State Aquaculture Drug Approval Partnership Project that was under the auspices of the Association of Fish and Wildlife Agencies.

SPAH previously recognized AADAP and

Continued on page 190

UPDATE: LEGISLATION AND POLICY

Jessica Geubtner

AFS Policy Coordinator
Geubtner can be contacted at
jgeubtner@fisheries.org.

Bush Administration sends aquaculture bill to Congress

On 12 March, Secretary of Commerce Carlos Gutierrez unveiled the Bush Administration's proposed legislative plans for offshore aquaculture in the U.S. Exclusive Economic Zone (EEZ), the area 200 miles offshore. In 2005, Senators Daniel Inouye (D–HI) and Ted Stevens (R–AK) introduced a similar bill, the National Offshore Aquaculture Act of 2005, which died in sub-committee. The announcement of a new aquaculture bill comes after the U.S. Department of Agriculture's (USDA) recent announcement that its National Organic Standards Board will consider creating organic labeling standards for farm-raised fish, including carnivorous species such as salmon and tuna.

The National Offshore Aquaculture Act of 2007 differs in a few of significant ways from the failed 2005 bill. The bill includes a clause which allows individual coastal states to prohibit the production of aquaculture up to 12 miles from their shores. The length of the permits for aquaculture facilities has also been extended from 10 years in the 2005 bill to 20 years in the 2007 bill. More significantly, in response to criticism from environmental groups of the 2005 bill, drafters of the 2007 bill have included language to address the potential environmental risks and impacts of aquaculture operations. The bill would require the Secretary of Commerce to develop a permitting process that takes into account the environmental impact of aquaculture operations such as disease and parasite transmission to wild fish stocks and escape of potentially invasive species. Additionally, the permitting process would require the input of relevant federal and state agencies and management councils and allow for public input. The proposed legislation would make the National Oceanic and Atmospheric Agency (NOAA), the agency charged with protecting the country's ocean resources, the federal agency responsible for issuing and administering open ocean aquaculture permits.

Proponents of the bill have argued, primarily on economic grounds, that the United States needs offshore aquaculture in order to end the "seafood trade deficit." Carlos Gutierrez has endorsed the bill as a step towards ending the export of jobs, technology, and investment in the $70 billion worldwide aquaculture industry, of which the United States accounts for 1%. Some proponents have gone so far as to describe aquaculture as a solution for an assortment of economic, environmental, social, health, and even national security problems.

Other supporters have suggested the near-absence of aquaculture in the United States is a sign that the nation is not keeping up in an expanding economic sector. However, other countries have had environmental problems arise from the development of offshore aquaculture. AFS members also commented on the issue in an article in *Fisheries* in December 2006 (Stickney, R.R., Costa-Pierce, B., Baltz, D. M., Drawbridge, M., Grimes, C., Phillips, S., and D. L. Swann. 2006. Toward sustainable open ocean aquaculture in the United States. Fisheries 31[12]:607-610).

FY 2008 budget update

On 23 March the Senate approved an almost $3 trillion budget resolution for fiscal year 2008 (FY 08). The Senate bill contains $31.322 billion for the Function 300 account, the primary funding source for most of the environmental and natural resource programs at the Environmental Protection Agency, Interior Department, NOAA, and USDA. A similar version was passed by the House Budget Committee the previous week. The House resolution includes $32.8 billion for Function 300. Both House and Senate Function 300 requests are higher than last year's funding level and President Bush's request for FY 2008.

Another funding issue faced by Congress was the emergency supplemental spending bill for the war in Iraq. This $121.6 billion spending bill passed the House and was favorably voted out of the Senate Appropriations Committee. The bill includes $60.4 million for salmon fishers and tribes in northern California and Oregon to address the salmon fishery failure on the Klamath River and $94 million for the Army Corps of Engineers to repair 213 sites in the levee system on the Sacramento and San Joaquin rivers damaged by storms last year.

Momentum for H.R. 1495, the Water Resources Development Act (WRDA), has slowed in spite of the efforts by House Transportation and Infrastructure Chairman James Oberstar (D-MN) and it is now unlikely that the House will consider the bill until after they return from the two-week April recess. A mark-up of the Senate version of WRDA is also unlikely to occur until after the recess. ♋

FISHERIES CURRENTS:
SCIENCE NEWS FROM AFS

Modeling the effects of longline gear changes

Longline fishing in the North Pacific has become increasingly controversial in recent years due to concerns about the effects of longline bycatch on marlin, sea turtle, and shark populations. Researchers are currently investigating several gear changes that could reduce bycatch, such as changing the depths of the lines and switching from conventional tuna hooks to circle hooks. Circle hooks are thought to catch fewer sea turtles and be less likely to be swallowed by fish, increasing post-release survival. In a recent paper in *Transactions of the American Fisheries Society,* scientists from the University of Wisconsin-Madison and Simon Fraser University in British Columbia used computer models to determine the potential effects on various species in the North Pacific food web by combining the use of circle hooks with catch-and-release practices in longlining. If circle hooks have a higher catch rate than conventional hooks, as some field studies suggest, marlin and shark populations would decline over 30 years without catch-and-release. However, combining the use of circle hooks with catch-and-release practices for marlins and sharks led to a dramatic increase in their modeled biomass. One trade off is that increasing marlin and large shark populations would in turn lead to declines in their prey species, such as yellowfin tuna and small sharks. However, the authors' models suggest that a combination of gear changes and bycatch release would be a more effective conservation strategy than a 50% reduction in fishing effort. More research on the catch rates of circle hooks in the Pacific longline fishery is badly needed to get a more accurate picture of the possible effects of their use on these apex predators. ***Circle Hooks for Pacific Longliners: Not a Panacea for Marlin and Shark Bycatch, but Part of the Solution,*** by Isaac C. Kaplan, Sean P. Cox, and James F. Kitchell. Transactions of the American Fisheries Society 136:392-401. Kaplan can be contacted at isaac.kaplan@noaa.gov.

Connectivity between rivers and their backwaters

The loss of connectivity between large Midwestern rivers and their associated floodplains and backwaters has been blamed for the decline of native fish species and expansion of exotic species. So when the U.S. Army Corps of Engineers began reconnecting rivers and backwaters in 40 habitat rehabilitation and enhancement projects (HREPs), primarily for sediment control, researchers began to study how these projects affected fish connectivity and accessibility. In a recent paper in the *North American Journal of Fisheries Management,* scientists from the Fisheries and Illinois Aquaculture Center of Southern Illinois University examined the distribution and movement of fishes through a HREP

Continued on page 191

Challenges for Diadromous Fishes in a Dynamic Global Environment

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Featured Plenary Presentations:

Robert McDowall (New Zealand) –*Diadromy in the ecology and evolution of aquatic organisms*

Thomas Quinn (USA) - *Anadromy and the life history of salmonid fishes: nature, nurture, and the hand of man*

Program oral sessions:

Dynamic Nature of Diadromy
K. Tsukamoto - *Evolutional and behavioral approach for the origin of fish migration: Anadromous salmon and catadromous eels have the common drive as a trigger for migratory behavior?* J.J. Dodson et al. - *Contrasting evolutionary origins of anadromy in euteleostean fishes.* I. R. Bradbury et al. - *The loss of anadromy and its consequences for neutral and non-neutral traits in rainbow smelt from coastal Newfoundland.* J. D. McCleave & E. Edeline - *The control of facultative diadromy in Anguilla spp.* T. M. Grothues et al. - *Modifying the migratory contingent model for Atlantic coast striped bass.* K.L. Howland et al. - *Variability in diadromous behaviour of a northern coregonid based on scanning proton microprobe analysis of otolith strontium.*

Climate Change and Anthropogenic Influences
R.J. Beamish. - *Changing climate and the need to change our thinking about the future of Pacific salmon.* G. Lassalle et al. - *Learning from the past to predict the future: responses of European diadromous fishes to climate change.* S.D. McCormick - *Taking it with you when you go: how the freshwater environment, including dams & contaminants,affects seawater performance.* W.A. Monk & R.A. Curry - *Ecological significance of spatial and temporal variability in stream temperatures across north-eastern North America.* M.J. Miller et al. - *Potential affects of ocean-atmospheric changes on recruitment of temperate anguillid eels in the Atlantic and Pacific oceans.* S. Bonhommeau et al. - *Impact of climate change on eel recruitment.*

Ocean Environment and Migration
M.J.W. Stokesbury et al. - *Tracking of diadromous species using hybrid acoustic and archival electronic tags.* D.J. Jellyman & M. Bowen - *The hunt continues – the use of pop-up tags and dispersal models to evaluate possible spawning areas of New Zealand freshwater eels.* R.G. Bradford et al. - *Behavioural and environmental influences on migration of silver American eel through the coastal zone.* J.F. Kocik et al. - *Assessing estuarine and coastal migration and survival of Atlantic salmon smolts in Maine using ultrasonic telemetry.* K.I. Bell. - *What comes down must go up: what are plausible marine early growth habitats for migratory fishes, shrimps, and gastropods of isolated volcanic islands?* D. K. Rowe & G. Kelly. - *Growth rate at sea influences the timing of inanga migration back to freshwater.* M. Iida et al. - *Migration strategy of a diadromous goby in Japan.*

Linkages With Ecosystem Energetics
R.J. Naiman et al. - *Marine-Derived Nutrients and the Dynamics of Riverine Ecosystems.* J.P. Smol et al. - *Salmon, nutrient cycling and lake sediments: a window on the past and a view to the future.* K.H. Nislow & B.E. Kynard - *The ecological role of sea lamprey in freshwater streams of the North Atlantic basin.* R.A. Cunjak et al. - *Benthic invertebrates consume marine-derived organic matter in Atlantic coast streams.* H.K Swanson & K.A. Kidd - *The effect of anadromous Arctic charr on food web structure in coastal arctic lakes.* R.N. Sinnatamby et al. *Spatial and temporal variability in the marine feeding ecology of Atlantic salmon in the north Atlantic.*

Population and Habitat Restoration
B. Jonsson & N. Jonsson - *Population and habitat restoration with respect to Atlantic salmon.* D. A. Secor - *Conservation of diadromous fish habitats: contingent structure, biodiversity, and the portfolio effect.* D.M. Kahn et al. - *Restoration of the Delaware River spawning stock of striped bass, one of the four major stocks along the Atlantic coast of the US.* T. Castro-Santos - *Bioengineers: meet the fish. A biological assessment of fish passage design.* A. R. M. Mohamed et al. *Distribution, abundance, growth rate and food habits of sbour juveniles in Mesopotamian restored marshes.* W. Dekker - *Restoration of the European eel, a long-lived and wide-spread species, by immediate regional protection.*

Management and Governance of Diadromous Fishes: Sociological, Economic, Political, and Ecological Considerations
E. Anderson et al. - *Indigenous management of fisheries in the Peruvian Amazon: The case of Lake Rimachi.* S. Blaber. *Socio-economic and bio-political linkages in the management of tropical shads. Can the ecosystem approach improve management of tropical estuarine fisheries for diadromous species?* R.T. Lackey - *Challenges to sustaining diadromous fishes through 2100: lessons learned from western North America.* N. Haggan et al. - *Salmon in ocean space and time.* M.B. Hammer - *Whose fish? Managing salmonidae and humans in complex social-ecological systems – examples from the Baltic Sea Region.* M.A.L. Siddique - *Conservation of juvenile hilsa shad in Bangladesh: Need to address the livelihood issues of fishers.* R.B. MacGregor et al. - *Socio-economic and biopolitical linkages in American eel management.* T.V. Willis - *Policy, politics, and science: Dispelling myths about alewife in the St. Croix River fisheries debate.* A.K. Hill - *The Santee Cooperative Accord: Restoring diadromous fish through prioritization of sub-basins.* E. Rochard et al. - *Diadromous diversity recovery and wish of inhabitants: Lesson from an eco-anthropological approach (The Seine basin, France).*

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JOURNAL HIGHLIGHTS: Transactions of the American Fisheries Society

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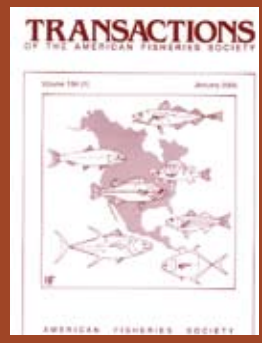

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Fine-Scale Population Structure of Rainbow Trout in the Spokane River Drainage in Relation to Hatchery Stocking and Barriers. Maureen P. Small, Jason G. McLellan, Janet Loxterman, Jennifer Von Bargen, Alice Frye, and Cherril Bowman, pages 301-317.

Modeling Annual Growth Variation using a Hierarchical Bayesian Approach and the von Bertalanffy Growth Function, with Application to Lake Trout in Southern Lake Huron. J. X. He and J. R. Bence, pages 318-330.

Effects of Population Increase on Cui-ui Growth and Maturation. G. Gary Scoppettone and Peter H. Rissler, pages 331-340.

Passive Integrated Transponder (PIT) Tagging Did Not Negatively Affect the Short-Term Feeding Behavior or Swimming Performance of Juvenile Rainbow Trout. Nathalie C. Newby, Thomas R. Binder, and E. Don Stevens, pages 341-345.

Measure Twice, Estimate Once: Pacific Salmon Population Viability Analysis for Highly Variable Populations. Charles M. Paulsen, Richard A. Hinrichsen, and Timothy R. Fisher, pages 346-364.

Field-Based Estimates of Thermal Tolerance Limits for Trout: Incorporating Exposure Time and Temperature Fluctuation. Kevin E. Wehrly, Lizhu Wang, and Matthew Mitro, pages 365-374.

Stock Identification of Atlantic Cod in U.S. Waters Using Microsatellite and Single Nucleotide Polymorphism DNA Analyses. Isaac Wirgin, Adrienne I. Kovach, Lorraine Maceda, Nirmal K. Roy, John Waldman, and David L. Berlinsky, pages 375-391.

[Note] **Circle Hooks for Pacific Longliners: Not a Panacea for Marlin and Shark Bycatch, but Part of the Solution.** Isaac C. Kaplan, Sean P. Cox, and James F. Kitchell, pages 392-401.

Upstream Swimming Performance of Adult White Sturgeon: Effects of Partial Baffles and a Ramp. Jason D. Webber, Stephanie N. Chun, Teresa R. MacColl, Leslie T. Mirise, Ayako Kawabata, Emily K. Anderson, Tae Sung Cheong, Lev Kavvas, Maureen McGee Rotondo, Karen L. Hochgraf, Roger Churchwell, and Joseph J. Cech, Jr., pages 402-408.

Approximate Sample Sizes Required to Estimate Length Distributions. L. E. Miranda, pages 409-415.

Effects of Increased Suspended Sediment on the Reproductive Success of an Upland Crevice-Spawning Minnow. Andrew B. Sutherland, pages 416-422.

[Note] **An Improved Technique for Small-Scale Radio-Tracking of Crayfish and Benthic Fishes in Upland Streams.** Ben Broadhurst and Brendan Ebner, pages 423-427.

A Comparison of Composite Habitat Suitability Indices and Generalized Additive Models of Invertebrate Abundance and Fish Presence–Habitat Availability. Ian G. Jowett and Andrew J. H. Davey, pages 428-444.

[Note] **Habitat-Specific Growth in Juvenile Pinfish.** Virginia R. Shervette and Frances Gelwick, pages 445-451.

Spawning Distribution of Sockeye Salmon in a Glacially Influenced Watershed: the Importance of Glacial Habitats. Daniel B. Young and Carol Ann Woody, pages 452-459.

The Hybrid Sole *Inopsetta ischyra* (Teleostei: Pleuronectiformes: Pleuronectidae): Hybrid or Biological Species? Daniel L. Garrett, Theodore W. Pietsch, Fred M. Utter, and Lorenz Hauser, pages 460-468.

[Note] **Otolith Microchemistry Provides Information Complementary to Microsatellite DNA for a Migratory Fish.** Frederick Feyrer, James Hobbs, Melinda Baerwald, Ted Sommer, Qing-zhu Yin, Kevin Clark, Bernie May, and William Bennett, pages 469-476.

Dynamics of Piscivory by Lake Trout following a Smallmouth Bass Invasion: A Historical Reconstruction. Yolanda E. Morbey, Kris Vascotto, and Brian J. Shuter, pages 477-483.

Genetic Relationships among Populations of the Senegalese Sole *Solea senegalensis* in the Southwestern Iberian Peninsula Detected by Mitochondrial DNA–Restriction Fragment Length Polymorphisms. Edgardo Díaz-Ferguson, Ismael Cross, Maria Del Mar Barrios, and Laureana Rebordinos, pages 484-491.

Assessing Potential Effects of Entrainment and Impingement on Fish Stocks of the New York–New Jersey Harbor Estuary and Long Island Sound. Douglas G. Heimbuch, Dennis J. Dunning, Quentin E. Ross, and Alan F. Blumberg, pages 492-508.

Morphological Variation of Siscowet Lake Trout in Lake Superior. Charles R. Bronte and Seth A. Moore, pages 509-517.

Classification of Larval and Adult Delta Smelt to Nursery Areas by Use of Trace Elemental Fingerprinting. James A. Hobbs, William A. Bennett, Jessica Burton, and Michelle Gras, pages 518-527.

Close Encounters with a Fish Screen II: Delta Smelt Behavior Before and During Screen Contact. David K. White, Christina Swanson, Paciencia S. Young, Joseph J. Cech, Jr., ZhiQiang Chen, and M. Levent Kavvas, pages 528-538.

Movement of Walleyes in Lakes Erie and St. Clair Inferred from Tag Return and Fisheries Data. Hui-Yu Wang, Edward S. Rutherford, H. Andrew Cook, Donald W. Einhouse, Robert C. Haas, Timothy B. Johnson, Roger Kenyon, Brian Locke, and Mark W. Turner, pages 539-551.

Use of IKONOS Imagery to Map Coastal Wetlands of Georgian Bay

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ABSTRACT: Wetlands throughout North America have been diminished in quantity and quality because of human activities, and it is therefore important that fishery managers monitor changes in supply of this critical fish habitat. Use of traditional field-based methods to detect and record the change in aquatic vegetation in Great Lakes wetlands is a daunting task because wetlands are extensive and widely distributed along the Great Lakes shoreline. Mapping wetlands for such a large geographic area necessitates the use of remote sensing technology to obtain an accurate inventory of these ecosystems. The objective of this study was to explore the capabilities of using IKONOS satellite imagery to map different types of aquatic vegetation and habitat features in Great Lakes wetlands. We acquired imageries for Fathom Five National Marine Park in Lake Huron and an area of eastern Georgian Bay in 2002 and chose 11 wetlands for habitat mapping with remote sensing software. The comparison of results of the image analysis with reference data indicated that the overall accuracy of mapping was approximately 90%. This suggests that high resolution IKONOS imagery can be used effectively to monitor the change in aquatic vegetation and thus track alterations in fish habitat in Great Lakes coastal marshes.

Uso de la colección de imágenes de IKONOS para mapear los humedales de la Bahía Georgiana

RESUMEN: Los humedales de América del Norte han disminuido en cantidad y calidad por las actividades humanas, por lo que es importante que los administradores de recursos pesqueros evalúen estos cambios en este hábitat crítico. El uso de métodos tradicionales para detectar y registrar cambios de la vegetación acuática en los humedales de los Grandes Lagos es una tarea descomunal, debido a que los humedales son extensos y están ampliamente distribuidos alrededor de la línea de costa. Para inventariar con precisión ecosistemas de humedales en áreas geográficas extensas es necesario el uso de tecnología de sensoría remota. El objetivo de este estudio fue explorar la potencialidad de las imágenes tomadas por el satélite IKONOS para dibujar mapas de los diferentes tipos de vegetación y características del hábitat de los humedales de los Grandes Lagos. Adquirimos imágenes del año 2002 para el Parque Marino Nacional Fathom Five, en el Lago Hurón, y el área Este de la Bahía Georgiana y seleccionamos 11 humedales para trazar mapas de hábitat con programas computacionales especializados en sensoría remota. La comparación de los resultados de los análisis de las imágenes contra datos de referencia indica que en general los mapas tienen una certeza cercana al 90%. Lo anterior sugiere que las imágenes de alta resolución tomadas por el satélite IKONOS pueden utilizarse para monitorear cambios en la vegetación y rastrear modificaciones en el hábitat de los humedales costeros en los Grandes Lagos.

INTRODUCTION

Coastal wetlands are known to be very important to the fisheries of the Laurentian Great Lakes because they provide spawning and nursery habitat for wetland-dependent species that include a large number of the commercially and recreationally important taxa (e.g., Jude and Pappas 1992; Wei et al. 2004). The U.S. Nature Conservancy estimated that about 80% of the approximately 200 fish species found in the Great Lakes use the near-shore areas for at least part of the year and directly depend on coastal wetlands for some part of their life cycles (Chow-Fraser and Albert 1999). Both government agencies and non-governmental organizations have now acknowledged the important ecological values and functions of these coastal ecosystems (Maynard and Wilcox 1997; Chow-Fraser and Albert 1999), and have devoted considerable effort over the past two decades towards developing strategies to protect and restore these habitats at a basin-wide scale.

An important first step in the management of coastal wetlands is the development of a basin-wide inventory that can be updated at regular intervals. The wide distribution of wetlands in the Great Lakes basin necessitates the use of remote sensing technology, such as aerial photographs or satellite images. With high-resolution color-infrared aerial photographs, detailed habitat features can be distinguished from each other, but the costs associated with this can be sufficiently high that updates can only be carried out at 10-year intervals (e.g., U.S. National Wetland Inventory; Wilen et al. 2002). By comparison, satellite data (e.g., Landsat 5 or 7) can be more cost-effective because of the large spatial coverage captured in each satellite scene, but the resolution is often too coarse to discriminate habitat features such as type of aquatic plants

at small spatial scales (e.g., Mumby and Edwards 2002). A third alternative, IKONOS (derived from the Greek word for "image"), is a high-resolution satellite capable of simultaneously collecting 1-m panchromatic (single band or monochrome imagery) and 4-m multispectral images (4 bands) over a relatively large geographic area. Suitable for mapping wetland habitat at much smaller spatial scales (e.g., < 10 m) than has been possible with other satellite imagery such as Landsat satellite, IKONOS has been used successfully in several coastal projects in marine systems (e.g., Mumby and Edwards 2002; Andréfouët et al. 2003; Riegl and Purkis 2005).

To date, no study has detailed the use of IKONOS in freshwater coastal areas, such as the Laurentian Great Lakes. Our objective was to use IKONOS imagery to map detailed habitat features in freshwater wetlands in a small region of Lake Huron and Georgian Bay. We first conducted ground surveys of these wetlands, and then used the location of ground features (emergent vegetation, submergent vegetation, open water, etc.) to guide the classification of aquatic vegetation cover in the IKONOS image. Finally we assessed the overall accuracy of this classification and evaluated the potential for using IKONOS imagery to map Great Lakes aquatic habitat at a basin-wide scale.

METHODS

Site description

Eleven wetland sites in the Georgian Bay region were examined (Table 1 and Figures 1 and 2). Ten of the 11 wetlands were found in Fathom Five National Marine Park (FFNMP), which is located at the boundary zone between Georgian Bay to the east and Lake Huron to the west. Two of the wetlands in this study are located on the mainland at the northern tip of the Bruce Peninsula: Hay Bay wetland complex and Ragged Bight wetland. In addition to natural stressors such as water level fluctuations, these wetlands are also affected by nutrient and sediment loading from their watersheds. The remaining FFNMP wetlands are located on two islands, the larger of which is Cove Island and the smaller is Russel Island. Most of these island wetlands are unaffected by human-induced stressors such as nutrient and sediment enrichment (Chow-Fraser, unpub. data). Herman's Bay is a very small (3-ha) pristine embayment, which is hydrologically attached to eastern Georgian Bay through Twelve Mile Bay (Figures 1 and 2). The shoreline is undeveloped and there is no obvious anthropogenic impact. Plant life in this marsh is extremely abundant and the distributional pattern of broad groups of wetland plants is distinct. These characteristics makes Herman's Bay an ideal site to explore the potential capability of IKONOS for detecting wetland plants at the level of species assemblages. Plant covers from Herman's Bay have been identified and classified into four types based on ground truth data collected in August 2004: (1) meadow, (2) emergent zone dominated by *Scirpus*, (3) emergent zone dominated by *Pontederia*, and (4) a mixed floating-emergent zone dominated by *Nuphar* and *Sparganium*.

Principles of mapping wetlands with remote sensing imagery

Satellite sensors can record reflectance from Earth surface features. Many of these features have distinctive spectral reflectance, which is referred to as spectral response pattern or spectral "signature." Automated image classification uses the spectral information represented by the digital numbers in satellite imagery and attempts to assign all pixels (points) in the image to particular classes based on this spectral information (e.g., open water, submergent vegetation, or emergent vegetation). Figure 3 illustrates a stage in a typical procedure used to map wetland habitat with remote sensing techniques. Initially, geographic coordinates (i.e., latitude and longitude acquired with GPS units) must be collected in the field, which will serve as reference (ground truth) data to classify the major features being mapped (i.e., open water, submergent vegetation, emergent vegetation in this hypothetical wetland). Based on these field data, representative areas can then be selected by analysts on satellite imagery (Figure 3a). Supervised by analysts and trained by the representative areas, image pixels with similar reflectance patterns are grouped into the same habitat class (Figure 3 b-c).

Procedures used to map aquatic habitat in FFNMP wetlands

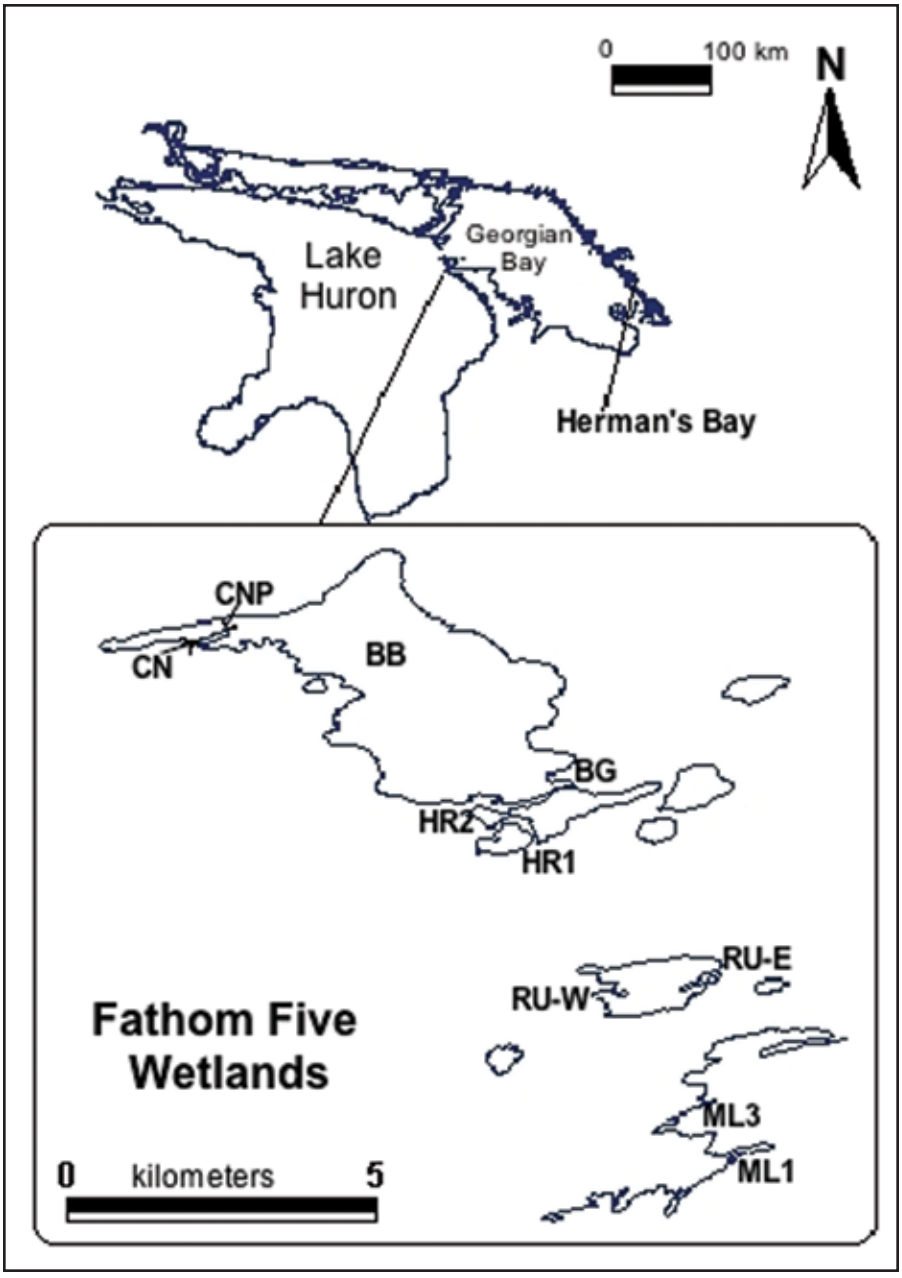
The classification procedures are similar to those for mapping terrestrial systems which can be found in most remote sensing textbooks. The procedures used to map FFNMP wetlands are summarized as follows:

(a) **Acquring IKONOS imagery.**
The relevant imageries (Figure 2) were separately acquired by Parks Canada (for wetlands in FFNMP) and the Georgian Bay Association Foundation (GBA Foundation) (for Herman's Bay) from Space Imaging (Thornton, CO 80241) in 2002. In each case, both Parks Canada and GBA Foundation indicated the area of interest by providing Space Imaging

Table 1. Summary of sites and a brief description of likely impact.

Site	Code	Area (ha)	Type of impact
1. Boat Passage	BG	16.7	Low human impact (Boat channel)
2. Cove Island Inner Harbour	HR1	5.7	No obvious human impact
3. Cove Island Outer Harbour	HR2	2.9	No obvious human impact
4. Cove Island North	CN	16.4	No obvious human impact
5. Cove Island North Pond	CNP	1.4	No obvious human impact, declining water level
6. Bass Bay	BB	39.0	No obvious human impact, declining water level
7. Hay Bay One	ML1	7.7	High human impact (public beach, high cottage density)
8. Ragged Bight	ML2	3.2	Moderate human impact
9. Russel Island East	RU-E	2.9	No obvious human impact, declining water level
10. Russel Island West	RU-W	3.8	No obvious human impact, declining water level
11. Herman's Bay	HM	3.0	No obvious human impact

Figure 1. Map of study wetland sites in Georgian Bay. See Table 1 for key to site codes.



with a set of geographic coordinates, as well as the preferred season.

(b) **Collecting ground-truth data.** First, we determined the number of habitat classes to be mapped. For FFNMP wetlands, we determined that five habitat features based on the dominant vegetation type and geological features would be suitable: (1) emergent vegetation, (2) submersed aquatic vegetation (SAV), (3) rock/shrubs, (4) rock, and (5) open water. However, for Herman's Bay we determined that five zones based on the distinct distribution pattern of plant assemblages would be more suitable: (1) sedge meadow, (2) *Scirpus validus* (tall emergent species that grew along the shoreline), (3) *Nuphar variegatum* and *Sparganium fluctuans* (both floating species growing in shallow to moderately deep water), (4) *Pontederia cordata* (short emergent species that grew in shallow water), and (5) open water without the presence of emergent or floating species. Note that we did not map the location of submergent species, because these were found growing below the water surface throughout the wetland, even where there were emergent and floating species. We verified that SAV was only absent in the vicinity of the opening to Twelve Mile Bay, where water depth approached 1.0 m. The second step was to locate homogenous areas (minimum size of 4 x 4 m) of each habitat class within the wetlands. Thirdly, we obtained geographic coordinates within each homogeneous patch for each of the five classes using a GPS unit. The number of geographical coordinates to be recorded could vary according to the habitat complexity and size of the wetlands. For instance, we collected 17 pairs of coordinates for SAV in Hay Bay 1 (ML1) while only two pairs of coordinates for the same class in Cove Island North Pond (CNP). This is because SAV in CNP was highly homogenous (i.e., CNP was almost 100% covered by SAV) and two points would be sufficient for us to select representative areas for SAV on the imagery.

(c) **Working with field data and satellite imagery in a remote sensing platform.** We imported the ground-truth data, along with the satellite imagery into a remote sensing platform using software called ENVI 4.1 (ITT Visual Information Solutions, formerly Research Systems, Inc., Boulder, CO). Then, representative areas, also called training areas, were identified within homogeneous areas for each habitat class on the imagery. The selection of appropriate training areas is generally based on the analyst's familiarity with the geographical area and the availability of ground truth data (Figure 3). In remote sensing, it is not unusual to have field and satellite data collected at different times for a variety of reasons (e.g., use of existing archive images, limited project budgets, timing of funding cycles, limited access to the field sites etc.). Since differences in vegetation cover between years may exist, the field data were not used directly in the classification procedure. Instead, field data were used to help the analyst to identify and choose representative areas of each habitat class on the imagery and then the representative areas were divided into a "training set" and a "testing set" to be used in a supervised classification procedure and to check for post-classification accuracy, respectively. For FFNMP wetlands, the training set was collected from Cover Island North

Figure 2. IKONOS images of Fathom Five wetlands and Herman's Bay.

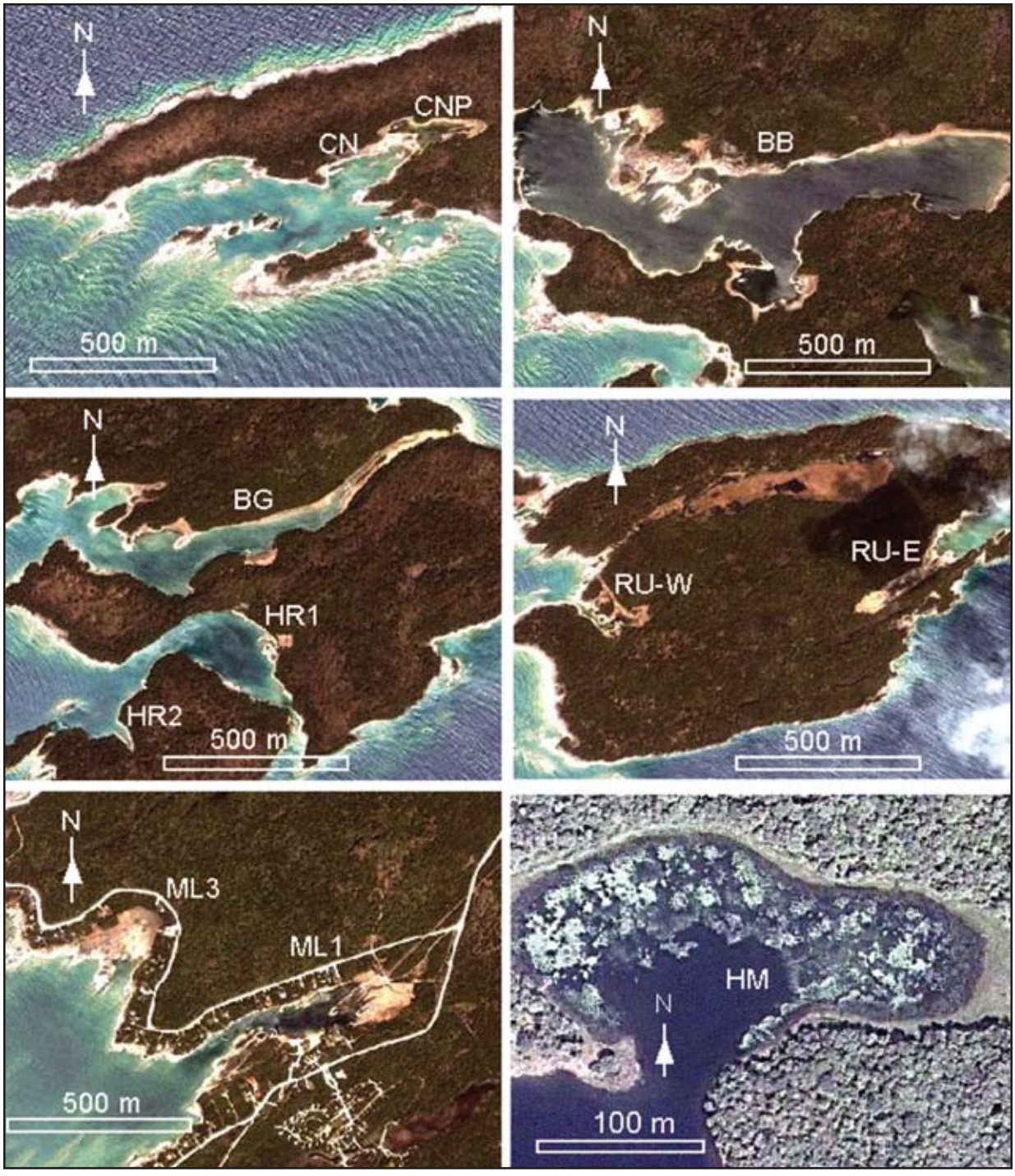


Figure 3. Supervised classification procedure for mapping wetland habitats.
(a) Three habitat classes in a hypothetical wetland. OP—open water, SAV—submergent vegetation, EM—emergent vegetation. Shaded areas are representative areas in the imagery identified by a human analyst with the aid of ground truth data (training areas).
(b) A digital representation of the imagery. Values represent the numerical "signatures" for each habitat class.
(c) Results of the supervised classification. Image pixels with similar numerical values will be grouped into the same habitat class.

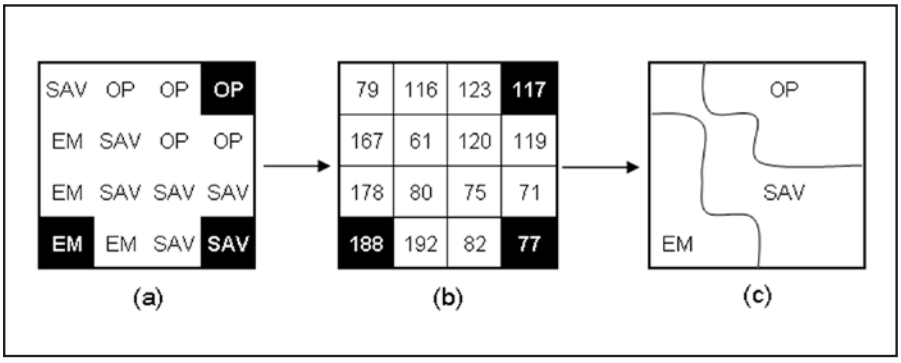
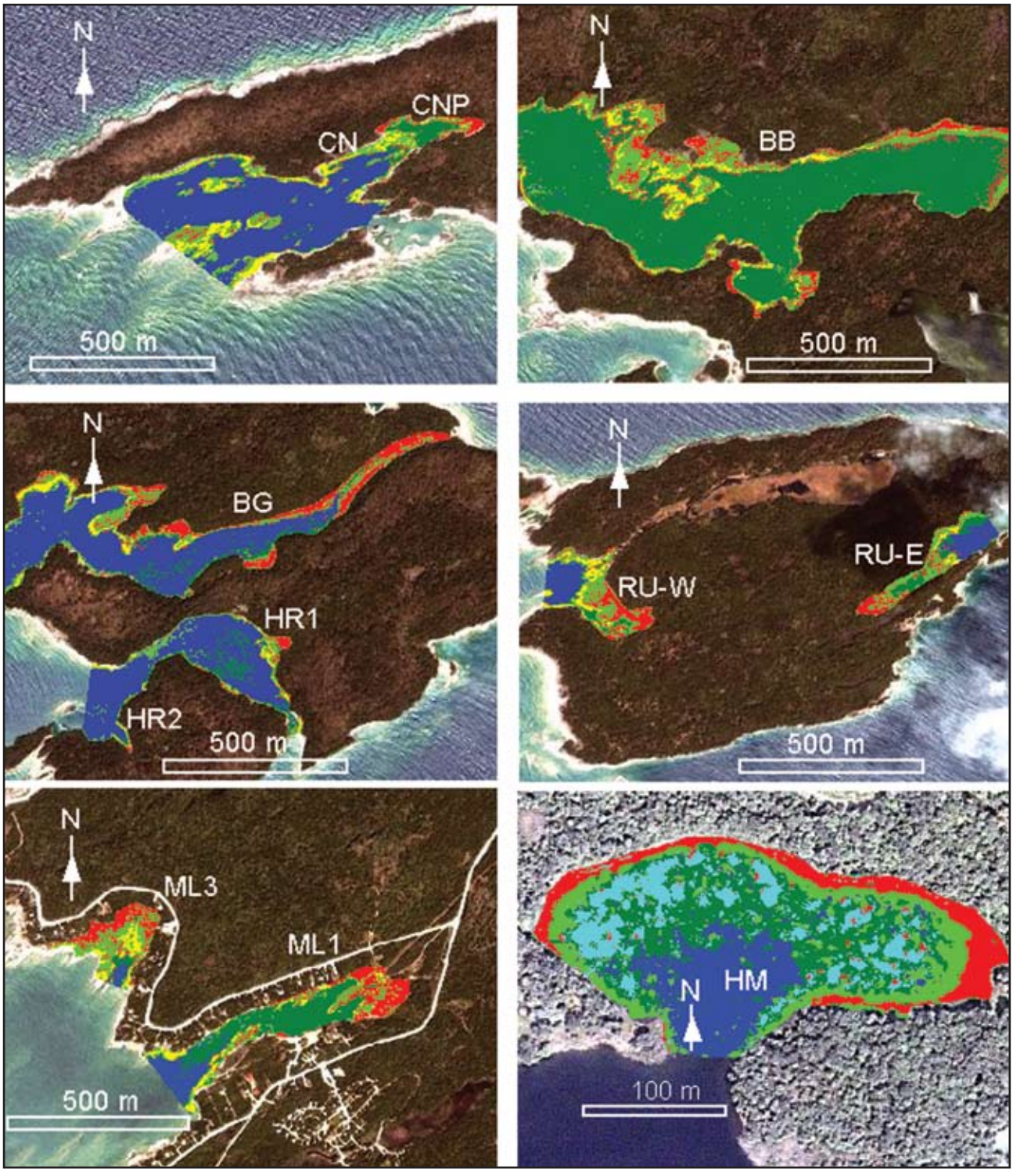


Figure 4. Results of supervised classification.

Fathom Five wetlands:
red—emergent plants;
light green—rock/shrubs;
dark green—submergent plants;
yellow—rock;
blue—open water.

Herman's Bay:
red—sedge meadow;
light green—*Scirpus*;
dark green—*Nuphar* and *Sparganium*;
cyan (light blue)—*Pontederia*;
blue—open water.



(CN) and CNP while the testing set was independently chosen from ML1. The training and testing sets for Herman's Bay were collected from the west and east portions of the wetland, respectively.

(d) **Supervised classification procedure. with maximum likelihood algorithm** Our "supervised classification" procedure is commonly used in remote sensing. This procedure is applied in two steps (Lillesand and Kiefer 2000): (1) in the training stage, representative sample sites of known ground features (training areas), are provided to the classification algorithm (e.g., Maximum Likelihood) and form the basis for image classification; and (2) in the classification stage, the computer algorithm (e.g., Maximum Likelihood) categorizes each pixel in the image into the representative class it most closely resembles (Figure 3). To reduce the complexity of classification and computational time, we used the wetland boundary to delineate the "region of interest" to avoid processing areas in the satellite image that occurred outside the wetland.

(e) **Determining classification accuracy.** A classification error matrix is a common means of expressing classification accuracy. In such a matrix the accuracy values of each column indicate the percentages that are correctly classified. The overall accuracy reported in the classification error matrix is calculated by dividing the number of image pixels classified correctly by the total number of reference image pixels. Producer accuracy (Prod. Acc.) is calculated by dividing the number of correctly classified pixels for a class by the actual number of ground truth pixels for that class. User accuracy (User Acc.) is calculated by dividing the number of correctly classified pixels for a class by the total pixels assigned to that class.

RESULTS AND DISCUSSION

The 10 sites chosen from FFNMP for this study were all located within the same region of the satellite image. The goal of the Fathom Five study was to evaluate the capability of IKONOS imagery to accurately map aquatic habitat at a regional level. Results of the supervised classification for Fathom Five wetlands are shown in Table 2a and Figure 4. The classification error matrix based on the representative areas (testing set) indicated that the overall accuracy was 84.5% (Table 3).

During periods of high water, wetlands located on Cove Island were hydrologically connected to the rest of the lake, but during recent periods of low water levels (since 1999), some of these wetlands have become disconnected and "stranded." We found that these stranded wetlands had almost 100 % cover of submergent plants, and this is unlike other wetland areas of FFNMP that are exposed to wave action, where submergent plants are scarce.

Unlike wetlands of FFNMP, Herman's Bay is a highly protected marsh. It has a low-energy environment that allows organic matter to accumulate and thus supports a variety of aquatic plants in the marsh (Figure 2). The supervised classification estimated the following coverages for the five habitat features:

Table 2. Results of the supervised classification for wetlands in FFNMP and Herman's Bay. Data shown are calculated areas occupied by the various habitat features. See Table 1 for explanations of site codes.

(a) Fathom Five Wetlands

Site code	Submergent (m^2)	Emergent (m^2)	Rock (m^2)	Rock-Shrub (m^2)	Open water (m^2)
BG	11,712	25,264	6,112	25,808	98,896
HR1	7,648	3,120	1,600	7,536	36,688
HR2	944	480	720	3,520	23,712
CN	5,200	4,544	14,064	28,704	111,904
CNP	6,160	3,600	816	3,920	0
BB	262,912	40,336	18,784	66,832	1,792
ML1	30,656	15,824	5,616	13,984	11,536
ML3	2,112	10,784	5,120	12,528	1,760
RU-E	5,920	5,408	1,296	9,072	7,920
RU-W	2,432	8,672	4,896	12,896	9,568

(b) Herman's Bay

Parameter	Wet meadow	Open water	*Scirpus*	*Pontederia*	*Nurpha* and *Sparganium*
Area (m^2)	4,709	6,540	6,768	5,527	9,124
% Total area	14.4 %	20.0 %	20.7 %	16.9 %	27.9 %

Table 3 (a). Error matrix for Fathom Five wetland classification

	Training set		Testing set	
Class	Prod. Acc. (%)	User Acc. (%)	Prod. Acc. (%)	User Acc. (%)
Submergent	98.57	98.57	100.00	86.17
Emergent	96.15	89.29	58.33	100.00
Rock	93.33	82.35	NA	NA
Rock-Shrub	78.57	91.67	NA	NA
Open water	100.00	100.00	NA	NA
	Overall Accuracy = 97.28		% Overall Accuracy = 84.50%	

Table 3 (b). Error matrix for Herman's Bay classification

	Training set		Testing set	
Class	Prod. Acc. (%)	User Acc. (%)	Prod. Acc. (%)	User Acc. (%)
Meadow	99.54	100.00	98.08	100.00
Open water	99.75	98.50	100.00	94.59
Sedge	95.24	96.62	84.09	88.10
Nuphar	95.12	95.71	76.67	67.65
Pontederia	99.44	99.44	91.30	97.67
	Overall Accuracy = 98.19%		Overall Accuracy = 90.82%	

20.0% open water, 27.9% *Nuphar* and *Sparganium*, 16.9% *Pontederia*, 20.7% *Scirpus*, and 14.4% sedge meadow (Table 2b). The classification error matrix based on the representative areas (testing set) indicated that the overall accuracy was 90.82 % (Table 3).

Studies have shown that there is considerable improvement in the capabilities of IKONOS over Landsat and other satellite imagery that are more suitable for coarse habitat mapping (e.g., Andréfouët et al. 2005). Andréfouët et al. (2005) indicated that overall accuracy for Landsat was 15–20% lower than that for IKONOS when used to classify tropical coral reef environments, and that only IKONOS produced sufficiently high accuracy (> 80%) for four of the five classes. Our results indicate that IKONOS imagery can be used for wetland inventories, because of the large spatial coverage (over 100 km^2) and the relatively high level of precision when carried out with the supervised classification, both of which are required when gathering synoptic information at regional or basin-wide scales. On an areal basis, the cost of IKONOS images is substantially lower than that for aerial photographs, but still very expensive when compared with Landsat images (Table 4). If the primary objective of an investigation is to map the total wetland area for a large geographical area, Landsat will be more cost-effective. If habitat features need to be monitored at a small spatial scale (e.g., 100 m^2), and the area to be mapped is < 500 km^2, then IKONOS would be a cost-effective option (Mumby and Edwards 2002). Results from Herman's Bay also demonstrate that IKONOS imagery can be used to accurately identify plant form as well as species assemblages where training data are provided at the appropriate level of resolution (i.e., four broad groups with distinctive spectral properties). Our results indicate that use of IKONOS imagery to inventory wetlands has the advantage of wide spatial coverage and the precision of supervised classification, thus meeting the requirement for gathering synoptic information on wetlands at regional scales. The high water transparency and relatively undisturbed nature of the wetlands in eastern and northern Georgian Bay make them excellent candidates for use with IKONOS imagery for wetland classification.

Table 4. Cost-benefits of IKONOS, aerial photo, and Landsat satellite imagery

	IKONOS	Aerial photo	Landsat
Resolution	1m, 4m	variable	15m, 30m, 60m
Pricing*	\$2000/100 km^2	\$54000/100 km^2**	\$425 per scene (31,110 km^2)
Accuracy of seagrass mapping***	89%	63%	59%

* Pricing for basic level of products
**Pricing for aerial photo is reported in Canadian dollars
***Mumby and Edwards (2002) and Mumby et al. (1997)

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FEATURE: BIOENGINEERING

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Potential Impacts of Hydrokinetic and Wave Energy Conversion Technologies on Aquatic Environments

ABSTRACT: A new generation of hydropower technologies, the kinetic hydro and wave energy conversion devices, offers the possibility of generating electricity from the movements of water, without the need for dams and diversions. The Energy Policy Act of 2005 encouraged the development of these sources of renewable energy in the United States, and there is growing interest in deploying them globally. The technologies that would extract electricity from free-flowing streams, estuaries, and oceans have not been widely tested. Consequently, the U.S. Department of Energy convened a workshop to (1) identify the varieties of hydrokinetic energy and wave energy conversion devices and their stages of development, (2) identify where these technologies can best operate, (3) identify the potential environmental issues associated with these technologies and possible mitigation measures, and (4) develop a list of research needs and/or practical solutions to address unresolved environmental issues. We review the results of that workshop, focusing on potential effects on freshwater, estuarine, and marine ecosystems, and we describe recent national and international developments.

Impactos potenciales en los ambientes acuáticos por utilizar energía hidrocinética y de olas

RESUMEN: Una nueva generación de tecnología hidrocinética y la transformación de la energía derivada de las olas naturales permiten derivar electricidad a partir del movimiento del agua sin alterar su cauce natural. En los Estados Unidos de América la Ley de Política de Energía aprobada en el 2005 promueve el desarrollo de este tipo de tecnología de producción de energía renovable y en todo el mundo hay un creciente interés por impulsarla. Este tipo de tecnología que podría extraer energía de las corrientes de los ríos, estuarios y océanos no ha sido evaluada. Consecuentemente, el Departamento de Energía de los Estados Unidos de América organizó un taller de trabajo para (1) identificar los diferentes equipos que se utilizan para la producción de energía extraída del movimiento del agua y su grado de desarrollo, (2) identificar los mejores lugares para aplicar dicha tecnología, (3) identificar los impactos potenciales y medidas de mitigación asociadas a su uso, y (4) enlistar las necesidades de investigación y soluciones prácticas aplicables a tópicos ambientales. Nosotros revisamos los resultados del taller de trabajo, enfocándonos en los impactos potenciales sobre los ecosistemas fluviales, estuarinos y marinos y describimos los avances de investigación nacional e internacional.

Conventional hydroelectric projects, with dams and reservoirs, are used all over the world to produce renewable energy. In the United States, conventional hydropower supplies 7% of the nation's electricity. The value of hydropower and other renewable energy sources is seen in renewed appreciation in light of increasing concerns about the effects of fossil fuel and biomass combustion on carbon dioxide levels in the atmosphere and global climate change. However, the ability of conventional hydropower to meet our increasing energy demands is limited, owing to a variety of environmental concerns, including degradation of fish passage, water quality, and aquatic and terrestrial habitats. It is unlikely that many new hydropower dams will be built in the United States, and there is increasing interest in removing older dams in order to restore free-flowing rivers. Nevertheless, hydropower still has a future on the U.S. and international scenes because considerable energy associated with the motions of water could be tapped by new, unconventional hydropower technologies. For example, Hall et al. (2004) estimated that as much as 3,400 MW of electricity generation potential could be exploited in U.S. rivers by small, unconventional systems such as free-flow (damless) turbines. Other estimates of the kinetic hydro potential of rivers, based on distribution of water velocities rather than stream flows, suggest much greater values. By comparison, a nuclear power plant or a large hydropower dam has a generating capacity of about 1,000 MW; most hydropower plants in the United States range from 10 to 1,000 MW in capacity

The resource potential of estuaries and ocean waters is also large. The Electric Power Research Institute (EPRI) has estimated that the annual average incident wave energy at a 60 m depth off the U.S. coastline is 2,100 TeraWatt hours per year, much of it on the West Coast (Bedard 2005a). This is equivalent to more than half of the net generation of electricity in the United States from all sources in 2004 (EIA 2006). New wave energy technologies have generated growing interest in Europe and Asia. Technologies that convert kinetic or ocean energy to electricity are being deployed in or planned for Australia, Korea, Portugal, Norway, Denmark, Russia, Sweden, and Scotland. Recent ocean energy research activities funded by the European Commission (EC) are described in EC (2006).

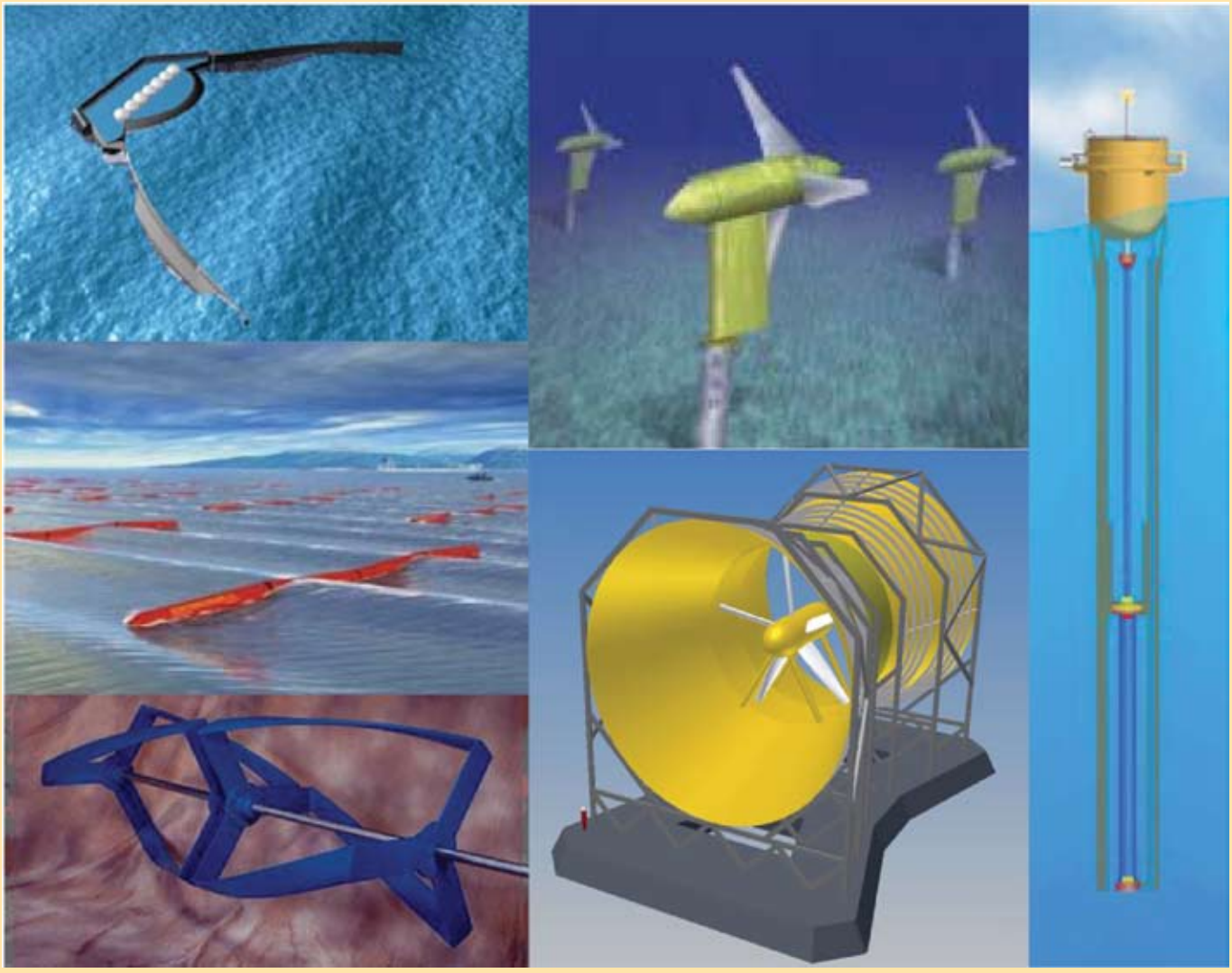
Interest in these novel hydropower technologies is growing in the United States as well. For example, Verdant Power has begun deploying underwater horizontal axis turbines in the East River in New York City as part of its Roosevelt Island Tidal Energy (RITE) project. In the summer of 2006, the Public Utility District No. 1 of Snohomish County, Washington, filed preliminary applications with the Federal Energy Regulatory Commission (FERC) to study seven sites in Puget Sound for tidal energy development (www.snopud.com). In response to the increasing numbers of permit applications, FERC held a technical conference in Washington, DC on 6 December 2006 to discuss the status of instream and ocean-based hydroelectric technologies (wave, tidal, and current) and to explore the environmental, financial, and regulatory issues related to the development of these new technologies. The U.S. Energy Policy Act of 2005 (EPAct) contains a number of provisions designed to encourage the production of renewable energy from kinetic hydro and ocean energy sources. It recognized both hydroelectric power and ocean energy (tidal, wave, current, and thermal) as forms of renewable energy, and set requirements for the federal government to purchase not less than 7.5% of its electricity from renewable sources by 2013. Section 388 of EPAct grants the Department of Interior's Minerals Management Service (MMS) responsibilities over offshore renewable energy and related uses on the Outer Continental Shelf (OCS). The MMS will grant leases, easements, or rights-of-way for renewable energy-related uses on federal OCS lands, act as a lead agency for coordinating the permitting process with other federal agencies, and monitor and regulate those renewable energy production facilities. MMS released a draft programmatic environmental impact statement in March 2007 (http:// ocsenergy.anl.gov/documents/index.cfm) to help anticipate significant issues, alternatives, and mitigation measures associated with the new Alternate Energy and Alternative Use Program. Further, EPAct Section 931 authorizes the U.S. Department of Energy to conduct research, development, demonstration, and commercial application programs for a variety of renewable energy technologies, including kinetic hydro turbines and ocean wave energy.

The technologies that would extract electricity from free-flowing streams, estuaries, and oceans have not been widely tested; indeed, many are little more than ideas from the drawing board. Consequently, the U.S. Department of Energy's (DOE) Wind and Hydropower Technologies Program convened a workshop in October 2005 to ascertain the technical and environmental issues associated with hydrokinetic and wave energy conversion devices. Representatives from private business, government (regulatory and resource agencies), and non-government organizations met for three days and shared ideas to identify the issues and develop lists of research needs. The proceedings of the workshop are available at: http://hydropower.inel.gov/hydrokinetic_wave/index.shtml. In this article, we focus on the potential impacts to aquatic organisms and ecosystems that were identified by the workshop participants and discuss how uncertainties about these impacts might be addressed.

Descriptions and illustrations of these novel renewable energy technologies can be found in the DOE workshop proceedings and other compilations (e.g., Figure 1, Table 1, and www.epri.com/oceanenergy). There are numerous ways to categorize these new devices, but they can most simply be divided into two classes: rotating machines and wave energy converters (Bedard 2005b). Rotating machines can be compared to wind turbines—a rotor spins in response to the movements of river or ocean currents, the rotational speed being proportional to the velocity of the fluid. The rotor may be encased in a duct that channels the flow (e.g., the Rotech Tidal Turbine; www.lunarenergy.co.uk) or open like a wind turbine (e.g., the Verdant horizontal axial turbine; www.verdantpower.com). Further, the rotor may be characterized by conventional "propeller-type" blades or helical blades (www.gcktechnology.com/GCK). Whether installed in rivers, estuaries, or in the open ocean, rotating machines convert kinetic energy (the energy associated with a body of water because of its motion) into electricity.

On the other hand, many of the wave energy technologies convert hydrostatic energy, the energy possessed by a body of water because of its elevation (i.e., head) relative to a reference point. These devices oscillate based on changes in the height of ocean waves (head or elevation changes). Several leading concepts are displayed in Figure 1. For example, AquaEnergy's AquaBuOY has been proposed for

Figure 1. Examples of kinetic and ocean energy conversion technologies considered at the DOE workshop. Clockwise from upper left: the Wave Dragon, Verdant Power's horizontal axis turbine, AquaEnergy's AquaBuOY, Lunar Energy's ducted tidal turbine, the Gorlov helical turbine, and Ocean Power Delivery's Pelamis. See the text for web links and descriptions of the devices.



deployment at Makah Bay, Washington (http://finavera.com). The AquaBuOY is a floating structure, moored to the ocean bottom, which uses the vertical motions of ocean waves to drive a pump that moves seawater over a turbine. Another example of a "point absorber," where a floating buoy responds to movements of the sea surface, is the Power Buoy (www.oceanpowertechnologies.com). Ocean Power Delivery's Pelamis consists of a series of semi-submerged cylinders linked by hinged joints (www.oceanpd.com). The motions of the cylinders relative to each other are resisted by hydraulic rams, which move high-pressure oil through hydraulic motors, which in turn drive electrical generators contained within the cylinders. Pelamis was tested in Scotland and is being deployed in Portugal. Overtopping devices such as the Wave Dragon (www.wavedragon.net), incorporate elements from traditional hydroelectric power plants in an offshore floating platform. Water is elevated into a floating reservoir and then passes down through low-head hydropower turbines. The Wave Dragon concept, essentially a floating hydroelectric dam, was tested off the coast of Wales, and has received further research and development funding from the European Union.

SUMMARY OF ENVIRONMENTAL ISSUES AND UNCERTAINTIES

Table 2 lists the potential environmental impacts of kinetic hydro and ocean energy conversion technologies identified by workshop participants. Most of the environmental issues will need to be addressed by all of the technologies considered at the workshop. For example, all of these machines will need to be secured to the river or ocean bottom in some way, either by pilings driven into the sediments or by anchors and mooring cables. Disruption of the sediments during installation will alter the bottom habitats and may increase turbidity or release buried contaminants. Sediment disruption may be a temporary event associated with installation, or may continue during operation owing to movements of the rotors or of unsecured power and mooring cables. Because these

Table 1. Generalized list of hydrokinetic and ocean wave energy technologies considered in the DOE Workshop.

General type	Example
Horizontal axis (reaction) turbine	Verdant horizontal axis turbine
Cross flow (helical) turbine	Gorlov turbine
Open center turbine	OpenHydro open center turbine
Ducted turbine	Rotech tidal turbine VA Tech Hydromatrix
Point absorber	Aqua Energy AquaBuoy Ocean Power Technology PowerBuOYy
Attenuator	Ocean Power Delivery Pelamis
Terminator	Energetech oscillating water column
Overtopping wave	Wave Dragon

Table 2. Description of the aquatic environmental issues that were identified by DOE Workshop participants.

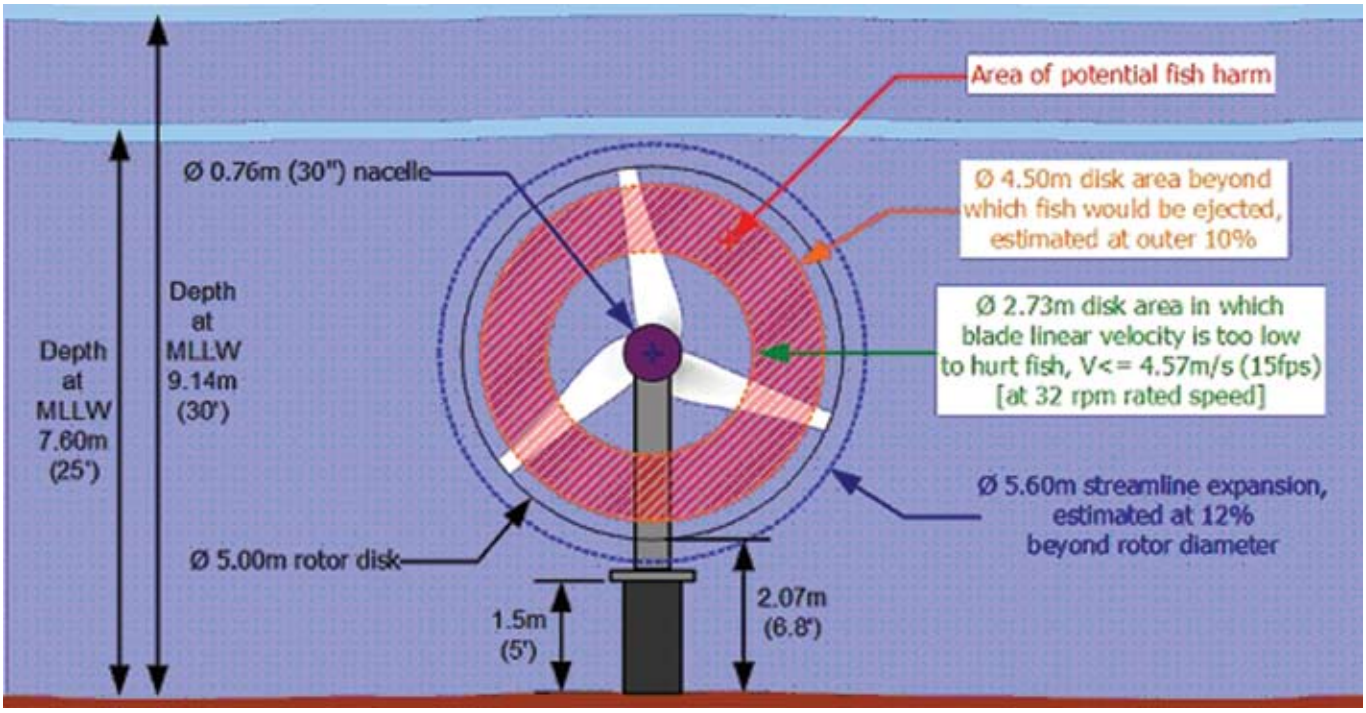
Environmental issue	Brief description of the issue
Alteration of river/ocean bottom habitats	Bottom habitats will be altered by securing the device to the bottom and running power cables to the shoreline. Moving parts (rotors) and mooring systems could affect bottom habitat during operation. Device may create structural habitat in open waters. Structures may obstruct movements/migrations of aquatic animals.
Suspension of sediments and contaminants	Deployment and operation may disrupt sediments and buried contaminants and increase turbidity. Erosion and scour may occur around anchors, cables, and other structures.
Alteration of hydraulics and hydrologic regimes	Movement of the devices will cause localized shear stresses and turbulence that may be damaging to aquatic organisms. On larger scales, extraction of energy from the currents may reduce the ability of streams to transport sediment and debris, cause deposition of suspended sediments and thereby alter bottom habitats.
Strike	Fish and other aquatic organisms, diving birds, and mammals may be struck by moving parts of the devices (e.g., rotors). Large mobile animals may become entangled in submerged cables.
Impingement on screens	Screens used to protect the machine or to reduce strike could themselves injure aquatic animals.
Effects of electromagnetic fields	Electromagnetic fields associated with all of these devices may attract, deter, or injure aquatic animals.
Toxicity of paints and other chemicals	Paints, cleaners, hydraulic fluids and chemicals used to control biofouling may be toxic to aquatic plants and animals.
Noise	Noise during construction and operations may attract, deter, or injure aquatic animals.
Effects of multiple units	Effects on hydrologic regimes, sediment dynamics, and strike determined for single machines may be very different than a full deployment of dozens or hundreds of machines.

devices extract energy from moving water or tides, they will alter local hydraulics. Shear stresses and turbulence will be created near rotors that may injure aquatic organisms or scour nearby sediments. On a larger scale, dozens or hundreds of these machines may alter the hydrologic regime and cause large areas of sediment scour or deposition. The significance of these impacts will depend on the design, size, and numbers of the devices and the method of their deployment, as well as the site-specific characteristics of the bottom sediments. Further, the potential negative impacts need to be considered in the context of other existing uses and stresses on these aquatic ecosystems (i.e., cumulative effects).

Similarly, effects of electromagnetic fields, noise during construction and operation, and the toxicity of paints and other chemicals will need to be addressed by all of these technologies. Technically, these issues should not be difficult to resolve. For example, the strength of magnetic fields can be measured for prototype machines and compared to levels that are known to affect animals. Similarly, the intensity and frequency of noise produced by the machines can be assessed by comparing measurements of prototypes to noise from other aquatic sources and to information in the literature about underwater sounds that injure, frighten, or attract aquatic animals. Shielding might be employed to reduce excessive noise and electromagnetic fields. The effects of chemicals can be controlled by using appropriate, non-toxic paints and ensuring that hydraulic fluids are well sealed within the machine.

Blade strike and impingement on protective screens are likely to be issues only for rotating machines. Fish, aquatic reptiles and mammals, and diving birds may be struck by the rapidly turning rotor and suffer injury or mortality. Screens used to exclude aquatic animals from the machine will reduce power production and may themselves cause injury if the

Figure 2. Hypothetical zone of potential damaging strike associated with a submerged free-flow (rotating) turbine. This is based on the assumption that the risk of strike injury is lower near the hub (where rotational velocity is low) and near the tip (where a fish can escape to the side) than in the mid-blade region. Source: Coutant and Cada (2005).



organism is impinged against the screen. The seriousness of strike is related to the animal's swimming ability and sensitivity to injury, and to the part of the rotor that the animal strikes (Figure 2). The rotor blade has a much higher velocity near the tip than near the hub, and the force of strike is expected to be proportional to the velocity. As was frequently noted at the workshop, because of design similarities between rotating kinetic hydro turbines and the enclosed runners in conventional hydroelectric turbines, existing literature on fish passage effects can be consulted to make preliminary estimates of the seriousness of damage to fish from strike, as well as other hydraulic stresses (pressure changes, shear stresses, and turbulence that occur near the rotor; see, for example, Cada et al. 1997; Ploskey and Carlson 2004). Compared to conventional hydroelectric turbines, some kinetic hydro designs have an unenclosed rotor and slower rotation rates, which could reduce the risk from strike.

Wave energy devices create structures in the open ocean. The effects of multiple surface structures and associated cables covering a sizeable area of the ocean may be negative, for example if they interfere with movements of whales and other large animals. Or they may be beneficial, serving as fish attracting devices, preserving areas of the ocean from commercial harvest, and providing roosting sites for birds and haul out sites for seals and sea lions. Colonization of the structures by marine organisms is likely to have negative consequences for maintenance and electricity generation and unknown environmental effects. The extraction of wave energy by these devices may alter sediment transport and thereby affect local beach geomorphology, benthic habitats, and intertidal ecology.

Beyond the environmental assessments of individual machines, the workshop participants expressed concerns about both multiple-unit deployments and the cumulative impacts of energy developments when added to other stresses on aquatic systems. In order for these technologies to make a significant contribution to our electricity supply, larger devices or installations of many small units will be needed. For example, Snohomish County Public Utility District has applied for a preliminary permit to investigate the possibility of installing 450 Tidal In Stream Energy Conversion (TISEC) devices, each with a 20-m-diameter rotating propeller blade, at a single site in Puget Sound, Washington (71 FR 37071; 29 June 2006). Williams (2005) suggested that 3,000 to 4,000 open center turbines could be deployed in the Gulf Stream to provide a generation potential of 10,000 MW of electricity. Impacts to bottom habitats, hydrology, or strike that are inconsequential for one or a few units may become significant if energy farms exploit large areas in a river, estuary, or nearshore ocean. By extracting energy from currents, very large installations might conceivably influence large scale ocean circulation patterns. It may not be easy to extrapolate effects from small to large numbers of units because the complicated interactions between water motions and turbines depend on placement of the machines (proximity to each other) as well as local hydraulic conditions. Hydraulic models will likely be needed to predict accurately the effects of multiple units. The deployment of turbines will add to existing environmental stresses and cumulative effects. In rivers, the effects of kinetic turbines would occur in the context of other impacts associated with boat traffic, water withdrawals, and discharges. In the ocean, energy developments must compete with aquaculture, offshore wind, gas and oil platforms, defense-related activities, mining, merchant shipping, recreational and commercial fishing, and recreational boating (Ogden 2005). Structures associated with an ocean energy farm could act as fish attracting devices and, by restricting commercial fishing in the area, conceivably have positive effects on aquatic communities. Perhaps the most sensitive habitats to cumulative impacts are

the estuaries, highly complex and productive ecosystems that are already subject to anthropogenic alteration from water diversion, habitat conversion, pollution, dredging, and urbanization (Swanson 2005). As with other cumulative effects, the contribution of new energy development to overall impacts on aquatic resources could be additive, synergistic, or offsetting.

RESOLUTION OF ENVIRONMENTAL ISSUES

Like the machines themselves, the research needed to understand and minimize environmental impacts can be divided into two classes: site-specific and general. Site-specific research would be conducted by the manufacturer/developer and might include impacts of particular design details (e.g., comparison of the toxicity of different paints or lubricating fluids; comparisons of noise measurements to tolerances of local fauna) or the effects on a particular river or estuary that is proposed for development (e.g., sediment cores, modeling of multi-unit placement relative to a specific bottom profile).

On the other hand, many environmental research questions of general interest might best be addressed by collaborative groups, and the results made freely available to all. Collaborative studies could include experiments to understand the mechanisms of impacts of kinetic hydro and wave conversion devices (e.g., the differences in frequency and severity of strike in ducted vs. unducted rotors or different rotor blade shapes; advanced physical and computational models of alternative multi-unit deployment strategies). Individual developers rarely have the resources to carry out this general research on their own, but the information that comes from such studies is often of interest to a wide audience seeking to refine their designs and operations in order to minimize environmental impacts. The results of collaborative efforts are much more likely to influence decision making if the studies are funded, designed, conducted, and analyzed by a broad group representing all interests.

The workshop participants considered several models for collaborative research. For example, EPRI's Ocean Energy Research Program has brought together agencies from coastal states, utilities, technology developers, research institutions, and other parties to demonstrate the feasibility of wave power (Bedard 2005a). The program's initial activities have focused on estimating power production, performing economic assessments, and identifying potential sites for conceptual wave energy plants; environmental issues have not been rigorously examined. The European Marine Energy Centre (EMEC) was established in Orkney, Great Britain, to conduct independent tests of marine energy technologies (Griffiths 2005; EMEC 2005). Construction of the center began in 2002 with funding from public agencies. Developers of wave or tidal energy conversion devices will then provide funds to the center for standardized, independent testing. EMEC has begun accepting wave and tidal devices; at present, their standardized tests and measurements are focused on verifying engineering performance. Environmental monitoring consists of recording sightings of marine mammals, but this is intended to ensure that there are no adverse effects from operation of the test site, rather than environmental research per se. Eventually EMEC hopes to help developers certify their machines for environmental standards as well. A U.S. Marine Energy Center headquartered in Oregon has been proposed (Rhinefrank 2005). Like EMEC, it would provide a standardized, controlled environment where developers could test their wave energy conversion devices. However, as with

the EPRI and EMEC efforts, the emphasis initially would be on characterizing engineering performance rather than studying potential environmental issues. Sundberg and Langhamer (2005) described the marine environmental studies that will be performed on a wave power project at Islandsberg, off the coast of Sweden. When fully built out, up to 40 buoys and 10 wave power devices will be deployed, covering an area of 40,000 m^2. Environmental studies planned for the 2008-2014 time frame include invertebrate colonization, larval recruitment, fish attraction, effects of anti-biofouling coatings, and use of the buoys by birds and seals.

The workshop participants agreed that an EMEC-like facility where environmental studies could be carried out by independent investigators and the results accessible to all would be a great value to the development of kinetic hydro and wave energy technologies. Alternatively, the needed information might be developed through a research program that systematically explores the most difficult environmental issues, as has been done for conventional hydropower turbines in the DOE's Advanced Hydropower Turbine System Program (http://hydropower.inel.gov). A research program might best identify widely applicable impact minimization measures and possible beneficial effects on the environment (e.g., creation of new structural habitat and de facto protected areas). In the absence of such general, nationwide programs, adequate site-specific monitoring, focusing on the potential issues raised at the workshop, will be essential to ensuring that large energy production fields do not have unacceptable environmental impacts.

All workshop participants agreed that adequate understanding of environmental effects by regulators and the public is essential to acceptance of their technologies. The developers emphasized that proportional response from regulators is needed – small deployments are likely to have small, localized impacts. Small-scale monitoring programs will help resolve issues of individual installations and, if results are disseminated, will help focus the more extensive monitoring that will be needed for large deployments. At this early stage of technology development, both regulators and developers need to be open to an adaptive management approach, in which environmental monitoring and phased deployment are adjusted to reflect the findings of the previous monitoring (as is planned for the Roosevelt Island Tidal Project in New York City; Coutant and Cada 2005). The process of collecting environmental effects data should be guided by what is needed to achieve the ultimate goal of full-sized, multi-unit projects. It was also pointed out that developers should realize that a "disassembly plan" may be required in the event that environmental impacts of a project cross a previously defined threshold for significant environmental impacts.

Kinetic hydro and wave energy technologies are on their way to deployment, and are likely to be just as variable in their environmental effects as they are in their design. We cannot know exactly what the impacts will be until some prototypes are installed and tested. Some of the environmental issues raised at the DOE workshop (e.g., chemicals and noise) will likely be easy to assess and mitigate. Others will require site-specific studies (e.g., scour and sediment deposition) to resolve. Still others may need considerable study and may not be easy to mitigate. The sharing of information from previous studies, both of conventional hydropower projects and new technologies, will be important to ensuring the environmentally sound development of these new renewable energy technologies. ♋

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FEATURE: HUMAN DIMENSIONS

Communicating and Interacting with Oregon's Coastal Marine Recreational Fishing Community

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ABSTRACT: As marine fishery resources in Oregon decline and demand by user groups increases, coastal fishing communities face more and more regulations. This leads to increased interaction between management agencies and user groups, frequently occurring through formal public involvement methods and informal interactions. Communication is at the core of these interactions. Effective two-way communication results in mutual understanding and a positive outcome for all parties involved. This small pilot study explored the current state of communication within and between Oregon's coastal marine recreational community and the fisheries management community. The primary objectives were to understand the methods of communication used within and between these communities, to describe the current state of communication between them, and to identify suggestions for improving communication. This article focuses on identified factors which affect communication between these communities, potential improvements to current communication, and suggests that taking small, important steps toward making effective communication a priority within and between communities could build upon their genuine and mutual concern for the future of the resource. Fisheries managers (and the commercial fishing community) would be wise to better understand this stakeholder group and learn strategies to communicate with this understudied and possibly under-represented user group in Oregon.

Comunicación e Interacción con la Comunidad de Óregon de Pesca Recreativa

RESUMEN: Como la abundancia de recursos pesqueros en el Estado de Óregon declina y la demanda incrementa, las comunidades pesqueras de la costa demandan cada vez más regulaciones. Esta situación lleva a un incremento en las interacciones, formales e informales, entre las agencias administrativas y los grupos de usuarios. La comunicación es el núcleo central de tales interacciones. La efectiva retroalimentación comunicativa produce el entendimiento mutuo y resultados positivos para todas las partes involucradas. Este estudio piloto explora el estado actual de comunicación entre y dentro de las comunidades costeras de pesca recreativa y la de administradores pesqueros de Óregon. El objetivo principal fue entender los métodos de comunicación entre las dos comunidades e identificar elementos para mejorarla. A partir de lo anterior se sugieren procedimientos para encaminarse hacia una comunicación eficaz dentro y entre las comunidades, sobre la base de su genuino interés común de conservar los recursos marinos. Los administradores pesqueros (y la comunidad de pescadores comerciales) podrían aprovecharse de este grupo de toma de decisiones y aprender nuevas estrategias para comunicarse con este poco estudiado y posiblemente insuficiente representado grupo de usuarios en Óregon.

Recreational crabbers in Oregon's coastal marine waters.

INTRODUCTION

Fisheries management is one of the most complex processes within our government. As marine fishery resources decline and demand by user groups increases, fishing communities have faced more regulations. This has led to increased interaction between management agencies and user groups. These interactions frequently occur through formal public involvement methods, as well as informal interactions. Effective, two-way communication in these settings results in mutual understanding and, potentially, the maintenance of positive relationships between management agencies and stakeholders.

A 2002 study titled "Investment in Trust: Communication in the Commercial Fishing and Fisheries Management Communities" explored communication between the commercial fishing community and fisheries managers (Conway et. al 2002; Gilden and Conway 2002). However, the commercial fishing community is only one of the stakeholders in the fisheries management process. Another key stakeholder in the allocation of marine fish stocks is the coastal marine recreational fishing community (CMRFC). Failure to communicate well with the CMRFC may reduce the effectiveness of marine resource management.

This study, conducted in the summer and fall of 2004, explored the current state of communication within and between Oregon's CMRFC and the fisheries management community (FMC). The primary objectives were to understand the methods of communication used within and between these communities, to describe the current

state of communication between them, and to identify suggestions for improving communication.

The results demonstrate how the CMRFC resembles and contrasts with the commercial fishing community when communicating with fisheries managers. For example, both the CMRFC and the commercial fishing community characterize the fisheries management process as complex and inflexible. Yet, the two groups also diverge on the most effective methods of communication that managers should use to reach specific stakeholder groups. Unlike the commercial fishing community, the history of the relationship between the CMRFC and the FMC has not been well documented. The CMRFC is more diverse in member location, values, and preferences than the commercial fishing community, possibly contributing to the need for targeted, innovative communication methods. As the CMRFC becomes more of a vocal, organized, and influential user group within Oregon, fisheries managers (and the commercial fishing community) would be wise to better understand this stakeholder group and learn strategies to communicate with them. This small pilot study provides insight into this understudied and possibly under-represented user group in Oregon.

BACKGROUND AND CONTEXT

Fisheries in the United States vary tremendously yet Oregon's fisheries face many of the concerns felt in other regions. Fisheries in Oregon are managed by state and federal agencies following the intent and framework of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). A fishing community, as defined by the Sustainable Fisheries Act, is a community which is "substantially dependent on" or "substantially engaged in" the harvest or processing of fishery resources to meet economic and social needs (Sharp and Lach 2003). Yet the term "community" is becoming almost as diverse and complicated as the term "sustainable" in that it can refer to a geographic region, an occupation, or a group of people participating in a common practice or interest (Shaffer and Anundsen 1993). Much has been documented about the fishing community—specifically the commercial fishing community, meaning those who work in fishing or fishing related occupations (Davis 1986; Smith and Jepson 1993; Conway et al. 2002). However, much less is known about the CMRFC in Oregon.

Fisheries managers cannot effectively communicate with constituents or accurately conduct management activities unless they know the preferences, attitudes, values, and behaviors of the users of the resource (Henning 1987; Barber and Taylor 1990; Brown 1996). Dean (1996:172) states that "it is essential that fisheries management agencies keep anglers informed and thoroughly listen to their needs and wants." This prescription advanced by Dean is impossible if fisheries managers don't understand the communication values and preferences of the CMRFC.

Communication is the process of assigning meaning to verbal and nonverbal messages. Effective communication requires both parties to have a willingness to understand each other (Conway et al. 1999). When the process of two-way communication results in mutual understanding and a positive outcome for all parties involved, effective communication has been achieved (Collier 1995). Accomplishing effective communication within fisheries management can result in positive outcomes and a greater understanding of the communities involved (Gilden and Conway 2002).

Recreational charter.

The CMRFC: Who They are, Their Impact and Views

Members of the Oregon CMRFC are defined as men, women, and families who concentrate their fishing effort in the marine waters off the Oregon coast (versus inland waterways). We included private recreational fishers and charter operators in this community given that both follow the same regulations. The CMRFC also encompasses recreational industry support individuals such as sport fishing organizations, fishing supplies stores (tackle shops), and marina representatives. In this study, most CMRFC members interviewed characterized the CMRFC as a large group of extremely independent individuals.

In 2000, 285,000 individuals participated in Oregon's coastal marine recreational fishery, with Winchester Bay, Newport, and Garibaldi capturing the greatest number of participants (PFMC 2003 **a**). In 2002, the CMRFC caught 432 metric tons of groundfish; nearly a third of the total catch—indicating the size of their impact on ocean fishery resources (PFMC 2003 **a**). They also regularly participate in the crab and salmon fisheries.

However, for many members of the CMRFC, the amount of catch is not the most important aspect of fishing for them. Mail surveys assessing the preferences, attitudes, values, and behaviors of recreational fishers have been conducted on a limited basis and in few locations (Dawson and Wilkins 1981). These surveys have revealed a diverse range of preferences as well as diverse motivations for fishing (Dawson and Wilkins 1981; Radomski 2001). Fishing is an important family experience, explained one marina representative, "They don't care if they catch 1 fish or 20 fish as long as they're together and they know they're goin' fishin'. Fishing is supposed to be fun."

Recreational fishers' views towards management agencies and regulations have also been assessed. The complexity of regulations frequently leads to angler confusion and subsequent frustration (Dawson and Wilkins 1980). Those familiar with the management process have characterized the system that produces fishery management regulations as "cumbersome and inflexible, with a tendency to enact regulations that fishers view as overly complex and inappropriate for their fishery" (PFMC 2003: 472 **b**). Specifically, in Oregon, the CMRFC has expressed frustration that anecdotal information is not included in management decisions (NMFS and NSGCP 2000).

Communication and the Fisheries Management Community

In Oregon, management of marine fisheries involves federal and state agencies working together. In this study we conceptualize the FMC as including members and staff of the Pacific Fisheries Management Council (PFMC), NOAA Fisheries (NMFS), Oregon Department of Fish and Wildlife (ODFW), and the Oregon State Police. These agencies are actively engaged in the management of marine recreational fisheries and are the most likely to have contact with the CMRFC. The Pacific States Marine Fisheries Commission (PSMFC) is often considered a management agency yet it has more accurately been described as a "neutral" supplier and collector of data (Gilden and Conway 2002).

At the federal level, fisheries manage-

ment is largely accomplished by a regional council (in this case, the PFMC). User groups can directly interact with the PFMC through the following mechanisms: interacting face-to-face or on the phone with managers or council members, providing written comments, attending or testifying at council meetings, serving on advisory panels, or by helping with research efforts.

At the state level, the ODFW Marine Program has several mechanisms in place which allow for constituent participation. Involvement at the state level is less formal, more accessible, and possibly more inviting to user groups such as the CMRFC. This has led to a greater level of involvement and interaction by CMRFC members with state-level fisheries managers. Federal fisheries management, however, remains somewhat of a mystery to the CMRFC.

Sociopolitical Context

In the fall of 2004 the marine recreational groundfish fishery was closed unexpectedly (an early season closure) due to an unanticipated amount of good weather, which had led to greater fishing effort by this user group, which thus reached the agency quota earlier than expected. As a result, the CMRFC was given very short notice about the closure, resulting in cancelled fishing trips. Consequently, charter operators lost a great deal of income. Not surprisingly, this event fostered negative feelings towards management. Therefore, the sociopolitical context these two communities were experiencing during the time of the project may have been reflected in the study.

METHODS

In order to study communication within and between these two communities, we conducted 31 interviews with members of both communities. Interviewees were selected through the method of "snowball sampling," a technique considered to be a good means of accessing a hard-to-reach population (Berg 2001; Robson 2002). In snowball sampling, contacts lead to other contacts for the study. Initial names of individuals are obtained from the literature or contacts of the principal investigator known to be involved and/or familiar with each community. After an initial contact or interview, each person is asked whom they think would be beneficial to contact as well. This method of snowball sampling was used within each category of community member (charter operators, private fishers, and recreational industry support). Those interviewed within the FMC ranged from fish checkers to agency staff and administrators, with a total of 10 individuals interviewed. All 21 members of the CMRFC interviewed were from Oregon but varied in their fishing location, targeted species, and frequency of participation. Interviewees from both communities represented the diversity found in each community (gender, age, occupation); Table 1 lists the geographic distribution and types of members interviewed from each community.

For the interviews themselves, we selected a style of semi-formal, semi-structured interviewing known as "ethnographic interviewing," as it is useful and appropriate when attempting to discover complex issues such as communication, emergent themes, and idiographic descriptions (Cassel and Symon 1994; Silverman 2001; Robson 2002). Rather than limiting interviews to a strict set of pre-determined questions, ethnographic interviews allow "informants" to help shape the interview and raise topics that might otherwise not be explored, thereby giving the "informant an opportunity to answer in ways that are important to him or her—not the researcher" (Schwartzman 1993:58).

Interviews were conducted in person and ranged from 30 minutes to 2 hours. Responses were captured via tape recorder, transcribed verbatim, and analyzed via content analysis (Berg 2001; Robson 2002). Unless otherwise noted, quotations are typical of what many interviewees said. To ensure confidentiality, only community identifier and type of community member follow quotations.

IDENTIFIED ISSUES AND THEMES

Even small sample sizes can reveal themes or issues important in the community. Several themes emerged with regard to what each community thought should be communicated and how it should be communicated, challenges to communication within communities and barriers to effective communication between communities, and how communication could be improved. They are discussed in the following subsections and summarized in Tables 2 and 3.

How the Fisheries Management Process Operates

Understanding how the fisheries management process operates was identified overwhelmingly as a need by both communities. Within the CMRFC, almost two-thirds of interviewees stated a desire to know how the fisheries management process operates. Almost a third of the interviewees stated they would like to know how to access the management process and be effective, including knowing whom within management agencies they can contact when they have questions. Members of the management community felt similarly with over two-thirds of interviewees stating that it was important for the CMRFC to know how the management process operates including which fisheries are state managed and which are federally managed.

Members of the CMRFC were generally more familiar with state-level management activities, most likely due to the local pres-

Table 1. Distribution and types of community members interviewed.

Geographic distribution of interviewees	**Number interviewed**
North Coast	9
Central Coast	5
South Coast	4
Urban Centers *	12
Types of CMRFC members interviewed	**Number interviewed**
Charter operators	4
Private fishers	9
Recreational fishing industry support**	8
Types of FMC members interviewed	**Number interviewed**
State agencies	2
Federal agencies	5
Enforcement agencies (state police)	2
Tri-state, neutral entity that collects/supplies data	1

* Urban centers include Portland or other cities in the Willamette Valley.
** Industry support includes advocates/organizational leaders, tackle shops, and marine representatives.

ence of state agencies. On the other hand, the CMRFC interviewees were largely unaware of the activities conducted by the PFMC and how state and federal agencies work together to accomplish management. One interviewee stated that they felt that it was the job of ODFW to explain the fisheries management process (although not adequately done).

> . . . from our own internal end of it here, [having] finances and people who would be more or less just dedicated to education, I think [would be] quite beneficial.
>
> *FMC, state agency*

> You have to give the Marine Program more money, more personnel. You have to arrange it so that the amount of money that comes from recreational fishermen, through the programs, actually goes to the Marine Program.
>
> *CMRFC, private fisher*

Two out of 10 CMRFC members interviewed expressed that management is doing the best they can within their constraints, recognizing that there are often unforeseen events the FMC cannot plan for. These individuals commented that it is beneficial to work with the management agencies, and when they provide input to the FMC, the FMC is grateful for the input.

Data

How data is collected, analyzed, and subsequently communicated was of great importance to the CMRFC. The opinions of those interviewed from the CMRFC were divided over the data used by the FMC to develop fisheries management plans (FMPs). Some individuals interviewed (3 out of 21) commented that they trust the science and data but mistrust how the data is used to develop FMPs. Whereas, double this number (6 out of 21 interviewed members of the CMRFC) expressed dissatisfaction with the data used to develop FMPs. In general, CMRFC members interviewed felt that the data was incomplete either due to a lack of sampling or failing to incorporate anecdotal data. Ten percent of those CMRFC interviewed

Table 2. Information requested or thought to be important for the CMRFC

Information Requested/Thought to be Important for the CMRFC	CMRFC (n = 21)	FMC (n = 10)
How the management process operates	62%	70%
How to effectively influence the management process	29%	70%
How data is collected, analyzed, and subsequently communicated:		
•Data quality is ok but mistrust how data is used,	14%	NM
•Dissatisfied with data quality	29%	NM
•Practical knowledge/data should be used	14%	NM
Regulatory information (size limits, species identification, seasons)	100%	80%
Rationale for regulations	33%	3%
Who controls the regulation (state or feds)	62%	NM
Information needs to be shared in a timely manner	24%	NM
Information needs to be shared in a user-friendly manner	57%	NM

* NM = not specifically mentioned by the FMC

Table 3. Utilized Communication methods and suggested improvements.

	Method		Suggested Improvement	
Face-to-Face	Informal:	Primarily occurs within communities	Increase between communities	
	Semi-formal:	CMRFC —> Tackle shops and marinas	FMC:	Better educate fish checkers
		CMRFC —> ODFW fish checkers	CMRFC:	Attend meetings; express opinions and potential solutions
	Formal:	ODFW and PFMC public meetings	FMC:	Make meetings accessible, understandable, and comfortable; provide information on how to participate; Hold meetings describing management rationale
Written	Newsletters:	Produced by—marinas, tackle shops, fishing organizations, management agencies	CMRFC:	Sign up to be on mailing lists
	Letters:	Public letters to the PFMC		
	Flyers:	Provide notification to the public regarding management meetings and decisions	FMC:	Distribute on time; make them clear and understandable (avoid the use of jargon)
	Brochures:	Tool used by management agencies to distribute information		
	Regulation booklet:	Prepared by ODFW detailing fishing seasons and regulations		
	Newspapers:	Effective method to distribute fishing announcements to a diverse constituent group	FMC:	Work closer with newspapers to print updates and to ensure they are accurate
Electronic	E-mail:	Primarily occurs within communities	FMC:	Attempt to respond to e-mails
	Websites:	Tool used to disperse fishing and management information; utilized by management agencies, fishing organizations, and state Extension offices	FMC:	Ensure websites are user-friendly and up-to-date
	Chat boards:	Development of I-fish.net; primarily used by CMRFC members	CMRFC:	Utilize for effective communication
			FMC:	Monitor conversations and participate
Radio	Telephones:	Infrequent form of communication between communities	FMC:	Make efforts to invite constituents to call if the have questions
	Boat radios:	Used by the CMRFC to communicate on the water	CMRFC:	Utilize this method more
	Radio Stations:	Effective method to distribute fishing announcements to a diverse constituent group	FMC:	Make attempts to work with stations to make public service announcements at a reasonable cost

expressed strong views towards data, saying that the data is "terrible" because of the parameters used to get data and the inadequate sampling along the coast. A few members of the CMRFC even expressed a desire to share their catch data with the FMC in order to improve data collection.

Findings in the data were also seen as problematic by some. Two of CMRFC members interviewed even disagreed with the FMC that the stocks are even in trouble. Almost a third of the CMRFC interviewees held negative opinions regarding the current stock assessments citing that scientists were "just guessing" or that the data is "over generalized."

Some of the CMRFC interviewees (3 out of 21) shared a desire that the FMC incorporate more practical knowledge into management decisions.

> The only thing that we wish is that they'd listen to us a little bit better sometimes because we're on the water and they're not. And that can be frustrating for us. We tell them what we actually see and their scientist is tellin' 'em something else and their scientists aren't on the water like we are.
>
> *CMRFC, charter*

Throughout the interviews the topics of data collection, analysis, and reporting were clearly sore spots for the CMRFC which in turn affects their willingness to communicate and to trust what is being communicated to them.

Regulations: Important and Complex

Knowing up-to-date regulations is central to participating in marine recreational fishing. Members of the CMRFC interviewed recognized this; every interviewee (100%) stated the need to know what the regulations are, including identification, season, and size limit information for each species. However, a third of them conveyed a desire to know more than just the regulations. They would also like to know which regulations are controlled by the state or the federal agencies, how the regulations are made, and the logic behind them. This is especially relevant for in-season adjustments, which are somewhat of a mystery to the CMRFC.

> A lot of recreational fishermen do not have a very positive attitude towards the managers because there's been a long history of making regulations without explaining why.
>
> *CMRFC, industry support*

> . . . education's so important. If you knew the reason behind why that rule was written the way it was written in the first place, then it would be like okay, okay, okay I understand now."
>
> *CMRFC, industry support*

According to a majority of those interviewed (8 out of 10) within the FMC, it is the responsibility of the CMRFC to know what the regulations are. However, they acknowledged their responsibility to provide the tools to the CMRFC in order to know what the regulations are.

Sixteen out of 21 interviewed within the CMRFC explicitly recognized the responsibility associated with participation in the fishery, and 4 acknowledged their responsibility to advocate for themselves both in the management process and at the legislature.

> . . . people need to be responsible for themselves for learning how a phone works, and ODFW can't be responsive to that. They can't be responsible for people understanding how to use the Internet.
>
> *CMRFC, private fisher*

> I always think it's my responsibility. I mean if I want to communicate with somebody it's not theirs, it's my responsibility to do that. . . . The state doesn't owe us anything."
>
> *CMRFC, private fisher*

However, there are segments of the CMRFC that do not take the time to read the regulations even though it is to their advantage to be aware and become involved.

> The fact of the matter is that we repeat [the message] over and over again but its to different audiences and often it's the first time that particular audience has heard it. We kind of have to think in that regard.
>
> *FMC, federal agency*

> If you are going to serve a customer you need to understand your customer and help them know what they need to know . . . Not all agencies embrace that philosophy.
>
> *CMRFC, industry support*

> And you know the information's out there but if they're not gonna look, they're not gonna find it. That's the big one... they go into it blindly. They can't afford to do that."
>
> *FMC, state agency*

Four (out of 21) CMRFC interviewees indicated that there are members who have seen the benefits of involvement and are currently working to reverse this trend of non-involvement. They contend that if individuals are willing to go fishing then they should be willing to go to a meeting to ensure their fishing future.

But it's not just if someone participates in a meeting or accesses the materials, it is the materials themselves. For example, all of the CMRFC interviewees (100%) stated that the regulation packet is not an adequate source of information due to the fact that they are printed before all management decisions are made. Furthermore, four members of the CMRFC interviewed felt Oregon recreational fishing was over-regulated.

> I am sure we are one of the most heavily regulated industries in the state and that feeling of big brother or government watching over you come[s] out.
>
> *CMRFC, charter operator*

A third of the members of the CMRFC interviewed mentioned the difficulty they had keeping track of the frequent in-season changes to regulations, and that it would be beneficial to have management information available statewide. Most CMRFC interviewees expressed a desire to receive advanced notification of in-season changes, so as not to be surprised with season closures or other in-season regulation changes.

Frequently, the CMRFC relies on tackle shops and marinas to stay up to date on regulation changes. Therefore, marinas and tackle shops have said they do their best to monitor management changes and try to understand the reason behind the change.

Despite the CMRFC's negative views regarding regulations, some acknowledge that the regulations are complicated due to the diversified fishing resource. Furthermore, a minority of those interviewed felt the regulations were in place for a reason.

Receiving Information: Desires and Constraints

Within the CMRFC, informal communication is common and generally occurs while on docks or on fishing trips. Meetings within the CMRFC also take place (Oregon Coast Sport Fishing Association). Events hosted by the Recreational Fishing Alliance or participation on an Internet chat board (such as Salty Dogs or I-fish; used by over a third of the CMRFC members interviewed) also provide opportunities to interact. Informal communication between communities currently is rare. As members of the CMRFC

begin to take involvement in the fisheries management process more seriously (presentations at council meetings; serving on advisory panels), formal communication between communities increases. However, often the same individuals attend the meetings and this does not allow for the diversity of opinions to be communicated to the FMC.

Receiving information in an understandable and timely manner was the most important characteristic to the CMRFC. Timely data, specifically, was important to one-fourth of the CMRFC interviewees, conveying the perspective that there is too much of a lag time between when a stock assessment is conducted and when the results are used in the development of FMPs.

> . . . there is a huge lag time between data. I mean we might do a stock assessment this year and it won't come into play for three years down the road. And that is hard for an industry to wait that long for something to happen.
>
> *CMRFC, charter operator*

Over half (12 out of 21) of the CMRFC members interviewed expressed the desire to receive information that is user-friendly and makes sense to them. This means presenting information in a concise format so that anglers do not have to spend large amounts of time sorting through long and confusing documents, or participating in bewildering, uncomfortable meetings.

> The average angler is not interested in going to a government meeting.
>
> *CMRFC, private fisher*

> There are a lot of details that need to be communicated and understood in order for someone to effectively interact and know where to best interact with the system and show up at the right time, the right place and with the right kind of comments.
>
> *FMC, federal agency*

> …it takes a long time to learn to understand what they are saying. They speak in acronyms. Most of the public would not be able to participate because they wouldn't have a clue what was being said…there's a definite communication breakdown…
>
> *CMRFC, charter operator*

Throughout the interviews, suggestions were made such as updating web sites more often or using written media as a way for the FMC to reach the CMRFC. In some cases tackle shops and marinas write columns in local newspapers updating management changes. This was suggested as being effective because it has the capability of reaching both a local audience and those in outlying areas.

However, many of the suggestions made by the CMRFC interviewees did not take into account the constraints—regarding the depth and timeliness of, and mechanisms for, communicating information—faced by management agencies. This is most likely due to a lack of understanding of the environment in which fisheries management currently takes place. At the federal and state level of fisheries management, all FMC members interviewed (100%) agreed that budget constraints were a primary barrier to improving communication efforts. The ODFW Marine Program was discussed by members of both communities interviewed as being faced with an unacceptable workload, a very tight budget, and limitations in communicating…even internally.

Coastal marine waters: a busy place during fishing season.

Similar to ODFW, interviewees from the PFMC said that being overwhelmed with duties leaves little time to devote to internal and external communication. Staff members indicated that their time was consumed with complying with legal requirements and following the guidelines of the management structure. People outside of the fishing community and the fisheries management community see this as well. One coastal marine extension agent reminded participants in an industry-related meeting that the PFMC has to follow a process that Congress dictates to them under the MSA, with further review and decision by the NMFS. They must meet all legal standards and "they get sued if they don't… and they still get sued even if they do. So, in defense of the PFMC, it is hard work to do this. People are really overwhelmed a lot of times."

However, a vital component to improving communication between communities is prioritizing communication within agencies. Currently, such efforts are "put on the back burner" often due to a lack of time and budget. In order to improve outreach efforts there must be a willingness to prioritize and invest in communications throughout management agencies. Improving coordination between the PFMC and ODFW could result in a more effective outreach campaign. According to over a third of the FMC members interviewed (4 out of 10), both internal and external communication needs to be improved within fisheries management agencies. There are changes occurring within the PFMC—an Enhancing Council Communications Plan—with regard to communication with the public, communication during council meetings, and communication with advisory bodies.

CONCLUSIONS

Although a small study, several clear points emerged from this research that can broaden our understanding of the CMRFC and the current relationship and state of communication between communities. The diverse range of preferences, views, and attitudes toward management agencies and regulations; values and motivations for fishing; and behaviors of Oregon members of the CMRFC interviewed for this study enhanced what has been learned from other studies (Dawson and Wilkins 1981; Radomski 2001). Themes such as complexity of regulations, frustration over how their "experiential information" is not being used, and lack of understanding and confusion about the management process all support earlier studies (Dawson and Wilkins 1980; PFMC 2003 **b**; NMFS and NSGCP 2000). Still, much is still unknown. Will more of these individuals join fishing organizations or do they prefer to remain connected only by their mutual interest? Do policies influencing management impact a particular group of recreational fishers (say, charter operators) or are impacts felt throughout the CMRFC (private fishers, charter operators, and recreational fishing industry support providers)? More in-depth and larger studies could help provide answers to these questions.

There are numerous dimensions to communication within and between these two communities. Our small sample of members of the FMC interviewed displayed some commonality in their views of the state of communication between the two communities. They described the CMRFC as an important user group but one with a diverse set of preferences, little active involvement in the management process, and a large geographic distribution. Although they claim they do the best they can to get the word out, they feel that it is the responsibility of the CMRFC to seek out the information and become involved in the management process.

Members of the CMRFC interviewed showed less commonality, which is not surprising given the diversity of the community. From those interviewed in the CMRFC, it appears that the CMRFC as a whole might be much more divided in their opinions on the state of communication. Attitudes towards the FMC and their communication efforts ranged from very negative to positive. Our results revealed a perceived distinction between federal agencies and state agencies regarding how they communicated with this user group. There was a general frustration with the number and complexity of regulations placed on the community.

This research supports the results of other studies in that this user group, like the commercial fishing community, views the complicated and inflexible structure of the management process as a barrier to involvement. Yet, the level of involvement in the management process appears to be correlated with a CMRFC members' attitude towards the FMC; positive views within the CMRFC and the desire to interact with the FMC on a more face-to-face basis. Members of the FMC could support this desire in order to build and maintain the respect of the CMRFC.

Similar to previous research that looked at the relationship between the commercial fishing community and the FMC (Gilden and Conway 2002), this research reveals underlying differences and mistrust between the FMC and the CMRFC. Before large improvements in communication can be made, these social communication barriers need to be addressed. Increasing communication with the CMRFC and using new and innovative communication methods are important. However, it's also important to recognize that this might not have large or lasting effects if the CMRFC still mistrusts the person or agency communicating with them. Informal communication through marinas and tackle shops, and the use of the Internet and radio might be helpful.

Complex barriers and past negative experiences between communities take time to resolve. As is the case with the commercial fishing community, the CMRFC and the FMC could begin to help themselves and each other if they were to take small, important steps toward making effective communication a priority within and between communities, and build upon their genuine and mutual concern for the future of the resource. ♋

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COLUMN: GUEST DIRECTOR'S LINE

5th World Fisheries Congress Planning Well Underway

Doug Beard
Beard is a member of the International Program Committee for the 5th World Fisheries Congress. He can be contacted at dbeard@usgs.gov.

Beard discusses the WFC program with Shugo Watabe, organizing committee chair.

Mark your calendars now for the 5th World Fisheries Congress (WFC), which will be held in Yokohama, Japan, from 20–24 October 2008. The goal of WFC meetings is to convene fisheries scientists from around the world to discuss and bring attention to the primary issues facing global fisheries. The 5th WFC is being organized by the Japanese Society of Fisheries Science (JSFS) as the lead society, and members of the World Council of Fisheries Societies are also included in the program planning. AFS has been heavily involved in the program planning for the 5th WFC and I participated in a recent program planning meeting for the upcoming WFC on behalf of AFS. Many of the priorities that AFS has brought to the WFC program planning committee have been incorporated into what we believe will be an excellent WFC program.

The objective of the 5th WFC is to address issues that contribute to the global welfare and environmental conservation of the world's fisheries. WFC will be organized around nine topical sessions, which include fisheries and fish biology; aquaculture; biotechnology; post-harvest science and technology; material cycling in aquatic ecosystems linking climate change and fisheries; freshwater, coastal, and marine environments; biodiversity and management; fisheries economics and social science; and education and international cooperation. Seven plenary speakers, including 2005 AFS Award of Excellence winner Ray Hilborn, will provide keynote presentations addressing the primary topics of WFC. Under each topical session, a series of subsessions will be developed to address specific issues surrounding each topic. AFS has submitted three possible subsessions: comparative large marine ecosystems dynamics, new techniques in stock assessment, and inland fisheries—the hidden crisis, for possible inclusion in the program. These three subsessions were positively received by JSFS. Further, JSFS is open to receiving more proposals and if you are interested in participating in the proposed subsessions or developing a proposal for a subsession, please contact me at dbeard@usgs.gov for more details. In addition to participating in subsessions, there will be an open call for papers during the fall of 2007, for those wishing to submit papers for possible inclusion into the program.

The 5th WFC will be held at the Pacifico Yokohama convention center, located on the waterfront in the port area of Yokohama. Yokohama is a short bus or train trip from Narita International Airport. It is also a short train trip to Tokyo, Hakone National Park, Mt. Fuji, and Nikko (an UNESCO World Heritage Site—http://whc.unesco.org/en/list/913) for those wishing to explore destinations further around Japan. Pre- and post-symposium tours for participants as well as guided spouse/guest tours of Yokohama and Tokyo area sights have been arranged by JSFS. Those wishing to travel further afield from Yokohama can use the Shinkansen (bullet train—www.japanrail.com/JR_shinkansen.html) from the Shin-Yokohama station and be in Kyoto within 2 ½ hours. And, of course, all fisheries biologists should see the world famous Tsukiji Fish Market in Tokyo (www.japan-guide.com/e/e3021.html).

AFS is proud of its long standing involvement with organizing and participating in the World Fisheries Congress, from its inception in Athens, Greece, through to our primary role at the 4th WFC in Vancouver. We encourage all AFS members to attend the 5th WFC in Yokohama, either as a presenter or a participant. For more details on the 5th WFC, please see www.5thwfc2008.com. I look forward to seeing you in Yokohama! ♋

Continued from page 162

UMESC for their contributions to the approval of Aquaflor® for the control of mortality due to enteric septicemia in catfish at Aquaculture America 2006. For more information, see www.fda.gov/cvm/CVM_Updates/SalmonidsUp.htm.

—Roz Schnick

New fishing site locator

The Recreational Boating and Fishing Foundation (RBFF) announced the launch of a new and improved TakeMeFishing.org website with an expanded "Where to Fish and Boat" locator that identifies places to fish and boat in all 50 U.S. states. With a database of more than 10,000 locations, visitors can search for places to fish and boat that are close to home or far away and have access to all the information they'll need to quickly and easily plan a day on the water. Search results are compiled and paired with fishing license information, local regulations, fishing reports, and other local fishing and boating information, all on one page.

To help families plan a day of fishing, TakeMeFishing.org tapped the expertise of state wildlife agencies and outdoor writers to identify the top three destinations located near major cities across the country. Each of these places is designated as a "Family Friendly Hot Spot." These places to fish and boat are close enough for a day trip and offer conveniences for families, including parking, bathrooms, shore access, boat ramps, and an abundance of fish. Each Family Friendly Hot Spot entry provides detailed information about the location.

RBFF is encouraging its stakeholders to take advantage of the enhanced web site and make sure their business, club, or organization is listed.

Updated fishing retention rates

Recruitment rates of youngsters in hunting and fishing have stabilized after declining through the 1990s, according to a new report based on preliminary data from the 2006 National Surveys of Fishing, Hunting and Wildlife-Associated Recreation and information from previous surveys.

"From 1990 to 2000 there was a steady decline in the percent of kids living at home who had ever participated in fishing and hunting," said U.S. Fish and Wildlife Service economist Jerry Leonard, who authored the report. "During the last 5 years this decline has stabilized. Now, 42% of our nation's youth have gone fishing and 8% have gone hunting at least once."

The report also shows that many first time hunters and anglers—about 33% of all first timers—are 21-years-old and older. However, overall retention rates for fishing continued to decline from 2000 to 2005. "In 1990, 65% of anglers fished in the previous 3 years," said Leonard. "That number fell to 61% by 1995, 60% by 2000, and 57% by 2005."

Recruitment declined the least among those with higher incomes, those living in less populated areas of the United States, and those living in the Midwest. In contrast, the greatest declines were among people with the lowest incomes, those living in urban areas, and those in the New England, Pacific coastal, Rocky Mountain, and Southwestern states. The report is available at http://library.fws.gov/nat_survey2001_recruitment.pdf. ♋

Continued from page 164

structure that reconnected the lower Illinois River and Swan Lake. They sampled fish entering the lake with nets set at three different depths—surface, intermediate, and bottom. The authors noted that a variety of native and nonnative species used the structure, some on a seasonal basis to enter the lake to use as a breeding or overwinter habitat. However, since some species such as carp seemed to prefer the middle and bottom depths, there is potential for HREPs to be used to hinder the movement of exotic fish species by closing off the bottom two-thirds of the structure. Further evaluation of the effectiveness of this approach and the costs and benefits is needed. *Backwater Immigration by Fishes through a Water Control Structure: Implications for Connectivity and Restoration,* by Douglas W. Schultz, James E. Garvey, and Ronald C. Brooks. North American Journal of Fisheries Management 27:172-180. Garvey can be contacted at jgarvey@siu.edu.

Bringing back coho to the Yakima River

The Yakima River in Washington, a tributary of the Columbia River, historically supported runs of tens of thousands of coho salmon each year, but the by the 1980s the coho were completely gone. Without a native stock to start from, researchers began a multi-year project to assess whether the coho could be brought back by using hatchery stocks either from within the basin or from elsewhere. In a recent paper in the *North American Journal of Fisheries Management,* scientists from the Yakama Nation, in cooperation with state, federal, and private scientists, studied the survival rates of fish of various origins released at different times and locations. They also compared the return rates for adults that were spawned in the wild as the result of the previous 10–20 years of stocking efforts against the returns of fish produced in the hatchery. The natural origin adult fish were larger and returned and spawned later than the hatchery fish. Naturally produced smolts were also 3.5–17 times more likely to survive than those raised in a hatchery, showing that naturalized Yakima coho are developing increasing fitness with more and more generations in the wild. Increasing upriver returns of adults are producing some sustainable spawning groups, showing that the former hatchery origin fish have demonstrated the ability to reestablish themselves in the Yakima River after just 3–5 generations of stocking in the wild. The next phase of the project is to develop a local sustainable brood source from these returning wild-spawned fish and continue to increase the fitness of the reintroduced Yakima stock. ***Evaluating the Feasibility of Reestablishing a Coho Salmon Population in the Yakima River, Washington.*** William J. Bosch, Todd H. Newsome, James L. Dunnigan, Joel D. Hubble, Douglas Neeley, David T. Lind, David E. Fast, Linda L. Lamebull, and Joseph W. Blodgett. North American Journal of Fisheries Management 27-198-214. Bosch can be contacted at bbosch@yakama.com. ♋

CALENDAR: FISHERIES EVENTS

To see more event listings go to www.fisheries.org and click About us, committees, calendar, and click Calendar of Events.

May 9-11—**Water Access: Working Waterways and Waterfronts,** Norfolk, VA. See www.wateraccess2007.com. Contact Tom Murray, tjm@vims.edu, 804/684-7190.

May 10-13—**Second International Symposium on Groupers of the Mediterranean Sea,** Nice, France. See www.ims.metu.edu.tr. Contact meltemok@ims.metu.edu.tr.

May 14-15—**AIBS Annual Meeting: Evolutionary Biology and Human Health and Annual Meeting of the Natural Science Collections Alliance,** Washington, DC. See www.aibs.org/annual-meeting.

May 14-16—**New Strategies for Urban Natural Resources: Integrating Wildlife, Fisheries, Forestry, and Planning Conference,** Chicago, IL. See www.informalearning.com/wildlife.

May 20-23—**Center for Natural Resource Economics and Policy Meeting: Challenges of Natural Resource Economics and Policy, the Second National Forum on Socioeconomic Research in Coastal Systems,** New Orleans, LA. See www.cnrep.lsu.edu/pdfs/CNEP.

May 22-24—**Backpack Electrofishing and Fish Handling Techniques: Effective Methods for Maximizing Fish Capture and Survey,** Seattle, Washington. See www.nwetc.org.

May 22-25—**29th Organization of Wildlife Planners Annual Meeting and Conference: Developing the Next Generation of Fish and Wildlife Aqencies,** Blacksburg, Virginia. See www.owpweb.org/Annual Conf/next_conference.php.

May 24-27—**Aquarama 2007: Tenth International Aquarium Fish and Accessories Exhibition and Conference,** Singapore. See www.aquarama.com.sg.

May 28-Jun 1—**Human and Climate Forcing of Zooplankton Populations,** Hiroshima, Japan. See www.pices.int/meetings/international_symposia/2007_symposia/4th_Zooplankton/4th_Zoopla.asp.

AFS Jun 6-9—**Fourth North American Reservoir Symposium,** Atlanta, GA. See www.sdafs.org. Contact Vic DiCenzo, vic.dicenzo@dgif.virginia.gov.

Jun 7-9—**15th International Conference on Environmental Bioindicators,** Hong Kong. See www.InformaLearning.com/EBI . Contact Jana Johnsen, Johnsen@informuse.com.

Jun 11-14—**International Symposium on the Science and Conservation of Horseshoe Crabs,** Oakdale, NY.

Jun 13-15—**Advanced Mobile Survey Hydroacoustic Techniques Workshop: HTI Model 241/244 Split-Beam Hydroacoustic Systems,** Yellowstone Park, WY. Contact Workshop2007@HTIsonar.com.

Jun 17-21—**Seventh Conference on Fish Telemetry,** Silkeborg, Denmark. See www.fishtelemetry.eu/.

Jun 17-21—**13th International Symposium on Society and Resource Management,** Park City, UT. See www.issrm2007.org.

Jun 18-22—**Seventh Symposium on Fish Immunology,** Stirling, Scotland. See www.abdn.ac.uk/noffi/.

AFS Jun 18-21—**Second International Symposium on Diadromus Fishes: Challenges for Diadromous Fishes in a Dynamic Global Environment,** Halifax, Nova Scotia, Canada. See www.anacat.ca . Contact Alex Haro, Alex_Haro@usgs.gov.

Jun 22-24—**Shanghai International Fisheries and Seafood Exposition,** Shanghai, China. See www.sifse.com.

Jun 23—**Seventh International Chrysophyte Symposium,** New London, Connecticut. Contact Anne Lizarralde, anne.lizarralde@conncoll.edu.

Jun 23-27—**Fourth Biennial Conference of the United States Society for Ecological Economics—Creating Sustainability within Our Midst: Challenge for the**

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.)

21st Century, New York, New York. See www.ussee.org/conference.htm.Contact conference@ussee.org.

Jun 26-29—**ICES/PICES Conference for Early Career Scientists: New Frontiers in Marine Science,** Baltimore, MD. See www.pices.int/newfrontiers.aspx.

Jul 4-7—**Conserv-Vision Conference,** Hamilton, New Zealand. See www.waikato.ac.nz/wfass/Conserv-Vision/.

Jul 11-16—**Joint Meeting of Ichthyologists and Herpetologists,** St. Louis, Missouri. See www.dce.ksu.edu/jointmeeting/.

Jul 17-21—**First International Sclerochronology Conference,** St. Petersburg, FL. See http://conference.ifas.ufl.edu/sclerochronology/.

Jul 22-26—**Coastal Zone '07,** Portland, OR. See www.csc.noaa.gov/cz/.

Jul 23-26—**2007 National Forum on Contaminants in Fish,** Portland, ME. See www.epa.gov.waterscience/fish/.

Jul 23-26—**Waterpower XV: Advancing Technology for Sustainable Energy,** Chattanooga, Tennessee. See www.hcipub.com.

Jul-27—**National Marine Educators Association Conference,** Portland, ME. Contact Downeast2007@gonmea.org.

Jul 30-Aug14—**Pan American Advanced Studies Institute Program on Contemporary Issues in Estuarine Physics, Transport, and Water Quality;** Puerto Morelos, Mexico. See http://pasi.coastal.ufl.edu.

Jul 31-Aug 1—**13th Annual Aquaculture Drug Approval Coordination Workshop,** Bozeman, MT. See www.fws.gov/fisheries/aadap. Contact Niccole Wandelear, niccol_wanderlear@fws.gov, 406/994-9913.

Jul 31-Aug 3—**Global Environment Facility Fourth Biennial International Water Conference,** Cape Town, South Africa. See www.iwlearn.net/iwc2007. Contact Mindy Butner, iwc2007@getf.org. 703/379-2713 x241.

Aug 12-18—**30th Congress of the International Association of Theoretical and Applied Limnology: Redefining Theoretical and Applied Limnology in the 21st Century,** Montreal, Canada. See www.sil2007.org.

Aug 15-16—**European Aquaculture Society: Aqua Nor Forum 2007,** Trondheim, Norway. See www.easonline.org/home/en/default.asp.

Aug 22-24—***Salvelinus Confluentus* Curiosity Society Annual Meeting,** Perkins Lake, ID. Contact Dan Kenney, dkenney@fs.fed.us, 208/622-0094.

Sep 2-6—**American Fisheries Society 137th Annual Meeting,** San Francisco, CA. See www.fisheries.org/sf/.

Sep 11-15—**Fish Stock Assessment Methods for Lakes and Reservoirs Conference: Towards the True Picture of Fish Stock,** Ceske Budejovice, Czech Republic. See www.fsamlr2007.czweb.org.

Sep 17-21—**International Council for the Exploration of the Sea,** Helsinki, Finland. See www.ices.dk.

Sep 18-21—**International Conference on Freshwater Habitat Management for Salmonid Fisheries,** University of Southampton, UK. See www.salmonidhabitat.com. Contact Lynn Field, admin@salmonidhabitat.com.

Oct 8-11—**Second International Symposium on Tagging and Tracking of Marine Fish with Electronic Devices,** San Sebastian, Guipuzcoa, Pais Vasco, Spain. See http://unh.edu/taggingsymposium/.

Oct 9-12—**International Symposium: Wild Trout IX,** West Yellowstone, MT. www.wildtroutsymposium.com/. Contact Dirk Miller, Dirk.Miller@wgf.state.wy.us 307/777-4556.

Student Writing Contest First Place Winner

Andrew L. Rypel
Rypel is a Ph.D. student at the University of Alabama.

Big bass in rivers? You're kidding me!

As the sun tucks away behind the swampy skyline, I stand in waders at the Sipsey River boat landing discussing fishing, religion, and this year's cotton crop with Joe Price, a 73-year-old retired farmer. "The river hasn't changed much." he says. I smile—half because I enjoy the nostalgia and half because it affirms my hypothesis that this river is still quite natural and also because any other statement might keep me up at night.

The Sipsey River, situated in west-central Alabama, is a special place for a number of reasons. Considered one of the 10 natural wonders of Alabama, the Sipsey is teaming with big fish, baldcypress trees, and healthy freshwater mollusk populations. Its splendor has remained in large part because there are no dams on the Sipsey River, a very rare attribute of rivers worldwide. What this means is that during wet periods (winter in Alabama), the river floods in dramatic fashion and humans do nothing about it. In late spring, the river falls back inside its banks but leaves behind pockets of water on the landscape (<1 acre), deemed floodplain lakes.

The connection between these lakes and the main channel, I believe, is crucial to the unchanging quality of the Sipsey River fishery. Largemouth bass populations are particularly healthy. The Sipsey River supports some of the best largemouth bass fishing around and this has flown under the radar—perhaps as the well-kept secret of a few. Fish over 8 lbs. are common enough that it doesn't take a Ph.D. in crankbaits or a $50,000 bass boat to catch one. Why does such an ecosystem produce these sized fish?

I have been investigating the Sipsey River fishery for over a year to evaluate how unregulated streamflow affects fish populations. Although I'm studying 10 different species, for now I'd like to tell you about the largemouth bass. Size-at-age data indicates that growth rates are high, much higher than state-wide averages. Floodplain lakes are also loaded with juvenile (current year's) bass during spring and early summer, suggesting that these are critical spawning and nursery habitats. Moreover, strength of annual largemouth bass cohorts indicates strong correlations with annual streamflow. Years of lower streamflow supports stronger largemouth bass year classes than higher flows years. Conversations with regional fisheries managers suggest similar ecological patterns operating in other river-floodplain ecosystems.

Southern reservoirs are the epicenter of largemouth bass fishing in America. In 2006, 10 of 14 Bassmaster's series tournaments are taking place in southern reservoirs, including the championship. In short, bass fishing is a big business and is important to many as a hobby to improve upon as well as a way to reconnect with nature. Why have unregulated rivers been ignored as places of high quality fishing or even as models of healthy ecosystems?

Maybe we just didn't think of it. After all, it is somewhat surprising that these swampy rivers produce lunkers. Or maybe it is because so few unregulated rivers remain. Bass fishing is a fairly recent phenomenon which has blossomed in the last 30 years, a timeframe through which dams had been erected on most rivers. Additionally, most of our unregulated rivers are located in regions of low human population which may limit word of mouth. Of course, I hope in writing this I'm not destroying the well-kept secret of many a savvy southern fisherman. I am interested in finding out why unregulated rivers promote healthy, fast-growing fish populations and transferring this knowledge to a regulated setting where hydrology is under our control. The goal is to restore a more natural hydrograph which would result in a better fishery and bigger fish.

It's a refreshing sunset at the Sipsey landing—not just because the baldcypress trees rise from the river water as if Jack planted his bean stalk here about a thousand times, or because of Joe's fish-filled cooler, but because we know this is a special place, largely untouched by human hands. The air seems fresher and we know that big fish (and snakes!) are swimming in this river. I imagine that this is how nature was intended to be enjoyed and how many rivers looked a thousand years ago. ♋

Student Writing Contest Second Place Winner

Rebecca Zeiber
Zeiber was an M.S. student at Purdue University and now is a science writer/editor with the New Hampshire Sea Grant program.

Mosquito-Eating Machine or Native Species Monster? Assessing the Impacts of Western Mosquitofish Stockings in Indiana Waters

The seine pull was much heavier at this lake than most I had visited recently. Dodging the rocks and dense vegetation was an exercise in futility, so we caught items other than small fish, which added to the weight of the seine. After hauling the wet net to shore, two small boys peered over my shoulder, anxious to see what we had caught. Jesse, a lanky boy of seven years, was wearing aquasocks to allow for easier walking as he conducted his volunteer duties. He began picking through the vegetation, mimicking my actions. His four-year-old brother, Joshua, hadn't quite gotten the hang of searching for the fish we needed. Instead, he was intent on plucking every bluegill from the seine and throwing them back in the lake.

I hadn't been back to this site since the month before, but Jesse remembered we were looking for banded killifish. He had graciously volunteered to help, and when our red truck pulled up next to his house on the lake today, he ran out to be one of our workers again. It was helpful having another pair of eyes search through our seine haul to find the small, striped fish, but it was his enthusiasm about my work that really made the day fun.

Collecting killifish is only a portion of my master's research at Purdue University. In Indiana, mosquitofish are stocked as biological control for mosquitoes. They were historically distributed in the southwestern portion of the state, but have spread throughout the state largely due to stocking. Mosquitofish can tolerate poor water quality conditions, produce a lot of offspring, and their aggressiveness towards native fishes and amphibians elsewhere has been well documented. However, little is known about how mosquitofish stockings impact aquatic communities in Indiana.

The Indiana Department of Natural Resources has identified several fish and amphibian species which have a high potential for being affected by introduced mosquitofish. Some species have a limited geographic range in the state, so any negative impact could affect their population viability. In 2005, we sampled throughout Indiana and collected mosquitofish, banded killifish, blackstripe topminnow, northern starhead topminnow, and northern studfish monthly from April through October. We first wanted to look at what each species was eating to determine if there was diet overlap and if mosquitofish actually ate more mosquitoes than native killifishes. My sampling occurred in streams, wetlands, and lakes, and we had volunteers like Jesse and Joshua to help us collect fish and ask a lot of questions. Talking to the public was a great part of my field work, and it always amazed me how many people are interested in what I am doing.

In addition to examining food habits, I also collected fish and amphibian eggs and larvae to evaluate behavioral interactions with mosquitofish. I spent hours watching their behaviors, taking note of chases, fin nips, and predation that occurred when mosquitofish and one of the other species were placed together in one microcosm. I was surprised to discover how aggressive mosquitofish are—they will continue to chase and nip the fins of a northern starhead topminnow until it has every fin bitten off and is unable to escape the attacks. Larger fish, like the northern studfish, are more "immune" to the effects of mosquitofish, and are generally able to withstand the aggression. Although mosquitofish don't seem to eat amphibian eggs, they really find the larvae of the western chorus frogs to be good snacks. Other amphibian larvae, like the tiger salamander, are chased by the mosquitofish, but wood frog larvae are often left alone.

My research is not finished yet, but I have already discovered quite a bit about mosquitofish, killifish, and amphibians. I used to pull gill nets on a boat, so it was a bit of an adjustment to work with smaller, non-game species using seines and dip nets. However, I have found my research and its implications to be incredibly rewarding. The results from my study will allow the state of Indiana to make management decisions regarding the stocking of mosquitofish throughout the state. Maybe someday, more kids like Jesse and Joshua will remember a banded killifish as easily as they remember largemouth bass. ♋

Continued from page 160

commercially valuable aquatic animals (sometimes called "green" or "conservation" aquaculture) is highly controversial and often criticized when used as a tool for conservation. Such efforts, however, are becoming more common as the crisis of declining marine populations becomes front page news. Frequently, little is known about the life history, physiological needs, or adequate diets for these organisms. Large programs of research are needed to make such aquaculture activities sustainable. Early aquaculture efforts are also problematic because they primarily rely on capture of wild-caught animals. Apart from increasing their total stocks of adult animals, farmers continue to seek wild breeders because culture-raised adults often show a marked decrease in reproductive capacity. Directed harvest of wild foods in support of aquaculture can also have major consequences on local marine ecosystems. In the short term, aquaculture may take pressure off large-scale harvest of declining populations, but without stricter collection and trade regulations these gains can only be considered temporary.

Aquaculture of syngathids has received considerable attention as a potentially lucrative commercial venture and as a tool for conservation of declining wild stocks. One fallacy often stated in the seahorse trade is that the availability of cultured seahorses will directly reduce the exploitation of wild populations. The weakness in this argument is clear when you consider that most seahorses globally are extracted in subsistence fisheries or from shrimp trawl bycatch, which will continue regardless. Project Seahorse argues that we should first be working to secure low-volume and high-value fisheries for such non-food uses as medicines, display, and ornament (http://seahorse.fisheries.ubc.ca/positions.html). Judging by the precedent with fish farming, seahorse aquaculture is unlikely ever to employ many small-scale fishers, especially given its technical challenges.

Amanda acknowledged that aquaculture may be able to play a role in conservation but insists it must first be economically viable. Too many seahorse breeding ventures base their business models on unrealistic production expectations and then fail quickly. This is particularly worrying where they have promoted new products and thus leave a legacy of yet greater demand for seahorses. Amanda pointed out that the second requirement is for any culture facility to meet standards with respect to sourcing of animals, discharge and escapes, water treatment, and more. Even then, an operation can only be considered conservation neutral. It will take a balanced assessment of its ecological and socioeconomic costs and benefits when compared with wild extraction before aquaculture can be considered to contribute to species and ecosystem conservation. This approach to aquaculture of syngnathids requires a big investment of time, education, and resources and holds the seed of many potentially hidden costs and benefits. Project Seahorse has assisted many syngnathid aquaculture ventures to address conservation and sustainability issues and will continue to do so in the future.

There are presently no formal stock enhancement or translocation programs for seahorses. There are, however, anecdotal reports of seahorse releases, both translocation and supplementation, intended for conservation benefits (Vincent and Koldewey 2006). Lack of any monitoring on population dynamics, stock structure, diseases, or genetics for wild or cultured seahorses makes it impossible to judge the impacts of such releases. The immediate and long-term impacts of seahorse releases of any kind on community ecology in these sensitive aquatic habitats also need serious consideration and further study. Amanda pointed out that the IUCN Reintroduction Specialist Group (www.iucnsscrsg.org) offers guidelines that could be of great value in deciding on fish releases and supplementations.

In closing, Amanda brought my attention to a recent increase in abundance of northeastern Atlantic pipefish in European coastal habitats, which may just be connected to climate change. The snake pipefish (*Entelurus aequoreus*) is the most oceanic species of pipefish in the North Atlantic Ocean and has been found since 2003 in unprecedented numbers, especially in areas with well-documented increases in sea surface temperatures (Kirby et al. 2006). Kirby et al. (2006) infer that climate change impacts on marine ecosystems may have unexpected and unpredictable effects on global distributions of marine species, leading to significant changes in ecosystem dynamics. As their number increases, these fish are becoming important food for sea birds (and larger predatory fish), with apparently commensurate increases in nest failure. Once again small syngnathids may point out our need for more comprehensive understanding of dynamic ecology in marine ecosystems.

I want to thank Amanda Vincent for her insightful comments and discussion on this issue for my column and hope that readers have gained a better insight into Project Seahorse and the valuable conservation efforts that are coming from that group. ♋

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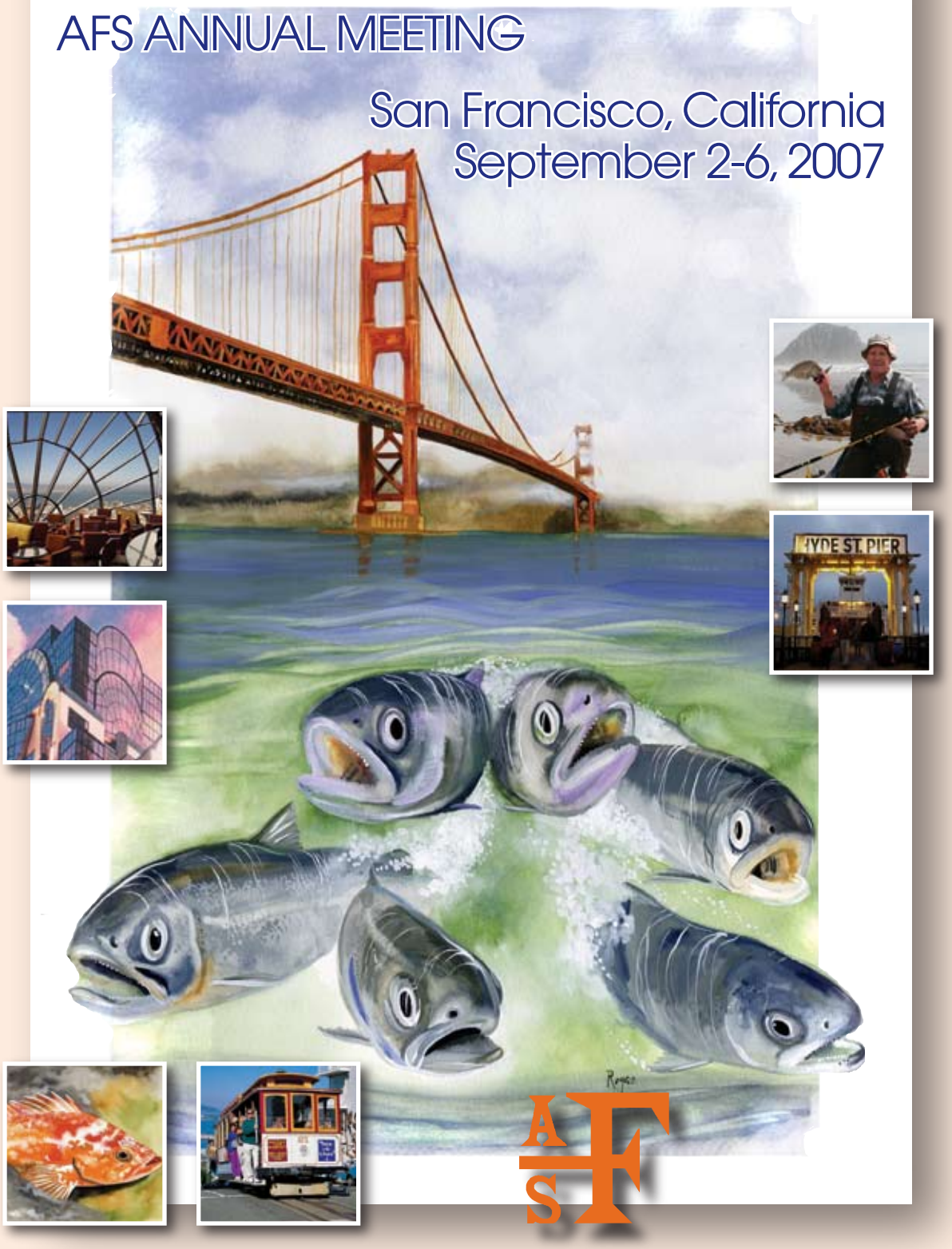
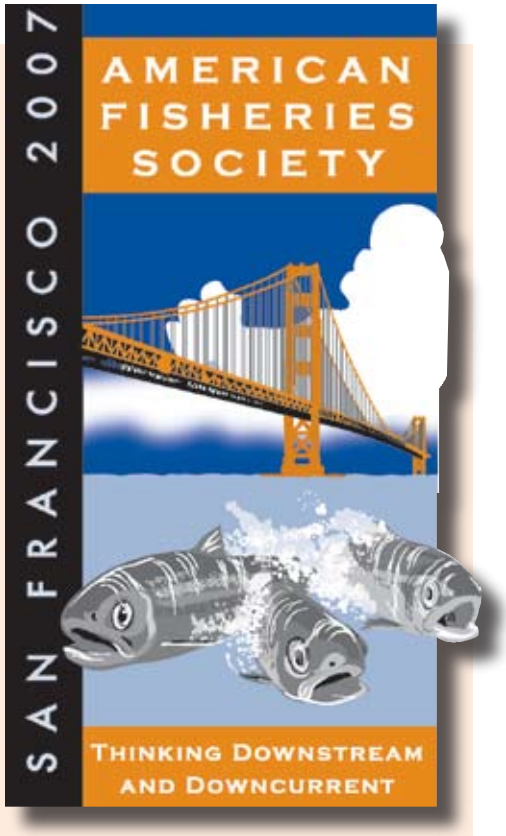
UPDATE:
AFS ANNUAL MEETING

San Francisco, California
September 2-6, 2007



Greetings Colleagues,



The 50 members of the 137th Annual Meeting Planning Committee are eager to facilitate your stay in San Francisco for what promises to be a busy and stimulating conference. We have accepted 61 symposia, received more than 1,800 abstracts, and expect nearly 2,500 registrants during the week of September 2–6. San Francisco consistently ranks among the world's top tourist destinations and September is the most beautiful month to visit the Bay Area. Our conference dates coincide with a holiday weekend and we encourage you to bring family and friends to enjoy Labor Day by the Bay! The city's popularity and the holiday weekend timing are excellent reasons to book your travel early. We hope the following information assists your travel plans. Please check the Annual Meeting website http://web.fisheries.org/sf/index.php and select the plan-your-trip menu for the latest updates. Our online registration system and a detailed schedule at a glance should be available in May.

Thank you on behalf of Team AFS in SF 2007,

David Manning, General Chair

Sunday, September 2

Registration	10:00 a.m. – 9:00 p.m.	SF Marriott
Continuing Education	8:00 a.m. – 5:00 p.m.	SF Marriott
Section Meetings	8:00 a.m. – 5:00 p.m.	SF Marriott
Welcoming Social	7:00 p.m. – 10:00 p.m.	SF Marriott

Monday, September 3

Registration	7:00 a.m. – 5:00 p.m.	SF Marriott
Plenary Session	8:30 a.m. – 12:00 p.m.	SF Marriott
Symposia, Sessions, Trade Show	1:00 p.m. – 5:00 p.m.	SF Marriott
Trade Show & Poster Social	6:00 p.m. – 8:30 p.m.	SF Marriott

Tuesday, September 4

Registration	7:00 a.m. – 5:00 p.m.	SF Marriott
Symposia, Sessions, Posters	8:00 a.m. – 12:00 p.m.	SF Marriott
Luncheons (Western Division)	12:00 p.m. – 2:00 p.m.	SF Marriott
Student Colloquium	1:30 p.m. – 3:00 p.m.	SF Marriott
Symposia, Sessions, Posters	1:30 p.m. – 3:00 p.m.	SF Marriott
AFS Business Meeting	3:00 p.m. – 5:00 p.m.	SF Marriott
Student Job Fair	5:00 p.m. – 6:00 p.m.	SF Marriott
Student Social	7:00 p.m. – 11:00 p.m.	Aquarium of the Bay

Wednesday, September 5

Spawning Run	6:00 a.m. – 7:30 a.m.	Presidio—Crissy Field
Registration	7:00 a.m. – 5:00 p.m.	SF Marriott
Symposia, Sessions, Posters	8:00 a.m. – 12:00 p.m.	SF Marriott
Luncheons (Cal-Neva)	12:00 p.m. – 2:00 p.m.	SF Marriott
Symposia, Sessions, Posters	1:00 p.m. – 5:00 p.m.	SF Marriott
Off-Site Social	6:00 p.m. – 10:00 p.m.	Hyde St. Pier-Fisherman's Wharf

Thursday, September 6

Registration	7:00 a.m. – 12:00 p.m.	SF Marriott
Symposia, Sessions, Posters	8:00 a.m. – 12:00 p.m.	SF Marriott
Symposia, Sessions	1:00 p.m. – 5:00 p.m.	SF Marriott
I Left My Heart in SF Social	5:30 p.m. – 7:30 p.m.	SF Marriott

Getting to San Francisco

The San Francisco Bay Area is serviced by San Francisco, Oakland, and San Jose international airports. Each is less than 1 hour from the Marriott. Once you arrive in the beautiful Bay Area, please think public transportation!! Like most metropolitan areas, traffic congestion both on the freeways and in downtown San Francisco may change your sunny disposition. In addition, car parking is limited and expensive in the city. However, the entire Bay Area is easily accessible by ferry, rail, shuttle, or bus. All transit information is available on the web, including detailed transit instructions and schedules to a variety of Bay Area locations and attractions.

The San Francisco Bay Area Rapid Transit (BART) light rail system is the fastest link between the Oakland (OAK) and San Francisco (SFO) airports and the SF Marriott. The annual meeting website has detail train, shuttle, taxi, and driving directions from each airport.

Lodging

Our room block at the Downtown SF Marriott is filling rapidly. You can make a reservation by visiting http://cwp.marriott.com/sfodt/afs/ or calling 1-888/575-8934. Please use the group code FIS for your reservation. We also have overflow capacity at the Parc Fifty-Five and Handlery Union Square hotels. All overflow rooms will be offered at the same $140 per diem rate as the Marriott. Both overflow hotels are a 10-minute walk from the Marriott. Reservations at all hotels can be made from the Annual Meeting website and you will automatically be assigned to the group block.

Getting Around San Francisco

Your AFS conference registration covers bus transportation to AFS socials at the Hyde St. Pier and the Aquarium of the Bay, as well as to the not-to-be-missed spawning run at Crissy Field adjacent to the Golden Gate Bridge. However, for City excursions outside of AFS events, the San Francisco Municipal Railway (MUNI) is the City's public transportation system, consisting of buses, streetcars, trolleys, and cable cars.

You can purchase a City Pass for $49 (adults) or $39 (youths between 5–17), which covers more than a week's worth of unlimited MUNI transportation, including cable cars. The city Pass also includes admission to more than a half-dozen local attractions, including the Steinhart Aquarium, Exploratorium Science Museum, and the San Francisco Museum of Modern Art. The City Pass is valid for nine days after first use. Purchase the city Pass from the San Francisco Visitors Information Center at Market and Powell Streets (Hallidie Plaza, 900 Market Street, lower level), or at participating attractions. For more information, visit www.citypass.com

In addition, a MUNI Passport, solely for transportation, may be purchased in daily, 3-day, and 7-day increments, at the Visitors Information Center. More information: 415/673-6864, or www.sfmta.com/cms/mfares/passvend.htm. Countless restaurants, shops, theaters, and stylish Union Square are only a few blocks from the Marriott.

Student Activities

The AFS student member registration fee will once again be a very low $95 (student non-member fee is $125)! Take advantage of this reduced student cost to attend what is promising to be one of the biggest and best AFS meetings ever. Short on cash and feel that you can't afford to attend this meeting? Well, we feel that you can't afford not to! Student employees will be needed to work during presentations to adjust lighting, operate audio-visual equipment, and perform other duties throughout the duration of the meeting. Students interested in working at the meeting will be paid $10 per hour. If you are interested in working at the meeting, please visit the Student Activities Page on the Annual Meeting website. A brief training session for all workers will be held on Sunday, September 2.

Continuing Education

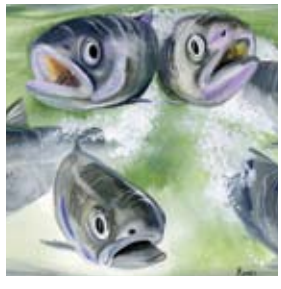
The Continuing Education Committee has developed a slate of 12 courses to be delivered at the 2007 Annual Meeting. Courses range from leadership skills to understanding the pathogen/host/environment interrelationship and the role of fish husbandry and management. With the slate of courses that have been developed for this meeting, we know that you will return to your job with new insights and increased professionalism, whether it is a managerial, technical, or field-oriented position. When you register for the meeting, consider taking one of the courses below. Some are even free!The course descriptions will be linked to the Annual Meeting website.

- Hydroacoustic Tools for Fish and Habitat Assessment
- How to Get the Right Things Done as well as Get Things Done Right
- River 2-D Modeling Short Course and Workshop
- Basic/Intermediate GIS Techniques for Fisheries Biologists
- Advanced GIS Techniques for Fisheries Biologists
- Leadership Principles Workshop—It's Not Just for Officers!
- Choosing the Appropriate Biotelemetry Technology
- Integrating Green and Gray Infrastructure: Using Highway Agency Processes to Conserve Aquatic Ecosystems
- Meta-Analysis in Fisheries Science
- Current and Emerging Pathogens of Fishes in the Pacific Northwest
- Introduction to Electrofishing

Tours and Sightseeing

It is hard to comprehend the number of activities available to Bay Area visitors and we encourage you to strike out on your own adventure. However, we do have a few special excursions in the works. Here's one example.

The Wine and Fish Tour will take you north across the scenic San Francisco Bay to the heart of California wine country in the Sonoma and Dry Creek Valley where you will spend the first part of your day touring Ridge Vineyards and tasting some of their amazing wines. From Ridge, your tour will take you to the Don Clausen Warm Springs Fish Hatchery near Geyserville where you will be treated to a lunch catered and see first hand the ground-breaking recovery effort that is making headway restoring coho salmon to the Russian River. Onward, the tour will take you down the Sonoma Highway to Landmark Vineyards where you will have the opportunity to taste some of their delectable wines, especially their award winning Chardonnays.



10 California Fishing Trips to Try By Brian Sak

Sak is an outdoor writer and photographer in Pinole, California.

Turn this year's Annual Meeting into the ultimate vacation by planning a trip to one of these prime Golden State angling destinations.

American Fisheries Society members, families, and friends attending the 137th Annual Meeting in San Francisco will have plenty of pre- and post-conference activities to choose from. Wine tasting in Napa and Sonoma counties, hiking Mounts Tamalpais and Diablo, and catching an Oakland Athletics (prior to the meeting) or San Francisco Giants (following the meeting) game are just some of the possibilities. A quiet day on the water, experiencing one of the Golden State's outstanding fisheries, is another.

California is unequaled when it comes to angling opportunities. Whether you prefer freshwaters to the sea, flowing streams over still reservoirs, or artificials in favor of live bait, there is something here for you. The tough part, to quote an overused adage, is "being at the right place at the right time." The 10 picks below, ordered in increasing distance from San Francisco, are some of what California has to offer in August and September.

Lingcod
Farallon Islands

The 36-mile excursion to the Farallons should be comfortable thanks to the calm seas that are typical off northern California in early fall. The lengthy trip will be worth the effort too, with lots of big lings getting ready to spawn—most boats return to port with fish pushing 20 lbs. The Farallon's lingcod hold in relatively deep water, so be prepared to get your offering to 200 feet. Lings are taken on traditional bottom-fishing gear, shrimp fly rigs baited with frozen squid, or hex bars and lead-head jigs with soft-plastic trailers.

For information, call Berkeley Marina Sport Center, 510/849-2727.

This lingcod hitched a ride on a rockfish that hit Steve Bicknell's shrimp fly rig.

Catfish
Lake Del Valle

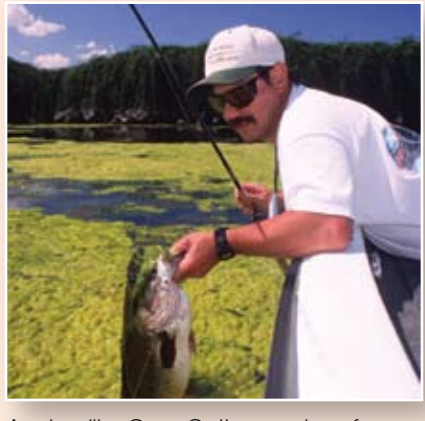
Less than an hour from San Francisco and Oakland, Del Valle affords some of the best catfish angling in the state. East Bay Regional Park District biologists stock the lake weekly during the summer with 500 to 1,000 lbs. of whiskerfish, with most cats in the 1-lb. class. There are also plenty of larger fish, with 30% of every truckload containing two- to six-pounders. One of Del Valle's features, lacking at many West Coast reservoirs, is the extensive shoreline access it provides—the bite peaks between late afternoon and evening in the small coves between the marina and dam.

For information, call Del Valle Marina, 925/449-5201.

Spotted Bass
Lake Berryessa

Although there are plenty of largemouths and smallmouths in Berryessa, spotted bass are quickly becoming the dominant species in terms of numbers. Fifty-plus fish days are not unheard of, with spots averaging 2 lbs. making up the majority of the catch. You'll find bass all over the main lake by targeting rocky points. Small white crankbaits are a good way to begin, but be ready to switch to soft-plastics if fish aren't aggressive—drop shot and split shot rigs with dark pattern plastics work best.

For information, call Walton's Pond, 510/352-3932.



Anglers like Greg Gutierrez miss a few fish when targeting largemouths with frog imitations, but when one is hooked it's usually a quality bass.

Largemouth Bass
Sacramento-
San Joaquin Delta

It doesn't matter whom you talk to: biologists, guides, touring pros, and local anglers all say the same thing—the Delta is the number one largemouth fishery west of the Rockies. Bass fishing on this tidal system can be great all year, but the fun explodes exponentially with the frog bite that typically occurs between late summer and early fall. You'll be good to go with several days of stable weather, stout gear, and a white frog imitation. Look for floating moss mats in areas with little current--try north/south running sloughs, marinas, and flooded islands for starters.

For information, call Hook, Line and Sinker, 925/625-2441.

Largemouth Bass
Clear Lake

The Golden State's largest natural freshwater lake is still the place to go for that creel of a lifetime. Although 5-fish limits tipping the scales at 50 lbs. are not unheard of this time of year, it takes effort to see those kinds of results. You can, however, expect to catch lots of largemouths in the 3-lb. class, with a legitimate chance of at least 1 fish pushing 10 lbs. Begin your search for big bass at the north end of the lake, where flooded tules concentrate fish. Start by staying off the bank, casting spinnerbaits, ripbaits, and swimbaits. Once you've worked the outer areas, move in and pitch jigs to holes, cuts, and isolated clumps of sparse tules.

For information, call Tackle It, 707/262-1233.

Smallmouth Bass
Lake Tulloch

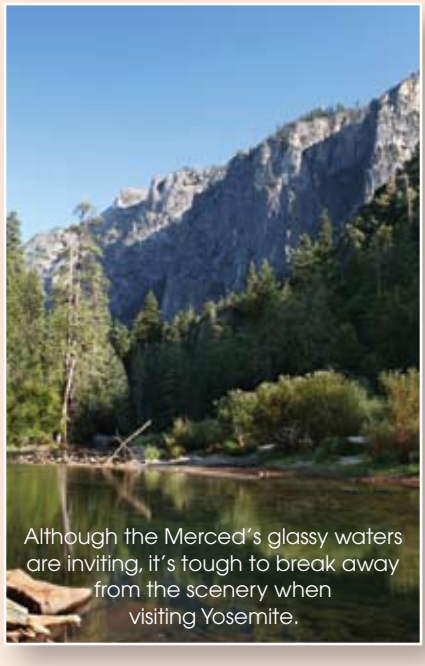
Sierra foothill reservoirs are not normally thought of as smallmouth destinations, but with a steady supply of cold water from New Melones Reservoir, Tulloch is one of the best in the state. You can expect bass averaging 2 lbs., with an occasional fish twice that size. The Green Springs arm is the best area for smallmouths, although the river produces its share of fish too. Spinnerbaits are a good way to begin, allowing you to cover water until you locate bass. Minnow plugs work well when you encounter schools of baitfish near the surface. When you head to the deeper waters, try small jigs and drop shot rigs.

For information, call Fisherman's Warehouse, 209/239-2248.

Cutbow Trout
Lake Amador

For those that are less than enthusiastic about chasing hatchery fish in a reservoir, Lake Amador cutbows offer an exciting alternative. These feisty fish, a Swedish crossbreed consisting of steelhead, rainbow, and cutthroat trout, are raised in Amador's own hatchery. And with their color, shine, and condition more akin to wild trout than hatchery fish, you'll be hooked after catching just one. Anglers fishing from shore do well soaking bright dough baits or night crawlers near the spillway and boat ramp. Boaters find success trolling flashy spoons and small plugs around the main body just off the dam.

For information, call Lake Amador Resort, 209/274-4739.



Although the Merced's glassy waters are inviting, it's tough to break away from the scenery when visiting Yosemite.

Rainbow Trout
Merced River

Most Yosemite National Park visitors don't head into the mountains for the fishing, making the area's streams some of the most underutilized in California. And although it's tough to concentrate on casting in the shadow of breathtaking Sierra vistas, that's what you'll have to do to catch rainbows in this wild-trout portion of the Merced. Fly-fishers do best along this accessible section of river, although spinning gear works when you're persistent. Caddis flies take most of the rainbows here, with stonefly and mayfly patterns useful at times. Be aware that the reach of the Merced flowing through the park is catch-and-release only, with an artificial lure with barbless hook requirement.

For information, call Yosemite Fly Fishing Guide Service, 209/379-2746.

Surfperch
Morro Bay

Miles of sandy beach offer surf casters plenty of options, with the fishing often best between Morro Rock and San Simeon. If you're not eager to wade into breaking waves, you can use the public pier at William R. Hearst Memorial State Beach. Regardless of where you choose to try, experienced anglers recommend being there at the turn of an outgoing tide. Barred and calico surfperch are common in and just outside of the surf, while walleyes and silvers can be taken further offshore. Both motor oil and root beer-colored plastic grubs, fished on small hooks about 2-feet below egg-shaped slip-sinkers, work well.

For information, call Virg's San Simeon Landing, 805/927-4676.

Yellowtail
Channel Islands

Are you looking for the fight of your life? You'll likely find all that you can handle from Santa Barbara south to Ventura, near the Channel Islands. Live squid is the bait of choice near the islands, but if they're not available sardines will do. Rig the squid near the tip of its head with a heavy-duty 3/0 hook—use a 1/0 hook in the nose for sardines. Cast either bait away from the boat, letting it drift to the bottom; bites often come on the fall. Be ready to loosen your drag when the fish you've hooked makes the first of several runs.

For information, call Cisco's Sportfishing, 805/985-8511.

Channel Island yellowtails are known for their fight.

JOB CENTER

To see more job listings go to www.fisheries.org and click Job Postings.

Fish and Wildlife Restoration Biologist, Montana Fish, Wildlife and Parks, Great Falls based.
Responsibilities: Plan, organize, and conduct lake and stream restoration projects and monitor the effectiveness.
Qualifications: M.S. in fish and wildlife management with specialized training in stream restoration. Experience working in commercial or irrigated agriculture is desirable.
Salary: $33,200–41,500 per year depending upon qualifications, internal equity, labor market, and program's ability to pay.
Closing date: 1 June 2007.
Contact: State of Montana application, copies of transcripts and answers to 3 supplemental questions must be submitted by closing date. For application material and complete vacancy announcement, go to www.fwp.mt.gov or contact Darlene, 406/444-1223, MFWP HR Bureau.

Vice President for Science, The Wild Salmon Center, Portland, OR.
Responsibilities: Reporting to the president and CEO, the vice president for science's principal responsibilities are to ensure that the center's conservation programs are based upon state-of-the-art conservation science, and to represent the center at international scientific forums as a leader in salmon conservation science. Maintains and enhances the center's existing network of contacts within the conservation science community. Responsible for science partnerships and supervision of all monitoring and research activities across the center's operations. Maintains and enhances the center's reputation and standing as the leading science-based Pacific salmon conservation organization.
Qualifications: See www.whitefoxgroup.com or www.wildsalmoncenter.org for full job description.
Salary: Commensurate with experience.
Closing date: 16 June 2007.
Contact: Send cover letter and resume to peter@whitefoxgroup.com.

Fish Culture Specialist I, Vermont Dept of Fish and Wildlife, Bennington.
Responsibilities: Professional work in the propagation of trout and operation and maintenance of a fish culture station. Responsible for maintaining the health, nutritional requirements, and proper rearing environment to promote optimum growth of several strains and species.
Qualifications: B.S. in fish culture or a natural resources related field with no experience or experience at a technical level in the propagation of fish in a fish culture station may be substituted for the B.S. degree on a six months for a semester basis. Note: Incumbents will be required to attend the division's course in fish culture, obtain a pesticide applicator's license, and CPR certification within six months of hire.
Salary: $13.79 per hour increasing to $14.41 per hour after successful completion of a probationary period.
Closing date: 29 June 2007.
Contact: Interested parties can find additional information and apply online at www.vtstatejobs.info. EOE/AA.

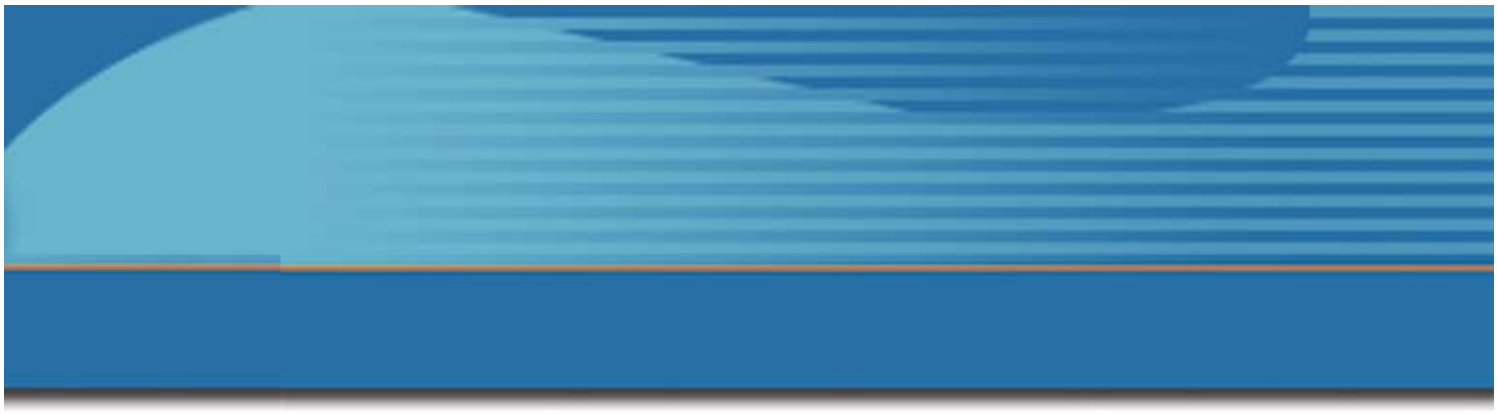
M.S. or Ph.D Graduate Assistantship, SUNY College of Environmental Science and Forestry, Syracuse, NY.
Responsibilities: Perform independent research on fish habitat enhancement in the upper St. Lawrence River. Research will involve an intense field and analytical effort. Must report results in written reports and peer-reviewed publications, and provide

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 for Associate, Official, and Sustaining organizations, and for Individual members hiring personal assistants. If space is available, jobs may also be printed in *Fisheries* magazine, free of additional charge.

oral presentations at professional meetings.
Qualifications: B.S./M.S. in biology, fisheries, or aquatic sciences with GPA greater than 3.0. Quantitative and spatial database and survey skills are preferred. The applicant must be highly motivated and demonstrate an ability to work well with others.
Salary: $18,000 per year, tuition waiver, housing available during field season.
Closing date: 31 May 2007 or until filled.
Contact: John M. Farrell, jmfarrell@esf.edu, Send applications to: Office of Instruction and Graduate Studies, SUNY-ESF One Forestry Drive, 227 Bray Hall, Syracuse, NY 13210, http://www.esf.edu/graduate/admission.htm

Senior Fisheries Biologist, HDR Inc., Anchorage, AK.

Responsibilities: Plan, direct and oversee all aspects of large scale, multi-discipline fisheries projects; provide oversight of field study program design and implementation for a wide variety of projects including fisheries assessments, fish population analyses, baseline studies, habitat improvement, and restoration; oversee advanced fisheries data analysis and provide quality assurance/quality control; build and maintain client relations; participate in project development and contract document preparation; and mentor mid- and junior-level fisheries biologists. This position will require field work in remote areas of Alaska for 1–2 weeks at a time.
Qualifications: B.S. in fisheries or related field, M.S. preferred. Fifteen plus years experience. Experience designing and directing large, complex, multi-discipline fisheries projects, including management of



field studies.
Contact: Apply online at www.gojobs.com/seeker/aoframeset.asp?JobNum=1044026&JBID=1334. Employer JobCode: 061860.

Associate Environmental Scientist, HDR, Inc., Sacramento, CA.
Responsibilities: Include preparing quantitative and qualitative fishery and aquatic resource impact evaluations; technical analyses; develop experimental designs; develop and review technical reports; support for various projects related to aquatic resources; work with clients, resource agencies, technical staff, and project managers to prepare technical sections of CEQA, NEPA, and ESA documents, technical memoranda, meeting minutes, transmittals, and presentations; perform archival/electronic research to obtain data, documents, and other information.
Qualifications: B.S./B.A. in fisheries, natural or aquatic resources, environmental studies, or a related field. Three plus years of related experience.
Contact: Apply on line at www.gojobs.com/seeker/aoframeset.asp?JobNum=1070690&JBID=1334. Employer JobCode: 061942

Fisheries Biologist-Seasonal, HDR Inc., Anchorage, AK.
Responsibilities: This is a seasonal position for a recent college graduate with a fisheries or related degree who can function as a field crew leader and execute work plans under the guidance of the project manager. Experience with juvenile fish (salmonid) identification, electrofishing, minnow trapping, aerial spawning counts, snorkel surveys, telemetry, and mark-recapture. This person will also conduct data entry and QC. Comfortable with working and living in a remote environment.
Qualifications: (1) Data synthesis and scientific writing (2) field work requiring data collection of fish population parameters and their habitats in streams and lakes for extended periods. (3) Environmental permitting, documentations, and associated regulatory processes desirable.
Contact: Apply online at www.gojobs.com/seeker/aoframeset.asp?JobNum=1521078&JBID=1334 Employer JobCode: 070259.

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