FISHERIES STOCK ASSESSMENT SCIENTISTS: Is There a Shortage? Addressing the Shortage through Undergraduate Workshops

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COVER: Florida Keys provides an attractive setting for undergraduate workshops about potential careers in fisheries stock assessment.

CREDIT: J. Berksen
What are archives? I invite you to check Wikipedia and see. Does AFS have archives? I asked this question of AFS Executive Director Gus Rassam and it is clear to me that in some ways we do and perhaps not in others. More correctly, some of our archives are not organized or archived in the usual sense that archives are secured. Of course, we have the necessary financial archives that are required by the IRS in case at some point an audit is called. We are required by law to keep such records for 10 years. We also have archives of some of our business meetings: briefing books, minutes of the Governing Board and the Management Committee, and as part of them reports of many Sections and Committees, both paper copies and more recently digital files. It is not clear to me how far back in time our paper archives at headquarters extend. We do have original hard copies of all of our journals and books and through Infobase, scanned digital copies of most of our journals and books going back to 1872. We have digital copies of most things about the Society since computers became pervasive in our lives, perhaps dating back to about 1978 or so. Finally our website is archived, perhaps by our own staff but most certainly by web archivists at institutions who study the web.

There are other whole sets of archives of concern to AFS that are distributed all over the continent. These are the records of the Divisions, Sections, Chapters, and Student Subunits. I know many of the Units are heavily involved in systematically scanning and archiving their paper records. There also are privately-held archives in the hands of aging AFS members, the families of deceased AFS members, and just regular “old” members like myself. One way we can start assimilating the collective archives is to create a database of holdings at all the various locations, accessible on the central AFS website where all could access it.

I invited Gary Whelan, president of the Fisheries History Section, to explain what his Section knows about preserving our history and what they are doing toward that goal. I also invited John Casselman, a senior member of AFS, to explain what sort of archives might be found in the hands of aging AFS members or the families of deceased but well-remembered AFS members.

**Whelan:** Archives are the written history of an organization that includes its past successes, failures, and the many lessons learned. One of the key problems in most organizations is the tendency to relearn the lessons of the past every 20–30 years. Archives preserve the institutional knowledge of an organization and, if indexed properly, allow those memories to come alive in current issue analyses and debates. As you mention above, the state of the American Fisheries Society archival material is fair at best and in danger at worst, as some of the records are in climate-controlled storage but much are not.

The Fisheries History Section has a solution for at least the more critical Society materials. We are extremely lucky to have Randi Smith of the U.S. Fish and Wildlife Service (USFWS), Fisheries History Section president elect and a professional archivist, as a member. USFWS is willing to provide climate-controlled, fire-protected, and secure space for Society archives at the D. C. Booth Historic National Fish Hatchery in Spearfish, South Dakota. This remarkable facility also has advanced collection management software that will help future researchers examine our materials. Currently, this facility has about 1,000 feet of available shelf space and already houses some Society materials from the Fish Culture Section and the Dakota Chapter. A key project for the Fisheries History Section will be to evaluate this outstanding offer and determine how best to guide the Society in implementing it.

In addition to the Society’s archival materials, the Fisheries History Section is working with the Society leadership and staff to ensure all of the journal materials are placed in Infobase. If you examine the current Infobase materials, a lot of materials are not digitized. For example, Section or Chapter information in early issues of *Fisheries* magazine are not captured digitally nor are the attendance lists and many of the question–answer sections of early *Transactions of the American Fisheries Society*. These are key pieces of our Society’s history that need to be preserved digitally and backed up on multiple servers in dispersed locations. It is our expectation that all of the Society’s journal materials will be digitized in the very near future.

**Franzin:** John, we have discussed the issue of important personal papers and collections that have been left behind by mentors and really well-known scientists. What can we do to preserve them?

**Casselman:** Eventually, the nagging concern will arise: what will I do with all I’ve assembled? How can I make sure that it’s available to others if and when they need it? Thank goodness for AFS journals and formal publications—that’s not the concern. The question is,
NFHAP News

The National Fish Habitat Board presented the Second Annual National Fish Habitat Awards on 27 April 2009 at the Jim Range National Casting Call on the Potomac River in Washington, D.C., hosted by the American Fly Fishing Trade Association. From nominations submitted by the hundreds of organizations that comprise the National Fish Habitat Partners Coalition, the awardees demonstrated an extraordinary commitment to fish habitat conservation, science, and education. For 2009, the selection committee added an additional award category, the Extraordinary Action category in support of fish habitat, bringing the total number of awards to four. In honor of conservation advocate Jim Range, who recently lost his battle with cancer, the selection committee renamed the Exceptional Vision Award to the Jim Range Conservation Vision Award. The winners of the 2009 National Fish Habitat Awards are as follows:

Outreach and Education Award: The Lake Leaders Institute, University of Wisconsin—Extension Lakes

The goal of the Wisconsin Lake Leaders Institute is to enhance Wisconsin’s lake resources through education, leadership, and citizen action. The institute assists citizens in developing and improving both their technical and people skills to enrich their communities and the waters within them. Participants learn in an atmosphere of openness, trust, friendship and camaraderie. Lake Leaders Institute courses give participants the opportunity to take field trips, enjoy natural beauty, exchange and forge ideas, and develop friendships. Over 200 Lake Leaders Institute graduates have made a personal commitment to engage others in their community to ensure water resources are preserved for future generations.

Jim Range Conservation Vision Award: Yvon Chouinard

Yvon Chouinard, Patagonia’s founder, started Patagonia in 1973 to meet the equipment and clothing needs of outdoor enthusiasts, primarily rock climbers, hikers, and anglers. From the very beginning, Patagonia devoted time and money to the increasingly apparent national and worldwide environmental crisis. In 1986, Patagonia began a program that makes it unique among corporate entities that care about fisheries habitat. Patagonia committed to donate 10% of profits each year to grassroots environmental groups. They later upped the ante to 1% of sales, or 10% of profits, whichever was greater. Patagonia has kept to that commitment every year since, and placed a high emphasis on fishery habitat protection over the years, as evidenced by the creation of the World Trout Initiative to specifically address trout habitats and populations, the 1% For the Planet program that supports local grass-roots projects which include fishery habitat projects, and the Conservation Alliance—a program that enlists other funding sources to participate in wildlife and fisheries habitat projects.

Scientific Achievement Award: Stephen J. Jordan, Lisa M. Smith, Janet A. Nestlerode, Environmental Protection Agency—Office of Research and Development

The team of Jordan, Smith, and Nestlerode broke new ground in quantifying the value of nursery habitats to a major fishery and ecological resource. In their research article (“Cumulative Effects of Habitat Alterations on Fishery Resources: Prediction at Regional Scales”) published in Ecology and Society, they modeled how the detailed spatial extent and distribution of marsh and submerged aquatic vegetation affect blue crab recruitment at the scale of the U.S. Gulf of Mexico, and show how the model can be used to predict the effects of habitat alteration on the fishery. The novel modeling concepts applied to this research can be used more widely in quantitative analysis of the consequences of fish habitat loss and restoration at spatial and temporal scales.

Extraordinary Action Award: Project SHARE

Project SHARE (Salmon Habitat and River Enhancement) was created in 1994 through the efforts of concerned landowners, salmon anglers, businesses and various government agencies, to establish a forum to protect and enhance

AFS member Steve Jordan accepts the Scientific Achievement Award from the National Fish Habitat Board.
Atlantic salmon habitat in the five Downeast rivers of Maine. This is based on the premise of voluntary participation by area landowners, businesses, as well as local, state and federal government, academia, conservation organizations, research and educational interests, and any other entity that will enhance the healthy functioning of these riverine ecosystems. Since 2006, Project SHARE Executive Director Steve Koenig has completed 22 Natural Resources Conservation Service projects that contributed $930,000 for stream habitat connectivity projects in Downeast Maine. Even more impressive is the 19 other (additional $1,000,000) projects currently under contract. Combining landowner and other contributions, these 41 stream restoration projects equate to nearly $2.6 million in on-the-ground conservation efforts that benefit endangered Atlantic salmon and other species such as brook trout and American eel.

10 Waters to Watch

The National Fish Habitat Action Plan also unveiled its 2009 “10 Waters to Watch” list at the Jim Range National Casting Call on 27 April. The “10 Waters to Watch” is a collection of rivers, streams, lakes, watershed systems, and shorelines that will benefit from strategic conservation efforts to protect, restore, or enhance their current condition. Thanks to the combined actions of concerned community groups, non-profit organizations, local watershed groups, Native American tribes, and state and federal agencies, these waters are being improved by planting streamside vegetation, removing structures blocking fish from habitat, and protecting bodies of water from the effects of industrial processes, agriculture, and livestock.

The 10 Waters to Watch in 2009 include:

- **Agulowak River, Alaska** (Southwest Alaska Salmon Habitat Partnership)—The Agulowak River is one of the salmon-rich jewels of southwest Alaska. The river provides a robust fishery for sport anglers, subsistence, and commercial users. The Conservation Fund and the Nushagak-Mulchatna/Wood-Tikchik Land Trust working together have secured a conservation easement with the major Native corporation landowner on its land within the Wood-Tikchik State Park, including both banks of the Agulowak River and approximately 39 miles of shoreline along Lakes Aleknagik and Nerka—a total of about 20,850 acres of land with high fish and wildlife values.

- **Jockey’s Ridge State Park, North Carolina** (Southeast Aquatic Resources Partnership)—Restoring coastal marsh habitat and protecting shorelines from erosion are the goals of this project in the Outer Banks, one of the nation’s most famous coastal habitats. Oyster reef creation and native cordgrass plantings are already underway.

- **Lake Houston, Texas** (Reservoir Fisheries Habitat Partnership Candidate)—Restoring native aquatic vegetation and reducing sedimentation will improve fish habitat for the entire watershed both upstream and downstream of Lake Houston, as well as within the reservoir, which is an important lifeline both economically and recreationally to the people of Houston.

- **Lower Flint River, Georgia** (Southeast Aquatic Resources Partnership)—Cooling water flowing from springs in the Flint River provides critical thermal refuge habitat for Gulf striped bass during the warm summer months. Sediment and debris clogs the springs, reducing flow and reducing fish habitat. This project will clean out the springs and enhance flows to provide more habitat for more fish.

- **Maggie Creek, Nevada** (Western Native Trout Initiative)—Improvement in agricultural and mining practices is helping to restore habitat in this Humboldt River tributary, helping Lahontan cutthroat trout, a federally-listed threatened species.

- **Meramec Watershed Basin, Missouri** (Fishers and Farmers Partnership Candidate)—This unique project teams agricultural landowners, state and federal agencies, and non-governmental organizations to identify shared goals that balance fish habitat with farming needs in the watershed by instilling stream-friendly farming practices which ultimately improve fish habitat.

- **Pine Creek, Wisconsin** (Driftless Area Restoration Effort)—Restoring stream banks which reduce sedimentation deposits will ultimately benefit this Midwestern fishery, enhancing a declining population of eastern brook trout.

- **Fork Little Conemaugh River, Pennsylvania** (Eastern Brook Trout Joint Venture)—Historic acid mine drainage will be mitigated through limestone beds and limestone dosing to resurrect this four-mile stretch of Pennsylvania brook trout waters, increasing the population in this critical tributary.

- **Teton Creek, Idaho** (Western Native Trout Initiative)—Restoring stream channels and eroding stream banks will help reduce sedimentation throughout this Western tributary, the largest of the Teton River, to provide pristine habitat to Yellowstone cutthroat trout.

- **Whitethorn Creek, West Virginia** (Eastern Brook Trout Joint Venture)—Riparian restoration and natural stream channel will decrease temperatures and provide cover and holding habitat in this critical wild brook trout system located in the headwaters of the South Branch of the Potomac.


Toxicity of Rotenone and Antimycin to Silver Carp and Bighead Carp. Jeff J. Rach, Michael Boogaard, and Cynthia Kolar, pages 388-395.


The Number of Redds Constructed per Female Spring Chinook Salmon in the Wenatchee River Basin. Andrew R. Murdoch, Todd P. N. Pearsons, and Travis W. Maitland, pages 441-446.


Using Species Composition Data from a Trawl Survey to Determine Potential Bycatch of the Commercial Trawl Fishery for Horseshoe Crab Limulus polyphemus in the Middle Atlantic Bight. Larissa J. Graham, Brian R. Murphy, and David Hata, pages 478-487.

On Tuesday, 27 April, AFS Executive Director Gus Rassam met with USDA Natural Resources Conservation Service (NRCS) Chief David White, National Biologist Terrell Erickson, and Ecological Sciences Division Director Mike Hubbs at the NRCS offices in Washington, D.C., to sign a memo of understanding between NRCS and AFS. This formal relationship between AFS and NRCS is designed to promote professionalism in the fisheries disciplines and enhanced information transfer, program effectiveness, and evaluation.

The MOU will serve as a framework for future collaboration between NRCS and AFS to:

- Work with educational institutions to identify ways in which these institutions can better educate, train, and ultimately prepare students for effective careers in the fisheries profession;
- Develop and implement a strategy to prepare future generations of fisheries professionals in response to demographic changes and reduced capacity;
- Increase diversity within the fisheries profession;
- Determine ways resources and expertise can be coordinated to better promote scientific professionalism and address mutually agreed upon fisheries concerns, especially those associated with imperiled or at-risk species and/or habitats; and
- Investigate methods to promote membership and participation in professional societies and encourage continuing education and other forms of professional development in fisheries disciplines.

NOAA submits proposed recovery plan to Congress

On 7 April 2009, the National Oceanic and Atmospheric Administration (NOAA) submitted to Congress a proposed spending plan for the $830 million received under the American Recovery and Reinvestment Act appropriation. The fisheries-related funding plans are:

- Marine and Coastal Habitat Restoration: $167 million for mid- and large-scale restoration projects addressing coral reef conservation, restoring fish habitats, and helping endangered species such as salmon and sea turtles. The projects will also contribute to the improvement of coastal resiliency in response to sea level rise and natural hazards.
- Southwest Fisheries Science Center: $102 million to complete the design, construction, and occupancy of the replacement NOAA Southwest Fisheries Science Center in La Jolla, California. The new facility will be on the University of California, San Diego campus.
- Fishery Survey Vessel Construction: $78 million to complete the construction of the sixth fisheries survey vessel that will replace the aged David Starr Jordan and support fisheries surveys and related research along the West Coast and Eastern Tropical Pacific Ocean.

Future of the European Union’s Common Fisheries Policy

In April, the European Commission adopted a green paper on the future of the European Union’s Common Fisheries Policy. The paper touches on all facets of current fisheries policy and explains why some problems still exist in spite of the progress that has been made since the reforms of 2002. The paper states that one of the main problems is the depleted state of European fish stocks. Eighty-eight percent of these stocks are overfished and 30% are “outside safe biological limits.” However, many fisheries are being fished 2 or 3 times more than what fish stocks can sustain, mostly as a result of fleet overcapacity.

Four other structural shortcomings of the present approach identified are:

- The lack of precise policy objectives, especially with regard to ecological responsibility and integration with general maritime issues;
- A decision-making system that is too centralized and focused on short-term solutions which more often than not undermine long-term sustainability;
- A framework that does not give sufficient responsibility to the industry; and
- The absence of political will towards compliance with fishing limitations.

The European Commission expressed concerned that if better environmental sustainability of fishing is not achieved in the coming years, the consequence will be impoverished seas and an economically unviable fishing industry.
INTRODUCTION

Stock assessments are critical to the management of marine fish stocks and fisheries. Stock assessment scientists develop the tools used to evaluate the status of fish stocks and fisheries, estimate the likely effects of alternative management policies, and contribute in the design of monitoring and research programs that provide the input necessary for assessments. Quantitative skills are essential; implementation of legislation, including the Magnuson-Stevens Fishery Conservation and Management Act (hereafter referred to as the Magnuson-Stevens Act), Marine Mammal Protection Act, and Endangered Species Act, requires the continual involvement of individuals with such skills. Stock assessment scientists are employed by many organizations, including state, federal, and tribal agencies; resource users, such as commercial and recreational fishing groups; non-governmental organizations (NGOs); and environmental consulting firms.

For years, anecdotal accounts have circulated of organizations, including the National Marine Fisheries Service (NMFS), facing difficulties in recruiting a sufficient quantity and quality of stock assessment scientists. University professors have also expressed concern in attracting incoming graduate students to work on stock assessment research projects.

As a result of these concerns, NMFS asked the National Research Council (NRC) to convene a workshop in 2000 to review NMFS plans for meeting its anticipated staff needs in stock assessment and social sciences. The NRC panel concluded, “For stock assessment scientists, NMFS is the primary employer and demand is already large relative to the total supply. NMFS’ anticipated expansion in this area exceeds the present capacity of university programs.” (NRC 2000). Over time, programs were designed and implemented to increase the number of stock assessment scientists (DOC and DOE 2008), but concerns about a shortage still persisted.

As a result, Congress, in its 2007 reauthorization of the Magnuson-Stevens Act (MSRA), directed that a study be conducted to determine if a shortage exists in the number of individuals with post-baccalaureate degrees who have the ability to conduct high quality scientific research in fishery stock assessment, fishery population dynamics, and related fields for government, non-profit, and private sector entities (P.L. 109-479, sec. 217). This essay is a synopsis of the studies that we conducted in response to the directive by Congress; the complete Congressional Report (DOC and DOE 2008) is available at the following website: www.st.nmfs.noaa.gov/report_congress/.

Based on the results of two studies, one investigating the anticipated demand and one estimating the current supply, the Congressional Report concludes that a shortage likely does exist. Numerical estimates of the shortage were calculated, albeit with a number of well-defined limitations and assumptions, as one would expect from broad-based surveys. In this essay, however, we take a slightly different approach in the hopes of eliciting further discussion as to whether a shortage exists, and if so, what the likely causes are and what the solutions may be. To do this, we draw evidence from the studies within the Congressional Report and pose the question, “Is the likelihood of a shortage sufficient to require the development...
and implementation of a strategy to increase the supply? If so, what should be the strategy’s components?”

For the purpose of this article, the term “stock assessment” will be used to represent “stock assessment, fishery population dynamics, and related fields.” The term “stock assessment scientist” will be used to represent “individuals who have the ability to conduct high quality scientific research in stock assessment, fishery population dynamics, and related fields.”

DEMAND

Over time, fisheries management has required increased involvement of stock assessment scientists. Further, legislation has given science, scientists, and stock assessment scientists a larger role in the management process. Increased data availability and computing power have allowed more complex questions to be addressed.

The MSRA increased the responsibilities of stock assessment scientists by requiring the establishment of annual catch limits and associated accountability measures on all stocks addressed in fishery management plans (Section 104 (a) (15)). Addressing this critical new requirement, along with additional requirements in other parts of the MSRA, created substantial new responsibilities for stock assessment scientists.

For the Congressional Report, we asked NMFS science centers about their current number of stock assessment scientists and their anticipated future needs (DOC and DOE 2008). They reported the following:

- NMFS currently employs about 90 stock assessment scientists.
- Approximately 40–44 retirements are anticipated over the next 10 years.
- To meet its growing responsibilities, NMFS would need to create 95–102 new stock assessment scientist positions within the next 10 years.
- Combining the number of retiring stock assessment scientist positions to be replaced with the number of new positions required summed to a total of 135–146 new hires within the next 10 years.
- The minimum number of new hires within the next 10 years amounts to 150% of the current number employed.
- Approximately one-half of the new hires are needed within the next 5 years.

The numbers above do not account for state marine fisheries agencies, regional fishery management councils, or interstate commissions, all of which are included in the Congressional Report. Neither the numbers above nor the Congressional Report account for tribal fishery management agencies, non-governmental organizations, environmental consulting firms, state and federal freshwater fisheries agencies, or the many other organizations that rely on individuals with the skills required of stock assessment scientists. Given the increasing role of stock assessment scientists in fisheries management, demand is likely to grow in all of these professional sectors.

SUPPLY

While the demand for stock assessment scientists has been increasing, the supply has not kept pace. As part of the Congressional Report addressing the supply of stock assessment scientists, we surveyed college and university department heads with fisheries-related programs (DOC and DOE 2008). Several of the survey components indicated a trend towards academia supplying insufficient numbers of graduates with training that would allow them to enter into a stock assessment position with a skill set advocated by NMFS. In particular, faculty expertise, graduate education, and quantitative training of undergraduates were viewed as major concerns in the supply issue.

Faculty Expertise

Faculty are at the center of the supply issue, as faculty teach courses and supervise research and training of students entering the discipline and job market. Department heads provided the following responses concerning faculty:

- Retiring population dynamics faculty will be replaced at a lower rate than fisheries faculty in general (77% vs. 91%).
- Assuming new faculty positions were available, only 12% of the hires would be in the field of population dynamics.
- Nearly one-third of fisheries programs reported that they do not have the resources necessary to train students to conduct research in population dynamics.

Graduate Education

As part of the supply survey, we created a list of graduate-level courses potentially available to fisheries students at most institutions with fisheries-related programs (DOC and DOE 2008). From that list, the NMFS science centers were polled to devise an “essential curriculum” that would prepare graduates for employment as stock assessment scientists for the federal government. Nine of the 32 courses identified were deemed essential by the NMFS science centers: population dynamics, fish ecology, multivariate statistics, sampling theory, fisheries or natural resources modeling, Bayesian statistics, stock assessment, risk and decision analysis, and fisheries or natural resources computer programming. Department heads were asked whether or not their universities offered each course and, if so, the percentage of their fisheries students who took each course. Results indicated that:

- Only 7% of the universities offered all 9 essential courses, while more than one-half of the universities offered 4 or fewer.
- Less than 12% of graduate students took a stock assessment course.
- A relatively small percentage of fisheries graduate students took courses in fisheries or natural resource modeling (18%), Bayesian statistics (13%), risk and decision analysis (6.2%), and fisheries or natural resources computer programming (3.5%).

Quantitative Undergraduate Education

Problems on the supply side are not limited to faculty expertise and graduate education. The lack of undergraduate students with strong quantitative skills translates into a lack
of adequately-trained incoming graduate students. Based on our survey:

- Department heads ranked the strength of recent first semester M.S. students in 12 skill areas in the following order: verbal communication, fishery biology, fishery ecology, critical thinking, information synthesis, fishery management, fishery science, written communication, mathematics, statistics, population dynamics, and modeling.
- They were also asked to compare these strengths for recent incoming M.S. students to students in the past decade. Not only were mathematics and population dynamics the two lowest ranking skill areas overall, but population dynamics was the only skill area where recent students were perceived to be weaker than students a decade ago.
- Department heads were less successful at recruiting M.S. students capable of conducting population dynamics research than M.S. students in general.

DISCUSSION

The discipline of stock assessment is neither the first nor the only discipline to notice a decline in the quality of quantitative education in U.S. institutions of higher learning. There has been an ongoing multidisciplinary call to improve undergraduate science, technology, engineering, and mathematics (STEM) education nationally (NRC 1996; NSF 1996). Stock assessment is only one of many disciplines feeling the effects of decreased performance from incoming graduate students in quantitative fields.

Demand for stock assessment scientists is increasing at a time when faculty are not being added or replaced in the same proportion as currently employed. As a result, limited graduate course offerings are likely to be further reduced, and quantitative skills of incoming graduate students will likely continue to decline.

As the leading employer of stock assessment scientists, the burden of reducing the shortage of stock assessment scientists, if one truly exists, largely lies with NMFS. Producing additional stock assessment scientists requires time: time to find promising students and time to train them adequately. The new mandates under the MSRA do not allow for delays, which means that efforts to increase the supply need to begin immediately. Such efforts would need to incorporate mechanisms to increase faculty with expertise in stock assessment, graduate course offerings, and the number of incoming graduate students with strong quantitative backgrounds. NMFS has created and implemented programs aimed at accomplishing each of these goals, but their current scale is likely to be insufficient to solve this potential shortage (DOC and DOE 2008).

REFERENCES


Addressing the Shortage of Stock Assessment Scientists through Undergraduate Workshops

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ABSTRACT: A recent Congressional report identified a shortage of scientists entering the discipline of stock assessment. The Southeast Fisheries Science Center of NOAA’s National Marine Fisheries Service and Virginia Tech created the Population Dynamics Recruiting Program (PDRP) to improve the quality of graduate students interested in entering the field. An annual week-long workshop identifies top students nationally with the potential to excel in population dynamics and educates them about the discipline. Program evaluation indicates that between 25% and 33% of workshop participants have subsequently entered graduate school in the field. Sixty-nine percent of those students knew little about the field before the workshop, and 85% reported wanting to pursue population dynamics because of their workshop experience. Continuing and strengthening the PDRP is an important component of a strategy to reduce the shortage of qualified stock assessment scientists.

Estudio sobre la escasez de evaluadores pesqueros a través de talleres estudiantiles

RESUMEN: En el reporte de un congreso reciente, se identifica una escasez de científicos dedicados a la disciplina de la evaluación pesquera. Como respuesta, El Centro de Estudios Pesqueros del Sureste, dependiente del Servicio de Pesquerías Marinas de la oficina de Administración Nacional Oceánica y Atmosférica, en conjunto con el Tecnológico de Virginia, crearon un Programa de Reclutamiento en Dinámica de Poblaciones (PRDP) para mejorar la calidad de los estudiantes graduados que estuvieran interesados en el área. En un taller anual con duración de una semana, se identificaron los mejores estudiantes a nivel nacional con el potencial de destacar en dinámica de poblaciones y se les instruyó sobre el tema. La evaluación indica que entre 25% y 33% de los participantes del taller han ingresado subsecuentemente a escuelas relacionadas al área. Sesenta y nueve por ciento de los estudiantes conocían muy poco acerca del tema antes de que comenzara el taller y una vez concluido, 85% reportaron tener deseos de continuar con el estudio de la dinámica de poblaciones. Continuar y fortalecer el PRDP es un componente importante de una estrategia para reducir la escasez de evaluadores pesqueros calificados.
INTRODUCTION

Stock assessment scientists are critical to fisheries management because they develop and apply the tools used to evaluate the status of fish stocks and fisheries and to estimate likely effects of alternative management policies. Over time, stock assessment scientists have played an increasingly important role in resource conservation, guiding the design of monitoring and research programs and providing critical information needed for science-based management.

A recent report to Congress identified a shortage of individuals with post-baccalaureate degrees who have the ability to conduct high quality scientific research in fishery stock assessment, fish population dynamics and related fields (DOC and DOE 2008). Three main causes of this shortage include (DOC and DOE 2008):

1. There are not enough university faculty to teach undergraduate and graduate students about the discipline and to supervise related research;
2. There are not enough graduate courses available that are essential to prepare graduates for employment as stock assessment scientists; and
3. The quantitative skills of graduate students presently entering fisheries programs are not sufficient for these students to enter the pipeline to stock assessment positions.

Eliminating this shortage will require solving all three problems.

As the largest U.S. employer of stock assessment scientists, the National Marine Fisheries Service (NMFS) carries much of the burden of reducing this shortage (DOC and DOE 2008). NMFS has established several programs designed to reduce it (DOC and DOE 2008). In order to increase faculty numbers, NMFS has long provided research support to university faculty, and also has encouraged NMFS stock assessment scientists to teach at universities and supervise graduate students. NMFS also has been working for years to increase the number of graduate students in the discipline by supporting graduate student assistantships and fellowships. The President’s 2009 budget includes an additional $1 million for this successful graduate population dynamics fellowship program (DOC and DOE 2008). NMFS also has many programs aimed at recruiting and educating undergraduate students, but historically, none has been directed specifically at the discipline of stock assessment, or designed to attract undergraduate students with better quantitative skills.

NMFS and Virginia Tech created the Population Dynamics Recruiting Program (PDRP) in 2003 to improve the quality of graduate students entering the field of population dynamics. Stock assessment focuses on exploited living marine resources and is a sub-discipline of population dynamics, which focuses on both exploited and non-exploited species, including legally protected species. NMFS hires population dynamics scientists to work in stock assessment and in related fields, and the same skills are required whether a population is exploited or not. Because of this, and because “population dynamics” is a broader and better understood term than “stock assessment” on college and university campuses, the program was named the Population Dynamics Recruiting Program. Here, the term “marine resources population dynamics” will be synonymous with the term “stock assessment.”

To improve the quantity and quality of graduate students entering fisheries degree programs to study population dynamics, the PDRP uses two main strategies:

1. Identifying top students with potential to excel in population dynamics and bringing them into the PDRP; and
2. Educating and motivating them so that they will potentially enter the discipline.

This article presents and evaluates the week-long undergraduate workshop of the PDRP.

WORKSHOP METHODS

Identifying Students

The PDRP looks for undergraduates with strong quantitative skills and interests, and a basic understanding of ecology. Such students typically are scattered at colleges and universities across the country, in a variety of majors such as ecology, environmental science, biology, fisheries science, wildlife science, natural resources management, conservation biology, and marine biology. Finding these students is not easy. Each year the PDRP contacts faculty members and other academic advisors across the country who are likely to know students who fit our profile. Over 400 individuals have been contacted annually by e-mail, mail and, to the extent possible, telephone to encourage their best students to apply.

Encouraging Students to Apply

The next challenge is encouraging the students identified to apply to the workshop. Many do not yet know about population dynamics, because the topic is not covered on all campuses or within all programs. Because of this, merely asking students to attend a population dynamics workshop would not draw as many qualified students as desired.

To heighten students’ interest, we offer a week-long workshop in the Florida Keys. The workshop’s timing in early January puts it before most students return to classes. All costs are covered for the students, which ensures that any qualified student can apply without financial concern.

Students are selected on the basis of grade point average (GPA); standardized test scores (verbal and quantitative); number of college-level math and statistics courses taken; number of college-level ecology-related courses taken; grades in math, statistics, and ecology courses; quality of thought, organization, and writing in their answers to essay questions on the application; internships, research experiences, and other out-of-classroom experiences; and the responses of their references to specific questions. In the first year (2004), 16 students were selected. In each of the following years (2005–2008), 15 students were selected.

The Workshop

Throughout the workshop, a case study approach (Herreid 1994, 2005) is applied to demonstrate the roles that population dynamics scientists play in the complex world of marine resources management. One case study presented each year focuses on sustainable harvest of a fish stock, such as swordfish (Xiphias gladius). Because many undergraduate students are interested in protected species, rather than or in addition to harvested ones, a second case study each year focuses on a protected resource, such as threatened loggerhead sea turtle (Caretta caretta). This combination also dem-
The workshop offers a wide range of activities, including field trips, lectures, discussions, computer exercises, student research, and student presentations, to keep students interested throughout the week. Half the instructors are NMFS scientists; the other half are Virginia Tech faculty. Instructors are selected for interest in workshop goals, subject expertise, effective teaching, and enthusiasm.

Workshop students typically get to know the instructors and teaching assistants much better than in an ordinary classroom setting. Students and instructors eat together, attend fieldtrips together, and share recreational activities during breaks. A popular event each year is an evening dedicated to answering questions about graduate schools and career opportunities. The strong relationships built at the workshop have provided opportunities for longer-term mentoring, benefiting both the agency and the students’ career development.

Many students consider careers in environmental science because they want to work towards conservation and sustainability. Throughout the workshop, instructors stress that individuals working in marine resource population dynamics help meet those goals by providing critical scientific guidance to policymakers.

The workshop occupies a NMFS stock assessment scientist and a Virginia Tech project coordinator for about four months each year, as well as six to eight additional instructors for about three weeks each. Non-personnel costs are about $50,000 per workshop.

**EVALUATION METHODS**

We evaluated the PDRP workshop program to answer three main questions:

1. Does the program attract the right students?
2. Have past workshop students entered graduate school in marine resources population dynamics?
3. Were those students influenced to enter graduate school in the discipline by the workshop?

We also investigated the workshop’s influence on all past students, including those who have not entered graduate school in the discipline. The evaluation took place under the auspices of Virginia Tech’s Institutional Review Board policies pertaining to research on human subjects (approval #06-229).

**Evaluation of Finding and Attracting Students**

To evaluate our effectiveness at attracting qualified students, the following information was compiled about each student accepted into the program from his or her application materials:

- College or university attended,
- State in which college or university is located,
- Undergraduate major,
- Year in school,
- Grade point average (GPA), and
- Standardized test scores (SAT, ACT, GRE).

Basic statistics (mean, standard deviation, minimum, and maximum) were calculated for GPAs and standardized test scores. Using tables from the national testing services, percentiles were assigned to mean values of standardized test scores.

**EVALUATING IMPACTS OF THE WORKSHOPS**

**Questionnaire**

To evaluate effectiveness of the PDRP workshops, participants from 2004–2007 were asked to complete a questionnaire in the spring of 2008 (N = 61). Participants from the 2008 workshop were not included because it was too soon after their workshop to query the longer term effects being investigated. The questionnaire was designed using the software package SurveyPro 4.0 (Apian Software, Inc.) and distributed online. Each past participant was contacted one week prior to the questionnaire’s opening with a letter explaining its goals and methods (Dillman 2000). Once the questionnaire was open, each past participant was sent unique login information. The questionnaire was closed after two weeks, and the results were compiled using SurveyPro 4.0 Net Collect software (Apian Software, Inc.).

**Students were asked the following:**

What schooling and jobs have been undertaken since the workshop?

We wanted to know how many were working on marine resources or population dynamics, how many were in graduate school, and how many were working with NMFS in some context (internships, jobs, graduate school funding). Most importantly, we wanted to know how many had entered graduate school to focus on marine resources population dynamics.

Did the workshop increase interest in our three main subject areas (marine resources, population dynamics, and potential employment with a marine resources agency)?

We asked whether interest in those areas increased (or not) as a result of the workshop, or if the respondent had been very interested even before the workshop.

What benefits were received?

We asked respondents to select zero or more possible benefits from a list of 17 (see results section). Students who did not respond to the questionnaire during the two-week response period were sent a final e-mail with the following abbreviated list of questions:

1. What professional interest are you pursuing right now (graduate school, working, etc.)? On what kinds of projects are you working?
2. Did you find the workshop beneficial? How?
3. Did the workshop help you decide whether or not you wanted to work with population dynamics? Marine resources? NMFS?

We hoped that the brevity and format of these questions would prompt a response from those who did not complete the online questionnaire.
RESULTS

Finding and Attracting Students

To date (2004–2008), 76 students representing 49 colleges and universities in 22 states have participated in five PdRP workshops (Table 1). Southeastern states sent the greatest number of participants, as did southeastern colleges and universities (Table 1).

Participants represented a wide range of undergraduate majors, including many subdisciplines of biology, ecology, and resource management. We also attracted one physics major and one psychology major. Over 25% of workshop participants (20) were enrolled in double majors. Of the 76 participants, 12 were sophomores (16%), 21 were juniors (28%), 41 were seniors (54%), and 2 had graduated but not yet entered graduate programs (3%).

Accepted students had high grade point averages (Mean = 3.72/4.00; Table 2). Regarding both quantitative and verbal exams, the mean SAT score was in the top 7% of students taking the exam nationally; mean ACT score, in the top 5%; and mean GRE score, in roughly the top 25% (Table 2). The medians of all distributions were above the means, indicating that more students received scores above the average than below it.

Questionnaire Response Rate

A total of 50 participants responded to the questionnaire during the 2-week time frame, for a response rate of 81.9%. Of the 11 who did not respond to the initial questionnaire, we were unsuccessful at contacting 3. Four of the remaining 8 responded to the abbreviated list of questions, and their responses were included where applicable.

Current Activities

Of the respondents, 88% (47 of 53) had completed undergraduate degrees by spring 2008. Of those, 74% (35) were either in graduate school or had completed a graduate degree.

With regard to the workshop topics, 18 of the graduate school attendees were focusing on population dynamics, 20 were focusing on marine resources, and 13 were focusing on both (Table 3). From this point forward, the 13 students whose graduate studies focus on marine resources population dynamics—the goal of our recruiting efforts—will be referred to as the “13 in-discipline graduate students.” Depending on the method used to count them, between 25% and 37% of past workshop participants have become in-discipline graduate students (Table 3). These 13 are comparable academically to the overall population of workshop participants, based on their workshop application materials.

Using similar calculations, between 34% and 51% of workshop participants have entered graduate school to study population dynamics in general, whether terrestrial, marine, or other (Table 3). Since the workshop, 33% percent of participants had worked for or with NMFS in some capacity.

Changes to Interest Levels

A majority of all respondents (n = 50) reported increased interest in all three areas (population dynamics, marine resources, and potentially working for a marine resources agency) specifically

Table 1. List of colleges and universities sending students to the 2004–2008 workshops. Seventy-six students representing 49 colleges and universities in 22 states have participated. Numbers in parentheses indicated the number by state or college/university. If no number is present, one student participated.

<table>
<thead>
<tr>
<th>State</th>
<th>College/University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>University of Alabama</td>
</tr>
<tr>
<td>California</td>
<td>Scripps College</td>
</tr>
<tr>
<td></td>
<td>University of California, Berkeley</td>
</tr>
<tr>
<td></td>
<td>University of California, San Diego</td>
</tr>
<tr>
<td>Florida</td>
<td>Florida Institute of Technology (2)</td>
</tr>
<tr>
<td></td>
<td>Florida State University</td>
</tr>
<tr>
<td></td>
<td>University of Florida (3)</td>
</tr>
<tr>
<td></td>
<td>University of Miami</td>
</tr>
<tr>
<td></td>
<td>University of West Florida</td>
</tr>
<tr>
<td>Georgia</td>
<td>Berry College</td>
</tr>
<tr>
<td></td>
<td>Emory University (3)</td>
</tr>
<tr>
<td></td>
<td>University of Georgia (2)</td>
</tr>
<tr>
<td>Indiana</td>
<td>University of St. Francis</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Centre College</td>
</tr>
<tr>
<td>Louisiana</td>
<td>Nicholls State University</td>
</tr>
<tr>
<td></td>
<td>Northwestern State University</td>
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<tr>
<td></td>
<td>Tulane University</td>
</tr>
<tr>
<td>Maine</td>
<td>Bowdoin College</td>
</tr>
<tr>
<td></td>
<td>Colby College</td>
</tr>
<tr>
<td></td>
<td>University of Maine at Orono</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Boston University</td>
</tr>
<tr>
<td></td>
<td>Smith College</td>
</tr>
<tr>
<td>Michigan</td>
<td>Michigan State University</td>
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<tr>
<td></td>
<td>University of Michigan</td>
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<tr>
<td>New Jersey</td>
<td>Princeton University</td>
</tr>
<tr>
<td>New York</td>
<td>Columbia University</td>
</tr>
<tr>
<td></td>
<td>Cornell University (2)</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Duke University (3)</td>
</tr>
<tr>
<td></td>
<td>North Carolina State University (2)</td>
</tr>
<tr>
<td>Ohio</td>
<td>Bowling Green University</td>
</tr>
<tr>
<td></td>
<td>Ohio Wesleyan University</td>
</tr>
<tr>
<td>Oregon</td>
<td>Willamette University (2)</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Dickinson College</td>
</tr>
<tr>
<td>South Carolina</td>
<td>Clemson University (2)</td>
</tr>
<tr>
<td></td>
<td>Coastal Carolina University (3)</td>
</tr>
<tr>
<td></td>
<td>College of Charleston</td>
</tr>
<tr>
<td></td>
<td>University of South Carolina (3)</td>
</tr>
<tr>
<td></td>
<td>Winthrop University</td>
</tr>
<tr>
<td>Tennessee</td>
<td>University of Tennessee (2)</td>
</tr>
<tr>
<td>Texas</td>
<td>Texas A&amp;M University (2)</td>
</tr>
<tr>
<td>Virginia</td>
<td>College of William and Mary (4)</td>
</tr>
<tr>
<td></td>
<td>Old Dominion University</td>
</tr>
<tr>
<td></td>
<td>University of Richmond (2)</td>
</tr>
<tr>
<td></td>
<td>University of Virginia (2)</td>
</tr>
<tr>
<td></td>
<td>Virginia Polytechnic Institute and State University (6)</td>
</tr>
<tr>
<td>Washington</td>
<td>University of Washington</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>University of Wisconsin, Stevens Point</td>
</tr>
</tbody>
</table>

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because of the workshop (Table 4). Only 2 of the 50 respondents (4%) said their interest had not increased in any of the three areas.

A greater proportion of the 13 in-discipline graduate students entered the workshop already interested in each of the 3 topics as compared to all respondents (Table 4). This was particularly true with regards to marine resources, where 62% of the 13 in-discipline graduate students reported that they had been very interested in the subject already, compared to 26% of all respondents (Table 4). Fifty-eight percent of all responding past participants reported their interest in working for a marine resources agency increased as a result of the workshop (Table 4).

**Workshop Benefits**

A majority of respondents reported that this was a field they knew little about before the workshop, including 69% of the 13 in-discipline graduate students (Table 5). All 13 in-discipline graduate students reported that as a result of the workshop they wanted to learn more about this field, and 85% reported that because of participation in the workshop they learned this was a field they wanted to pursue (Table 5). These specific benefits were not limited to the in-discipline graduate students, as 80% of all respondents and all 13 of the in-discipline graduate students reported that the workshop influenced their career paths (Table 5) by teaching them about possible career opportunities and helping them better define their professional interests (Table 5). Similarly, 86% of all respondents and 85% of the 13 in-discipline graduate students reported that the workshop influenced their educational paths (Table 5), both in deciding what to study in graduate school and in deciding where to go to graduate school (Table 5).

All respondents reported receiving many benefits from the workshop (Table 5). More than 90% reported learning more about population dynamics, marine resources, and NMFS, indicating that a primary objective of the workshop was met (Table 5). Participants also appreciated the opportunities to establish contact with other top students and professionals in the field (Table 5).

**DISCUSSION**

**Reaching the Goal**

Colleges and universities are experiencing difficulty finding qualified graduate students to conduct population dynamics-related research. As part of the Congressional report (DOC and DOE 2008), department heads of university and college marine fisheries programs were surveyed. Results indicated that their success...
at recruiting graduate students to conduct population dynamics research was lower than at recruiting graduate students in general (DOC and DOE 2008). Department heads were also asked to rate the aptitude and ability of their recent first-semester fisheries graduate students in 12 skill areas related to graduate student success. Most felt students were “adequate,” “strong,” or “very strong” in all areas except modeling (DOC and DOE 2008). Population dynamics and statistics followed modeling as the next weakest skills (DOC and DOE 2008). Department heads reported that although most skills had improved in the past decade, skills in population dynamics and mathematics had remained stable or declined (DOC and DOE 2008).

The discipline of stock assessment is neither the first nor the only discipline to notice a decline in the quality of quantitative education in the United States. There has been an ongoing multidisciplinary call to improve undergraduate science, technology, engineering, and mathematics (STEM) education nationally (NRC 1996; NSF 1996). To reverse this trend, institutions of higher education must place a higher priority on the quantitative training of undergraduates.

The PDRP showed them that population dynamics combines those subjects and that population dynamicists play important, fascinating roles in marine conservation. Use of real case studies was essential to this process. In addition, students were given more individual attention by instructors than is possible in the typical undergraduate classroom. Increasing interest and excitement about a specific career path, possibly for the first time in the students’ academic experience, was part of the PDRP’s strategy. Our evaluation indicates this strategy was successfully accomplished.

Finding Students

Finding the right students for this program has been time consuming but, over time, word of the program has spread, and recruiting has become easier. Our students have come from a wide range of colleges and universities and a diverse group of majors, NMS is attempting to find and recruit students whose interests and abilities make them most likely to succeed as graduate students, and later as researchers, in marine resource population dynamics.

Table 4. Reported increase in interest in focus areas (n = 50). Comparison of all respondents (denoted as All) to the 13 in-discipline graduate students (denoted as 13).

<table>
<thead>
<tr>
<th>Looking back, perceived increase in interest in focus areas</th>
<th>Population dynamics</th>
<th>Marine resources</th>
<th>Working for a marine resources agency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>13</td>
<td>All</td>
</tr>
<tr>
<td>Yes, my interest increased</td>
<td>80%</td>
<td>69%</td>
<td>60%</td>
</tr>
<tr>
<td>I was already very interested</td>
<td>12%</td>
<td>31%</td>
<td>26%</td>
</tr>
<tr>
<td>No, my interest did not increase</td>
<td>8%</td>
<td>0%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Table 5. Percentage of the 13 in-discipline graduate students and all respondents who either strongly agreed or agreed about specific workshop benefits.

<table>
<thead>
<tr>
<th>Workshop benefits</th>
<th>Percentage of 13 in-discipline graduate students</th>
<th>Percentage of all responding past participants (n = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was introduced to a subject I knew little about</td>
<td>69%</td>
<td>76%</td>
</tr>
<tr>
<td>I learned that this was a field I wanted to learn more about</td>
<td>100%</td>
<td>88%</td>
</tr>
<tr>
<td>I learned that this was a field I wanted to pursue</td>
<td>85%</td>
<td>45%</td>
</tr>
<tr>
<td>I learned more about possible career opportunities</td>
<td>100%</td>
<td>90%</td>
</tr>
<tr>
<td>The workshop helped me define and/or narrow my professional interests</td>
<td>92%</td>
<td>82%</td>
</tr>
<tr>
<td>The workshop helped influence my career path</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td>The workshop helped influence my educational path</td>
<td>85%</td>
<td>86%</td>
</tr>
<tr>
<td>The workshop helped me decide what to study in graduate school</td>
<td>77%</td>
<td>69%</td>
</tr>
<tr>
<td>The workshop helped me decide where to go to graduate school</td>
<td>54%</td>
<td>27%</td>
</tr>
<tr>
<td>I learned more about NOAA/NMFS.</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>I learned more about marine resources</td>
<td>100%</td>
<td>94%</td>
</tr>
<tr>
<td>I met and established good contact with professionals in the field</td>
<td>92%</td>
<td>94%</td>
</tr>
<tr>
<td>I met new friends with similar interests</td>
<td>85%</td>
<td>88%</td>
</tr>
<tr>
<td>I was able to apply what I had learned in school</td>
<td>69%</td>
<td>76%</td>
</tr>
<tr>
<td>The workshop helped me decide whether or not to go to graduate school</td>
<td>46%</td>
<td>55%</td>
</tr>
<tr>
<td>I learned that this was a field I did not want to pursue</td>
<td>0%</td>
<td>12%</td>
</tr>
</tbody>
</table>
as expected. If we had limited recruiting efforts to undergraduate fisheries programs, we would have missed most of the students we selected. The intense effort involved in publicizing the program widely has proven worthwhile.

The PDRP is supported entirely by the Southeast Fisheries Science Center (SEFSC) of NMFS. The program's original goal was to recruit stock assessment scientists to the southeastern United States. Because of that, advertising in the first two years focused on southeastern colleges and universities, which explains the predominance of southeastern schools in Table 1. In our third year, we expanded advertising efforts nationwide, to benefit all of NMFS.

Participation from individual universities and colleges has varied greatly. Some large, well-known schools have not been represented, while lesser-known schools were. This is partially due to the rarity and patchy distribution of interested and qualified students. Another cause is likely the level of dissemination of workshop information on individual campuses. While the PDRP organizers worked hard on advertising, it was still up to the contacts at each school to spread the word. It became clear from talking with workshop participants that many found out about the workshop from a specific e-mail or conversation with a faculty member or advisor who targeted that student because of his or her strengths. We continue to personally contact faculty members and academic advisors at universities and colleges in an effort to ensure that they encourage their top students to apply for future workshops.

The use of standardized tests as indicators of ability has been controversial (e.g., Crouse and Trusheim 1988; Leonard and Jiang 1999; Zwick 2002). Test scores are used by the PDRP in admissions because grade point averages are not comparable across campuses. However, poor standardized test scores did not by themselves eliminate any student. If other factors indicated a good match for the program, the student was accepted. Similarly, strong test scores alone were not sufficient for admission.

Evaluation of applications has varied slightly each year, as we attempt to better identify excellent students likely to enter the field. For example, our efforts so far have been aimed at students with strong quantitative backgrounds and a basic understanding of ecology. However, the evaluation reported here indicates that 62% of the 13 in-discipline graduate students had been very interested in marine resources before the workshop, compared to 26% of all respondents, which suggests that prior interest is an important determinant of career path even for students who were influenced by the workshop. Therefore, we anticipate weighing applicants’ interest in marine resources more heavily in future admissions than we have in the past.

**Ultimate Evaluation**

Because the ultimate goal of the PDRP is to increase the number of highly qualified applicants for stock assessment positions with NMFS, ultimate evaluation of the PDRP would be its contribution to this goal. Generally, stock assessment jobs with NMFS require a doctoral degree. Because the first PDRP workshop took place in 2004, it will be several years before workshop students, who participate as undergraduates, are ready to start professional careers. Therefore, it is too soon to make that ultimate evaluation of the PDRP.

The immediate goal of the PDRP is to improve the number of highly qualified applicants for graduate school in the discipline. The need for this comes from a survey of college and university marine fisheries program department heads in the Congressional report (DOC and DOE 2008). Once a significant number of our workshop students have entered graduate school, it will be informative to ask college and university department heads whether quantitative skills have improved, particularly among entrants from the PDRP. Because only 13 PDRP workshop students have entered graduate school in the discipline, it is also too soon to ask that question.

No evaluation can tell us how many of the PDRP participants would have entered the field if they had not attended a PDRP workshop. Still, the current evaluation demonstrates that the workshops have played a major role in decisions regarding the in-discipline graduate students’ chosen career paths.

**Benefits to Participants**

The PDRP was designed to provide benefits to all workshop students, not just those entering marine resources population dynamics. The workshop is structured to educate all participants about the complexity of marine resources management, the roles of science within the process, and about themselves, so they can make better decisions about their futures. The program appears to have accomplished these goals.

**Costs vs. Benefits**

The first four workshops together cost approximately $200,000 plus personnel time. Given that the program has produced 13 in-discipline graduate students (as of spring 2008), the cost was $15,400 per workshop student who entered graduate school in the discipline. Including only the in-discipline graduate students who knew little about the discipline before the workshop (n = 11), the cost would be $22,200 per student. Including only students who responded that they learned this was a field they wanted to pursue because of the workshop (n = 11), the cost would be $18,100 per student. Accounting for personnel time would increase these figures by about 80%.

The number of past workshop participants from the first four years of the program who will enter the discipline of marine resources population dynamics will likely increase above the current number of 13. Past workshop participants may eventually enter graduate school in the discipline including:

1. Those who had not yet finished their bachelor's degrees at the time of the questionnaire (n = 6),
2. Those who had completed their bachelor's degrees but had not yet entered graduate school (n = 12), and
3. Those currently or previously enrolled in graduate school not focusing on marine resources population dynamics (n = 2) who may eventually focus on the discipline in a future degree.

Forty-five percent (22) of respondents stated that this was a field they wanted to pursue. As this happens, the cost per student recruited will decrease.

The workshops have successfully recruited into the field some highly promising individuals who otherwise would not have been there. The attendant costs can be considered nominal if one considers both the difficulty in recruiting such individuals and the expected career length of a NMFS biologist, about 20 to 40 years. No calculation can quantify the very high value of recruiting
exceptional individuals who will, in the years and decades ahead, move the field forward and provide strong science on which to base management of U.S. marine resources.

As a result of the workshop, some participants became knowledgeable about NMFS and interested in working for a marine agency, although not necessarily in population dynamics. Almost 60% of respondents stated that their interest in working for a marine resources agency increased as a result of the workshop. One-third of the respondents had worked with NMFS since their workshop. Given the outstanding quality of students in the program, recruiting participants into the agency, regardless of the discipline, provides additional rich benefits.

We conclude that the PDRP has motivated a new group of students to enter graduate school in population dynamics, increasing not only the quality of students entering the discipline, but also the number. In this way the PDRP has contributed to solving two of the three problems causing the critical shortage of stock assessment scientists.

ACKNOWLEDGMENTS

The PDRP workshops have had many excellent instructors including Erik Williams, Liz Brooks, and Paul Richards. Logistical support for the workshop program has been provided by Lynn Hayes and David Waterman of Virginia Tech. Additional support for the program has been provided by Bonnie Ponwith, Alex Chester, Joe Powers, and Gerry Scott. The authors wish to thank Al Zale, Joe Powers, and a number of anonymous reviewers and for their excellent comments about earlier versions of the manuscript. Funding for the PDRP comes from a grant from the NMFS Southeast Fisheries Science Center to Virginia Tech.

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ABSTRACT: Federal fisheries managers are required by National Standard 8 of the Magnuson-Stevens Act to consider the social and economic impacts of their proposed regulations on fishing communities. For social impacts, this is often achieved by intensive qualitative research techniques. Efforts have been underway to utilize more quantitative measures that rely on secondary data. Secondary data relies upon information that has already been collected, usually for another purpose. Unfortunately, this often means that direct measures of variables of interest to fisheries managers are often unavailable. Utilizing the Fishery Stock Status Index, this research develops two new indicators that directly measure the sustainability of the fish species a community relies upon for income. These two new measures could be of great assistance to fisheries managers as they assess the impacts of regulatory change.

INTRODUCTION

Since the addition of National Standard 8 (NS-8) to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the National Marine Fisheries Service (NMFS) has made a concerted effort to improve social impact analysis on fishing communities. Despite considerable effort to identify and profile fishing communities in all regions of the United States, these profiles provide limited information for use in impact assessments (Ingles and Sepez 2007; Jepson and Jacob 2007). Census data that are often collected are essential descriptors for the community, but have little relevance to the various fishing endeavors that occur within. While the agency does have landings and permit data at the community level, they are at times difficult to report when the number of fishing related businesses may be small, presenting confidentiality issues as a result. Furthermore, with time-limited fishery management actions occurring on a regular basis, it is difficult to quickly gather relevant data to assess a community’s well-being. Therefore, it becomes difficult to situate the impacts of regulation within a community and continue to meet the mandate as outlined in the act.

The timeliness of analysis can present problems, as secondary data are often time sensitive yet consist of data that can be a decade old. Time-honored traditions of qualitative data collection, such as ethnography, oral history, and participant observation can provide very rich and descriptive analysis that can provide context to management actions that may not be attainable through quantitative analysis. Yet these efforts can be time consuming and expensive, and with limited budgets, ensuring valid and adequate sampling can be problematic. Pinto da Silva and Hall-Arbor (2008) and Ingles and Sepez (2007) provide a more in-depth discussion on situating the impacts of management actions within a community. To address some of these problems, we explore a method of situating secondary data within the fishing community to provide a local context for the impact of management actions.

THE MAGNUSON-STEVENS FISHERIES CONSERVATION AND MANAGEMENT REAUTHORIZATION ACT

The NMFS focus on sustainability is descendent from a direct line of fisheries regulations starting with the MSFCMA, which was amended in 1996 to include 10 “national standards for fishery conservation and management” (Jacob et al. 2001). These national standards are an obvious key to sustainability; however, translating sustainability into a measurable quantity can be difficult. One example is the Fishery Stock Sustainability Index (FSSI) that directly measures sustainability. The FSSI is a key variable of interest to fisheries managers, but is only available at the national or regional level. Adapting the FSSI for local
use would make it an ideal indicator of how vulnerable or resilient a community might be in the face of shifts in the market and changes in resource abundance, as well as assessing the impacts of natural disasters and determining the potential outcomes of management and regulatory changes. NMFS fisheries managers would benefit by determining the potential social and economic impacts of their decisions by meeting the requirements of NS-8.

THE FISHERY STOCK SUSTAINABILITY INDEX

The purpose of this research is to adapt the national and regional level FSSI into a tool that can be used at the community level to help manage local fisheries and assess potential outcomes of regulations. This is achieved by using community landings data along with the FSSI to help assess the sustainability of the fisheries that are relied upon for local income. This is done by means of a “weighted average” that establishes the percentage of landings that come from a particular species and multiplies it by the FSSI score for that species. After the percentage of every species landed in a community is determined and multiplied by the appropriate stock FSSI, the products are summed and then a local FSSI (L-FSSI) score is generated. This score ranges from zero to four and is interpreted similarly to the original metric in the FSSI. In addition, we adapt an analytical tool from economics called the “location quotient” to further interpret the local landings data to potentially identify over-reliance on a specific fishery stock.

The FSSI was developed in 2005, although NMFS has been collecting and reporting data on fishery sustainability for about a decade (Buck 2007). Collected at the national and regional level (the eight fisheries management regions in the United States), the FSSI is one of several assessment and accountability tools that the NMFS uses to measure the effectiveness and efficiency of the agency. The FSSI, along with other measures, are reported to the U.S. Office of Management and Budget (OMB) that in turn gives the agency an overall efficiency rating based on setting ambitious goals, achieving results, and managerial effectiveness. The FSSI is a performance measure that assesses the sustainability of 230 fish stocks that are important to commercial and recreational sectors. Most of the fish species are measured as individual stocks, however a few are measured as a stock complex (NMFS 2008).

Since there are 230 stocks that are assessed by the FSSI, the best score that can be achieved is 920 (230x4). For the first quarter of 2008 the FSSI score was 531, meaning that the agency could improve fisheries by a total of 389 points (NMFS 2008). By this method, NMFS is able to show improvements or declines in their performance of the management the nation’s fisheries.

METHODS

The development of the L-FSSI is dependent upon assembling local community landings data. In general, using landings to predict future impacts can be risky as you are looking back at what was, rather than examining the fishery’s current state. Additionally, it is possible for landings to be relatively stable even as overfishing is occurring and the fishery becomes less sustainable. However, adding information from the FSSI to local landings data can help strengthen landings as a better outcome and predictive variable for fisheries management.

An important issue in using community-level landings data revolves around federal confidentiality rules. NMFS does not allow reporting landings data when there are less than three fishers, processors, or distributors in a given community (Impact Assessment 2005). The “rule of three” protects confidentiality by prohibiting the reporting of information that might be attributed to a single business or individual. This keeps potential competitors from gaining inside information about the activities of that business or individual (Impact Assessment 2005).

There are many small rural communities that have only one or two fish processors that contribute a relatively large amount of jobs and income to the local economy (Impact Assessment 2005). Nonetheless the data cannot be reported because of the rule of three. In many cases this essentially makes community-level landings data unavailable to researchers outside of NMFS because of the sensitive and confidential nature of the information. However, since the L-FSSI is an aggregate of all landings data and does not report information by individual species, it would not violate federal confidentiality rules.

Although the L-FSSI score for an individual community would not violate federal confidentiality rules, we need to report community-level landings data by species to show exactly how the measure is constructed. As such we have decided to present fictitious data that represents an amalgam of several Gulf Coast fishing communities. This will allow us to illustrate the logic of the FSSI index without violating federal confidentiality rules. Shrimpville (fictional place and data) represents a typical shrimp fishing community on the Gulf of Mexico region (Table 1). The majority of landings come from brown (Farfantepenaues aztecus) and white shrimp (Liptopenaus setiferus). There are some minor landings of finfish. If we were to take all of the FSSI scores for all the species fished in Shrimpville and summed them, the total comes to 17. Since there are 5 different species that were landed, the average FSSI = 3.40 (sum of FSSI 17 divided by number of species 5 = 3.40). However, this misrepresents the real FSSI of the community since red snapper (Lutjanus campechianus), which only makes up .21% of landings has an FSSI of 1. By taking the pounds reported of landings for each species and dividing them by the sum of all landings, a percent of total landings by species is computed. For example, brown shrimp had 1,991,578 lbs. reported and is divided by the 3,205,703 lbs. in total landings to represent 62.13% of all landings in Shrimpville. When the percent of landings is multiplied by the FSSI score for each species, the sum of that product is the L-FSSI. This L-FSSI is a weighted average FSSI that considers all species in the local fishery. It returns to the original scoring metric, which ranges from 0 to 4. The L-FSSI in Shrimpville is 3.99, which indicates the fishery is very sustainable. By comparison Fintown (which is a fin-fishing reliant community) is far more vulnerable. The L-FSSI in Fintown is 1.62, indicating that the species that the fishers in the community rely upon are less sustainable. This suggests that the community is vulnerable to any changes in the fishery.

Even though Shrimpville has a very high L-FSSI, there are a variety of points that need to be made. First, since the L-FSSI is dependent upon landings there is some fundamental information that is not included that would need to be compensated for by other indicators. For example, presently effort by shrimpers in the Gulf of Mexico is down and yet landings have remained fairly steady (DeSantis 2008). In addition, the cost of fuel has risen sharply while prices for shrimp have declined in real dollars (DeSantis 2008). Further, in 2008 brown shrimp...
Table 1. Community landings data with Gulf of Mexico landings data.

**Shrimpville (Fictitious Place and Data)**

<table>
<thead>
<tr>
<th>Species</th>
<th>Pounds Reported</th>
<th>FSSI</th>
<th>Shrimpville (local) %pounds</th>
<th>Shrimpville (local) %pounds*FSSI</th>
<th>Gulf (region) %pounds</th>
<th>L-FSSI Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrimp, Northern Brown</td>
<td>1,991,578</td>
<td>4</td>
<td>62.13%</td>
<td>2.4850</td>
<td>44.79%</td>
<td>1.39</td>
</tr>
<tr>
<td>Shrimp, Northern White</td>
<td>1,206,955</td>
<td>4</td>
<td>37.65%</td>
<td>1.5060</td>
<td>41.95%</td>
<td>0.90</td>
</tr>
<tr>
<td>Snapper, Red</td>
<td>6773</td>
<td>1</td>
<td>0.21%</td>
<td>0.0021</td>
<td>1.49%</td>
<td>0.14</td>
</tr>
<tr>
<td>Cobia</td>
<td>360</td>
<td>4</td>
<td>0.01%</td>
<td>0.0004</td>
<td>0.03%</td>
<td>0.37</td>
</tr>
<tr>
<td>Snapper, Vermilion</td>
<td>37</td>
<td>4</td>
<td>0.00%</td>
<td>0.0000</td>
<td>0.57%</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,205,703</strong></td>
<td><strong>17</strong></td>
<td><strong>100.00%</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Average FSSI</strong></td>
<td>3.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.99</td>
</tr>
</tbody>
</table>

**Fintown (Fictitious Place and Data)**

<table>
<thead>
<tr>
<th>Species</th>
<th>Pounds Reported</th>
<th>Fintown(local) FSSI</th>
<th>Fintown (local) %pounds</th>
<th>Fintown (local) %pounds*FSSI</th>
<th>Gulf (region) %pounds</th>
<th>L-FSSI Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snapper, Red</td>
<td>243,978</td>
<td>1</td>
<td>17.84%</td>
<td>0.1784</td>
<td>1.49%</td>
<td>11.97</td>
</tr>
<tr>
<td>Amberjack, Greater</td>
<td>89,076</td>
<td>1</td>
<td>6.51%</td>
<td>0.0651</td>
<td>0.29%</td>
<td>22.46</td>
</tr>
<tr>
<td>Lobster, Caribbean Spiny</td>
<td>156,209</td>
<td>1.5</td>
<td>11.42%</td>
<td>0.1713</td>
<td>1.40%</td>
<td>8.16</td>
</tr>
<tr>
<td>Crab, Florida Stone Claws</td>
<td>225,437</td>
<td>1.5</td>
<td>16.48%</td>
<td>0.2473</td>
<td>1.53%</td>
<td>10.77</td>
</tr>
<tr>
<td>Mackerel, Spanish</td>
<td>176,921</td>
<td>4</td>
<td>12.94%</td>
<td>0.5174</td>
<td>0.55%</td>
<td>23.52</td>
</tr>
<tr>
<td>Mackerel, King</td>
<td>143,877</td>
<td>3</td>
<td>10.52%</td>
<td>0.3156</td>
<td>0.34%</td>
<td>30.94</td>
</tr>
<tr>
<td>Gag</td>
<td>332,145</td>
<td>0.5</td>
<td>24.29%</td>
<td>0.1214</td>
<td>0.47%</td>
<td>51.67</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,367,643</strong></td>
<td><strong>12.5</strong></td>
<td><strong>100.00%</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Average FSSI</strong></td>
<td><strong>1.56</strong></td>
<td></td>
<td></td>
<td><strong>1.00</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1.62</strong></td>
</tr>
</tbody>
</table>

**Gulf of Mexico Data 2006 (Real Data)**

<table>
<thead>
<tr>
<th>Species</th>
<th>Pounds</th>
<th>FSSI</th>
<th>%pounds</th>
<th>%pounds*FSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrimp, Brown</td>
<td>139,955,385</td>
<td>4</td>
<td>44.79%</td>
<td>1.7915</td>
</tr>
<tr>
<td>Shrimp, White</td>
<td>131,095,568</td>
<td>4</td>
<td>41.95%</td>
<td>1.6781</td>
</tr>
<tr>
<td>Shrimp, Pink</td>
<td>12,485,948</td>
<td>4</td>
<td>4.00%</td>
<td>0.1598</td>
</tr>
<tr>
<td>Grouper, Red</td>
<td>6,081,226</td>
<td>4</td>
<td>1.95%</td>
<td>0.0778</td>
</tr>
<tr>
<td>Crab, Florida Stone Claws</td>
<td>4,789,141</td>
<td>1.5</td>
<td>1.53%</td>
<td>0.0230</td>
</tr>
<tr>
<td>Snapper, Red</td>
<td>4,645,016</td>
<td>1</td>
<td>1.49%</td>
<td>0.0149</td>
</tr>
<tr>
<td>Lobster, Caribbean Spiny</td>
<td>4,367,510</td>
<td>1.5</td>
<td>1.40%</td>
<td>0.0210</td>
</tr>
<tr>
<td>Snapper, Vermilion</td>
<td>1,769,801</td>
<td>4</td>
<td>0.57%</td>
<td>0.0227</td>
</tr>
<tr>
<td>Mackerel, Spanish</td>
<td>1,732,888</td>
<td>4</td>
<td>0.55%</td>
<td>0.0222</td>
</tr>
<tr>
<td>Gag</td>
<td>1,458,224</td>
<td>0.5</td>
<td>0.47%</td>
<td>0.0023</td>
</tr>
<tr>
<td>Snapper, Yellowtail</td>
<td>1,154,007</td>
<td>4</td>
<td>0.37%</td>
<td>0.0148</td>
</tr>
<tr>
<td>Mackerel, King</td>
<td>1,058,990</td>
<td>3</td>
<td>0.34%</td>
<td>0.0102</td>
</tr>
<tr>
<td>Amberjack, Greater</td>
<td>908,189</td>
<td>1</td>
<td>0.29%</td>
<td>0.0029</td>
</tr>
<tr>
<td>Tuna, Little Tunny</td>
<td>319,573</td>
<td>1.5</td>
<td>0.10%</td>
<td>0.0015</td>
</tr>
<tr>
<td>Shrimp, Royal Red</td>
<td>293,981</td>
<td>1.5</td>
<td>0.09%</td>
<td>0.0014</td>
</tr>
<tr>
<td>Dolphinfish</td>
<td>225,073</td>
<td>4</td>
<td>0.07%</td>
<td>0.0029</td>
</tr>
<tr>
<td>Cobia</td>
<td>93,609</td>
<td>4</td>
<td>0.03%</td>
<td>0.0012</td>
</tr>
<tr>
<td>Triggerfish, Gray</td>
<td>32,778</td>
<td>0.5</td>
<td>0.01%</td>
<td>0.0001</td>
</tr>
<tr>
<td>Drum, Red</td>
<td>22,192</td>
<td>1.5</td>
<td>0.01%</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>312,489,099</strong></td>
<td></td>
<td><strong>100.00%</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Average FSSI</strong></td>
<td><strong>2.67</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weighted Average</strong></td>
<td><strong>3.85</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Shrimp were abundant but their size was smaller, decreasing their value (DeSantis 2008). The point is that high levels of landings and sustainability does not ensure immunity from risk.

To further explore the risk and vulnerability of the mix of species a community relies upon, we have utilized an established economic calculation called the location quotient (LQ). The LQ is an analysis tool that compares local workforce statistics with national averages, derived by taking the percentages of the workforce employed in each major industry locally and dividing them by the percentages of the workforce employed in the industry groups nationally (Richardson 1979). The LQ is interpreted simply: if the LQ is near or at 1, then local employment is similar to that in the nation. If it is below 1 then it is likely the local area is not meeting local demand for that industry. If the figure is over 1 then it is assumed the community exports products from that industry to other areas (Richardson 1979).

The L-FSSI quotient is calculated the same as the LQ, by dividing the local percentage of total landings for a species by the regional percentage of total landings for the same species. For example, the percentage of total landings for brown shrimp (62.12%) in Shrimpville, when divided by the percentage of total landings for brown shrimp in the Gulf of Mexico (44.79%), yields a L-FSSI quotient of 1.39. The mathematical interpretation of this number is straightforward. Shrimpville’s landings for brown shrimp (as a total of all landings) are 39% greater locally than for the Gulf of Mexico region. The fisheries management interpretation of this quotient indicates that Shrimpville is 39% more reliant upon brown shrimp than the average fishing community in the Gulf of Mexico. This means if there is a regulatory change that impacts brown shrimp in the Gulf of Mexico, Shrimpville is more likely to be adversely affected. This sort of information is precisely what is needed for compliance to NS-8. Conversely, if the number is under 1, such as the landings for cobia (Rachycentron canadum) where the L-FSSI quotient is .37, then local landings are lower than the regional average. Mathematically, this means the local landings for cobia are approximately 63% lower than the proportion of landings for the Gulf of Mexico region. Since the FSSI for cobia is 4, it would be reasonable for local fishers to target more cobia. When looking at red snapper, we see the L-FSSI quotient is .14 for Shrimpville, however, since the FSSI for red snapper is 1, it would make little sense to target red snapper more.

For the fictitious place called Fintown, the majority of landings come from species with very low FSSI scores. As a consequence the L-FSSI is low. In addition the L-FSSI quotient indicates that Fintown is more dependent upon individual species than the regional average. For example, the L-FSSI for red snapper in Fintown is 11.97, meaning that the proportion of total landings in Fintown is nearly 12 times higher than the proportion in the Gulf of Mexico. This along, with the FSSI score of 1, gives evidence that this community is reliant on red snapper and potentially vulnerable to any regulatory changes, market changes, or fluctuations in stock.

**DISCUSSION**

The L-FSSI and L-FSSI quotient could be valuable fisheries management tools. In particular the measures could be informative during allocation/reallocation decisions, assessing the impact of changes in regulations including potential closures. These indicators specifically address NS-8, which demands that fisheries management account for community level impacts. These statistics offer the potential to become the best predictors of community impact, short of completing an in-depth community case study or ethnography. The data for the L-FSSI and the L-FSSI quotient are readily available to NMFS employees and could be calculated for every fishing community in the United States. The L-FSSI could be publicly released without any problem with federal confidentiality rules. However, the L-FSSI quotient, because it relies on individual species data, could not be released publicly in the majority of circumstances because of the “rule of three.” Nonetheless, the L-FSSI quotient could provide valuable information to NMFS employees in their work duties. Both of these measures are very easily calculated and easily interpreted. However, because these indicators are based on landings, it is essential to incorporate local knowledge into the figures. For example, the issues with brown shrimp in the Gulf of Mexico (small but abundant) along with market forces (depressed prices) and local effort (major decrease) have to be fully incorporated into the interpretation. Generally this requires some local knowledge of conditions. Nonetheless, this would require less effort than commonly utilized qualitative methods.

**ACKNOWLEDGMENTS**

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**REFERENCES**


ESSAY: FISHERIES MANAGEMENT

Exploring the Conflict between Broad Scale and Local Inland Fisheries Management: The Risks to Agency Credibility

Andrew H. Fayram, Dennis A. Schenborn, Joseph M. Hennessy, Nancy A. Nate, and Patrick J. Schmalz

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INTRODUCTION

In Wisconsin and many other states and provinces, management agencies are given the task of managing large numbers of waterbodies with limited personnel, time, money, and equipment to collect information (Hayes et al. 2003; Lester et al. 2003). Two common strategies exist for collecting data needed to make quantifiable science-based policy decisions in this environment where public fishing rights and open access policies exist. The first strategy involves collecting data from individual waterbodies to respond to anglers’, resort owners’, and other stakeholders’ desires to maximize the potential of individual waterbodies. The second strategy involves collecting data from strata that are sufficiently large to maximize potential at a more regional scale. The inherent competition between these two strategies is common to many state agencies (Hayes et al. 2003). Many management agencies use some form of randomized and standardized sampling to make general statements about the success or failure of management actions. Collection of data in this manner provides a substantial amount of information about fisheries resources on a broad spatial scale but may provide little information about specific waters due to the random nature of the design.

Although agencies generally have relatively little standardized data from any individual waterbody, calls to manage each waterbody individually continue. For example, of the 67 fishing regulation changes that were proposed for Wisconsin waters between 2003 and 2005, 23 regulation proposals were of “statewide” significance and the remaining 44 affected individual waterbodies (Wisconsin Department of Natural Resources unpublished data). Quantifying the efficacy of the regulations instituted on individual waterbodies is difficult because many years often elapse between data collection efforts on a particular waterbody due to the reality of limited resources.

Relatively long time series of standardized data are often necessary to determine if a management goal has been attained (e.g., maximum production, or number of large fish, or a certain species composition) in an individual waterbody (Isermann 2007). Given the reality of limited resources, this is impractical except in the most important or unique inland recreational fisheries or those used exclusively for research. Management of individual waterbodies or fish stocks is certainly possible, as demonstrated by the success of the management of individual salmon stocks in Alaska, among others (Alverson 2002; State of Alaska: Office of the Governor 2002). However, to more precisely manage some aspect of a fishery (e.g., maximizing size structure or harvest) in most waterbodies rather than just preventing stock collapse, fisheries management agencies would need to intensively monitor and manage each fish stock in each waterbody and collect information on recruitment, population density, fishing mortality, natural mortality, angler behavior, growth rates, catch, and harvest on a relatively frequent basis. Focusing available resources to intensively sample a small number of waterbodies would likely lead to resentment by users of waterbodies that were not among those to be sampled intensively. Although the spatial scale at which management occurs is somewhat arbitrary, it is important that both the scale at which management goals are set and the scale at which data are collected are the same in order to most efficiently determine whether management goals have been achieved.

Local fisheries managers are generally well versed in fisheries science and therefore are likely to implement management actions that achieve management goals on many individual waterbodies. However, many regulations implemented by managers are incremental in nature and therefore changes in fish populations associated with regulations changes are difficult to detect (Allen and Pine 2000). In addition, regulations are sometimes implemented in the absence of sufficient historical data, making “before-and-after” comparisons difficult. As a result, fisheries may in fact be responding to management actions as desired, but we may have difficulty demonstrating this fact and managers have little to counter claims made by
stakeholders that another regulation or another stocking rate will improve fishing success. Management agencies can effectively address stakeholder requests to use a different management technique by collecting data in a fashion that allows a statistically quantifiable assessment of management actions. Judging the success or failure of management strategies in individual waterbodies using data that are not sufficient to detect changes of reasonable magnitude may result in less effective management and loss of agency credibility. We use the term “agency credibility” to refer to the trust that various stakeholders have in a management organization to successfully manage fisheries resources in a manner that reflects user desires.

Given a fixed resource base, management agencies face choices about the trade-offs between data collection and other management activities that can benefit fisheries (Hansen and Jones 2008). Among these choices is whether to increase monitoring intensity to be able to detect smaller changes in population metrics of interest at the expense of activities that may also benefit fish populations (e.g., habitat improvement). Increasing sampling frequency to the point of detecting very small differences that are not of biological importance or not of interest to anglers would be an unwise use of resources but this situation rarely occurs in areas with a large number of modestly-valued fisheries resources.

AGENCY CREDIBILITY AND THE MANAGER’S DILEMMA

Many of the lessons learned from commercial fisheries stock collapses are applicable to recreational fisheries as well, in part because there is increasing awareness of the similarities between commercial and recreational fisheries with regard to their potential impacts (Cooke and Cowx 2004, 2006; Lewin et al. 2006). Certainly, numerous factors need to be addressed for recreational fisheries management to be successful (Arlinghaus 2006) but agency credibility is key if success is to be achieved. Lack of credibility and trust in fisheries management organizations can lead to decreased compliance with fisheries regulations (Jentoft 2000) and decreased latitude in implementing management actions, thereby making fisheries management more difficult. Alverson (2002) suggests that one common thread among instances where fisheries management has succeeded is that the management organization retained the political support of resource users. Similarly, Hennessey and Healy (2000) suggest that the management failures of some New England fisheries were due to scientific uncertainty coupled with low credibility of managers among the stakeholders. Scientific uncertainty can be reduced by appropriate sampling designs but can never be eliminated. However, by sampling fisheries resources in a way that allows fisheries agencies to quantitatively demonstrate successes, as well as admitting failures, credibility among stakeholders can be improved.

Agency credibility is at risk both when local needs are not addressed and when a management program cannot demonstrate success or failure in terms understandable to the stakeholders. Within the dilemma, a dynamic and uncomfortable tension exists among fisheries scientists and stakeholders because of their differing perspectives and goals (Table 1). These competing perspectives create a tension that pulls management decision-making in different directions. For example, on one side of the dilemma, stakeholders desire maximum production (or some other variable) for each harvested species and in each waterbody every year. If that doesn’t happen, they may demand a new management solution (e.g., stock a different species, or limit someone else’s harvest) even without data to support any action. On the other side is recognition that: (a) natural systems vary, (b) anglers can change their fishing effort on a regional scale in response to catch (Cox et al. 2002; Beard et al. 2003), and (c) the monitoring systems required to determine if management actions are appropriate on each water in response to (a) and (b) are often impractical from an agency perspective. Unfortunately, managers rarely have the luxury of ecologically sound and statistically valid conclusions before being compelled to act.

Submitting to short-term public demands at the expense of long-term or broader scale goals has been called the pathology of natural resource management (Meffe and Carroll 1997; Meffe et al. 2002). Submitting to these demands may also lead to inconsistent and needlessly complex fishery regulations or other management strategies within a region. This is particularly true if the public debate centers on the choice of management strategy (e.g., what to stock, which regulation will work best) instead of on the choice of a goal (e.g., sustainability, fish population structure). Conversely, managing fisheries in the absence of sufficient public involvement leads to accusations of scientific elitism (an agency that doesn’t listen or respond) and little agency credibility.

Agency credibility depends on the ability of its fisheries managers to resolve the dilemma by selecting and implementing “management decisions that show resource stewardship, agency responsiveness, and accountability” (Schenborn 1989). Resource stewardship requires solid fisheries science and long-term goals. Agency responsiveness requires a willingness to work with local interests on both long and short-term needs within the framework of what is biologically possible. Finally, agency accountability for results includes the obligation to quantitatively monitor, evaluate, and communicate the consequences of management decisions to stakeholders and decision makers.

The Holy Grail of fisheries management is to achieve sustained local and political support for long-term consistent goals and policies based on solid fisheries science that result in sustainable fisheries whose characteristics reflect user desires. Consistent policy with support requires stakeholder and agency agreement on goals and adaptable strategies whose effects can be practically monitored and refined in an adaptive management framework (Wondolleck and Yaffee 2000; Arlinghaus et al. 2002; Meffe et al. 2002). Appropriate statistical design is a requirement of successful adaptive management program. Unfortunately, even when adaptive management attempts have succeeded in implementing large scale experiments, they often fail to entail appropriate statistical design (Walters 1997). Agency credibility does not depend on the certainty of results of future management actions but does depend on the ability to accurately portray the degree of uncertainty and effect sizes that can be measured. Conducting sampling and establishing management
goals at the same spatial scale provides a good opportunity to quantify the inherent variability in metrics of interest as well as changes that will be detectable, thus laying the groundwork for an adaptively-managed system. Learning in this sense is both a scientific and social endeavor wherein fisheries managers and stakeholders share what they monitored or experienced and what they learned about specific fisheries management actions. Credibility with stakeholders flows from their involvement in initial goal setting, collecting sufficient data to be able to determine what progress has been made toward the goal, and keeping stakeholders informed of this progress.

CONCLUSIONS

To successfully manage inland fisheries, agencies must:

1. Address the desires of local stakeholders;
2. Address the desires of stakeholders outside of the immediate area or dominant user group;
3. Collect data sufficient to detect successes or failures of management strategies; and
4. Account for differences in productive capacity of individual waterbodies.

Various sampling methodologies satisfy each of these goals to different degrees. One extreme creates an individual management strategy for each species in each waterbody while the other creates a general management strategy for a large number of different waterbodies. Given fiscal and staffing realities in regions where there are numerous similar fisheries of modest economic importance, data collection is generally not sufficient to allow precise fisheries management unless all assets are focused on a few lakes or fish stocks. Managing fisheries at a scale larger than individual waterbodies generally seems appropriate except for the most valuable or unusual fisheries. In addition, the larger the scale of the management unit, the less important accounting for angler movement will be since distance is a predictor of angler effort (Cox et al. 2002).

The exact scale of management (and thereby sampling) should be determined based on logistics such as the availability of funding and personnel and the variability of measures of interest. Fiscal realities necessitate the management of similar groups of waterbodies as a unit in most cases. However, the scale of management should be the smallest economically feasible scale that is also biologically meaningful and provides enough data to quantify changes in fish populations of sufficient magnitude to be of interest to stakeholders in a time frame that is politically and sociologically acceptable. Carpenter and Brock (2004) suggest that an intermediate management scale (i.e., larger than individual lake and smaller than regional) may be appropriate. Similarly, Lester et al. (2003) suggest that watershed may be an appropriate sampling scale while Hayes et al. (2003) suggest that lake class based on lake size, location, and thermal status is the appropriate sampling scale. Regardless of the scale of the management unit (lake class, county, region, ecoregion, watershed etc.), and metric of interest (population density, growth, mortality etc.), all fisheries for a given species within the management unit should be managed in the same way to the extent possible in order to preserve statistical power. If the regulations or other management strategies are changed in one waterbody based on solid data and analysis, then it is reasonable that those strategies should also be changed similarly in the other waterbodies in the unit. Managing aquatic resources in such a fashion does not preclude management agencies from providing diverse fishing opportunities. Stakeholder groups in different areas will likely differ

Table 1. Observed differences of perspective between fisheries managers or fisheries science and stakeholders.

<table>
<thead>
<tr>
<th>Fisheries management concept</th>
<th>Stakeholders</th>
<th>Fisheries professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stochasticity</strong></td>
<td>Stakeholders have a bias toward a stable and maximum sustained yield (or other population characteristics viewed as important).</td>
<td>Fish populations fluctuate in response to environmental variables.</td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td>Many stakeholders and some fisheries managers seek short-term fixes to a specific local fishery issue and focus their attention accordingly.</td>
<td>Management agencies collect data and craft policies that are intended to work best at broad spatial scales and longer-term scales for practical reasons presented in this essay.</td>
</tr>
<tr>
<td><strong>Certitude</strong></td>
<td>Many stakeholders (often driven by anecdote) “know” that the fish always came back in the past without a harvest reduction, are “certain” that a regulation change will hurt their business or sport experience, or are “sure” that a specific management action they heard was applied elsewhere will work in their fishery.</td>
<td>Management actions have probabilistic results. Given a harvest reduction or size limit, a specific fish population may or may not attain a specific population size or size structure within a specified time span.</td>
</tr>
<tr>
<td><strong>Error bias</strong></td>
<td>Many stakeholders have a bias that argues for immediate action even without data to support any conclusion. Their rationale being that the status quo is not acceptable and something must be done to change that immediately.</td>
<td>Fishery science has a bias that argues against actions unless the preponderance of data support a conclusion consistent with the proposed action.</td>
</tr>
</tbody>
</table>
in their opinion of which aspects of the local fisheries are most important to them and regulations and opportunities would differ accordingly. In addition, waterbodies that are particularly valuable merit annual sampling and individual management and therefore regulations on these waterbodies are likely to differ, offering a variety of angling opportunities. Indeed, some degree of spatially heterogeneous fisheries management may prove to be optimal in terms of value and resilience (Carpenter and Brock 2004).

We recognize the fact that there will be opportunities to improve some component of a particular fishery and not in the other waterbodies in a group (e.g., habitat enhancement). We do not advocate sacrificing an opportunity for fisheries enhancement simply for the sake of replication and the integrity of sampling design. One benefit of collecting data in a systematic and quantifiable fashion is the potential to increase stakeholder confidence. Preventing fisheries enhancement projects simply to retain the integrity of the sampling design would certainly run contrary to this benefit. In general, we advocate replicating management strategies across physically and spatially similar waterbodies to the extent possible while still recognizing unique fisheries enhancement opportunities within a management unit.

By tying the management of all of the waterbodies in a unit together as much as possible, we provide ourselves the opportunity to determine if our management strategies are working on a time scale that is reasonable. What we sacrifice in terms of specifically addressing the desires of the local stakeholders, we gain by more comprehensively addressing the desires of stakeholders on a broader scale (although since the management unit is likely to be relatively small, local stakeholders are likely to play a large role in determining management priorities). What we sacrifice by not precisely managing fish populations in each waterbody, we gain by being able to manage a group of waterbodies in a relatively precise fashion because we will sample the group frequently enough to make quantitative estimates of the efficacy of our management strategies on time scales relevant to both politicians and stakeholders. Only by managing fisheries at a scale that both recognizes the desires of local stakeholders and provides the opportunity to quantitatively evaluate and demonstrate successes and failures can agencies maximize stakeholder support, manage fisheries appropriately, and provide the potential to learn and adaptively manage fisheries over time.

ACKNOWLEDGMENTS

We thank Dave Neuswanger, Mike Vogelsang, Mike Staggs, the Fisheries science editor, Dan Hayes, Robert Arlinghaus, Nigel Lester, and three anonymous reviewers for their insightful comments on earlier drafts of this manuscript. Partial funding for this project was provided by the Federal Aid in Sport Fish Restoration program.
REFERENCES


National Fish Habitat Action Plan Update

Someone once noted that when elephants fight, it’s the grass that suffers most! Finding a common issue for fisheries scientists, managers, and the larger fisheries community to rally around isn’t difficult. But the “grass” still suffers!

The most important issue for the Society and the larger fisheries community is the protection, mitigation, and restoration of aquatic habitat. It’s simple: no habitat, no fish!

I represent the Society on the National Fish Habitat Board (NFHB). AFS is a permanent member of the board. Delegating a permanent board seat to the Society emphasizes the board’s commitment to science. The NFHB recognizes that the most important and fundamental principle is using science and scientific assessment as the basis for decision-making.

The board’s commitment to science provides the rationale for sound aquatic habitat management.

While the scientific community understands the importance of aquatic habitat, it has taken many years to rally sufficient support in the larger fisheries community and to organize ourselves to initiate the process of writing a National Fish Habitat Action Plan (NFHAP). Over the past five years, the Society has been actively involved in the writing of the plan, with several of our members participating in leadership roles. The NFHAP is the first attempt to bring national attention to the pitiful condition of U.S. aquatic resources. We are outlining a path and forming partnerships to reverse these declines. The plan has been actively “tested” over the last few years, emphasizing the “partnership” approach on a national scale.

The implementation of the plan is now well in place, and recently the board introduced legislation in the 111th Congress to create a National Fish Habitat Conservation Act. This legislation uses the success of the National Waterfowl Conservation Act as a “template.” If Congress passes this bill, the board will be formally established and will be given the authority to manage the national process. The bill authorization includes up to $75 million per year to directly support fish habitat work.

The board has worked closely with the U.S. Fish and Wildlife Service, NOAA Fisheries, and the U.S. Geological Survey, as well as other federal and state agencies, to provide a significant amount of funds to perform actual “on-the-ground” fish habitat work ($2.4 million in FY08).

The board, working closely with our partners, has been successful in generating some funds to support a communications officer, develop the national habitat assessment, and start development of the companion database to access national fish habitat resources. Nine regional partnerships are currently recognized, with several candidate partnerships waiting to be recognized.

The Society, over the past few years, has sponsored numerous fish habitat symposia and meetings, generating a vibrant discussion about the scientific needs for performing fish habitat assessment. At the AFS Governing Board meeting in March, a new Fish Habitat Section was approved; the timing couldn’t be better. This new Section will further institutionalize our role and emphasize the Society’s commitment in dealing with aquatic habitat issues.

At upcoming AFS Annual Meetings, symposia such as “Conservation of Fish through Partnerships,” “Society’s Role in Protecting Instream Flows,” “Mapping Distributions of North American Freshwater Fishes,” and “North American Spatial Framework for River Assessment” are examples of the types of forward-looking efforts, at which we have excelled, to produce the best quality science. One major activity that will support the NFHAP legislation is a conference to be held from 23–25 June at the National Conference Center near Dulles Airport and Washington, DC. This conference will bring attention to all the activities occurring in support of national plan.

Details of the conference can be found at www.fishhabitat.org and www.conferencecenter.com.

While the Society has been active, we are not alone; in fact, we could not have accomplished this on our own. This has taken the combined efforts of the entire fisheries community who care about the future of this most valuable national resource.

Our nation is facing unprecedented challenges and there are a huge number of competing priorities. Passage of the legislation isn’t a given nor is the appropriation of the funds.

As this legislation weaves its way through the Congressional process, please pay attention and be supportive. Passage will take the combined resources of all of us. This act will be the vehicle to protect fish habitat for future generations!
North Central Division Presents annual awards

The North Central Division (NCD) of AFS presented its annual awards at the 69th Midwest Fish and Wildlife Conference held in Columbus, Ohio, from 14-17 December 2008. The number of nominations received again this year provided plenty of work for the 13 individuals who served on the review panel.

During the plenary session of the conference, NCD President Jessica Mistak presented a certificate and plaque for Most Active Large Chapter to John Kubisiak, president of the Wisconsin Chapter. The Most Active Small Chapter Award was presented to Dave Kittaka, who accepted on behalf of the Indiana Chapter. The Most Active Student Subunit Award was presented to Ashley Moerke, who serves as the Subunit advisor, and a number of students from Lake Superior State University. The Best Communications Award is a relative newcomer to the slate of NCD Awards, as it represents excellence in information exchange by a Chapter through the innovative and functional use of its newsletter and webpage. Michelle Cain, the newsletter editor for the Indiana Chapter, accepted the award from President Mistak on behalf of the Chapter and Jason Doll (not pictured), who serves as the webmaster.

Also presented during the plenary session was the North Central Division’s Meritorious Service Award. This special award recognizes extraordinary service to the American Fisheries Society and to those who have made a genuine and long-lasting contribution to the betterment of the profession and to the Society. Tom Gengerke exemplified this standard with his many roles and years of service within AFS. Gengerke has been heavily involved with the Missouri River and recently retired from the Iowa Department of Natural Resources. A Certified Fisheries Professional who was the Iowa Chapter president, chair of the NCD Walleye Technical Committee, and chair of the AFS Boards of Professional Certification and Appeals, he was also the president of the Fisheries Management Section and a recipient of their Conservation and Achievement Award in 2006. It was an honor for the North Central Division to recognize Tom Gengerke with the Meritorious Service Award.

During the annual business meeting, President Mistak presented a plaque and certificate of appreciation to Past President Joe Hennessy. Also, recognized for years of service as the NCD secretary/treasurer, Randy Schultz was also presented a certificate of appreciation by President Mistak. Schultz also joins...
Tom Gengerke received the NCD Meritorious Service Award from Jim Wahl at the Iowa Chapter AFS Meeting.

The NCD leadership team, after being elected first vice president, along with Jason Goeckler as the incoming secretary/treasurer.

Eight students were selected by their respective Chapters to be recipients of the Joan Duffy Student Travel Awards. Checks were presented at the business meeting to: Mark Fincel, South Dakota State University; Katie Renschen, Northland College, Wisconsin; Andrew Drake, University of Toronto; Mark Kaemingk, Central Michigan University; Wes Bouska, Kansas State University; Michael Wilson, University of Illinois at Urbana-Champaign; Travis Neebling, Iowa State University; and Jay Beugly, from Ball State University, Indiana.

—Mark Porath

NCD Outgoing NCD Secretary/Treasurer Randy Schultz was presented a certificate of appreciation for his years of service by President Jessica Mistak.

College, Wisconsin; Andrew Drake, University of Toronto; Mark Kaemingk, Central Michigan University; Wes Bouska, Kansas State University; Michael Wilson, University of Illinois at Urbana-Champaign; Travis Neebling, Iowa State University; and Jay Beugly, from Ball State University, Indiana.

President Mistak with Joan Duffy Student Travel Award recipients at the Midwest Fish and Wildlife Conference in Columbus, Ohio.

Tom Gengerke receives the NCD Meritorious Service Award from Jim Wahl at the Iowa Chapter AFS Meeting.

The elected officers for the North Central Division of AFS are (left to right): Mark Porath, president elect; Jessica Mistak, president; Randy Schultz, first vice president; and Jason Goeckler, secretary/treasurer. Stuart Shipman (not pictured) is the NCD representative to the AFS Nominating Committee.

Stuart Shipman (not pictured) is the NCD representative to the AFS Nominating Committee.

President Mistak with Joan Duffy Student Travel Award recipients at the Midwest Fish and Wildlife Conference in Columbus, Ohio.

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Virginia Chapter
Holds 19th annual meeting

On 10–12 February 2009, the Virginia Chapter’s 19th annual meeting was held at the Stackhouse Theater, in the Elrod Student Commons, on the Washington and Lee University (W&L) campus. A workshop, “Topics on Fish Kills and Fish Health: A Workshop for Field Biologists,” was held on Tuesday the 10th. A total of 98 registered for the workshop and meeting; of these 25 were students. Complimentary registrations were offered to an additional 20 students from W&L and 1 from Virginia Military Institute, along with an additional 9 faculty and staff members of W&L, bringing total attendance to 128. Workshop participants heard presentations by Rocco Cipriano (bacterial pathogens), Vicki Blazer (inter-sex fish), Don Orth (necropsy), Debora Iwanowicz (parasites of fish), John Coll (viral pathogens), and Alex Barron (consumption advisories). Beyond the workshop’s 6 invited presentations by experts in the field, students contributed 11 of the additional 23 technical presentations during the contributed presentation sessions, as well as a majority of the 5 posters presented at the Wednesday social.

The annual business meeting was held on the 11th, with Steve McMullin, past president of the Southern Division of AFS, providing opening remarks. At the business meeting, new officers were installed. Eric Brittle (Virginia Department of Game and Inland Fisheries [VDGIF]) was installed as president, Adrienne Averett (Virginia Department of Environmental Quality), was installed as president elect, Steve Owens (VDGIF) was installed for a second consecutive term as treasurer, and Bill Kittrell (VDGIF) was installed as secretary. Bob Greenlee (VDGIF) will now serve as past president. Robert Humston (W&L) agreed to continue as newsletter editor.

Scholarships and awards were also distributed at the business meeting. Bill Kittrell (VDGIF) was given the Eugene W. Surber Professional Fisheries Biologist Award. Robert Leaf of Virginia Tech was awarded the Robert Ross Graduate Scholarship, and Shannon White of Randolph-Macon College was awarded the Robert E. Jenkins Undergraduate Scholarship. Both scholarships were awarded at the full $500 level. Shannon White, with co-presenter Josh Harris, also received the Best Student Presentation Award ($100). The Natural Resource Conservationist award was not given this year.

Socials were held both evenings at the Hampton Inn Col Alto, in Lexington, with a raffle (emceed by Tom Wilcox) held during the Wednesday evening event. Thanks to Wilcox’s unique talents, the raffle was extremely successful, offering high entertainment value for all involved.

—Robert S. Greenlee
Electronic Balloting on AFS Constitution and Rules Changes

By Gwen White

AFS Constitutional Consultant Gwen White can be contacted at gwhite@dnr.in.gov.

We are testing a new mechanism for electronic review to facilitate broader and more timely participation of the AFS membership in updating the protocols that guide Society structure and function. We request your patience and welcome any suggestions on creating an effective electronic review process.

The following changes were recommended by the Governing Board at their meeting on 7 March 2009. All three proposals are provided for your review at www.fisheries.org.

Comments can be submitted in the online forum by July 15 or e-mailed to the AFS Constitutional Consultant, Gwen White, gwhite@dnr.in.gov.

Active Members may consider three amendments to the AFS Constitution and Rules for adoption by electronic ballot between August 1 and August 15.

The three proposals address the following protocols:

a. Constitution Article IV and IX. Parliamentarian—Establishes the Constitutional Consultant as a nonvoting member of the Management Committee, creates an Apprentice position to the Constitutional Consultant, and a Past Constitutional Consultant’s Advisory Council.

b. Constitution Articles III, VII, and IX. Appointment of committee and editorial board members—Allows the AFS President to delegate responsibility to appoint committee and editorial board members to the chair and journal editor, respectively.

c. Rule 4.H. Fish Habitat Section—Upon petition from over 100 Active Members, the Governing Board recommends establishing a new Fish Habitat Section.

Randolph Macon student Shannon White (on left in both photos) receives Robert E. Jenkins Undergraduate Scholarship Award from Scott Smith and receives best student presentation award from Scott Smith.
PREAMBLE

The American Fisheries Society has followed a pattern of preparing an organizational strategic plan every five years. This new plan will steer the Society during 2010–2014, but has been crafted with a vision to 2020 and beyond. The AFS Strategic Plan Revision Committee used information from a 2008 AFS member survey and input from several committees and the Governing Board to develop a draft Plan. The Committee is now submitting the draft to the Governing Board and the members for their review and input (via the web). The Plan contains a worldview of the fisheries future, revised AFS mission and vision statements, and three goal statements with objectives and suggested strategies under each goal. The three overarching Plan goals cover: (1) Global Fisheries Leadership, (2) Education, and (3) Values of Membership. The Plan does not include specific actions. Rather, it is suggested that the annual operational plans of the Society, and each of its Units, include development of specific actions to implement the Plan.

In short, we must plan for the unpredictable, seize opportunity, and thrive on change. We will use our collective intellectual capacity to the fullest to achieve our goals.

It is recommended that implementation of the new Plan include an online reporting system where AFS Unit leaders can report their accomplishments under each objective and share their Unit’s ideas for implementing the Plan. This new Plan builds on the many successful and popular activities that AFS already engages in, such as our Annual Meetings and publications, and emphasizes topics the Committee believed could be improved upon. Among the many topics included in the Plan, innovative ideas are presented for: increasing workforce and member diversity, expanded use of electronic communication technologies, additional fisheries resource policy promotion, and increasing retention and recruitment of members.

WORLDVIEW OF THE FISHERIES FUTURE

The future context within which fisheries science and management will occur will have significant changes from that of the previous Strategic Plan:

1. Globalization of trade and transportation will require greater cross-border understanding of the opportunities, threats, and cultural perspectives affecting international stock management, invasive species, and disease introductions.
2. Climate change will drive decision-making for aquatic habitat protection and rehabilitation, due to impacts on migration, invasive species and disease epidemiology, water supplies, food production, and energy resources.
3. Economic pressure, volatile markets, a transient and retiring workforce, and demands from rising economies will require organizations to do more with fewer resources, modify training and hiring practices, and dramatically restructure some commercial and recreational fisheries as well as use of and access to aquatic resources.
4. Ecosystem-based management coupled with social and economic concerns will continue to drive research and management agendas that will, by necessity, be shared among agencies operating as consortia.
5. Nature deficit syndrome brought about by increasing urbanization and electronic media will present challenges, with constituents who will have minimal exposure to and appreciation for the scientific principles that control fisheries and ecosystem function while at the same time being more receptive to environmentally sound “green” approaches, all of which affect the
public perception of fisheries research and management practices.

6. Electronic communication and social networking will be the predominant means of interacting, particularly among young professionals, international colleagues, and dispersed organizations, replacing participation in traditionally-structured meetings and the expectation of professional societies to serve as information intermediaries that provide quality assurance and technical insight.

7. The business model for professional societies and government will shift to include greater demand for services that immediately benefit members, more direct participatory decision-making in collective actions, and operation as an intelligent, adaptive, knowledge-based organization.

**AFS 2020 VISION**

To respond effectively to this future context, an organizational vision for AFS was developed:
The members of the American Fisheries Society (AFS) envision a future where worldwide fisheries production is optimized and sustained while biodiversity and functional integrity of marine, freshwater, and estuarine ecosystems are maintained. AFS will be the premier organization of fisheries-related professionals that:

1. Supports recruitment, training, and retention of fisheries professionals with a diverse array of technical skills to meet the needs for workforce continuity and adaptability.
2. Promotes sound, science-based research, management, and aquaculture practices for the conservation of fisheries populations, aquatic communities, and their habitats.
3. Functions as an intermediary for evaluation, interpretation, and transfer of high quality fisheries-related information using the best available communications technology.
4. Prepares and positions fisheries information to inform society on how social, economic, and political decisions impact the world’s rivers, lakes, estuaries, and oceans, and the fisheries resources that depend on those habitats.
5. Provides forums for effective discourse contributing to the identification of science-based solutions to local, national, and global fisheries-related issues.
6. Supports an integrated network of AFS Units that collaborate to fulfill the Society's mission.
7. Promotes diversity in the natural resources workforce to reflect the broad range of perspectives and skills needed to address complex fisheries issues.
8. Builds partnerships with other natural resource professional and scientific organizations to achieve common goals.
9. Supports adequate and stable funding for fisheries research and management.

**AFS MISSION STATEMENT**

The mission of the American Fisheries Society is to advance sound science, promote professional development, and disseminate science-based fisheries information for the global protection, conservation, and sustainability of fishery resources and aquatic ecosystems.

The mission of AFS will be carried out effectively, and our organizational vision will be attained, if each of the Goals described below is met. Conservation and sustainability will be achieved through stewardship, restoration, and responsible use of fishery resources and aquatic ecosystems. Fisheries and aquatic science will be advanced through developing and disseminating research-based information to a variety of audiences and by enhancing the public image of fisheries professionals. Professionalism and excellence in research, education, aquaculture, policy, and management will characterize the activities of AFS members.
**AFS 2020 GOALS, OBJECTIVES, AND STRATEGIES**

**Goal 1: Global Fisheries Leadership**
AFS will be a global leader providing information and technical resources for the sustainability and conservation of fisheries resources.

**Objective 1.1.** Promote fisheries conservation throughout North America and the world, at all levels of government and society, and among all levels of AFS by supporting sound science and networking opportunities (see also Objective 3.4)

**Strategies**
1. Continue to host and sponsor excellent conferences and meetings at local, regional, and international levels of AFS to provide the platform for managers and scientists to exchange ideas.
2. Maintain and improve the excellence and expediency of AFS publications.
3. Identify and network with global professional and conservation organizations to promote mutual goals of conservation and encourage cooperation among professionals of different scientific societies.
4. Help lead the World Council of Fisheries Societies and strive to unite fisheries scientists worldwide to improve conservation of the world’s fish stocks.
5. Work closely with interested foundations and agencies to increase funding and create endowments to support programs within AFS.
6. Encourage support for increased funds to support state, federal, academic, and tribal fisheries programs, particularly critical research.
7. Build stronger partnerships with fisheries-related stakeholders, such as anglers, commercial harvesters, aquaculturists, watershed groups, and local governments, to promote benefits to fisheries among the array of competing demands on aquatic resources.
8. Continue to pursue international relationships and establishment of additional Units as needed worldwide (e.g., Puerto Rico Chapter, Canadian Division, International Section).

**Objective 1.2.** Increase science-based fisheries conservation by increasing interactions with AFS members and government policy makers.

**Strategies**
1. AFS headquarters and all Units use established guidelines for responsible science-based advocacy activities.
2. Communicate AFS goals for aquatic stewardship in resource advocacy more effectively through the use of sound science as it relates to fisheries conservation.
3. Increase policy activity by producing additional science-based position statements, conferences, books, and symposia on important fisheries topics while maintaining and updating current position statements.
4. Promote fisheries programs and research by focusing on how AFS can accomplish interaction through use of more online communication tools.
5. Collaborate with leading fisheries organizations and consultants to facilitate the preparation of background documents for AFS policy statements.
6. Communicate to key government leaders, non-governmental organizations, and the private sector the importance of fish and their habitats to the extent that they give high priority to dedicated, sufficient funding.
7. Develop an effective network to promote best-science-based fisheries conservation and aquatic habitat protection and restoration, targeting local, state, regional and national legislators.

**Objective 1.3.** Promote fisheries conservation through development and dissemination of public outreach materials. (See also Objective 3.4)

**Strategies**
1. Increase the emphasis on fisheries science and aquatic conservation-related outreach materials produced for non-scientists, teachers, and the public through diverse media.

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**Idea for strategy 1.1-1**
- Meetings and conferences will be convened in cooperation with other organizations

**Idea for strategy 1.1-7**
- Solicit and document annual comments and input from external resource stakeholders

**Idea for strategy 1.2-3**
- Topics could include global overfishing, oxygen-depleted “dead zones,” climate change effects on fisheries, toxic lead in the aquatic environment, and many others

**Idea for strategy 1.2-7**
- Such as the North American Agenda for Aquatic Resources

**Ideas for strategy 1.3-1**
- Work with NOAA, Outdoor Writers Association, and others
2. Collaborate with other groups to develop and disseminate outreach materials.
3. Increase attention to marine and estuarine issues by working with members and appropriate Units to address top priorities

**Goal 2: Education/Continuing Education**
AFS will facilitate life-long learning through world-class educational resources at all academic levels and provide training for practicing professionals in all branches of fisheries and aquatic sciences.

**Objective 2.1.** Ensure that educational institutions at all levels are maintaining excellent academic programs in fisheries sciences and related disciplines to assure recruitment of fisheries professionals that meet the needs of employers.

**Strategies**
1. Work with colleges and universities to maintain, modify, or develop curricula of the highest quality for both undergraduate and graduate students that provide an array of courses and experiences needed to effectively manage and conserve fisheries resources and meet the needs of employers.
2. Encourage colleges and universities to strive for diversity among students in fisheries sciences and related fields, reflecting the composition of society.
3. Promote and encourage academic excellence, public leadership, and youth development in fisheries through science programs at all educational levels.

**Objective 2.2.** Ensure that the fisheries professional certification program reflects the integration of many sciences relevant to fisheries while ensuring its recognition as a mark of scientific excellence and expertise.

**Strategies**
1. Review the professional certification program to make it relevant to the array of disciplines represented by AFS members and employers.
2. Evaluate the fees and administrative costs of the AFS certification program relative to other professional societies.
3. Promote the professional certification program and the benefits of certification to universities, AFS members, other fisheries-related professions, and law professionals.

**Objective 2.3.** Provide a wide array of continuing education opportunities using innovative methods to reach the widest possible audience of fisheries professionals.

**Strategies**
1. Coordinate continuing education activities among all levels of AFS using cost-effective and user-friendly means.
2. Offer continuing education courses on a wide array of topics that are pertinent to AFS members by a variety of means.
3. Develop effective distance education methods by researching those used by universities and other professional societies and determining costs and benefits associated with various strategies.

**Ideas for strategy 1.3-2**
- Media could include TV and radio shows, articles for popular outdoor periodicals
- Groups may include anglers, teachers, Fisheries Conservation Foundation, Sea Grant
- Materials could include pamphlets, fellowships, and workshops
Goal 3: Value of Membership

AFS will serve its members and fisheries-related constituencies to fulfill the mission of the Society.

Objective 3.1. Determine and respond to the needs and opinions of AFS members.

Strategies
1. Regularly survey members to identify their needs and opinions on a broad range of AFS issues.
2. Provide a web-based forum for members to communicate with AFS leadership.
3. Utilize standing and special committees at multiple levels of AFS (e.g., Chapters, Divisions, Sections, and Parent Society) to effectively respond to membership concerns.
4. Consider survey results and feedback from the Membership Concerns Committee when developing AFS guiding documents and plans (annual plans of work/operational plans, the AFS Strategic Plan, etc.).
5. Maintain a leadership role in providing information and training to enhance salaries commensurate with training investments, safety, and working conditions for fishery professionals.
6. Communicate to employers the value of leadership, planning, collaboration, and communication skills that employees develop through active involvement in AFS.
7. Ensure AFS services and products are affordable, viable, and beneficial to members.
8. Encourage recognition of volunteer contributions to the success of the Society at all levels through awards and other mechanisms.
9. Provide quality information management and communication services to all members.

Objective 3.2. Enhance participation of students and professionals at all levels of the Society to assure recruitment, retention, and leadership development into the future.

Strategies
1. Provide a wide array of opportunities for college and university students and professionals at all levels to participate in AFS and experience the benefits of membership.
2. Provide services and guidance on building organizational capacity in AFS Units.
3. Develop a marketing plan for increasing college and university faculty and student participation in AFS.

Objective 3.3. Promote diversity within AFS and the fisheries profession.

Strategies
1. Remove obstacles to full participation of under-represented groups (including women) in AFS meetings, publication activities, and governance.
2. Educate and engage the AFS membership in diversity-related issues.
3. Increase the visibility of fisheries and natural resource sciences, environmental awareness, and career opportunities to under-represented populations, especially in minority-serving institutions.
4. Support efforts of professional and academic organizations involved in increasing diversity in student and professional populations in fisheries and natural resource careers.
5. Develop scholarships for under-represented groups at all college and university levels to facilitate recruitment into AFS and the fisheries profession.
6. Collaborate with First Nations to identify and address common concerns within the fisheries profession.
7. Foster reciprocal society membership with members of the World Council of Fisheries Societies to increase international participation in AFS.

Ideas for strategy 3.1-1.
• Maintain updated records of membership and unit officers to allow for easy polling
• Information can be gathered via web-based forums, surveys, or other means

Ideas for strategy 3.1-6
• Agencies can also support their staff in serving as officers and by sharing the cost of membership and professional certification.

Ideas for strategy 3.1-9
• For example, the AFS Jobs Bulletin
• Use most up-to-date software to maintain membership lists

Ideas for strategy 3.2-1
• Internships, travel grants, scholarships, reduced registration
• Mentoring and guidance on mentoring to provide consistent experience

Ideas for strategy 3.2-2
• Leadership training, web development, fundraising, relationships within AFS hierarchy, congress of AFS leaders

Ideas for strategy 3.2-3
• Faculty sponsorship of students

Ideas for strategy 3.3-1
• Mentoring program for female members, childcare and family-friendly activities at Annual Meetings

Ideas for strategy 3.3-5
• Opportunities similar to Hutton or J. Frances Allen scholarships
**Objective 3.4.** Develop innovative and cost-effective methods to make fisheries science and management information readily available to AFS members and all levels of government entities worldwide.

**Strategies**

1. Pursue open access formats for publications.
2. Develop cost-effective means to broadcast AFS meetings and disseminate information to AFS members at all levels.
3. Encourage development of regional Topic-Oriented Meetings separate from the Annual Meeting.
4. Develop online virtual centers of excellence to tackle issues of concern to fisheries professionals.
5. Foster online forums to encourage member communication.
6. Develop a method for state and federal agencies, consulting firms, and other employers of fisheries professionals to make technical reports and gray literature electronically accessible.

**Objective 3.5.** Practice good governance and organizational management.

**Strategies**

1. Improve the transparency and continuity of governance procedures and Society decision-making.
2. Develop cost-effective and efficient means of managing membership information that will allow for better organization and governance of AFS Units.
3. Develop a universal process for all Units to preserve the long-term institutional memory of AFS by archiving important documents and other communications and making archives available to AFS membership.
4. Ensure that AFS remains financially secure.
5. Implement this Strategic Plan, including an online process for reporting progress.

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**Ideas for strategy 3.4-2**

- Electronic media, including web casts and videos
- Increase remote participation

**Idea for strategy 3.4-5**

- New online marine journal web forum

**Ideas for strategy 3.5-1**

- Governing Board meeting minutes on AFS website
- Updated documentation of Society practices

**Idea for strategy 3.5-2**

- Access for Unit leaders to recent membership information

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Glossary

Advocacy: Acting to promote, recommend, or favor a particular cause, action, or alternative.

Angler: A person who fishes with hook and line as a hobby or sport.

Aquaculture: The cultivation of aquatic organisms in controlled environments.

Aquatic: Any water-based or water-dependent environment or system including marine, freshwater, estuarine, lake, riverine, and wetland systems.

Collaborate: To work with others in the achievement of common goals.

Commercial harvesters: Individuals or industries who harvest or collect aquatic resources for sale or trade.

Community: Plant and animal populations occupying a given area and having substantial interactions.

Conservation: The act of preserving or protecting biological communities and the products they yield, as may be the case with fish and aquatic systems.

Continuing education: Educational opportunities extending beyond formal college or university curricula, generally applies to enhancement or extension of professional skills.

Distance education: Educational opportunities, often continuing education, obtainable outside the immediate location of a college or university.

Diversity: Variety in form or character, as in a group that varies culturally, racially, physically, by religious beliefs, and by gender.

Ecosystem: A system formed by the interactions of a community of organisms among themselves and with their environment, generally involves large spatial scales.

Ecosystem-based management: Manipulation of ecosystems for human benefit while considering all forms of interactions among the community of organisms comprising the system.

Estuarine: An adjective describing that part of a river system which flows into a sea and affected by the sea's tide and intrusion of water with dissolved sea salts.

Fishery: An aquatic ecosystem from which aquatic organisms are harvested for commercial uses or sport, including the people, boats, and/or gear used in the harvest.

Fisheries professional: A person employed or engaged in an area of study, research, or management of fishery resources who is expected by employers and peers to be technically proficient and to conduct themself in an ethical manner. A fisheries professional is a form of aquatic resource professional.

Fisheries science: Application of the principles of science to the study of fisheries, systematic study of fisheries using observed facts to make inference about the functioning of the system and affects of harvest of aquatic organisms.

Fishers: Individuals who participate in either commercial or sport fishing.

Freshwater: Water that does not contain a large concentration of dissolved salts, as are generally found in inland lakes and streams.

Gray literature: Scientific publications that have not been subjected to an anonymous peer-review process determining their scientific merit.

Habitat: The place in which a plant or animal can survive in nature, that natural environment that provides the needed elements for reproduction, growth, and survival of an organism.

Invasive species: A species of plant or animal with the ability to establish populations outside of its natural range, often with negative effects on native species.

Leadership: Exerting the function of a leader, that is a person or group who guides or directs an aggregate of people.

Life-long learning: Continued learning throughout the life of an individual, often used in reference to continuing education.

Marine: Pertaining to the sea, in reference to plants and animals that have the ability to live in water with high dissolved salt concentrations as found in seas.


Overfishing: Harvesting of fish or other aquatic organisms from a fishery to the extent that the maximum productivity of fish is reduced due to that taking of too many fish early in their life span or too many reproducing adults.

Professional diversity: Reflects the number and heterogeneity of members in terms of academic discipline, occupation, employer, subject matter expertise, educational background, and work experience.

Recruitment: The addition of individuals to a population, such as members of a professional society.

Retention: Retaining the membership of individuals in a population, such as members of a professional society.

Stakeholder: An individual or group with an interest, generally financial or ethical, in the outcome of decisions or policy-making activities.

Stewardship: Management of another’s property or affairs in a fair and ethical manner, often applied to the management of natural resources by professionals, such as fisheries professionals.

Social diversity: Reflects the number and heterogeneity of members in terms of race, ethnicity (region of origin), gender, physical and mental ability, and beliefs.

Sustainability: Fisheries and other aquatic resources are sustainable when they, and the ecosystems that support them, are managed in such a way that their optimal viability and productivity are maintained for the benefit of future generations.

Transparency: Open, frank, and candid in operation, such as in the administration of a professional society.
Early on in *Advances in Fisheries Science* is the following quote from Ray Beverton:

> Having devoted my career to providing a scientific basis for sound and sustainable harvesting of our natural fish resources, it troubles me greatly that the present state of the world’s fisheries is deeply depressing. This is not what Sidney Holt and I were hoping for when we embarked on our immediate post-war endeavours in those heady days of the late 1940s. (Beverton 1998)

Despite this gloomy observation, Editors Andy Payne, John Cotter, and Ted Potter argue that this book is a celebration of what has been achieved since Beverton and Holt published their major work *On the Dynamics of Exploited Fish Populations* in 1957. Undoubtedly there is much to celebrate but it must be said that the failure of nations to regulate their fisheries, despite understanding the root of the problem for decades, is a sorry reflection on the relationship between us humans and the world in which we live. So far the control of the natural world has eluded us. This is partly because the regulation of fisheries is a problem of regulating human behavior and we have not yet found a good way of doing this with guaranteed success.

*Advances* is a multi-author book with the majority of the contributors coming from or having connections to the Fisheries Laboratory, Lowestoft, UK, now called the Centre for Environment, Fisheries and Aquaculture Science (CEFAS). The foreword to the book is written by the surviving member of the duo, Sidney Holt, who provides a wonderful insight into the thinking behind the 1957 work and subsequent developments. As Holt himself comments, it is disappointing that present theory of exploited fish populations still depends very heavily on work developed over 50 years ago.

It is also disappointing to see that a book such as this focuses mostly on just the biology of exploited stocks. There are chapters, such as that by Reeves et al., that recognize the human dimension and begin to look at the role fishers play in generating fishing effort and complying with regulations. I estimate that 17 of the 21 chapters deal mostly with technical issues that are either to do with the biology of exploited species or with issues such as tagging or recording what fish are doing. Given that the main problem with most overfished stocks is that there are too many fishers trying to catch too few fish, the solutions needed are those that show how management agencies can successfully reduce the amount of fishing and then sustain it at a lower level. For many exploited stocks we probably know what that lower level should be but the hard part is getting to the lower level and then staying there.

One of the most original chapters, by Simon Jennings and Nick Dulvy, develops Beverton and Holt’s insights into the life history strategies of exploited fish. These insights remained unknown to the wider audience of evolutionary biologists until taken up and developed by Charnov (1993). This episode demonstrates how Beverton and Holt’s major book was so dense in detail, but so applied, that much of its originality was lost on the audiences who might have benefited. This was either because evolutionary biologists did not see the book as being relevant to them or because applied fisheries biologists ignored everything but the parts of direct relevance to fisheries management. Jennings and Dulvy make a good job of re-exposing these hidden parts of *On the Dynamics of Exploited Fish Populations*.

Sidney Holt ends his foreword by quoting a passage from the book by Michael Graham, *The Fish Gate*, published in 1943, that emphasizes that in order to understand fisheries one has to understand all parts of the fish supply business. The way in which fishmongers and fish buyers behave is as relevant as the growth rate of the fish stock being exploited. Modern fisheries science is now emphasizing the way in which exploited stocks are embedded in the ecosystem, but there is still a failure to provide a theory that encompasses the multi-faceted nature of fish supply. Economic theory as developed by Colin Clark and others perhaps comes closest to what is required. Graham argued that the S-shaped curve of the logistic model of population growth somehow encapsulated the nature of fisheries. Beverton and Holt took theory to a new level in their work, going well beyond the simplicity of the logistic model with their three-dimensional yield isopleths, but we now need to find a way to capture the multivariate nature of fish supply, which includes the social science and economics of fisheries. Although some of the chapters in this book provide some of the building blocks of a
future theory, none gives a vision of how that theory might look.

The book is skillfully edited and clearly presented. Most chapters are written in a lucid and interesting style with good illustrations. The price is, as usual with this type of book, very high and this will limit its sale to libraries and to those fishery scientists who have a direct stake in the business. It is unlikely to be bought by graduate students, although they will undoubtedly want to consult it as a guide to what is current and where they need to go as they develop their careers.

REFERENCES


—Paul J. B. Hart
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University of Leicester, UK
pbh@le.ac.uk

New Titles

**The Ecology of Juvenile Salmon in the Northeast Pacific Ocean: Regional Comparisons.**

This collection of papers stems from an AFS symposium at the Anchorage Annual Meeting. The volume contains nine papers that examine regional variation in the ecology of juvenile salmonids in the Pacific Ocean. Topics include an historical overview, distributions of juvenile fish and their prey and parasites in space and time, descriptions of feeding ecology, and estimates of early growth and mortality. By necessity, the volume does not provide a complete overview of juvenile salmonid marine ecology, but it is a good entry point into the early marine phase of these widespread species.

**Anadromous Sturgeons: Habitats, Threats, and Management.**

This volume contains papers from an AFS symposium from the Annual Meeting held in Quebec City. As suggested by the title, the 23 papers are organized into three sections: habitats, threats, and restoration, and management and population trends. Geographical coverage includes the Pacific and Atlantic oceans and the Baltic Sea and papers present information on a wide number of sturgeon species. The volume is a timely contribution to scientific information on imperiled sturgeon across their range.

**Burbot: Biology, Management, and Culture.**

**Fish Cytogenetics.**

**Fish Life in Special Environments.**

**Fish Reproduction.**

**Ocean Environment and Fisheries.**

**Redband trout: resilience and challenge in a changing landscape.**
*Edited by R. K. Schroeder, and J. D. Hall.* Oregon Chapter American Fisheries Society, Corvallis, OR. 2007. 127 pp. (cloth); (paper); www.orafs.org/.

**Species and System Selection for Sustainable Aquaculture.**

**Aquaculture Genome Technologies.**
Eels at the Edge
Science, Status, and Conservation Concerns

John Casselman and David K. Cairns, editors

There is a catastrophic worldwide decline of anguillid (freshwater eel) species. World authorities on the three species consider mechanisms for addressing this concern and reversing trends. This book emphasizes recent and new insights into basic biology, resource status, and management procedures. Chapter authors provide innovative approaches to stock assessment and management. Includes a subject index.

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what will be done with all the rest of the unpublished, one-of-a-kind grey literature, data, samples, and the like? Almost certainly, someone someday will care and may even try to find it. Unfortunately, there has been a perception that this “ancient material” is dated. There is value in those assemblages, which only increases with time. Long-term data, regardless of its form, has tremendous value and can provide insights.

The real questions are: what exists and where is it? How readily can it be accessed? Two recent examples come to mind—what about the massive treasure trove of unpublished reports, observations, etc., that was assembled to support the classic fisheries tome Freshwater Fishes of Canada by Bev Scott and Ed Crossman? Most certainly, students of Canadian fish and fisheries will want to know someday. Similarly, how many know where to find the documents, diaries, and data that were assembled by the early fish surveyors of the Barren Grounds study of northern Canada in 1959? How better could we document climate change than to resurvey and compare? Those of us who know of the existence of such assemblages are duty bound to try to protect them so that they are available in the future. To lose them is regrettable, to say the least.

Why not strike a committee to address this challenging problem of archiving? We have already lost too much. If we did nothing more than start an inventory of what exists and where, that would be a tremendous contribution. This could be initiated through a general survey. I am sure there are many great suggestions out there on how to approach this recurring conundrum, since each generation of professionals has to address the issue. This should already have been addressed in a thorough and logical way. If we in AFS don’t value and protect what existed in the past and make it available for the future, who else will? It isn’t long until it disappears from our professional consciousness.

No one else will know of it unless it is at least inventoried. How many recall the excellent article put together by Pat Rivers and Bill Ardren in Fisheries in 1998 (“The Value of Archives“)? It would be interesting to know whether that plea to protect and archive calcified structures stimulated action. Fortunately, the electronic age has put published science at our fingertips. Can we somehow use it to help capture and disseminate the rest? A concerted effort is long overdue.

Whelan: The Fisheries History Section is also concerned with personal collections and what will happen to these materials. With the large number of baby-boomer Society members retiring in the near future, we all need to think about our personal collections and legacy that we leave those in the future. It is critical that we inform our heirs what to do with this material that may be the key to some future decision. Arrangements for these materials should be made or they will end up in the dumpster or at a garage sale. If individuals can’t bear to part with their stuff, they need to be sure someone knows what is significant, and what to do with it as part of their personal wishes. One very creative idea provided to me by James Reynolds (Fisheries History Section newsletter editor) that has been implemented by another Society member is to write one’s professional story to preserve a life’s work and its many tales for one’s family. These stories also are likely to be of interest to one’s alma mater, employer(s), and other interested parties. Another option is giving your materials to the D. C. Booth Historic National Fish Hatchery as they will accept and properly preserve personal collections, including photos, grey reports, objects of fisheries management, publications, and field notebooks, to name a few.

In my discussions with Randi Smith and other agency librarians, they have provided a key word of warning for all to consider, and that is not to destroy paper records after digitizing. While digital copies are very useful and very easy to put online and use for research, they cost money to maintain and vanish if the website or server disappears. They also can be fragile, and need to be maintained. Scanning is not the end of the process. The storage life of paper is well known but for digital media it is uncertain, as disks are not permanent, nor are the systems on which they operate. So scanning does not relieve someone of the responsibility of preserving the original hard copies.

Casselman: Many local museums are interested in fish and fisheries and some are establishing fisheries funds or collections. Possibly we could encourage these local repositories to assemble material and even volunteer to help do so. Some societies are encouraging senior people to write up well-researched biographies of others (see articles in Copeia, for example David Smith’s 2006 historical perspective on W. B. Scott). Encouraging these would be one way to extend the past into the future.

Franzin: This is becoming an increasingly important subject because the Society’s and our members’ personal professional archives are a reflection of what the profession is, has been, and will be. Without an understanding of our history and knowledge of our present, our future is tenuous as we are doomed to repeat the lessons of the past. We will have no direction from whence we came since 1870.

REFERENCES


### CALAENDRA: FISHERIES EVENTS

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

More events listed at www.fisheries.org, click "Who We Are," click "Calendar."

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<tr>
<td>May 22-26</td>
<td>Third and Last GLOBEC Open Science Meeting</td>
<td>Victoria, British Columbia, Canada</td>
<td><a href="http://www.globec.org">www.globec.org</a></td>
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<td>May 25-29</td>
<td>World Aquaculture 2009</td>
<td>Veracruz, Mexico</td>
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<td>Jun 1-11</td>
<td>Indo Pacific Fish Conference and Australian Society for Fish Biology</td>
<td>Fremantle, Western Australia</td>
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<td>Jun 14-19</td>
<td>Seventh International Conference on Molluscan Shellfish Safety</td>
<td>Nantes, France</td>
<td><a href="http://www.icmss09.com">www.icmss09.com</a></td>
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<td>Jun 16-17</td>
<td>World Ocean Council—Sustainable Ocean Summit</td>
<td>Belfast, Ireland</td>
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<td>Jun 23-26</td>
<td>International Paleolimnology Symposium</td>
<td>Guadalajara, Jalisco, Mexico</td>
<td><a href="http://www.paleolim.org">www.paleolim.org</a></td>
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<td>Jul 20-24</td>
<td>Sixth International Fisheries Observer and Monitoring Conference</td>
<td>Portland, Maine</td>
<td><a href="http://www.st.nmfs.noaa.gov/iformc209">www.st.nmfs.noaa.gov/iformc209</a></td>
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<tr>
<td>Jul 22-27</td>
<td>Early Life History Section’s 33rd Annual Larval Fish Conference and American Society of Ichthyologists and Herpetologists Conference</td>
<td>Portland, Oregon</td>
<td><a href="http://www.dce.k-state.edu/conf/jointmeeting">www.dce.k-state.edu/conf/jointmeeting</a></td>
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INTRODUCTION TO INSTREAM HABITAT MODELING USING MESOHABSIM

Piotr Parasiewicz, Rushing Rivers Institute, piotr@rushingrivers.org

Student $150, member $250, nonmember $300

This course will serve as an introduction to modeling instream habitat using the MesoHABSIM approach (and associated SimStream software) and how it can be applied to river restoration and management.

MAPPING AQUATIC HABITAT OF INLAND FRESHWATER SYSTEMS USING SIDE-SCAN SONAR (NEW VERSION)

Adam J. Kaeser, Thom Litts, Georgia Department of Natural Resources; Adam.kaeser@dnr.state.ga.us, Thom.litts@dnr.state.ga.us

Student $75, member $100, nonmember $150

This course is an introduction to using the inexpensive Humminbird® Side Imaging system to map and quantify benthic habitats at the landscape scale. The course includes a practical session covering techniques for geoprocessing sonar imagery and map development within ArcGIS 9.x.

SHARING STREET SMARTS ABOUT GETTING THEM TO SAY “YES” TO CONSERVATION

Michael E. Fraidenburg, fraid@earthlink.net

Student $25, member $40, nonmember $60

Join this facilitated “discussion in the round” to tell your career experiences about “How did you get them to do that?” (implement conservation actions). We will video tape the session and create a DVD of your best advice. That way other professionals can learn from your experiences. Come prepared to tell case histories and then analyze these for the lessons you learned that will help other professionals create conservation successes. There are prerequisites for this course. For more information and the prerequisites, see www.ConservationProfessional.com and look under AFS 2009.

EFFECTIVE SPEAKING WHEN THE HEAT IS ON!

Michael E. Fraidenburg, fraid@earthlink.net

Student $25, member $40, nonmember $60

Learn to design and deliver presentations that persuade, even when there is mistrust and anger in the meeting room. Bring and present a short segment of a presentation and receive real-time coaching. Come and learn six speaking models you can use to persuade. For more information, see www.ConservationProfessional.com and look under AFS 2009.

BASIC/INTERMEDIATE GIS FOR FISHERIES BIOLOGISTS

Joanna Whittier, Kansas State University, whittier@ksu.edu

Student $125, member $220, nonmember $250

This course will provide an overview of basic/intermediate GIS skills for fisheries biologists using ArcGIS, including use of existing data, creating your own data, and review of fundamental concepts for GIS.

ADVANCED GIS FOR FISHERIES BIOLOGISTS

Joanna Whittier, Kansas State University, whittier@ksu.edu

This course will provide an overview of basic/intermediate GIS skills for fisheries biologists using ArcGIS, including use of existing data, creating your own data, and review of fundamental concepts for GIS.
Building on the “Basic/Intermediate GIS for Fisheries Biologists” course, this course will focus on geoprocessing, interpolation, and spatial analysis methods to aid in fisheries monitoring and research.

LEADERSHIP AT ALL LEVELS IN AFS
Dirk Miller, Wyoming Game and Fish Department, Dirk.miller@wgf.state.wy.us

FREE
This course will focus on helping AFS leaders understand how to work effectively within the AFS governance structure at all levels: Chapter, Section, and Division.

AN INTRODUCTION TO PROGRAMMING IN R FOR FISHERIES SCIENTISTS
Elise Faye Zipkin, USGS, ezipkin@usgs.gov; Cheryl Murphy, Michigan State University, camurphy@msu.edu
Student $75, member $125, nonmember $175

This course will introduce the basics of program R (and using a command-line interface), drawing from examples in fisheries research. Topics will include: interactive calculations, importing/exporting data, built-in and user-defined functions, graphing, and statistical analyses (linear regression, t-test, randomization, anova, basic nonlinear optimization). Program R is a powerful open-source mathematical and statistical software program gaining popularity in the fisheries and ecological sciences. No prior experience with R or programming is required or expected.

VEMCO ACOUSTIC TECHNOLOGY WORKSHOP
Nancy Edwards, VEMCO Division and AMIRIX Systems Inc., nancy.edwards@amirix.com

FREE
This course will discuss VR2 (VR3 & VR4) passive and active automated acoustic receiver technology, designed and produced by VEMCO, and its application to assess movement patterns, behavior, and site fidelity of fishes and invertebrates.

HOW TO DESIGN NATURAL CHANNELS USING PRINCIPLES OF GEOMORPHOLOGY
J. George Athanasakes, Stantec, George.Athanasakes@stantec.com
Student $75, member $125, nonmember $175

This course will provide an overview of stream restoration and will focus on the procedures necessary to design a stream using Natural Channel Design techniques. It will focus on design elements that enhance the structural or functional aspects of aquatic habitat.

SCIENCE, TOOLS, AND INFORMATION RESOURCES ON UPSTREAM FISH PASSAGE
Doug Dixon, Bioengineering Section AFS, ddixon@epri.com
Student $75, member $125, nonmember $175

This course will focus on the basic and applied science of upstream fish passage, including the reasons for providing passage at dams and road culverts and crossings; the physics of water flow and fish biology relevant to fishway design and operation; fishway design and performance evaluation; and criteria and processes for fishway implementation.

NATURAL CHANNEL DESIGN: INSTREAM STRUCTURES FOR HABITAT ENHANCEMENT
John Parish, Parish Geomorphic Ltd., jparish@parishgeomorphic.com; Wolfgang Wolter, AECOM, Wolfgang.Wolter@aecom.com; Bruce Kilgour, Kilgour & Associates Ltd., bkilgour@kilgourassociates.com
Student $75, member $125, nonmember $175

Topics include an introduction to stream restoration, benefits of stream restoration, adaptive environmental management, use of instream structures for habitat enhancement, and design and implementation of instream structures including working examples. A case study will be presented that encompasses topics presented earlier in the session that will examine the physical, biological, and technical aspects of channel and structure design with a focus on fish habitat. Material will be presented in lecture format with encouragement of participation from students.
Post-doctorial Researcher, Oregon State University, College of Oceanic and Atmospheric Sciences.

Salary: $45,000-47,000 per year.

Closing: 30 April 2009.

Responsibilities: Work with an interdisciplinary team of researchers studying the trophic interactions, distribution, and abundance changes of commercial groundfish populations in the eastern Bering Sea and Gulf of Alaska in relation to changing oceanic and demographic conditions. Perform advanced statistical analyses of groundfish distribution and trophic interactions. Opportunities exist to participate in research cruises.

Qualifications: Ph.D. in biological oceanography, fisheries, ecology, biostatistics, or related disciplines, preferably with interests in population ecology. Experience with or a desire to learn advanced statistical analysis, such as Generalized Additive Models and geostatistics is required.

Contact: See application instructions at http://oregonstate.edu/jobs, posting 0003756 and for the position announcement, see www.coas.oregonstate.edu/ or contact Lorenzo Ciannelli, 541/737-3142, lciannel@coas.oregonstate.edu. AA/EOE. See http://bsierp.nprb.org/index.htm.

Ph.D. Assistantship in Mapping Ecosystem Services, Virginia Polytechnic Institute.

Salary: $22,000–24,000 per year plus tuition.


Responsibilities: Participate in a multidisciplinary effort to examine where/when biological conservation enhances delivery of aquatic ecosystem services. Participate in conceptual-model development for and spatial analyses of relations among conservation practices, biodiversity, delivery of ecosystem services, and human well being in a U.S. river basin. Perform project data analysis and report writing, while completing Ph.D. coursework.

Qualifications: M.S. in landscape ecology, ecological economics, conservation biology, geography, or related discipline. Commitment to multidisciplinary research, demonstrated scientific productivity, including peer-reviewed publications, strong statistical skills experience with large geo-spatial datasets, excellent writing skills.

Contact: Send letter of interest, resume, GRE scores, names of three references to Paul Angermeier, Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, Virginia 24061-0321; 540/231-4501; biota@vt.edu.

Fishery Research Program Associate, Great Lakes Fishery Commission, Michigan.

Salary: $33,000–36,000 two-year renewable term, full benefits package.

Closing: 30 June 2009.

Responsibilities: Assist science director with research planning, contract administration, and fishery research projects in support of the commission’s Fishery Research and Science Transfer Programs. Help coordinate panels of scientists from Canada and the USA. Become familiar with a broad range of research projects that span the biological and social sciences. Two-year renewable term.

Qualifications: Basic background in biology, fishery biology, conservation, or a related discipline. Interest in fishery management. Organizationally skillful. Proficient with word processing and spreadsheets and possessing excellent communication skills. Statistical background useful.

Start date: August 2009.

Contact: E-mail application, letter, and vita to slrp@glfc.org. Great Lakes Fishery Commission, 2100 Commonwealth Boulevard, Suite 100, Ann Arbor, Michigan 48105-1563; www.glfc.org.

Science and Policy Coordinator, Federal and State Cooperative Programs, Texas Parks and Wildlife Department (TPWD).

Salary: $4,775.29 per month.

Responsibilities: Scientific and technical expertise and oversight for federal and state cooperative programs. Serve as primary liaison between TPWD and federal partners and sponsors on program science and policy issues, including compliance with ESA and NEPA. Coordinate division efforts to conserve rare, threatened, and endangered species. Coordinate division input into the update of the Texas Wildlife Action Plan and participate in the development and implementation of habitat conservation and recovery implementation plans. Work closely with partners to coordinate, improve, and stimulate interest in species conservation and to secure support for local conservation programs. For full announcement see www.tpwd.state.tx.us/business/jobs/postings/page09_34_255.

Qualifications: B.S. in biological sciences. M.S. preferred with a minimum of three years of progressive experience as a fisheries or aquatic biologist.

Contact: Timothy Birdsong, Timothy.Birdsong@tpwd.state.tx.us, 512-389-4744. See www.tpwd.state.tx.us/business/jobs/postings/?page=09_34_255.

Ph.D. or M.S. Graduate Assistships, Auburn University, Alabama.
Salary: Ph.D.—$18,000 per year. M.S.—$17,000 per year. Tuition waiver to qualified applicants.

Closing: 30 May 2009.

Responsibilities: Study ecology, movements, habitat use, age structure, fecundity, and nursery habitats of marine fishes in the northeast Gulf of Mexico. Take offshore trips 5–10 days per month, 10 to 40 km. Work with SCUBA visual counts, trap nets, gill net, hook-line, and ultrasonic to track reef fishes, which can be used for thesis completion.

Qualifications: M.S., or B.S. in biology or related science, minimum GPA of 3.0, and GRE of 1000 verb math. Scuba diving ability.

Contact: Send CV, GPA, and GRE score to Stephen T. Szedlmayer, szedlst@aces.edu, Marine Fish Laboratory, Department Fisheries, Auburn University, 8300 State Highway 104, Fairhope, Alabama 36532.

Closing: 1 August 2009 or until filled.

Responsibilities: Use store scanner data to analyze market trends and retail pricing issues for catfish, crawfish, clam, and shrimp, and use household-based scanned data to analyze consumer behavior.

Qualifications: Admission requires a B.S. degree in aquaculture, fisheries, agricultural economics, or a related field, a minimum GPA last 2 years of 3.0 and GRE score of 1,000 verbal quantitative. Minimum TOEFL score of 550 paper based or equivalent for international students. Strong quantitative statistics, mathematics skills, and computer proficiency required. Maintenance of large data set is desired.

Contact: Complete forms at below link and mail hardcopy to Dey Aqua and Fish Center, UAPB 1200 North University Drive, Mail Slot 4912, Pine Bluff, Arkansas 71601. For questions see www.uaex.edu/aqfi, mdey@uaex.edu.

Lead Technician, Hubbs-Sea World Research Institute, Catalina Growout Facility, San Diego, California.

Salary: First year—$17,800. Second year—$18,800.

Closing: 30 June 2009 or until filled.

Responsibilities: Husbandry of fish held in netpens including providing daily feed, removal of dead or moribund fish, assessing fish health and measuring fish. Must live in close proximity to the pen located at Two Harbors on Santa Catalina Island. On-site housing watercraft may be provided and the daily care and upkeep of the watercraft is mandatory.

Qualifications: Ability to work independently with nominal direct supervision. Communicate with coworkers, supervisors, and the public as part of a team. SCUBA certification with boat handling and seamanship skills. Must be in good health, and physically able to work alone on floating platforms, use tools, power equipment and have the ability to safely lift 50 pounds.

Contact: Please send resume to Michael Shane, mshane@hswri.org. See www.hswri.org.
Before tagging, it is critical to evaluate the study objectives, the animals involved, and the methods of recovering or detecting tags. We enjoy helping our customers select the right type of tag for their research, and sometimes, a combination of tags, simultaneously or over time, is the best solution. Research programs tend to be stronger if they don’t depend on any one tag type but use the strengths of different tags to address a range of questions.

Dr. Nathan Brennan and fellow researchers at Florida’s Mote Marine Lab demonstrated how tags can be effectively combined\(^1\). Common snook (\textit{Centropomus undecimalis}) are valued as one of the top marine sport fishes in Florida. Despite restrictive fishing regulations, they are considered overfished. Managers are investigating the potential of stock enhancement to help snook recover to sustainable levels. Dr. Brennan’s research focuses on evaluating whether releasing juvenile hatchery fish would supplement or displace wild juveniles. After estimating the pre-release abundance of wild juvenile snook, they stocked hatchery juveniles at high and low densities into estuarine creeks.

Dr. Brennan et al. found little movement of stocked or wild snook between streams. They also concluded that the experimental releases of high densities of juvenile hatchery-reared snook did increase total abundance of juveniles without suppressing the density of wild snook. This research is an important step in understanding the dynamics of enhancing Florida’s snook populations.

Located east of Seattle, Lake Washington supports the world’s longest floating bridge at 7,578 ft (2,310 m), commonly referred to as the “520 Bridge” (State Route 520). The 520 Bridge connects Seattle with Eastside communities and is a high priority with the Washington State Dept. of Transportation (WSDOT) as they move forward with replacing the aging bridge.

When WSDOT began the SR 520 Program, they set out to better understand fish behavior with the help of the U.S. Fish and Wildlife Service (USFWS). It’s known that structures, such as bridges in and near waterways, can influence the ecological dynamics of the aquatic environment. Such influences can affect behavior, habitat use, and survival. For example, many naturally-reared Chinook salmon smolts (Oncorhynchus tshawytscha) in Lake Washington must pass beneath the 520 Bridge as they migrate toward Puget Sound. The goal of the study was to evaluate movement and habitat use of the salmon smolts and two predators - northern pikeminnow (Ptychocheilus oregonensis) and smallmouth bass (Micropterus dolomieu) near the bridge.

Researchers employed HTI’s fine-scale acoustic tracking system to track fish in a 17.2 ha area along a 1,838 ft (560 m) stretch of the bridge from late May through early August. The study site was on the west end of the bridge, and was believed to lie within a major migratory corridor for salmon smolts. Naturally-reared smolts moving from south Lake Washington travel north along the western shore of the lake and encounter the bridge before moving toward the entrance to the Lake Washington Ship Canal en route to Puget Sound. Hatchery-reared smolts occur throughout the lake and many move along the southwestern shore of the lake and encounter the bridge. Tagged smolts were released 2,625 ft (800 m) south (upstream) of the study site to observe behaviors as they voluntarily entered the study site and encountered the bridge. Most predators were captured on-site, tagged, and released near the place of capture.

Though differences in timing of migrational cues (e.g., moon apogee), physiological smolt status, water temperature, and prey availability may have contributed to differences in behaviors observed between release groups, the ultimate questions remain. How does the current bridge affect fitness and survival of Chinook salmon, and how should the new bridge be designed and sited to minimize impacts to Chinook salmon?

HTI is proud to provide the tools needed for WSDOT and USFWS to observe fish behavior, and for the opportunity to be involved as they continue their commitment to environmental stewardship. To learn more about acoustic technology used in this study, visit us at HTIsolar.com.