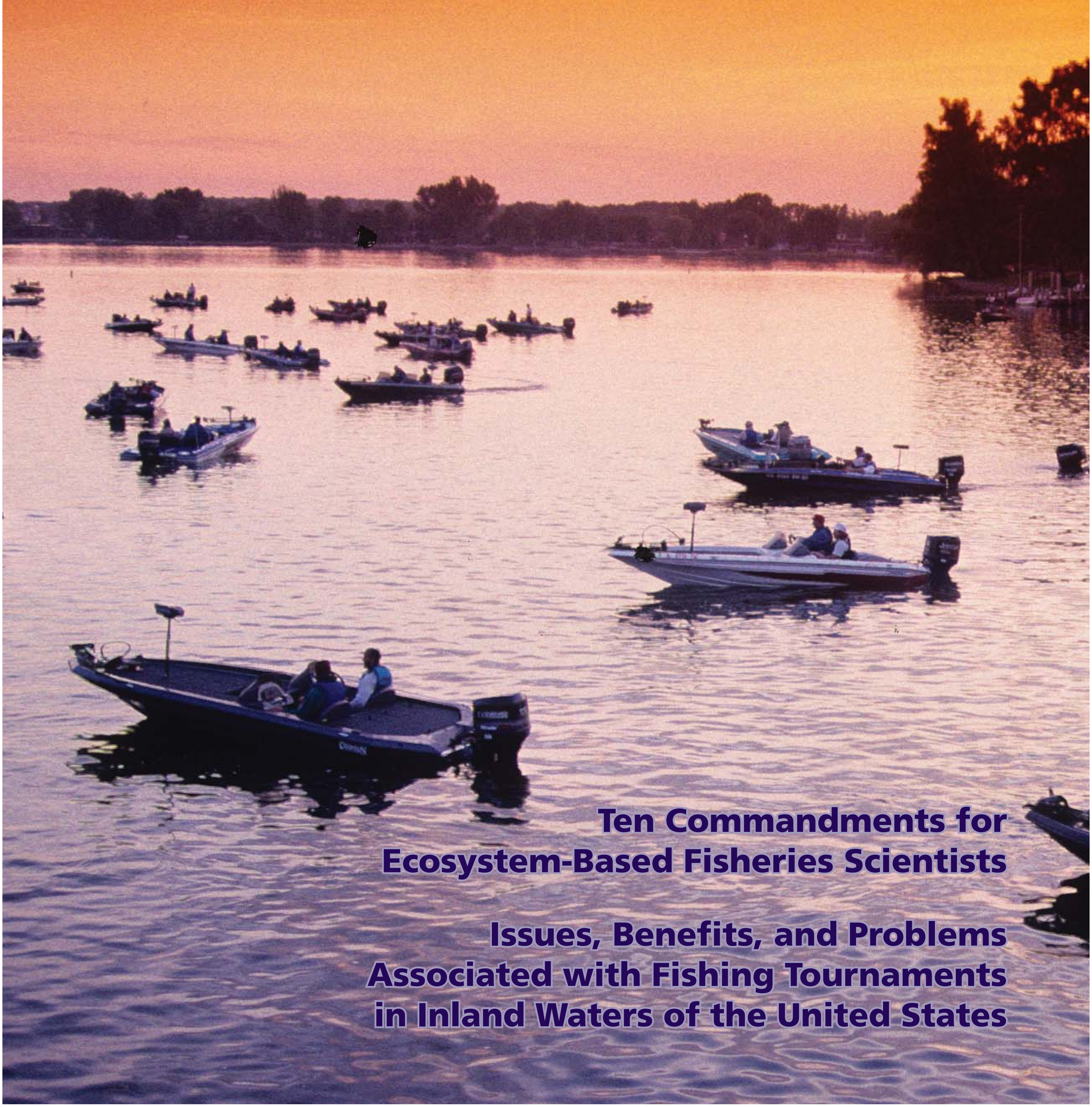
Fisheries

MAY 2007
VOL 32 NO 5

American Fisheries Society • www.fisheries.org



Ten Commandments for Ecosystem-Based Fisheries Scientists

Issues, Benefits, and Problems Associated with Fishing Tournaments in Inland Waters of the United States

Bringing Back Winter Flounder

Hatchery reared winter flounder are tagged with fluorescent red Visible Implant Elastomer to distinguish them from wild fish after release. Dr. Fairchild releases the flounder into shallow coastal waters at a length of about 40 mm.

The winter flounder *Pseudopleuronectes americanus* is an important commercial and recreational fish along much of North America's Atlantic coast. Inshore habitat degradation and overfishing contributed to stock declines throughout their range, leaving catches at a fraction of historical levels. Reducing fishing mortality and protecting essential habitat have helped stocks to begin recovery, but they still have a long way to go.

To accelerate the recovery of winter flounder, researchers in New Hampshire, led by Dr. Elizabeth Fairchild, are developing and evaluating a stock enhancement program. They have established the culture techniques for winter flounder, determined the optimal size for releasing juveniles for predator avoidance[1] and evaluated release sites[2]. They are now evaluating how well the released fish contribute to the natural populations and developing strategies to maximize post release survival[3].

An essential aspect of the investigation is the ability to identify individuals derived from the release program. This is achieved using NMT's Visible Implant Elastomer (VIE). Critical characteristics of VIE include the ability to tag small fish, the capacity to identify different batches of fish, the rapid rate of tagging that can be achieved, and the low cost tag.

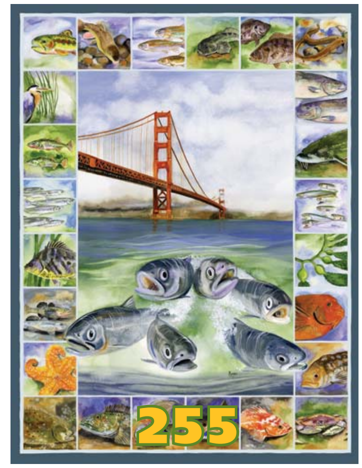
Please contact us to discuss our systems for tagging aquatic organisms.

1. Fairchild EA, Howell WH. 2000. J. Sea Research 44(1-2):81-90.
2. Fairchild EA et al. 2005. Aquacul. Res. 36(14):1374-1383.
3. Fairchild EA, Howell WH. 2004. J. Fish Biol. 65:69-87.

Northwest Marine Technology, Inc.
www.nmt.us
Shaw Island, Washington, USA

Corporate Office
360.468.3375 office@nmt.us

Biological Services
360.596.9400 biology@nmt.us



PERSPECTIVE

FEATURE

COVER: The number of fishing tournaments, especially those targeting black bass, have increased rapidly over the past few decades.
CREDIT: Doug Stamm / stammphoto.com

COLUMNS

DEPARTMENTS

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

MAY 2007
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AMERICAN FISHERIES SOCIETY • WWW.FISHERIES.ORG
EDITORIAL / SUBSCRIPTION / CIRCULATION OFFICES
5410 Grosvenor Lane, Suite 110 • Bethesda, MD 20814-2199
301/897-8616 • fax 301/897-8096 • main@fisheries.org

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Fisheries is printed on 10% post-consumer recycled paper with soy-based printing inks.

COLUMN: PRESIDENT'S HOOK

Jennifer L. Nielsen

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

Savoring the Concept

OK, I confess, in my alternate persona I'm a die-hard "foodie." I prefer family gatherings over a good meal to a night on the town. A foodie has been variously defined as: a person who has an ardent or refined interest in food; someone in the culinary fast lane; a person devoted to the sensuous enjoyment of food and drink. Even Amazon has a "foodie" section with topics ranging from modern food worship to articles by the truly epicurious. One of my favorite magazines is *Gastronomica: the Journal of Food and Culture* (University of California Press). My mind wanders off when someone asks, "Have you experienced the taste of power; the sweet taste of victory?" What exactly does sweet success taste like? Instead of casting a smug smile, my mouth opens and I explode in visions of culinary convention full of vivid images bathed in aromatics from my last "best meal." What kind of sweet flavor do you ascribe to victory—cherries dipped in dark chocolate or candied ginger? Exploring flavors divorced from food requires a distinctive facet of imagination I seem to lack.

Fish have always been a strong subject in the foodie literature. Think about Julia Child with a whole striped bass on the bench. I think part of the reason I have spent so much time studying fish as a scientist is because they taste so good when they are fresh out of the water. I've made it a point to never eat my study animals, despite the fact I have

> *Fish,*
> *to taste right,*
> *must swim three times—*
> *in water,*
> *in butter,*
> *and in wine.*
>
> POLISH PROVERB

Sutton Salmon Supreme

- 1 Tbsp fresh **lemon** zest
- 1 cup **pomegranate** syrup
- ½ cup extra virgin **olive oil**
- 1 tsp **Jamaican hot sauce**
- 3 cloves minced **garlic**
- 2 tsp whole **cumin** seeds
- ½ cup fresh **parsley** (substitute fresh cilantro if you like)
- ¼ cup chopped **shallots**
- Four 6 oz fresh **Alaskan salmon** fillets —skin on
- 16 ripe **figs** washed and cut in half
- Pinch of **sea salt**

- In a bowl, **mix** the zest, pomegranate syrup, olive oil, hot sauce, garlic, cumin, parsley, shallots, and salt.
- **Marinate** the salmon in this sauce for 1 h covered in the refrigerator.
- **Place** fillets skin down on a glass plate or platter.
- **Coat** the salmon with 1/3 of the marinade.
- **Scatter** figs and drizzle with marinade.
- **Broil** 5–7 minutes under high flame until fish and sauce begin to caramelize, then turn off the broiler.
- **Drizzle** more marinade over all.
- **Bake** at 300° F until fish is flaky when prodded with a fork but still moist, not dry.
- **Transfer** to dinner plates, drizzle with caramelized juices, and serve at once.

Continued on page 250

NEWS: FISHERIES

VHS virus spreading to more species

The viral hemorrhagic septicemia virus (VHSV), which causes anemia and hemorrhaging in fish, has now been identified in 19 species. Three new fish kills have occurred in 2007 since the virus was identified in the Great Lakes in 2005. In the St. Lawrence River, hundreds of thousands of round gobies have succumbed to the disease; gizzard shad die-offs from VHSV in Lake Ontario west of Rochester and in Dunkirk Harbor on Lake Erie also have been reported. This month the Wisconsin Department of Natural Resources made a presumptive identification of the virus for the first time in the Lake Winnebago chain of inland lakes about 25 miles south of Green Bay on Lake Michigan; confirmation is pending. Millions of dead freshwater drum washed onto the beaches of Lake Erie in 2006, all victims of VHSV.

"It's pretty obvious this is an epidemic even if it isn't official," said AFS member Paul Bowser, professor of aquatic animal medicine in the Cornell College of Veterinary Medicine. "There are just so many species affected and so many mortalities."

Other species from the Great Lakes area that have tested positive by Cornell include bluegill, rock bass, black crappie, pumpkinseed, smallmouth and largemouth bass, muskellunge, northern pike, walleye, yellow perch, channel catfish (an important aquaculture species), brown bullhead, white perch, white bass, emerald shiner, bluntnose minnow, freshwater drum, round goby, gizzard shad, and burbot.

Salmon tracking program expands to California

A successful pilot program launched last year that used genetics to determine the river origin of Chinook salmon caught off Oregon's central coast will begin its second season this month and expand to the entire coast off Oregon as well as to northern California waters. The hope is to discover more about the distribution of salmon in the ocean so that fisheries managers can make in-season decisions and allow the harvest of healthy stocks while mitigating the harvest of weakened runs. The ultimate goal is to avoid shutting down the entire coastal fishery, as happened in 2006 to protect weakened runs from the Klamath River.

Dubbed Project CROOS (Collaborative Research on Oregon Ocean Salmon), the effort is a unique collaboration among scientists, commercial fishermen, and fisheries managers. During the field studies, 72 Oregon fishing vessels took part and provided 2,567 viable tissue samples from fresh-caught salmon to an Oregon State University (OSU) genetics laboratory in Newport. Of that total, OSU geneticists were able to assign a probability of 90% or more in determining river origin to 2,097 fish—meaning they could determine with a high degree of certainty the hatchery, river basin, or coastal region of origin of about four out of every five fish. Confirmation for their protocol came from traditional research methods, such as from the 31 fish that had coded wire tags attached, listing their hatchery of origin.

"Every piece of the project that we experimented with last year worked," said AFS member Gil Sylvia, director of OSU's Coastal Oregon Marine Experiment Station and a co-principal investigator on the project. "We have the protocols down. We know we can identify with a high degree of certainty the origin of wild or hatchery fish caught offshore--and do it within roughly 24 hours. Now our goals are to learn whether Klamath stocks are aggregated within a specific area at a certain time, and whether there are differences in the catch composition close to shore and outside of six miles," he added.

In other CROOS initiatives, OSU researchers will work with fishery managers to create a trial management simulation model for ocean salmon fishing and a new website that will include a variety of data accessible to fishermen, as well as information about fresh-caught individual salmon that will be available to consumers.

UPDATE: LEGISLATION AND POLICY

Jessica Geubtner

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

Last month AFS joined other fisheries and wildlife non-profit groups in signing onto legislation that will authorize funding for programs to assist state and federal agencies in responding to anticipated effects of climate change on fish, wildlife, and their habitats. The bill was introduced in the House Natural Resources Committee. A letter was sent to Chairman Rahall and Congressman Young urging that they authorize funding for those programs. Attached to this letter was a proposal for Senator Bingaman, chair of the Senate Energy Committee, which more explicitly parses out the use of the money to state and federal programs. This proposal would set aside over $2 billion per year for fish and wildlife conservation in response to climate change, and see that it is equally divided between state and federal programs.

The letter also recommends authorizing a new program to require the development of a coordinated strategy among federal agencies, with input from state wildlife management agencies. Implementation of the coordinated strategy should be done through well-regarded federal programs, such as those under the Farm Bill, North American Wetlands Conservation Act, and others with demonstrated track records of success.

Some of the specific requests listed in the letter are:

STATE AGENCIES

Traditional State Wildlife Conservation Programs

- In General—For each calendar year, $600 million per year shall be made available to states through the Pittman-Robertson Wildlife Restoration Act and the Wallop-Breaux Federal Aid in Sportfish Restoration Act for the purpose of developing and implementing plans to conserve game species of fish and wildlife from the ongoing impacts of climate change.
- Climate Change Impacts—Amounts made available through the Pittman-Robertson and Wallop-Breaux acts shall be used by states to improve the ability of game species of fish and wildlife to survive the effects of climate change by:
  1. Developing assessment information, conducting research, and undertaking monitoring of game species of fish and wildlife and their habitats;
  2. Developing and undertaking projects to manage, conserve, and restore individual game species of fish and wildlife populations;
  3. Implementing actions to manage, conserve, and restore fish and wildlife habitat.

FEDERAL AGENCIES

National Strategy

- Identify all fish and wildlife populations affected by global warming, including game and nongame species, habitat at risk, and wildlife mitigation strategies.
- Fish and wildlife mitigation strategies should establish priorities for the conservation of game and nongame fish and wildlife, based upon which actions will have the greatest long-term benefit to the species and the ecosystem.
- Overall, the national climate change wildlife conservation strategy shall be developed within two years by the Secretary of the Interior, in consultation and coordination with the Secretaries of Agriculture and Commerce, and state wildlife agencies, tribes, conservation organizations, and the public.
- National climate change wildlife conservation strategies shall be based on best available science, as identified by the Science Advisory Board, and coordinated with State Wildlife Action Plans and other wildlife conservation plans.
- Implement on federal and private lands and through federal wildlife programs.

Science

- The Science Advisory Board will advise the Secretary of the Interior in developing the National Strategy.
- The National Global Warming and Wildlife Science Center in the U.S. Geological Survey would research impacts on wildlife and mechanisms for adaptation and would support federal land management agencies.

Funding

$1.2 billion per year shall be made available as follows:

- $50 million for planning;
- $100 million for monitoring;
- $1.050 billion for implementation of fish and wildlife adaptation strategies through existing federal programs.

Proposed increased protection for coral reefs

The Bush Administration has delivered proposed legislation to Congress calling for greater protection for U.S. coral reefs. Nearly a quarter of the world's reefs are under risk of collapse from human pressures and 20% have already been effectively destroyed and show no immediate prospects for recovery. Major causes of reef decline include land-based pollution, disease, habitat destruction, overfishing, climate change, vessel groundings, and coastal development.

The Coral Reef Ecosystem Conservation Amendment Act of 2007 would reauthorize the Coral Reef Conservation Act of 2000 and add greater protections for coral reefs while enhancing marine debris removal and increasing the government's ability to work through cooperative partnerships.

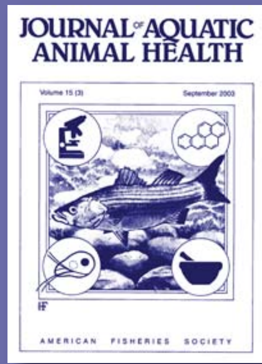
In order to address marine threats that have continued to increase since the original legislation was passed in 2000, this bill focuses on issues associated with climate change, such as coral disease and bleaching. A new emergency response account would fund stabilization and restoration following incidents that injure coral reefs. The bill also makes it unlawful to destroy or injure any coral reef and allows the government to recover response and restoration costs from responsible parties. It provides for the removal of abandoned fishing gear, marine debris, and abandoned vessels from coral reef ecosystems in federal waters and allows for assistance to states for removal of marine debris.

On a personal note …

After almost four years of working for you as policy coordinator, I've decided it is time to move on. I will be working on the Integrated Ocean Observing System for Ocean.US. I've greatly enjoyed working with the membership over the years, and I truly hope our paths will continue to cross in the future. Thank you all for making my time at AFS enjoyable and enlightening!

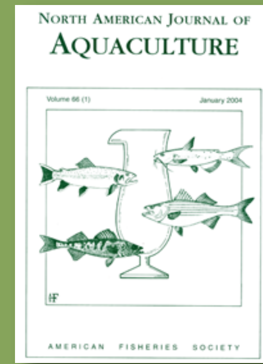
JOURNAL HIGHLIGHTS:

JOURNAL OF AQUATIC ANIMAL HEALTH VOLUME 19, ISSUE 1 (MARCH 2007)



JOURNAL HIGHLIGHTS:

NORTH AMERICAN JOURNAL OF AQUACULTURE VOLUME 69, ISSUE 1 (JANUARY 2007)



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Ten Commandments for Ecosystem-Based Fisheries Scientists

Robert C. Francis
Mark A. Hixon
M. Elizabeth Clarke
Steven A. Murawski
Stephen Ralston

Francis is professor emeritus in the School of Aquatic and Fishery Sciences, University of Washington, Seattle, and can be contacted at bfrancis@u.washington.edu. Hixon is Helen Thompson Professor of Marine Conservation Biology in the Department of Zoology, Oregon State University, Corvallis and can be contacted at hixonm@science.oregonstate.edu.. Clarke is director of the Fishery Resource Analysis and Monitoring Division at the NOAA Fisheries Service Northwest Fisheries Science Center, Seattle. Murawski is director of scientific programs and chief science advisor at the NOAA Fisheries Service Headquarters, Silver Spring, Maryland. Ralston is a supervisory research fishery biologist for the Fishery Ecology Division at the NOAA Fisheries Service Southwest Fisheries Science Center, Santa Cruz, California.

ABSTRACT: In an effort to accelerate the ongoing paradigm shift in fisheries science from the traditional single-species mindset toward more ecosystem-based approaches, we offer the following "commandments" as action items for bridging the gap between general principles and specific methodologies.

1. Keep a perspective that is holistic, risk-averse, and adaptive.
2. Question key assumptions, no matter how basic.
3. Maintain old-growth age structure in fish populations.
4. Characterize and maintain the natural spatial structure of fish stocks.
5. Characterize and maintain viable fish habitats.
6. Characterize and maintain ecosystem resilience.
7. Identify and maintain critical food web connections.
8. Account for ecosystem change through time.
9. Account for evolutionary change caused by fishing.
10. Implement an approach that is integrated, interdisciplinary, and inclusive.

Although the shift in worldview embodied in these commandments can occur immediately without additional funding, full implementation of ecosystem-based fisheries science will require an expanded empirical basis as well as novel approaches to modeling. We believe that pursuing these action items is essential for productive marine fisheries to become truly sustainable for present and future generations.

Diez preceptos para científicos pesqueros que aplican el enfoque ecosistémico

RESUMEN: Tratando de acelerar el cambio entre los paradigmas de manejo pesquero de un enfoque convencional que considera la evaluación de una sola especie a otro que toma en cuenta a todo el ecosistema, nosotros proponemos los siguientes preceptos como elementos que contribuyan a tender un puente entre los principios generales y las metodologías específicas de ambas posiciones:

1. **Considerar una perspectiva hiolística, precautoria y adaptativa.**
2. **Examinar cuestiones clave, no importa que tan básicas sean.**
3. **Conservar las estructuras poblacionales de edad y crecimiento.**
4. **Caracterizar y conservar y la distribución espacial de los stocks.**
5. **Caracterizar y conservar los hábitats viables.**
6. **Conocer y conservar la resiliencia de los ecosistemas.**
7. **Identificar y conservar las conexiones críticas del las tramas tróficas.**
8. **Registrar temporalmente los cambios del ecosistema.**
9. **Registrar los cambios evolutivos causados por la pesca.**
10. **Proponer sistemas de manejo integrales, interdisciplinarios e incluyentes.**

Si bien el cambio general de perspectiva derivada de estos preceptos puede ocurrir inmediatamente, la implementación total del manejo pesquero a partir de un enfoque ecosistémico requiere ampliar la base empírica y el desarrollo de nuevas herramientas de modelación. Consideramos que el cumplir con los elementos enumerados anteriormente es fundamental para que las pesquerías marinas sean verdaderamente sustentables ales entre los temas e impactos de los torneos y se sugiere que los efectos de los torneos no varían entre las diferentes tipos de pesquería. Comparando estos resultados con un estudio previo se observa que la problemática y los beneficios asociados al desarrollo de los torneos han cambiado de 1989 a la fecha; los temas sociales siguen siendo relevantes, pero los impactos biológicos se consideraron como de poca importancia. Las agencias reconocen que los torneos pueden mejorar el manejo de las pesquerías y el reclutamiento de los pescadores. Para la planeación de los futuros torneos debe considerarse un trabajo más integral.

Who in blazes are we to have the audacity to issue 10 commandments? Well, we certainly do not believe that we are Yahweh et al. Rather, because you are reading this, we suspect that the title grabbed you, and so our goal regarding this outrageously grandiose heading is fulfilled. In reality, our humble intention is to stimulate much needed discussion regarding the explicit details of ecosystem-based fisheries science as a bonafide new discipline. We perceive a need to bridge the gap between general principles, which are already well-articulated, and specific methodologies for full implementation, which is the present challenge and beyond the scope of this article. Our intention is to help ecosystem-based fisheries science escape the danger of becoming either "quasi-religious" (sensu Larkin 1996:149) or "surreal" (sensu Longhurst 2006:108) by proposing tangible action items. Given our collective backgrounds, we address only the natural sciences, yet emphasize the need for ecosystem-based management to integrate the natural and social sciences (see Commandment 10).

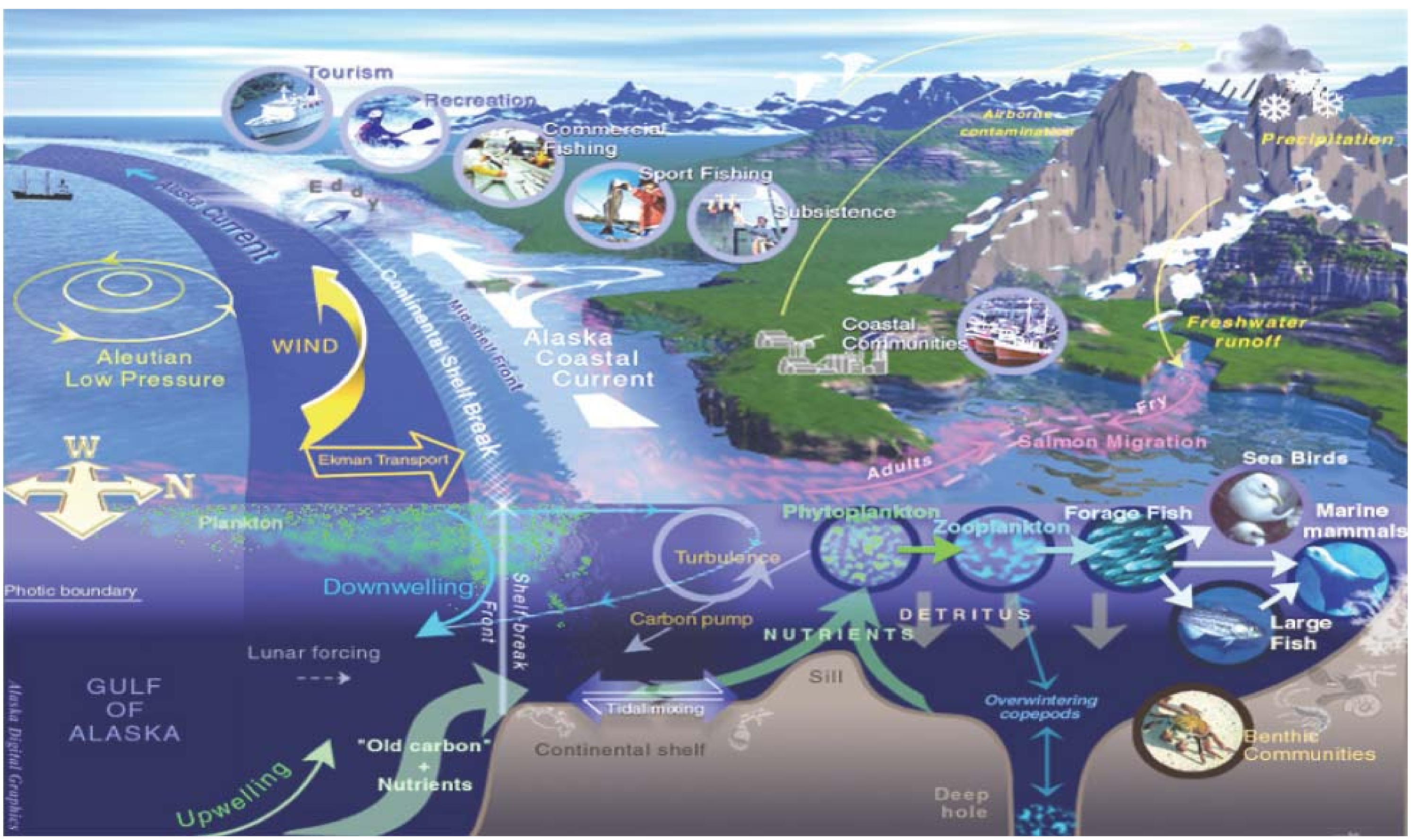
Although a marine "ecosystem" is a human construct that artificially delineates a portion of the ocean, and given that the biosphere comprises highly integrated linkage of all such systems, we are content using definitions proposed by NOAA (2005:3) in the context of this article: "An ecosystem is a geographically specified system of organisms, including humans, the environment, and the processes that control its dynamics. An ecosystem approach to management is management that is adaptive, specified geographically, takes into account ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives."

The ongoing transition in fisheries management from a traditional single-species focus toward ecosystem-based approaches has many characteristics of a classic Kuhnian "paradigm shift." According to Kuhn (1962), during the course of a scientific revolution, an established worldview is replaced by another set of fundamental assumptions. Typically, more progressive, open-minded, and often younger practitioners of the new paradigm face substantial resistance from entrenched defenders of the status quo. We personally have witnessed such resistance toward ecosystem-based management by some fisheries scientists, the same professionals who are the primary purveyors of science for management decisions. However, the paradigm shift in fisheries science is not entirely Kuhnian because the ongoing transition toward ecosystem-based approaches has been more evolutionary than revolutionary, and no one to our knowledge is advocating the complete abandonment of traditional fisheries biology.

Despite some resistance toward ecosystem-based approaches, single-species fisheries science and management is increasingly seen as necessary yet insufficient, and often ineffective for maintaining catches that are both productive and sustainable ("sustainable" in both the modern and post-modern sense of Quinn and Collie 2005, but see Longhurst 2006). This problem is especially evident where bycatch is substantial, where bottom gear impacts seafloor habitats, where fisheries exploit multiple species simultaneously, and when various assumptions of traditional single-species approaches are violated (Browman and Stergiou 2004 and included papers). There is ample evidence that many marine fishery stocks are not managed sustainably, even those subjected to rigorous scientific scrutiny (Hilborn et al. 2003). Worldwide, an estimated 25% of major stocks are over-exploited, depleted, or recovering from depletion, 52% are fully exploited, and 23% are under or moderately exploited (FAO 2006; see also Mullon et al. 2005). Some practitioners are gravely concerned that only about a quarter of the stocks are clearly healthy (e.g., Jennings 2004), whereas others are content that only a quarter of the stocks are depleted or otherwise over-exploited (e.g., Mace 2004). Regardless of whether one sees the glass as three-quarters empty or three-quarters full, and despite the fact that traditional fisheries biology has been adequate in some systems (Hilborn 2005), more effective approaches to fisheries science seem prudent.

Although ecosystem-based fishery concepts have existed for many years (e.g., Sette 1943; Iles 1980), and have been implemented in some regions for some time (e.g., Murawski et al. 2000; Witherell et al. 2000), critics of traditional management have only recently pressed for a more holistic scientific approach that incorporates the ecosystem context of fisheries into management policy (e.g.,

Commandment 1. The Gulf of Alaska from a holistic ecosystem perspective (NOAA Fisheries Service).



Botsford et al. 1997; Pikitch et al. 2004; USCOP 2004; Field and Francis 2006). To date, most publications on ecosystem-based management have focused on broad principles (e.g., Ecosystem Principles Advisory Panel 1999; NRC 1999; Gislason et al. 2000; Coleman and Travis 2002; Link 2002a; Barange 2003; Francis 2003; Rose and Cowan 2003; Browman and Stergiou 2004, 2005; Walters and Coleman 2004; Guerry 2005; McLeod et al. 2005).

Beyond useful compendia of ecosystem-based management guidelines (e.g., Larkin 1996; Link 2002b; Fowler 2003; Walters and Martell 2004; Garcia and Cochrane 2005; NRC 2006), there has been no definitive exploration of explicit action items for a full transition to what we call "ecosystem-based fisheries science" (EBFS). We believe that EBFS should not replace traditional fisheries biology per se, but rather that conventional single-species approaches should be incorporated into the broader and ecologically more realistic discipline of EBFS. In an effort to clarify the essential components of EBFS and to address the important question posed by Frid et al. (2006) regarding advances in natural science required for ecosystem-based management, we offer the following 10 commandments to both the revolutionaries and the reactionaries in this ongoing paradigm shift. Although these action items are general in nature, most examples are drawn from the California Current Ecosystem, with which most of us have the greatest experience.

COMMANDMENT 1: *Keep a perspective that is holistic, risk-averse, and adaptive*.

> *Out of context, the best minds do the worst damage.*
>
> —Wes Jackson (Berry 2005:45)

This fundamental commandment provides the necessary worldview and general context for all that follows. For us, EBFS is more an issue of context and mindset than of method (and thus does not require vast quantities of additional data and funding). Berry (2005:42) says this regarding context in modern agriculture:

> *It is no longer possible to deny that context exists and is an issue. If you can keep the context narrow enough (and the accounting period short enough), then the industrial criteria of labor saving and high productivity seem to work well. But the old rules of ecological coherence and of community life have remained in effect. The costs of ignoring them have accumulated, until now the boundaries of our reductive and mechanical explanations have collapsed.*

Walters and Kitchell (2001) point out that over the past half century, context has changed in marine fisheries as well. They argue that there have been three important steps in the evolution of the theory of fishing. The first two focused on abundance of individual single-species stocks and the direct effects of exploitation on stock productivity, respectively. The third step—focus on ecological interactions—has become necessary with recent severe stock depletions and their unexpected or unknown ecosystem consequences, rendering some single-species techniques either unreliable or unsatisfactory when considered in isolation (e.g., Longhurst 1998; Pauly et al. 1998; Bundy 2001; Jackson et al. 2001). As a result, fishery resource managers are confronted with increasingly complex issues—issues characteristically involving tradeoffs and interactions within and between nature and society.

With this in mind, we believe that Field and Francis (2006:552) provide a useful basis for characterizing EBFS and, in particular, the role of the biological sciences in its implementation:

> *A common theme is that such an ecosystem approach involves a more holistic view of managing resources in the context of their environment than presently exists. For marine fisheries management, this must include taking into greater consideration the constantly changing climate-driven physical and biological interactions in the ecosystem, the trophic relationships between fished and unfished elements of the food web, the adaptation potential of life history diversity, and the role of humans as both predators and competitors. Recognizing that all management decisions have impacts on the ecosystem being exploited, an ecosystem-based approach to management seeks to better inform these decisions with knowledge of ecosystem structure, processes and functions.*

Recently there has been a serious attempt to join the concept of sustainability with the growing scientific understanding that both human and natural systems are complex and adaptive (Holling 2001). Holling and Meffe (1995) made the point that science and policy are inextricably linked when it comes to natural resource issues. What they call "command and control" policy—reduce system variability and make the system more predictable—is based on a "first-stream" scientific view of natural and social systems that concentrates on stability near an equilibrium steady-state. Clearly, the concept of maximum sustainable yield (MSY) falls into this realm. An alternative basis for natural resource policy, what Holling and Meffe call "golden rule" policy—retain or restore critical types and ranges of natural and social variation, and facilitate existing processes and variability—is based on a "second-stream" scientific view of natural and social systems that concentrates on conditions far from any equilibrium. In this case, instabilities can flip a system into another regime of behavior (see Commandments 2, 6, 7, and 8). Developed by Holling and colleagues, these concepts have formed the basis for the integrated concept of "social-ecological systems" (Berkes et al. 2003), and a new field of sustainability science that seeks to understand the fundamental character of interactions between nature and society (Kates et al. 2001; Hughes et al. 2005).

Once fisheries are viewed from such a holistic perspective, then ecosystem-based fisheries science necessarily becomes both risk-averse and adaptive. The biosphere is so complex that we will never have sufficient information to understand ecosystems completely. At the same time, those who dismiss the ecosystem approach as being too data-hungry miss the point. Fishery science will always be severely data-limited and uncertainty will always be high (Walters and Martell 2004). As such, the onus is on fishery scientists to encourage implementation of risk-averse management approaches that set fishing quotas, gear restrictions, and fishing zones in ways that are relatively conservative compared to traditional approaches.

There are two major incarnations of risk-averse decision making, also characterized as the so-called precautionary principle. First, quoting the United Nations Food and Agricultural Organization's "Code of Conduct for Responsible

Fisheries" (FAO 1995:5): "The absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species, and non-target species and their environment." Second, Dayton (1998) describes reversal of the burden of proof, involving a shift in perspective from risk-prone type I error (e.g., increasing exploitation rates until it is demonstrated that those rates have negative effects on a stock) to risk-averse type II error (e.g., not increasing exploitation rates until it has been demonstrated that negative effects are unlikely). Fundamentally, this shift requires nothing more than sound judgment, derived from a holistic appreciation that fisheries systems are complex beyond our immediate grasp. Approaches for implementing the precautionary approach are detailed in the following commandments (see also González-Laxe 2005).

Hand-in-hand with a precautionary approach is the adaptive approach, which calls for learning by doing in the face of incomplete knowledge. As originally proposed by Holling (1978) and refined by Lee (1993), adaptive management treats economic uses of nature as experiments, so that we may learn efficiently from experience. As Lee (1993:9) says, "Linking science and human purpose, adaptive management serves as a compass for us to use in searching for a sustainable future." Of particular importance to this discussion, adaptive management is ecosystem-based rather than based solely on jurisdictional criteria, and operates on a time scale that is biologically driven. In the context of adaptive management, ecosystem-based fisheries scientists should encourage implementation of management policies that test hypotheses regarding sustainable fisheries in a cycle of informed trial-and-error (Walters and Hilborn 1976; Walters 1986). Modeling plays a central role in this approach, both in generating hypotheses and synthesizing information (Latour et al. 2003; Walters and Martell 2004). Lee (1993) gives an excellent example of an attempt at adaptive management regarding salmon enhancement in British Columbia.

COMMANDMENT 2: *Question key assumptions, no matter how basic.*

Here lies the concept, MSY.
It advocated yields too high.
—Peter Larkin (1977:10)

This is a critical commandment for any kind of science, but is particularly true for science which is advisory to fishery management decisions. For example, the most common and sophisticated single-species stock assessment models often assume that: (1) recruitment is solely a function of spawning biomass; (2) natural mortality is constant over the time frame of stock assessment; (3) unexploited biomass is constant; (4) if exploitation ceases, the stock biomass will rebuild to that unexploited level due to endogenous density-dependent mechanisms; and (5) for any given level of fishing effort, stock biomass will approach an equilibrium at which it will remain in perpetuity. Now the question is not whether these assumptions are actually true, but whether making these assumptions affects the integrity of the stock assessment. Consider documented violations of each assumption:

1. Recruitment of many marine fish stocks appears to depend as much on stock structure (e.g., spatial distribution, age structure) as on cumulative stock biomass (Berkeley et al. 2004b).
2. Natural mortality can be highly variable in time and space (Sogard 1997), and constant values used in stock-assessment models often have little or no empirical basis (Vetter 1988). Walters (2000) argues that whole-ecosystem processes (e.g., food web dynamics) can have profound effects on individual stock processes, such as natural mortality and the nature of recruitment.
3. If one takes the best estimate of highly variable recruitment from a recent stock assessment of Pacific hake (*Merluccius productus*) and simply runs an unexploited version of the stock assessment model over that trajectory, estimated unexploited stock biomass will vary considerably. One might then ask what the concept of constant unexploited biomass (B_o) means in this case. Additionally, increasing evidence indicates that density dependence in at least demersal (seafloor-associated) marine fishes is largely caused exogenously by predation rather than endogenously by competition (Hixon and Jones 2005). Accordingly, a more modern view of MSY and its associated biomass (B_{MSY}) is as a dynamic equilibrium incorporating natural variability in recruitment and survivorship, and potentially incorporating biological interactions if they can be quantified (Mace 2001).
4. The collapse of fisheries for northern cod (Bundy 2001; Haedrich and Hamilton 2000, Longhurst 1998) and West Coast rockfish (Ralston 1998; Gunderson 1984; Levin et al. 2006) clearly show the incapacities of marine ecosystems to "rewind" from overfishing. When marine ecosystems are contorted enough by exogenous factors, thresholds are passed and the rules of organization change. Not only are new stability domains created, but also reversibility (i.e., stock rebuilding) is no longer a meaningful assumption.
5. The cases of Pacific hake (above) and Bristol Bay sockeye salmon (*Oncorhynchus nerka;* Hilborn et al. 2003) suggest that stocks may have no long term equilibrium behavior.

Once again, any scientific assessment requires making assumptions about the way nature works. The important point is to be explicit about those assumptions and question them within the context of the particular issue being addressed.

Walters et al. (2005) have used ecosystem models to show that widespread application of the contemporary (MSY-proxy) single-species management approach could lead to dramatic impacts on ecosystem structure, particularly where such approaches are applied to forage species. The lesson is that fisheries scientists should exercise caution in recommending MSY policy based on single-species assessments that ignore the ecosystem roles of exploited species. There are at least two perspectives on coping with this issue, both of which are held by different authors of this article. One is to view MSY as an evolving and viable paradigm that has not always been implemented properly in the past, but is nonetheless essential in fisheries science (Mace 2001, 2004). The other is to replace MSY with a more holistic "ecologically sustainable yield" (ESY) (Zabel et al. 2003). The concept of ESY could include a variety of indicators (Froese 2004), including

1. Percentage of mature fish in the catch, with the target approaching 100%;
2. Percent of fish near optimum length in the catch, with the target approaching 100%; and

3. Percentage of "big, old, fat female" spawners in the catch (see Berkeley et al. 2004b), with the target approaching 0%.

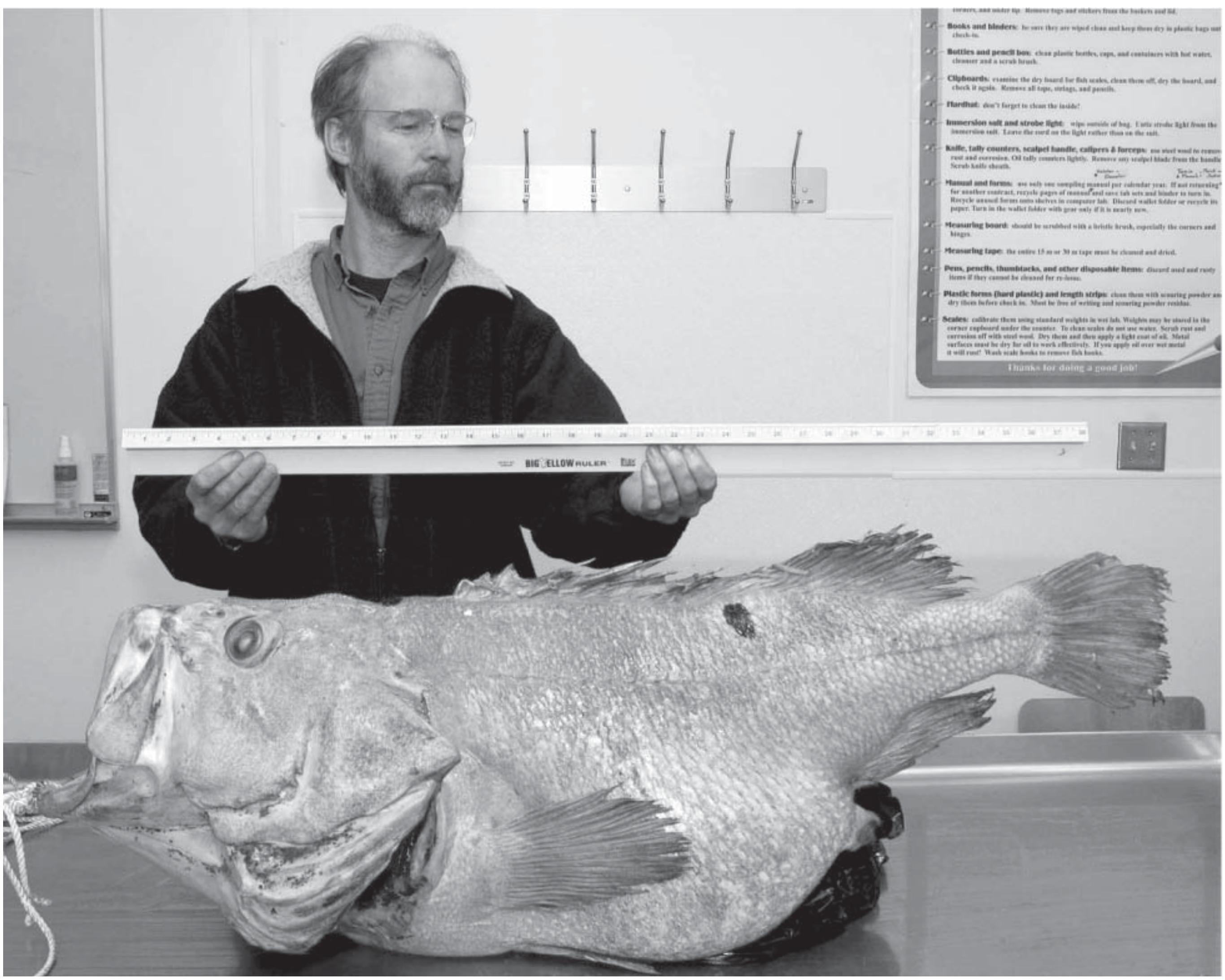
COMMANDMENT 3:
Maintain old-growth age structure in fish populations.

Logic surely demands that a fishery for a species having intermittent recruitment must somehow eschew the common practice of truncating the age structure.

—Alan Longhurst (2002:6)

Recent (and even not so recent) studies belie three implicit assumptions of traditional fisheries biology regarding spawning females of relatively long-lived species. The first assumption is that all eggs are identical, and in particular, that eggs from younger smaller females and older larger females are equivalent (Beverton and Holt 1957). This notion has persisted despite early evidence that larger females produce larger eggs (Nikolsky 1953). Recent experiments on Pacific rockfish (genus *Sebastes*) have demonstrated that older females produce eggs with larger oil droplets, resulting in larvae that both grow faster and survive starvation better than larvae from younger females (Berkeley et al. 2004a). Such maternal effects are evident in a variety of fish species (reviews by Chambers and Leggett 1996; Heath and Blouw 1998; Berkeley et al. 2004b; Berkeley 2006; Longhurst 2006).

The second assumption of traditional fisheries biology is that all mature females are equivalent in terms of spawning behavior. They often are not. In a broad range of marine fishes, older females spawn earlier and may have more protracted spawning seasons than younger females (Berkeley and Houde 1978; Pederson 1984; Lambert 1987; Berkeley et al. 2004b). In environments where larval food production and larval drift vary either seasonally or in unpredictable ways, fish that spawn at the wrong time or place will not contribute to the new cohort because their larvae will perish. Off Oregon, older female black rockfish (*Sebastes melanops*) spawn earlier than younger females (Bobko and Berkeley 2004), and in some years are responsible for producing most of the new cohort despite the fact that older females comprise a small fraction of the spawning stock (Bobko 2002). Similar patterns are



Commandment 3. Big (44 in), old (ca.100 y), fat (60 lb.), fecund female shortraker rockfish (*Sebastes borealis*) taken off Alaska (Karna McKinney, Alaska Fisheries Science Center, NOAA Fisheries Service).

evident in Icelandic cod (*Gadus morhua*; Marteinsdottir and Thorarrisson 1998) and North Sea haddock (*Melanogrammus aeglefinus*; Wright and Gibb 2005).

The third assumption is that long-lived individuals per se are not essential for an exploited stock to persist. In reality, the evolution of long life spans with repeated spawning (iteroparity) is now recognized as a bet-hedging response to variable environments where larval survival and successful recruitment may be uncommon (Leaman and Beamish 1984; Longhurst 2002, 2006; Hsieh et al. 2006). Long-lived spawners thus provide a "storage effect" whereby a stock will persist as long as enough adults outlive periods unfavorable to successful spawning and recruitment (Warner and Chesson 1985). This pattern is expected to be particularly important at the margins of species ranges, where successful recruitment is often rare (MacCall 1996). Additionally, age-related differences in the time and location of spawning (Berkeley and Houde 1978; Lambert 1987; Hutchings and Myers 1993) may spread larval production in a way that accounts for temporal and spatial variability in larval environments. Indeed, there is genetic evidence that Hedgecock's (1994a,b) "sweepstakes hypothesis" occurs in West Coast rockfishes (review by Berkeley et al. 2004b; see also Field and Ralston 2005). Available data indicate that each new cohort is the product of a small fraction of all spawners, and that this small group of successful spawners changes both spatially and temporally due to unpredictable variation in larval environments.

The fact that traditional fishery biology often subsumes these considerations indicates that the age and size structure of a stock are likely as important as the magnitude of its spawning biomass in providing sustainable catches (Berkeley et al. 2004b; Beamish et al. 2006). The obvious conclusion is the need to minimize what has conventionally been seen as an expected and harmless side-effect of fishing to maximize density-dependent surplus production: age and size truncation (the loss of older age classes and larger size classes). Such alteration of population structure is prevalent among many fishery species (e.g., for the West Coast, see Harvey et al. 2006; Levin et al. 2006) and is now seen as leading to "longevity overfishing" (Beamish et al. 2006; Hsieh et al. 2006).

Old-growth age structure can be maintained by three approaches (Berkeley et al. 2004b):

1. Lowering catch rates substantially, which can be economically infeasible;
2. Implementing slot limits (release of both small and large individuals), which is often impossible due to capture mortality (e.g., via swimbladder expansion); and
3. Implementing marine protected areas (MPAs) to ensure that at least part of the stock can reach old age and large size.

Berkeley (2006) has modeled these scenarios and concluded that, for species similar to rockfishes, utilizing MPAs may provide the greatest fishery yields. At the very least, ecosystem-based fisheries scientists should monitor age and size structure, and incorporate these considerations into stock assessments.

COMMANDMENT 4: *Characterize and maintain the natural spatial structure of fish stocks.*

> *Broad spatial distribution of spawning and recruitment is at least as important as spawning biomass in maintaining long-term sustainable population levels.*
>
> —Steven Berkeley et al. (2004b:23)

Traditional fisheries biology was founded on the assumption of unit stocks: regionally interbreeding populations that are reproductively closed (Cushing 1968; Pitcher and Hart 1982). In modern parlance, a stock is actually a "metapopulation" comprising local populations linked by larval dispersal (Kritzer and Sale 2004), rather than the older and often false assumption of a larger, spatially discrete and reproductively isolated population (reviews by Frank and Leggett 1994; Field and Ralston 2005). Recent genetic and otolith microchemical studies indicate that marine stocks have complex spatial structures at much smaller scales than previously assumed (reviews by Laikre et al. 2005; Gunderson and Vetter 2006). For example, most of some 60 species of rockfish (*Sebastes*) are assessed as single stocks along the entire Washington-Oregon-California coast of the United States. Yet, recent genetic analyses show substantial geographical discontinuities that indicate multiple, isolated stocks along this coastline (Rocha-Olivares and Vetter 1999; Buonaccorsi et al. 2002, 2004, 2005; Cope 2004; Miller and Shanks 2004; Gomez-Uchida and Banks 2005; Hawkins et al. 2005; Miller et al. 2005).

The important implication of these findings is that a decline in fish abundance in one region may not be replenished quickly or inevitably from another region. Thus, averaging stock assessments among regions may result in localized overfishing. Management fallout from this scenario is that the fishing community in one region may be unfairly penalized for overfishing that occurs in another, ecologically distinct region.

How can this dilemma be avoided? In short, the artificial spatial scale of stock assessment and management must better align with the natural spatial scale of target populations. Each managed species should be screened for stock subdivision using now well-developed and reasonably-priced genetic and otolith approaches. We anticipate that ecological regions will emerge where stock boundaries of particular groups of species are coincident. Until such analyses are completed, and as the first approximation in an adaptive process, initial subdivisions could be based on well-documented biogeographic boundaries, such as the series of large capes along the U.S. West Coast. Such ecologically-based regions should initially define the spatial units of stock assessment and management, rather than the arbitrary political regions presently used. Eventually, new data will allow delineation of actual metapopulation boundaries.

If present management regions, such as the entire U.S. West Coast, are subdivided into so many ecologically-based regions that multiple stock assessments as traditionally implemented become prohibitively expensive, then more robust and less data intensive approaches should be implemented to assure stock sustainability and ecosystem integrity (see Froese 2004). These approaches include less aggressive catch quotas, as well as use of novel tools to ensure stock viability, such as marine protected areas (NRC 2001; Ward et al. 2001; Shipley 2004; Sobel and Dahlgren 2004). In any case, continuing to rely on traditional stock assessments that either ignore or artificially delineate the true spatial structure of fish populations is clearly a recipe for disaster.

COMMANDMENT 5:
Characterize and maintain viable fish habitats.

No habitat, no fish—
it's as simple as that.

—Anonymous

Within the biogeographical region inhabited by a particular stock, the types of fish habitats and their spatial distributions must also be incorporated into fisheries science if sustainability is to be ensured (Benaka 1999; Coleman and Travis 2000). Seafloor mapping and fish habitat characterization over broad spatial scales is now a reality (Barnes and Thomas 2005 and included papers). Until Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) were incorporated as part of fisheries management law in the United States, there was little focus on habitat by traditional fisheries biology. An ecosystem-based approach includes identification of nursery habitats, spawning sites, and other areas required to maintain stock integrity, and protection of those areas from bottom-gear impacts and other deleterious activities (NRC 2001, 2002). Importantly, much seafloor habitat is biogenic, created by corals, kelps, seagrasses, and other structure-forming organisms, so protection of fisheries habitat is truly equivalent to conserving the biodiversity of seafloors (see Kaiser et al. 2002, 2006). Additionally, stock assessments of demersal species should take into account the fact that the seafloor is heterogeneous, thereby increasing the accuracy of assessments via integration of spatially explicit population sampling with seafloor habitat mapping (Nasby-Lucas et al. 2002; NRC 2004). In short, ecosystem-based fisheries science is inherently place-based at multiple spatial scales.

COMMANDMENT 6:
Characterize and maintain ecosystem resilience.

Even though the scientists on a team may be world-class experts in their respective component fields, they are all likely to be amateurs when it comes to the system as a whole.

—Craig Nicholson et al. (2002:383)

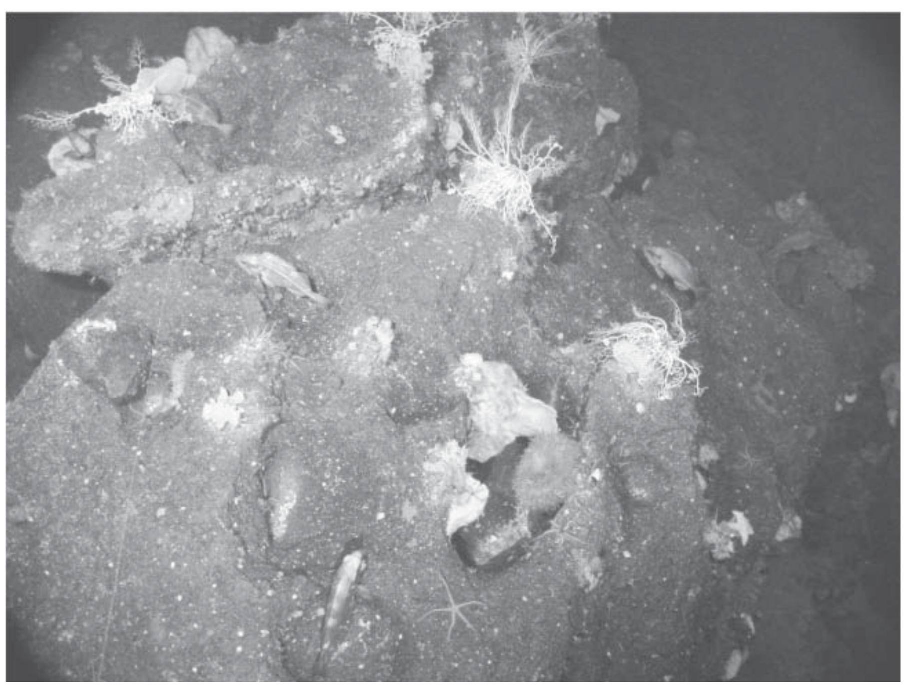
The science of both ecological and social systems has undergone a major conceptual change in the past few decades—the recognition that nature is seldom linear (the rules of organization can change) and often unpredictable (Berkes et al. 2003). The concept of "resilience" is a useful scoping device for integrating ecosystem and social system complexity. This concept originated in ecology and has been applied and studied primarily in the context of non-human systems. However, there have recently been attempts to apply the concept in the broader context of social-ecological systems (Levin et al. 1998; Berkes et al. 2003). Taking the narrower line and focusing on natural ecosystems, "resilience" is defined as "the extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping into alternate states" (Hughes et al. 2005:380). Walker et al. (2004) describe four crucial components of resilience (see also Gunderson 2000):

1. **Latitude:** the maximum amount a system can be changed before losing its ability to recover;
2. **Resistance:** the ease or difficulty of changing the system;
3. **Precariousness:** how close the current state of the system is to a limit or threshold; and
4. **Panarchy:** dependence of the focal system on processes occurring and scales above and below (influence of cross-scale interactions).

The first three components define the capacity of an ecosystem to maintain its current rules of organization. Since food webs comprise the fundamental organizing relationships in ecosystems (Paine 1980), these first three components really refer to the nature of the stability domain of the existing food web—how broad is it, how resistant is it to change, and how close is the current food web to reorganizing. Gaichas (2006) and Little et al. (personal communication School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington) attempt to quantify these first three components with regard to the Gulf of Alaska and Northern California Current coastal marine ecosystems, respectively.

The final component of resilience, panarchy, refers to the cross-scale effects that can occur in both space and time. Climate change is a perfect example of a major marine ecosystem perturbation that is occurring at very different temporal and spatial scales than those that previously dominated the structure and function of most marine fishery ecosystems, and yet has a huge potential impact on ecosystem resilience (see Commandment 8). A sec-

Commandment 5. Bank rockfish (*Sebastes rufus*) and basket stars live at 200-m depth on a rocky seafloor at Cherry Bank off California (Northwest Fisheries Science Center, NOAA Fisheries Service).



ond example of panarchy is metapopulation structure manifested as a complex network of source and sink populations with vast spatial reach (Frank and Leggett 1994). Field and Ralston (2005) describe an example of this phenomenon regarding rockfish in the California Current system.

And so, within the context of an ecosystem as a complex adaptive system (Levin 1998), there are two looming questions that must eventually be addressed by ecosystem-based fisheries scientists:

1. How is ecosystem resilience created and maintained in exploited systems?
2. How can this understanding be translated into fishery management policy?

Evolving ecosystem indicators will provide useful tools for monitoring resilience (reviews by Cury and Christensen 2005; Jennings 2005). In any case, the emerging paradigm is one in which marine biodiversity per se at the genetic, population, and ecosystem level is valued by fisheries science as an essential requisite for the resilience of fisheries (Hughes et al. 2005). This recognition underscores the importance of monitoring bycatch and other collateral loss of sea life during fishing activities and minimizing that loss via gear modifications and marine protected areas (Crowder and Murawski 1998; Lewison et al. 2004). It also indicates the value of marine reserves for enhancing resilience by ensuring that at least portions of ecosystems remain relatively intact (NRC 2001).

COMMANDMENT 7:
Identify and maintain critical food-web connections.

> *To keep every cog and wheel is the first precaution of intelligent tinkering.*
>
> —Aldo Leopold (1953:146)

The structure of an ecosystem is defined by relationships, and food webs create the fundamental organizing relationships in ecosystems (Paine 1980), especially in the context of fisheries (Mangel and Levin 2005). From this point of view, one of the most important tasks of EBFS is to understand food web relationships, and subsequently use them to form a context for setting fishery management policy. Mathematical modeling is an imperfect but useful tool for exploring the consequences of various fishery management policies. And if we want to explore complex interactions and tradeoffs, we are almost forced to use some kind of mathematical model. Walters and Martell (2004:xix) put it this way:

> *[Fisheries] management is a process of making choices. There is no way to make choices without making at least some predictions about the comparative outcomes of the choices, and these predictions cannot be made without some sort of "model" for how the world works.*

And thus, like it or not, to the extent that food-web processes affect ecosystem resilience and fishery productivity, they need to be better understood and incorporated into stock-assessment and management models. Of course, models have their limits in terms of their abilities to represent complex adaptive dynamics.

The words of Levin (1998:433) certainly ring true in this regard: "All ecosystems are complex adaptive systems, governed by similar thermodynamic principles and local selection." Yes, the laws of thermodynamics are universal and do apply. And it is those laws that serve as a basis for the way we model ecosystems. However, the ocean environment is highly variable. The heat of the sun, spin of the Earth, and structure of the ocean basins create an ever-changing mosaic of marine habitats—a mosaic that, over deep time, has guided the evolution and organization of life in so many different directions. On top of that, ecosystems are non-linear—their rules of interaction change as the system evolves.

And so, what evidence do we have that, in fact, food web processes affect ecosystem resilience and fishery production? And what actions can we take to begin to further understand these patterns and mediate management concerns?

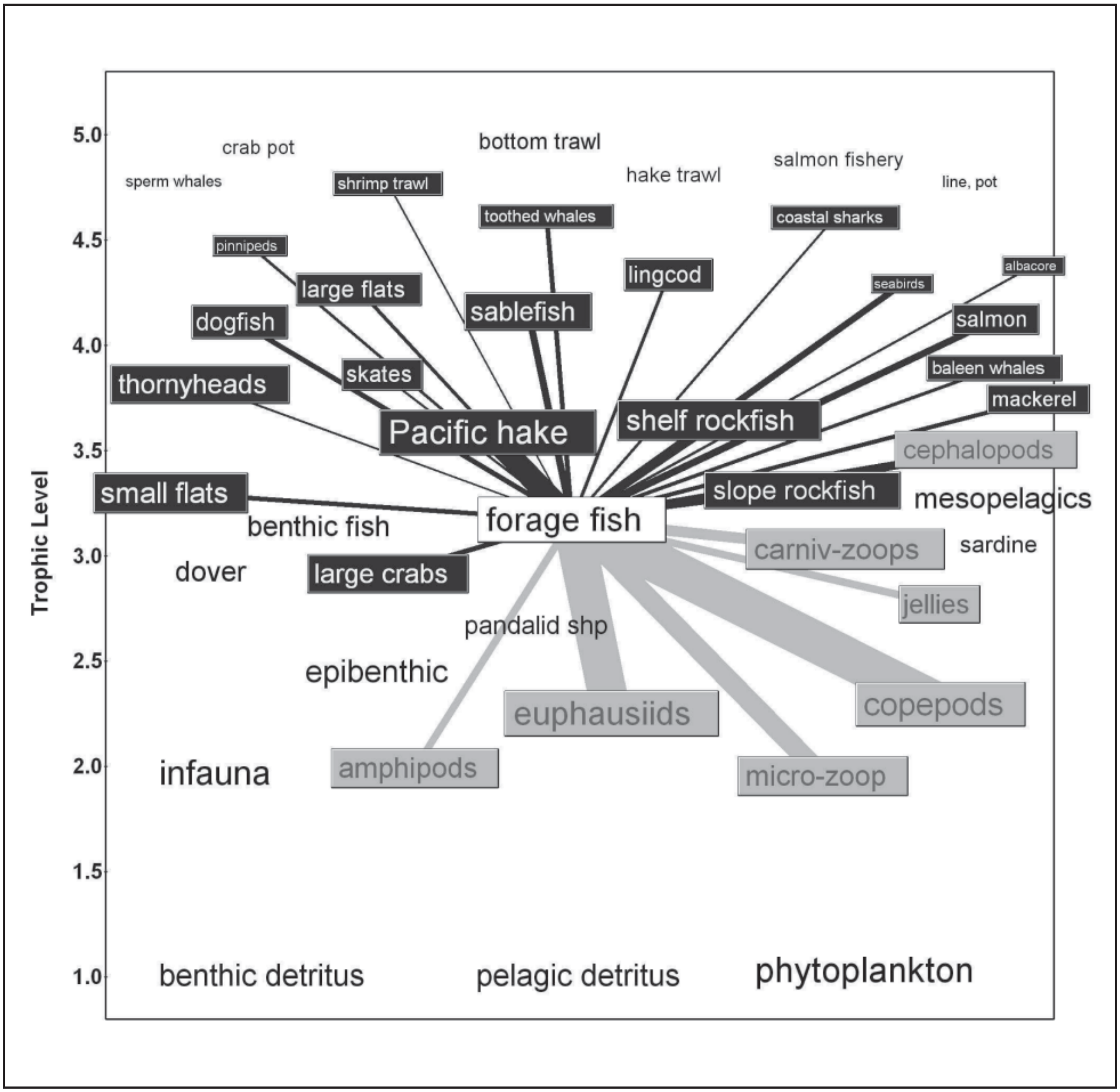
1. **Northern cod collapse.** A model of the Newfoundland-Labrador ecosystem (Bundy 2001) suggested that although overfishing drove massive declines in northern cod abundance, cod recovery was likely hindered by top-down food web processes. This seems to be a concrete example of the existence of ecological feedbacks such as cultivation-depensation (Walters and Kitchell 2001). In addition, the model suggested that declines in cod and several other heavily fished species may have resulted in increases in commercially valuable invertebrates. This example suggests that the entire single-species concept of overfishing and recovery needs to be readdressed in an ecosystem context. This conclusion overlaps with Commandment 2 by questioning key assumptions of conventional fisheries biology and the whole concept of recovery from overfishing.
2. **Alaska ecosystem reorganization**. Springer et al. (2003) present a convincing argument that the sequential collapse of four northeastern Pacific marine mammal species (northern fur seal, harbor seal, Steller sea lion, and sea otter) in recent decades was caused by increased predation (top-down forcing) which resulted from altered food-web dynamics brought about by the post-World War II decimation of the great whales of the region. They postulate that the extremely rapid reduction of whale biomass profoundly altered the workings of the ecosystem, in terms of both predation by baleen whales on zooplankton and forage fish, and predation by killer whales on great whales. A combination of population-matrix and bioenergetic models was used to support the robustness of their inference. Their conclusion is that commercial whaling in the North Pacific set-off one of the longest (half-century) and most complex ecological chain reactions ever described. This example suggests that exploiting species with strong connections to forage organisms could trigger severe and long-term ecosystem shifts. Additionally, it points out the potential top-down effects of large-scale and rapid removals. Both these lessons indicate that ecosystem-based fisheries scientists would do well to recommend avoidance of such activities.
3. **Fishing-induced trophic cascade on Scotian Shelf.** Frank et al. (2005) documented long-term dramatic shifts in the Scotian Shelf ecosystem caused by the overfishing of northern cod and other large predatory fishes (see also Scheffer et al. 2005). The demise of these top predators caused increases in the abundance of their prey (including small fishes and shrimp), which in turn resulted in declines of their prey (large-bodied zooplankton), which in turn caused increases in the abundance of their prey (phytoplankton), which ultimately resulted in declines in nitrate utilized by the phytoplankton, a classic

trophic cascade. As in previous examples, this case suggests the importance of an ecosystem perspective in developing the concept of overfishing (see Murawski 2000; Little et al. personal communication).

4. **Northern California Current ecosystem and climate.** Field et al. (2006) showed that climate can affect ecosystem productivity and dynamics both from the bottom-up (through short- and long-term variability in primary and secondary production) as well as from the top-down (through variability in the abundance and spatial distribution of key predators). Incorporating both top-down and bottom-up effects of climate forcing into an Ecosim model for the Northern California Current significantly improved the performance of the model over a 40+ year historical time series. This pattern certainly shows the controlling influence that climate has on a major predator like Pacific hake (*Merluccius productus*). Clearly, fisheries scientists recommending harvest policy on such species should keep this example in mind.

Echoing the ramifications of Com-

Commandment 7. The central and crucial role of various forage fish (mostly clupeids and osmerids) in the northern California Current food web during the 1990s. Black boxes are predators of these forage fish and gray boxes are their prey, including very small cephalopods. Boxes are positioned by mean trophic level and sized by log-scaled standing-crop biomass. Trophic lines are scaled by biomass flow from prey to predator (John Field and Kerim Aydin).



mandment 6, such case studies underscore the importance of maintaining the integrity and biodiversity of marine ecosystems, not only obviously important top predators and forage species, but also the entire the food web on which fishery species depend. In this sense, it is imperative to keep in mind that target populations not only may be regulated and stabilized by their predators and competitors (review by Hixon and Jones 2005), but also may in turn affect the populations and biodiversity of their prey (review by Hixon 1986).

COMMANDMENT 8:
Account for ecosystem change through time.

> *Nothing is permanent but change.*
> —HERACLITUS

The issue of time presents itself to fishery scientists in at least two ways. First, it challenges the conventional scientific method in terms of our inability to predict the behavior of complex adaptive systems. And second, it stretches the traditional time domain of management in terms of the effects of the physical climate on ecosystem structure and dynamics. Consider each of these issues in turn:

Scientific method. Clearly ecosystem structure unfolds in time and this happens at a vast number of scales. Carpenter (2002) points out that the range of turnover times in ecosystems spans at least 12 orders of magnitude, from the split-second generations of bacteria to the millennial generations of redwoods. In order to operationalize the concept of the ecosystem in the context of resource management, we must allow our thinking to range from evolutionary time (Levin 1998) to sudden interannual shifts in ecosystem organization (Hughes 1994).

Folke et al. (2004) point out the importance of slow changing variables in structuring ecosystem resilience. Examples include long-term shifts in marine ecosystems induced by exploitation (see Commandment 7). Carpenter (2002:2070) describes "the long now" as a way of connecting the past, present, and future of ecosystems. What he strives for is a way to look forward in a way informed by the past:

> *The ecology of the long now helps us understand how present ecosystem states came to be, how present decisions impact future ecosystems, and how systems of people and nature might be perpetuated.*

Of particular importance is the idea that prediction has very limited use when dealing with ecosystems, because in order to predict for a given time horizon, one must treat slow variables as parameters (constants). And with the exception of very limited time horizons:

> *The future dynamics of ecosystems are contingent on drivers that are outside the domain of ecology, such as climate change, human demography, or globalization of trade. The probability distribution of ecological predictions depends in part on the distributions of such drivers, but future driver distributions may be unknown or unknowable. Therefore the uncertainty of the ecological prediction cannot be calculated.*

And so, how do we examine the future under such constraints on prediction? Carpenter (2002) proposes scenarios—narratives of plausible futures consistent with ecological understanding and their estimated probabilities based on current knowledge. Perhaps, most importantly, is the point that "scenarios encourage action whereas uncertainties sometimes lead to doubt, inaction, and further analysis" (Carpenter 2002:2080). Scenarios provide a context for the future by stimulating broad thinking. Bundy (2001) used a model of the Newfoundland-Labrador ecosystem and fishery to explore scenarios for observed ecosystem responses after cessation of fishing in the early 1990s (e.g., failure of cod to recover, increases in snow crab and shrimp fisheries). Little et al. (pers. comm.) used a similar model of the Northern California Current ecosystem and fishery to develop scenarios for both short-term and long-term interactions and feedbacks between fleet and ecosystem structures.

Physical climate. Climate variability clearly has a huge impact on the structure and dynamics of marine ecosystems. Focusing on the California Current coastal marine ecosystem as an example, the effects of climate on the biota of the ecosystem have long been known (e.g., Hubbs 1948; Chelton et al. 1982). Currently the El Niño/Southern Oscillation (ENSO) is widely recognized to be the dominant mode of interannual variability in the equatorial Pacific, with impacts throughout the rest of the Pacific basin and globe (Mann and Lazier 2006). In addition to interannual variability in ocean conditions, the North Pacific seems to exhibit substantial interdecadal variability (Francis et al. 1998). Mantua et al. (1997) first described what is now commonly referred to as the Pacific (inter) Decadal Oscillation (PDO) which is defined technically as the leading principal component of North Pacific (N of 20° N) sea surface temperature between 1900-1993. Numerous studies have shown links between these two climate processes and biological production in the California Current (e.g., McGowan et al. 1998, Peterson and Schwing 2003, Peterson and Keister 2003 for zooplankton; Hare et al. 1999, Logerwell et al. 2003 for salmon; Field and Ralston 2005 for rockfish recruitment; Field et al. 2006, Little et al. personal communication for the Northern California Current Ecosystem).

Processes we have come to think of as cyclic are really evolutionary when examined at the appropriate time scale. Using proxy records from trees and corals, Gedalof et al. (2002) indicate that the PDO does not appear to have been a robust feature of North Pacific climate variability over the past two centuries. Whereas it had a strong interdecadal signature during the twentieth century (Mantua et al. 1997), it had a much reduced influence during the nineteenth century. Recent studies have questioned whether the PDO continues to be the dominant mode of interdecadal variability in North Pacific climate (Bond et al. 2003; Goericke et al. 2005).

Beyond recognized cyclical variation, the world oceans are now changing directionally into unknown territory due to global climate change, including increasing ocean acidity (reviews by Orr et al. 2005; Roessig et al. 2004; Harley et al. 2006). Despite denial in nonscientific circles, it is now obvious that the oceans are warming (Levitus et al. 2000; Hansen et al. 2005) and the scientific consensus regarding this fact is equally clear (Oreskes 2004; IPCC 2007). A major effect of ocean warming is ongoing poleward shifts in the geographic distributions of fishery species (Perry et al. 2005), as well as species of plankton (Hays et al. 2005), benthos (Barry et al. 1995), and marine diseases (Harvell et al. 1999). Models additionally predict that upwelling patterns, and thus the distribution and abundance of productive fisheries, could shift dramatically (Bakun 1990; Diffenbaugh et al. 2004). Indeed, spatial patterns of primary production in the North Atlantic (Richardson and Schoeman 2004) and secondary production in the Southern Ocean (Atkinson et al. 2004) are already changing detectably. Additionally, the frequency of cyclical events, such as El Niño conditions, is predicted to increase (Timmermann et al. 1999). In the Pacific, Paya (2005) and Field (personal communication, NOAA Fisheries Service Southwest Fisheries Science Center, Santa Cruz, California) report a recent poleward range expansion of jumbo squid (*Dosidicus gigas*) into waters off Chile and California, respectively, with potentially profound effects on food webs (e.g., consumption of hake in both systems). Paya (2005) estimates that squid predation has decimated the Chilean hake biomass from 1.2 million to 300,000 metric tons in 2 years.

Such ongoing and predicted shifts indicate the need for ecosystem-based fishery scientists to monitor at least the boundaries and characteristics of stocks through time, and in any case, to implement both precautionary and adaptive approaches to address unpredictable directional change in fishery systems. In any case, what is true today may very well not be so tomorrow.

The degree to which long-term climate change is affecting the world's oceans and their ecosystems relative to other forms of variability is currently a major concern, and the consequent interactions among monotonic (global warming), interdecadal (PDO), and interannual (ENSO) climate variability are difficult to disentangle. The bottom line is that climate variability and change have major impacts on coastal marine ecosystems and their fisheries, and so any ecosystem-based fishery science must attempt to take these phenomena into account despite ever-growing uncertainty. The first step would be to reject any notion that we have the capacity to fine-tune allowable biological catches to the razor edge of MSY (Schrank 2007). Rather, the risk-averse approach to MSY is to set targets with sufficient margins of error to reflect variations in life history and recruitment of target species, ocean productivity, and errors in estimation and implementation. Perhaps MSY would be more realistically characterized as a time-dependent variable (MSY_t). Additionally, marine reserves could serve as reference sites to help disentangle the local effects of fishing from the global effects of human activities (NRC 2001).

COMMANDMENT 9:
Account for evolutionary change caused by fishing.

> *Yet ultimately the success for fishery management may be judged not by the catch achieved in any given year or decade, but by whether it was sustained across future generations.*
>
> —David Conover (2000:306)

Traditional fisheries biology has not fully recognized the potential of fishing mortality to cause directional selection in fish populations (reviews by Frank and Leggett 1994; Conover 2000; Hutchings 2000; Law 2000; Stokes and Law 2000; Walters 2000; Law and Stokes 2005; Longhurst 2006). A truly ecosystem-based fisheries scientist takes a Darwinian perspective of how fishing affects fish populations, acknowledging that most fisheries are selective by their very nature, and therefore comprise large-scale uncontrolled manipulations of life-history evolution via artificial selection (Rijnsdorp 1993). More generally, we believe that ecosystem-based management—that broader context now being forced on us by history and the law of consequences—is essentially the incorporation of more holistic evolutionary and ecological principles into natural resource management.

Selective fishing-induced mortality affects previously unfished populations by, first, reducing absolute fitness within the population (i.e., decreasing the proportional frequency of genotypes between generations), and second, changing the relative fitness of genotypes that code for different life histories within the population (Conover 2000). There are two specific issues regarding documentation of these effects (Stokes and Law 2000): (1) whether there is genetic variation for traits selected by fishing, and (2) how strong the selection caused by fishing is. Available evidence suggests that heritabilities of traits affected by fishing are large enough to lead to observable evolution over mere decades of fishing. There is also ample evidence that large phenotypic changes have occurred in major fish stocks due to differentially targeting larger and older size and age classes (i.e., size and age truncation), including reduction in length and age at maturation and overall reduction in size-at-age (reviews by Stokes and Law 2000; Law and Stokes 2005). More directly, Conover and Munch (2002) demonstrated experimentally that selective fishing can cause evolutionary change, and Olsen et al. (2004) showed that such genetic effects occurred during the decline and collapse of the northern cod fishery.

Because fisheries-induced genetic changes in stocks are not easily reversed (de Roos et al. 2006), precautionary catch quotas and other efforts to sustain old-growth age structure, including life-history reference points in stock assessments, are important tools to avoid unwanted artificial selection. Additionally, theory suggests that marine reserves can protect against strong fisheries-based selection for earlier maturation (Baskett et al. 2005).

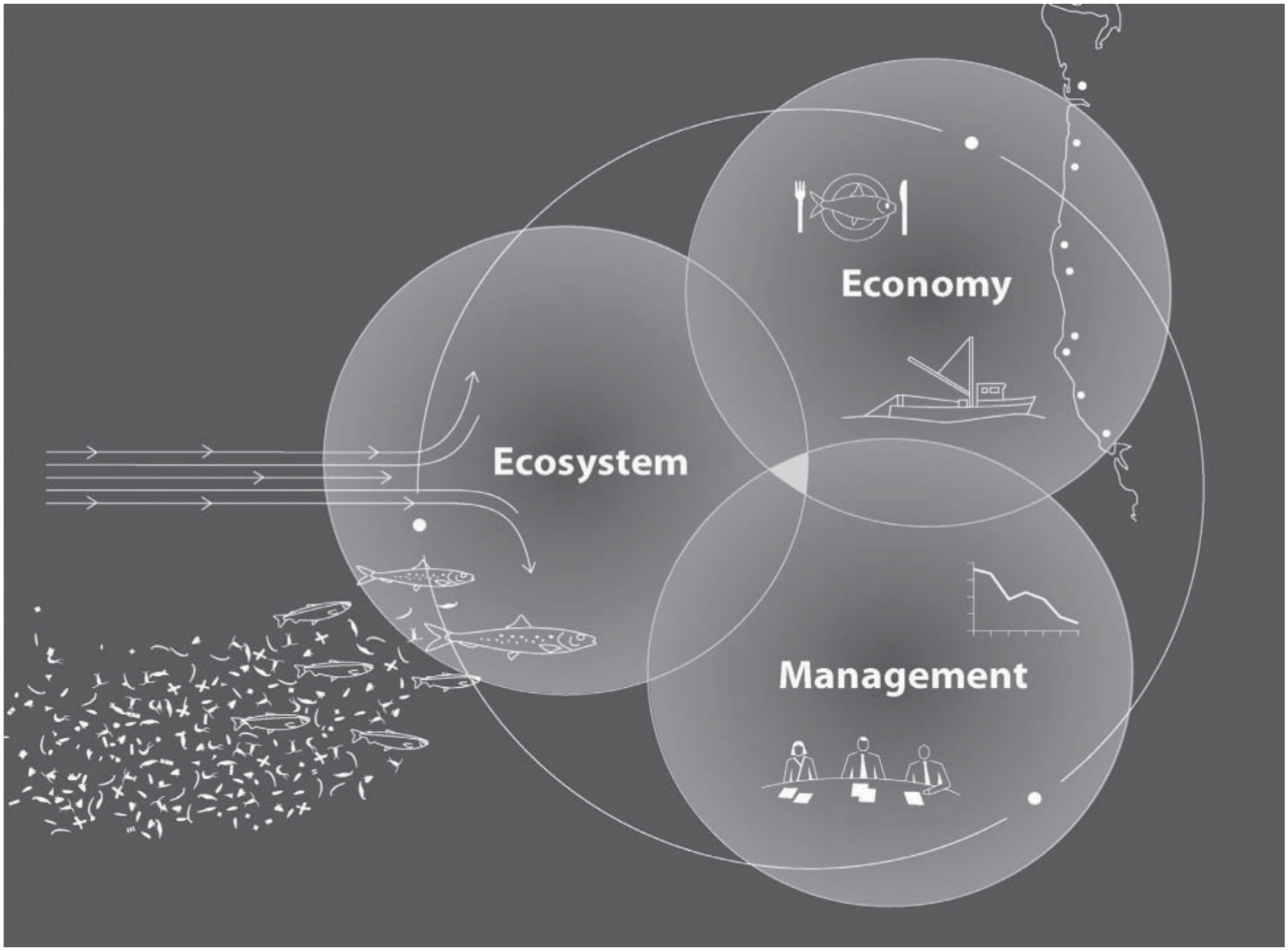
COMMANDMENT 10:
Implement an approach that is integrated, interdisciplinary, and inclusive.

> *When we try to pick out anything by itself, we find it hitched to everything else in the universe.*
>
> —John Muir (1911:110)

The kinds of issues raised by moving to a more holistic ecosystem-based approach to fishery science simply cannot be addressed adequately by a single disciplinary perspective. These issues require an integrated view to bridge perspectives and disciplines both within and among the natural and social sciences, integrating and synthesizing knowledge from disparate disciplines into an emerging field of "integrated assessment" (Nicolson et al. 2002). Add to this synthesis the fact that fishery science is only useful to the extent that it can help facilitate resource management decisions, and the reach of ecosystem-based fishery science broadens even more. Effective implementation of ecosystem approaches to fisheries management must necessarily embrace the full range of stakeholders and all concerned citizens.

In considering integrated assessment, two important points arise. First, integrated system models are often very useful tools for interdisciplinary researchers in that they:

Commandment 10. Marine fisheries as integrated social-ecological systems, including ecosystem-based fisheries science (Amity Femia).



1. Help codify knowledge from different disciplines into a unified and coherent framework,
2. Encourage integrated and clear thinking about causal relationships,
3. Allow researchers, managers and stakeholders to explore plausible scenarios, and
4. Identify crucial information gaps (Nicolson et al. 2002).

Second, in concert with Holling (1993) and Holling and Meffe (1996), we propose that EBFS should focus on "second stream" approaches to science (focus on interdisciplinary, holistic relationships between nature and society) which encourage management approaches (e.g., the "golden rule" of facilitating existing processes and variability) that are proactive rather than reactive.

Finally, one of the corollaries to all of these commandments is that ecosystem-based approaches require ecosystem-based data. Not only will information gaps need to be filled by additional scientific research and monitoring, but also ecosystem-based fisheries scientists would do well to better include and integrate the vast experiential knowledge of fishermen. Although such knowledge is informal, qualitative, and provincial, the accumulated information held by the fishing community is immense and certainly an important source of supplemental data.

THE FUTURE AWAITS

We acknowledge that these 10 "commandments" raise substantial questions regarding the details of implementation. We nonetheless argue that the ongoing paradigm shift toward ecosystem-based fisheries science must necessarily involve these action items to effectively guide fisheries management toward long-term and productive sustainability. Success will depend on creativity and ingenuity to devise specific methods to bridge the gap between general principles and full implementation. We emphasize that this paradigm shift does not comprise an abandonment of traditional fisheries biology, but rather a holistic extension of conventional approaches that grapples with the complexity of social-ecological systems in the face of incomplete knowledge.

Although the shift in worldview embodied in these commandments can occur immediately, the full implementation of ecosystem-based fisheries science will require an expanded empirical basis as well as novel approaches to modeling. This expanded knowledge base must include mechanistic ecological studies in the field, not only ocean observing systems (NRC 2003). Ultimately, we believe that ecosystem-based fisheries science must be fully implemented as soon as possible to avoid—or at least to delay—critical declines in seafood for an ever-expanding human population.

ACKNOWLEDGMENTS

This article evolved from a Western Society of Naturalists Presidential Symposium, "Re-integrating marine ecology and fisheries biology," convened by MAH on 14 November 2004 in Sonoma, California. We thank the National Marine Protected Areas Center Science Institute, courtesy of C.M. Wahle, for partially supporting this symposium. We are grateful for constructive comments from S. A. Berkeley, J. C. Field, D. L. Fluharty, the editor, and three anonymous peer reviewers. The ideas and opinions expressed herein are those of the authors as individuals, and do not necessarily reflect those of their employers.

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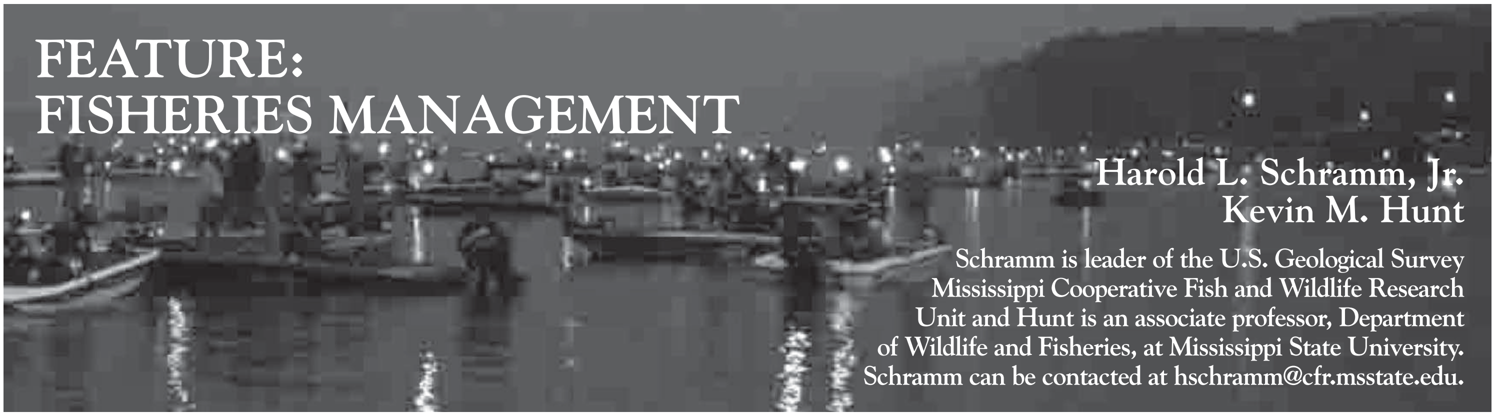


FEATURE:
FISHERIES MANAGEMENT

Harold L. Schramm, Jr.
Kevin M. Hunt

Schramm is leader of the U.S. Geological Survey Mississippi Cooperative Fish and Wildlife Research Unit and Hunt is an associate professor, Department of Wildlife and Fisheries, at Mississippi State University. Schramm can be contacted at hschramm@cfr.msstate.edu.

Fishing tournaments cause crowding at access areas and on the water. Social aspects of resource use remain as paramount problems with fishing tournaments.

Issues, Benefits, and Problems Associated with Fishing Tournaments in Inland Waters of the United States: A Survey of Fishery Agency Administrators

ABSTRACT: A web-based survey was administered to state fisheries agency administrators in 2005 to assess and prioritize the impacts of tournament fishing on management of inland fishery resources. Surveys were completed by fishery administrators of 48 state agencies and the District of Columbia. Respondents rated tournaments as neither strongly benefiting nor adversely affecting fishery management. Benefits of tournaments to fishery management grouped into four factors (in order of decreasing impact) characterized as enhancing fishery management agency effectiveness, stimulating interest in fishing and fishery resources, measuring economic value, and collecting biological information. Adverse impacts grouped into six factors (in order of decreasing impact), characterized as resource crowding, user-group conflicts, costs of tournaments to fishery agencies, non-traditional uses of fisheries resources, fish introductions, and adverse affects on fish populations. Tournament issues and impacts generally did not differ regionally and suggested the effects of tournaments do not vary among different fisheries. Comparison with previous surveys indicates that the prevalence of some benefits and problems have changed since 1989. Social issues remained paramount problems, but biological impacts were considered a lesser problem. Agencies recognized that tournaments can benefit fisheries management efforts and angler recruitment. Future management of tournaments should consider a management team approach.

Temática, beneficios y problemas asociados a los torneos de pesca realizados en aguas continentales de los Estados Unidos: una encuesta de la Agencia de Administradores Pesqueros

RESUMEN: En el 2005 se aplicó, vía Internet, una encuesta a los administradores pesqueros estatales para evaluar y priorizar el impacto de los torneos de pesca en el manejo de los recursos pesqueros de aguas continentales. Contestaron 49 administradores, incluido el del Distrito de Columbia. Ellos consideran que si bien los torneos no aportan beneficios mayores sobre el manejo de los recursos pesqueros, tampoco hay efectos adversos. Los beneficios se agruparon en cuatro tipos (mencionadas en orden de importancia decreciente): mejoras en el manejo pesquero por la eficacia de la Agencia, se estimula el interés en la pesca y los recursos pesqueros, evaluación de la derrama económica y el registro de información biológica. Los impactos adversos fueron agrupados en seis tipos (mencionados en orden de importancia decreciente): presión sobre los recursos, conflictos entre los diferentes tipos de usuarios, el costo de los torneos a las agencia pesqueras, usos no tradicionales de los recursos pesqueros, introducción de especies e impactos negativos en las poblaciones pesqueras. Se muestra que no existen diferencias regionales entre los temas e impactos de los torneos y se sugiere que los efectos de los torneos no varían entre las diferentes tipos de pesquería. Comparando estos resultados con un estudio previo se observa que la problemática y los beneficios asociados al desarrollo de los torneos han cambiado de 1989 a la fecha; los temas sociales siguen siendo relevantes, pero los impactos biológicos se consideraron como de poca importancia. Las agencias reconocen que los torneos pueden mejorar el manejo de las pesquerías y el reclutamiento de los pescadores. Para la planeación de los futuros torneos debe considerarse un trabajo más integral.

The rapid growth of fishing tournaments, especially bass tournaments (competitive fishing events targeting black bass [*Micropterus* spp.]), in the 1970s and 1980s generated both interest and concern among state fisheries management agencies. Some fisheries biologists and managers accepted tournaments as a valid use of fishery resources or saw tournaments as a potential benefit to fishery management, but many were concerned about adverse effects on fishery resources (Schramm et al. 1991a, 1991b). More recently, Muth et al. (1998) reported 35% of fisheries and wildlife professionals thought fishing tournaments were an appropriate use of fisheries resources, but 33% thought tournaments were an inappropriate use.

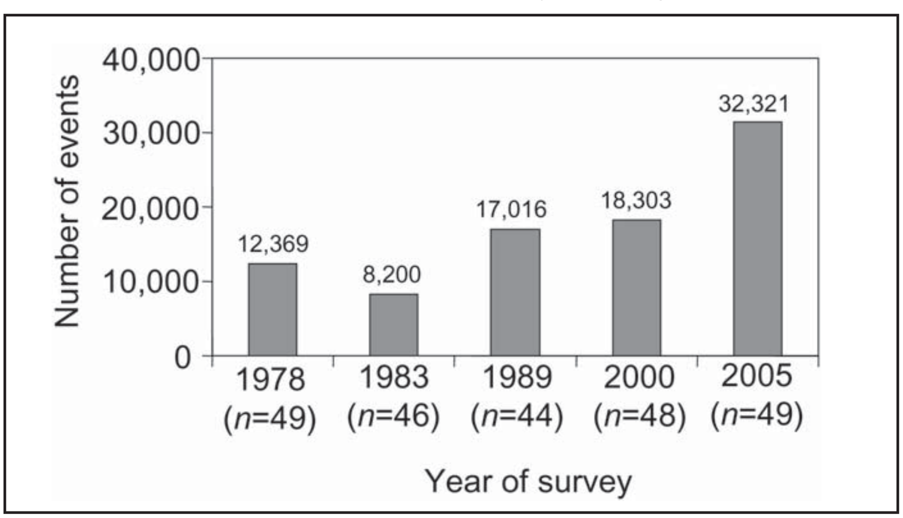
In 1986, the Competitive Fishing Committee was formed as a joint committee of the Fisheries Administrators and Fisheries Management Sections of the American Fisheries Society (Schramm et al. 1991b). The committee's charge was to assemble information about tournaments and other forms of competitive fishing. In 1989, the committee surveyed all fisheries agencies in North America to determine the scope of competitive fishing and to identify, through open-ended questions, biological and administrative benefits and problems (Schramm et al. 1991b). Based on the survey responses, the committee concluded that: (1) tournament fishing was a growing use of inland and marine fisheries resources, (2) tournament fishing provided both benefits and challenges to fisheries management, (3) problems associated with tournament fishing for some agencies were benefits to others, (4) problems were often perceived rather than documented, and (5) some benefits were potential opportunities but were not necessarily realized. Furthermore, the committee suggested that many aspects of tournament fishing remained undocumented.

In light of the perceived and real problems expressed by fisheries management agencies, the committee offered several suggestions for relieving some of the problems and resolving some of the contention associated with tournament fishing (Schramm et al. 1991a). The committee called for additional research to explore social issues such as conflicts among user groups and impeded access. Tournament fishing has clear economic aspects, but these remain largely undocumented. The committee suggested implementation of a permitting system to more fully capitalize on biological data opportunities, facilitate scheduling and distribution of tournaments where crowding and access are problems, encourage appropriate fish handling practices, and establish communication channels with anglers.

At the highest levels of competition, tournaments mean big money for the competitors. Tournaments generate substantial revenue for local economies.

Sixteen years have elapsed since the committee surveyed fisheries management agencies about problems and benefits associated with tournament fishing. Since then, tournament use of fisheries resources appears to have increased (Figure 1). Furthermore, given the recent growth in media attention to tournament fishing, most notably televised broadcasts of fishing tournaments and web sites that focus on tournaments, one could argue that tournaments are more conspicuous now than 16 years ago. Hence, the impacts of tournaments are potentially greater than in the 1980s when the committee surveyed fisheries agencies. Thus, we surveyed U.S. fisheries management agencies to assess and prioritize the current impacts of tournament fishing management on inland waters. This information was then used to evaluate changes in beneficial and adverse effects of tournaments on fisheries resources and fisheries management that may have occurred since the 1989 committee survey.

Figure 1. Estimated numbers of tournaments on inland waters in the United States. *n* is the number of responding fisheries management agencies. Estimates for 2005 are from the present survey; estimates for 1978 were from Shupp (1979), for 1983 were from Duttweiler (1985), for 1989 were from Schramm et al. (1991b), and for 2000 were from Kerr and Kamke (2003). Estimates for 1989 include some competitive events that may not be categorized as tournaments.



METHODS

We asked the chief fisheries administrator of each state inland fisheries management agency in the United States to complete a web-based survey. The survey was pre-tested by seven fisheries management biologists and administrators in different state agencies and modified as necessary to improve clarity and ease of completion. A brief letter that explained the purpose of the survey, stated the estimated time to complete it (15 minutes), solicited their participation, and provided the web address for the survey was sent to each administrator beginning in January 2005. As necessary, administrators were contacted up to four times to obtain a completed survey. The survey was approved for implementation by the Mississippi State University Institutional Review Board (IRB Docket #05-083).

To focus responses to the questions and facilitate and standardize estimation of the number of events, the administrators were asked to consider only those events that (1) are usually called tournaments (e.g., bass tournaments, walleye [*Sander vitreus*] tournaments) or (2) award substantial cash or goods (e.g., boats, vehicles) as prizes. Administrators were instructed to exclude events that target youth, such as fishing clinics, derbies, or rodeos, or other social events with fishing as a component. This clarification was intended to avoid variation in interpretation of what types of events to include in their assessment, a problem noted in the 1989 Competitive Fishing Committee survey (Schramm et al. 1991b), and to exclude events that may be more difficult to accurately account for.

The survey began by asking administrators to use a 10-point scale (1 = strong adverse effect, 10 = strong beneficial effect) to provide an overall rating of tournament impacts on their agency. The same question was repeated as the last question of the survey to assess whether the survey questions influenced their perceptions of tournaments or impacts of tournaments to their agencies. Additional questions explored specific tournament-related issues and obtained information on tournament permitting, registration, and reporting. Differences in overall rating of tournament impacts before and after the survey were tested by paired *t*-test. Differences in frequencies were tested by Chi-square. All tests were conducted with SAS Version 9.1, and differences were considered statistically significant at $\alpha = 0.05$.

We developed two separate measurement scales to allow administrators to evalaute benefits of and problems with fishing tournaments. The benefit-measurement scale included 21 items, and the problem-measurement scale included 29 items. Items included in these measurement scales were developed from fisheries agency responses obtained in previous competitive fishing and administrative surveys (Schramm et al. 1991b; Muth et al. 1998; Kerr and Kamke 2003) and reflected the ecological, economic, political, and social components of fisheries management (Krueger and Decker 1999). Administrators rated how each item helped (for benefits) or adversely affected (for problems) their agency with a 4-point response format: 1 = "never," 2 = "rarely," 3 = "occasionally," or 4 = "often." Survey instructions emphasized reporting realized, as opposed to perceived or potential, benefits and problems. To facilitate data interpretation of benefits and problems, the number of items in each measurement scale was reduced by exploratory factor analysis. Factor analysis is a statistical procedure to detect patterns or structure in the relationships among variables, in this case individual items on benefit and problem scales. In particular, it seeks to discover if the observed variables can be explained largely or entirely in terms of a much smaller number of variables called factors. We used principal component analysis with varimax rotation to determine the factor structure of the benefit and problem measurement scales. Only item groupings with eigenvalues >1.0 were considered valid factors. Individual items were retained within a factor if (1) its factor loading was >0.5, and (2) the item contributed to a Cronbach's alpha >0.70 for all items in the factor (Kim and Mueller 1978).

Additionally, states were grouped into six regions (Figure 2) to test for geographic differences in specific tournament-related issues and benefit and problem factors. Differences in frequencies were tested by Chi-square, and differences in impact rating scores for benefit and problem factors were tested by analysis of variance.

RESULTS

Responses were received from 48 of 50 states and the District of Columbia (for data analysis and reporting, the District of Columbia was considered a state). Twenty-seven states had procedures for measuring the number of tournaments in their state; among these states, average known number of tournaments

Figure 2. Regions of the United States used to evaluate differences in impacts of tournaments on fisheries management agencies. Utah did not respond to the survey.

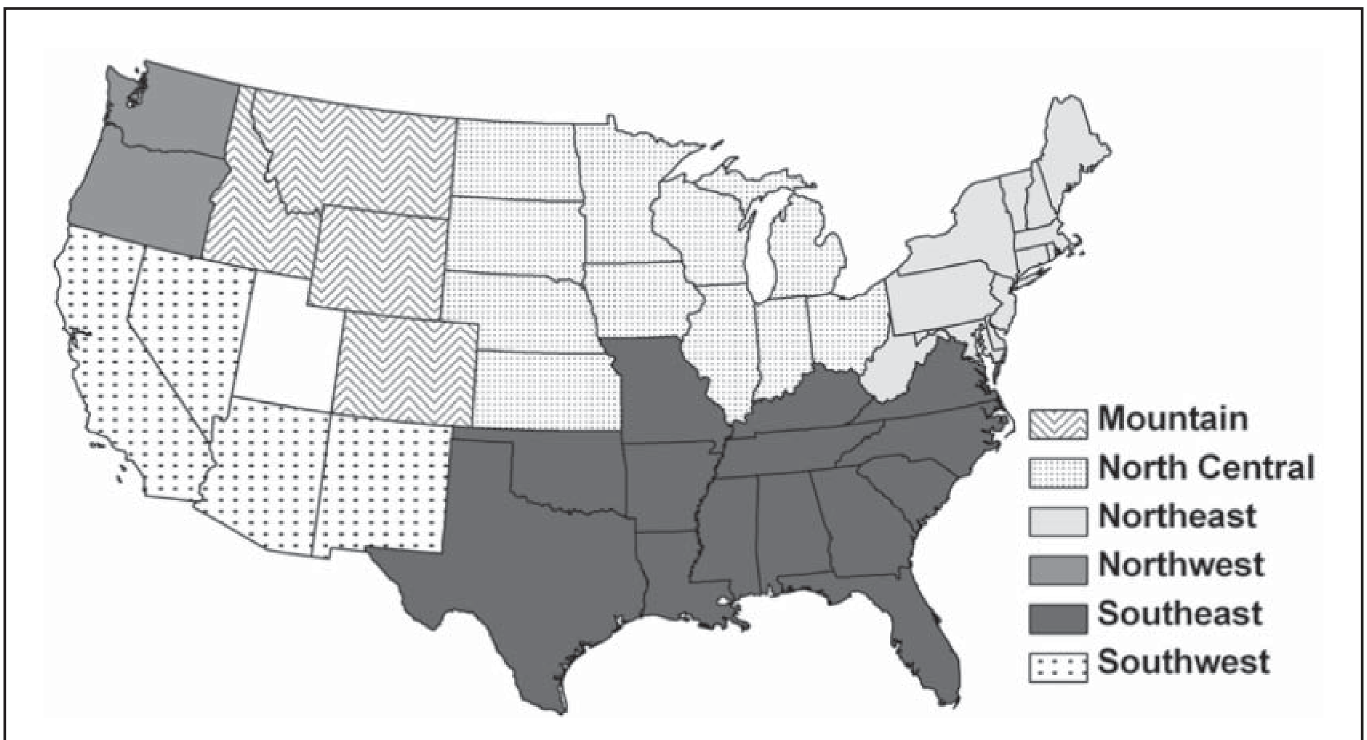


Table 1. Mean known and estimated numbers of tournaments in 48 states and the District of Columbia during calendar years 2002, 2003 and 2004. No information is shown for states that did not report known or estimated number of tournaments.

State	Number of tournaments annually	
	Known	Estimated
Alabama		
Arizona		500
Arkansas		1,000
California	1,667	2,000
Colorado	1	45
Connecticut	756	
Delaware	79	100
District of Columbia		20
Florida	1,483	1,917
Georgia		809
Hawaii	24	
Idaho	193	
Illinois		
Indiana		250
Iowa	629	
Kansas		300
Kentucky		1,100
Louisiana		
Maine	292	
Maryland		1,000
Massachusetts	619	
Michigan		
Minnesota	547	
Mississippi		500
Missouri	1,866	
Montana	45	60
Nebraska	95	
Nevada	86	90
New Hampshire	481	
New Jersey		1,200
New Mexico		
New York		500
North Carolina		2,000
North Dakota	102	
Ohio	500	700
Oklahoma	1,184	1,305
Oregon		195
Pennsylvania	1,464	
Rhode Island	143	
South Carolina		
South Dakota	158	
Tennessee		1,133
Texas		6,000
Vermont	151	
Virginia		600
Washington	315	
West Virginia	506	
Wisconsin	311	600
Wyoming	56	
Total	13,753	32,321

during 2002-2004 ranged from 1 in Colorado to 1,866 in Missouri (Table 1). Average estimated number of events per year during 2002-2004 ranged from 20 in the District of Columbia to 6,000 in Texas. The estimated mean number of events annually during 2002-2004 for the 43 states that reported known or estimated number of events (known number was used if estimated number was not reported) was 32,321. Six states did not provide counts or estimates of the annual number of tournaments.

Overall Impact of Tournaments on Fisheries Management

Collectively, fisheries management agencies were neutral about the overall impact of tournaments (Table 2). The overall tournament impact rating tended to be toward the center of the rating scale, i.e., neutral effect, and no agency reported strong adverse (rating ≤ 2) or beneficial effects (rating ≥ 9) of tournaments. The overall rating of tournament impacts on fishery management activities was 5.8 (SE = 0.18) before the survey and 6.0 (SE = 0.19) after the survey (paired *t*-test, $t = 2.29$, $n = 49$, $P = 0.03$). The small change in rating, although statistically significant, was not considered meaningful and suggests that the survey instrument itself did not influence the respondents' overall assessment of tournament impacts on their agency.

Seventy-seven percent of responding agencies ($n = 48$) reported requests from tournament organizations for exemptions from current fishing regulations; 30% of the agencies solicited for exemptions had granted them (Table 2). Agencies in all regions had received requests for exemptions to current regulations, but fewer agencies received requests in the Northeast and Southeast. Except for the Northwest region (two states), less than one-third of the states in other regions granted exemptions to current regulations.

Forty-three percent of the agencies ($n = 47$) reported municipalities or other public organizations and 62% reported tournament or private organizations had attempted to influence fishery management decisions to make fishery resources more attractive to tournaments (Table 2). Attempts by external agencies to influence fisheries management decisions to favor tournaments did not differ regionally.

Tournament Management by Fisheries Management Agencies

Thirty-three percent of the states ($n = 48$) required a no-cost tournament registration, 29% required a for-fee tournament permit, and 56% required some form of tournament permit or registration or both (Table 2). Required tournament registration or some form of permitting was more prevalent in the North Central, Northeastern, and Northwestern states than in Southeastern and Southwestern states. Forty-six percent of the states required some form of tournament reporting; required tournament reporting was more prevalent in the Mountain, North Central, Northeast, and Northwest regions. Forty-eight percent of the state agencies reported that another agency required a no-cost tournament registration, a for-fee tournament permit from another agency was required in 37% of the states, some form of registration or permit was required from another agency in 28% of the states, and some form of tournament reporting was required by another agency in 19% of the states. Details of tournament registration, permits, and reporting were not solicited, but other agencies required some form of tournament registration or permit in 14 states that also required registration or a permit by the state fisheries agency. Tournament registration or a tournament permit was not required by any agency in eight states. Of 46 responding states, tournament reporting was required by multiple agencies in 5 states and not required by any agency in 22 states.

Three of 44 agencies reported receiving unsolicited "use fees" from tournament organizations. Twenty-five percent of the agencies reported that tournament organizations should pay use fees (Table 2). In response to an open-ended question, agencies noted that these fees would be used to administer tournament programs (permits, reporting, etc.; six agencies), fund resource management (three agencies), fund black bass management (two agencies), provide sanitary facilities and site clean up after tournaments (one agency), or provide requested services such as law enforcement for traffic control (one agency).

Table 2. Effects of fishing tournaments on state fisheries management agencies. Values in parentheses are SE. *P* is the probability of a significant difference among regions by analysis of variance for the first item or by Chi-square analysis for all remaining items.

		Region						
Item	**All states**	**Mountain**	**Northcentral**	**Northeast**	**Northwest**	**Southeast**	**Southwest**	***P***
Overall, how do tournaments affect your agency and fisheries management activities?[1]	5.8 (0.18)	5.0 (0.41)	5.0 (0.30)	5.7 (0.43)	6.0 (0.00)	6.4 (0.27)	6.3 (0.85)	0.07
Do tournament organizations seek exemptions from current regulations? (% yes)	77	100	100	60	100	56	100	0.04
Are exemptions from current regulations granted to requesting tournament organizations? (% yes)	30	25	27	33	100	17	25	0.31
Do municipalities or other public agencies attempt to affect fisheries management decisions to make a fisheries resource attractive to tournaments? (% yes)	43	25	50	20	50	63	25	0.31
Do tournament organizations or other private agencies attempt to affect fisheries management decisions to make a fisheries resource attractive to tournaments? (% yes)	62	50	80	50	50	56	75	0.73
Does your agency require:								
a no-cost tournament registration? (% yes)	33	25	55	55	50	6	0	0.04
a for-fee tournament permit? (% yes)	29	50	36	45	50	6	25	0.22
any type of permit or registration for tournaments? (% yes)	56	75	82	82	100	13	25	<0.01
any type of reporting from tournaments? (% yes)	46	75	60	64	100	19	25	0.05
Does another agency in your state require:								
a no-cost tournament registration? (% yes)	48	75	27	45	50	50	75	0.51
a for-fee tournament permit? (% yes)	37	50	40	20	50	37	75	0.55
any type of permit or registration for tournaments? (% yes)	58	75	45	45	50	63	100	0.42
any type of reporting from tournaments? (% yes)	19	33	18	0	0	25	50	0.31
Should tournaments or tournament organizations pay a "use fee" (in addition to any registration or permit fees) to your agency? (% yes)	25	33	30	22	50	27	0	0.81
Does your agency provide information to:								
tournament anglers? (% yes)	62	50	60	73	100	60	25	0.51
tournament organizations? (% yes)	66	50	70	82	100	60	25	0.31
general angler population? (% yes)	64	25	70	82	100	60	25	0.15

[1] Mean response score; responses were measured on a 10-point scale with 1=strong adverse effect and 10 = strong beneficial effect.

Sixty-two percent of the agencies ($n = 47$) provided tournament information to tournament anglers, 66% provided information to tournament organizations, and 64% provided tournament information to the general angler population (Table 2). The proportions of agencies reporting information differed little among regions.

Benefits

The 21 benefit items ranged from 73% of the respondents indicating an item affected management "often" or "occasionally" (hereafter, benefit items that affect management often or occasionally will be referred to as primary benefits) to only 6% indicating an item was a primary benefit (Table 3). Factor analysis identified four factors, which for convenience of presentation and discussion we have assigned descriptive names: *enhance management*, *grow fishing*, *economic measurement*, and *biological monitoring*. Five items did not group into any factor, based on the defined criteria, and are presented as single, non-factored items in Table 3.

Managers considered those aspects of tournaments that enhanced fishery management agency effectiveness (*enhance management*) and that stimulated interest in fishing and fishery resources (*grow fishing*) to have the greatest primary benefits. Items that grouped into *economic measurement* were considered primary benefits by 18-43% of the respondents, and items that grouped into *biological monitoring* were primary benefits for less than 16% of the respondents. The individual items "reduce harvest by stimulating a live-release ethic among anglers" and "collect fishery assessment data to supplement current agency efforts" did not group with other items into factors but were considered primary benefits by at least 65% of the respondents. No significant differences were found among regions in average scores of benefit factors (Table 4).

Problems

The 29 problem items ranged from 92% of the respondents indicating an item adversely affected management "often" or "occasionally" (hereafter, primary problem) to only 4% indicating an item was a primary problem (Table 5). Factor analysis identified six factors that we have descriptively named *resource overuse*, *user-group conflicts*, *cost to agency*, *non-traditional management model*, *fish introductions*, and *fish population impacts*. Seven of the 29 items did not group with any factor based on the defined criteria and are presented as single, non-factored items in Table 5.

Administrators rated those items associated with *resource overuse* or *user-group conflicts* as

Table 3. Factors and survey items associated with inland fishing tournaments that benefit fisheries management agencies. Items were scored on a 4-point scale with 1 = never, 2 = rarely, 3 = occasionally, and 4 = often. Values in parentheses are SE.

Factor (in italics) Items in Factor: Fishing tournaments help my agency…	Factor reliability	Factor or item mean	Percentage of agencies reporting receiving realized benefits often or occasionally for item	Overall rank of benefit item among all 21 items[1]
Enhance management	0.87	2.86 (0.09)		
promote fishing as a valued activity		3.11 (0.13)	73	1 (tie)
by promoting positive attitudes toward my agency		3.00 (0.11)	73	1 (tie)
better communicate with anglers		2.89 (0.12)	67	5
by stimulating requests for information about fishing		2.75 (0.11)	63	8
by generating political support for fisheries management efforts		2.63 (0.11)	60	9
obtain additional angler input on potential fishery issues		2.74 (0.13)	59	10
Grow fishing	0.75	2.85 (0.10)		
by promoting awareness and use of fishery resources		2.98 (0.12)	71	3
recruit new anglers		2.71 (0.11)	64	7
Economic measurement	0.79	2.10 (0.11)		
estimate or recognize economic aspects of fishing		2.26 (0.14)	43	12
by generating local economic benefit information		2.26 (0.14)	42	13
better measure angler expenditures		1.77 (0.11)	18	16
Biological monitoring	0.79	1.54 (0.09)		
collect fishery assessment data to replace agency efforts		1.60 (0.12)	16	17
estimate exploitation rate		1.68 (0.11)	14	18 (tie)
collect fish to replace current agency efforts		1.49 (0.10)	8	20
collect biological data from fish to replace agency efforts		1.38 (0.09)	6	21
Non-factored items				
reduce harvest by stimulating a live-release ethic among anglers		3.04 (0.14)	69	4
collect fishery assessment data to supplement current agency efforts		2.89 (0.14)	65	6
collect biological data to supplement agency efforts		2.43 (0.12)	45	11
collect fish to supplement current agency efforts		2.26 (0.12)	31	14
generate revenue for my agency		2.04 (0.16)	29	15
estimate population size		1.70 (0.10)	14	18 (tie)

[1] Rank based on percentage of agencies that reported receiving realized benefits often or occasionally for item.

most problematic; at least 79% of the respondents considered *resource overuse* items to be primary problems (Table 5). Except for "stimulate anti-fishing sentiment," at least 55% of respondents rated the other two items in the *user-group conflict* factor as primary problems. Items in the factors *fish population impacts* and *fish introductions* were primary problems to less than 31% of the fisheries agencies. The items "concentrate fish at tournament release sites" and "reduce fishing and boating courtesy" did not group with other factors but were primary problems to at least 65% of agencies.

Two problem factors differed among regions (Table 4). A greater percentage of respondents in the Mountain and North Central regions considered *cost to agency* a primary problem than did respondents from Southeastern states. *Fish introductions* were more often a primary tournament-associated problem in the Mountain and Northwestern regions than in the North Central and Northeastern regions.

DISCUSSION

The American Fisheries Society Competitive Fishing Committee previously concluded that competitive fishing was a growing use of fishery resources (Schramm et al. 1991b). The present survey indicates the number of tournaments continues to increase (Figure 1). Analysis of temporal trends in tournaments was complicated by the completeness and accuracy of survey responses in this and all previous studies. Our estimate of 32,321 tournaments does not include estimates from several states. Substituting the number of tournaments reported by Kerr and Kamke (2003) for values missing in our survey, the estimated number of inland tournaments in the United States increases to 33,971. We made a concerted attempt to obtain more complete estimates of numbers of tournaments than previous efforts, and classification differences (e.g., what constitutes a tournament) probably accounted for some of the temporal differences in numbers of tournaments. Nevertheless, in agreement with Kerr and Kamke (2003), it is clear that tournaments remain a prevalent use of inland fisheries resources.

The most prevalent benefits of tournaments to fishery management agencies were the factors *enhance management* and *grow fishing*. These two factors appear complementary. The *grow fishing* factor reflects the strong interest by fisheries agencies in recruiting new anglers and stimulating interest in fishing and fishery resources. The *enhance management factor*, in addition to the item "promote fishing as a valued activity," contains items that contribute to providing the types and quality of fishing opportunities that are conducive to angler recruitment and retention. Several items in the *enhance management* factor (e.g., "promoting positive attitudes toward my agency," "generating political support for fisheries management efforts," "stimulating requests for information

Table 4. Mean response scores of benefit and problem factors of tournaments on state fisheries management agencies. Responses were 1 = never, 2 = rarely, 3 = occasionally, 4 = often; survey items included in each factor are listed in Tables 3 and 5. Values in parentheses are SE. P is the probability of a significant difference among regions by analysis of variance.

	Region						
Factor (in italics)	**Mountain**	**North Central**	**Northeast**	**Northwest**	**Southeast**	**Southwest**	***P***
Benefits from tournaments							
Enhance management	2.33 (0.15)	2.58 (0.18)	3.02 (0.25)	2.83 (0.00)	3.14 (0.11)	2.63 (0.48)	0.09
Grow fishing	2.37 (0.20)	2.77 (0.21)	2.77 (0.19)	2.50 (0.50)	3.11 (0.22)	2.63 (0.37)	0.49
Economic measurement	1.92 (0.60)	1.91 (0.22)	1.87 (0.22)	2.00 (0.00)	2.52 (0.17)	2.33 (0.30)	0.21
Biological monitoring	1.81 (0.73)	1.52 (0.14)	1.66 (0.28)	1.75 (0.00)	1.45 (0.08)	1.63 (0.26)	0.92
Problems from tournaments							
Resource over use	3.00 (0.51)	3.34 (0.16)	3.11 (0.12)	3.13 (0.37)	3.09 (0.13)	3.00 (0.00)	0.82
User-group conflicts	2.50 (0.17)	2.64 (0.22)	2.70 (0.22)	2.33 (0.00)	2.67 (0.15)	2.08 (0.46)	0.67
Cost to agency	3.00 (0.19)[ab]	2.58 (0.17)[b]	2.30 (0.24)[abc]	2.67 (0.33)[abc]	1.87 (0.18)[c]	1.92 (0.34)[bc]	0.04
Non-traditional models	2.38 (0.20)	2.41 (0.23)	2.05 (0.23)	2.00 (0.17)	2.23 (0.14)	2.21 (0.26)	0.86
Fish introductions	2.75 (0.25)[a]	1.73 (0.18)[b]	1.65 (0.22)[b]	3.00 (0.50)[a]	2.13 (0.18)[ab]	2.13 (0.31)[ab]	0.02
Fish population impacts	2.06 (0.31)	1.68 (0.20)	1.95 (0.17)	2.13 (0.13)	1.80 (0.14)	2.42 (0.30)	0.42

[a,b,c] Values in a row with different letters are significantly different ($P < 0.05$) by Tukey Honestly Significantly Different test.

about fishing") suggest an "agency-centered" perspective. Because fishery agency effectiveness increases when the agency works with a valued resource, provides a valued activity, and has strong angler and political support, we contend that enhance management pertains to enhancing the resource, not enhancing the management agency.

Biological monitoring was least frequently a primary benefit, and several biological data items that did not group with a factor ("estimate population size," "collect biological data to replace current agency efforts") were also infrequently considered primary benefits. The relatively low benefit of biological data collection sharply contrasts with agency attitudes in 1989, when obtaining catch statistics and biological data were the most often-stated benefits of competitive fishing (Schramm et al. 1991b). Although fishery monitoring was infrequently considered a benefit of tournaments in the current survey, agencies were more likely to use biological and fishery assessment data obtained from tournaments to supplement rather than to replace agency-collected data. Several agencies collect catch data from tournaments to calculate various catch statistics (e.g., catch rate, percentage of anglers catching limits, number of hours spent to catch a black bass exceeding 5 lbs. [2.27 kg]). These summary statistics provide important trend data for managers, are frequently used by bass clubs in selecting tournament sites, and provide a good vehicle for manager-angler communications. Reasons why *biological monitoring*, which potentially provides useful and easily obtained information and is a good avenue for communication with anglers, was infrequently considered a primary benefit in the present survey may warrant further investigation.

The factor *economic measurement* was also a primary benefit for less than one-half of the agencies. The relatively low rating was unexpected for two reasons. First, respondents to the 1989 survey frequently listed recognizing and measuring economic values as benefits of tournaments (Schramm et al. 1991b). However, this rating change between surveys could be due to the emphasis on reporting realized benefits in the current survey, whereas perceived benefits may have been reported in the 1989 survey (Schramm et al. 1991b). Second, fishery managers increasingly are competing with other water-user groups such as navigation, agriculture, development, and hydropower on water quality and supply issues. Economics is inevitably an important part of water management decisions. Thus, any opportunity to generate and measure economic values would be expected to be considered a primary benefit. The less-than-expected recognition of economic measurement of tournaments may be partially attributable to agencies concern for the total recreational value of fisheries resources (Todd Driscoll, Texas Parks and Wildlife Department, pers. comm.).

Items grouped with *resource overuse* and *user-group conflicts* remain as the most frequent negative impacts (cf. Schramm et al. 1991b). Social conflict was the most frequently stated known or suspected impact of competitive fishing by respondents to the 2000-2001 survey (Kerr and Kamke 2003). The continued importance of these items provides direction for future management activities, but also suggests little progress has been made in 16 years. Alternatively, the continued high prevalence of these problems may suggest that these issues are not easily solved.

We suggest that concern with *resource overuse* pertains more to crowding issues than exploitation of fish, since the lowest-ranking problem factor was *biological impact*. In 1989, stock reduction and fish mortality were often-stated biological problems associated with tournament fishing (Schramm et al. 1991b). Since then, modeling studies have predicted that live-release largemouth bass (*Micropterus salmoides*; Hayes et al. 1995; Allen et al. 2004) or walleye (Hayes et al. 1995) tournaments could affect the abundance of larger fish at high levels of tournament catches, but few population effects are expected at present levels of tournaments. Edwards et al. (2004) found low mortality in Connecticut black bass tournaments and forecast no adverse population effects of bass tournaments. Furthermore, no sport fish population declines have been attributed to tournament fishing. Known or suspected exploitation was a concern of 8 of 12 Canadian provinces but of only 5 of 50 states in the 2000-2001 survey conducted by Kerr and Kamke (2003). While maximizing the survival of individual tournament-caught fish remains a goal of fisheries managers and tournament organizations for improved public relations (e.g., Edwards et al. 2004; Schramm et al. 2006), it appears that concern about the effect of tournament mortality on population exploitation has dwindled among administrators. The few studies evaluating the effect of tournament mortality support this finding, at least for several species at present levels of tournament participation.

Relocation of fish was the third-most preva-

Table 5. Factors and survey items associated with inland fishing tournaments that adversely impact fisheries management agencies. Items were scored on a 4-point scale with 1 = never, 2 = rarely, 3 = occasionally, and 4 = often. Values in parentheses are SE.

FACTOR (in italics) Items in Factor: Fishing tournaments adversely affect my agency by …	Factor reliability	Factor and item mean	Percentage of agencies reporting realized problems often or occasionally	Overall rank of problem item among all 29 items[1]
Resource overuse	0.83	3.11 (0.08)		
crowding at access sites		3.43 (0.09)	92	1
concentrating fishing effort		3.11 (0.10)	88	2
increasing complaints about exploitation of game fishes		2.87 (0.09)	80	5
crowding of anglers on the water		3.04 (0.11)	79	6
User-group conflicts	0.74	2.56 (0.10)		
increasing conflicts among anglers		3.04 (0.10)	84	3
increasing conflicts with non-angling user groups		2.60 (0.14)	55	8 (tie)
stimulating anti-fishing sentiments		2.04 (0.13)	31	17 (tie)
Cost to agency	0.74	2.22 (0.11)		
additional fiscal and personnel costs at tournaments		2.36 (0.13)	55	8(tie)
additional fiscal and personnel costs of permitting tournaments or managing data from tournaments		2.43 (0.15)	51	11
promoting negative public attitude about my agency		1.87 (0.12)	23	22
Non-traditional management model	0.84	2.19 (0.09)		
stimulating controversy about the use of public resources for private financial gain		2.62 (0.14)	55	8 (tie)
changing perceptions of traditional uses of game fishes		2.47 (0.13)	50	12
creating situations in which economic benefits are pitted against biologically sound management recommendations		2.13 (0.14)	37	14 (tie)
establishing unreasonable catch expectations		2.15 (0.13)	31	17 (tie)
conveying an image that all resources are healthy and fish are abundant		1.91 (0.11)	19	24
making fishing a spectator sport		1.83 (0.12)	17	25 (tie)
Fish introductions	0.74	2.00 (0.11)		
creating pressure for my agency to introduce non-native fishes		2.02 (0.11)	31	17 (tie)
encouraging unauthorized fish introductions		1.98 (0.12)	29	21
Fish population impacts	0.83	1.82 (0.09)		
reducing the abundance of larger fish		1.91 (0.10)	21	23
reducing fish recruitment		1.80 (0.11)	17	25 (tie)
reducing population fitness		1.74 (0.11)	17	25 (tie)
reducing standing stocks of gamefish		1.83 (0.09)	13	28
Non-factored items				
concentrating fish at tournament release sites		3.11 (0.12)	82	4
reducing fishing and boating courtesy		2.70 (0.11)	65	7
promoting a live-release ethic that conflicts with management goals		2.28 (0.15)	39	13
stimulating controversy about disposal of dead fish after a tournament		2.19 (0.11)	37	14 (tie)
increasing legal or enforcement problems		2.23 (0.10)	33	16
seeking exemptions to waterbody or statewide regulations		2.21 (0.10)	31	17 (tie)
altering the number, location, or time fish are stocked		1.30 (0.07)	4	29

[1] Rank based on percentage of agencies that reported receiving realized benefits often or occasionally for item.

lent impact of tournaments identified by U.S. fisheries agencies in 2000–2001 (Kerr and Kamke 2003), and "concentrating fish at tournament release sites" was a primary problem for 80% of the respondents in the present survey. This topic has received moderate research attention for black bass, and the majority of the findings indicate that tournament-caught fish are slow to disperse more than several kilometers from release sites (Wilde 2003 and references therein). One reason for concern about the lack of post-release dispersal may be that these artificially concentrated fish are vulnerable to capture and, thus, harvest, thereby increasing fish harvest above levels that would occur if the fish were more widely distributed in the environment (Lantz and Carver 1976; Gilliland 2000). Some tournament organizations are making efforts to distribute fish after the tournaments. Kerr and Kamke (2003) reported three state fisheries agencies have requirements for relocation of tournament-caught fish.

The *non-traditional management model* factor was recognized as a problem by an intermediate number of agencies. The individual items in this factor ranged from low recognition as a problem ("making fishing a spectator sport") to more than one-half of the agencies recognizing "use of public resources for private financial gain" and "changing perception of traditional uses of game fishes" as primary problems. Possibly the items in this factor may explain why one-third of fisheries and wildlife professionals considered tournaments an inappropriate use of fisheries resources (Muth et al. 1998). Although the items grouped in this factor are diverse, a commonality is that the items address relatively new perspectives and issues that deviate from the traditional use of sport fishery resources and fisheries management issues; in a word, these items represent change. Addressing these unfamiliar issues may be a substantial challenge to fisheries management agencies, because these issues represent a paradigm shift for established fisheries managers who envision their work as providing fishing opportunities to only traditional recreational anglers—anglers who fish to relax, to escape, to enjoy the outdoors, or for social connection (Driver and Knopf 1976; Buchanan 1983; Fedler and Ditton 1994).

The *non-traditional management model* problem factor is an interesting contrast to the *enhance management* benefit factor. For example, the problem item "changing perception of traditional uses of game fishes" may offer a way to "promote fishing as a valued activity," a benefit item. Further, "better communications with anglers," a benefit item, may offer a pathway to reduce the problems of "unreasonable angler expectations," "pitting economic benefits against biologically sound management," and "conveying an image that all aquatic resources are healthy and fish are abundant." At the same time, better communications with anglers may help promote positive attitudes toward fisheries agencies and generate political support for fisheries management efforts. These contrasts suggest that tournaments, while creating problems, also provide opportunities to address problems related to tournaments.

Fish introductions was a high-ranking tournament-related problem in the Mountain and Northwest regions. The high rating of introduced fishes in these two regions may be related to the impacts of non-native predators on efforts to conserve and restore native and imperiled fishes. For example, non-native smallmouth bass (*Micropterus dolomieu)* and walleye have been implicated in reducing salmonid escapement in the Columbia River (e.g., Poe et al. 1994; Zimmerman 1999). Tournaments emphasize the beneficial aspects of smallmouth bass and walleye populations and, possibly, contribute to their relocation, thereby complicating native species management.

MANAGEMENT AND RESEARCH IMPLICATIONS

Tournament fishing is a substantial and continually evolving use of fishery resources with clear benefits to the resource, angler recruitment, sportfishing industries, and fisheries management, but tournament fishing also presents management problems. An obvious management strategy is to capitalize on the benefits while eliminating, or at least minimizing, the problems. We suggest that this can be accomplished and that an open dialogue between fishery agency managers, tournament organizations, and tournament anglers is essential to the process. All entities have much to gain from achieving consensus-based management objectives and strategies (Decker et al. 2001). Further, we also envision occasions when municipal governments and other non-fishing stakeholders should also be involved in planning discussions.

Based on the problems and benefits listed by fisheries management agencies, the Competitive Fishing Committee suggested implementation of a tournament permit system (Schramm et al. 1991a). They envisioned a permit system would allow event scheduling, thereby reducing crowding and user-group conflicts, and possibly allow agencies to direct tournaments away from those fisheries that would benefit from less fishing effort or fishing mortality. Some type of tournament permitting or reporting system may also facilitate obtaining useful information about events that can be used for biological, economic, and political purposes. Although the number of agencies that have implemented tournament registration or permit systems has increased since 1989 (Kerr and Kamke 2003 and this study), the continued importance of resource overuse and user-group conflicts suggests that a process that includes permits, registration, or reporting has not fully solved paramount tournament-related problems. Managers' concerns about tournaments have shifted away from biological impacts since 1989, and the potential benefit of tournaments as a source of useful biological data has not materialized or is no longer viewed as useful. Thus, some of the drivers that stimulated the committee to encourage tournament permitting have changed. There are important benefits to be gained from effective accounting of tournaments, and thus some form of tournament permitting or registration may be appropriate. However, it is apparent that new or additional approaches are needed if the problems recognized by fisheries administrators are, indeed, problems that warrant solution.

Planned communication among anglers, tournament organizations, fisheries management, and other entities (e.g., round tables, advisory panels, task forces) may be effective in achieving solutions to recurring problems (Decker et al. 2001). We emphasize that fishery managers do not have to solve all problems alone; rather, they may benefit by creating a forum for diverse stakeholders to work together. Three-fourths of the fisheries agencies had been approached for exemptions to regulations, and public and private entities have tried to influence fisheries management actions to benefit tournaments in more than one-half of the states. Proactive communication opportunities may alleviate these divisive activities.

Compared to the 1989 competitive fishing survey (Schramm et al. 1991b), there was a substantial decline in concern about adverse biological effects of tournaments. Yet, 80% of the fisheries agencies were adversely affected often or occasionally by complaints about game fish exploitation. This incongruity suggests that agencies aren't effectively sharing information with the public. Specifically, if there is information available since the 1989 study that has changed administrators' attitudes about the biological impacts of tournaments (as reflected by the lower importance of biological impacts measured in this study), then there is information that could be shared with the public. Alternatively, additional research on the biological impacts of tournaments may be warranted if the existing information is insufficient to satisfy the demands of various stakeholders.

An unresolved issue is whether tournaments for different species or species groups impact fisheries management agencies differently. We did not ask respondents to identify the fish targeted in tournaments. Doing so may have provided estimates of the numbers and impacts of tournaments for different species or species groups, but providing information about the effects of tournaments for different fishes on fisheries management essentially would have required administrators to complete a survey for each species or species group, a request that we considered unreasonable when designing our survey. Fisheries resources differ geographically, and tournaments likely follow these differences. For example, competitive fishing events target salmonids and black bass in the Northeast; black bass and walleye in North Central states; striped bass (*Morone saxatilis)* and black bass in several Eastern, Southwestern, and Midwestern states; and black bass, crappies (*Pomoxis* spp.), and catfishes (Ictaluridae) in the Southeast (Table 2 in Schramm et al. 1991b). Therefore, given the regional differences in fisheries targeted by tournaments, the general lack of regional differences in effects of tournaments on fisheries management agencies suggests that the issues, benefits, and problems associated with competitive fishing are independent of types of fisheries resources.

We foresee further growth of tournaments, and surmise that much of this growth may be fueled by tournaments for fishes for which there presently are few tournaments, like catfish, striped bass, hybrid striped bass (*M. saxatilis* x *M. chrysops*), and crappies. Nevertheless, whether tournament fishing grows or not, we believe that the commercial aspects of tournament fishing will grow substantially if current media trends continue. The media has embraced tournament fishing, and fishing tournaments are beginning to occupy a place in American culture similar to that of other professional sports. The heightened exposure can be an asset by making fishing more visible and possibly recruiting anglers, but it may also be a liability if, for example, it establishes unreasonable expectations among anglers or generates more attempts by tournament organizations and other entities to influence fisheries management activities (Schramm and Harrison in press). We suggest that the potential negative repercussions can be reduced, even reversed, if fisheries management actively works together with tournament organizations and the media to educate anglers and the general public about the importance, wise use, and management of fisheries resources and define the role tournament fishing has in conservation efforts (Evans in press; Schramm and Harrison in press).

Future research should continue to investigate trends in the number of fishing tournaments and their impact on fisheries management agency decision-making. We believe researchers should continue to define what they mean by "tournament" to make trend analysis consistent across time and space. Additionally, our results suggest the general lack of regional differences in effects of tournaments on fisheries management indicated that the issues, benefits, and problems are possibly independent of types of fisheries resources, i.e., species and geographic location within the United States. Since our tournament-benefit and tournament-problem measurement scales were developed from previous agency tournament studies, were found to be reliable, and were asked in a non-species-specific nature, we suggest continued use of these scales could assist in documenting changes in agency attitudes towards tournaments over time. Nevertheless, despite identifying 10 benefit and problem factors, further research may shed light on additional benefits and problems not identified in this study or its predecessor conducted in 1989. For example, some of the benefit- and problem-scale items did not load on any of the specified factors; whether they tapped some unidentified benefit or problem factor needs additional investigation. Further, with the dynamic nature of fisheries management and anticipated continued growth in tournaments, new benefits and problems will eventually emerge.

ACKNOWLEDGMENTS

This study was funded by the U.S. Geological Survey Mississippi Cooperative Fish and Wildlife Research Unit and the Department of Wildlife and Fisheries, Mississippi State University. Gene Gilliland, Jay Haffner, Chris Horton, Bill Hyatt, Bruce Shupp, Doug Stang, and Dave Terre provided useful comments for improving the survey instrument. Useful reviews of earlier drafts of this manuscript were provided by Todd Driscoll, Gene Gilliland, Ken Sprankle, and Doug Stang.

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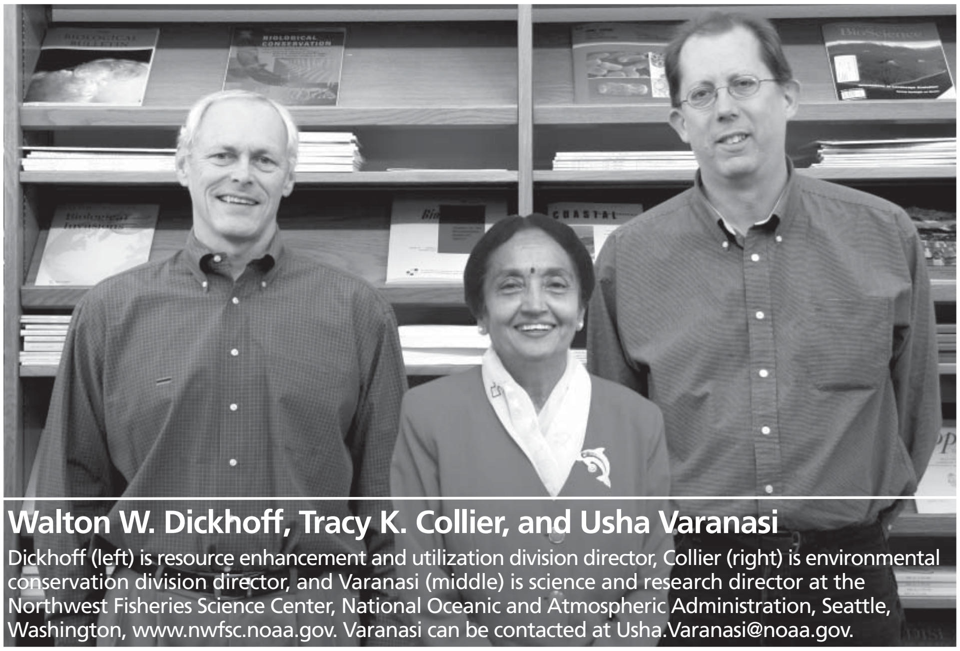
COLUMN: GUEST DIRECTOR'S LINE

The Seafood "Dilemma"—A Way Forward



Walton W. Dickhoff, Tracy K. Collier, and Usha Varanasi

Dickhoff (left) is resource enhancement and utilization division director, Collier (right) is environmental conservation division director, and Varanasi (middle) is science and research director at the Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration, Seattle, Washington, www.nwfsc.noaa.gov. Varanasi can be contacted at Usha.Varanasi@noaa.gov.

Increasing seafood consumption will improve health and save lives. A study by the Harvard Center for Risk Analysis suggested that if every adult in the United States consumed 8 ounces of salmon per week, each year there would be 20,000 fewer deaths due to heart attack and 8,000 fewer strokes and stroke-related deaths. A Harvard meta-analysis of previous studies also concluded that the benefits of increased seafood consumption outweighed the added risks from contamination by two to three orders of magnitude (Mozaffarian and Rimm 2006). Another recent report from the National Institutes of Medicine (2007) provides further evidence for the numerous benefits associated with eating seafood, but also points out that certain fish and shellfish in specific locations can contain a variety of substances that pose health risks to various sub-populations. The nature of our seafood supply is changing. To meet the growing demand for seafood, there are more cultured products available and imports of seafood from foreign sources are increasing. Surveillance of these products is minimal, especially for compounds that are difficult or expensive to monitor. At the same time, risks, or perceptions of risk, are also changing because many coastal areas are subject to habitat degradation and contamination by chemicals and biological agents. People well versed in these issues realize that benefits and risks vary among types and sources of seafood; however, this complexity still results in considerable confusion on the part of the public about which seafood choices are appropriate given various risk factors. This confusion, which we call a "seafood dilemma," is believed to lead to less seafood consumption than is otherwise advisable and consistent with a healthy diet. Working in the field for over three decades, we feel compelled to offer suggestions to assuage this dilemma. In this commentary, we propose that a U.S. nationwide program is needed to analyze and evaluate seafood for beneficial properties, as well as harmful chemicals and pathogens, and to provide standardized and user-friendly information on the quality and safety of our nation's seafood supply. Such information will improve public understanding and confidence in the safety and quality of seafood, which will enhance human health and well being.

Benefits of seafood consumption

Fish are an important source of high quality protein and other essential nutrients, including omega-3 fatty acids that have a variety of benefits. Dozens of epidemiological studies show that consumption of fish, especially fatty cold-water species such as salmon, mackerel, sardines, and herring, protects against cardiovascular disease and promotes human brain development (Mozaffarian and Rimm 2006; Institute of Medicine 2007). Other studies suggest that eating fish can protect against some cancers, asthma, diabetes, rheumatoid arthritis and other inflammatory diseases, Alzheimer's disease, depression, and macular degeneration (Rose and Connolly 1999; Calder 2006; Hodge et al. 2006). The American Heart Association recommends that adults consume fish at least twice per week to protect against cardiovascular disease. The U.S. Department of Agriculture (USDA) recommends consuming fish (as well as nuts and vegetable oils) to maximize mono- and polyunsaturated fats in our diets (http://www.health.gov/dietaryguidelines/dga2005/document/). Our research center has been a pioneer in the identification of fish oils and their health benefits (Stansby 1967, 1990). We have first-hand experience in the challenges of communicating scientific information in the area of seafood safety (Brown et al. 1999, Hom et al. 1999). Despite the growing list of reports on the health benefits of seafood, there is a clear need to better predict and understand the pathways that lead to the health benefits from fish consumption. For example, there has been speculation that cultured fish, especially those raised on non marine-derived feedstocks, are markedly lower in beneficial fatty acids. We also do not know if consumption of shellfish confers similar health benefits as the consumption of fatty fish. It is also not certain which specific active components in seafood protect against various diseases. A great deal of evidence shows that the omega-3 fatty acids and eicosapentaenoic and docosahexaenoic acids (EPA; 20:5n-3, and DHA; 22:6n-3) are important in protecting us from cardiovascular disease, but supplements of these substances extracted from seafood may confer fewer health benefits than comparable levels contained in intact seafood rich in high quality protein. There is no federal guidance on the use of supplements, and it is believed that consumption of fish in the diet is the preferred recommendation.

Real and perceived risks of seafood consumption

In contrast to the benefits of fish consumption, there are also risks associated with the presence of chemical and biological contaminants in seafood. Depending on the species and area of capture, wild fish contain variable levels of chemical contaminants (e.g., mercury and organic compounds such as polychlorinated biphenyls [PCBs], dioxins, and polybrominated diphenyl ethers [PBDEs]). Mercury is arguably the most worrisome of the many chemical contaminants that can be found in fish. Mercury, and its biologically active form, methylmercury, are thought to be injurious to the developing human nervous system. Thus, while the Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) acknowledge the importance of fish in the diet, these agencies also currently recommend limiting consumption of certain types of fish (shark, swordfish, king mackerel, tilefish) for women who are or might become pregnant, nursing mothers, and young children. In addition to its effect on the nervous system, methylmercury may also counteract the protective effects of omega-3 fatty acids on cardiovascular disease. There are also currently over 2,000 localized fish consumption advisories in the United States based on mercury contamination. Most of these are in fresh waters and thus are probably not significant contributors to the commercial seafood supply. However, even in these cases there is concern for populations who consume fish as subsistence or as part of recreational activities. There are half as many fish consumption advisories based on organic chemical contaminants.

Balancing Risks and Rewards

The meta-analysis conducted by Mozaffarian and Rimm (2006) concludes that for the many fish consumption studies they reviewed, the human health benefits for the population as a whole (measured as numbers of premature mortalities) exceeded the health risks (all factors combined) by two to three orders of magnitude. While these results are generally reassuring, there remain a number of risk factors related to particular species, locations, and human sub-populations (pregnant and nursing women, young children, and subsistence consumers).

Other potential risks associated with seafood consumption are the presence of pathogens (bacteria, viruses) or marine-derived algal toxins, especially in shellfish. Contamination of shellfish with pathogens and algal toxins is a continuing national problem that every year results in closures of beaches to harvesting and recalls or warnings about shellfish consumption. Although pathogens in shellfish can be neutralized by cooking, raw shellfish are a delicacy to many consumers, and are a culturally important part of the diet of many Native American tribal members. Moreover, algal toxins remain injurious even after cooking. The shellfish industry is well aware of these issues, and researchers are working on new technologies to reduce risks in both raw and cooked seafood.

In addition to contamination concerns, consumer confidence in the marketplace is being eroded by mislabeling or substitution of fish species (product fraud). The extent to which species substitution is occurring is unknown, but is feared to be widespread. New techniques of DNA-based species identification are promising avenues for truth in marketing and restoring consumer confidence (Marko et al. 2005).

Challenges and the need for a seafood safety assessment program

A crucial element that would help better educate the public is the provision of additional objective information on both benefits and risks of seafood in ways that consumers can easily understand. The United States currently lacks a systematic effort to collect and report such information in a user-friendly manner. This was evident following Hurricane Katrina when there was great concern about potential contamination of seafood from the northern Gulf of Mexico as a result of the pumping of floodwaters from the submerged city of New Orleans and the ebbing of the storm surge along the coasts of Louisiana, Mississippi, and Alabama. While there was unprecedented coordination among state and federal agencies in mounting a response and conducting analyses, three issues impaired the ability to clearly communicate information on seafood safety to the public once sampling and analyses were underway. The first of these was the lack of baseline, or pre-storm data. Levels of chemical contaminants in seafood from the affected region (Krahn et al. 2006) could only be compared to sparse, decade-old information from a now discontinued national fish surveillance project, described in McCain et al. (2000), and there were no pre-storm data on levels of pathogens. Secondly, there were disparities in methods, instrumentation, and quality assurance procedures among laboratories and agencies. Third, in some cases different agencies had widely different guidance or regulatory criteria.

Overall, we believe that the seafood dilemma faced by U.S. consumers of wild, imported, and domestically-cultured seafood is derived from the following gaps in data and policies:

1. The levels of beneficial substances in seafood are not well quantified across regions and across seafood sources (e.g., cultured vs. wild). Moreover, the mechanisms by which seafood confers health benefits and the specific attributes of seafood that are involved are not well understood.
2. There is insufficient current information on the levels of chemical contaminants and pathogens in seafood, and differences in sampling protocols and analytical methods make it difficult and sometimes impossible to make comparisons among the data that do exist.
3. Not all contaminants, even within a well-studied class such as PCBs, are equally toxic, and not all strains of a microbial species are equally pathogenic. Although there are recent advances in molecular techniques to differentiate pathogenic vs. nonpathogenic microbes, standard methods for analyses of both toxins and pathogens with the necessary detail are lacking. Moreover, new contaminants and pathogens are appearing in our marine waters, and methods to detect and report these substances are in many cases undeveloped. Accurate methods using cutting-edge technology will prevent unnecessary fishery closures and reduce the temporal and spatial extent of closures.
4. Regulatory criteria on allowable limits for consumption of contaminated seafood have not been developed for many substances, and when such criteria do exist they may be inconsistent among various federal and state environmental and health agencies.

Recommendations

We propose that a U.S. national seafood assessment program is needed that could provide better and more timely information to consumers and regulators. This program would directly address the seafood dilemma faced by U.S. consumers and should enhance the health benefits derived from increased seafood consumption, as well as public confidence in the seafood supply. This program would:

- Conduct a sustained monitoring effort that systematically collects representative samples of commercially and recreationally harvested fish and shellfish from the waters of the U.S., domestically cultured seafood, and imported wild and cultured seafood. The frequency of market surveillance should be increased to improve detection of banned and harmful substances and species substitutions.
- Develop consistent regulatory criteria among federal (e.g., EPA, FDA, USDA, and NOAA), state, and local regulatory agencies.
- Increase analytical capacity for pathogens, algal toxins, and chemical contaminants, both for known risks as well as emerging threats. Support more DNA-based species identification for detection of species substitutions. A certain amount

of this analytical capacity would be dedicated to ongoing analyses of substances and pathogens of concern, while some capacity would be used for methods development, standardization (including interlaboratory comparisons), and quality assurance.

- Develop analytical capacity to identify and quantify nutritionally beneficial components of fish and shellfish, including the omega-3 fatty acids. Most of this capacity would be dedicated to ongoing analyses of beneficial components of seafood, with some attention given to methods development and standardization. Close coordination with the public health community to better understand beneficial aspects of seafood consumption would greatly enhance this effort.
- Provide publicly available user-friendly data on the health benefits and risks associated with different species and sources of seafood. This database should also link to more technical syntheses of this information for health care providers, public health agencies, and regional environmental managers.
- Develop a seafood tracking system that would identify the source of seafood from catch waters to the end consumer (on the East Coast such a system is in place to track interstate movement of hard clams and other species).
- Routinely convene an external advisory panel constituted of representatives from the seafood and aquaculture industries, environmental interest groups, and the public health community to help set priorities, monitor progress and coordination among federal agencies with seafood safety programs, and communicate results.

A program such as this to deal with the complexities of the seafood dilemma will not be a trivial task. The potential benefit to public health and well-being, however, makes such an effort well worthwhile.

Acknowledgments

The authors thank the following for their critical review: John E. Stein, Harold Barnett, Ronald Johnson, Peggy Krahn, Tony Lowery, Rohinee Paranjpye, Mark Strom, and Gina Ylitalo. This publication was supported, in part, by the West Coast Center for Oceans and Human Health (WCCOHH) as part of the NOAA Oceans and Human Health Initiative, WCCOHH publication 22. The WCCOHH is part of the National Marine Fisheries Service's Northwest Fisheries Science Center, Seattle, Washington.

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AFS Constitution and Rules Amendments

Gwen White

White is the AFS constitutional consultant and can be contacted at GWhite@dnr.IN.gov.

The following amendments to the AFS Constitution and Rules will be voted on by the membership at the AFS Annual Meeting in San Francisco, on Tuesday, 4 September 2007, at the San Francisco Marriott.

Audit Committee

The Governing Board recommends creation of a standing Audit Committee in the AFS Constitution as follows.

Background: At their March 2007 meeting, the Governing Board recommended approval of the following amendment to the AFS Constitution and adopted changes to Procedures to create an Audit Committee as a Standing Committee. The Audit Committee is currently a Special Committee appointed by the President.

This committee conducts a review of Society finances to address Congressional concerns regarding nonprofit organizations where the Executive Director is also the chief financial officer. The committee provides recommendations to the Executive Director, AFS President, and Management Committee concerning Society financial affairs and the external audit.

The Governing Board also approved adding a description of the committee to the *Procedures Manual.*

Process: Constitutional amendments must be published in an issue of *Fisheries* at least 30 days ahead of a vote by Active Members at the Society Business Meeting in San Francisco, September 2007.

Recommended Amendment: CONSTITUTION

[ADD language to *Article IX.2. Standing Committees]*

B. AUDIT COMMITTEE conducts an audit of Society finances and provides a report to the Executive Director and President concerning the results and any recommendations.

[Note that this changes lettering for all subsequent committees in Article IX.2.]

Nominating Committee

The Governing Board recommends amendments to stipulations affecting the Nominating Committee in the AFS Constitution as follows.

Background: At the September 2006 meeting, the Governing Board recommended approval of the following amendment to the AFS Constitution and adopted changes to Procedures. The AFS Constitution does not allow members of the committee to be nominated to Society office.

Robert's Rules of Order suggests that such limitations not be placed on a member's rights to election to office. The restriction on participation in the Nominating Committee also caused confusion during selection of committee members due to need to predict which individuals are likely to be candidates for office that year. To accommodate this, the *AFS Procedures Manual* previously barred the two past-presidents of Divisions and Sections from serving on the Nominating Committee to free them for nomination as a Society officer.

In response, the Governing Board frequently voted to suspend these procedures to allow nomination of such individuals to the committee. At their September 2006 meeting, the Governing Board voted to remove this eligibility restriction from the *Procedures Manual.*

By making these changes, any Active Member would be able to serve on the Nominating Committee and would be eligible for nomination to Society office. Members of the Nominating Committee who were identified as candidates for office may recuse themselves.

Process: Constitutional amendments must be published in an issue of *Fisheries* at least 30 days ahead of a vote by Active Members at the Society Business Meeting in San Francisco, September 2007.

Recommended Amendment: CONSTITUTION

[STRIKE a phrase from *Article IX.2. Standing Committees*]

Q. NOMINATING COMMITTEE names a slate of candidates for the Society offices of President-elect, First Vice-president, and Second Vice-president according to procedures approved by the Governing Board; it must name at least two candidates for Second Vice-president. ~~Members of the Committee may not be nominated to a Society office.~~ (see Article III. 3 B. i.)

Fisheries Administration Section

Recommended Rules Amendment: At the request of Section members, the Governing Board recommends simplifying the description of the Fisheries Administration Section in the AFS Rules as follows.

Background: At the September 2006 Annual Business Meeting in Lake Placid, Active Members of the Society approved a change in the name and charge of the Fisheries Administrators Section and made amendments from the floor to list additional levels of government agencies with related administrative programs. The Section has asked for the description to be more clear and comprehensive by simply striking the list of agency types.

Process: An amendment to the AFS Rules does not have to be published in an issue of *Fisheries*. However, by providing this explanation in advance, Active Members may be better prepared to vote at the Society Business Meeting in San Francisco, August 2007.

RULE 4. Description of Sections

I. The FISHERIES ADMINISTRATION SECTION is an association of members who have a stake in the administration of ~~federal, tribal, District of Columbia, state or provincial~~ fisher~~y~~**ies** agencies ~~and fisheries~~ **or** programs; and who wish to encourage timely discussions and exchanges of information on issues that impact fisher~~y~~**ies** management programs and ~~fishery~~ users. ♋

CALENDAR: FISHERIES EVENTS

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

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

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

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

8-21—**Second International Symposium on Diadromus Fishes: Challenges for Diadromous Fishes in a Dynamic Global Environment,** Halifax, Nova Scotia, Canada. See www.anacat.ca . Contact Alex Haro, Alex_Haro@usgs.gov.

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

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

Jun 23-27—**Fourth Biennial Conference of the United States Society for Ecological Economics—Creating Sustainability within Our Midst: Challenge for the 21st Century,** New York, NY. See www.ussee.org/conference.htm. Contact conference@ussee.org.

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

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

Jul 7-11--Jul 11-16—**Joint Meeting of Ichthyologists and Herpetologists,** St. Louis, Missouri. See www.dce.ksu.edu/jointmeeting/ .

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

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

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

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

Jul 24-26—**Hydro Basics Course,** Chattanooga, Tennessee. See www http://www.hcipub.com/.

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

Jul 30-Aug14—**Pan American Advanced Studies Institute Program on Contemporary Issues in Estuarine**

Physics, Transport, and Water Quality; Puerto Morelos, Mexico. See http://pasi.coastal.ufl.edu.

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

Jul 31-Aug 2—**Backpack Electrofishing and Fish Handling Techniques—Effective Methods for Maximizing Fish Capture and Survival,** Grand Junction, Colorado. See www.nwetc.org/bio-407_07-07_grand_junction.htm.

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

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

Aug 5-10—**2007 Joint Annual Meeting of the Ecological Society of America and the Society for the Ecological Restoration,** San Jose, CA. See www.esa.org.

2008

Feb 28-Mar 2—**Southern Division of the American Fisheries Society and West Virginia Chapter of AFS,** Wheeling, WV. See AFS www.sdafs/org/meetings.

Aug 17-21—**American Fisheries Society 138th Annual Meeting,** Ottawa, Ontario.

2009

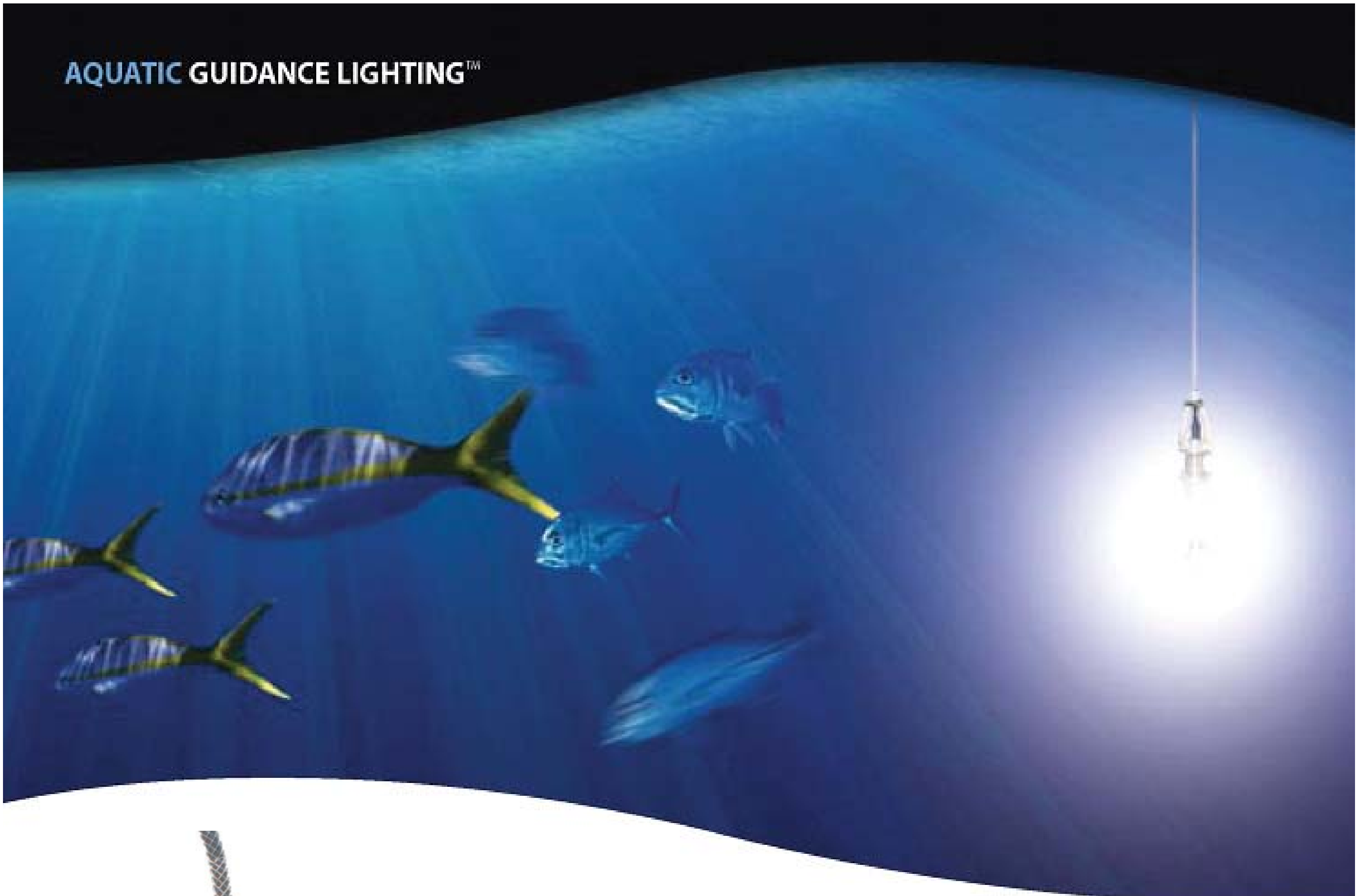
Aug 30-Sep 3—**American Fisheries Society 139th Annual Meeting,** Nashville, TN.

Continued from page 212

worked on some of the most succulent beasts of the sea. I'm an unsentimental scientist who is comfortable matching Asian pears and pine nuts with fish in the pot, while working tirelessly to keep my study specimens very much alive—a complex perversion drawn from some vision of conserving the gene pool as well as sustainable seafood. It is probably just a grand illusion, but life seems too short to be casual about who and what we eat. We all draw the line somewhere.

Alaska is a paradise for fish. So I fish for trout, harvest salmon at sea just before they hit freshwater for that perfect taste, and hook halibut on timely fishing trips to the local depths to fill my freezer. I love chilled, not-quite-dead, raw oysters fresh from the waters of Halibut Cove with just the right white wine. I grew up with cooks from the Chesapeake Bay and was spoiled as a young child with an appreciation for all things that live in water. For as long as I can remember I've been surrounded by great food. Four great years were spent learning how to cook seafood and shellfish while attending art school in the Marais in Paris and I still think of chefs as artists who studied under great masters in France. In France I learned a respect for food origins, their heritage, and the differences among local varietals. This is true for fish as well as vegetables, wines, and cheeses. I can attest to the fact that watercress-poached trout from a cold, high altitude Sierra Madre stream in Mexico tastes very different from trout caught in a glacial Alaskan lake poached in the same ingredients. Both are delicious, but each is distinctly different. True genius lies in a marriage of the product and the kitchen, linking the fish to the chef and back to the ceremony of the meal. Real cooking is at least as much fun as molecular genetics!

So imagine my delight when I heard that the Fisheries Conservation Foundation (FCF) is planning a benefit dinner at Scott Howard's restaurant in San Francisco at the end of the 2007 Annual Meeting, dedicated to sustainable seafood. This evening of six-course dining and fine wines will stimulate conversation about the health of our oceans and rivers, the fish living in these aquatic habitats, and how we manage our fisheries. The meal will be accompanied by delectable, sustainable seafood dishes produced by six of bay area's best chefs. Dinner won't be inexpensive, but all proceeds of the benefit will contribute to AFS and FCF efforts to sustain our fisheries and our understanding of sustainable seafood—see www.fisheries.org/sf/ for upcoming information about how to participate. What were they thinking? Did they know the succulent taste of appropriate condition and the subtle demands a well-positioned menu can evoke? I hope so, and hope this event will engage and educate people about the natural beauty of sustainable foods from river and sea prepared as an elegant meal. The most important lesson I have learned is to put as much passion into the food when you cook it as you would when eating it. ♋



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REPORT: RESOURCE POLICY COMMITTEE

Comments on the draft policy statement should be directed to Resource Policy Committee Chair Kim Hyatt at HyattK@pac.dfo-mpo.gc.ca.

Economic Growth and Fish Conservation

PREFACE

The current draft policy statement on conflict between economic growth and sustainable fisheries has been submitted for publication in *Fisheries* following more than two years of work by members of the Resource Policy Committee (RPC). The issue of the need for a policy statement on this topic was first broached by members of the Water Quality Section of AFS. Subsequent discussions on the merits of the RPC coordinating development of a draft policy statement on this subject involved many members of the RPC along with members of the Water Quality and Socioeconomics Sections of AFS.

Progress in dealing with this issue to date has consisted of:

- Assembly of a background paper (currently posted on the Water Quality Section website) on conflicts between economic growth and fisheries sustainability, and options for their solution;
- Publication of a summer 2006 *Fisheries* article (Bigford et al. 2006) providing alternate viewpoints from the RPC working group on the nature of the problem and recommended solutions (i.e., accelerating economic growth threatens the sustainability of many fish species and fisheries, "green" microeconomic policies could constitute a solution to maintenance of sustainable fisheries if applied to realize their full potential, or alternately fish and associated fisheries will only be sustainable if macroeconomic policies are pursued to commit nation states to steady state economies),
- A motion and positive vote from the AFS Governing Board meeting in Lake Placid that the RPC proceed to develop a draft policy statement on fisheries sustainability and economic growth for consideration by the Governing Board; and
- A Governing Board endorsement at its mid-term meeting in Atlanta (March 2007) to publish the draft statement in Fisheries to obtain feedback from AFS members to aid the RPC in drafting a final policy statement to submit for a ratification vote at the AFS Annual Meeting in San Francisco in September 2007.

Development of an economic growth and fish conservation policy statement has been both a challenging and rewarding experience, from which a few general conclusions have emerged as follows:

- Dialogue focused on this issue by RPC members over the past 18 months has been exceptionally spirited and sometimes divisive (Bigford et al. 2006).
- The interdisciplinary nature of the dialogue has been highly beneficial in "educating" RPC and AFS members (through articles in *Fisheries*) about the diverse information sources and beliefs supporting the opinions of RPC and AFS members on this issue.
- At present, there is no truly authoritative test to unequivocally differentiate between the efficacy of microeconomic versus macroeconomic solutions proposed as alternatives in promoting a future for sustainable fisheries. Accordingly, even Socioeconomics Section members of AFS hold divergent views about support for either of these options (see accompanying commentary box by Socioeconomics Section President John Whitehead). However, quoting the eminent biologist John Maynard Smith, from a different context (Flannery 2005:18), "It would be as foolish to argue about which of these views is correct as it would be to argue whether algebra or geometry is the correct way to solve problems in science. It all depends on the problem you are trying to solve."
- The comments above notwithstanding, the RPC has decided it is time to move the draft policy statement "out of committee" and before the general membership of AFS to obtain their views. We note there is considerable common ground concerning recommendations that flow from either the micro- or macro- economics positions. All involved in discussions to date agree that aggressive pursuit of either "solution" will require much greater interaction, informed dialogue, and subsequent actions by natural scientists, economists, social scientists, educators, policy makers, and legislators if fish biodiversity and sustainable fisheries are to be generally maintained.
- AFS has both an opportunity and a responsibility to play a pivotal role in achieving these objectives.

Reference

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DRAFT AFS POLICY STATEMENT: ECONOMIC GROWTH AND FISH CONSERVATION

Representatives of the AFS Resource Policy Committee

Kim Hyatt, Fisheries and Oceans Canada; Tom Bigford, NOAA Fisheries; Tracy Dobson, Michigan State University; Bonnie McCay, Rutgers University; Victoria Poage, U.S. Fish and Wildlife Service.

Representatives of the AFS Water Quality Section

Bob Hughes, Oregon State University; Lou Reynolds, U. S. Environmental Protection Agency; Brian Czech, Virginia Polytechnic Institute and State University.

A. Issue Definition

Economic growth has been a profoundly

important process shaping national and global societies. It has been associated with substantial improvements in the living conditions of human beings, and is an explicit policy goal of most national and international governments. However, economic growth also poses numerous challenges to sustainable resource management. And some believe that growth has actually become "uneconomic" in the sense that it now does more harm than good to living conditions in the aggregate. The appropriateness of economic growth as a public policy goal is a matter for citizens and governments to assess and decide, but to do so, in an informed way, requires knowledge of many factors affected by economic growth. The American Fisheries Society (AFS) does not presume to know if economic growth remains an appropriate policy goal for North American nations or other nations of the world. However, the AFS does believe that the relationship of economic growth to fish and conservation of regional and global biodiversity is a key factor for consideration by citizens and policy makers.

Economic growth is an increase in the production and consumption of goods and services. At any geographic scale (local, state/provincial, national, continental, global), economic growth may occur from increasing population or increasing production and consumption per person. For most of recorded human history, population and per-person levels of production and consumption have grown except during unusual periods. Economic growth of a nation is generally indicated by increasing gross domestic product (GDP). The size of the global economy is indicated by gross world product (GWP).

As economies grow, all or some of their sectors grow. These sectors include industries that derive energy or materials from ecosystems through activities such as mining, agriculture, logging, fishing, ranching, and electricity generation. They also include manufacturing sectors ranging from heavy (e.g., iron ore refining) to light (e.g., computer chip manufacturing). Economic sectors also include services such as banking, insurance, and information exchange. Economic growth typically involves an expansion of infrastructure such as roads, power lines, canals, and reservoirs, as well as urban housing and commercial sprawl (for example, malls, golf courses, and marinas).

The majority of current fish population declines are almost invariably caused either directly (e.g., through fisheries overexploitation) or indirectly by economic activities associated with the above sectors. In most cases complex interactions among activities within numerous sectors are involved. The expansion of these sectors occurs in all biomes and in all types of ecosystems. In the case of aquatic and marine ecosystems, fish and their habitats are directly affected. In the case of terrestrial ecosystems, fish habitats are indirectly impacted.

In addition to fish population declines from overexploitation and habitat loss, economic growth entails increasing levels of pollution, which may be discharged from point or diffuse sources. Although some pollution problems have been solved, economic growth complicates the situation by the introduction of a rapidly increasing variety of pollutants to atmospheric, terrestrial, and aquatic systems. Consequently, many ecosystems face chronic disruption and biodiversity reductions that are especially acute in aquatic ecosystems. Of particular concern, recent unprecedented rates of global warming are now known to be largely a function of greenhouse gas emissions, which in turn are predominantly a result of fossil fuel combustion. Because fossil fuels are the primary energy source for economic production in North American and global economies, global warming is largely a function of economic growth.

Another effect of economic growth that is harmful to native fish species, fisheries, and associated ecosystems are invasive alien species. Although some species introductions are intentional and occasionally beneficial, the spread of unwanted alien species and their negative impacts on natural ecosystems is principally an unintentional effect of increasing levels of national and international trade.

The empirical linkage of declines in fish habitats, fish species, commercial and recreational fisheries, and fish assemblages to the rapidly increasing volume of national and global economic activities is evidence of a conflict between economic growth and fish conservation. Numerous ecological principles provide a theoretical explanation for this empirical conflict, most notably the principle of competitive exclusion. Growth of the human economy occurs at the competitive exclusion of other species including fish from their habitats. This principle suggests that stabilizing aggregate human population and per-person production and consumption is necessary for effective national and global conservation of fish and sustainable fisheries.

Some believe that technological development will allow humans to maintain economic growth without harming the environment. Indeed, there is a long list of technological developments that have diminished the environmental impacts of economic growth. However, on balance, these have been insufficient to halt or reverse a general pattern of accelerating rates of loss for biological diversity and fisheries in both global and North American aquatic ecosystems. Although some technological development may be used for purposes of conservation, when technological development is used principally for purposes of economic growth, it tends to result in the extraction of more natural resources, accompanied by increased impacts on fish and their aquatic habitats.

B. Needed Actions

The AFS takes the position that there is a fundamental conflict between the recent historic to current pattern of national and global economic growth and: (1) fish conservation, (2) sustainable fisheries, and (3) the integrity of aquatic and marine ecosystems. The AFS also takes the position that the conflict between economic growth and fish conservation should be considered in public policy decisions pertaining to economic growth. For society to maximize benefits from fish and associated industries, debates and decisions involving economic growth and natural resources must be based on striving for ecologically sustainable economies. Although approaches taken to date have enlarged national and global economies, they have clearly failed to demonstrate ecological sustainability at either scale. For purposes of fish conservation, AFS believes that a prudent approach would be to move towards a sustainable economy in which the human economy, biodiversity in general, and fish species in particular are relatively stabilized and reasonably balanced within a few human generations. This will undoubtedly entail the application of a mixture of both microeconomic and macroeconomic tools. For example, carbon emissions may be capped, and tradeable permits allocated among industries to reduce greenhouse gas emissions and improve air quality. More directly related to fish species, individual transferable quotas (ITQs) may be granted to commercial fishers within the framework of a total allowable catch (TAC). However, these microeconomic tools are unlikely to have more than local, temporary effects on fish conservation unless the macroeconomic policy goal is something other than limitless economic growth.

Declines in environmental quality, including the loss of native fish species and sustainable fisheries, are not accounted for in income accounts such as GDP and GWP. Current economic policies rarely take into account the value of ecosystems and natural resources in performing valuable services such as maintenance of water supply, flood control, and climate regulation. Thus, although GDP is a reasonably good measure of the physical dimensions of an economy, GDP is not an accurate measure of economic health or of the non-economic aspects of economic growth where marginal costs exceed benefits. The AFS believes that the stated health of an economy should reflect the condition and sustainability of fish species, biodiversity, ecological integrity, and natural resources at large, as well as the economy's ecological footprint.

The AFS believes that greater attention needs to be given to the fundamental conflict between economic growth and the conservation of fish and aquatic biodiversity at national and global scales. To accomplish this will require concerted efforts by the membership and leadership of AFS to immediately accelerate the development of a richer dialogue and action agenda on these issues among fisheries scientists, social scientists, economists, educators, policy makers, legislators, and the general public.

COMMENTS ON THE RPC POLICY STATEMENT

John Whitehead
Whitehead is president of the AFS Socioeconomics Section.
These views are not representative of every member of the Socioeconomics Section.

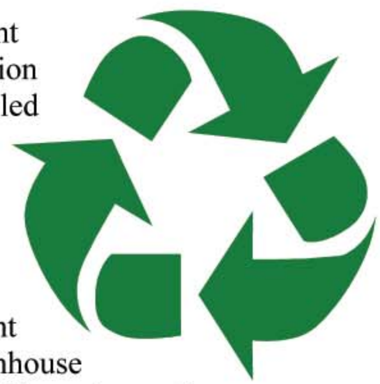
The AFS should strive to ensure fisheries professionals are engaged in the public debate regarding economic activity and the costs that it imposes on fisheries and the environment. In particular, the public needs to be educated regarding the value of fisheries and fisheries habitat and the types of policies that need to be adopted to ensure that society receives the maximum social value from our fisheries resources.

The RPC Policy Statement advocates a major change to macroeconomic policy. Reducing or even just capping economic growth would require a contractionary macroeconomic policy leading to increases in interest rates, decreases in government spending, and increases in tax rates. None of these policies guarantee an improvement in environmental quality and could lead to perverse environmental consequences. It is not economic growth, per se, that damages environmental quality, but economic growth in the wrong areas. Microeconomic policies that target problem areas are more likely to improve environmental quality. Pursuit of macroeconomic and microeconomic policies at the same time, with the same purpose, are akin to driving a nail with a hammer and then making sure it is flush with a sledgehammer.

The AFS should focus on policies that educate economic experts, government leaders, and the public about the negative environmental effects associated with unregulated economic activity. The AFS should argue that society should insist on more effective fisheries conservation as a requisite to long term economic growth, because it is in the best interests of society to control the rapidly increasing social costs of continued environmental degradation.

AFS 2007 is Going Green

The 137th Annual Meeting Planning Committee has been researching ways to minimize the use of resources and reduce waste during the conference. Our host hotel, the Downtown San Francisco Marriot, supports sustainable practices through their Environmentally Conscious Hospitality Operations program. The Marriot received the 2006 Recycler of the Year Award from the San Francisco Department of the Environment. They also compost more than a half-million pounds of food scraps and other items annually! The hotel provides a linen and towel reuse program and the catering service will be using reusable china, linens, and bulk condiments. Marriott was named an ENERGY STAR® Partner of the Year by the US Environmental Protection Agency in 2005, 2006, and 2007. They are the first hospitality management company to join the EPA's Climate Leaders program and are on track to reduce greenhouse gas emissions by nearly one-fifth over the ten year period from 2000 to 2010: a total of one million tons of climate warming gases.



Hosting the annual meeting in San Francisco provides an excellent opportunity to reduce travel emissions because public transportation is so widely available. Visit the annual meeting website for detailed information about the San Francisco Municipal Railway's street cars, buses, and cable cars, the Bay Area Rapid Transit District (BART), and Caltrain. Many wonderful attractions are also within walking distance of the Marriott.

Transportation to the national meeting may be the most significant environmental impact of our event. To reduce the impact of greenhouse gas emissions from travel to the conference, attendees might consider going carbon neutral. Purchasing carbon offsets is an easy way to mitigate the carbon dioxide generated from travel. For more information, visit the following websites:
(http://www.davidsuzuki.org/Climate_Change/What_You_Can_Do/carbon_neutral.asp)
(http://www.carboncounter.org/)

The planning committee is using sustainable or recycled materials whenever possible. We will use recycled paper for the program guide, organic cotton and water-based inks for the beautiful conference art shirts, and durable reusable water bottles generously donated by the San Francisco Public Utilities Commission. We are attempting to incorporate green practices in as many ways as possible. Please check the conference website for continued efforts and contact Sarah Giovannetti, U.S. Fish and Wildlife Service – Red Bluff office, at 530-527-3043 ext. 256 or sarah_giovannetti@fws.gov if you have more green meeting ideas.

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

Fish Culture Specialist I, Vermont Dept of Fish and Wildlife, Bennington. **Responsibilities:** Professional work in the propagation of trout and operation and maintenance of a fish culture station. Responsible for maintaining the health, nutritional requirements, and proper rearing environment to promote optimum growth of several strains and species.
Qualifications: B.S. in fish culture or a natural resources related field with no experience or experience at a technical level in the propagation of fish in a fish culture station may be substituted for the B.S. degree on a six months for a semester basis. Note: Incumbents will be required to attend the division's course in fish culture, obtain a pesticide applicator's license, and CPR certification within six months of hire.

EMPLOYERS: To list a job opening on the AFS Online Job Center submit a position description, job title, agency/company, city, state, responsibilities, qualifications, salary, closing date, and contact information (maximum 150 words) to jobs@fisheries.org. Online job announcements will be billed at $350 for 150 word increments. Please send billing information. Listings are free for Associate, Official, and Sustaining organizations, and for Individual members hiring personal assistants. If space is available, jobs may also be printed in *Fisheries* magazine, free of additional charge.

Salary: $13.79 per hour increasing to $14.41 per hour after successful completion of a probationary period.
Closing date: 29 June 2007.
Contact: Interested parties can find additional information and apply online at www.vtstatejobs.info. EOE/AA.

Senior Fisheries Biologist, HDR Inc., Anchorage, AK.
Responsibilities: Plan, direct and oversee all aspects of large scale, multi-discipline fisheries projects; provide oversight of field study program design and implementation for a wide variety of projects including fisheries assessments, fish population analyses, baseline studies, habitat improvement, and restoration; oversee advanced fisheries data analysis and provide quality assurance/quality control; build and maintain client relations; participate in project development and contract document preparation; and mentor mid- and junior-level fisheries biologists. This position will require field work in remote areas of Alaska for 1–2 weeks at a time.
Qualifications: B.S. in fisheries or related field, M.S. preferred. Fifteen plus years experience. Experience designing and directing large, complex, multi-discipline fisheries projects, including management of field studies.
Contact: Apply online at www.gojobs.com/seeker/aoframeset.asp?JobNum=1044026&JBID=1334. Employer JobCode: 061860.

Associate Environmental Scientist, HDR, Inc., Sacramento, CA.
Responsibilities: Include preparing quantitative and qualitative fishery and aquatic resource impact evaluations; technical analyses; develop experimental designs; develop and review technical reports; support for various projects related to aquatic resources; work with clients, resource agencies, technical staff, and project managers to prepare technical sections of CEQA, NEPA, and ESA documents, technical memoranda,

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Fisheries, May 2007

meeting minutes, transmittals, and presentations; perform archival/electronic research to obtain data, documents, and other information.
Qualifications: B.S./B.A. in fisheries, natural or aquatic resources, environmental studies, or a related field. Three plus years of related experience.
Contact: Apply on line at www.gojobs.com/seeker/aoframeset.asp?JobNum=1070690&JBID=1334. Employer JobCode: 061942

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