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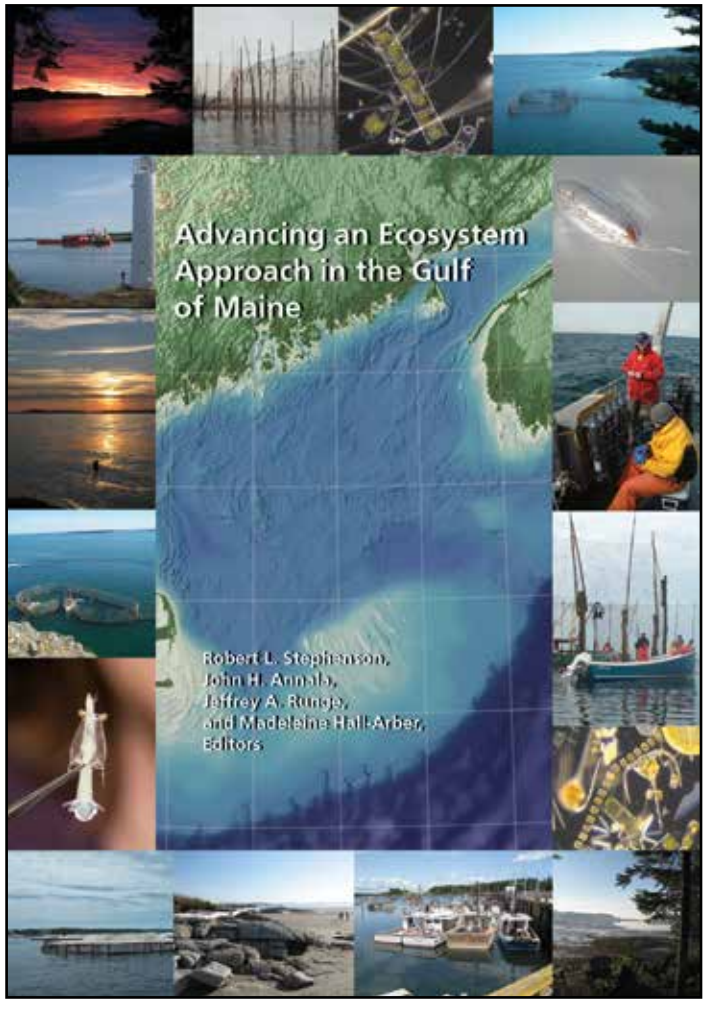
Advancing an Ecosystem Approach in the Gulf of Maine

Robert L. Stephenson, John H. Annala, Jeffrey A. Runge,
and Madeleine Hall-Arber, editors

The Gulf of Maine (GOM) is arguably one of the best studied marine ecosystems in the world. Interest in its physical environment, fisheries, and Canada/USA boundary have resulted in considerable research attention for more than a century. The GOM is also highly managed by two nations with a commitment to implementing an ecosystem approach to management.

The papers in this book review the management and policy tools and approaches required to implement integrated policy and management in the GOM; synthesize the current ecological and oceanographic understanding of the GOM, and the social, economic, and cultural interactions within the gulf; assess anthropogenic and external influences on the gulf ecosystem; and examine the science required to observe and predict changes in the GOM ecosystem, along with strategies to implement an ecosystem approach to management.



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Cover: **Climate change will exacerbate many habitat fragmentation issues like this blockage of a kokanee salmon migration by low summer flows at a poorly fit road culvert. Proactive and strategic habitat restoration and management will be needed to help minimize the impacts of a changing climate on fish populations. Photo credit: Clayton Nalder.**

538 Lake Erie charter boats await passengers for a great day of fishing. Photo Credit: Ohio Sea Grant.

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Developing a Legacy through Mentoring

John Boreman, President

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Bill Vantrin taught me how to fish. I was seven or eight at the time, and Bill was renting the farmhouse next door to my grandmother's summer cottage in the Catskills. In the evening, when Bill got home from work, he and I would dig earthworms from the garden, put them in a tin can (keep in mind that this was the mid-1950s), grab our fishing poles and start heading up Shandelee Creek (a tributary of the Willowemoc River that ran behind our houses), looking for a pool with the perfect overhanging rock that might hide a brookie. He taught me how to use a fishing reel, tie a hook on a line, put a worm on the hook, and drop the bait slowly alongside the rock. If I was lucky (it was all luck for me in those days and probably still is) the bait would be grabbed just before it hit bottom. Bill was a patient tutor—he had to be. He was dealing with a kid who thought fishing for brook trout was the most exciting thing in the world and wanted to do it day after day after day. Bill and I had developed the basics of a mentoring relationship: learning, dialogue, and challenge.

Each and every one of us can look back on our careers and remember those people who took the time and had the patience to work with us one-on-one, tutoring us in a variety of ways to help us do our jobs better and gain self-confidence while doing so. Think of the personal characteristic or skill that you possess that creates a positive impression on others and I bet you can say to yourself: "I picked that up from so-and-so." They wore the hats of professors, teachers, coaches, lab instructors, clergy, fellow workers, friends, our employees, and even our children. They required nothing more than our attention and respect, and yet they gave us the tools we needed to succeed. Oftentimes, they had more faith in us than we did in ourselves. I'm not referring to people who answered our questions; I'm referring to those who took the time to make sure we really understood the answer, perhaps helping us to frame the question in a better context, and challenging us to use the answer as a stimulus to learn more. They were our mentors.

The relationship between mentor and mentee needs to be nurtured; it cannot be forced. Too often I have seen agencies and organizations (even the American Fisheries Society) pair up fisheries professionals who are well into their careers with new employees or students, too often resulting in an ephemeral relationship that only lasts for one mentoring session. The pairings are also made under the false assumption that the mentor should be senior in grade to the mentee. The mentor–mentee relationship works best when there is a sustained interpersonal chemistry between the parties that grows out of the true desire of the mentor to help the mentee, the desire of the mentee to be helped, and mutual respect.

Think about the number of people you have mentored during your career, even if it has been a short one so far. What situations created the mentoring opportunities? What information, skills, or experience did you impart to your mentees? Did they benefit from the exchange? Are you proud of their accomplishments? Do you still keep in touch with them? I once had a senior staff member who complained about the agency-wide mandate for employees to undertake professional development as part of their annual performance plan. The person was planning to retire within the next year or two and had reached the pay cap years earlier. He did not see the necessity of having the requirement in his performance plan, although he recognized its importance for employees who still had a long career ahead of them. I suggested that he view the requirement not as improvement of his performance but improvement of the performance of his fellow workers and, through them, the agency as a whole. After giving it some thought, he decided to devote more of his time to mentoring, considering it as his legacy to the agency he had served for over 30 years.

For the past decade or so we have heard about the impending dearth of leadership in the fisheries professions due to the retirements of those of us in the baby boomer generation. A number of leadership development programs were instituted by government agencies and professional organizations, including the American Fisheries Society. These programs provide an opportunity for those of us who are more toward the end of our careers to share our experiences and lessons we have learned (sometimes from our mistakes) with the younger generations. We should be more open to serving as a mentor and should seek out such opportunities rather than wait for them to happen spontaneously. Think of it as our legacy to the American Fisheries Society.

Ohio's 2010 Lake Erie Charter Fishing Industry

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ABSTRACT: *Charter fishing provides important angler access to Lake Erie sport fishing. It is economically important to local harbor communities, with 79% of charter anglers coming from over 50 miles away. To update information from our 2006 survey, we conducted a mail survey of 500 randomly selected Ohio charter boat captains in early 2010 and received usable information from 239 captains. In 2010 the Ohio Department of Natural Resources licensed 786 charter guides compared to 783 licensed captains in 2006. Possibly reflecting difficult economic times, charter firms in 2010 made on average 10.1 fewer trips per firm (34.6) than in 2006 (44.7). These captains made an estimated 21,082 charter trips in 2010, of which over 81% were full-day and almost 19% were half-day trips. Mean total revenues earned in 2010 ($15,132 ± $16,110) declined over 13% from 2006. Declining harvests, invasive species, and increasing operating costs highlight the concerns noted by captains responding to the survey. Policies and actions to address declining sport fish populations, invasive species, and other key issues may have positive impacts on the industry and help it continue into the future.*

La industria pesquera tipo chárter del lago Erie en Ohio durante 2010

RESUMEN: la pesca tipo chárter ofrece a los pescadores un importante acceso a la pesca deportiva en el lago Erie. Se trata de una actividad económicamente relevante para las comunidades locales, en las que 79% de los pescadores de chárteres provienen de lugares situados hasta 50 millas de distancia. Con el fin de actualizar la información recabada en un sondeo realizado en 2006, a inicios de 2010 se condujo otro sondeo por correo a 500 capitanes de barcos chárter en Ohio, recibiéndose información utilizable de 239 de ellos. En 2010, el Departamento de Recursos Naturales de Ohio otorgó 786 guías para chárteres en comparación con los 783 capitanes con licencia registrados en 2006. En 2010, las firmas de barcos chárter realizaron, en promedio, 10.1 menos viajes por firma (34.6) que en 2006 (44.7) lo cual posiblemente sea el reflejo de un periodo difícil en términos económicos. Los capitanes hicieron alrededor de 21,082 viajes chárter en 2010, de los cuales más del 81% tuvieron una duración de un día entero y casi 19% duraron medio día. Los dividendos totales promedio en 2010 ($15,132 ± $16,110) se redujeron más de 13% desde 2006. La disminución de la captura, especies invasivas y el incremento en los costos de operación subrayan la preocupación que expresaron los capitanes que respondieron el sondeo. Las políticas y acciones que surjan en torno a la reducción de las poblaciones sujetas a la pesca deportiva, especies invasoras y otros factores clave pudieran tener impactos positivos en la industria y servirían para mantener la actividad en el futuro.

INTRODUCTION

Lake Erie charter fishing offers access to a high-quality, fun, safe, and productive angling opportunity on a large freshwater sea to many ordinarily shore-bound and small-boat anglers who do not have a Great Lakes–worthy craft. To operate in Ohio waters of Lake Erie, charter captains must be licensed by the U.S. Coast Guard to carry passengers and must obtain an annual Ohio guide's license from the Ohio Department of Natural Resources (ODNR). The number of Ohio-licensed guides in 2010 was 786, which falls below the 10-year average of 829 and was down slightly from 2009 (ODNR 2011b).

A survey of the Ohio charter captains was conducted in 2010 to update the database for this industry. This was the seventh such survey to be conducted by Ohio Sea Grant Extension since 1985. In preceding surveys, the Ohio Lake Erie charter fleet was shown to be the largest charter fishing fleet on the Great Lakes. However, this charter fleet has much in common with the charter fishing industries of the other Great Lakes states and therefore may be illustrative of basic fishery trends, industry issues, business concerns, social changes, and the natural resource dependence of many U.S. charter fishing industries (Lichtkoppler and Hushak 1993, 2001; Lichtkoppler 1997).

Lake Erie is the shallowest, southernmost, and most nutrient rich of the five Great Lakes, and this makes it the most biologically productive (Government of Canada and U.S. Environmental Protection Agency 1995). The Lake Erie walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), and smallmouth bass (*Micropterus dolomieu*) fisheries are well known.

Coastal Ottawa County, in the heart of Lake Erie's western basin, ranks first of all Ohio counties in fishing license sales, illustrating the importance of the fishery to the local economies (ODNR 2011a).

Though Lake Erie remains Ohio's greatest natural resource, it also faces its share of challenges. Ohio Sea Grant (2010) identified seven critical issues confronting Lake Erie: sedimentation and dredging, nutrient loading and phosphorus, harmful algal blooms, the dead zone, aquatic invasive species, climate change, and coastal community and economic development. These issues can have direct effects on the fishery. For instance, sedimentation and dredging often result in increased turbidity and nutrient and phosphorous resuspension as well as resuspension of contaminants like mercury and polychlorinated biphenyls. Aquatic invasive species alter the native ecosystem and compete with native species for resources. Continued warming of Lake Erie's climate could alter the native fish assemblage structure as well as exacerbate the other critical issues.

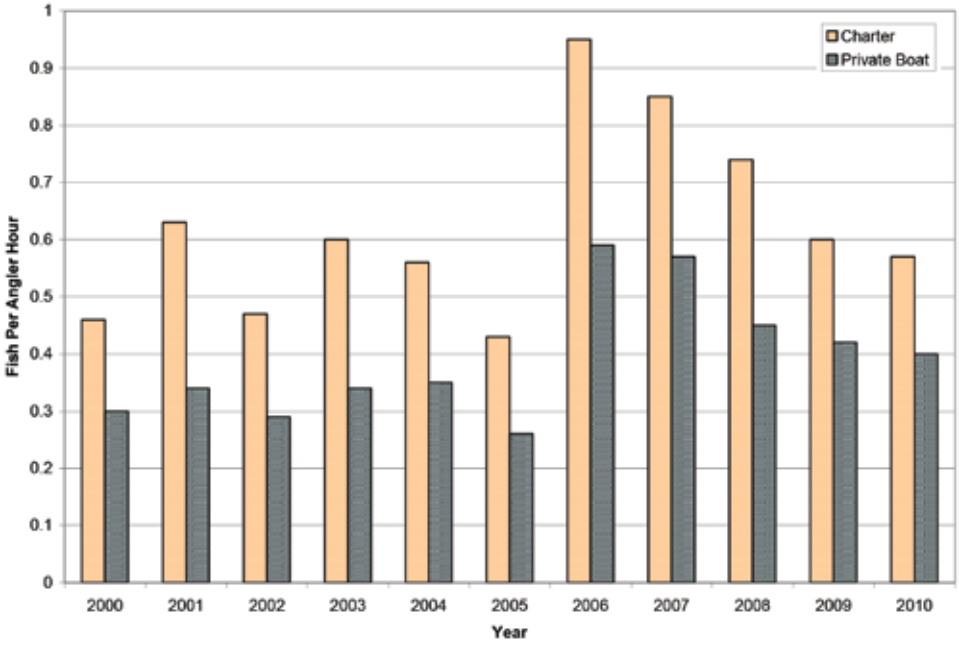

Figure 1. Sport angler harvest rate 2000–2010.

Ohio's Lake Erie walleye and yellow perch fisheries are sustained by naturally reproducing populations and are managed by the wildlife agencies of Ohio, Michigan, Pennsylvania, New York, and the Province of Ontario Ministry of Natural Resources. Management decisions by each jurisdiction on the lake, such as daily bag limits, are derived from quotas based largely on population abundance as determined by the Great Lakes Fishery Commission's Lake Erie Committee (ODNR 2011b). Since the recorded abundance of walleye population in 2003—rated excellent by the ODNR—this fish population has decreased and has been subject to mortality. The relatively low abundance has caused concern among charter captains about the potential to decrease bag limits should the trend continue. Yellow perch abundance has followed a similar trend and was below the long-term average in the Ohio waters of Lake Erie in 2010. In 2003 and 2007 the recorded classes of both walleye and yellow perch were major contributors in the 2010 harvest (ODNR 2011b).

The ODNR (2011b) reported that the Ohio charter fleet targets 86% of its angling effort for walleye and about 13% for yellow perch. Charters use a variety of walleye fishing methods and the preferred method has varied from west to east. Survey data indicate that casting was most popular followed by flat-line trolling in the western end of the lake; flat-line trolling, casting, and controlled-depth trolling were common in the central portion of the lake; and controlled-depth trolling was the method of choice in Ohio's eastern Lake Erie waters. The casting numbers were the lowest recorded since 1989, which may be a function of a smaller and more widely dispersed walleye population. The 2010 charter boat harvest of walleye was down 13% during 2009, and at an estimated 127,000 fish it was well below the 10-year average of 237,000 fish. Targeted walleye fishing via charters was the lowest recorded since 1980, and the targeted walleye harvest rate of charters at 0.57 walleye per hour was the lowest since 2005. Still, the 2010 walleye harvest rate of charters remained higher than the private boat harvest rate (0.40 fish per hour), a trend that has remained consistent since 1975 (ODNR 2011b; Figure 1).

METHODS

In 2010, a list of Ohio-licensed charter guides was obtained from the ODNR, Division of Wildlife. Starting with the 2006 survey, we updated and modified the survey instrument to reflect changing needs and current issues of the industry. Open-ended survey items relating to captains' opinions of the future of the industry and opinions on what clientele look for were eliminated in favor of targeted multiple-choice items for operations characteristics and more options for future plans. New survey items focusing on any major changes made recently and concerns with the seven critical issues facing Lake Erie were also added. Core economic items (revenues, expenses) and social items (why charter, future plans) concerning the charter business that have been asked since 1985 were not changed.

In early 2011, a randomly drawn sample of 500 of the 786 licensed charter guides was surveyed by mail using a modified Dillman (1978, 2000) technique. Different from previously conducted charter captain surveys, an online survey option was also provided in 2010. However, fewer than 25 captains participated using the online survey option. Of the 500 surveys, 21 (4.2%) were returned as undeliverable, out of business, or indicating that they did not charter in 2010. Subtracting 4.2% from the 786 licensed captains yielded an estimated 753<active

Ohio charter captains in 2010. Nonrespondents were sent up to three reminder letters. A total of 239 of 479 surveyed captains returned surveys with usable data, providing a response rate of about 50%. In this article we primarily report the information provided by the 217 six-pack (six-passenger) charter captains who operate their own business and responded to our survey. Where appropriate we also report the wages earned and opinions of charter captains who pilot larger vessels and do not operate their own businesses.

Linder et al. (2001) stated that failure to address nonresponse error was an issue in social science research. Linder et al. (2001) and Miller and Smith (1983) stated that comparing early and late respondents was an acceptable method of addressing nonresponse error. To obtain an acceptable number of late respondents we defined our late respondents as those returns that came in after the third contact by mail. We compared the responses from 186 captains operating their own charter businesses who provided economic data to the responses of early respondents (n = 100), late respondents (n = 67), and electronic respondents (n = 19) using a one-way analysis of variance. There were no significant differences ($P \leq 0.05$) for the 23 economic variables tested. When comparing the mean number of trips taken by early, late, and electronic respondents we found that they were the same except that electronic respondents reported significantly more trips (5.2 trips) for steelhead (*Oncorhynchus mykiss*) than did the early or late respondents (F = 15.4, df = 152, $P \leq 0.05$). We then tested the mean responses for attitudinal variables of early (n = 131), late (n = 85), and electronic respondents (n = 23). A significant difference between the respondent groups was found for only one of 19 attitudinal variables. The importance of catching fish was significantly higher for early and electronic respondents than for the late respondents (F = 4.0, df = 234, $P \leq 0.05$). From this we conclude that the results reported in this article are representative of the Ohio Lake Erie charter angling industry in 2010.

RESULTS

Charter Business Characteristics

According to survey findings, in 2010 the average six-pack Ohio charter fishing captain had been licensed for 13 years ± 10 years. Ohio charter captains may be grouped into two categories: (1) those who own and operate their own businesses and (2) those who work for a salary or for hire by other firms (Table 1). Approximately 81% of 239 respondents either owned or leased/rented a boat or operated their own firm under some other arrangement. Multiplying 81% by the estimated 753 active captains gives us an estimated total of 610 charter firms. Those remaining were salaried employees and freelance hires paid by the trip. Of those owning or leasing their boats, most (84%) operated their businesses as sole proprietorships. Approximately 16% of the captains (37) were work-for-hire captains who did not own a charter boat. Most businesses (91%) operated one boat, which was typically 8.69 ± 1.0 m (28.5 ft) long, 17 ± 8.3 years old, and powered by an inboard (70%), inboard/outdrive (18%), or outboard (12%) motor.

TABLE 1. Organization of Ohio's Lake Erie charter boat fishing businesses.

Business organization	Number of respondents	Percentage of respondents
Charter firms		
Owned own boat	186	78
Leased/rented boat	2	1
Other arrangement	5	2
Work-for-hire captains		
Freelance hire per trip	37	16
Salaried employee	8	3
Total	238	100
Charter firm ownership		
Sole proprietorship	154	84
Partnership	4	2
Corporation	18	10
Other	7	4
Total	183	100

Photo 1. Western Lake Erie charter boats at docks. Photo Credit: Ohio Sea Grant.

Photo 2. Central Lake Erie Basin charter boats. Photo Credit: Ohio Sea Grant.

The average estimated replacement cost for an Ohio charter vessel was $77,941 ± $60,920, and replacement cost for onboard business-related equipment was $9,528 ± $8,237. About 4 out of 10 (43%) of the respondents used a vehicle for towing their boat and other charter-related business. The average replacement cost of the vehicle was $23,379 ± $20,131; replacement cost for the trailer was $3,728 ± $2,823. Respondents indicated thata the vehicle was used for boat towing 14% of the time and for other charter business about 31% of the time.

Nearly all (92%) responding captains were six-pack operators, specifically licensed to carry no more than six passengers. Nearly one in 10 (8%) of the responding captains were licensed to carry more than six passengers. More than one fourth (26%) of captains responding indicated that they began their charter operation more than 20 years ago. Almost half (47%) indicated getting into the charter fishing industry within the past 10 years. More than half of the captains (56%) indicated that they were professional charter fishing captains because they like the opportunity to help people enjoy fishing, 54% said that it is a secondary source of income (that helps pay boating expenses), and 53% said that they like the work (Table 2). Charter operations were the primary source of income for only 12% of the charter captains responding.

Charter Trips

According to survey findings, captains averaged 28.1 full-day and 6.5 half-day paid charter trips per year. Most (73%) of these trips were for walleye, 18% for yellow perch, 3% for smallmouth bass, 1% for steelhead, and 5% were for a combination of species (Table 3). Just 21% of 173 responding captains ran more than one charter per day. On average, captains running more than one trip per day ran doubles on only slightly less than 6 days in 2010. June was the busiest month for Lake Erie charter captains, with an average of 10.2 trips. Over one fourth (29%) of all trips taken in 2010 were in June. This was followed by July with 7.5 trips (22% of the total) and May with 6.0 trips (17% of the total). Captains averaged 4.5 trips in August, about 3.9 trips in September, 2.0 trips in October, and 1.4 trips in April. The number of trips taken in March and November was negligible. A limited number (10%) of captains reported conducting some charter fishing trips on other Great

TABLE 2. Reasons for Ohio charter captains entering/remaining in the charter fishing business (number of respondents = 233). Respondents were asked to check all items that applied and multiple choices were allowed.

Reason	Number of respondents	Percentage of respondents
Help people enjoy fishing	131	56
Secondary source of income	126	54
Like the work	124	53
Primary income source	28	12
Other	25	11

TABLE 3. Reported average number of trips, average charge per trip and calculated revenues earned per firm by species sought and trip length.

Fish species	Trip length	Average number of trips per business[a]	Average charge per trip[b] ($)	Revenues earned per business[c] ($)
Walleye	Full day	20.9	491	10,262
	Half day	4.5	392	1,764
Steelhead	Full day	0.4	513	205
	Half day	0	372	0
Smallmouth bass	Full day	0.9	483	435
	Half day	0	380	0
Yellow perch	Full day	4.4	405	1,782
	Half day	1.7	355	604
Combination of species	Full day	1.5	491d	737
	Half day	0.3	392	102
Subtotal	Full day	28.1		13,421
	Half day	6.5		2,470
Totals		34.6		15,891

[a] Rounded to the nearest tenth.

[b] Rounded to the nearest dollar.

[c] Revenues are estimated by multiplying the average number of trips times the average charge per trip.

[d] Because over 97% of the combination trips were for walleye and another species we used the charges for walleye trips for the combination trips.

TABLE 4. Estimated number of trips, average charge per trip, revenues earned, and percentage of total revenues by the Ohio charter industry in 2010 by fish species and trip length.

Fish species	Trip length	Estimated number of trips	Average charge per trip[a] ($)	Total revenues earned[b] ($)	Percentage of total revenues
Walleye	Full day	12,749	491	6,259,759	64
	Half day	2,745	392	1,076,040	11
Steelhead	Full day	244	513	125,172	1
	Half day	0	372	0	0
Smallmouth bass	Full day	549	483	265,167	3
	Half day	0	380	0	0
Yellow perch	Full day	2,684	405	1,087,020	11
	Half day	1,037	355	368,135	4
Combination of species	Full day	915	491	449,265	5
	Half day	159	392	62,171	1
Subtotal	Full day	17,141			
	Half day	3,941			
Totals		21,082		9,692,729	100

[a] Rounded to the nearest tenth.

b The number of trips is an extrapolation of respondent trip rates applied to the estimated population of 610 active Ohio charter firms (excluding party boats). Revenues are calculated from the number of trips multiplied by the average charge per trip.

Lakes. Charter fees varied according to target species, length of the charter, and services offered. The most popular trip was the whole-day walleye charter, with costs averaging $491 ± $111 per boat.

Applying the response data from Table 3 to the total population of 610 charter firms yielded an estimated 21,082 charter trips, of which more than 81% were full-day and almost 19% were half-day trips (Table 4). Estimated total revenues were generated by multiplying the number of trips times the average charge per trip. Walleye accounted for approximately three quarters (75%) of the estimated revenues; yellow perch made up 15% of the total estimated revenues, a combination of species 5%, smallmouth bass almost 3%, and steelhead made up the final 1% of estimated total revenues.

Costs and Returns

Operating costs include costs necessary to run the operation and do not include the cost of buying a boat. Typical operating costs include fuel and oil, dockage, maintenance and repair, and costs for advertising and insurance. Capital is required to purchase a boat and, as such, those expenses are considered capital costs. Interest on boat loans, depreciation on purchased boats, and opportunity costs are also capital costs. Operating costs and boat loan payments are cash outlays required to run the charter business. A boat loan must be paid regardless of whether the vessel is used as a charter boat or not and is not an operational cost.

TABLE 5. Average annual operating costs for all reporting boat-owning captains, captains reporting boat loans, captains reporting depreciation, and captains not reporting a boat loan or depreciation. *N* = number of respondents.

	All firms		Firms with boat loans		Firms with depreciation		Firms without boat loans or depreciation	
Item	Expense ($)	*N*	Expense ($)	*N*	Expense ($)	*N*	Expense ($)	*N*
Fuel/oil	3,826	139	4,010	54	3,366	22	3,734	70
Dockage	1,276	151	1,409	55	1,210	23	1,193	80
Boat maintenance and repair	1,056	145	1,050	55	2,052	23	750	74
Equipment repair	928	139	835	52	1,099	23	926	71
Miscellaneous	926	132	1,274	51	1,261	22	567	66
Advertising	909	137	1,023	54	1,118	23	796	67
Insurance	810	149	917	56	821	23	716	77
Boat storage fees	663	143	826	55	857	21	500	74
Office and communications	517	132	654	51	552	22	389	66
Labor (hired)	435	131	449	48	377	23	423	67
Boat repair not covered by insurance	369	133	676	49	635	20	215	71
License fees	211	141	208	52	344	23	196	73
Drug testing/ professional dues	93	145	93	55	82	23	94	74
Boat launch fees	57	141	52	52	69	22	56	74
Total operating costs	12,405	132	14,365	46	13,237	20	11,053	73

TABLE 6. Average revenue, cash flow needs, and net cash flow to the firm for Ohio Lake Erie charter boat businesses in 2010 estimated by all businesses, businesses reporting boat loan payments, businesses reporting depreciation, and businesses not reporting boat loan payments and/or depreciation. *N* = number of actual respondents.

	All businesses		Businesses reporting boat loan		Businesses reporting depreciation		Businesses not reporting boat loan payments or depreciation	
Income/expenses	Amount ($)	*N*	Amount ($)	*N*	Amount ($)	*N*	Amount ($)	*N*
Average revenue	15,132	153	17,729	54	14,010	23	13,694	83
	±16,110		±16,739		±8,947		±16,646	
Cash flow needs								
Average operating costs	12,405	132	14,365	46	13,237	20	11,053	73
Boat loan payments	2,373	130	5,509	56	1,061	21	NA	NA
Cash needed	14,778		19,874		14,298		11,053	
Net cash flow	354		−2,145		−588		2,641	

Overall annual operating costs averaged $12,405 ± $11,332. In 2010, as in 2006, the cost of fuel and oil was the highest operating cost by far at $3,826 on average (Table 5). Fuel and oil costs increased from $75.42 per trip in 2006 to $110.75 per trip in 2010. Given the rise in oil prices in 2010, the proportion of fuel costs relative to total operating costs increased in 2010. Average fuel and oil costs represented 31% of total average operating costs compared to 29% in 2006. Similar to 2006 findings, boat dockage, maintenance, and equipment repair were the next highest operating expenses in 2010 (Table 5). These expenses averaged $3,260 or 26% of total operating expenses in 2010, a 3% decrease from the 2006 average.

The average annual depreciation reported was $2,773. This was down 60% from data reported in 2006 (Table 6). Opportunity costs (the costs of owning a boat instead of investing those dollars in something else) were estimated at 5% of the average

TABLE 7. Economic cost components, total economic cost, and net return to the operator for Ohio Lake Erie charter boat businesses in 2010 estimated by all businesses, businesses reporting boat loan payments, businesses reporting depreciation, and businesses not reporting boat loan payments and/or depreciation. *N* = number of actual respondents.

	All businesses		Businesses reporting boat loan		Businesses reporting depreciation		Businesses not reporting boat loan payments or depreciation	
Income/expenses	**Amount ($)**	***N***	**Amount ($)**	***N***	**Amount ($)**	***N***	**Amount ($)**	***N***
Economic costs								
Average operating cost	12,405	132	14,365	46	13,237	20	11,053	73
Capital costs								
Opportunity costs[a]	4,373	163	5,232	53	4,168	22	3,810	95
Depreciation	2,773	63	4,071	14	7,595	23	NA	NA
Total economic cost	19,551		23,668		25,000		14,863	
Net return to operator	−4,419		−5,939		−10,990		−1,169	

[a] Opportunity costs are estimated at 5% of the average estimated replacement cost of the boat and on board equipment.

TABLE 8. Captains' perceived importance of marketing a limit catch (harvest) for the following species to their charter business.

		Percentage of those responding				
Species	**Number of respondents**	**Not extremely important**	**Not very important**	**Somewhat important**	**Very important**	**Extremely important**
Walleye	231	2	3	23	46	26
Yellow perch	219	3	3	20	43	31
Smallmouth bass	146	25	28	25	13	9
Steelhead	122	35	29	20	9	7

TABLE 9. Concerns of the Ohio Lake Erie charter fishing industry on a scale of 1 = least important to 5 = most important.

Concern	Score	Standard deviation	Number of respondents
Future of the fishery	4.7	±0.6	234
Catching fish	4.3	±0.8	235
Attracting customers	4.1	±1.1	233
Business expenses	3.9	±1.2	231

estimated replacement cost of the boat and onboard equipment. Opportunity costs overall averaged $4,373 annually. Total capital costs (depreciation and opportunity costs) overall were $7,146, down 37% from the 2006 value of $11,372.

Total costs are represented by capital costs and operating costs combined. The total costs of the average charter operation were $19,551, a 16% decrease from $23,268 in 2006. Given these data, a typical captain would have to run at least 40 full-day walleye charter trips at the average $491 per trip to yield a net positive return to the operation compared to 50 trips in 2006. Operations with boat loans would have to run over 48 full-day walleye trips, somewhat more than the 45 trips in 2006. Captains reporting depreciation would have to run 51 full-day trips in 2010 compared to 53 trips in 2006. Captains without boat loan payments and fully depreciated boats would need to run 31 trips in 2010 compared to 33 in 2006 to yield a net positive return.

Operating expenses and boat loan payments comprise the cash required to sustain a charter firm. Almost 43% (56 of 130) of respondents indicated that a boat loan was part of their cash flow needs (Table 6). They indicated that the average monthly boat loan payment was $459 per month, up from $376 four years ago. The average annual operating cost was $12,405, down from $16,412 in 2006. For respondents reporting boat loan payments, the average annual cost was $14,365 (Table 7). The average annual operating cost was $13,237 for operations reporting depreciation. Those who reported neither a boat loan nor depreciation reported an average annual operating cost of $11,053. In short, the typical charter firm that owns and operates a single vessel must generate sales between $11,053 and $14,365 to meet the cash flow needs of the operation. These figures were down 4% to 14%, respectively, from figures reported by Lichtkoppler et al. in 2008.

Annual revenues ranged from an average of $13,694 for operations not reporting loan payments or depreciation to $17,729 for operations reporting a boat loan. In light of cash flow needs, this results in a net negative cash flow of −$2,145 for operations reporting a boat loan. For those operations with neither a loan payment nor depreciation, net cash flow was $2,641.

Operating Characteristics

Of the 786 licensed charter captains in 2010, an estimated 4.2% (33) were not actively chartering in 2010. Of the remaining 753 active captains, 81% or 610 were boat-owning charter firms and the rest (143) were captains for hire who worked for others and were paid either in wages or by the trip an average of $4,862 ± $5,954. The estimated number of active charter firms declined almost 5% (from 639 in 2006 to 610 in 2010) and the estimated number of paid charter trips declined over 26%, down from 28,563 in 2006 to 21,082 in 2010. In 2010, the active charter captains generated an estimated $9.93 million in gross revenues (610 firms × $15,132 per firm plus 143 captains for hire × $4,862). Similar calculations for 2006 adjusted for inflation to 2010 dollars showed an over 13% decline in estimated gross revenues from $11.47 million in 2006 (Lichtkoppler et al. 2008; U.S. Department of Labor 2011).

TABLE 10. Concerns of the Ohio Lake Erie charter fishing industry. Respondents were asked to indicate their most important concern within each category.

Concern	Number of respondents	Percentage of respondents
Future of the fishery		
Aquatic invasive species	69	29
Fisheries management	52	22
Illegal fishing practices	32	14
Overharvest of fish stocks	28	12
Harmful algal blooms	26	11
Lake Erie dead zone	6	3
Sedimentation and dredging	4	2
Climate change	0	0
Other	18	8
Total	235	~100
Catching fish		
Low fish abundance	157	68
Poor weather conditions	44	19
Government regulations	12	5
Lake Erie dead zone	12	5
Other	7	3
Total	232	100
Attracting customers		
Reduced walleye catch limits	63	27
Low catch rates	61	26
Negative Lake Erie publicity	26	11
Poor weather conditions	24	10
Harmful algal blooms	21	9
Government regulations	13	6
Marketing	13	6
Fish consumption advisories	0	0
Other	12	5
Total	233	100
Business expenses		
Cost of fuel	201	87
Fixed operating costs	20	9
Boating equipment	5	2
Cost of boat loan	0	0
Other	5	2
Total	231	100

Captains indicated that yellow perch was the most important species to market a limit catch for (Table 8). Three quarters (75%) of captains indicated that this was very important or extremely important. Walleye was the second most important species, with 72% of captains indicating that this was very important or extremely important. Nearly two thirds (64%) indicated that marketing a limit catch for steelhead was not very important or not extremely important. More than half (53%) indicated the same for smallmouth bass.

Nearly all captains (95%) indicated that they were very concerned about the future of the Lake Erie sport fishery (Table 9). When asked to select the most important concerns about the future of the fishery respondents ranked aquatic invasive species and fisheries management as the greatest concerns (Table 10). Low fish abundance was the top concern related to catching fish. A reduced walleye limit, followed by low catch rates,

Photo 3. Western Lake Erie charter boats at the ready. Photo Credit: Ohio Sea Grant.

Photo 4. Lake Erie charter boats await passengers for a great day of fishing. Photo Credit: Ohio Sea Grant.

Photo 5. Lake Erie 6-pack charter boats. Photo Credit: Ohio Sea Grant.

TABLE 11. Activities changed by Ohio Lake Erie charter captains over the last 5 years (number of respondents = 234). Respondents were asked to select all applicable changes.

Activity	Percentage of respondents indicating a change in activities over the last 5 years
Increased prices of charter services	47
Decreased number of annual trips	29
No major changes	25
Increased number of annual trips	23
Bought a bigger boat	16
Began charter business	16
Bought a newer boat	14
Bought own charter boat	13
Expanded into multi-activity and/or non-fishing charters	7
Hired additional first mate(s)	6
Operated a newer boat	6
Operated a bigger boat	6
Branched out into other fishing-related businesses	5
Decreased prices	5
Bought an additional boat	3
Operated an additional boat	2
Hired additional charter captain(s)	2
Other	11

TABLE 12. Five-year plans of Ohio Lake Erie charter captains (number of respondents = 232). Respondents were asked to select all of the plans that applied to them.

Activity	Percentage of respondents selecting a change planned for their charter activities in the next 5 years
Increase number of annual trips	44
Increase prices of charter services	29
No major changes	27
Quit the charter business	16
Buy a newer boat	9
Buy a bigger boat	8
Expand into multi-activity and/or non-fishing charters	7
Branch out into other fishing-related businesses	7
Decrease number of annual trips	6
Operate a bigger boat	4
Buy own charter boat	4
Hire additional charter captain(s)	3
Hire additional first mate(s)	3
Buy an additional boat	3
Operate an additional boat	3
Operate a newer boat	2
Decrease prices	2
Other	11

was the top concern related to attracting customers. The cost of fuel was by far the most important concern related to business expenses.

Twenty-five percent of captains indicated that no major changes were made to their charter businesses over the past 5 years (Table 11) and a similar proportion (27%) indicated that no major changes were planned for the next 5 years (Table 12). Nearly one half of captains (47%) responding indicated that they had recently increased prices. More than a quarter (29%) indicated that they planned to increase prices over the next 5 years. Only 5% of respondents indicated that they had reduced prices and 2% mentioned plans to decrease prices in the future. Though more than a quarter (29%) indicated that they had decreased the number of charter trips made per year, nearly a quarter (23%) indicated an increase. Furthermore, 44% of captains indicated plans to increase the number of trips in the next 5 years. Fewer than one in 10 captains indicated plans to branch out in other fishing-related businesses (7%), buy a bigger boat (8%), and/or buy a newer boat (9%). Sixteen percent of captains indicated plans to quit the charter business at some point over the next 5 years.

In the 2010 survey we were interested in seeking the opinions of charter captains on the seven critical issues identified by Ohio Sea Grant affecting Lake Erie that could impact the charter industry. Captains were asked to rate these issues in order of importance to them, and these data are shown in Table 13. Aquatic invasive species, harmful algal blooms, and nutrient loading and phosphorous were at the top, with the dead zone, coastal community/economic development, sedimentation and dredging, and climate change at the bottom.

Strategies for Charter Businesses

Economics of charter angling have not changed dramatically from previous years. Consequently, strategies for maintaining a charter business were similar to 2006 findings and other past research efforts (Lichtkoppler 1997; Lichtkoppler and Hushak 2001; Kuehn et al. 2005; Lichtkoppler et al. 2008). Findings from 2006 held true through 2010, with the biggest difference being a drastically lower depreciation expense and decreased boat loan payments as strategies to stay in business. In the next 5 years captains plan on increasing revenues by increasing the number of charter trips (44%) and increasing prices of charter services (29%). Very few captains plan to buy new and bigger boats (9% and 8%, respectively) or branch out to other fishing-related businesses (7%; see Table 12).

In 2010, at an average price of $491 for a full-day walleye trip, a captain would have to run at least 40 trips to cover the total average economic cost of running a charter business. In 2006 it would have taken 50 trips (Figure 2). If we compare the number of trips necessary in 2010 in each category to those in 2006 we can see that, except for those firms with boat loans, it took fewer trips in 2010 to maintain the business. It appears that in 2010 the captains attempted to control costs primarily by reducing the capital costs of boat ownership.

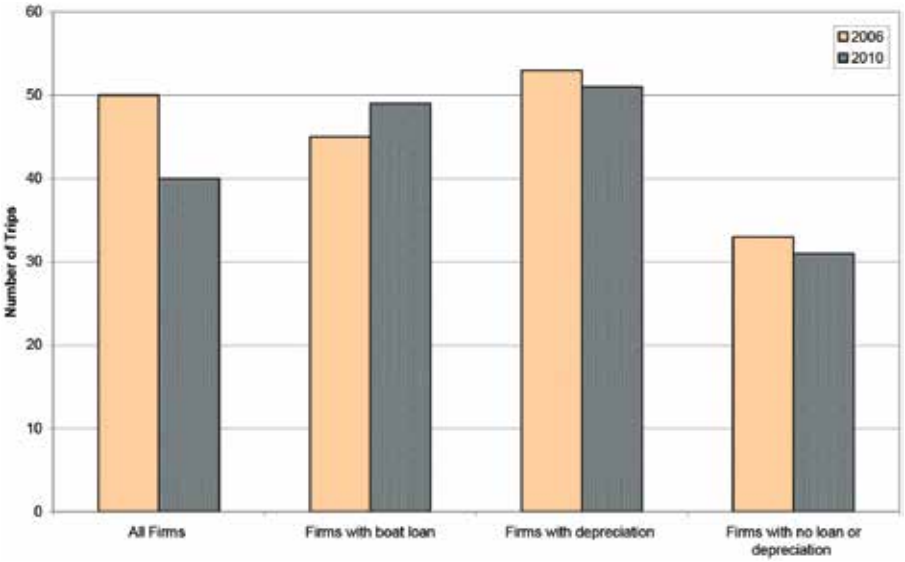

Figure 2. Number of paid charter trips needed to meet the total operating cost of operating a charter business.

TABLE 13. Critical issues confronting Lake Erie. Respondents were asked to rate the issues on a scale of 1 = not very important to 5 = extremely important.

Lake Erie issue	Score	Standard deviation	Number of respondents
Aquatic invasive species	4.5	±0.9	224
Harmful algal blooms	4.0	±1.0	225
Nutrient loading and phosphorus	3.9	±1.1	224
The dead zone	3.3	±1.3	219
Coastal community/economic development	3.0	±1.2	217
Sedimentation and dredging	2.9	±1.3	214
Climate change	2.5	±1.3	207

Results from the current survey indicate that high fuel costs and high boat loan payments impede cash flow. For all reporting firms, firms reporting depreciation, and firms reporting no boat loan payments and no depreciation, fuel was the largest cash need. For firms reporting boat loans, the boat loan payment was the largest single need for cash for the firm. Firms reporting boat loan payments also reported higher sales, which was likely a side effect of trying to meet revenue needs by running more trips. Capital costs of owning a boat were a large part of the total economic cost of running a charter firm, ranging from 26% for those not reporting a boat loan or depreciation to 47% for those reporting depreciation. Only 8% of respondents plan to purchase a bigger boat in the next 5 years, so captains may be holding onto older, paid-off charter boats in good condition to reduce expenses. Since 1990, the average age of the charter fleet has continually increased from 5.5 years to 17 years (Lichtkoppler and Hushak 2001; Kuehn et al. 2005; Lichtkoppler et al. 2008). Additionally, only 9% of responding captains plan to purchase a new boat in the next 5 years.

Though captains plan to increase revenue by increasing prices and number of trips, these may not be viable options if the populations of sport fish continue to decline and/or current poor economic conditions persist. If cost is prohibitive to smaller groups, captains could strategize to combine small groups and individual anglers to fill the six-pack and defray angler costs, thus increasing the possible numbers of trips during a prolonged downturn in the economy. Other strategies utilized in the past have included offering half-day trips, offering more trips by following the seasonal migration of fish from port to port, and marketing to underrepresented audiences such as women. As noted in earlier charter surveys, captains should market a nature-based tourism experience on a world-class resource and try to expand the client base by cooperating with local, state, and regional tourism bureaus (Lichtkoppler et al. 2008).

In 2006, 5% of captains planned to expand into multi-activity and/or non-fishing charters (Lichtkoppler et al. 2008). According to 2010 data, 7% of captains followed through on this plan. Multi-activity trips could be packaged to expand on additional interests of fishing clients such as winery tours, golfing, Lake Erie island excursions, and Cedar Point, to name a few. Examples of non-fishing charters include dive and snorkel charters, lighthouse cruises, and sunset cruises. Another nature-based activity that continues to increase in popularity is birding, and the western basin of Lake Erie is a geographical hot spot for migration. Thousands of birders flock to Ohio's Lake Erie shoreline every year and could represent a new clientele group for charter captains. The profitability of these and other opportunities may be discovered by research regarding potential charter clientele preferences and reasons for chartering.

CONCLUSION

The Lake Erie charter industry provides ordinarily landbound anglers with fishing opportunities on the "big water" and attracts anglers from outside the immediate area. As many as 786 licensed charter captains conduct an estimated 21,082 full-day trips per year. Three quarters of these trips are focused on walleye fishing. With decreasing walleye and yellow perch populations in Lake Erie, a potential reduction in walleye and yellow perch bag limits could adversely impact the number of charter operations as well as interest in fishing. Captains could look to multispecies trips, taking advantage of the diversity of sport fish in Lake Erie and keeping total take-home weight of fillets similar. This could also create a transition for the industry in the event that lake temperatures continue to rise and coolwater species decrease in number as some models suggest. Other factors causing a decline in angling participation may include poor spring weather conditions, such as increased storm events potentially due to climate change; poor recruitment of larval

sport fish; perceived health issues due to fish consumption advisories; phosphorus loading causing harmful algal blooms; and resultant beach warnings and closures.

The ongoing poor economy also continues to exert stress on the charter industry. More than 16% of survey respondents indicated plans to shut down their charter fishing operation within the next 5 years. This is, in part, due to rising fuel and operating costs, concerns about the impact of invasive species on the industry, decreasing harvest rates, and the fact that charter captains are an aging group, with nearly one third of active captains involved in charters for more than 20 years. The percentage of captains indicating that they will leave the industry is typical of previous surveys (Lichtkoppler 1997; Lichtkoppler and Hushak 2001; Kuehn et al. 2005; Lichtkoppler et al. 2008). There is a concern that if new charter operations are not initiated to replace the operations with plans to phase out, there will be fewer charter operations in the future. We speculate that the decline in the number of active charter firms, reduction in the number of charter trips taken, and decline in both average and gross revenues likely reflect a combination of factors. These include a less than stellar number of catchable walleye compared to 2006, a loss of jobs and income among the blue-collar population most likely to go charter fishing, the population of older anglers who are less likely to go charter fishing as they age, and the decline in the general economy in the Lake Erie region.

Despite potential low profit margins, many captains continue their involvement with the charter industry. Anecdotal evidence suggests that reasons include a personal connection to Lake Erie, enjoyment from teaching people how to fish, and the role of educating clientele on Lake Erie issues, which could result in enhanced protection of the resource. Negative headlines persist at a time when the lake is inundated with issues like harmful algal blooms, invasive species, and sediment and nutrient loading. Current conditions in parts of the lake are as poor as they have been since the 1960s and 1970s. The charter fleet is a powerful ally to Lake Erie managers and organizations because charter captains are able to help with detection and observation of problems as well as education and communication with the public and key decision makers. The added educational value could help maintain some productivity in the charter industry and sustain some economic benefit to the captains and the Lake Erie tourism industry.

In coastal communities with a concentration of charter firms, this industry generates significant tourism dollars for the local economy. Almost 8 out of 10 (79%) charter clientele were estimated to come from 50 miles or further from the captains' home ports. Half of all charter fishing trips take place in June and July. Charter captains should consider fostering relations with other Lake Erie tourism-related industries to better realize the benefits of cross-promotion and extending the busy season beyond these months. Tourism organizations, chambers of commerce, fisheries managers, and Sea Grant/Extension may also want to consider playing a role. Despite the economic and environmental stressors confronting the Lake Erie fishery in 2010, it still remains the largest freshwater fishery in the world. Marketing strategies should promote Lake Erie's world-class fishery in order to maintain the viability of the charter industry in the future.

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The Past as Prelude to the Future for Understanding 21st-Century Climate Effects on Rocky Mountain Trout

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ABSTRACT: *Bioclimatic models predict large reductions in native trout across the Rocky Mountains in the 21st century but lack details about how changes will occur. Through five case histories across the region, we explore how a changing climate has been affecting streams and the potential consequences for trout. Monitoring records show trends in temperature and hydrographs consistent with a warming climate in recent decades. Biological implications include upstream shifts in thermal habitats, risk of egg scour, increased wildfire disturbances, and declining summer habitat volumes. The importance of these factors depends on the context, but temperature increases are most relevant where population boundaries are mediated by thermal constraints. Summer flow declines and wildfires will be important where trout populations are fragmented and constrained to small refugia. A critical information gap is evidence documenting how populations are adjusting to long-term habitat trends, so biological monitoring is a priority. Biological, temperature, and discharge data from monitoring networks could be used to develop accurate vulnerability assessments that provide information regarding where conservation actions would best improve population resilience. Even with better information, future uncertainties will remain large due to unknowns regarding Earth's ultimate warming trajectory and how effects translate across scales. Maintaining or increasing the size of habitats could provide a buffer against these uncertainties.*

El pasado como preludio del futuro para comprender los efectos del clima del siglo 21 en la trucha de las Montañas Rocallosas

RESUMEN: los modelos bioclimáticos pronostican para el siglo 21 importantes reducciones en las poblaciones de truchas oriundas de las Montañas Rocallosas, sin embargo aun falta detallar cómo se darán estos cambios. Mediante cinco casos de estudio distribuidos a lo largo de la región, se explora cómo el clima cambiante ha ido afectando los ríos y cuáles serían las potenciales consecuencias para las truchas. Registros de monitoreo indican tendencias en la temperatura y en hidrógrafos que son consistentes con el calentamiento del clima en décadas recientes. Las implicaciones biológicas incluyen cambios en los hábitats térmicos de los caudales, riesgo de lavado de huevos, incremento en perturbaciones por incendios y decremento en los volúmenes de agua durante el verano. La importancia relativa de estos factores depende del contexto, pero el incremento en la temperatura resulta se torna más relevante en aquellas poblaciones cuyos límites están determinados por esa variable. El flujo de agua durante el verano se reduce y los incendios forestales cobrarán importancia donde las poblaciones de trucha se encuentren fragmentadas y confinadas a pequeños refugios. Un importante hueco de información es la evidencia que sirva para documentar cómo las poblaciones se están ajustando a las tendencias de largo plazo en cuanto a la condición de los hábitats, de manera que el monitoreo biológico se convierta en una prioridad. Datos biológicos, de temperatura y de descarga de ríos que provengan de redes de monitoreo pudieran utilizarse para desarrollar evaluaciones precisas sobre vulnerabilidad que provean información acerca de los lugares en los que las acciones de conservación mejorasen lo más posible la resiliencia de las poblaciones. Incluso disponiendo de mejor información, la gran incertidumbre que depara el futuro seguirá presente, ya que aun existen varias incógnitas con respecto a la trayectoria de calentamiento de la tierra y de cómo los efectos se transmitirán a través de distintas escalas. El mantenimiento o incremento del tamaño de los hábitats pudiera servir como una suerte de amortiguador contra tal incertidumbre.

INTRODUCTION

Global warming is altering the characteristics of aquatic ecosystems worldwide (Reist et al. 2006; Heino et al. 2009; Rieman and Isaak 2010) and stream environments across the Rocky Mountains of the Western United States are no exception (Stewart et al. 2005; Luce and Holden 2009; Leppi et al. 2011; Isaak et al. 2012). The high elevations of these mountains have historically provided cold stream and river habitats that support trout, salmon, and char, which are iconic of the region and sustain popular fisheries. Physiological requirements of these fishes for cold temperatures, combined with historic population declines from a century of intensive land use and development, have raised concerns regarding how climate change may affect their future status across the region. Several recent reviews described a range of potential climate effects (Independent Science Advisory Board 2007; Rahel et al. 2008; Haak et al. 2010; Rieman and Isaak 2010), but the general conclusions are that stream habitats will become warmer, more variable with regards to thermal and hydrologic conditions, and prone to larger, more frequent disturbances that are significantly different from historical conditions (Jentsch et al. 2007). Fish populations, in response, are predicted to adapt in place through phenotypic or genotypic means, move to track suitable habitats, or be extirpated (Crozier et al. 2008; McCullough et al. 2009).

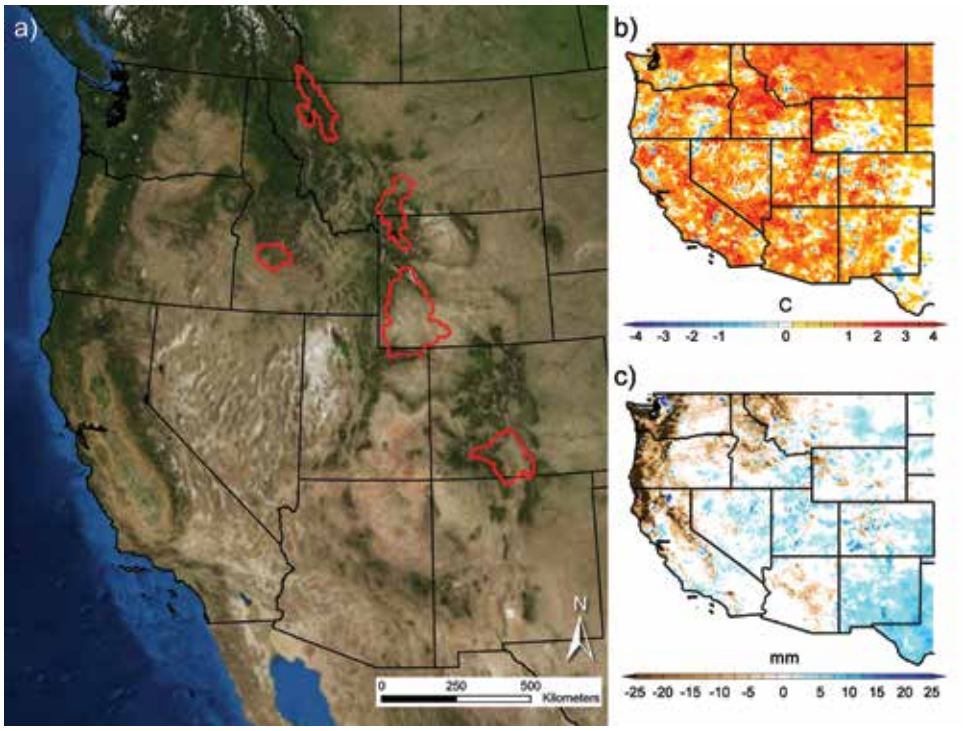

Figure 1. (a) Locations of case history areas examined to describe historical effects of climate change on trout streams across the Rocky Mountains. Change in (b) mean annual air temperature and (c) precipitation from 1950 to 2009. Mapped anomalies are the differences between averages for 1950–1959 and 2000–2009 based on PRISM data that were interpolated from climate monitoring stations (Daly et al. 1994).

Numerous bioclimatic models have been developed for trout in the Rocky Mountain region that forecast range reductions on the order of 20–90% over the next 50–100 years (Eaton and Schaller 1996; Keleher and Rahel 1996; Rahel et al. 1996; Mohseni et al. 2003; Rieman et al. 2007; Kennedy et al. 2009; Williams et al. 2009; Wenger et al. 2011a). These broad-scale assessments have been valuable for raising awareness within the scientific community and the general public about the risks posed by climate change. However, given their geographic scope and purpose (predicting changes that have yet to occur), these assessments cannot describe the mechanisms by which such large changes ultimately transpire. Predictions from current models also lack the spatial precision that managers need to make decisions about where to undertake habitat restoration within a river network and which methods would best improve population resilience against future changes. Understanding these details and improving the predictive accuracy of fish population and habitat models is essential if research is to provide the information needed to manage trout populations through a transitional century (Isaak and Rieman, 2012).

Complicating matters, environmental and biological changes will not be uniform across the ranges of species. Subregional differences in climate, diverse mountain topographies, variation in stream sensitivity to climate forcing (Hari et al. 2006; Tague et al. 2008), variation in species complexes and the strength of competitive interactions (Peterson et al. 2004; Rahel et al. 2008), availability of climate refugia (typically at higher elevations), and interactions among climate stressors (Jager et al. 1999; Wenger et al. 2011b) may all be important determinants of local changes. Thus, despite relatively consistent global and regional climate forcings as warming proceeds, the specific biological and management consequences of these trends will vary among individual streams and populations.

To better understand these consequences, we explore historical trends and the current state of knowledge in a series of retrospective case histories that include the Flathead River Basin (FRB) in northwest Montana and southeast British Columbia, the Boise River Basin (BRB) in central Idaho, the Greater Yellowstone Ecosystem (GYE), the Green River Basin (GRB) in western Wyoming, and the Rio Grande Headwaters Basin (RGB) in southern Colorado (Table 1; Figure 1, panel a). The areas selected for the case histories encompass a range of physiographic settings, species complexes, and contemporary management issues (e.g., hybridization, habitat degradation/fragmentation, wildfire, drought, nonnative species invasions) that managers of trout populations across the Rocky Mountains often address. Because climate change has been ongoing for multiple decades, it is already possible in many instances to

TABLE 1. Characteristics of river basin areas across the Rocky Mountains used in climate case histories.

Study area and land ownership	Mean air temperature trend (1950–2009)[a]	Focal species	Habitat fragmentation	Primary climate stressors	Management concerns exacerbated by climate change
Flathead River (primarily federal)	0.16°C/decade	Bull trout, westslope cutthroat trout	Moderate	Stream temperature increases, winter flow increases	Upstream movement of rainbow trout/cutthroat trout hybridization. Reduction in bull trout recruitment from higher winter flows
Boise River (primarily federal)	0.17°C/decade	Bull trout, rainbow trout	Moderate	Stream temperature increases, wildfire disturbances	Greater bull trout habitat fragmentation and loss as temperature increases and wildfires occur
Greater Yellowstone Ecosystem (federal, state, and private)	0.14°C/decade	Yellowstone cutthroat trout, brown trout, rainbow trout	Moderate for cutthroat trout, minor for brown trout and rainbow trout	Stream temperature increases	Temperature increases facilitate expansion of nonnative trout into native cutthroat trout habitat and may increasingly force closures of significant river trout fisheries
Green River (primarily federal)	0.28°C/decade	Colorado River cutthroat trout	Significant	Summer flow declines and drought, wildfire disturbances	Extirpations of local populations as summer flow decreases reduce habitat volume and increase susceptibility to drought. Wildfires cause disturbances and may excessively warm streams. Ongoing temperature increases facilitate expansion of nonnative trout into cutthroat trout habitat
Rio Grande (federal and private)	0.04°C/decade	Rio Grande cutthroat trout	Significant	Summer flow declines and drought, wildfire disturbances	Extirpations of local populations as summer flow decreases reduce habitat volume and cause some streams to become intermittent. Wildfires cause disturbances and may excessively warm streams. Ongoing temperature increases could facilitate expansion of nonnative trout into cutthroat trout habitat and reduce thermal suitability of mainstem habitats necessary to connect populations

[a]Air temperature trends were averages based on the monitoring records at the three nearest weather stations in the U.S. Historical Climate Network (Menne et al. 2009).

see the early indications of stream ecosystem responses and to think more clearly about the future. At the end of these case histories, we discuss their emergent generalities and potential management responses, put forth a brief research agenda, discuss strategies for hedging risk and dealing with uncertainty, and offer concluding thoughts on what the remainder of this century may bring.

HISTORICAL CLIMATE TRENDS

Long-term monitoring records from weather stations across the Western United States show a heterogeneous but systemic warming pattern from 1950 to 2009 (Figure 1, panel b). It is estimated that mean annual air temperatures across the West warmed by 0.8°C during the 20th century, which is significantly more than the 0.6°C global average temperature increase (Intergovernmental Panel on Climate Change 2007; Saunders et al. 2008). Westwide trends in annual precipitation were less obvious during this same time period, which is consistent with the projection uncertainties in global climate models for this factor (Figure 1, panel c). However, subregional differences in precipitation showed increases across much of the Southwest and decreases across the Northwest.

Trends within the five case history areas were also apparent. Mean annual air temperatures increased at local weather stations, although rates of warming varied among areas, as was the case at the regional scale (Table 1). Increasing air temperatures interacted with precipitation trends to affect hydrologic regimes in several ways. The most consistent response was earlier spring snowmelt runoff and lower summer flows (Figure 2). This pattern is typical in hydrologic regions dominated by snow because warmer temperatures melt accumulated snowpacks earlier each decade (Stewart et al. 2005; Luce and Holden 2009; Fritze et al. 2011; Leppi et al. 2011). An exception occurred in the RGB, where increasing annual precipitation resulted in less consistent runoff trends. Also noteworthy in the FRB and at one of the GRB gages was a second spike of increasing flows that has developed in the early winter. This pattern often occurs where winter precipitation consists of mixed snow and rain because warming temperatures cause more precipitation to fall as rain, which translates rapidly to streamflow rather than accumulating as snowpack (Knowles et al. 2006; Hamlet and Lettenmaier 2007).

PRIMARY CLIMATE STRESSORS WITHIN CASE HISTORY AREAS

Flathead River Basin, Northwest Montana

The upper FRB (14,300 km^2) is in the headwaters of the Columbia River and drains the west flank of the Rocky Mountains in southeast British Columbia and northwest Montana (elevation range: 1,000–2,800 m). The FRB is one of the most pristine and diverse landscapes in the United States and significant portions of the basin form Waterton-Glacier International Peace Park, a World Heritage Site and biosphere reserve. Streams here are recognized as range-wide strongholds for native salmonids of regional concern, including westslope cutthroat trout (*Oncorhynchus clarkii lewisi*; Muhlfeld et al. 2009a) and bull trout (*Salvelinus confluentus*; Rieman et al. 1997b, 2007).

Despite the quality of stream habitats in the FRB, climate change promises to exacerbate current threats and may create new risks for these species. In the case of cutthroat trout, for example, hybridization and introgression with introduced rain-

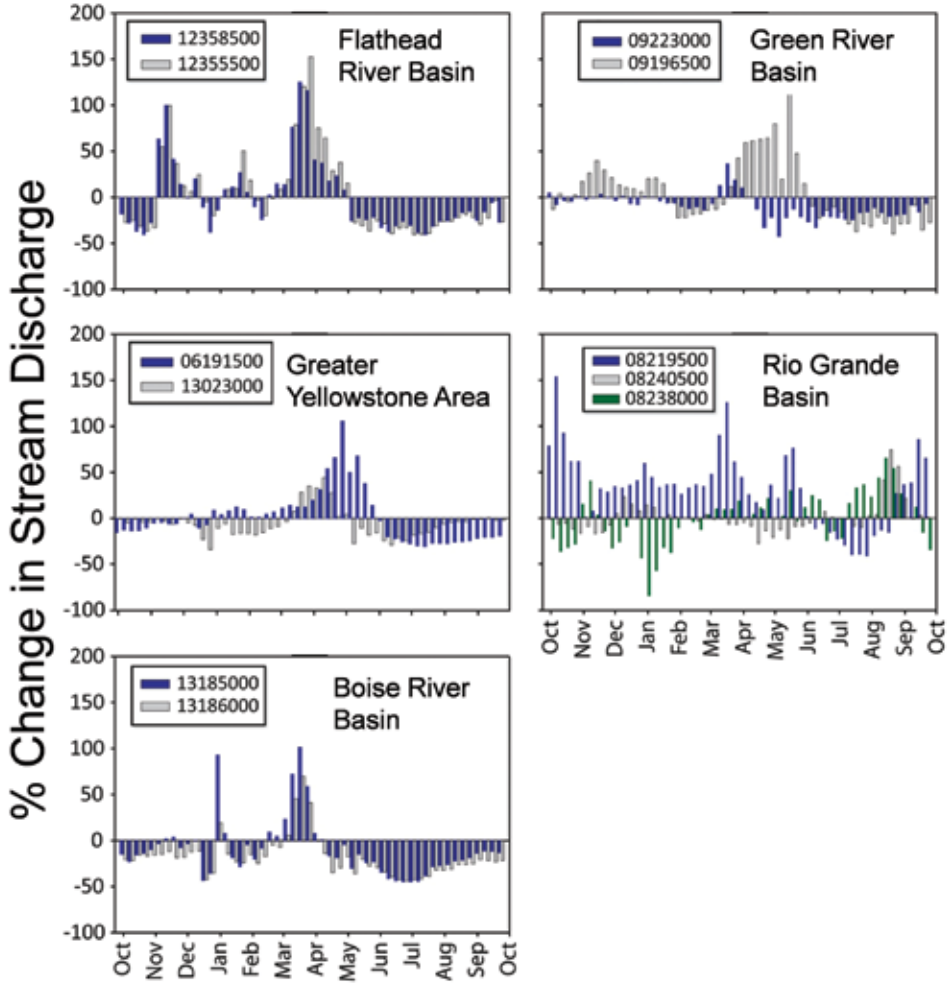

Figure 2. Changes in stream discharge as a percentage of the 1950 average determined from weekly regressions for the period 1950–2009. Streamflows were measured at U.S. Geological Survey gages within each study area and gage numbers are provided in figure legends.

bow trout (*O. mykiss*) is a significant threat (Leary et al. 1987; Muhlfeld et al. 2009b, 2009c) because pure cutthroat trout populations currently persist in only 10–20% of their historical range (Shepard et al. 2005). Zones of hybridization occur more commonly where mean summer stream temperatures exceed 9°C (Muhlfeld et al. 2009b, 2009c) and the warmer thermal niche of rainbow trout begins to overlap with cutthroat trout (Wenger et al. 2011a).

To examine how climate warming trends and recent wildfires may have affected the potential for hybridization, a multiple regression model was developed to predict summer stream temperatures in 1978 and 2008 for the North Fork FRB (Jones et al., in press). Changes between these years suggest that temperatures increased by 0.87°C, which increased the percentage of the stream network with summer temperatures ≥9°C from 15% in 1978 to 33% in 2008 (Figure 3). Over the same time period, extensive genetic surveys tracked the spread of hybridization through the North Fork FRB. Surveys in the late 1970s and early 1980s showed that most cutthroat trout populations were genetically pure, except for a few hybrids in one stream (Marnell 1988). More recent surveys suggest that hybridization has spread upstream from hybrid source populations in warmer tributaries through the mainstem of the Flathead River (Boyer et al. 2008; Muhlfeld et al. 2009c). Although factors such as habitat degradation and connectivity have important effects on hybridization, temperature increases and wildfire disturbances may be allowing rainbow trout distributions to expand upstream and enhancing the spread of hybridization. Of the estimated 1,300 km of fish-bearing streams in the North Fork FRB, approximately 350 km now contain hybridized populations, which represents a 27% increase in recent decades (Figure 3, panel d).

Bull trout are less susceptible to introgressive hybridization with introduced brook trout (*S. fontinalis*) because most hybrids are infertile (Spruell et al. 2001). However, bull trout are more sensitive to the direct effects of climate warming than cutthroat trout (Rieman et al. 2007; Wenger et al. 2011b). Bull trout have thermal niches that are several degrees colder than those of other trout and char species in the Western United States (Selong et al. 2001), so natal spawning and rearing habitats are often fragmented and constrained to the coldest headwater streams (see BRB case history below; Rieman and McIntyre 1995; Dunham and Rieman 1999). Bull trout are also fall spawners, which means that eggs and alevins are vulnerable to high winter flows that may mobilize stream substrates and crush eggs or displace newly emerged fry (Shellberg et al. 2010). This vulnerability may explain why bull trout populations often fare poorly in streams with frequent high winter flows (Wenger et al. 2011b) and suggests that recent increases in winter flood risks across portions of the FRB are a cause for concern (Figure 2; Hamlet and Lettenmaier 2007). These shifts in hydrologic regimes may have played a role in declining populations over the last 20 years, although most declines are probably due to expanding population of nonnative lake trout (Ellis et al. 2011).

Boise River Basin, Central Idaho

The upper BRB in central Idaho encompasses 6,900 km^2 of steep terrain (elevation range: 1,000–3,000 m) and is drained by approximately 2,500 km of fish-bearing streams. In contrast to the hydrologic trend of increasing winter flows observed in the FRB, there is little evidence of a similar pattern emerging in the BRB that could pose a threat to bull trout populations (Figure 2). Of greater relevance is a trend toward warmer stream temperatures, given that both the native rainbow trout and bull trout are constrained by the distribution of thermally suitable

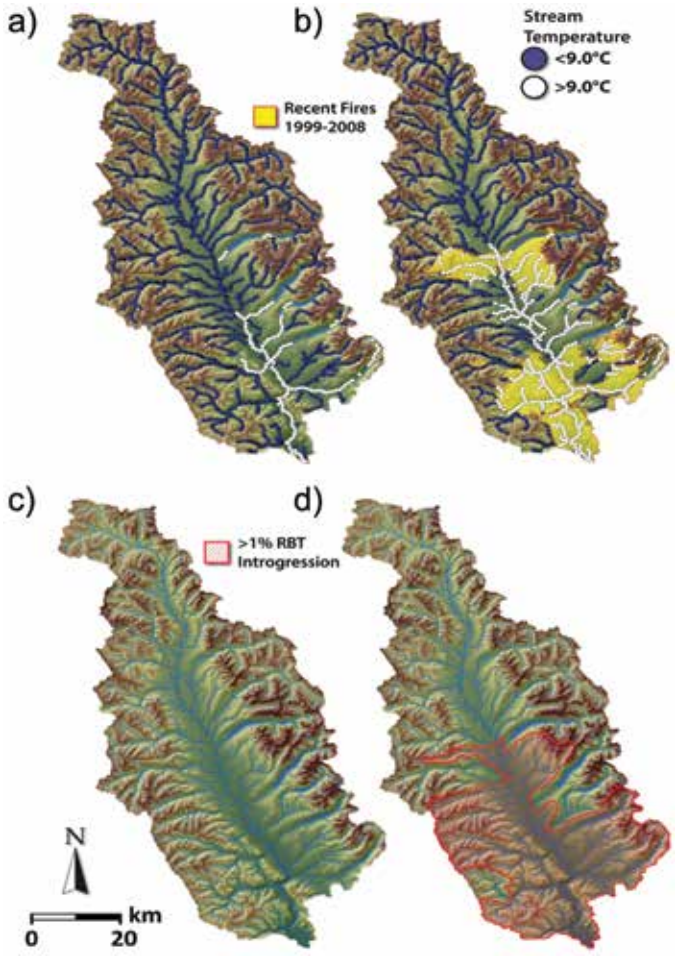

Figure 3. Changes in habitat thermally suitable for hybridization between native westslope cutthroat trout and nonnative rainbow trout in the North Fork Flathead River basin between (a) 1978 and (b) 2007. Changes in distribution of rainbow trout introgression between (c) 1978 and (d) 2007.

habitats within the basin (Rieman et al. 1997a; Dunham and Rieman 1999).

Similar to the FRB, a temperature model was developed using a database of local, empirical measurements (780 summers of data measured from 1993 to 2006), and historical stream warming trends were reconstructed using the model (Figure 4; Isaak et al. 2010). Reconstructed trends indicate that mean summer stream temperatures have been increasing at the rate of 0.27°C/decade in recent decades and that most of the increase was associated with long-term (i.e., 30 year) trends in summer air temperatures. Declining trends in summer flows and wildfires that burned 14% of the basin also played roles in stream warming but accounted for only 10–20% of the temperature increases across the basin (Isaak et al. 2010).

Stream temperature increases had different effects on thermally suitable habitats for bull trout and rainbow trout (Figure 4, panels c and d). Rainbow trout habitats, constrained to lower elevations by cold temperatures, shifted upstream as warming occurred and reductions in the total amount of habitat did not occur (Isaak et al. 2010). Bull trout distributions, in contrast, were located further upstream and constrained by stream slope and small size at the upstream extent of the network. As streams warmed, therefore, net reductions in bull trout habitat occurred, which were estimated to be 8–16% per decade (Isaak et al. 2010).

Greater Yellowstone Ecosystem

The GYE includes portions of Montana, Wyoming, and Idaho centered on Yellowstone National Park. The GYE encompasses a wide elevation range (1,038–4,189 m) and forms the headwaters of three major U.S. river drainages, the Columbia, Missouri, and Colorado rivers. The area is renowned for providing some of the world's finest trout fisheries and recreational anglers flock to the area each year (Baginski and Biermann 2010). Yellowstone National Park, for example, provided 250,000 angler days annually from 1975 to 2000 (Kerkvliet et al. 2012). As temperatures have increased in recent decades, fisheries managers have, on occasion, issued widespread angling closures during the warmest summers. Two such incidents occurred within Yellowstone National Park during the last decade and were motivated by concerns that fish growth and survival would be adversely affected by the stresses associated with catch-and-release angling (Boyd et al. 2010).

In a rarity for the GYE and Rocky Mountain streams in general, one long temperature monitoring record exists at a site on the Madison River downstream of a small lake. Temperatures at this site have been recorded throughout the year since 1977, which makes it possible to describe historical seasonal trends. Simple linear regressions suggest that river temperatures have been increasing at this site over the last several decades (Figure 5), with the smallest warming rates during the winter (December–February = 0.06°C/decade) and larger rates in the spring (March–May = 0.28°C/decade) and summer (June–August = 0.24°C/decade). During this same period, the number of thermally stressful days for trout (mean temperatures > 21°C) increased at the rate of 4.6 days/decade from 6 days/year in the 1980s to 15 days/year in the most recent decade. Although a long-term monitoring record is available for only this single site in the GYE, Madison River temperature trends were similar to those at a nearby site on the Missouri River and the general pattern of stream warming across the Northwestern United States during this same period (Isaak et al. 2012).

Green River Basin, Western Wyoming

The GRB includes the area above Flaming Gorge Dam and drains 39,194 km^2 in western Wyoming and northeastern Utah (Figure 6). Elevations range from 2,000 to 4,300 m and Colorado River cutthroat trout (CRCT; *O. c. pleuriticus*) are the native trout. This subspecies currently occupies 14% of its native range across the broader Colorado River basin (Hirsch et al. 2006). Historical declines have been attributed to interactions with nonnative trout species and habitat degradation from grazing, water withdrawal for irrigation, oil and gas development, and logging. Remaining populations of CRCT are highly fragmented and often inhabit only isolated headwater stream sections (usually < 10 km; Figure 6) above natural and anthropogenic barriers that prevent upstream invasions from nonnative brook

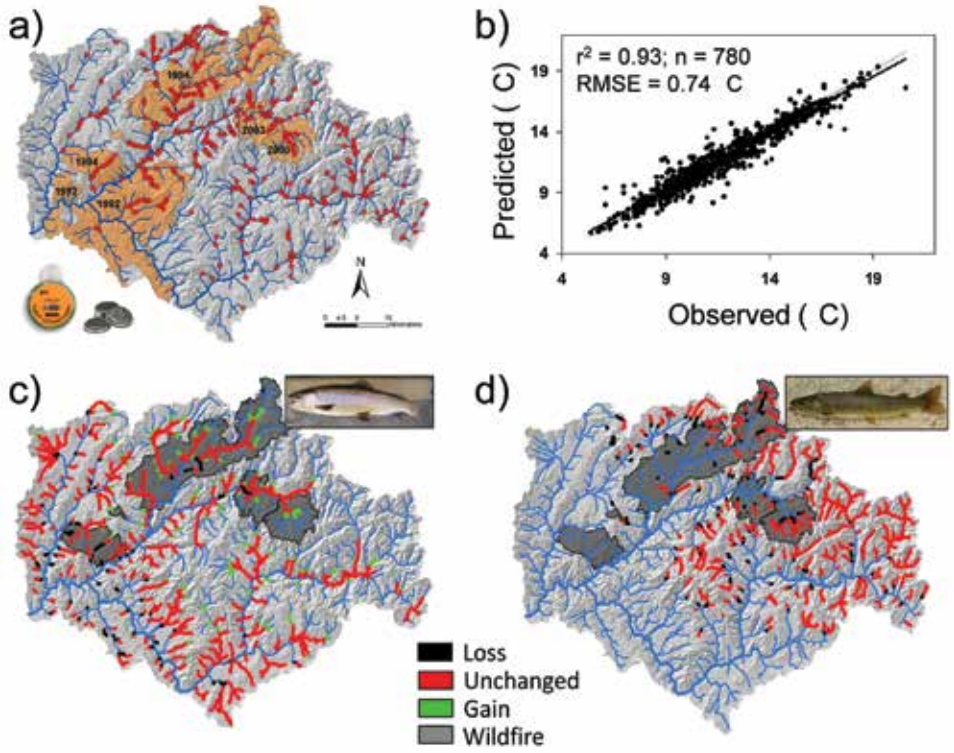

Figure 4. (a) Locations of summer stream temperature measurements in an interagency database developed for the Boise River basin in central Idaho. (b) Summer mean stream temperatures predicted from a new type of spatial statistical model for stream networks. Maps of shifts in thermally suitable habitat for (c) rainbow trout and (d) bull trout from 1993 to 2006 due to long-term trend rates (i.e., 30–50 years) in stream warming associated with climate change and wildfires (gray polygons). Figures reproduced from Isaak et al. (2010).

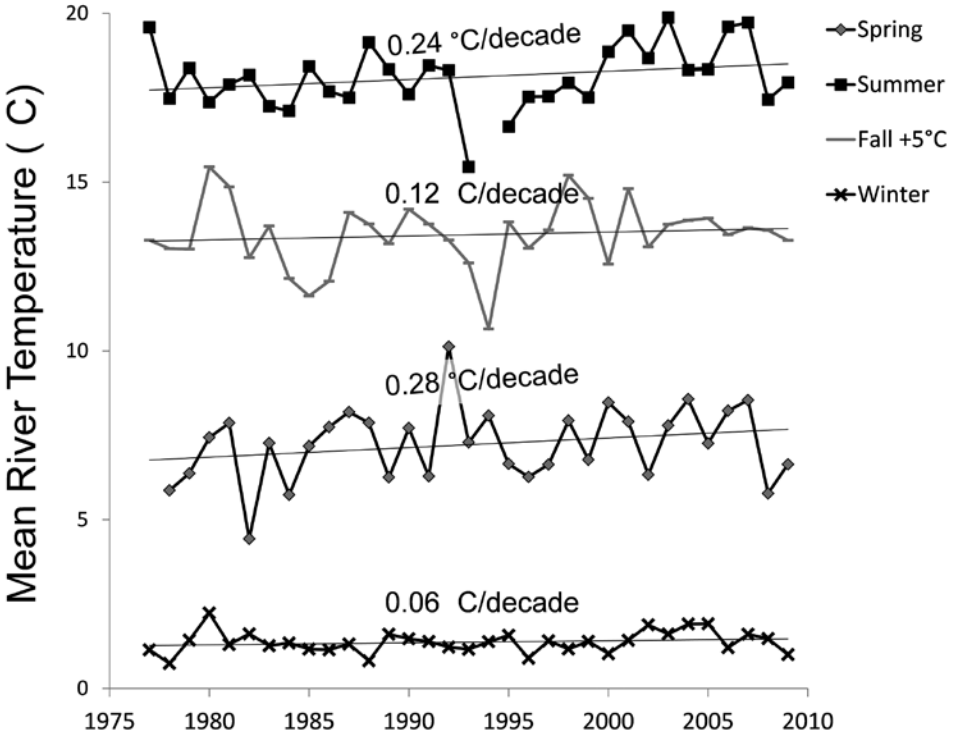

Figure 5. Trends in mean seasonal temperatures from 1977 to 2009 in the Madison River, Montana, downstream of Ennis Lake. Trend estimates are based on the slopes of simple linear regressions.

trout, brown trout (*Salmo trutta*), and rainbow trout (Fausch et al. 2006; Hirsch et al. 2006). Ironically, this fragmentation may limit the negative effects of temperature increases because the downstream boundaries of CRCT populations are often determined by other factors. Moreover, the upper extents of many streams across the GRB are currently too cold to support recruitment of juvenile fish (Coleman and Fausch 2007a, 2007b), and these areas could become more suitable with temperature increases (Harig and Fausch 2002; Cooney et al. 2005).

The limited potential for negative temperature effects on CRCT populations does not make them immune to other risks posed by climate change. In particular, the small size of the streams occupied by many populations makes them vulnerable to declines in summer discharge (Figure 2). Because discharge scales directly with habitat volume (McKean et al. 2010), there may be 20% less summer habitat in the GRB now than there was in 1950 based on historical trends (Clow 2010; Leppi et al. 2011). Where the upstream extent of populations is currently constrained by stream size rather than temperature, declining flows may shift the transition point between perennial flow and intermittency downstream or cause stream drying in places that fragment historically perennial reaches (Lake 2003). Summer flow declines could also reduce stream productivity by decreasing macroinvertebrate drift rates (Harvey et al. 2006) or interactions with riparian zones (Baxter et al. 2005; Riley et al. 2009), which could impair fish growth and survival during the brief summer season (Jenkins and Keeley 2010).

Rio Grande Headwaters Basin, Southern Colorado

The RGB encompasses 20,000 km^2 at elevations ranging from 2,250 to 4,400 m in southern Colorado. Approximately 50% of the area is federally managed, with most such

lands at higher elevations surrounding the relatively arid San Luis Valley. Intensive water development in the valley has altered many streams, which are often entirely diverted into irrigation canals and ditches as they approach private lands. Rio Grande cutthroat trout (*O. c. virginalis*) are native to the RGB, and recent status assessments indicate that the remaining 120 conservation populations occupy about 12% of the historical habitat across Colorado and New Mexico (Alves et al. 2008).

Many of the climate-related threats described for Rio Grande cutthroat trout are similar to those for CRCT because both subspecies are restricted to small, isolated stream fragments (mean = 7.6 km for Rio Grande populations; Pritchard and Cowley 2006; Zeigler et al. 2012) but recent natural disturbances associated with extreme climatic conditions also highlight the extirpation risks for some of these populations. An extreme drought in 2002 reduced trout abundance in several conservation populations, and anecdotal evidence suggests that a few populations may have been extirpated (Japhet et al. 2007; Patten et al. 2007). Annual discharge measured at local stream gages in 2002 was less than 25% of the average for the previous 60-year period. Similarly, extreme low flow years occurred several times during this period, so these stresses are not unprecedented, but climate model projections of 10–20% annual precipitation declines across the Southwest (Hoerling and Eischeid 2007; Karl et al. 2009) suggest that what are currently considered extreme droughts could become the "new normal." Because Rio Grande cutthroat trout populations occur in streams with average widths < 3 m and baseflow discharges ≤ 40 L/s (Figure 7; Alves et al. 2008, A. Todd, unpublished), little capacity exists to absorb additional changes.

Warm and dry conditions associated with climate change may also be increasing the frequency and extent of wildfires across the Rocky Mountains (Westerling et al. 2006; Littell et al. 2009). Although wildfires are a natural landscape element in the West, they temporarily decrease the quality of stream habitats for fish populations through temperature increases, altered stream chemistry, and ash and sediment inputs (Rieman et al. 1997a; Dunham et al. 2003). A recent wildfire in Medano Creek illustrates the risks when interactions occur with relatively small, isolated populations. Medano Creek is one of the longest stream segments (~21 km) currently occupied by Rio Grande cutthroat trout, but in June 2010 fires burned across the lower half of this drainage (Figure 8). Post-fire surveys suggest that fish were absent from the most severely burned reaches immediately following the fire but they subsequently returned to these reaches, albeit at lower densities (Colorado Parks and Wildlife, unpublished data). Unburned portions of Medano Creek probably provided a refuge from which burned sections of stream were later recolonized. If the fire had burned across the entire drainage or a similar fire had burned across a smaller conservation area, the entire population could have been extirpated (e.g., Probst et al. 1992; Rinne 1996). Natural recolonization from another population would be unlikely given extensive habitat fragmentation, so active translocation would have been needed to refound the population.

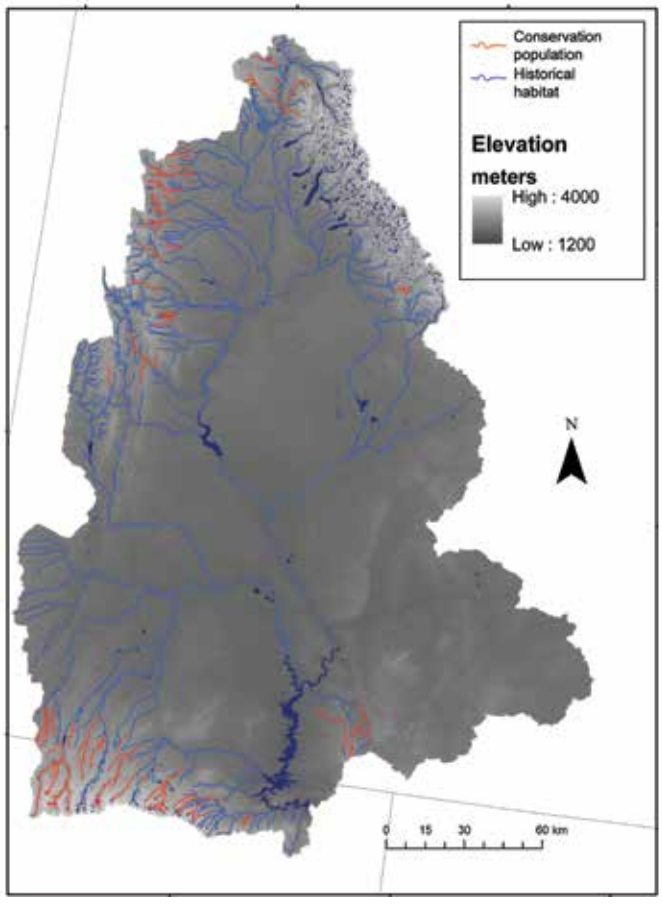

Figure 6. The Upper Green River basin showing the distribution of Colorado River cutthroat trout conservation populations and historical habitats.

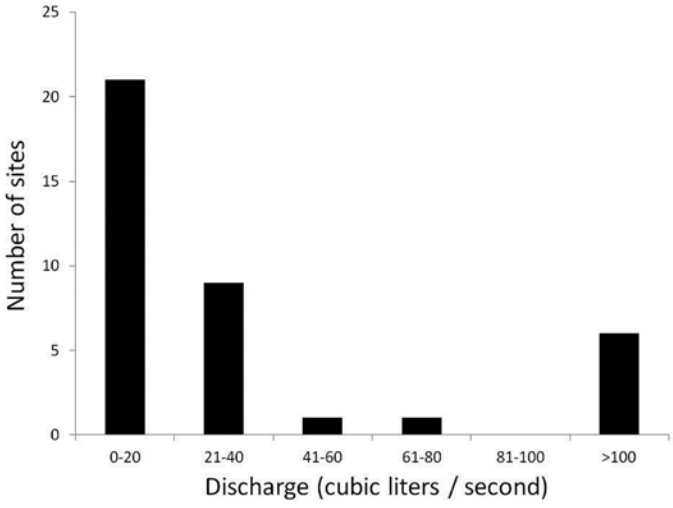

Figure 7. Frequency histogram showing the discharge in streams containing conservation populations of cutthroat trout in the Rio Grande during base flows in 2011 (n = 38). Measurement sites include mainstems near termini, important tributaries, and mainstems below the influence of important tributaries.

DISCUSSION

Climate change is often thought of as a future abstraction, but our case histories illustrate that this is not the case. Stream environments across the Rocky Mountains have been changing in ways that have important implications for trout populations.

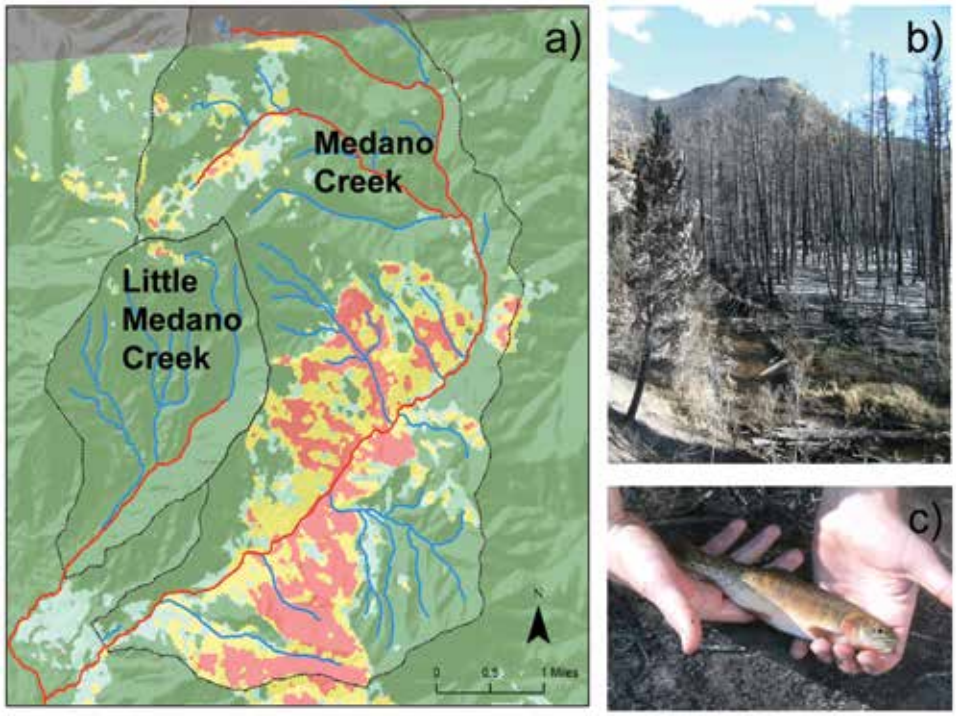

Figure 8. (a) Map showing stream kilometers occupied by Rio Grande cutthroat trout (blue lines) and wildfire extent and severity for the 2010 Medano Creek fire. Photos show (b) burn severity adjacent to the stream and (c) cutthroat trout sampled after the fire. Photo credit: Andrew Todd.

Trends in temperature and stream hydrology consistent with a warming climate are common in long-term monitoring records across the region and within case history areas. Biological implications include upstream advances in thermally suitable habitats, nonnative species and zones of hybridization, greater risk of egg scour for fall-spawning species, increased incidence of wildfires, and declining summer habitat volumes. The relative importance of these changes varies throughout the region and depends on local conditions, so context matters, even with a global phenomenon like climate change. In general, temperature increases may be more relevant in the northern Rocky Mountains where population boundaries (e.g., bull trout in the BRB), angling opportunities (e.g., some trout fisheries in the GYE), and zones of competitive overlap (e.g., cutthroat and rainbow trout in the FRB) are often mediated by temperatures. In the southern Rocky Mountains, in contrast, decreasing summer flows and disturbances indirectly related to climate change like extreme droughts and wildfires may be greater risk factors because populations are heavily fragmented and confined to small headwater streams.

Many actions may be taken to enhance the resistance and resilience of native trout populations to the effects of climate change (see Rieman and Isaak [2010] and Luce et al. [2012] for recent reviews). Briefly, these actions consist of maintaining or restoring instream flows and increasing riparian vegetation to shade streams and maximizing summer habitat volume. Where small streams are significantly degraded, these actions alone might offset significant amounts of future climate effects (Meier et al. 2003; Cristea and Burges 2009). Removal of barriers to fish movement could decrease fragmentation and allow populations to shift their distributions and track thermal habitat as needed, but removing barriers may also allow invasions of nonnative species, so assessments of the tradeoffs are needed (Peterson et al. 2008b; Fausch et al. 2009). Control or elimination of nonnative competitors is an option in some circumstances (Peterson et al. 2008a; Rahel et al. 2008), as is assisted migration to move native species into suitable but currently unoccupied habitats (Harig and Fausch 2002; Dunham et al. 2011; Lawler and Olden 2011). Where fire poses a significant threat to isolated populations, fisheries biologists and fire managers could collaborate to conduct prescribed burns and other treatments of terrestrial vegetation that reduce the risk of catastrophic wildfires (Rieman et al. 2010; Luce et al. 2012).

A 21st-Century Agenda

Perhaps more challenging than knowing which conservation actions to take is knowing where, and in some cases whether, to take them given that needs that will outstrip available resources. The changes in stream environments caused by a warming climate are complex and have location-specific implications, so precise information about the most relevant stream and biological attributes will be required. The coarse predictions output from regional bioclimatic models that rely almost exclusively on air temperature and elevation as surrogates for stream temperature and hydrology will not suffice (Wiens and Bachelet 2009). Our case histories illustrate, however, that most areas already have some information that can be used for describing local effects more precisely and providing initial threat assessments. Moving beyond this stage to develop a solid scientific foundation for assessing risk and informing decision making requires addressing key data and knowledge deficits.

Stream Data

The most relevant stream data for climate assessments consist of discharge and stream temperature measurements and, in ideal situations, would be derived from spatially representative, long-term monitoring programs. Such data rarely exist, however, and collection of new data will often be necessary. New measurements could be spread across the area of interest to cover the range of conditions and climatic variation to develop predictive models, as was the case with stream temperature in the FRB and BRB (Isaak et al. 2010; Jones et al., in press). Alternatively, new measurements could be obtained from all of the conservation populations and streams of interest, as was the case with discharge measurements in the RGB (A. Todd, unpublished) or as Trumbo et al. (2010) did with tem-

Plate 1. Climate change may exacerbate many habitat fragmentation issues like this blockage of a kokanee salmon migration by low summer flows at a poorly fit road culvert. Photo credit: Clayton Nalder.

perature measurements in conservation populations of eastern brook trout. Regardless of the design specifics, modern digital sensors make collection of accurate stream temperature and discharge data routine and inexpensive, so expansion of these databases could occur rapidly (Stone and Hotchkiss 2007; Isaak and Horan 2011; Porter et al. 2012).

As stream databases improve, they will enable more precise assessments of climate change effects within streams, across river basins, and throughout regions. Measurements of discharge or temperature taken within all of the RGB or GRB cutthroat trout streams, for example, could be used to rank the vulnerability of all populations based on their relative sensitivities across contrasting climate years (Post et al. 2009; Trumbo et al. 2010) or by habitat size, which provides an index of population resilience (Dunham et al. 2002; Isaak et al. 2007). Across larger areas or where more data and analytical resources are available, empirical measurements could be used to parameterize models that translate climate change scenarios from global models to stream environments using statistical techniques for streams (Isaak et al. 2010; Ver Hoef and Peterson 2010) or process-based, mechanistic models (Webb et al. 2008; Wenger et al. 2010). Models that do this translation, often referred to as "downscaling," provide important advantages, including the ability to interpolate information between measurement locations so that stream attributes can be continuously mapped and to play "what-if" games and examine potential changes associated with different climate scenarios (Wiens and Bachelet 2009). These features are needed to put individual populations and streams within the broader spatial and temporal contexts that strategic assessments for climate change ultimately require.

Biological Data

Even as new analytical tools, monitoring techniques, and sensor technologies make it possible to develop more precise information about stream habitat responses to climate change, an important deficit exists in our understanding of the biological consequences. A rich literature links fish ecology to stream hydrology and thermal regimes (Fausch et al. 2001; McCullough et al. 2009; Poff et al. 2010), but most previous studies were typically of short duration or were conducted in laboratory settings. It is unknown how this knowledge translates to natural settings and multiple fish generations subject to small, incremental changes. It is not surprising, therefore, that none of our case histories provided conclusive evidence of biological responses to long-term climate trends but instead consisted of anecdotal accounts that describe potential population losses or model predictions of thermal habitat shifts. This scarcity of biological evidence is not uncommon, even globally, for freshwater fishes (Heino et al. 2009; Isaak and Rieman 2012) and, as a result, little proof exists that the large range shifts and contractions predicted for Rocky Mountain trout populations are actually occurring. Worth noting, however, is that evidence of range shifts is common for many other plant and animal taxa (Parmesan and Yohe 2003; Parmesan 2006), and early indications of range contractions may be emerging at the southern extent of trout distributions in Europe (Hari et al. 2006; Winfield et al. 2010; Almodovar et al. 2012).

The biological data necessary to document climate change effects on trout populations are not difficult to collect but do require persistence and a commitment to multi-decadal monitoring efforts. In particular, abundance and distribution monitoring near thermally mediated population boundaries are needed (e.g., Rieman et al. 2006; Isaak et al. 2009; Tingley and Beissinger 2009), as are data on occurrence dates for specific life history events such as migrations, spawning, or egg hatching and emergence (e.g., Elliott and Elliott 2010; Crozier et al. 2011). Resurveys of historical fish sampling locations (e.g., Adams et al. 2002; Hitt and Roberts 2012) and examination of changes in site occupancy relative to local climatic conditions (e.g., Beever et al. 2010) could be an especially powerful way to document possible biological trends in the short term. Useful information can also be extracted from existing databases of distributional surveys by referencing patterns of species occurrence against outputs from temperature or hydrologic models to define climatic niches in natural settings (Isaak et al. 2010; Wenger et al. 2011a, 2011b; Al-Chokhachy et al., in press).

Size as a Hedge Against Uncertainty

Better understanding of climate effects on stream ecosystems will reduce uncertainties but by no means eliminate them, given the complexities involved (Cox and Stephenson 2007). We should not wait years or decades, therefore, to create the "perfect model" before taking action. Short-term prioritization schemes are needed that begin to reduce long-term risks and also provide flexible frameworks that can be revised with better information as it is developed. One approach robust against uncertainties is to focus on the largest populations and habitats and treat them as fundamental conservation units in any climate-related conservation strategy (Hodgson et al. 2009). The locations of these areas are often known because population inventories have been completed in many places and default selection of the largest areas would significantly reduce an otherwise large array of initial possibilities. Populations in large habitats are less likely to be extirpated because these habitats encompass greater heterogeneity, are more likely to have internal refugia (Sedell et al. 1990), and may support a wider diversity of life history forms that use habitat in different ways to provide additional resilience (Hilborn et al. 2003). In more concrete terms, larger habitats mean that there is less chance that all areas will simultaneously experience a wildfire or become intermittent during a drought or that elevational refugia are lacking to allow populations an upstream retreat as temperatures increase.

As the largest habitats and populations are secured, conditions in peripheral populations that may interact with core populations via dispersal could be assessed and ranked for subsequent restoration in attempts to create local enclaves or metapopulations that possess additional resilience (Rieman and Dunham 2000; Williams et al. 2011). Such a "largest plus nearest" strategy could facilitate natural recolonization when

individual populations are extirpated. If this strategy were replicated across the area of concern, it could also mitigate against climate risks posed by broadly synchronized events such as wildfires or regional droughts and heat waves that could extirpate several nearby populations simultaneously. An important element of designing effective conservation reserves may be accommodating these extreme events, which are predicted to increase more rapidly than changes in mean conditions (Jentsch et al. 2007; Meehl et al. 2009) and could alter historical relationships between habitat size and population persistence (e.g., Dunham et al. 2002; Morita et al. 2009).

CONCLUSION

The next decade will see significant improvement in our understanding and ability to predict climate change effects on stream ecosystems across the Rocky Mountains. The overarching threat and complexity that climate change presents are fostering collaborative relationships that span jurisdictional and disciplinary boundaries and accelerating the development and adoption of better spatial data sets and integrative modeling frameworks. Estimates of the rates at which important biophysical parameters are changing will be derived to facilitate more sober assessments of how this phenomenon is affecting trout populations, and this information will feed into better risk assessments.

A willingness to accept and manage in concert with many of these changes will require changing mindsets from last century's paradigm of dynamic equilibrium to one of dynamic disequilibrium for the 21st century (Milly et al. 2008; Pielke 2009). Under the new paradigm, stream habitats will become more variable, undergo gradual shifts through time, and sometimes decline. Many populations and species will retain enough flexibility to adapt and track their habitats, but others are likely to be overwhelmed by future changes. When climate impacts are combined with pressures from a growing human population and imposed on stream ecosystems already significantly degraded from their natural potential, conservation needs will be daunting and informed management more crucial than ever.

Despite the best intentions, we will not be able to preserve all populations of native trout in the Rocky Mountains this century. However, it should soon be possible to have the tools and information to know when and where resource commitments are best made under a given set of assumptions about future climate change. If broad coalitions of stakeholders can collaborate to effectively use this information, it will be possible to at least minimize the population losses that occur. Moreover, because we are relatively early in the trajectory of global climate change, management decisions in the next decade will have disproportionately large effects on the amount of native trout biodiversity that remains in Rocky Mountain streams a century from now.

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From the Archives

The Black Bass is a good kited of fish to stock a large, clear, rapid river, with stony bottom, where the crawfish and helgamite are to be found. They scarcely ever cat other fish if they can get the crawiish, and I do not recommend putting them in any waters where the crawfish is not plenty, and they are rarely fouled except among the stones. I would not recommend them for small ponds. If Black Bass are put in small ponds they eat the young of' all kinds of' fish, bite the old fish, and before starving, would cat themselves if possible. They have the bull dog disposition as far as courage is concerned.

Seth Green (1876): Propagation of Fish, Transactions of the American Fisheries Society, 5:1, 8-13.

The Steven Berkeley Marine Conservation Fellowship

This fellowship was created by AFS in 2007 to honor the memory of Steven Berkeley, a dedicated fisheries scientist with a passionate interest in integrating the fields of marine ecology, conservation biology, and fisheries science to improve fisheries management. Berkeley was a long-time member of AFS and a member of the first Board of Directors of the Fisheries Conservation Foundation. The fellowship comprises a competitively based $10,000 award to a graduate student actively engaged in thesis research relevant to marine conservation. Research topics may address any aspect of conservation; a focus on fisheries issues is not required.

Requirements for application:

1. The applicant must be a student officially accepted or currently enrolled in a M.S. or Ph.D. program.
2. The student must be actively engaged in thesis research related to some aspect of marine conservation; the intent of the award is to support ongoing research costs.
3. The student must be a member of AFS in good standing; membership can be obtained at the time of application submission.
4. Applications must be emailed by February 1, 2013.

Berkeley Fellowship application details are located on the AFS Marine Fisheries Section website: http://fishweb.ifas.ufl.edu/mfs/index_files/Berkeley_Fellowship.htm

NEW AFS MEMBERS & NEWLY CERTIFIED FISHERIES PROFESSIONALS - PFC

New Members
Julio Achupallas
Brenda Anderson
Tim Barrett
Monica Blanchard
Andrew Bolerjack
Douglas Brander
Amy Breedlove
Seana Buchanan
Ariane Cantin
Robert Christensen
Michael Courtney
Karson Coutre
Cortlyn Davies
Anna Dellapenta
Kerri DeShetler
Jessica Dodds
Timothy Feehan
Elizabeth Figus
Daniel Fiorenza
Cameron Fuess
Michael Fulbright
Jessica Gill
Conrad Gowell
Dustin Harrison
Alastair Harry
Skyler Hedden
James Hill
Jessica Holsman
Tom Houston
Evan Ingram
Shawn Johnson
Thomas Johnson
Jaewoo Kim
Britney Kreiner
Drake LaFleur
Steven LaForge
Jason McFarland
Darrel Mecham
Benjamin Medley
Joachim Moenig
Eric Motsinger
Siobhan Murray
Lisa Natanson
Elizabeth Ng
Phong Nguyen
Michael Penn
Jessica Ramsay
Steven Rawles
Samantha Root
Mojgan Rostaminia
Seth Rudman
Dee Sagawe
Nick Schell
Alex Schoppa
Braxton Setzer
Chelsey Sherwood
Erin Shew
Gregg Shirk
Margaret Siple
Andrew Spence
Bret Stephens
Andy Stevens
Michael Sundberg
Kisei Tanaka
John Thames
Erin Thayer
Bradley Thompson
Coowe Walker
Na Wang
Michael Weimer
Easton White
Samuel Williams
Kyle Wilson
Justin Woods
Daniel Zurlo

Certified Fisheries Professionals-FPC
David C. Caroffino
Kenneth K. Cunningham
Steve Gale
Isabelle l. Girard
Michael J. Greco
Jason Olive
Robert Paul Romaire
Matthew Christopher Ward

Associate Fisheries Professionals-FPA
Johnathan G. Davis
Kevin Randy Keretz
Larry Larralde
Edwin Scott Smith
Peter M. Staudenmeier

2012 American Fisheries Section Award Winners

The following AFS Sections announced award recipients at the Annual Meeting in Saint Paul, Minnesota:

Canadian Aquatic Resources Section

Peter A. Larkin Award: Ph.D. level – Lee Gutowsky, Carleton University

M.Sc. level – Stephanie Avery-Gomm, University of British Columbia

Equal Opportunities Section

Native People's Travel Award recipients: William Bernier

Education Section

AFS Best Student Poster Award at the 2011 Annual Meeting in Seattle, Washington

Winner: Gerard Carmona-Catot, University of California-Davis

Honorable Mentions: Hillary A. Meyer, South Dakota State University and Joshua W. Morse, Oberlin College.

AFS/SEA Grant Best Student Paper at the 2011 Annual Meeting in Seattle, Washington

Winner: Michael R. Lowe, University of Southern Mississippi

Honorable Mentions: Anthony R. Sindt, Iowa State University and Jonathan D. Carey, University of Massachusetts-Dartmouth

Young Professional Achievement Award: Justin VanDeHey

Estuaries Section

Distinguished Service Award: Thomas Bigford

Student Travel Award:

Michelle Walsh–University of New Hampshire
Augustin Engman–North Carolina State University
Michael Lowe–University of Southern Mississippi

Fisheries and Information Technology Section

Best Student Poster Award: Matthew DeAngelo, St. Louis University

Fish Culture Section

Student travel award winners for Aquaculture America 2012: Blake Hauptman (Best Abstract), Daniel Russo (Best Abstract), and Carlin Fenn (Joint FCS-US Aquaculture Society Best Abstract Award)

Student travel award winners for AFS 2012: Brian Gause (Best Abstract) and John Bowzer (Best Abstract) Hauptman - Montana State University; Russo - University of North Carolina Wilmington; Carlin Fenn, Brian Gause, and John Bowzer - Southern Illinois University

Fish Health Section

Snieszko Student Travel Award: WI: Kamalakar Chatla-Mississippi State University; Jingun Lu-Mississippi State University, Robert (Adam) Ray-Oregon State University, Neeti Dahal-Mississippi State University, Scott Jones-University of Arkansas at Pine Bluff

First Place Student Paper Award: Nicholas Phelps-St. Paul MN

Second Place Student Paper Award: Amy Long-Univ. of Idaho

Fisheries Administration Section

2012 Outstanding Sport Fish Restoration

Sport Fishery Development and Management Category

- Kansas Department of Wildlife, Parks and Tourism
- Project: Fishing Impoundments and Stream Habitats (FISH)

Research and Surveys Category

- Idaho Department of Fish and Game
- Project: "Tag-You're-It"

Aquatic Education Category

- Iowa Department of Natural Resources
- Project: Urban Fishing Program Development and Case Study - Fish Iowa!

Fisheries Management Section

Award of Excellence: Dr. David Welch

Conservation Achievement Award: Muskies Canada Inc. and Muskies Inc.

Hall of Excellence: Phil Bettoli

Genetics Section

James E. Wright Award: Joy Young

Stevan Phelps Memorial Award: Jeffrey F. Bromaghin, Danielle F. Evenson, Thomas H. McLain and Blair G. Flannery for their paper "Using a Genetic Mixture Model to Study Phenotypic Traits: Differential Fecundity among Yukon River Chinook Salmon, Transactions of the American Fisheries Society," Transactions of the American Fisheries Society 140:235-249.

Marine Fisheries Section

Steven Berkeley Marine Conservation Fellowship: Tony Spitzack, Washington State University

Honorable Mention: Caitlin Cleaver, University of Maine and
Geoffrey Smith, University of Florida

Oscar E. Sette award: Andre E. Punt

Student Travel award: Chelsey Campbell, University of Florida
Iris Kemp, University of Washington
Kostantine Rountos, SUNY - Stony Brook

2013 American Fisheries Society Awards

CALL FOR AWARD NOMINATIONS

The American Fisheries Society (AFS) is seeking nominations and applications for several 2013 awards. Award recipients will be honored at the Annual Meeting in Little Rock, Arkansas, on September 8–12, 2013. Nominations typically require a candidate's name, full contact information, biographical information, and/or history of service to the Society. Some awards require additional nomination materials. For more information on how to nominate an individual or organization, see descriptions below or contact the award chair. You may also contact Gail Goldberg, AFS awards coordinator, by e-mail at ggoldberg@fisheries.org or phone, (301) 897-8616 x201, or you may visit the AFS web site: fisheries.org/awards_call for updates as they become available.

AWARD OF EXCELLENCE

The Society's highest award for scientific achievement is presented to a living AFS member for original and/or outstanding contributions to fisheries and aquatic biology. Nominations should be submitted electronically by PDF attachment to an e-mail.

Materials should include a detailed letter of nomination to address award criteria, vitae of nominee, and additional supporting materials as needed. Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package.

Click "Applications" on the fisheries.org/awards_call menu options to find the criteria for selection and other important nomination information.

Nomination deadline: **April 1, 2013**
Contact: Christine Moffitt, Committee Chair
Department of Fish and Wildlife Resources
USGS–Idaho Cooperative Fish and Wildlife Research Unit
104C CNR, Sixth and Line Street
University of Idaho, Moscow, ID 83844-1141
Phone: (208) 885-7047; Fax: (208) 885-9080
E-mail: cmoffitt@uidaho.edu

CARL R. SULLIVAN FISHERY CONSERVATION AWARD

The Carl R. Sullivan Fishery Conservation Award is presented to an individual or organization for outstanding contributions to the conservation of fishery resources. Eligibility is not restricted to AFS members, and accomplishments can include political, legal, educational, scientific, and managerial successes. Nominations should include a synopsis of fishery conservation contributions; a description of the influence of those contributions on improved understanding, management, or use of fishery resources; and at least one additional supporting letter. Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package. Nominations should be submitted electronically by PDF attachment to an e-mail.

Nomination deadline: **April 1, 2013**
Contact: Contact: Bob Hughes, Committee Chair
June–November
200 SW 35th St., Corvallis, OR 97333
Phone: (541) 754-4516; Fax: (541) 754-4716

December–May
Amnis Opes Institute
112 Aspen Meadows Road #39, Driggs, ID 83422
Phone: (208) 354 2632
E-mail: hughes.bob@epa.gov

DISTINGUISHED SERVICE AWARD

The Distinguished Service Award recognizes outstanding contributions of time and energy for special projects or activities by AFS members. The number of recipients may vary. A single member, a group of members, and AFS staff are eligible candidates. Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package. Nominations should include a description of the outstanding contributions by the candidate(s) and be submitted electronically by PDF attachment to an e-mail.

Nomination deadline: **April 1, 2013**
Contact: Contact: Bob Hughes, Committee Chair
June–November
200 SW 35th St., Corvallis, OR 97333
Phone: (541) 754-4516; Fax: (541) 754-4716

December–May
Amnis Opes Institute
112 Aspen Meadows Road #39, Driggs, ID 83422
Phone: (208) 354 2632
E-mail: hughes.bob@epa.gov

EXCELLENCE IN PUBLIC OUTREACH

The Excellence in Public Outreach Award is presented to an AFS member who goes the "extra mile" in sharing the value of fisheries science/research with the general public through the popular media and other communication channels. Two or more individuals may act as nominators, but at least one nominator must be an AFS member. Entries must include a biographical sketch of the nominee (not to exceed three pages) and supporting evidence of communicating the value of fisheries issues/research to the general public through the media and other communication channels, plus any evidence of teaching others about communication with the public. Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package. Nominations should be submitted electronically by PDF attachment to an e-mail.

Nomination deadline: **April 1, 2013**
Contact: Cleve Steward, Committee Chair
AMEC Environment & Infrastructure
Phone: (206) 719-1260
E-mail: cleve.steward@amec.com

HONORARY MEMBERSHIP

Honorary membership is presented to individuals who have achieved outstanding professional accomplishments or have given outstanding service to the Society. Honorary members must be nominated by at least 100 active members and elected by a two-thirds majority of active members voting.

Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package.

Nomination dateline: **April 1, 2013**
Contact: Gail Goldberg
American Fisheries Society
5410 Grosvenor Lane, Suite 110
Bethesda, MD 20814
E-mail: ggoldberg@fisheries.org

MERITORIOUS SERVICE AWARD

The Meritorious Service Award is presented annually to an individual AFS member for loyalty, dedication, and meritorious service to the Society over a long period of time and for exceptional commitment to the programs, objectives, and long-term goals of the Society. Nominations should include the candidate's name, full contact information, biographical information, and/or history of the nominee's service (not to exceed three pages) to the Society. Letters supporting the nomination are welcome. Nominations and any supporting letters must be submitted electronically via PDF attachment to an e-mail.

Nomination deadline: **April 1, 2013**
Contact: Bob Curry, Committee Chair
NC Wildlife Resources Commission
Division of Inland Fisheries
1721 Mail Service Center, Raleigh, NC 27699-1721
Phone: (919) 707-0221; Fax: (919) 707-0028
E-mail: robert.curry@ncwildlife.org

OUTSTANDING CHAPTER AWARD

The Outstanding Chapter Award recognizes outstanding professionalism, active resource protection, and enhancement programs, as well as a strong commitment to the mission of the Society. Three awards are given, one for small chapters, one for large chapters, and one for a student subunit of a chapter. Chapters should submit an application to their division presidents to be considered. Division presidents may nominate two best chapters from their divisions, one with fewer than 100 members and another with 100 members or more. Applications can be obtained from the AFS web site. Click on "Applications" for menu options to find more information. Nominations should be submitted electronically by PDF attachment to an e-mail and include full contact information of the chapter president (i.e., address, e-mail, phone, etc.) to complete the package.

Nomination deadline: **April 1, 2013**
Contact: Phil Downey, Committee Chair
Aquatec Biological Science
273 Commerce St., Williston, VT 05495
Phone: (802) 860-1638; Fax: (802) 658-3189
E-mail: pdowney@aquatecb.com

PRESIDENT'S FISHERY CONSERVATION AWARD

The President's Fishery Conservation Award is presented in two categories: (1) an AFS individual or unit or (2) a non-AFS individual or entity, for singular accomplishments or long-term contributions that advance aquatic resource conservation at the regional or local level. The award is administered by the Past President's Advisory Council. A nomination package should include a strong and detailed letter describing the nominee's contribution and the evidence for accomplishment at the regional or local level. If the nomination is for an individual, include a curriculum vitae if possible. Nominations may be supported by multiple individuals by signing one nomination letter or by submitting supporting letters in addition to the main nomination letter. Include the nominee's title and full contact information (address, e-mail, and phone). Nominations should be submitted electronically by PDF attachment to an e-mail.

Nomination deadline: **April 1, 2013**
Contact: Bill Fisher, Committee Chair
NY Cooperative Fish Wildlife Resource Unit
Bruckner Hall/Cornell University
Ithaca, NY 14853-3001
Phone: (607) 255-2839; Fax: (607) 255-1895
E-mail: wlf9@cornell.edu

WILLIAM E. RICKER RESOURCE CONSERVATION AWARD

The William E. Ricker Resource Conservation Award is presented to any entity (individual, group, agency, or company) for accomplishment or activity that advances aquatic resource conservation that is significant at the national or international level. The award is administered by the Past President's Advisory Council. A nomination package should include a strong and detailed letter describing the nominee's accomplishments and the evidence for being significant at the national or international level. If the nomination is for an individual, include a curriculum vitae if possible. Nominations may be supported by multiple individuals by signing one letter or by submitting supporting letters in addition to the main nomination letter. Include the nominee's title and full contact information (address, e-mail, and phone). Nominations should be submitted electronically by PDF attachment to an e-mail.

Nomination deadline: **April 1, 2013**
Contact: Bill Fisher, Committee Chair
NY Cooperative Fish Wildlife Resource Unit
Bruckner Hall/Cornell University
Ithaca, NY 14853-3001
Phone: (607) 255-2839; Fax: (607) 255-1895
E-mail: wlf9@cornell.edu

RETIRED MEMBERS TRAVEL AWARD FOR THE AFS ANNUAL MEETING

The AFS has established this travel award to encourage and enable members of the Society to attend annual meetings, particularly those members who might play a more active role in the meeting. The Society recognizes that some retired members who desire to participate in the annual meeting might be inhibited for financial reasons. Retired members may not have funds for travel to meetings that were available to them while employed. Therefore, this award is meant for those members who truly have a need for financial assistance. The Society has neither means nor desire to verify financial need, so your request for support is based on an honor system. However, you must be a dues-paying retired member of the AFS to apply. A maximum of $1,500 may be awarded for reimbursable expenses. Click on "Applications" for the form on the AFS web site. Nominations should be submitted electronically by PDF attachment to an e-mail.

Deadline: **April 1, 2013**
Contact: Bill Fisher, Committee Chair
NY Cooperative Fish Wildlife Resource Unit
Bruckner Hall/Cornell University
Ithaca, NY 14853-3001
Phone: (607) 255-2839; Fax: (607) 255-1895
E-mail: wlf9@cornell.edu

THE EMMELINE MOORE PRIZE

The AFS has established a career achievement award, named after the first female AFS president, Emmeline Moore (1927–1928), to recognize efforts of an individual member in the promotion of demographic diversity in the society. This award will be presented to an individual who demonstrates strong commitment and exemplary service to ensuring equal opportunity access to higher education in fisheries and/or professional development in the broad range of fisheries science disciplines. Qualified nominees must exhibit clear evidence of service and commitment to diversity initiatives, including a strong research or fisheries management leadership background, public understanding of diversity issues, technical and popular writing, and inspirational leadership. Candidates should also have enunciated principles that lead to greater involvement of underrepresented groups

in fisheries science, education, research, or management. Nominees for the award are restricted to AFS members. A nomination package should include a detailed letter of support (maximum three pages) describing the nominee's accomplishments and including evidence of involvement in diversity initiatives given the criteria noted above. The main letter of nomination can be supported through several signatures, or up to three additional letters of support can be submitted. Please include the nominee's title and full contact information (i.e., address, e-mail, phone etc.) in the nomination letter to complete the package. Nominations should be submitted electronically by PDF attachment to an e-mail.

Nomination Deadline: **April 1, 2013**
Contact: Larry A. Alade, Committee Chair
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole Laboratory/Population Dynamics
166 Water Street, Woods Hole, MA 02543
Phone: (508) 495-2085; Fax: (508) 495-2393
E-mail: larry.alade@noaa.gov

STUDENT WRITING CONTEST

The Student Writing Contest recognizes students for excellence in the communication of fisheries research to the general public. Undergraduate and graduate students are asked to submit a 500- to 700-word article explaining their own research or a research project in their lab or school. The article must be written in language that is understandable to the general public (i.e., journalistic style). The winning article will be published in *Fisheries*. Students may write about research that has been completed, is in progress, or is in the planning stages. The papers will be judged according to their quality and their ability to turn a scientific research topic into a paper for the general public and will be scored based upon a grading rubric. Check the AFS web site on the main awards page for the grading rubric; for examples of past winning papers, see *Fisheries* 32(12):608–609 and *Fisheries* 34(1):39. Please include your full contact information (i.e., address, e-mail, phone, etc.) to complete the package.

Submission deadline: **April 1, 2013**
Contact: Walt Duffy, Committee Chair
CA Cooperative Research Unit
Humboldt State University, Arcata, CA 95521-8299
Phone: (707) 826-5644; Fax: (707) 826-3269
E-mail: wgd7001@humboldt.edu

AWARDS ADMINISTERED BY SECTIONS

Education Section

Excellence in Fisheries Education Award

The American Fisheries Society (AFS) Excellence in Fisheries Education Award was established in 1988. The award is administered by the Education Section and is presented to an individual to recognize excellence in organized teaching and advising in some aspect of fisheries education. Nominees may be involved in extension or continuing education, as well as traditional college and university instruction. Nominees must be AFS members, have been actively engaged in fisheries education within the last 5 years, and have at least 10 years of professional employment experience in fisheries education. Two or more people may act as nominators, but at least one nominator must be an AFS member. The nominator(s) is responsible for compiling supporting material and submitting the application. The suggested format for applications can be found on the Education Section web site. Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package.

Nomination deadline: **April 1, 2013**
Contact: Jason Vokoun, Committee Chair
Wildlife and Fisheries Conservation Center
Department of Natural Resources and the Environment
University of Connecticut
Phone: (860) 486-0141
E-mail: jason.vokoun@uconn.edu

John E. Skinner Memorial Fund Award

The John E. Skinner Memorial Fund was established in memory of John Skinner, former California–Nevada Chapter and Western Division AFS President. The fund provides monetary travel awards (up to $800 per award) for deserving graduate students or exceptional undergraduate students to attend the AFS annual meeting. The 2013 meeting will be held in Little Rock, Arkansas, from September 8 to 12. Any student who is active in fisheries or related aquatic disciplines is eligible to apply. Awardees are chosen by a committee of the AFS Education Section. Selection is based on academic qualifications, professional service, and reasons for attending the meeting. In addition to travel assistance to attend the AFS annual meeting, award recipients will receive a one-year paid membership to the AFS.

Application forms for 2013 for the student and advisor (separate forms) are available at fisheries.org/docs/award_skinner1.doc (student form) and fisheries.org/docs/award_skinner2.doc (mentor form).

Completed applications (for both student and advisor) must be received no later than **April 1, 2013**.

Contact: Dan J. Daugherty, Committee Chair
Texas Parks and Wildlife Department
Heart of the Hills Fisheries Science Center
5103 Junction Hwy., Mountain Home, TX 78058
Phone: (830) 866-3356 x211; Fax: (830) 866-3549
E-mail: Dan.Daugherty@TPWD.state.TX.us

Equal Opportunities Section

J. Frances Allen Scholarship Award

The AFS is pleased to announce that applications are being accepted until April 1, 2013, for the J. Frances Allen Scholarship for a female doctoral fisheries student. The J. Frances Allen Scholarship was established in 1986 to honor Allen, who pioneered women's involvement in the AFS and in the field of fisheries. The scholarship fund was established with the intent of encouraging women to become fisheries professionals. Eligibility: The qualified applicant must be a female Ph.D. student who was an AFS member as of December 31, 2012. The applicant must be conducting aquatic research in line with AFS objectives, which include "all branches of fisheries science, including but not limited to aquatic biology, engineering, fish culture, limnology, oceanography, and sociology." Typically, this award is given to a student who has completed preliminary exams.

Application: To apply, submit items A through D:

A. **Resumé** with information in the following format:
- Educational history: Degrees, grade point average for each degree (overall and in major), and relevant courses taken.
- Professional experience: Positions held, levels of position, and years of experience at each level.
- Publications: Separated into refereed and other.
- Presentations: "First author" implies that you presented it, "second author" assumes that you did not; specify if otherwise.
- AFS participation: Year joined, meeting attendance and participation, committee involvement, and presentations at AFS meetings.

B. **Transcripts** from all institutions of higher education: include enrollment in Ph.D. program. Please include transcripts with your application; do not have them sent separately. You may scan an official transcript as long as it is of high quality.

C. **Dissertation research proposal**: Do not exceed four single-spaced pages (excluding title page, abstract, and references). The proposal must be submitted in the following single-spaced format with headings:

- Title page: With project title, area of research (genetics, modeling, ecology, etc.), applicants name and affiliation
- Abstract: Not to exceed one-half page, describing research proposed
- Introduction: Including project justification and background
- Specific objectives and hypotheses if appropriate
- Summary of procedures/methods: Justification for choices including preliminary testing and references
- Expected and preliminary results
- Significance of research: Include anticipated application of findings
- Literature cited: Follow *Transactions of the American Fisheries Society* format<

D. **Three letters of recommendation**: One must be from the applicant's major advisor and one must be from an AFS member. Each letter should address (1) the applicant's promise as a fisheries scientist, (2) the potential of the applicant to complete his or her proposed work, and (3) the significance of the applicant's proposed research to the advancement of fisheries science. If those writing letters prefer, letters may be e-mailed separately to the address below, but they *must be received by the deadline* and should contain the applicants name along with J. F. Allen Scholarship in the subject heading. Please include the nominee's title and full contact information (i.e., address, e-mail, phone, etc.) in the nomination letter to complete the package.

Please contact the committee chair if you have any questions. Send electronic applications and recommendations (preferably in one mailing), to be received **April 1, 2013**, to:

Brooke Penaluna, Committee Chair
Subject: J. Frances Allen Scholarship
Phone: (541) 758-8783
E-mail: brooke.penaluna@oregonstate.edu

An application will not be reviewed if any part is missing or it is received after the deadline.

Criteria for selection: Selection will be made by the J. Frances Allen Scholarship Committee of the AFS Equal Opportunity Section. Proposal reviews by scientists in appropriate fields will be solicited by the committee. An awardee will be selected on a competitive basis with an emphasis placed on research promise, scientific merit, and academic achievement. Submission of an application acknowledges the applicant's acceptance of the committee's decision as final.

Public Announcement and Notification: Public announcement of the recipient will be made at the 2013 AFS Annual Meeting in Little Rock, Arkansas. In addition, a written announcement will appear in *Fisheries* and the recipient will receive an official letter of award. The recipient is encouraged to present the results of his or her research at an annual meeting of AFS. It is expected that the research findings will be published in an appropriate fisheries journal upon project completion, at which time the support from this scholarship and AFS will be acknowledged.

Marine Fisheries Section

The Steven Berkeley Marine Conservation Fellowship

This fellowship was created by AFS in 2007 to honor the memory of Steven Berkeley, a dedicated fisheries scientist with a passionate interest in integrating the fields of marine ecology, conservation biology, and fisheries science to improve fisheries management. Berkeley was a long-time member of AFS and a member of the first board of directors of the Fisheries Conservation Foundation. The fellowship comprises a competitively based $10,000 award to a graduate student actively engaged in thesis research relevant to marine conservation. Research topics may address any aspect of conservation; a focus on fisheries issues is not required. Please use the current application requirements at the link below, because revisions have been made recently.

For more information and application requirements see: fishweb.ifas.ufl.edu/mfs/index_files/Berkeley_Fellowship.htm

Send electronic applications and recommendations, to be received no later than **February 1, 2013**, to: Howard Williams, e-mail: hwilliams@fisheries.org

Fourth Call for Papers: Little Rock 2013

The Arkansas Chapter of the American Fisheries Society is pleased to announce the fourth call for symposia, contributed oral, and contributed poster presentations for the 143rd Annual Meeting of the American Fisheries Society to be held in Little Rock, Arkansas! The meeting theme, "Preparing for the Challenges Ahead" is likely to stimulate thoughts and presentations on:

- Challenges facing natural resource agencies regarding mandates to do more with fewer resources
- Challenges facing educators regarding a growing knowledge base, changing student expectations, and teaching to Millennials
- Challenges facing students regarding their roles as future scientists and managers serving increasingly more diverse stakeholders
- Other challenges that confront fisheries and natural resource professionals

AFS 2013 will be 8-12 September in Little Rock, at the Statehouse Convention Center located at the east end of President Clinton Avenue. The River Market District in Little Rock and the Argenta District in North Little Rock offer the best in dining, entertainment, museums, and shopping. Let us show you some southern hospitality next year in Little Rock.

GENERAL INFORMATION

Fisheries and natural resource professionals are invited to submit symposia proposals or abstracts for contributed oral, poster, and speed presentations that address the meeting's theme, or on other issues and subjects pertinent to our field. We encourage state and federal fisheries professionals, private biologists, academics, and students to participate. There will be four types of sessions at the meeting: Symposia (oral presentations organized by individuals or groups with a common interest), Contributed Oral Presentations (grouped together into themes), Contributed Poster Presentations (organized to coincide with either symposia or contributed oral presentations themes), and Speed Presentations for students or professionals just beginning research or interested in feedback on a specific issue.

A NEW TIME FORMAT

The Little Rock meeting will be experimenting with a new presentation time format. Regular symposia presentations and oral contributed presentations are designed to fit into 20 minute time slots. However, presenters should plan on presenting for 12 minutes, leaving 3 minutes for questions and 5 minutes for room changes (and further questions). It is important for symposia and oral contributed presenter to plan for, and abide by, this new time format.

SYMPOSIA

The Program Committee invites proposals for Symposia. We are specifically requesting topics related to the meeting theme of "Preparing for the Challenges Ahead." Topics not addressing the meeting theme should be of general interest to AFS members. Symposia that address challenges facing broad groups of fisheries professionals, along with solutions to specific challenges will receive priority.

Symposium organizers are responsible for recruiting presenter, soliciting their abstracts, and directing them to submit their abstracts through the AFS online submission forms. Organizers are not required to recruit a full symposium at the time of proposal submissions. The Program Committee is particularly interested in working with symposium organizers to incorporate into symposia appropriate presentations that are submitted as contributed oral or poster presentations. A symposium should include a minimum of 10 presentations and we encourage organizers to limit their requests to 1-d symposia (about 20 oral presentations). Time slots are limited to 20 minutes, but multiple time slots (i.e., 40 or 60 minutes) may be offered to keynote symposia speakers.

Symposium proposals must be submitted by 11 January 2013. All symposium proposal submissions must be made using the AFS online symposium proposal submission form available on the AFS website (www.fisheries.org). The Program Committee will review all symposium proposals and notify organizers of their acceptance or refusal by 1 February 2013. If accepted, organizers must submit a complete list of all confirmed presentations and titles by 22 February 2013. Symposium presentation abstracts (in the same format as contributed oral or contributed poster presentation abstracts; see below) are due by 15 March

2013. All symposium presenters are expected to deliver PowerPoint presentations.

The Program Committee is developing ways to increase the accessibility of symposia to all potential participants. See future calls for papers, e-mail messages, and the meeting web site for more details.

FORMAT FOR SYMPOSIUM PROPOSALS

(submit using AFS online symposium submission form)

When submitting your abstract, include the following:

- Symposium title: Brief but descriptive
- Sponsors: If applicable, indicate sponsorship. Please note that a sponsor is not required.
- Organizer(s): Provide name, affiliation, telephone number, and e-mail address of each organizer. The first name entered will be the main contact person.
- Chairs: Supply name(s) of individual(s) who will chair the symposium.
- Description: In 300 words or less, describe the topic addressed by the proposed symposium, the objective of the symposium, and the value of the symposium to AFS members and meeting participants.
- Audiovisual requirements: LCD projectors and laptops will be available in every room. Other audiovisual equipment needed for the symposium will be considered, but computer projection is strongly encouraged. Please list special AV requirements.
- Special seating requests: Standard rooms will be arranged theatre-style. Please indicate special seating requests (for example, "after the break, a panel discussion with seating for 10 panel members will be needed").

The Program Committee invites abstracts for contributed oral presentations, contributed poster presentations, or speed presentations. Authors must indicate their preferred presentation format:

- Contributed oral presentation only,
- Contributed poster presentation only,
- Contributed oral presentation preferred, but poster presentation acceptable, or
- Speed Presentation

CONTRIBUTED ORAL AND POSTER PRESENTATIONS

Only one contributed oral presentation will be accepted for each senior author. Contributed oral presentations will be organized by 20 minute time slots (i.e., 12-minute presentation, 3 minutes for questions, and 5 minutes for room changes). All oral presenters are expected to deliver PowerPoint presentations.

We encourage poster submissions because of the limited time available for oral presentations. The program will include a dedicated poster session to encourage discussion between poster authors and attendees. The dedicated poster session will include traditional hard copy posters. In addition, the Program Committee is exploring methods for incorporating electronic posters, such as inclusion of electronic posters in symposia or other sponsored electronic poster opportunities.

SPEED PRESENTATIONS

The Program Committee is interested in organizing one or more speed presentation sessions. Speed presentations would require a brief (2-3 sentences) abstract submitted through the AFS abstract submission site. Speed presentations would be an outlet for students or professionals just beginning their research or interested in feedback on a small specific issue. The format for a speed presentation would be 1 or 2 PowerPoint slides used during a 3-minute presentation, followed by 2 minutes for questions or feedback.

STUDENT PRESENTERS

Student presenters must indicate if they wish their abstract to be considered for competition for a best student presentation (i.e., paper or poster, but not both) award by submitting to the Best Student Presentation competition section. If a student does not wish to be considered, they should submit to the normal contributed abstracts section. Components of the application will include an extended abstract and a check-off from their mentor indicating that the study is at a stage appropriate for consideration for an award. Please note that speed presentations are not eligible for best student presentation.

ABSTRACT SUBMISSIONS

Abstracts for contributed oral and poster presentations and speed presentations may be submitted after 1 February 2013 and must be received by 15 March 2013. All submissions must be made using the AFS online abstract submission form, available at www.fisheries.org. When submitting your abstract:

- Use a brief but descriptive title, avoiding acronyms or scientific names in the title unless the common name is not widely known;
- List all authors, their affiliations, addresses, telephone numbers, and e-mail addresses; and
- Provide a summary of your findings and restrict your abstract to 200 words.
- Use 2-3 sentences for a speed presentation abstract.

All presenters will receive an email confirmation of their abstract submission and will be notified of acceptance and the designated time and place of their presentation by 5 April 2013.

The Program Committee will group contributed oral and poster presentations thematically based on the title and two or three keywords you will choose and prioritize during the abstract submission process. Speed presentations will be combined into separate sessions.

Late submissions will not be accepted. AFS does not waive registration fees for presenters at symposia, workshops, or contributed oral or poster presentation sessions. All presenters and meeting attendees must pay registration fees. Registration forms will be available on the AFS website (www.fisheries.org) in May 2013. There is a cost savings for registering early.

FORMAT FOR ABSTRACTS

Title: An Example Abstract for the AFS 2013 Annual Meeting
Format: Oral
Authors: Lochmann, Steve. Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff, 1200 N. University Dr., Pine Bluff, AR 71601; 870-575-8165; slochmann@uaex.edu
Racey, Christopher. Arkansas Game and Fish Commission, 2 Natural Resources Drive, Little Rock, AR 72205; 501-223-6371; clracey@agfc.state.ar.us
Presenter: Steve Lochmann
Abstract: Abstracts are used by the Program Committee to evaluate and select papers for inclusion in the scientific and technical sessions of the 2013 AFS Annual Meeting. An informative abstract contains a statement of the problem and its significance, study objectives, principle findings, and applications. The abstract conforms to the prescribed format. An abstract must be no more than 200 words in length.
Student presenter: No

PROGRAM COMMITTEE CONTACTS

Program Chair:
Steve Lochmann, University of Arkansas at Pine Bluff, slochmann.afs2013@gmail.com, 870-575-8165

Contributed Oral Presentation Subcommittee Chair:
Rick Eades, Nebraska Game and Parks Commission, rick.eades@nebraska.gov, 402-471-5554

Contributed Poster Presentation Subcommittee Chair:
Greg Summers, Oklahoma Department of Wildlife Conservation, gsummers@odwc.state.ok.us, 405-325-7288

Speed Presentation Subcommittee Chair:
Nick Phelps, University of Minnesota – Veterinary Diagnostic Laboratory, phelp0830@umn.edu, 612-624-7450

Symposia Subcommittee Chair:
Tom Lang, Kansas Department of Wildlife, Parks & Tourism, tom.lang@ksoutdoors.com, 620-672-0722

Committee Members:
Amanda Rosenberger, USGS Missouri Cooperative Fish and Wildlife Research Unit, rosenbergera@missouri.edu, 573-882-9653

Quenton Fontenot, Nicholls State University, quenton.fontenot@nicholls.edu, 985-449-7062

Steve Sammons, Auburn University, sammosm@auburn.edu, 334-844-4159

Georgia Chapter of the American Fisheries Society

Come join us for our annual meeting at the

Oceanside Inn and Suites on Jekyll Island

January 22 – 24, 2013

Check our website for more information: www.gaafs.org

Expect presentations of a wide range of topics which focus on the conservation and sustainability of fishery resources and aquatic ecosystems.

Presentations may include completed projects, management results, and progress of ongoing work.

Are you interested in presenting?

Send your abstract to John Kilpatrick

John.Kilpatrick@dnr.state.ga.us

News from the International Fisheries Section

Brian Bellgraph

Secretary, International Fisheries Section of the AFS.
E-mail: brian.bellgraph@pnnl.gov

International Fisheries Section Members and International Friends,

I hope this update finds you all well. Below is a summary of the activities of the International Fisheries Section (IFS) of the American Fisheries Society (AFS) that have taken place within the past several months.

IFS OFFICER CHANGES

Please welcome our newly elected president-elect, Dr. Bill Franzin, who assumed this position from Carl Burger at the AFS meeting in St. Paul this past August. Carl Burger is now our IFS president, and Felipe Amezcua has become our newest past-president of AFS. Many thanks are afforded to Felipe for his tireless work to reestablish the IFS as an active section within the AFS. Thank you Felipe, and we welcome your leadership as our new past-president! Many, many thanks are also due to Lourdes Gonzalez-Peralta, who "graduated" from her position as past-president. It seems that Lourdes has been an IFS officer for eternity, and we thank her very much for her dedication to enlivening the IFS. Finally, both Staci Rijal and I have one year remaining in our respective duties as treasurer and secretary, respectively.

IFS BUSINESS MEETING FUNDING THANK YOU TO NORTHWEST MARINE TECHNOLOGY

The IFS officers would like to extend a large congratulation to Northwest Marine Technology for their generous support of refreshments for the IFS business meeting and social at the St. Paul meeting. Thank you Northwest Marine Technology!

UPCOMING MEETING IN MAZATLAN, MEXICO

Please make plans to attend the upcoming 2014 Annual Meeting of the Western Division of the American Fisheries Society to be held in Mazatlan, Sinaloa, Mexico, on April 7–11, 2014. This is very exciting, because it will be the first meeting of an AFS division outside the United States or Canada. We are looking for a large contingent of fisheries scientists to attend from around the world to make this a successful meeting. The IFS is planning to sponsor and host a symposium at the conference, so stay tuned for updates if you are interested in attending. There will also be travel grants available for both Americans/Canadians to travel to Mexico (because it is difficult for Americans to get funding from our institutions for international travel); the IFS will also have a travel fund available for international travel through the IFS Endowment Fund; application criteria and guidelines can be found at www.fisheriessociety.org/ifs/IFSEndowment.html.

CARL BURGER'S WORK PLAN

With his recent advancement within the officer ranks, Carl has established a work plan with three primary goals for his 2-year period as IFS president: (1) a focus on fundraising to expand the budget of the IFS; (2) fostering new international units of AFS, with a near-term focus on Latin America; and (3) developing international venues to discuss topic-specific issues in fisheries science. If you are interested in serving as a committee chair in regards to any of these goals, please contact Carl.

INTERNATIONAL FISHERIES SCIENCE PRIZE

As many of you have heard, Dr. Ian Cowx of the Institute of International Fisheries at the University of Hull, England, won the distinguished quadrennial International Fisheries Science Prize, which was awarded during the 2012 World Fisheries Congress in Edinburgh, Scotland, in May. Congratulations to Professor Cowx for this milestone award. We also gratefully thank Dana Schmidt for his commitment and professionalism as the chair of the International Science Prize Committee, which worked tirelessly to choose Professor Cowx from a cadre of exceptional candidates.

From the Archives

So far, we have bent our energies to producing fish in vast numbers, with but little consideration of the many delicate conditions necessary to their future growth; and in my opinion, if the rivers were as pure today as when our forefathers landed on Plymouth Rock, there would now be the same immense shoals of salmon, shad and alewives ascending our rivers that there were then, multiplied tenfold by our methods of artificial propagation.

Fred Mather (1875): Poisoning and Obstructing the Waters, Transactions of the American Fisheries Society, 4:1, 14-19.

Using Film Documentaries as Fisheries Teaching Tools

Francis Juanes

AFS Book and Film Review Editor, Department of Biology, University of Victoria, Victoria, BC, V8W 3N5, Canada. E-mail: juanes@uvic.ca

I have taught a fisheries science and management class for many years at the University of Massachusetts and now at the University of Victoria. Because of my background and experience as a fisheries ecologist, the course focuses mainly on the fish and how to assess their populations in order to give managers useful information with which to manage different fisheries. I talk about fishing history (starting with the Greeks); fishing gear; status of local, regional, national, and global fisheries; population dynamics; and detailed coverage of various fisheries models. The one thing that is usually missing is the human component of fisheries, which is, arguably, equally as important as (or perhaps more than) science in managing fisheries. To fill this gap I have had guest speakers come to give talks to my students, but more recently I have turned to showing films. Students are generally receptive to good documentaries, and a good film can pack a ton of easily digestable information into one hour. Films, unlike most lectures, often provoke strong viewpoints and active discussions. Students also seem to identify with particular characters even if these characters are from very different cultures than their own.

In the last decade, fisheries science has grown in general interest and popularity, as indicated by (1) frequent papers in top journals like *Science* and *Nature*; (2) the increase in films about fish and fishing including feature films (*Gone Fishing*, *The Perfect Storm*, *Salmon Fishing in the Yemen*, etc.); (3) animated films (*Finding Nemo*, *A Shark's Tale*, etc.); (4) sport-fishing series (*Bass Tech*, *Fish Warrior*, and, more recently, an entire cable network, The World Fishing Network); and (5) perhaps most surprising, reality shows about fishers and the fishing industry (*Wicked Tuna*, *Lobstermen*, *Swords*, and, most famous, *Deadliest Catch*). There has also been a dramatic increase in documentaries about the fishing profession, the fishing industry, and local, national, and global fisheries conservation issues. It is these documentaries that I have found most valuable as teaching tools. The best ones focus on the fishing community—both fishers and their families and the industry they work for—but also include the important role of managers and politicans (and sometimes scientists). Here, I want to briefly highlight two such documentaries that I have used in the classroom. In future issues I will review newer films, focusing on their pedagogical potential.

Taking Stock is a film produced in 1994 by the National Film Board of Canada (director: Nigel Markham). Even though it is almost 20 years old, it still holds tremendous power and feeling. The film focuses on the personal, community, and industrial effects of the closure of a Canadian northern cod fishery in 1993, particularly focusing on Newfoundland, where about 80% of the population depended on the fishery. The film's power resides in taking us through the history of the fishery and the consequences of the closure through the eyes of the many players involved. The film highlights where all of the errors were made but does not take sides; it even includes scientists from the Department of Fisheries and Oceans talking about mistakes in the stock assessments. The film begins with images of Pierce Burry, "son of a fisherman, grandson of a fisherman, and great-grandson of a fisherman" going out to check his nets for the last time as the fishery closure has just taken effect. In the course of the next 47 minutes, in addition to Mr. Burry and his family, we meet a variety of players all involved or affected by the moratorium: Winnifred Mackay, a fishplant worker who is suddenly out of work; Claude Bishop, a cod assessment scientist for the Department of Fisheries and Oceans; Vic Young, the CEO of Fisheries Products International, the company that owned most of the fishing industry and that had pushed for the development of the offshore fisheries; Bill Cox, a trawlerman who works for Fisheries Products International ("Give me saltwater and a boat and I will be OK"); various federal fisheries ministers; and Cabot Martin, a lawyer and spokesman for the Newfoundland Inshore Fisheries Association. Everyone blames everyone else for the tragedy, and in the end perhaps everyone is right.

Gutted: The Demise of Scotland's Fishing Industry was made 10 years later (directed by David Peat, produced by Thirteen/WNET New York for *Wide Angle* on PBS) and covers similar ground but from the eastern side of the Atlantic. Sandy West comes from a family with generations of cod fishermen in Fraserburg, Scotland. New European Union (EU) fleet reduction regulations have forced him to decomission his newly purchased fishing boat, the *Steadfast*. The film is focused around the West family's emotional final voyage toward demolition at a scrap yard in Denmark, where all salvageable parts are sold to pay for the trip home. It also describes the birth and activities of the "Cod Crusaders," a group of spouses in the community who attend the EU Fisheries Commission meetings in an attempt to save a way of life in their town. In contrast, Will White and his family are successful herring and mackerel fishers as part of the pelagic fleet, a fishery that had collapsed in the 1970s but recovered after a 5-year EU ban. Curiously, the film also includes an interview with Leon Panetta (complete transcript is online, see web page below), former White House chief of staff and director of the CIA, present U.S. secretary of defense, and then-chair of the Pew Oceans Commission, about how to promote a sustainable future for the fishing industry and the worlds' oceans.

There are many similarities in both films but also important contrasts that can be fruitfully explored in discussions. These similarities and contrasts help students understand the complex nature of fisheries management by putting faces on all the different players.

For more information on these films see:

http://www.onf-nfb.gc.ca/eng/collection/film/?id=32271

http://ffh.films.com/id/12787/Gutted_The_Demise_of_Scotlands_Fishing_Industry.htm

http://www.pbs.org/wnet/wideangle/episodes/gutted/introduction/457

If you know of any film with teaching potential that the readers of *Fisheries* or students in a class would be interested in having reviewed, please send ideas to juanes@uvic.ca.

Gifts for the Holiday Season

Donald C. Jackson

Department of Wildlife, Fisheries and Aquaculture, P.O. Box 9690, Mississippi State University, MS 39762. E-mail: djackson@cfr.msstate.edu

An autumn rain gently drifts across the freshly planted wheat on my farm this afternoon. The rain came later than anticipated but its beauty completely trumped its tardiness. It started at dawn while I was squeezing in an early morning duck hunt on a nearby marsh before going to church. I'd expected the rain yesterday at dusk and accordingly had been at my pond to meet it, fly rod in hand. But the rain didn't come. It didn't really matter. The bluegill in the pond, like me, had sensed the front moving in and came to my surface flies with smacks, slurps, and swirls. Eighteen beautiful fillets are in my refrigerator, resting now in a covered dish with ice to keep them fresh, destined for a family fish fry tomorrow evening. The ducks from this morning's hunt will be on the grill later this week.

As I fished and hunted over the past 24 hours I engaged in reflections, a sort of internal dialogue. I sensed deeply the change in seasons around me on the Mississippi landscape as well as the change in seasons within me—on a different sort of landscape. Although I'm still working at my faculty position as a fisheries professor at Mississippi State University, retirement looms on the horizon. In my reflections this morning I acknowledged love for the work and the field but also acknowledged that there comes a time when an aging professional gets out of the way so that the new cohort of professionals can take over—encouraging transition from sunset to sunrise. With the sunrise comes a fresh wind that has incredible potential.

Then I thought about the students in our program, both undergraduate and graduate. They are very, very good—perhaps the best we've ever had. I asked myself a few questions: "What can those of us in the sunset phase of our careers do to help us find our separate peace during our season of transition—to help us 'let go,' and what can we do to help the new cohort get a good jump start in their careers? What have we not yet done? What gifts have we yet to share with them?"

Our students are like so many scattered throughout academic programs in fisheries and wildlife. They are hungry in the purest sense for a chance to do their work. But they are concerned that they don't have the proper skill sets. They *see* the necessary skills via various media but have not had a chance to acquire those skills. We teach them the science but they know that our fields are more than just science.

In their young lives they've done the best that they can with the opportunities available to them. Beyond academics, some find the way to engage in hiking, camping, canoeing—perhaps a little fishing and (more rarely) hunting—and, when possible, real-life research experience. But most have grown up in urban or suburban environments. They did not grow up surrounded by the outdoors. They had to go out, away from their home environments, to engage it. Some have never had opportunities to experience much, if any, of the world I have experienced during the past 24 hours—to hunt, fish, or watch rain fall gently on wheat they've planted themselves for deer and geese or to clean fish and game. They may not even own a gun or fishing equipment. Many don't know how to shoot, fish, and trap or how to drive a tractor, paddle a boat, or operate a chainsaw. They don't know knots or how to sharpen a knife or ax. Some don't even know how to swim. *And it is not their fault*.

They come to us. They put their lives into our hands. They will learn what we teach them and trust that we are teaching them what they need to know to be good at their professions in natural resources. Are we giving them what they need? One thing about it, we really can't use the model that we were raised in. The world has changed and with it comes the reality that if we're to produce competent and self-confident young professionals, we're going to have to make up for what they didn't get as they were growing up—not just the skills but also a particular mind set of connectedness with the rhythms of the Earth.

As I continued my reflections, particularly during this morning's duck hunt, with my son (a graduate student in landscape architecture) quietly sitting beside me in the blind, I tried to take myself back 40 years to my days as a graduate student. I thought about my student colleagues. They are now senior faculty, staff, and administrators. As students we were full of energy and drive and, although we were reluctant to admit it, we were scared. We were not simply scared of the great unknown in a world full of unemployment. We were scared that the choices we would be forced to make would in some way destroy dimensions of our humanity and crush our dreams. We were idealistic in our youth, but deep in our hearts and minds we knew that we would need to conform to the framework of employment in agencies, academic institutions, and businesses.

We were blessed by faculty (not all, but thankfully some) who taught us more than science. They helped us understand that we could be human and still be professional and that all professionalism is reflected through personality. They did not relax the rigor of their courses and exams, but they built the bridges that helped us be successful in those realms. They did not beat us down. They pulled us up. They were catalysts, enablers, friends. All are gone now and some are dead. But they remain alive in our hearts. We can still hear their echoes. One

had a cross-stitch over his desk that has been my guiding principle throughout my career: "No success is worth failure in the home."

I came home from my hunt, cleaned and packaged the ducks I'd shot, then showered, dressed, and went to church. Once there I walked through the drizzle across the parking lot, went through the door and quietly took my seat. I was late, but folks in the congregation expect that from me during hunting season or when there are special mornings perfect for fly-fishing.

What I encountered there in church on this drizzly morning was absolutely amazing. The theme of my reflections while hunting continued right there in the sanctuary. The entire service was all about welcoming youth and not putting stumbling blocks in their way. It emphasized the importance of reaching out to help those young in the disciplines find their way—and to be patient with them.

The more I listened during church, the more I realized that my fisheries courses necessarily have become transformed into something I never anticipated during early years of my career. In my courses we do rigorous science but also a heck of a lot more. There's a different pace—something's different than in years past. There's more intense engagement but it flows freely. Sometimes I feel like an old oak tree at the end of its life spewing acorns everywhere as some sort of last hurrah. And the kindness expressed to this aging professor by these young students is incredible, as is their attentiveness. They've touched my heart. The classroom is packed—at 8:00 a.m. Through teaching this course as I am currently doing, I think I've stumbled into the state of separate peace in the sunset—the separate peace that I've been searching for. So, in sincere humbleness, I want to share the formula with you during this holiday season.

I now begin my fisheries lectures with poetry (all sorts—but always with an outdoor framework), use parables as well as personal experience and stories to make points (the students want to know *who* the professor is, not just *what* the professor is), absolutely avoid PowerPoint presentations (the students are thankful and tell me so), speak frankly and openly about issues, and end with a charge, a challenge, and a word of encouragement. We don't talk about grades.

Our laboratory exercises leave us wet, muddy, and covered with grease and fish slime. I crawl into the muck with them. We do survival swimming and practice lifesaving techniques. We back boat trailers and drive boats. We set nets of all sorts, do shoreline seining, and go electrofishing. We practice angling using various methods: fly, spin, bait casting. We talk about lures and angling techniques. They learn how to clean fish. I teach them how to construct and set a trotline. They learn how to drive a tractor. And we do science. We collect data and try to make sense of it—in the field.

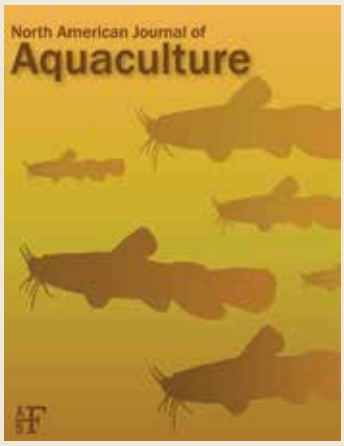
In this regard we cut through to the core. We don't want to clog our brains with complexity and unnecessary detail. We stay focused. We convert Celsius to Fahrenheit using the formula $F = 2C + 32$, recognizing that it is easier to remember 2 than it is 9/5. We operate with an understanding that pounds/acre is roughly equivalent to kilograms/hectare, recognizing that there are about 2 pounds in a kilogram and about 2 acres in a hectare. For confidence intervals we use a *t*-value of 2.0 because it is easier to remember 2 than it is 1.96 or go running off to find a *t*-table. Then I ruin them by telling them that in the Southeastern United States, alkalinity in milligrams per liter will translate into fish standing crop at pounds per acre or kilograms per hectare. (Try that—it tends to work—for lotic as well as lentic systems.) Discussing surface-to-biomass ratios and respiration when addressing growth curves makes sense when young fish are golf balls and old fish are bowling balls. They know that fish don't shrink but that fish can gain or lose significant condition within a month and that when fish are stressed they don't grow or reproduce much. Balance and sustainability are states of mind, not ecological reality. Nature can't be rushed. We focus on safety, technique, and the courage to "make the call." We call the shots, make the diagnosis, and don't blink. Physicians practicing the medical arts do it. So can fisheries managers. I emphasize the difference between the work we do in scientific research and the work we do in practical fisheries management using the above-mentioned shortcuts, all the while reminding the students that the art of applied management is deeply rooted in scientific discipline. So, we talk science. We use professional language. We travel in something equivalent to Miss Frizzle's *Magic School Bus*. We get dirty and make mistakes (and admit them).

This formula is working for me as a professional who works primarily in the realm of fisheries biology and, more nights than not, even as an aging man, I seem to sleep well when I think about it. Fisheries biology is, however, only one of the many professional disciplines expressed throughout the ranks of the American Fisheries Society. Each discipline will have its own suite of practical knowledge to be shared with our emerging cohorts of young professionals. Yet regardless of the formula you may use as you seek to invest a little in immortality during your pilgrimage, here's something to remember: young professionals are hungry for compass bearings, operational frameworks, perspective, tools, skills, and opportunity for purposeful living. They are like Old Geppetto in the story *Pinocchio*. He didn't want a toy boy. He wanted a *real* boy. Toys are fun to play with and make-believe worlds certainly have their purposes, but they really are not a substitute for real-life experiences.

So "when we wish upon a star" during this season of giving, how about we pull out the stops and give all we've got to those who are following us on this path—some real-life experiences, spiced for the holidays with crusty perspectives that have survived through the tumbling generations of fisheries professionals. Let's not hoard a single mite. The students' gift to *us* will be that of having our dreams realized—and yes—perhaps a little bit of immortality.

JOURNAL HIGHLIGHTS

North American Journal of Aquaculture
Volume 74, Number 4, October 2012



Parental Male Effects on Landlocked Fall Chinook Salmon Progeny Survival. *Matthew M. Wipf and Michael E. Barnes. 74: 443–448.*

[Communication] Koi × Goldfish Hybrid Females Produce Triploid Progeny when Backcrossed to Koi Males. *Boris Gomelsky, Kyle J. Schneider, and Debbie A. Plouffe. 74: 449–452.*

[Communication] Demonstration of Blue Crab Culture in Inland Low-Salinity Waters of West Alabama. *Luke A. Roy, Gregory N. Whitis, and William C. Walton. 74: 453–456.*

Effects of Diets with 28% or 32% Protein and Meat and Bone Meal or Corn Gluten Feed on Performance of Golden Shiners in Pools. *R. T. Lochmann and H. Phillips. 74: 457–462.*

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[Technical Note] Efficacy and Physiological Responses of Grass Carp to Different Sedation Techniques: I. Effects of Various Chemicals on Sedation and Blood Chemistry. *Brian R. Gause, Jesse T. Trushenski, John C. Bowzer, and James D. Bowker. 74: 560–566.*

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CALENDAR
Fisheries Events

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

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

More events listed at www.fisheries.org

DATE	EVENT	LOCATION	WEBSITE
January 15–17, 2013	South Coast Fish Passage Design and Engineering Field School	Ventura CA	http://www.calsalmon.org/srf-trainings/field-schools/jan-2013-fish-passage-design-and-engineering-field-school
January 17–19, 2013	2013 Annual Meeting of the Texas Chapter of the American Fisheries Society	Montgomery, TX	http://www.sdafs.org/tcafs/meetings/13meet/2013meethome.html
January 22–24, 2013	Georgia Chapter of the AFS Annual Meeting	Jekyll Island, GA	www.gaafs.org
February 5–7, 2013	32nd International Kokanee Workshop	Fort Collins, CO	Jesse Lepak at Jesse.Lepak@state.co.us
February 7–8, 2013	Winter Fisheries Training for Acoustic Tag & Hydroacoustic Assessments	Seattle, WA	www.HTIsonar.com/at_short_course.htm
February 14–15, 2013	Using Hydroacoustics for Fisheries Assessment	Seattle, WA	www.HTIsonar.com/at_short_course.htm
February 21–25, 2013	Fish Culture Section Mid-Year Business Meeting	Nashville, TN	www.was.org/WasMeetings/meetings/Default.aspx?code=AQ2013
February 21–25, 2013	Aquaculture 2013	Nashville, TN	www.was.org/WasMeetings/meetings/Default.aspx?code=AQ2013
March 13–16, 2013	31st Annual Salmonid Restoration Conference	Fortuna, CA	http://www.calsalmon.org/salmonid-restoration-conference/31st-annual-salmonid-restoration-conference
March 26–29, 2013	Responses of Arctic Marine Ecosystems to Climate Change Symposium	Anchorage, AK	seagrant.uaf.edu/conferences/2013/wakefield-arctic-ecosystems/index.php
April 8–12, 2013	7th International Fisheries Observer and Monitoring Conference (7th IFOMC)	Viña del Mar, Chile	www.ifomc.com/
April 15–18, 2013	Western Division of the AFS Annual Meeting	Boise, ID	www.idahoafs.org/meeting.php
April 25–26, 2013	NPAFC 3rd International Workshop on Migration and Survival Mechanisms of Juvenile Salmon and Steelhead in Ocean Ecosystems	Honolulu, HI	http://www.npafc.org/new/index.html
June 24–28, 2013	9th Indo-Pacific Fish Conference	Okinawa, Japan	http://www.fish-isj.jp/9ipfc
July 14–20, 2013	2nd International Conference on Fish Telemetry	Grahamstown, South Africa	Contact: Dr. Paul Cowley at tagfish@gmail.com
August 3–7, 2014	International Congress on the Biology of Fish	Edinburgh, United Kingdom	http://icbf2014.sls.hw.ac.uk

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

Hatchery Division Manager
WA State Dept of Fish & Wildlife
Permanent

Salary: $79,207.00–$88,008.00

Closing: Until filled

Responsibilities: The Hatcheries Division Manager provides leadership for the largest hatchery system in the United States. The hatcheries system is vitally important in maintaining salmon, steelhead, and trout fishing opportunities in Washington State, and an integral part of recovery programs to preserve threatened and endangered species.

Contact: For more information see the WDFW Employment Page for a complete listing at below link. This will explain job duties, minimum qualifications, competencies and desirable qualifications. If you have questions about this recruitment, you may contact Margaret Gordon, Recruitment Specialist at 360 902-2209.

Link: http://wdfw.wa.gov/employment/index.htm

Fish Hatchery Supervisor II
NV Dept of Wildlife
Permanent

Salary: $46,416–$69,029/year

Closing: 2/1/13

Responsibilities: 1) Fish hatchery manager responsible for oversight of four employees and a large hatchery facility. 2) Care for fish, eggs, spawning, transport, and all other facets of fish culture within a large state production trout facility. 3) Administration of budget, employee evaluations, inventory, report and document writing and data input. Feed calculations, density calculations, and disease recognition and treatment.

Qualifications: Bachelor's degree from an accredited college or university in biology, wildlife management, fisheries or other closely related field and three years of technical experience in wildlife management including: caring for fish, fish eggs, transplanting and operation of related hatchery equipment. One year of the above experience must have been in a lead-worker capacity. Prior work experience in fish culture or fish management deemed acceptable may replace a college level degree.

Contact: Dave Badger, Personnel Officer (775)688-1522 Apply online at link below.

Email: dbadger@ndow.org

Link: https://nvapps.state.nv.us

Regional Fisheries Management Biologist
WY Game and Fish Dept
Permanent

Salary: $4,569.00–$5,375.00 per month

Closing: Until filled

Responsibilities: Conserve and enhance the aquatic resources of northwest Wyoming, including waters in the Big Horn, Yellowstone and Shoshone River drainages. Additional details available at https://statejobs.state.wy.us/JobSearchDetail.aspx?ID=20678

Qualifications: Prefer Master's degree in fishery biology, biology, zoology, ichthyology, wildlife management, or closely related field, PLUS two years of professional work experience in fisheries management, aquatic resource research or aquatic habitat management.

Contact: Preference will be given to applicants who submit a cover letter to Mr. Dave Zafft, Fisheries Management Coordinator, 528 S. Adams St., Laramie, WY 82070 (FAX 307-745-8720, or below email), in addition to submitting the state application.

Email: david.zafft@wyo.gov

Link: https://statejobs.state.wy.us/JobSearchDetail.aspx?ID=20678

Fisheries Biologist / Lake Management
Solitude Lake Management, HQ in VA
Permanent

Salary: Commensurate with experience and includes benefits package

Closing: Until filled

Responsibilities: Growing professional services firm dedicated to preservation and restoration of fresh water resources is seeking qualified candidates to support our growth in the Lake Management services we offer. Candidates will be expected to perform all field work required to support our lake and fisheries management services, to include pesticide applications for the treatment and control invasive aquatic vegetation, algae, and other water quality issues through the application of aquatic herbicides, installation of fountains and aeration systems, and application of other water quality restoration products to maintain a healthy aquatic ecosystem. Candidates will also assist our fisheries management division with fish stocking, fish surveys and population assessments, habitat management, water quality monitoring, and other related fisheries services.

Qualifications: Qualified candidates should be able to demonstrate and document previous experience in this field and will be expected to become a licensed aquatic pesticide applicator for the states in which they will work.

Contact: Kevin Tucker, by below email or by phone 1-888-480-5253

Email: ktucker@solitudelake.com

Link: http://www.solitudelakemanagement.com

Don't miss the 2013 Annual Meeting!!

Western Division AFS

Fisheries: Learning from the Past and Looking Towards the Future

Sponsored by AFS Idaho Chapter and AFS Western Division

Join us in downtown Boise

- April 15-18, 2013
- Conference at the Boise Centre
- Rooms will be reserved at the Grove Hotel
- For more details or updates on the meeting visit http://www.idahoafs.org/meeting.php

While in Boise, you can also:

- Tour the World Center for Birds of Prey
- Experience spring skiing at Bogus Basin
- Whitewater raft one of the local world famous rivers
- Hike, jog, or bike the green belt, foothills, or local wildlife management area.
- Tour local wineries (20+) or breweries (7)
- Fish for steelhead in the Boise River just 5 minutes from the Grove Hotel.

All photos courtesy of Boise Metro Chamber of Commerce

Contacts:

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