American Fisheries Society Symposium 75:51–74, 2011

Opinions of Fisheries Researchers, Managers, and Anglers towards Recreational Fishing Issues: An Exploratory Analysis for North America

Caleb T. Hasler* and Alison H. Colotelo
Fish Ecology and Conservation Physiology Laboratory
Department of Biology and Institute of Environmental Science, Carleton University
1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada

Tobias Rapp
Inland Fisheries Management Laboratory, Faculty of Agriculture and Horticulture
Humboldt-University of Berlin, Philippstrasse 13, Haus 7, Berlin 10115, Germany

Elizabeth Jamieson
Department of Civil Engineering, University of Ottawa
161 Louis Pasteur, Ottawa, Ontario K1N 6N5, Canada

Karyne Bellehumeur
Fish Ecology and Conservation Physiology Laboratory
Department of Biology and Institute of Environmental Science, Carleton University
1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada
and
Department of Biology, University of Ottawa
550 Cumberland Street, Ottawa, Ontario K1N 6N5, Canada

Robert Arlinghaus
Department of Biology and Ecology of Fishes
Leibniz-Institute of Freshwater Ecology and Inland Fisheries
Müggelseedamm 310, Berlin 12587, Germany
and
Inland Fisheries Management Laboratory, Faculty of Agriculture and Horticulture
Humboldt-University of Berlin, Philippstrasse 13, Haus 7, Berlin 10115, Germany

Steven J. Cooke
Fish Ecology and Conservation Physiology Laboratory
Department of Biology and Institute of Environmental Science, Carleton University
1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada

Abstract.—There is a need to better understand the perspectives of various recreational fishing stakeholder groups regarding key issues related to fisheries sustainability. To provide a first snapshot and to inform future human dimension studies in this area, we distributed a Web-based open-access survey to fisheries researchers, fisheries managers, and anglers in North America. Attitudes of these respondents towards issues such as overharvest, impacts of catch and release, recreational fisheries management, and research priorities for the future were assessed. We found similar opinions and perspectives by the responding recreational anglers, managers,

* Corresponding author: chasler@connect.carleton.ca

and researchers on a number of issues, such as the perceived impact of commercial fishing contributing to fish stock declines, the perceived importance of using and promoting gear that minimizes stress and injury to individual fish when fish are to be released, and the belief that conflicts among stakeholders is growing as is the global anti-fishing movement based on animal rights thinking. Differences among responding groups included that researchers tended to be more concerned than anglers and managers with the potential of recreational angling contributing to fish stock declines. Responding anglers were also less content with their involvement in the fisheries management process than were responding managers and researchers, and these anglers also indicated a greater desire for more human dimensions research on understanding angler attitudes and behavior than was evident for responding managers and researchers. This preliminary survey revealed some variation in attitudes among recreational fisheries stakeholders. However, due to lack of random sampling, the study results cannot be extrapolated to the population level. We nevertheless conclude that improved communication and better understanding about the different perspectives among fisheries researchers, managers, and anglers and intrasectorally among different angling groups are needed, particularly when addressing contentious issues of relevance for the entire recreational fishing sector.

Introduction

In natural resource management, it is becoming increasingly common for different stakeholder groups to experience conflict, due to divergent interests and varying attitudes and opinions about contentious issues (Buckles 1999; Adams et al. 2003). As a result, it is becoming important for resource managers to involve most, if not all, stakeholders in discussions about management policies, as a way to solicit constituency support and facilitate rule compliance and to effectively conserve and manage the resource base (Krueger and Decker 1999; Plummer and Fitzgibbon 2004). In particular, fisheries managers face complex situations in which policy may be viewed and accepted differently by multiple stakeholder groups, such as anglers, commercial fishers, fisheries researchers, and the local community itself. Each group can have contrasting attitudes and opinions regarding the accepted future use and development of aquatic resources (Hutchings et al. 1997; Kearney 2001, 2002; Wilson et al. 2003). The resulting disconnects among the stakeholder groups can lead to inappropriate implementation of management activities (Miranda and Frese 1991) and lack of compliance with policy (Sullivan 2002) and can come across as weaknesses within the sector (i.e., recreational fisheries), leaving the entire sector vulnerable to attack from outside groups (e.g., the animal right movement, Arlinghaus et al. 2007a, 2007b).

Surveys constitute a cost-effective approach to assessing the values, attitudes, perspectives, and other human dimensions of various stakeholders (Pollock et al. 1994) and are routinely used by recreational fisheries managers and researchers to understand the angling public (Wilde et al. 1996). However, as yet, no study has been conducted that has comparatively investigated the opinions of all the major recreational fishing stakeholder groups (i.e., anglers, managers, and researchers) on the same issues. By avoiding investigations into the differences in opinions of all stakeholders, there is the possibility of shortcomings in fisheries management practice, as stakeholder groups can rarely predict the attitudes and perspectives of another group and this can result in misconceptions and misguided management decisions or inappropriate behaviors, as well as development of false stereotypes (Arlinghaus 2005, 2007).

Differences in opinions and attitudes also occur among fisheries researchers and among managers within an organization's staff (Knuth et al. 1995; Connelly et al. 2000). For example, researchers might reach different conclusions when looking at the same data set, resulting in contested scientific disputes (compare Rose 2003; Sneddon et al. 2003; Newby and Stevens 2008). Also, fisheries managers might differ in their attitudes towards the implementation of policy and day-to-day practices (e.g., hatchery management). Indeed, Knuth et al. (1995) found that federal fisheries managers and provincial

or state managers in North America differed in their beliefs about effective lake trout *Salvelinus namaycush* rehabilitation measures in the Laurentian Great Lakes.

Similarly, managers and resource users such as anglers might have different opinions and attitudes on some issues of contemporary relevance for fisheries practice. For example, Smith et al. (1997) reported that the views of coastal residents on Pacific salmon *Oncorhynchus* spp. restoration in Oregon (USA) differed significantly from agency staff regarding the impact of marine mammals, the use of hatcheries, and the importance of naturally spawning salmon stocks. Burger et al. (1999) reported a study from New Jersey (USA) where public officials rated environmental issues more severe than the local anglers, and Sterl et al. (2008) found that wildlife professionals in national parks in Vienna (Austria) rated the biological impact of recreational anglers much more severe than the anglers themselves. Connelly et al. (2000) reported that opinions of fisheries managers and anglers were similar on a number of management-related issues, although differing attitudes among managers and anglers were found for a range of issues, including agency performance, fish consumption advisories, necessity to protect endangered fish species, and access issues.

The lack of comparative studies on the attitudes of various recreational fishing researchers on common issues hampers identification of common ground and the need for altered type and quality of communication among stakeholders. Level of misperception and false ascription of attitudes and perception by one fisheries stakeholder group on another can have repercussions for fisheries management and ultimately undermine effective fisheries governance (Connelly et al. 2000) or culminate in intense conflict among stakeholders (Arlinghaus 2005).

The goal of this paper was to comparatively report on the attitudes and opinions of three primary recreational fisheries stakeholders towards emerging issues by focusing on North America. Through application of a snowball-type, Internet-based survey technique, our objective was to provide a first snapshot about the degree of similarity and divergence in the perspectives and attitudes of various stakeholder groups towards emerging themes of contemporary relevance in fisheries management. Although we are aware that our sampling was not conducted using principles of random sampling, we hope that our work stimulates more rigorous assessments of similar issues on a global scale or for particular continents or nations.

Methods

The survey was designed for recreational fisheries stakeholders in North America and focused on anglers, recreational fisheries managers, and recreational fisheries researchers. Our survey unfolded around several major topics that are pertinent to recreational fishing in North America, generally following the content in the recently published "EIFAC Code of Practice for Recreational Fisheries" (EIFAC 2008). We used the content of this document to determine topics for our survey, assuming that these issues represent important contemporary topics in recreational fisheries. Specifically, we assessed the stakeholders' values, attitudes, opinions, and perspectives on the following broad categories: (1) underlying values in terms of how humans should interact with nature along an anthropocentric to biocentric value orientation continuum (see Table 1 for item wording); (2) actual and potential consequences of recreational angling for fish populations (Table 2); (3) recreational fishing practices particularly related to the catch-and-release process (Table 3); (4) recreational fisheries management (Table 4); (5) trends in conflict-prone stakeholder interactions (Table 5); (6) the contentious issue of whether fish can feel pain and if that matters for fisheries management practice (Table 6); and finally, (7) research priorities (Table 7).

Questionnaire Structure and Content

To begin the survey, respondents were asked to identify himself or herself as being either a recreational angler (any person who actively participates in recreational fishing in North America and does not consider himself/herself a recreational fisheries manager or researcher), a fisheries manager (any person who is responsible for management and governance of any recreational fishery in North America and does not consider himself/herself a fisheries researcher), or a fisheries researcher (any person actively conducting research and publishing findings on

Table 1.—Comparison of level of agreement (% of respondents) among anglers (A), fisheries managers (M), and fishing researchers (R) of North America on four biocentric value items. The agreement category comprises those respondents agreeing strongly and those agreeing. Similarly, the disagreement category comprises respondents disagreeing strongly and disagreeing with each of the items. ns = not significant.

Item	Stakeholder group	Agree	Neutral	Disagree	Statistic
The aquatic environment should be protected for its own sake rather than simply to meet our needs.	A (N = 166)	88	7	5	ns
	M (N = 28)	93	7	0	
	R (N = 34)	91	9	0	
Advances in technology will eventually provide a solution to most of our problems with aquatic habitats.	A (N = 166)	23	23	54	$\chi^2 = 18.049$; $p = 0.0209$
	M (N = 27)	11	22	67	
	R (N = 34)	9	12	79	
Humans should manage fish populations for the benefit of humans.	A (N = 166)	56	21	21	ns
	M (N = 28)	58	21	21	
	R (N = 34)	33	21	46	
Creating or enhancing recreational fishing opportunities is more important than the conservation of biodiversity (i.e., nonsportfish and other organisms).	A (N = 139)	13	29	58	$\chi^2 = 37.772$; $p < 0.0001$
	M (N = 27)	11	26	63	
	R (N = 30)	0	3	97	

recreational fisheries, its practices and outcomes of management measures, and recreational fish species). In terms of demographic data, respondents identified themselves as belonging to a specific stakeholder group; managers and researchers were directed to answer some specific questions regarding their career. For example, managers were asked to provide their job title, how many different aquatic ecosystems they manage, and what best describes their work (e.g., decision making, public outreach, policy implementation, or development). Researchers were asked to identify what type of recreational fisheries research they were involved with and how many years they have been active in recreational fisheries research. We also asked several specific questions on recreational fishing participation, such as did respondents actively participate in recreational fishing and how often they did so in 2007. Additionally, we also asked where respondents recreationally fished in various aquatic environments (freshwater, marine, coastal [<3 nautical miles], estuary).

Regarding the first topical areas addressed in the questionnaire, value orientations, we presented respondents with wording reflecting a continuum of a value orientation ranging from anthropocentrism (e.g., humans should manage fish populations for the benefit of humans) to biocentrism (e.g., the aquatic environment should be protected for its own sake rather than simply to meet human needs). Item wordings followed selected items of the new ecological paradigm scale by Dunlap et al. (2000). Level of agreement towards each of the items was assessed on a 5-point Likert agreement scale.

The second topic we dealt with was the "actual and potential consequences of recre-

Table 2.—Comparison of level of agreement (% of respondents) among anglers (A), fisheries managers (M), and fishing researchers (R) of North America on items related to the actual and potential consequences of recreational fishing for fish populations and habitats. The agreement category comprises those respondents agreeing strongly and those agreeing. Similarly, the disagreement category comprises respondents disagreeing strongly and disagreeing with each of the items. ns = not significant.

Item	Stockholder group	Agree	Neutral	Disagree	Statistic
Global fish stocks are in decline and fisheries exploitation associated with commercial fishing is a contributing factor.	A (N = 166)	80	16	4	ns
	M (N = 28)	90	7	3	
	R (N = 34)	94	3	3	
Nonfishing-related habitat changes have had stronger impacts on fish than recreational fishing.	A (N = 166)	85	10	5	$\chi^2 = 15.804$; $p = 0.0453$
	M (N = 28)	82	7	11	
	R (N = 33)	67	21	12	
Introduction of nonnative sport fish has contributed to fish declines.	A (N = 165)	66	25	9	ns
	M (N = 28)	64	25	11	
	R (N = 34)	79	18	3	
Recreational fishing activity has the potential to pollute ecosystems.	A (N = 149)	49	17	34	$\chi^2 = 21.255$; $p = 0.0065$
	M (N = 27)	44	23	33	
	R (N = 29)	83	10	7	
Local anglers are an important driver of fish declines through overharvesting.	A (N = 166)	35	21	44	$\chi^2 = 19.057$; $p = 0.0146$
	M (N = 28)	47	11	42	
	R (N = 33)	70	15	15	
Recreational fishing has the potential to cause genetic changes in fish populations through selection.	A (N = 163)	43	24	33	ns
	M (N = 28)	39	29	32	
	R (N = 33)	70	15	15	
Relative to commercial fisheries exploitation, recreational fishing impacts are negligible.	A (N = 164)	57	23	20	$\chi^2 = 54.858$; $p < 0.0001$
	M (N = 28)	21	39	40	
	R (N = 33)	18	9	73	
Recreational fishing results in smaller fish overall.	A (N = 165)	16	32	36	ns
	M (N = 28)	32	32	36	
	R (N = 34)	38	35	26	

ational angling." The respondents were asked to indicate their level of agreement with eight general items using a 5-point Likert agreement scale (Table 2). Many items were worded to reflect the relative importance of recreational fishing compared to commercial fishing in affecting fish stocks (see Cooke and Cowx 2006). Other items emphasized biological issues resulting from recreational fishing, such as overharvest (Post et al. 2002; Lewin et al. 2006), fishing-induced evolutionary change potentially resulting in smaller body sizes (Jørgensen et al. 2007), introduction of nonnative fish species (Cambray 2003), and habitat changes

Table 3.—Comparison of level of agreement (% of respondents) among anglers (A), fisheries managers (M), and fishing researchers (R) of North America on items emphasizing impacts and norms associated with recreational fishing practices. The agreement category comprises those respondents agreeing strongly and those agreeing. Similarly, the disagreement category comprises respondents disagreeing strongly and disagreeing with each of the items. ns = not significant.

Item	Stakeholder group	Agree	Neutral	Disagree	Statistic
Impacts of recreational fishing on individual fish					
Recreational fishing causes avoidable injury to an individual fish.	A (N = 149)	33	34	33	$\chi^2 = 33.714$; $p < 0.0001$
	M (N = 27)	59	37	4	
	R (N = 32)	79	16	6	
Recreational fishing activity causes avoidable stress to an individual fish.	A (N = 147)	46	22	32	ns
	M (N = 27)	63	26	11	
	R (N = 32)	62	22	16	
What happens to an individual fish with respect to injury, welfare, and survival is irrelevant as long as there are no negative impacts on the fish population as a whole.	A (N = 148)	37	24	37	ns
	M (N = 27)	52	11	37	
	R (N = 29)	38	24	38	
Impacts of gear type					
Gear types (e.g., specific hooks, line type, etc.) that cause less injury to fish should be used even when the gear type reduces the catch rates.	A (N = 151)	62	23	15	ns
	M (N = 27)	63	26	11	
	R (N = 32)	81	13	6	
If the use of a specific angling gear type has been shown to reduce injury but not mortality of fish, it should be promoted.	A (N = 150)	58	25	17	ns
	M (N = 27)	56	26	18	
	R (N = 31)	39	45	16	
All lead fishing tackle should be prohibited	A (N = 150)	37	18	45	ns
	M (N = 27)	30	37	33	
	R (N = 30)	50	20	30	
Recreational fishing practices or gear that cause harm to individual fish, even though they do not result in problems at the population level, should be prohibited.	A (N = 148)	35	24	41	ns
	M (N = 27)	18	30	52	
	R (N = 29)	28	17	55	
Anglers should be required to take a course in proper angling practices and	A (N = 149)	33	15	52	ns
	M (N = 27)	18	19	63	
	R (N = 32)	40	29	31	

Table 3.—Continued.

Item	Stakeholder group	Agree	Neutral	Disagree	Statistic
gear choice to minimize negative impacts on fish well-being.					
Catch-and-release process					
Releasing a portion of fish after capture is an essential practice for ensuring the sustainability of recreational fisheries.	A (N = 148)	86	6	8	χ^2 = 17.44; p= 0.0258
	M (N = 27)	77	11	12	
	R (N = 31)	64	20	16	
If a fish survives a catch-and-release angling event, it has the same potential lifetime reproductive success as a fish that was not captured and released by an angler.	A (N = 149)	72	21	7	χ^2 = 24.822 p = 0.0017
	M (N = 27)	63	15	22	
	R (N = 30)	43	20	37	
When a fish is hooked too deeply to remove the hook easily and if the fish is going to be released, it is better to cut the line quickly rather than attempt to remove it.	A (N = 149)	90	5	5	ns
	M (N = 27)	93	7	0	
	R (N = 32)	81	19	0	
A fish that is bleeding extensively from the gills or mouth should be harvested, even if it is outside of the slot size.	A (N = 149)	37	17	46	ns
	M (N = 27)	41	4	55	
	R (N = 31)	19	27	54	

and pollution (Cooke and Cowx 2006; Lewin et al. 2006). In addition to the 5-point Likert agreement scale items mentioned above, respondents were also asked about their perception about the likelihood that recreational fishing is more or less sustainable than commercial fisheries.

The third topic in our survey was "recreational fishing practices," which was focused on the catch-and-release process and the gear and handling-related factors influencing the outcome of the release event (Arlinghaus et al. 2007a, 2007b). The respondents were again asked to indicate their level of agreement with 12 items using a 5-point Likert agreement scale (Table 3). Most items were derived from previous research on the effects of gear type on fish injury, stress, survival, and postrelease behavior (e.g., Cooke and Hogle 2000; Cooke et al. 2001; Arlinghaus et al. 2007a, 2007b, 2008). Some items were worded normatively (e.g., if a particular effect of catch and release on the individual would occur what would be the proposed implications for fisheries practice) while other items were more knowledge-based (e.g., focusing on what happens to the individual fish postrelease that survives the procedure). In addition to catch-and-release related items,

Table 4.—Comparison of level of agreement (% of respondents) among anglers (A), fisheries managers (M), and fishing researchers (R) of North America when asked a number of questions about recreational fisheries management. The agreement category comprises those respondents agreeing strongly and those agreeing. Similarly, the disagreement category comprises respondents disagreeing strongly and disagreeing with each of the items. ns = not significant.

Item	Stakeholder group	Agree	Neutral	Disagree	Statistic
Management authority					
Governments should be fiscally responsible for recreational fisheries management.	A (N = 140)	70	22	8	χ^2 = 16.333;
	M (N = 27)	75	7	18	p = 0.0378
	R (N = 30)	90	3	7	
Fisheries management agencies are effective in engaging anglers in their decision-making processes.	A (N = 139)	29	19	52	ns
	M (N = 26)	42	23	35	
	R (N = 30)	37	23	40	
Stakeholder involvement					
Anglers should be more involved in defining and directing scientific research priorities for recreational fisheries.	A (N = 140)	66	21	13	χ^2 = 24.870;
	M (N = 27)	55	26	19	p = 0.0016
	R (N = 30)	34	30	36	
Anglers should be involved in all fisheries management decisions.	A (N = 140)	68	21	11	χ^2 = 21.477;
	M (N = 26)	57	12	31	p = 0.0060
	R (N = 30)	20	17	33	
Research findings related to the recreational fishing sector are effectively transferred to fisheries managers.	A (N = 139)	15	56	29	χ^2 = 34.441;
	M (N = 26)	42	23	35	p < 0.0001
	R (N = 29)	45	10	45	
Management actions					
Recreational fishing (whether harvest or catch and release) should be limited during the reproductive period for a given species.	A (N = 140)	71	11	18	ns
	M (N = 27)	48	15	37	
	R (N = 29)	73	14	13	
Stocking fish is a valuable tool in recreational fisheries management.	A (N = 140)	70	17	13	χ^2 = 20.785;
	M (N = 27)	70	19	11	p = 0.0077
	R (N = 30)	47	20	33	
Aquatic protected areas are effective management tools in recreational fisheries.	A (N = 140)	44	34	22	ns
	M (N = 27)	56	22	22	
	R (N = 29)	72	10	18	
On every water body, there should be a fraction of	A (N = 140)	21	34	45	ns
	M (N = 27)	26	22	52	

Table 4.—Continued.

Item	Stakeholder group	Agree	Neutral	Disagree	Statistic
the aquatic system that should never be exposed to any recreational fishing activity	R (N = 30)	40	17	33	
Total catch-and-release fisheries are sufficiently benign (e.g., have little to no effect); therefore, the activity should be allowed even within a no-take (i.e., no harvest) fishing zone.	A (N = 139) M (N = 27) R (N = 30)	36 49 17	36 22 6	28 29 77	$\chi^2 = 32.172$; $p < 0.0001$

we also included one item on how to deal with the emerging issue of lead tackle pollution (Kelly and Kelly 2004; Radomski et al. 2006).

The next topic assessed in the survey were issues related to "fisheries management" (Table 4). Again, a 5-point Likert agreement scale was used to elicit the respondent's attitudes towards 10 items. The items were focused around three broad themes: management authority, stakeholder involvement in fisheries management, and selected management actions. The management authority questions asked for the role and the success of governmental bodies in fisheries management. Regarding stakeholder involvement, attitudes towards the level and quality of angler involvement in fisheries management and research were assessed. Finally, attitudes toward selected biological issues facing many fisheries managers, including whether angling should be suspended during reproductive pe-

Table 5.—Comparison of level of agreement (% of respondents) among anglers (A), fisheries managers (M), and fishing researchers (R) of North America when asked about a number of emerging themes on stakeholder interactions in recreational fisheries. The agreement category comprises those respondents agreeing strongly and those agreeing. Similarly, the disagreement category comprises respondents disagreeing strongly and disagreeing with each of the items. ns = not significant.

Item	Stakeholder group	Agree	Neutral	Disagree	Statistic
Conflict between different angling interest groups is increasing.	A (N = 138) M (N = 26) R (N = 30)	59 65 70	28 23 14	13 12 16	ns
There is a growing "anti-fishing" movement based on animal rights thinking.	A (N = 138) M (N = 26) R (N = 30)	65 58 67	20 19 17	15 23 16	ns
Conflict between the recreational fishing sector and other fishing sectors (e.g., commercial) is increasing.	A (N = 138) M (N = 26) R (N = 29)	65 61 55	29 31 34	6 8 11	ns

Table 6.—Opinions (% of respondents) of North American recreational anglers (A), recreational fisheries managers (M), and recreational fishing researchers (R) about selected issues associated with fish feeling pain. ns = not significant.

Item	Stakeholder group	Yes	No	Not sure	Statistic
In your opinion, do fish feel pain?	A (N = 137)	35	37	28	ns
	M (N = 26)	58	30	12	
	R (N = 30)	40	20	40	
If it was found conclusively that fish feel pain, should all recreational fishing be banned?	A (N = 137)	0	96	4	ns
	M (N = 26)	0	100	0	
	R (N = 30)	0	97	3	
If it was found conclusively that fish feel pain, should only catch-and-release fishing be banned?	A (N = 137)	1	90	9	ns
	M (N = 26)	4	92	4	
	R (N = 30)	3	87	10	

riods to ensure sustainable levels of recruitment (Maitland 1995; Cooke and Suski 2005), the contentious issue of "no take fishing zones" (Bartholomew and Bohnsack 2005; Cooke et al. 2006), other forms of aquatic protected areas to protect dwindling fish stocks (Helvey 2004; Meester et al. 2004), and stocking (Arlinghaus et al. 2002; Cooke and Cowx 2006; Lewin et al. 2008), were solicited.

The next two topics in the survey encompassed issues related to conflict-prone stakeholder interactions and the relationship among the public, managers, and researchers (Table 5). Using a 5-point Likert agreement scale, we assessed attitudes towards the effectiveness of implementation of new research into management practice, the degree of conflict among angler groups and between the recreational fishing sector and other sectors. We also asked whether there was a perception of a growing anti-fishing movement based on animal-rights thinking. Because discourse on the appropriateness of recreational angling in the public realm seems to be largely contingent on the question whether fish feel pain and if that matters morally (Huntingford et al. 2006; Arlinghaus et al. 2007a, 2007b, in press; Arlinghaus 2008), we also asked three items related to this contentious topic. Specifically, we asked whether respondents believed that fish feel pain and what would follow for fishing practice if it would be conclusively shown that fish feel pain (Table 6).

Our last topic assessed in our survey covered "research priorities." Research topics included in the list for prioritization built on the aspects addressed earlier were categorized into "broad issues," "fisheries management," and "fisheries practices" (Table 7). Altogether, 28 potential research topics were presented to respondents and the level of ascribed importance solicited using a 5-point importance scale ranging from very important to not sure.

Survey Implementation

An online program was used to build a custom survey that was hosted on a commercial server (www.surveymonkey.com). Such Internet survey methods have a number of advantages, but also some important limitations, relative to other survey designs (Fricker and Schonlau 2002; Beidernikl and Kerschbaumer 2007). One advantage is that they can reach large numbers of potential respondents very quickly, the disadvantage being the typically nonrandom-sampling-based survey nature that precludes generalized insights. The survey began with a preamble describing the survey and its aim, as well as providing contact information for respondents to send comments. To invite anglers to participate in the survey, the survey link was posted on numerous recreational fishing discussion boards throughout the United States and Canada, which were found using an online search engine (www.google.com) and through

Table 7.—Comparison of the degree of importance (% of respondents) attached by North American recreational anglers (A), recreational fisheries managers (M), and recreational fishing researchers (R) to various research priorities in recreational fisheries. Importance scale was 5 = very important, 4 = important, 3 = somewhat important, 2 = not important, and 1 = not sure. ns = not significant.

Item	Sector	5	4	3	2	1	Statistic
Global issues							
What is the effect of habitat alteration on recreational fisheries?	A (N = 124)	59	30	10	0	1	ns
	M (N = 24)	67	25	8	0	0	
	R (N = 31	55	35	7	3	0	
What are the factors that promote development of a sustainable fishery?	A (N = 124)	40	43	13	0	4	ns
	M (N = 24)	38	46	8	4	4	
	R (N = 30)	50	33	13	4	0	
Will global climate change affect recreational fisheries?	A (N = 126)	36	40	17	5	2	ns
	M (N = 24)	33	25	33	9	0	
	R (N = 31	35	39	23	3	0	
What is the economic value of global recreational fisheries?	A (N = 124)	46	32	19	1	2	ns
	M (N = 24)	38	33	29	0	0	
	R (N = 31	39	19	42	0	0	
What factors determine recreational fishing participation?	A (N = 123)	19	37	21	10	13	ns
	M (N = 24)	29	38	21	12	0	
	R (N = 30	3	53	31	13	0	
Is angling compatible with ideas of ecotourism?	A (N = 125)	21	38	22	9	10	ns
	M (N = 24)	21	29	38	8	4	
	R (N = 30)	17	20	40	20	3	
How can a better integration of angling interests in the global fisheries policy be achieved?	A (N = 124)	17	33	28	11	11	ns
	M (N = 24)	13	21	37	21	8	
	R (N = 30)	13	37	40	10	0	
How do recreational fisheries systems differ cross-culturally?	A (N = 124)	11	29	32	20	8	ns
	M (N = 24)	8	21	46	25	0	
	R (N = 30)	7	23	43	27	0	
To what extent do recreational fisheries develop in economies in transition?	A (N = 124)	8	34	39	8	11	ns
	M (N = 24)	12	13	46	21	8	
	R (N = 30	7	23	43	23	4	
Do fish feel pain?	A (N = 125)	1	6	18	61	14	ns
	M (N = 24)	4	4	17	71	4	
	R (N = 31	3	13	19	59	6	
Fisheries management							
What are the effects of harvest regulations (e.g, bag limits, minimum size limits)?							
What are the effects of harvest regulations (e.g., bag limits, minimum size limits)?	A (N = 118)	70	24	6	0	0	χ^2 = 33.728;
	M (N = 24)	50	33	13	4	0	$p < 0.0001$
	R (N = 30)	20	70	10	0	0	
What factors constitute a	A (N = 117)	55	31	11	0	3	χ^2 = 24.151

Table 7.—Continued.

Item	Sector	5	4	3	2	1	Statistic
well-managed fishery?	M (N = 24)	29	46	17	8	0	$p = 0.0022$
	R (N = 29)	34	59	0	7	0	
What is the maximum size of a fish that should be legally harvested to ensure sustainable population growth?	A (N = 118)	50	32	13	4	1	ns
	M (N = 24)	29	38	25	8	0	
	R (N = 29)	28	62	10	0	0	
What are the behaviors of anglers?	A (N = 120)	53	33	12	2	0	$\chi^2 = 15.417$
	M (N = 24)	29	42	25	4	0	$p = 0.0172$
	R (N = 29)	21	58	21	0	0	
What are the most vulnerable periods for a fish as it relates to recreational fishing (i.e., spawning, migration, witner, etc.)?	A (N = 117)	46	38	11	5	0	ns
	M (N = 24)	38	25	29	8	0	
	R (N = 29)	41	45	7	7	0	
What is the economic importance of sport fish?	A (N = 120)	50	34	13	3	0	ns
	M (N = 24)	37	38	21	4	0	
	R (N = 30)	27	47	23	3	0	
What is the level of compliance to regulations among anglers?	A (N = 117)	57	24	16	1	2	$\chi^2 = 24.226$
	M (N = 23)	26	35	30	9	0	$p = 0.0021$
	R (N = 29)	31	55	14	0	0	
What is the minimum amount of time a collapsed fishery should be left dormant before angling is allowed to begin?	A (N = 116)	38	38	17	4	3	ns
	M (N = 24)	29	29	25	13	4	
	R (N = 29)	28	52	17	3	0	
What are the attitudes of anglers?	A (N = 119)	39	40	17	3	0	$\chi^2 = 12.642$
	M (N = 24)	25	42	33	0	0	$p = 0.0491$
	R (N = 29)	10	52	35	3	0	
What are the effects of aquatic protected areas (e.g., fish sanctuaries)?	A (N = 119)	28	38	22	8	4	ns
	M (N = 24)	38	21	25	12	4	
	R (N = 29)	34	34	14	14	4	
Can stock enhancement mitigate fish mortality caused by recreational fishing?	A (N = 116)	19	35	28	8	10	ns
	M (N = 24)	25	33	38	4	0	
	R (N = 29)	17	31	21	28	3	
What is the heterogeneity of anglers?	A (N = 117)	21	15	21	20	23	$\chi^2 = 19.495$
	M (N = 24)	8	13	33	33	13	$p = 0.0124$
	R (N = 29)	7	31	34	28	0	
Practices							
What is the role of all involved environmental factors on the mortality of fish?	A (N = 118)	43	40	11	4	2	$\chi^2 = 15.566$
	M (N = 24)	29	33	34	4	0	$p = 0.0490$
	R (N = 30)	40	57	3	0	0	

Table 7.—Continued.

Item	Sector	5	4	3	2	1	Statistic
Practices of tournaments (retention, weigh-in, etc.) and their influence on individual fish.	A (N = 117)	33	34	19	11	3	ns
	M (N = 24)	21	33	29	17	0	
	R (N = 30)	27	37	26	10	0	
Fishing practices (handling, gear, etc.) and their influence on stress.	A (N = 118)	35	39	21	3	2	ns
	M (N = 24)	25	17	46	12	0	
	R (N = 30)	23	40	33	4	0	
How does catch-and-release angling influence the spawning behaviors of fish?	A (N = 118)	17	37	19	13	14	$\chi^2 = 16.084$
	M (N = 24)	17	21	46	12	4	$p = 0.0412$
	R (N = 30)	30	37	23	10	0	
What is the effect of "fizzing" (use of needle or other device to release air from inflated swim bladders) for promoting survival of decompressed fish?	A (N = 118)	13	32	18	12	25	ns
	M (N = 24)	12	13	37	21	17	
	R (N = 30)	13	27	37	17	6	
Is there a maximum number of times that a fish can be angled before mortality is a definite outcome?	A (N = 118)	9	23	31	18	19	ns
	M (N = 24)	4	21	42	25	8	
	R (N = 30)	7	37	46	10	0	

postings on numerous recreational fishing groups using a popular social networking Web site (www.facebook.com) by creating a group, posting the link to the survey, and advertising it on several recreational fishing group "walls." Web-based fishing boards and groups were monitored to evaluate respondent's comments regarding the survey and to watch for the potential calls of abuse (Norman and Russell 2006).

Fisheries managers within North America were invited to participate in the survey by sending individual emails, which included the survey link to appropriate managers (ones stated as being associated with recreational fisheries) found on state, provincial, or federal government resource Web sites (e.g., Fisheries and Oceans Canada, U.S. Fish and Wildlife, Texas Parks and Wildlife, and Ontario Ministry of Natural Resources). Fisheries researchers were invited by searching for names through the current primary literature in North American Journal of Fisheries Management, Fisheries Management and Ecology, and Fisheries Research. One-hundred and five appropriate researchers were found and subsequently emailed by searching journal paper titles and selecting only researchers from North America who publish on recreational fishing topics such as catch-and-release angling, human dimensions of recreational fisheries, biological responses of fish to angling, and the effects of fishing tournaments on fish (for years: 2005, 2006, and 2007). Recipients were also encouraged to forward the survey link to any recreational fisheries stakeholder of their own category (i.e., researchers to researchers) that they felt would be willing to participate effectively using a nonprobabilistic snowball distribution technique.

Given our nonrandom method of survey distribution, it is not possible to accurately quantify the number of stakeholders that were presented with the opportunity to participate in this survey, nor was it possible to calculate response rates or other metrics of survey quality and representativeness. Our results are thus not to be uncritically applied as being representative for the general population of stakeholders

surveyed. However, we believe that we have captured a diversity of opinions, and due to the way of survey administration, relative differences in opinions among stakeholder groups provide valid insights. Anglers were posting the link on multiple Web discussion boards, and we observed that managers and researchers sent the link to colleagues and to professional e-mail lists (e.g., the Human Dimensions of Fisheries Mailing List of the American Fisheries Society). After 5 d, the survey was closed to participants. The authors were concerned with the possibility of abuse due to the number of recreational fishing discussion boards that began to post negative comments and speculate about ways of systematically influencing the survey (see Norman and Russell 2006 for similar experiences). Because access to the survey was limited by one survey per Internet protocol (IP) address, as per the recommendations by Bowen et al. (2008), we assume that limited bias due to repeated survey response by individual anglers occurred. The entire survey consisted of 75 questions and took an average of 22.6 min (12.8–24.1 min, interquartile range) to complete. Only completed surveys from respondents who identified themselves as being from North America and either being recreational anglers, recreational fisheries managers, or recreational fisheries researchers were included in the statistical analysis.

Data Analysis

U.S. and Canadian recreational anglers, managers, and researchers were pooled to deal with nation-specific small sample sizes. To analyze and report data, agreement scale data were regrouped (strongly agree and agree, neutral, disagree and strongly disagree) to enable the use of contingency analysis that necessitate a minimum of five cases per cell. Categorical data (agreement and importance scale data) were compared among stakeholder groups using χ^2 contingency table analyses, and continuous data were compared using one-way analysis of variances. All statistical analysis was conducted using JMP 7.0.2 (SAS Institute Inc., Cary, North Carolina). Significance was assessed at $\alpha = 0.05$; however, due to the nonrandom sampling design and the lack of respondents being uniformly distributed throughout North America, the findings are discussed in the context of the presumably biased respondents and not the sector in general. We also did not extrapolate our findings to the population level and stress here that the results are only valid in terms of relative differences among stakeholder groups responding to this survey. It is not possible to derive results that pertain to the entire population of stakeholders because of our nonrandom sampling scheme. It would thus not be acceptable to infer from relative frequencies for a particular stakeholder to that stakeholder group "in general." In addition, we do not dispute that it is likely that the respondents of this survey represent biased opinions within each sector.

Results

Survey Respondent Characteristics

In total, 226 recreational fisheries stakeholders completed the survey: 164 anglers, 28 managers, and 34 researchers. Sixty-two percent of respondents reported that they lived in the United States and 29% in Canada. Nine percent of respondents classified themselves as being involved in both Canada and the United States. Anglers most commonly indicated participation in recreational fishing in the United States (59%). The remaining anglers participated in Canada (34%) or in both countries (7%). Anglers also indicated that they went fishing in other countries (e.g., Mexico, Spain, The Bahamas, and the United Kingdom). Of the managers surveyed, 64% were from the United States, 29% were from Canada, and 7% considered themselves as working in both countries. Similarly, the majority of researchers were from the United States (71%), with the remaining identifying themselves as Canadian (12%) or both (15%).

Of the 28 managers, 7 were administrators (e.g., directors and chiefs), 19 were fisheries biologists or aquatic biologists, and 2 were technicians. The duties of administers included implementing policy, managing specialized recreational fisheries, and making fisheries management decisions, while the duties of biologists and technicians included surveying the public, education, research, decision making, interacting with stakeholders, and fisheries and habitat assessments. Researchers ($N = 34$) were asked to list their particular research fields and the number of years in which they have been

actively researching recreational fisheries. Ten of the researchers considered catch-and-release angling a research interest, nine considered themselves as having ecology-based interests, eight were focused on human dimensions, and six had interests in fisheries management. Researchers on average had 16 years of fisheries research experience (5.25–23.75, interquartile range), with one researcher having only 1 year of experience and six having more than 25 years of experience (we did not assess career length for managers).

On average, respondents classified as anglers participated in recreational fishing on 74 d (±62, SD) during the 2007 fishing seasons, managers fished 24 d (±28) annually, and researchers fished recreationally 19 d (±19) per year. Anglers were found to participate in recreational fishing more often during 2007 than managers and researchers (analysis of variance [ANOVA]; df = 2, 221; $F = 17.87$; $p < 0.0001$; Tukey-Kramer-posthoc-test, $p < 0.05$). Overall, respondents identified freshwater species as their choice of target (83%; mainly black bass species (*Micropterus* spp. and salmonids), and only 17% of species reported as targets were marine. Reflecting their target species, 89% of respondents fished in freshwater habitats. About a third of respondents reported primarily using coastal areas (35%), which were defined as areas being less than three nautical miles from shore, estuaries (27%), and marine areas (22%).

Values Held by the Stakeholder Groups

Respondents were identified as exhibiting biocentric rather than anthropocentric value orientations (Table 1). Biocentric values were indicated by more than 88% of each respondent group, agreeing with the item "the aquatic environment should be protected for its own sake, rather than simply to meet our needs," and more than half of the sample (58% for anglers and 63% for managers and researchers) exhibited disagreement with the item "creating or enhancing recreational fishing opportunities is more important than the conservation of biodiversity (i.e., nonsport fish and other organisms)." Biocentric values were particularly prevalent among recreational fisheries researchers and managers and appeared somewhat less pronounced among anglers, as anglers disagreed with several items designed to measure biocentric values (Table 1). Anglers differed in terms of their value orientation to some degree from managers and researchers, and in fact, the level of agreement with two of the four items used to assess biocentric value orientations indicated differences among sectors. In particular, fewer anglers (58%) thought that conservation of biodiversity is more important than enhancing fishing opportunities compared to managers (63%) and researchers (97%; Table 1). Similarly, more anglers believed in technological advances potentially solving environmental problems (23% of anglers) as compared to managers (11%) and researchers (9%).

Actual and Potential Consequences of Recreational Angling

More than 80% of anglers, managers, and researchers agreed with the proposition that "global fish stocks are in decline and fisheries exploitation associated with commercial fishing is a contributing factor" (Table 2). Further, most respondents (63% of researchers, 67% of managers, and 75% of anglers) believed that the development of sustainable recreational fisheries is more likely than development of sustainable commercial fisheries. Similarly, the majority of each of the stakeholder groups agreed that recreational fisheries are "more sustainable" when compared to the commercial fishing sector (75% of anglers, 67% of managers, and 63% of researchers). However, respondents indicated potential differences among perspectives towards the relative role of recreational fishing exploitation in global fish declines (Table 2). While 57% of anglers believed that recreational fishing exploitation has negligible impacts compared to commercial fishing, only about 20% of managers and researchers thought of recreational fishing exploitation impacts as being negligible. Moreover, compared to anglers (35%), a higher fraction of managers (47%) and researchers (70%) agreed with the item that "local anglers are an important driver of fish declines through overharvesting," and there was a tendency for the researchers participating in the survey to express a more concerned attitude towards various biological impacts associated with recreational fishing compared to the anglers and managers that completed the survey. This included the potential of angling to cause genetic

changes through selection (70% of researchers believed this versus only 43% of anglers and 39% of managers) and for angling to pollute ecosystems (83% of researchers believed this to be the case compared to less than 50% of managers and anglers). In addition, more than 80% of managers and anglers thought that "nonfishing related habitat changes have had stronger impacts on fish than recreational fishing"; only about two-thirds of researchers agreed with this item. Opinions were, however, similar in terms of the importance of the spread of nonnative fish species contributing to fish declines, with more than two-thirds of all respondents sharing an affirmative attitude towards this issue.

Recreational Fishing Practices

Some of the respondent types (46%, 63%, and 62% of anglers, managers, and researchers, respectively) agreed that recreational fishing activity causes avoidable stress to individual fish (Table 3). However, more recreational fisheries managers (59%) and researchers (79%) than anglers (33%) indicated that recreational fishing causes avoidable injury to individual fish. Interestingly, 52% of managers thought that what happens to fish (with respect to injury, welfare, and survival) is not relevant as long as there are no negative impacts on the fish population as a whole, whereas only about a third of the anglers and researchers believed that this is the case.

The vast majority of each respondent type (62% of anglers, 63% of managers, and 81% of researchers) agreed that gear types that cause less injury to fish should be used even when this gear reduces catch rates (Table 3). Moreover, anglers (58%) and managers (56%) and about 40% of fisheries researchers felt that the use of specific angling gear types that have been shown to reduce injury, but not mortality, of fish should be promoted. However, many respondents disagreed (41% anglers, 52% managers, and 55% researchers) that gears that cause harm to individual fish, even though they do not impact the population level, should be prohibited (Table 3). Anglers, managers, and researchers were unsure as to whether lead fishing tackle should be banned to protect the aquatic environment; equal numbers agreed and disagreed with this issue. Finally, 52% of anglers and 63% of managers disagreed that anglers should be required to take a course in proper angling practices and gear choice to minimize negative impacts on fish, but only about one-third of researchers disagreed with this idea.

In terms of attitudes to various aspects of the catch-and-release angling process, the majority of anglers (90%), managers (93%), and researchers (81%) agreed that "cutting the line" is the best practice for removing the hook from a fish that is deeply hooked (Table 3). Similar numbers of anglers (46%), managers (55%), and researchers (54%) that submitted answers to the survey disagreed that it was appropriate to harvest an extensively bleeding fish if it was outside of the slot size. However, more anglers (72%) and managers (63%) than researchers (43%) agreed with the idea that if a fish survives a catch-and-release angling event, it has the same potential lifetime reproductive success as a fish that was not captured and released. In addition, more anglers (86%) agreed that releasing a portion of fish after capture is an essential practice for ensuring the sustainability of recreational fisheries when compared to managers (77%) and researchers (64%). No differences were found among respondent types when asked about the percentage of fish that are caught and then released by recreational anglers (anglers: 39% (±24%, SD); managers: 36% (±24%); researchers: 36% (±25%); ANOVA; df = 2, 205; $F = 0.266$; $p = 0.766$), and when asked about the percentage of fish mortality (caused by recreational angling) that should be a concern to fisheries managers (anglers: 25% [±16%]; managers: 32% [±18%]; researchers: 22% [±16%]; ANOVA; df = 2, 192; $F = 2.11$; $p = 0.124$).

Fisheries Management

Of the responding recreational fisheries stakeholders, more researchers (90%) than anglers and managers (70% and 75%) indicated agreement with the statement that governments should be fiscally responsible for recreational fisheries management (Table 4). Anglers, managers, and researchers were indecisive as to whether fisheries management agencies were effective in engaging anglers in their decision-making processes, and there were differences on the issue whether "research findings related to the recreational fishing sector are effectively transferred to fisheries managers." Only 15% of anglers agreed with this item while close to 42%

of managers and 45% researchers affirmatively responded to this issue.

A disconnect in the attitudes among respondents was also found when they were asked whether anglers should be involved in all fisheries management decisions. Only a third of researchers (20%) compared to 68% and 57% of anglers and managers, respectively, agreed with this item (Table 4). Likewise, 66% and 55% of anglers and managers, respectively, agreed that anglers should be more involved in defining and directing scientific research priorities for recreational fisheries, but only 34% of researchers shared this opinion.

When asked about management actions, researchers differed in their opinion from managers and anglers on a number of issues, but there were also areas where respondents shared attitudes (Table 4). For example, 73% researchers, 48% of managers, and 71% anglers were of the opinion that recreational fishing should be limited during the reproductive period for a given species (Table 4). However, while anglers and managers (70% of each group) thought that stocking fish is a valuable tool in recreational fisheries management, a lower fraction of researchers (47%) believed this to be the case. Likewise, a greater proportion of researchers (77%) than anglers and managers (around 30%) indicated disagreement with the idea that "total catch-and-release fisheries are sufficiently benign, therefore, the activity should be allowed even within a no take fishing zone." There was also a nonsignificant tendency for researchers (72%) managers (56%) to agree more than anglers (44%), with the idea that aquatic protected areas are effective management tools in recreational fisheries. All respondents were undecided on whether a fraction of every water body should never be exposed to any recreational fishing activity.

Stakeholder Interactions and the Question of Whether Fish Feel Pain and if that Matters

The different respondent groups exhibited similar opinions on emerging issues related to stakeholder interactions and conflicts among stakeholder groups (Table 5). Each of the respondent groups agreed that there was increasing conflict among different angling interest groups (59% of anglers, 65% of managers, and 70% of researchers, respectively). Likewise, each respondent group believed that conflict between the recreational fishing sector and other fishing sectors is increasing (65%, 61%, and 55% of anglers, managers, and researchers, respectively). Similar numbers of each respondent group also believed that there is a growing anti-fishing movement based on animal rights thinking (65%, 58%, and 67% of anglers, managers, and researchers, respectively, Table 5). Between 35% and 58% of each respondent group believed that fish can feel pain, but differences were not indicative (Table 6). There were also no differences in the opinion of respondents on the issue whether recreational fishing should be banned if it was found that fish could feel pain. All respondent groups (>96%) disagreed with this statement (Table 6). Similarly, all respondent groups (>87%) disagreed with the idea that only catch-and-release angling should be banned if it was found that fish could feel pain.

Research Priorities

When asked about global issues affecting recreational fishing and the associated research needs, respondent groups exhibited similar opinions. More than 80% of each respondent group thought the following research areas are very important or important to address (Table 7): impacts of habitat alteration on recreational fisheries and factors that promote the development of a sustainable fishery. Similarly, more than 50% of each respondent group felt that other important research priorities included understanding the impact of global climate change and its effects on recreational fisheries, analyses of the economic value of the global recreational fisheries, and the factor affecting recreational fishing participation. Research priorities that were perceived of less overall importance included assessing the compatibility of angling with ecotourism, determining how recreational fisheries systems differ cross-culturally, and determining to what extent recreational fisheries develop in economies in transition. Finally, 61% of anglers, 71% of managers, and 59% of researchers did not think that the question of whether fish could feel pain is an important research priority for the future (Table 7).

When respondents were asked about research priorities associated with fisheries management, most areas were considered very important and important research priorities by all

respondent groups (Table 7). Research topics ranged from understanding the role of harvest regulations and other management tools (e.g., protected areas) in recreational fisheries to typical human dimensions issues such as understanding the rule compliance of anglers, the economic importance of recreational fisheries, or, more generally, angler behavior and underlying attitudes (Table 7). In contrast to the broad research priority issues, there were differences in the importance attached to fisheries management-related research areas among respondent groups. In most cases, anglers expressed a greater importance to fisheries management-related research priorities than managers and researchers. For example, notably more anglers (70%) and managers (50%) responded that understanding the effects of harvest regulations was very important, whereas 20% of researchers responded this way (Table 7). Other research priorities perceived more importantly by anglers than by managers and researchers included understanding factors that contribute to a well-managed fishery and various human dimensions issues such as understanding the behavior and attitudes of anglers, rule compliance by anglers, and heterogeneity within anglers.

When respondents were asked about research priorities associated with recreational fishing practices, more than 50% of each of the respondent groups considered understanding the role of all involved environmental factors on the mortality of fish and the impacts of tournaments on fish mortality as either very important or important (Table 7). There were also notable differences in the opinions of respondent groups on a number of research priorities related to recreational fishing practice. In particular, a larger fraction of anglers (83%) and researchers, (97%) compared to managers (62%), thought that understanding the role of environmental factors in fish mortality was very important or important. Similarly, more anglers (54%) and researchers (67%) than managers (38%) thought that understanding how catch-and-release angling influences the spawning behaviors of fish was very important or important.

Discussion

Despite the insights gained by our comparative exploratory analysis about the opinions of various recreational fisheries groups, we want to acknowledge the limitations and risks associated with open online surveys (see Fricker and Schonlau 2002; Beidernikl and Kerschbaumer 2007 for detailed overviews). Firstly, our survey may have been biased by enthusiastic individuals who responded very quickly once our survey was online; thus less avid and engaged anglers might not have had an opportunity to respond because the survey was closed after 5 d (an avidity bias). Second, we could not control the distribution of the survey, so the survey may have been biased by like-minded people sending the link to other like-minded people (as previously noted by Norman and Russell 2006), as well as by people encouraging others to not fill out the survey. Third, though we controlled the number of survey responses per IP address, we could not control people using separate computers or Internet connections to fill out our survey multiple times. Fourth, there was also the potential for misrepresentation because we had no control of proving respondents were from the stakeholder groups they identified themselves as being from. Because we were aware of these risks before we implemented the survey, we chose to limit the time period people had to respond, a common technique in snowball online surveys (Beidernikl and Kerschbaumer 2007). In fact, simply by asking questions about pain and welfare, some presumed that the survey was actually implemented or commissioned by PETA (People for the Ethical Treatment of Animals) or other radical anti-fishing groups. We chose to end the survey immediately once we were made aware of negative rhetoric and threats to limit the potential for abuse of the survey. We assume that biases and abuse was to some degree controlled by this practice.

The responses by anglers we received are very likely biased by the fact that anglers that participated in the survey were extremely avid participants. This bias, inter alia, prevents the survey responses from being extrapolated to the fishing public in North America, as there was no independence in our sample size. Anglers that responded to our survey reported to fish an average of 74 d/year. For comparison, in 2006, 29.9 million Americans spent on, average, 17 d/year participating in recreational fishing (U.S. Fish and Wildlife Service 2007).

Anglers responding to the present survey fish more than the average American angler and may therefore be more knowledgeable about environmental issues (Bryan 1977; Arlinghaus and Mehner 2003a), and they may also have very particular attitudes towards contentious issues of contemporary relevance that differ from less avid and specialized anglers (Oh and Ditton 2006). Moreover, because our survey was administered online, anglers with access to computers, who typically are younger and more educated, are likely to be overrepresented (Zhang 2000). Similarly, we cannot be sure that the opinions of managers and researchers we achieved are representative of these stakeholders. In addition, we grouped Canadian and U.S. stakeholder groups; however, Knuth et al. (1995) noted differences between Canadian and American fisheries managers in their views towards fisheries management issues. This use of a pooled sample lumps the opinions into one category for North America, where in reality differential opinions and region-specific attitudes likely exist. Future research should aim at larger sample sizes and should take a randomly collected approach to be able to contrast American and Canadian researchers, managers, and various angler groups to fully understand the opinions of North American fisheries stakeholders. Nevertheless, our survey yielded important first information as to the potential similarity and differences among managers and researchers and very avid angler groups on topics of contemporary relevance, and we discuss the results of our survey below.

Consensus among the different stakeholders within a sector such as recreational fishing is advantageous because it supports shared goals and objectives and reduces conflict (Arlinghaus 2005, 2007). In our exploratory comparative study focused on North America, we found similar opinions and perspectives by (very avid) recreational anglers, as well as recreational fisheries managers and researchers on a number of issues, such as underlying biocentric value orientations and beliefs, the impact of commercial fishing contributing to fish stock declines, the importance of using and promoting gear that minimizes stress and injury to individual fish, the opinions that fishing should be limited during the reproductive period of fish, the belief that conflicts among stakeholders is growing as is the global anti-fishing movement based on animal rights thinking, and the perspective that even if fish can feel pain, it is of no major relevance for fisheries practice. Although this is a preliminary survey, our results suggest that many recreational anglers, managers, and researchers might have common perceptions of issues facing the recreational fishing industry. In agreement with our study, Connelly et al. (2000) also reported a number of similarities in the attitudes and opinions of anglers and the staff of the New York Bureau of Fisheries, but we also found important differences in the opinions of various stakeholder groups. For example, under the topics of actual and potential consequences of recreational angling and recreational fishing practices, we found that recreational fisheries researchers perceived recreational angling and its practices, such as catch and release, excessive and selective fishing mortality, and pollution, as having a greater potential to negatively affect fish populations, individual fish, and ecosystems compared to recreational fisheries managers and anglers. Indeed, some, clearly not all (Schramm et al. 1999), studies have reported that anglers tend to underrate their impact on fish stocks relative to the opinion of professional experts (Burger et al. 1999; Arlinghaus 2006; Sterl et al. 2008). Perhaps researchers and managers are better informed about the true potential of anglers to contribute to fish stocks declines resulting from overharvest and unwanted catch-and-release mortality due to their higher exposure to scientific literature and own data analysis and experiences. A further reason might include that individual anglers might have a difficulty in perceiving the entire dynamics of complex fisheries systems because it is difficult to discern cause and effect in such nonlinear and highly complex systems. Maybe researchers and managers need to improve efforts in communicating such system dynamics to anglers (Post et al. 2002; Arlinghaus and Mehner 2003a).

In the present study, the notion of catching and releasing a large fraction of fish was well accepted by all stakeholder groups, albeit researchers were somewhat more critical towards this management tool, particularly in no-take marine areas (compare Bartholomew and Bohnsack 2005; Cooke et al. 2006). Interestingly, all stakeholders thought that using and pro-

moting appropriate gear that minimizes stress and injury of angled fish is a good idea. This perspective aligns with recent scientific studies that focus on the well-being, health, and fitness of individual fish as affected through the recreational fishing process (Arlinghaus et al. 2007a, 2007b; Arlinghaus 2008) and are also in agreement with the Code of Practice for Recreational Fisheries (EIFAC 2008).

All respondents in our survey felt negatively about commercial fishing impacts of the global fish stocks, which corresponds with several high profile papers on the downsides of excessive commercial fishing activity (e.g., Pauly et al. 2002; Beddington et al. 2007). However, researchers were more inclined to believe that recreational fishing might result in fishing-induced genetic changes through fishing-induced selection than were managers and anglers. Other more critical perspectives towards the impact of recreational fishing on fish stocks and ecosystems were expressed by researchers compared to managers and anglers. For example, we found that researchers responding to the survey were more concerned with the use of fish stocking to support recreational fish populations than responding anglers and managers. Indeed, stocking seems to be a panacea for recreational fisheries management as perceived by some managers and many anglers (Arlinghaus and Mehner 2003a, 2005). A more critical perspective of researchers towards traditional, but ecologically risky tools of fisheries management and towards the impact of recreational fishing practice for fish stocks and ecosystems makes sense in light of the amount and quality of scientific data that the different stakeholder groups are exposed to, particularly for such novel and hotly debated topics such as fishing-induced evolution (Jørgensen et al. 2007, 2008). While this might explain why the different sectors differently perceived the impact of angling on fish stocks, we want to stress that some of the anglers we surveyed were likely rather familiar with a wide range of scientific topics as the responding anglers belonged to the most avid anglers within the angler populations of North America (as indicated by the high fishing days reported), and these more avid and emotionally attached anglers are probably well informed about a number of scientifically discussed topics (Bryan 1977; Hahn 1991; Allen and Miranda 1996; Arlinghaus and Mehner 2003b; Arlinghaus 2007). Presumably, our exploratory findings indicate that anglers and researchers indeed differ in their perceptions ascribed to the impact of recreational fishing on stocks and ecosystems.

A topic where anglers, managers, and researchers shared opinion was the issue of whether fish feel pain and if that matters for fisheries practice. We found that there was no "majority vote" among the anglers, managers, and researchers regarding this issue. We were not surprised that there was no consensus on this issue, as lately it has been a widely debated topic by fish biologists and no agreement has been reached so far (Rose 2002, 2003; Huntingford et al. 2006; Arlinghaus et al. 2007a, 2007b; Newby and Stevens 2008). However, each respondent group thought that neither recreational angling nor catch-and-release fishing should be banned if it would be found with certainty that fish can feel pain and suffer. Thus, respondents agreed that whether fish feel pain is largely irrelevant in its consequences for fisheries management and fisheries practice. This does not mean that the stakeholder groups are not concerned with the impacts of recreational fishing on individual fish, and indeed, as previously discussed, most agreed to improve gear choices to reduce negative impacts, for example. What this result instead shows is that the level of protection offered to the welfare of individual fish is independent of the question of sentience in the world of fish. In other words, recreational fisheries stakeholder groups do not follow animal liberation philosophy in terms of attaching morally relevant criteria to the fish-feel-pain issue (compare Arlinghaus et al. 2009). This perspective lends towards a pragmatic solution to the fish welfare issue, which is different from the legal situation in Germany and Switzerland (Arlinghaus 2007; Arlinghaus et al., in press).

We noted differences among anglers, managers, and researchers in terms of the need and quality of angler involvement in fisheries management. Responding anglers generally believed to a greater extent relative to responding managers and researchers that their involvement in fisheries management decisions is inappropriate. This lack of involvement in fisheries management decisions suggest that

managers and researchers may do a less than ideal job in either communicating with anglers about the needs, rationale, and directions of fishing regulations or, generally, the participatory approaches of management agencies to solicit angler input prior to making decisions are perceived inappropriate by more avid anglers. Similarly, responding anglers attached greater importance to almost all human dimensions research topics, such as angler behavior and angler attitudes, when asked about future research priorities compared to managers and anglers. Traditionally North American fisheries management training lacks human dimensions training on recreational fisheries (Fulton and Adelman 2003), which might explain these findings. All stakeholders, however, attached similar importance to many biological research topics associated with recreational fisheries.

Our study is exploratory in nature by providing first insights into the similarity of viewpoints shared by various responding fisheries stakeholders and areas where values and perspectives differ. We do not claim to present a representative sample of North America or of the sector, but rather use our approach to highlight areas that need further and more sophisticated and controlled study. We also explicitly recognize the limitations of using an open Web-based survey tool for addressing polarizing issues in resource management, such as some of the topics covered in this paper. Still needed are inexpensive tools for surveying large components of widely distributed populations (e.g., across countries), especially when it is difficult to identify and contact respondents. Despite all these limitations, our survey results suggest that responding stakeholders share opinions on a number of issues. However, the disagreement of opinion on other issues suggests that there are opportunities for improved communication and for better partnering among stakeholder groups to develop and refine policy and management strategies and work for common goals. Clearly, there is a need for further research to understand the psychological determinants of the divergent opinion and how these divergent opinions are associated with actual or perceived stakeholder conflicts, acceptance of novel research findings by managers and anglers, and development and justification of fisheries management policies by managers, as well as the acceptance of these policies and regulations by anglers.

Acknowledgments

The authors thank Kyle Hanson for important discussions throughout the preparation of the survey and the writing of the manuscript, and two anonymous reviewers for constructive help. This project was part of a graduate course on fisheries management at the Ottawa Carleton Institute of Biology. The survey was approved by the Carleton University Board of Ethics. Funding was provided by the Adaptfish project within the Pact for Innovation and Research to RA (www.adaptfish.igb-berlin.de).

References

Adams, W. M., D. Brockington, J. Dyson, and B. Vira. 2003. Managing tragedies: understanding conflict over common pool resources. Science 302:1915–1916.

Allen, M. S., and L. E. Miranda. 1996. A qualitative evaluation of specialization among crappie anglers. Pages 145–151 *in* L. E. Miranda and D. R. DeVries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society, Symposium 16, Bethesda, Maryland.

Arlinghaus, R. 2005. A conceptual framework to identify and understand conflicts in recreational fisheries systems, with implications for sustainable management. Aquatic Resources, Culture and Development 1:145–174.

Arlinghaus, R. 2006. Overcoming human obstacles to conservation of recreational fishery resources, with emphasis on central Europe. Environmental Conservation 33:46–59.

Arlinghaus, R. 2007. Voluntary catch-and-release can generate conflict within the recreational angling community: a qualitative case study of specialised carp (*Cyprinus carpio* L.) angling in Germany. Fisheries Management and Ecology 14:161–171.

Arlinghaus, R. 2008. The challenge of ethical angling: the case of C&R and its relation to fish welfare. Pages 223–233 *in* Ø. Aas, R. Arlinghaus, R. B. Ditton, D. Policansky, and H. L. Schramm, Jr., editors. Global challenges in recreational fisheries. Blackwell Scientific Publications, Oxford, UK.

Arlinghaus, R., and T. Mehner. 2003a. Management preferences of urban anglers: habitat rehabilitation measures versus other options. Fisheries 28(6):10–17.

Arlinghaus, R., and T. Mehner. 2003b. Socio-economic characterisation of specialised common carp (*Cyprinus carpio* L.) anglers in Germany, and implications for inland fisheries management and eutrophication control. Fisheries Research 61:19–33.

Arlinghaus, R., and T. Mehner. 2005. Determinants of management preferences of recreational anglers in Germany: habitat management versus fish stocking. Limnologica 35:2–17.

Arlinghaus, R., S. J. Cooke, J. Lyman, D. Policansky, A. Schwab, C. D. Suski, S. G. Sutton, and E. B. Thorstad. 2007a. Understanding the complexity of catch-and-release in recreational fishing: an integrative synthesis of global knowledge from historical, ethical, social, and biological perspectives. Reviews in Fisheries Science 15:75–167.

Arlinghaus, R., S. J. Cooke, A. Schwab, and I. G. Cowx. 2007b. Fish welfare: a challenge to the feelings based approach, with implications for recreational fishing. Fish and Fisheries 8:57–71.

Arlinghaus, R., T. Klefoth, A. J. Gingerich, M. R. Donaldson, K. C. Hanson, and S. J. Cooke. 2008. The behaviour and survival of pike (*Esox lucius* L.) with a retained lure in the lower jaw. Fisheries Management and Ecology 15:459–466.

Arlinghaus, R., T. Mehner, and I. G. Cowx. 2002. Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europe. Fish and Fisheries 3:261–316.

Arlinghaus, R., A. Schwab, S. J. Cooke, and I. G. Cowx. 2009. Contrasting pragmatic and suffering-centred approaches to fish welfare in recreational angling. Journal of Fish Biology 75:2448–2463.

Bartholomew, A., and J. A. Bohnsack. 2005. A review of catch-and-release angling mortality with implications for no-take reserves. Reviews in Fish Biology and Fisheries 15:129–154.

Beddington, J. R., D. J. Agnew, and C. W. Clark. 2007. Current problems in the management of marine fisheries. Science 316:1713–1716.

Beidernikl, G., and A. Kerschbaumer. 2007. Sampling in online surveys. Pages 90–96 *in* R. A. Reynolds, R. Woods, and J. D. Baker, editors. Handbook of research on electronic surveys and measurements. Idea Group, Hershey, Pennsylvania.

Bowen, A. M., C. M. Daniel, M. L. Williams, and G. L. Baird. 2008. Identifying multiple submissions in Internet research: preserving data integrity. AIDS Behavior 12:964–973.

Bryan, H. 1977. Leisure value systems and recreational specialization: the case of trout fishermen. Journal of Leisure Research 33:344–347.

Buckles, D. 1999. Cultivating peace: conflict and collaboration in natural resource management. International Development Research Centre/The World Bank, Ottawa, Ontario.

Burger, J., J. Sanchez, M. McMahon, J. Leonard, C. G., Lord, R. Ramos, and M. Gochfeld. 1999. Resources and estuarine health: perceptions of elected officials and recreational fishers. Journal of Toxicology and Environmental Health Part A 58:245–260.

Cambray, J. A. 2003. Impact on indigenous species biodiversity caused by globalisation of alien recreational freshwater fisheries. Hydrobiologia 500:217–230.

Connelly, N. A., T. L. Brown, and B. A. Knuth. 2000. Do anglers and fishery professionals think alike? Fisheries 25(2):21–25.

Cooke, S. J., and I. G. Cowx. 2006. Contrasting recreational and commercial fishing: searching for common issues to promote unified conservation of fisheries resources and aquatic environments. Biological Conservation 128:93–108.

Cooke, S. J., and W. J. Hogle. 2000. The effects of retention gear on the injury and short-term mortality of smallmouth bass. North American Journal of Fisheries Management 20:1033–1039.

Cooke, S. J., and C. D. Suski. 2005. Do we need species-specific guidelines for catch-and-release recreational angling to conserve diverse fishery resources? Biodiversity and Conservation 14:1195–1209.

Cooke, S. J., A. D. Danylchuk, S. A. Danylchuk, C. D. Suski, and T. L. Goldberg. 2006. Is catch-and-release recreational fishing compatible with no-take marine protected areas? Ocean and Coastal Management 49:342–352.

Cooke, S. J., K. Dunmall, J. F. Schreer, and D. P. Philipp. 2001. The influence of terminal tackle on physical injury, handling time and cardiac disturbance of rock bass. North American Journal of Fisheries Management 21:333–342.

Dunlap, R. E., K. D. Van Liere, A.G. Mertig, and R. E. Jones. 2000. Measuring endorsement of the new ecological paradigm: a revised NEP scale. Journal of Social Issues 56:425–442.

EIFAC (European Inland Fisheries Advisory Commission). 2008. EIFAC code of practice for recreational fisheries. EIFAC Occasional Paper 42.

Fricker, R. D., and M. Schonlau. 2002. Advantages and disadvantages of Internet research surveys: evidence from the literature. Field Methods 14:347–367.

Fulton, D. C., and I. R. Adelman. 2003. Social science (the human dimension) in fisheries. Fisheries 28(11):4.

Hahn, J. 1991. Angler specialization: measurement of a key sociological concept and implications for fisheries management decisions. Pages 380–389 *in* D. Guthrie, J. M. Hoenig, M. Holliday, C. M. Jones, M. J. Mills, S. A. Moberly, K. H. Pollock, and D. R. Talhelm, editors. Creel and angler surveys in fisheries management. American Fisheries Society, Symposium 12, Bethesda, Maryland.

Helvey, M. 2004. Seeking consensus on designing marine protected areas: keeping the fishing community engaged. Coastal Management 32:173–190.

Huntingford, F. A., C. Adams, V.A. Braithwaite, S. Kadri, T. G. Pottinger, P. Sandøe, and J. F. Turnbull. 2006. Current issues in fish welfare. Journal of Fish Biology 68:332–372.

Hutchings, J. A., C. Walters, and R. L. Haedrich. 1997. Is scientific inquiry incompatible with government information control? Canadian Journal of Fisheries & Aquatic Sciences 54:1198–1210.

Jørgensen, C., K. Enberg, E. Dunlop, R. Arlinghaus, D.S. Boukal, K. Brander, B. Ernande, A., Gårdmark, F. Johnston, S. Matsumura, H. Pardoe, K. Raab, A. Silva, A. Vainikka, U. Dieckmann, M. Heino, and A. D. Rijnsdorp. 2007. Managing evolving fish stocks. Science 318:1247–1248.

Jørgensen, C., K. Enberg, E. Dunlop, R. Arlinghaus, D. S. Boukal, K. Brander, B. Ernande, A., Gårdmark, F. Johnston, S. Matsumura, H. Pardoe, K. Raab, A. Silva, A. Vainikka, U. Dieckmann, M. Heino, and A. D. Rijnsdorp. 2008. The role of fisheries-induced evolution—response. Science 320:48–50.

Kearney, R. E. 2001. Fisheries property rights and recreational/commercial conflict: implications of policy developments in Australia and New Zealand. Marine Policy 25:49–59.

Kearney, R. E. 2002. Co-management: the resolution of conflict between commercial and recreational fishers in Victoria, Australia Ocean and Coastal Management 45:201–14.

Kelly, A., and S. Kelly. 2004. Fishing tackle injury and blood lead levels in mute swans. Waterbirds 27:60–68.

Knuth, B.A., S. Lerner, N.A. Connelly, and L. Gigliotti. 1995. Fishery and environmental managers' attitudes about and support for lake trout rehabilitation in the Great Lakes. Journal of Great Lakes Research 21(Supplement 1):185–197.

Krueger, C. C., and D. J. Decker. 1999. The process of fisheries management. Pages 31–59 *in* C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America, 2nd edition, American Fisheries Society, Bethesda, Maryland.

Lewin, W. C., R. Arlinghaus, and T. Mehner. 2006. Documented and potential biological impacts of recreational fishing: insights for management and conservation. Reviews in Fisheries Science 14:305–367.

Lewin, W.C., D. McPhee, and R. Arlinghaus. 2008. Biological impacts of recreational fishing resulting from exploitation, stocking and introduction. Pages 75–92 *in* Ø. Aas, R. Arlinghaus, R. B. Ditton, D. Policansky, and H. L. Schramm, Jr., editors. Global challenges in recreational fisheries. Blackwell Scientific Publications, Oxford, UK.

Maitland, P. S. 1995. Ecological impact of angling. Pages 443–452 *in* D. M. Harper, and A. D. J. Ferguson, editors. The ecological basis for river management. Wiley, Chichester, UK.

Meester, G. A., A. Mehrotra, J. S. Ault, and E. K. Baker. 2004. Designing marine reserves for fishery management. Management Science 50:1031–1043.

Miranda, L. E., and W. Frese. 1991. Can fishery scientists predict angler preferences? Pages 375–379 *in* C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America, 2nd edition, American Fisheries Society, Bethesda, Maryland..

Newby, N. C., and E. D. Stevens. 2008. The effects of the acetic acid "pain" test on feeding, swimming, and respiratory responses of rainbow trout (*Oncorhynchus mykiss*). Applied Animal Behaviour Science 114:260–269.

Norman, A. T., and C. A. Russell. 2006. The pass-along effect: investigating word-of-mouth effects on online survey procedures. Journal of Computer-Mediated Communication 11:1085–1103.

Oh, C., and R. B. Ditton. 2006. Using recreation spe-

cialization to understand multi-attribute management preferences. Leisure Science 28:369–384.

Pauly, D., V. Christensen, S. Guenette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson, and D. Zeller. 2002. Towards sustainability in world fisheries. Nature (London) 418:689–695.

Plummer, R., and J. Fitzgibbon. 2004. Co-management of natural resources: a proposed framework. Environmental Management 33:876–885.

Pollock, K. M., C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society, Special Publication 25, Bethesda, Maryland.

Post, J. R., M. Sullivan, S. Cox, N. P. Lester, C. Walters, E. A. Parkinson, A. J. Paul, L. Jackson, and B. J. Shuter. 2002. Canada's recreational fisheries: the invisible collapse? Fisheries 27(1):6–17.

Radomski, P., T. Heinrich, T. S. Jones, P. Rivers, and P. Talmage. 2006. Estimates of tackle loss for five Minnesota walleye fisheries. North American Journal of Fisheries Management 26:206–212.

Rose, J. D. 2002. The neurobehavioural nature of fishes and the question of awareness and pain. Reviews in Fisheries Science 10:1–38.

Rose, J. D. 2003. A critique of the paper: "Do fish have nociceptors: evidence for the evolution of a vertebrate sensory system" published in Proceedings of the Royal Society B 270:1115–1121, 2003 by Sneddon, Braithwaite and Gentle. Pages 49–51 *in* H. E. Erickson, editor. Information resources on fish welfare 1970–2003. U.S. Department of Agriculture, Beltsville, Maryland.

Schramm, Jr., H.L., J. T. Forbes, D. A. Gill, and W. D. Hubbard. 1999. Fishing environment preferences and attitudes toward overharvest: are catfish anglers unique? Pages 417–425 *in* E. R. Irwin, W. A. Hubert, C. F. Rabeni, H. L. Schramm, Jr., and T. Coon, editors. Catfish 2000: proceedings of the international ictalurid symposium. American Fisheries Society, Symposium 24, Bethesda, Maryland.

Smith, C. L., J. D. Gilden, J.S. Cone, and B. S. Steel. 1997. Contrasting views of coastal residents and coastal coho restoration planners. Fisheries 22(12):8–15.

Sneddon, L. U., V. A. Braithwaite, and M. J. Gentle. 2003. Do fishes have nociceptors? Evidence for the evolution of a vertebrate sensory system. Proceedings of the Royal Society of London B 270:1115–1121.

Sterl, P., C. Brandenburg, and A. Arnberger. 2008. Vistors' awareness and assessment of recreational disturbance of wildlife in the Donau-Auen National Park. Journal of Nature Conservation 16:135–145.

Sullivan, M. 2002. Illegal sport harvest of walleye protected by size limits in Alberta. North American Journal of Fisheries Management 22:1053–1063.

U.S. Fish and Wildlife Service. 2007. 2006 National survey of fishing, hunting, and wildlife-associated recreation: national overview. U.S. Department of the Interior and U.S. Department of Commerce, Washington, D.C.

Wilde, G. R., R. B. Ditton, S. R. Grimes, and R. K. Riechers. 1996. Status of human dimensions surveys sponsored by state and provincial fisheries management agencies in North America. Fisheries 21(11):12–17.

Wilson, D.G., J. Raakjaer Nielsen, and P. Degnbol, editors. 2003. The fisheries co-management experience: accomplishments, challenges and prospects. Kluwer Press, Dordrecht, Netherlands.

Zhang, Y. 2000. Using the internet for survey research: a case study. Journal of the American Society for Information Science 51:57–68.