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Perceived Crowding among Hunters and Anglers: A Meta-Analysis

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This article examines perceived crowding using 95 hunter and 30 angler evaluation contexts obtained from 28 hunter and 12 angler studies. Each study used the 9-point scale developed by Heberlein and Vaske (1977). Data were obtained from journal articles, dissertations, theses, government reports, and proceedings published from 1975 to 2005. A snowball approach was used to obtain unpublished datasets. Comparative analysis arrays and traditional meta-analysis were used to describe the findings. The comparative analysis provided a tool for contrasting the consequences of changing use conditions or managerial actions, and allowed for comparisons between similar areas. Across all evaluation contexts, crowding scores ranged from 0% to 100% with meta-analytic means of 51% for hunters and 57% for anglers. These meta-analyses encourage practical approaches to exploring and understanding hunter and angler perceptions of crowding.

Keywords perceived crowding, comparative analysis, meta-analysis, hunters, anglers

Fisheries and wildlife managers are interested in providing anglers and hunters with "high quality" experiences. Human dimensions researchers have empirically examined a range of quality indicators. Three decades ago, for example, Hendee (1974) proposed the notion of a multiple satisfaction approach to game management, and subsequent researchers have explored the dimensions underlying the concept (Fulton & Manfredo, 2004; Gigliotti, 2000; Heberlein, Trent, & Baumgartner, 1982; Vaske, Fedler, & Graefe, 1986). Some investigators have considered hunters' (Fulton et al., 1995) and anglers' (Martinson & Shelby, 1992) normative tolerances for encounters with other recreationists in a variety of contexts (e.g., remote wilderness, urban settings) and for a variety of species (e.g., elk, deer, salmon). Others have addressed issues related to interpersonal and social values conflict between hunters and other stakeholders (Morgan, Newman, & Wallace, 2007; Schuster, Hammitt, Moore, & Schneider, 2006; Vaske, Donnelly, Wittmann, & Laidlaw, 1995).

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One of the most studied indicators of a quality experience is perceived crowding. Crowding is defined as a negative evaluation of density and involves a value judgment that the density or number of encounters with other visitors is too many (Altman, 1975; Desor, 1972; Schmidt & Keating, 1979; Stokols, 1972). The term *perceived crowding* is often used to emphasize the subjective or evaluative nature of the concept. Perceived crowding is a psychological dimension that exists in the minds of individuals and is usually measured by self-report techniques. Heberlein and Vaske (1977), for example, developed a simple measure of perceived crowding that asks people to indicate how crowded the area was at the time of their visit. Responses are given on the following scale:

1	2	3	4	5	6	7	8	9
Not at all Crowded		Slightly Crowded			Moderately Crowded		Extremely Crowded	

A response of 1 or 2 indicates *not at all crowded*, 3–4 indicates *slightly crowded*, 5–7 indicates *moderately crowded*, and 8–9 indicates *extremely crowded*. The single-item crowding measure is easy to fill out, interpret, and compare across studies, and has been widely used in outdoor recreation research (Shelby, Vaske, & Heberlein, 1989). To date, the measure has been used in at least 181 different studies, including 615 evaluation contexts (Vaske & Shelby, in press). Evaluation contexts may refer to (a) specific locations where recreationists evaluate crowding (e.g., at the mouth of a river vs. upstream), (b) time (e.g., year of study, opening day vs. rest of the season), or (c) users evaluating other types of recreationists (e.g., anglers evaluations of kayakers). Over the past 30 years, approximately 85,000 individuals have responded to the 9-point perceived crowding scale (Vaske & Shelby, in press).

To better understand crowding, researchers have expanded their investigations from single activity/resource descriptive studies to comparative analyses of data aggregated across a variety of activities and resources (Shelby, Heberlein, Vaske, & Alfano, 1983; Shelby et al., 1989; Vaske & Donnelly, 2002). By contrasting identical measures of the same concept across a number of activities, resources, and visitor characteristics, aggregated data sets can reveal patterns in the findings and identify factors that typically cannot be manipulated in a single study (e.g., the relationship of multiple activities and settings on crowding). Given the number of studies and evaluation contexts that have used the 9-point crowding measure (see, for example, Shelby, 2006), the opportunity exists for contrasting crowding results from specific activities and resources. This article describes hunter and angler crowding perceptions using comparative analyses and formal meta-analyses.

Methods

The data for this article were obtained from secondary analysis of journal articles, dissertations, theses, government reports, and proceedings published between 1975 and 2005. Data were also obtained using a snowball approach where all known researchers, who had measured perceived crowding in natural resource applications were contacted. These individuals were asked to provide information on other investigators conducting similar research. Unpublished and published datasets were obtained using this method.

Overall, 28 hunting and 12 angling studies were identified, representing 95 hunter and 30 angler evaluation contexts, respectively. Some evaluation contexts referred to specific locations where anglers or hunters evaluated crowding. For example, salmon anglers on the Kenai River were asked to evaluate crowding on the upper bank, middle bank, and lower

bank of the river. Evaluation contexts also represented time (year of study, low use vs. high use days, opening day vs. rest of season), or users evaluating other types of users (e.g., anglers evaluating rafters). These evaluation contexts constituted the basic unit of analysis.

For each evaluation context, perceived crowding is reported by collapsing the scale into a dichotomous variable (*not at all crowded* vs. any degree of crowding). This provided a conceptually meaningful break point between those who labeled the situation as *not at all crowded* (scale points 1 and 2, a positive evaluation), and those who labeled the situation as *slightly, moderately*, or *extremely crowded* (scale points 3 through 9, a negative evaluation). Vaske and Shelby (in press) and Shelby (2006) examined 615 evaluation contexts and found no empirical differences between the alternative reporting methods (scale points 1 and 2 vs. 3 through 9, scale points 1 through 4 vs. 5 through 9, mean, median, mode). In their analyses, the correlations between these alternative reporting methods were greater than .9. Based on these findings, the researchers recommended using the summary statistic that is most appropriate for the situation. For this study, the most frequently used reporting method was chosen to minimize missing data (*not at all crowded* vs. any degree of crowding).

Table 1 details the location, date, population studied, sample size, response rate, and survey mode utilized in the angler studies. Angler crowding studies using the 9-point scale have been conducted in Alaska, Arizona, California, Colorado, Maryland, Wisconsin, and New Zealand. Specific angler types have included salmon anglers, drift boat anglers, and trout anglers. All angler studies used on-site interviews. Of the 12 angler studies, 9 reported response rates in excess of 80%. In total, 2,321 anglers have completed the 9-point crowding scale since 1975.

Table 2 provides study level information for the 28 hunter studies. Hunter perceptions of crowding have been studied in Colorado, Maryland, Massachusetts, Utah, and Wisconsin for various species (deer, pheasant, goose, turkey), and methods of take (rifle, bow, muzzleloading). Some used mailed surveys, and others used on-site interviews.[1] Of the 18 hunter studies that reported response rate information, 13 reported response rates greater than 70%. In total, 10,723 hunters have completed the 9-point crowding scale since 1977.

Results

This study employed two meta-analytic strategies. First, a comparative analysis arrayed the evaluation contexts from 100% to 0% crowded (see Shelby et al., 1989; Vaske & Shelby, in press for more information). Separate arrays were created for hunters and anglers. The arrays facilitated a descriptive understanding of the data. Second, a formal meta-analysis was used to calculate the means, confidence intervals, and tests for homogeneity of variance for the hunters and anglers.

Comparative Analysis

Across all angler evaluation contexts, crowding ranged from 18% to 100% (Table 3). Crowding in the hunter contexts ranged from 0% to 91% (Table 4). Arraying study and evaluation context information allows managers to (a) compare findings against similar areas, and (b) compare possible consequences of changing use conditions or management actions. For example, trout anglers on Maryland's Gun Powder River on opening day were more crowded than anglers late in the season when the number of anglers had declined (76% compared to 23%). Similar findings were observed for fishing during the November opening period compared to fishing later in the season on the Colorado River

Table 1
Description of studies conducted on anglers

State or country	Study site	Date	Population studied	Citation	Study sample size	Response rate (%)	Survey mode
Alaska	Kenai River	1993	Driftboat Anglers	Alaska Division of Parks & Recreation (1993)	1530	95	On-site
			Salmon Anglers				
	Willow Creek	1991	Salmon Anglers	Alaska Division of Parks & Recreation (1991)	96	85	On-site
Arizona	Colorado River—Glen Canyon Nat'l Rec. Area	1984	Anglers	HBRS (1985)	211	83	On-site
California	Klamath River	1984	Salmon Anglers	Shelby & Stein (1984)	50	43	On-site
	Lake Sonoma	2000	Anglers	Carroll (2001)	157	89	On-site
Colorado	Cache la Poudre River	1993	Anglers	Vaske (1993)	89	95	On-site
	Colorado Reservoirs	1998	Anglers	Donnelly & Vaske (1998)	312	94	On-site
Maryland	Gun Powder River	1984	Trout Anglers	McGurrin (1984)	162	97	On-site
	Savage River	1980	Trout Anglers	Vaske & Donnelly (1980)	203	89	On-site
New Zealand	Rakaia River	1983	Salmon Anglers	Shelby (1983)	119	40	On-site
	Waimakariri River	1985	Salmon Anglers	Shelby (1983)	138	30	On-site
Wisconsin	Brule River	1975	Anglers	Heberlein & Vaske (1977)	2965	95	On-site

Table 2
Description of studies conducted on hunters

State or country	Study site	Date	Population studied	Citation	Study sample size	Response rate (%)	Survey mode
Colorado	Mt. Evans	1994	Deer Hunter	Vaske, Donnelly, Wittmann, & Laidlaw (1995)	986	96	On-site
Maryland	Fishing Bay	1986	Goose Hunters	Vaske, Fedler, & Graefe (1986)	230	95	On-site
	State Wide—Maryland	1977	Turkey Hunters	Donnelly & Vaske (1981)	452	93	Mailed
		1984	Deer Hunter—Rifle	Vaske, Graefe, & Caldwell (1984)	998	72	Mailed
		1984	Deer Hunter—Bow				
		1984	Deer Hunter—Muzzle Loader				
	Tuckahoe State Park	1984	Goose Hunters	Vaske et al. (1984)	62	98	On-site
Massachusetts	Cape Cod	2004	Hunters—Field sample	Kuentzel (2005)	408	94	On-site
		2005	Hunters—Volunteer sample			63	Mailed
		2005	Hunters—License holders in Barnshaft County			52	
Utah	Grand Staircase—Escalante Nat'l Monument	1999	Hunters	Palmer, Lael, & Brunson (2000)	163	67	Mailed
Wisconsin	Bong Wildlife Mgmt. Unit	1979	Pheasant Hunters	Heberlein et al. (1980)	924	80	On-site
		1981	Pheasant Hunters	Heberlein (1981)	743	44	On-site

(*Continued*)

Table 2
(*Continued*)

State or country	Study site	Date	Population studied	Citation	Study sample size	Response rate (%)	Survey mode
	Grand River Marsh	1978	Firing Line Hunters	Kuentzel & Heberlein (1998)	448	75	On-site
		1978	Managed Hunt		935	100	On-site
	Horicon Marsh	1982	Firing Line Goose Hunters	Kuentzel & Heberlein (1992)	445	75	On-site
		1982	Managed Hunt Goose Hunters		913	100	On-site
	Public Hunting Area	1980	Pheasant Hunters	Heberlein et al. (1980)	194	93	On-site
	Sandhill Wildlife Mgmt. Unit	1979	Deer Hunters	Heberlein & Kuentzel (2002)	285		On-site
		1980	Deer Hunters		349		On-site
		1981	Deer Hunters		212		On-site
		1982	Deer Hunters		325		On-site
		1983	Deer Hunters		142		On-site
		1984	Deer Hunters		308		On-site
		1985	Deer Hunters		122		On-site
		1986	Deer Hunters		119		On-site
		1987	Deer Hunters		372		On-site
		1988	Deer Hunters		249		On-site
		1989	Deer Hunters		261		On-site
	State Wide Wisconsin	1977	Deer Hunters	Heberlein & Laybourne (1978)	235	83	Mailed
		1982	Deer Hunters		235		Mailed
			Goose Hunters	Kuentzel & Heberlein (1982)	254	50	Mailed

Table 3
Ranking of perceived crowding for anglers with different evaluation contexts

Study site	State or country	Date	Evaluation context			Perceived crowding (%)
			Evaluation by	Evaluation for	*n*	
Kenai River	Alaska	1993	Salmon Anglers	Upper Bank Anglers—High Use Days	41	100
Colorado River—Glen Canyon Nat'l Rec. Area	Arizona	1984	Anglers	Thanksgiving Week		94
Kenai River	Alaska	1993	Salmon Anglers	Upper Bank Anglers—Low Use Days	201	85
Kenai River	Alaska	1993	Driftboat Anglers	Upper River Driftboat Anglers—High Use Days	14	85
Kenai River	Alaska	1993	Salmon Anglers	Lower Bank Anglers—High Use Days	26	82
Willow Creek	Alaska	1991	Salmon Anglers	Other Salmon Anglers	96	79
Kenai River	Alaska	1993	Driftboat Anglers	Lower River Driftboat Anglers—High Use Days	9	77
Gun Powder River	Maryland	1984	Trout Anglers	Opening Day		76
Waimakariri River	New Zealand	1985	Salmon Anglers	Other Salmon Anglers	138	75
Kenai River	Alaska	1993	Driftboat Anglers	Upper River Driftboat Anglers—Low Use Days	65	74
Rakaia River	New Zealand	1983	Salmon Anglers	At River Mouth	68	74
Klamath River	California	1984	Salmon Anglers	Fall Season Salmon Anglers	50	70
Kenai River	Alaska	1993	Salmon Anglers	Lower Bank Anglers—Low Use Days	350	69
Kenai River	Alaska	1993	Driftboat Anglers	Middle River Driftboat Anglers—High Use Days	10	67
Kenai River	Alaska	1993	Salmon Anglers	Middle Bank Anglers—High Use Days	36	63

(*Continued*)

Table 3
(*Continued*)

Study site	State or country	Date	Evaluation context		*n*	Perceived crowding (%)
			Evaluation by	Evaluation for		
Kenai River	Alaska	1993	Salmon Anglers	Middle Bank Anglers—Low Use Days	130	63
Kenai River	Alaska	1993	Driftboat Anglers	Middle River Driftboat Anglers—Low Use Days	12	54
Brule River	Wisconsin	1975	Anglers		170	52
Lake Sonoma	California	2000	Fishing—Boaters	All Users	30	47
Rakaia River	New Zealand	1983	Salmon Anglers	Upstream	67	45
Cache la Poudre River	Colorado	1993	Anglers	Other Anglers	87	40
Colorado Reservoirs	Colorado	1998	Anglers	North Catamount Reservoir	161	39
Kenai River	Alaska	1993	Driftboat Anglers	Lower River Driftboat Anglers—Low Use Days	26	39
Colorado Reservoirs	Colorado	1998	Anglers	South Catamount Reservoir	139	35
Cache la Poudre River	Colorado	1993	Anglers	Rafters	86	34
Colorado River - Glen Canyon Nat'l Rec. Area	Arizona	1984	Anglers	Midweek		32
Cache la Poudre River	Colorado	1993	Anglers	Kayakers	83	29
Savage River	Maryland	1980	Trout Anglers	Lower Use Period	203	25
Gun Powder River	Maryland	1984	Trout Anglers	Late Season		23
Colorado Reservoirs	Colorado	1998	Anglers	Crystall Reservoir	76	18

Table 4
Ranking of perceived crowding for hunters with different evaluation contexts

Study site	State or country	Date	Evaluation context		*n*	Perceived crowding (%)
			Evaluation by	Evaluation for		
Sandhill Wildlife Management Unit	Wisconsin	1986	Deer Hunters—Trophy buck hunt (Either sex) SE	Other Deer Hunters—Low Density Hunt	33	91
Bong Wildlife Management Unit	Wisconsin	1979	Pheasant Hunters	Opening Day	755	89
Horicon Marsh—Firing Line	Wisconsin	1982	Goose Hunters	Firing Line	445	86
Public Hunting Area	Wisconsin	1980	Pheasant Hunters	Opening Day	194	85
Grand River Marsh—Firing Line	Wisconsin	1978	Firing Line	Other Goose Hunters	448	79
Bong Wildlife Management Unit	Wisconsin	1981	Pheasant Hunter	Opening Day	418	75
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Doe hunt (Anterless) NW	Other Deer Hunters—High Density Hunt	84	74
Mt Evans	Colorado	1994	Deer Hunter	Other Deer Hunters	389	72
State Wide—Maryland	Maryland	1984	Deer Hunter—Muzzle loader	No Specific Resource	6	70
Bong Wildlife Management Unit	Wisconsin	1981	Pheasant Hunters	Rest of Season	325	68
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 2 NW	Other Deer Hunters—High Density Hunt	69	68
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 2 NE	Other Deer Hunters—High Density Hunt	65	68
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 1 SE	Other Deer Hunters—High Density Hunt	75	67
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 1 NW	Other Deer Hunters—High Density Hunt	82	67

(*Continued*)

Table 4
(*Continued*)

Study site	State or country	Date	Evaluation context		*n*	Perceived crowding (%)
			Evaluation by	Evaluation for		
Sandhill Wildlife Management Unit	Wisconsin	1983	Deer Hunters—Trophy buck hunt (Either sex) NW	Other Deer Hunters—High Density Hunt	81	62
Fishing Bay	Maryland	1986	Goose Hunters	Firing Line	30	61
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Doe hunt (Anterless) NE	Other Deer Hunters—Low Density Hunt	33	61
State Wide-Maryland	Maryland	1984	Deer Hunter—Bow Hunters	No Specific Resource	62	60
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 2 NW	Other Deer Hunters—High Density Hunt	81	59
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 2 SE	Other Deer Hunters—High Density Hunt	73	58
State Wide—Maryland	Maryland	1984	Deer Hunters—Rifle Hunters	No Specific Resource	927	54
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 1 NW	Other Deer Hunters—High Density Hunt	77	53
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Trophy buck hunt (Either sex) SE	Other Deer Hunters—High Density Hunt	85	52
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Doe hunt (Anterless) NE	Other Deer Hunters—High Density Hunt	48	52
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 2 SE	Other Deer Hunters—High Density Hunt	91	50
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 2 SE	Other Deer Hunters—High Density Hunt	82	49
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 2 SW	Other Deer Hunters—High Density Hunt	49	49

Bong Wildlife Management Unit	Wisconsin	1979	Pheasant Hunters	Rest of Season	169	48
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 1 SW	Other Deer Hunters—Low Density Hunt	27	48
State Wide—Wisconsin	Wisconsin	1977	Deer Hunters	No Specific Resource	235	46
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Trophy buck hunt (Either sex) NE	Other Deer Hunters—Low Density Hunt	27	44
State Wide—Maryland	Maryland	1977	Turkey Hunters	No Specific Resource	452	44
Cape Cod	Massachusetts	2005	Hunters—License holders in Barnshaft County	Other hunters	223	42
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Trophy buck hunt (Either sex) SW	Other Deer Hunters—Low Density Hunt	24	42
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Trophy buck hunt (Either sex) NE	Other Deer Hunters—Low Density Hunt	29	41
State Wide—Wisconsin	Wisconsin	1982	Deer Hunters	Other Deer Hunters	235	41
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Trophy buck hunt (Either sex) SE	Other Deer Hunters—Low Density Hunt	30	40
Sandhill Wildlife Management Unit	Wisconsin	1985	Deer Hunters—Trophy buck hunt (Either sex) SW	Other Deer Hunters—Low Density Hunt	25	40
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Trophy buck hunt (Either sex) NW	Other Deer Hunters—Low Density Hunt	33	39
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Doe hunt (Anterless) NW	Other Deer Hunters—High Density Hunt	44	39
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 1 NW	Other Deer Hunters—Low Density Hunt	34	38
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Doe hunt (Anterless) SW	Other Deer Hunters—High Density Hunt	38	37
Sandhill Wildlife Management Unit	Wisconsin	1985	Deer Hunters—Trophy buck hunt (Either sex) NE	Other Deer Hunters—Low Density Hunt	28	36

(*Continued*)

Table 4
(*Continued*)

Study site	State or country	Date	Evaluation context		*n*	Perceived crowding (%)
			Evaluation by	Evaluation for		
Sandhill Wildlife Management Unit	Wisconsin	1979	Deer Hunters—Doe hunt (Anterless) Day 2	Other Deer Hunters—Low Density Hunt	137	35
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Doe hunt (Anterless) SE	Other Deer Hunters—High Density Hunt	52	35
Cape Cod	Massachusetts	2005	Hunters—Volunteer sample	Other hunters	88	33
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Trophy buck hunt (Either sex) SW	Other Deer Hunters—Low Density Hunt	15	33
Grand Staircase—Escalante National Monument—Hunters	Utah	1999	Hunters	Post-Designation Experience Visitors	65	32
Sandhill Wildlife Management Unit	Wisconsin	1983	Deer Hunters—Trophy buck hunt (Either sex) SE	Other Deer Hunters—Low Density Hunt	22	32
Cape Cod	Massachusetts	2004	Hunters—Field sample	Other hunters	97	31
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 1 SW	Other Deer Hunters—Low Density Hunt	16	31
Sandhill Wildlife Management Unit	Wisconsin	1986	Deer Hunters—Trophy buck hunt (Either sex) SW	Other Deer Hunters—Low Density Hunt	27	30
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 1 NE	Other Deer Hunters—Low Density Hunt	35	29
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Trophy buck hunt (Either sex) SW	Other Deer Hunters—Low Density Hunt	24	29
Sandhill Wildlife Management Unit	Wisconsin	1984	Deer Hunters—Trophy buck hunt (Either sex) NW	Other Deer Hunters—Low Density Hunt	35	29

Sandhill Wildlife Management Unit	Wisconsin	1985	Deer Hunters—Trophy buck hunt (Either sex) SE	Other Deer Hunters—Low Density Hunt	34	29
Sandhill Wildlife Management Unit	Wisconsin	1986	Deer Hunters—Trophy buck hunt (Either sex) NW	Other Deer Hunters—Low Density Hunt	31	29
Sandhill Wildlife Management Unit	Wisconsin	1986	Deer Hunters—Trophy buck hunt (Either sex) NE	Other Deer Hunters—Low Density Hunt	28	29
State Wide—Wisconsin—goose	Wisconsin	1982	Goose Hunters	Other Goose Hunters	254	27
Tuckahoe State Park	Maryland	1984	Goose Hunters	Low Density Dispersed Hunt	62	27
Grand Staircase—Escalante National Monument	Utah	1999	Hunters	Paunsaugunt Limited-Entry Hunt	163	26
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Doe hunt (Anterless) NW	Other Deer Hunters—Low Density Hunt	28	25
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Doe hunt (Anterless) SE	Other Deer Hunters—Low Density Hunt	26	23
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 1 NE	Other Deer Hunters—Low Density Hunt	13	23
Grand Staircase—Escalante National Monument—Hunters	Utah	1999	Hunters	Pre-Designation Experience Visitors	36	22
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Doe hunt (Anterless) SE	Other Deer Hunters—Low Density Hunt	41	22
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Trophy buck hunt (Either sex) NW	Other Deer Hunters—Low Density Hunt	19	21
Sandhill Wildlife Management Unit	Wisconsin	1983	Deer Hunters—Trophy buck hunt (Either sex) NE	Other Deer Hunters—Low Density Hunt	19	21
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt(Mixed) Day 1 SE	Other Deer Hunters—Low Density Hunt	38	21
Sandhill Wildlife Management Unit	Wisconsin	1979	Deer Hunters—Doe hunt (Anterless) Day 1	Other Deer Hunters—Low Density Hunt	148	20

(*Continued*)

Table 4
(*Continued*)

Study site	State or country	Date	Evaluation context		*n*	Perceived crowding (%)
			Evaluation by	Evaluation for		
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 2 NE	Other Deer Hunters—Low Density Hunt	20	20
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Trophy buck hunt (Either sex) NE	Other Deer Hunters—Low Density Hunt	15	20
Sandhill Wildlife Management Unit	Wisconsin	1985	Deer Hunters—Trophy buck hunt (Either sex) NW	Other Deer Hunters—Low Density Hunt	35	20
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 2 NE	Other Deer Hunters—Low Density Hunt	15	20
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 1 SE	Other Deer Hunters—Low Density Hunt	37	19
Sandhill Wildlife Management Unit	Wisconsin	1982	Deer Hunters—Doe hunt (Anterless) SW	Other Deer Hunters—Low Density Hunt	28	18
Sandhill Wildlife Management Unit	Wisconsin	1983	Deer Hunters—Trophy buck hunt (Either sex) SW	Other Deer Hunters—Low Density Hunt	17	18
Grand River Marsh—Managed Hunt	Wisconsin	1978	Managed Hunt	Other Goose Hunters	935	17
Horicon Marsh—Managed Hunt	Wisconsin	1982	Goose Hunters	Managed Hunt	913	17
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Trophy buck hunt (Either sex) SE	Other Deer Hunters—Low Density Hunt	33	15
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 2 NW	Other Deer Hunters—Low Density Hunt	37	14
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 1 NW	Other Deer Hunters—Low Density Hunt	21	14

Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Doe hunt (Anterless) NE	Other Deer Hunters—Low Density Hunt	24	13
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt(Mixed) Day 2 SW	Other Deer Hunters—Low Density Hunt	15	13
Sandhill Wildlife Management Unit	Wisconsin	1981	Deer Hunters—Doe hunt (Anterless) SW	Other Deer Hunters—Low Density Hunt	17	12
Sandhill Wildlife Management Unit	Wisconsin	1980	Deer Hunters—Doe hunt (Anterless) Day 2 SW	Other Deer Hunters—Low Density Hunt	23	9
Sandhill Wildlife Management Unit	Wisconsin	1987	Deer Hunters—Trophy buck hunt (Mixed) Day 1 NE	Other Deer Hunters—Low Density Hunt	25	4
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 1 SW	Other Deer Hunters—Low Density Hunt	15	0
Sandhill Wildlife Management Unit	Wisconsin	1988	Deer Hunters—Trophy buck hunt (Mixed) Day 2 SE	Other Deer Hunters—Low Density Hunt	12	0
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 1 NE	Other Deer Hunters—Low Density Hunt	15	0
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 1 SW	Other Deer Hunters—Low Density Hunt	13	0
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 1 SE	Other Deer Hunters—Low Density Hunt	12	0
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 2 NW	Other Deer Hunters—Low Density Hunt	21	0
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 2 NE	Other Deer Hunters—Low Density Hunt	13	0
Sandhill Wildlife Management Unit	Wisconsin	1989	Deer Hunters—Trophy buck hunt (Mixed) Day 2 SW	Other Deer Hunters—Low Density Hunt	14	0

(94% compared to 32%). Wisconsin pheasant hunters at the Bong Wildlife Management Unit were more crowded on opening day than they were later in the season for two different study years (89% and 75% compared to 68% and 48%). A similar pattern existed for high use versus low use days (e.g., on the Kenai River, 77% of driftboat anglers on the lower river were crowded on high use days compared to 39% on low use days).

Different locations within the same natural resource showed variations in crowding. At the Rakaia River in New Zealand, for example, 74% of the salmon anglers felt crowded at the mouth of the river where densities were higher. This dropped to 45% for individuals who were fishing upstream where there were fewer other anglers. On the Kenai River in Alaska, 100% of the salmon anglers on the upper bank felt crowded compared to 63% on the middle bank of the river. In three Colorado reservoirs that are in close proximity to each other, the North Catamount and South Catamount reservoirs showed higher crowding levels (39% and 35%, respectively), then the more remote Crystall Reservoir (18%).

Management regulations that limit the number of hunters or anglers in an area can directly influence perceived crowding. At the Grand River Marsh in Wisconsin (1978), for example, goose hunters traditionally set up along the refuge's boundary at 40 to 50 yard intervals. As additional hunters arrived these gaps were filled in until hunters were only separated by 25 to 30 yards. Hunters repeated this process by forming additional lines further back from the refuge boundary (Kuentzel & Heberlein, 1998). Under these conditions, 79% of the hunters felt crowded. When the Wisconsin Department of Natural Resources (WDNR) offered an experimental dispersed hunt that required a 100 yard separation between blinds, perceived crowding dropped to 17%. A comparable study conducted in 1982 at Horicon Marsh in Wisconsin showed a similar decline (86% to 17%) in perceptions of crowding after the WDNR introduced a permit system restricting hunting. Management actions in these situations reduced perceptions of crowding.

Fishing Bay Wildlife Management Area (18 blinds constructed in a line at intervals of approximately 100 yards) and Tuckahoe State Park (4 blinds dispersed across a field) are located on Maryland's Eastern Shore. Over 60% of the waterfowl hunters at Fishing Bay felt crowded compared to 27% at Tuckahoe State Park. In contrast to the physical attributes of Grand River Marsh, the marshy area surrounding Fishing Bay does not permit multiple rows of hunters. Goose hunters at Grand River Marsh (79%) reported more crowding than those at Fishing Bay (61%).

At the Sandhill Wildlife Management Unit in Wisconsin researchers manipulated hunter densities in a series of experiments conducted between 1979 and 1989 (Heberlein & Kuentzel, 2002). Hunters were randomly assigned to one of four quadrants (NW, NE, SW, SE) in the Sandhill area. The experimental design included (a) high hunter density (5.0 to 10.7 hunters per km^2) in all four quadrants, (b) low hunter density (1.4 to 4.8 hunters per km^2) in all four quadrants, and (c) high hunter density in one quadrant with low density in the other three quadrants (Heberlein & Kuentzel, 2002). The density experiments involved three types of hunts: antlerless-only permits, either sex format, or mixed permits (some individuals of a group held anterless-only and others held either sex). Results indicated that deer hunters in the high-density hunts at Sandhill were generally more crowded than those in hunts managed for low density (12 of 14 evaluation contexts with crowding >50% were high density hunts).

Meta-Analysis

Separate meta-analyses were conducted for anglers and hunters (Table 5).[2] Sample size was not related to perceived crowding in the angler studies ($r = -13$, $p = .517$). Sample size,

Table 5
Summary statistics for the all contexts, and hunter and angler subgroups

			95% CI		
Groups	*n*	Mean *ES*	Lower limit	Upper limit	*Q*
Angler subgroup	26	0.57	0.55	0.59	561.09
Hunter subgroup[a]	69	0.51	0.51	0.52	4626.45

$p < .05$ for both groups.
[a]18 hunter evaluation contexts were deleted due to low sample size ($n < 25$).

however, was related to crowding in the hunter studies. Small sample sizes ($n < 25$) were removed from the hunter analyses, which minimized this potential bias ($r = .20$, $p = .103$). In addition, with the small sample size studies removed, the non-experimental hunting studies were not statistically different from the experimental studies at Sandhill Wildlife Management Unit ($t = 1.51$, $p = .136$; $r_{pbi} = -.18$, $p = .136$).

For the meta-analysis, the percents shown in Tables 3 and 4 were converted into proportions (e.g., 91% feeling crowded was converted to .91). This proportion represented an effect size and was computed for each evaluation context (see Lipsey & Wilson, 2001 for more information on proportions as effect sizes). Table 5 shows the average mean proportions for hunters and anglers, with confidence intervals. For angler contexts, 57% of respondents, on average, felt some degree of crowding across the 26 evaluation contexts. For the hunter contexts, 51% of respondents felt crowded across 69 evaluation contexts. The confidence intervals for anglers (55–59%) and hunters (51–52%) did not overlap; however, the differences were minor.

To determine the degree of between-study variability in the angler and hunter studies (Table 5), the chi-square distribution and the *Q* statistic (the sum of squares of the effect size around the weighted mean effect size) was used to test for homogeneity (Lipsey & Wilson, 2001). In a homogeneous distribution the dispersion of the effect sizes around a mean is no greater than would be expected from subject-level sampling error. In a heterogeneous distribution, other sources may explain the differences in the effect sizes besides sampling error. The resulting *Q* values for anglers ($Q = 561.09$; $df = 25$) and hunters ($Q = 4626.45$; $df = 68$) were significant, $p < .05$. Although the null hypothesis that the variability of the effect sizes can be attributed to sampling error alone was rejected for both groups (i.e., the means were from heterogeneous groups), the findings provided an accurate summary of the angler and hunter studies conducted to date. Further segmentation into subgroups (e.g., salmon anglers vs. trout anglers, elk hunters vs. deer hunters) to detect the source(s) of heterogeneity were not appropriate at this time given the small sample sizes.

Discussion

Unlike some indicators of quality hunting and fishing experiences such as overall satisfaction that typically show little variation (Shelby & Heberlein, 1986), perceived crowding varied by changing use conditions and management actions. This article summarized data from 28 hunter and 12 angler studies. Crowding varied between settings (i.e., 18% to 100% for the angler studies, 0% to 91% for the hunter studies), and at different locations within the same natural resource (e.g., mouth of the river vs. upstream). Hunters and

anglers at specific areas with higher densities of recreationists reported higher levels of crowding. Crowding was consistently higher on opening days versus the rest of the season for several activities (e.g., pheasant hunting, trout and salmon angling) across different resources (e.g., Gun Powder River, Colorado River). Crowding was lowest for situations where management indirectly (e.g., changes in the physical attributes of the resource) or directly intervened to restrict hunter numbers and produce low-density experiences. Results from the Grand River Marsh, Horicon Marsh, the Sandhill Wildlife Management Unit, Fishing Bay Wildlife Management Unit, and Tuckahoe State Park supported this conclusion. Although such findings by themselves are not new (e.g., Heberlein & Kuentzel, 2002; Shelby et al., 1989; Vaske & Shelby, in press), the consistency of the results for hunters and anglers from the comparative analyses highlights the generalizability of past research.

With relatively few exceptions (e.g., Hunt, Floyd, & Ditton, 2007), the use of formal meta-analysis techniques in the human dimensions literature remains largely unexplored. The meta-analysis illustration in this article revealed that the average mean effect size may be used to compare the results from individual studies or evaluation contexts. Consistent with prior thinking (e.g., Hendee, 1974) and research summaries (e.g., Shelby & Heberlein, 1986; Shelby et al., 1989; Vaske & Shelby, in press) hunters and anglers were not homogeneous groups. Meta-analysis statistics (e.g., *Q*), however, provided a gauge for determining the degree of homogeneity. When the mean effect size is not homogeneous, fixed, random, or mixed effects models can facilitate understanding the source(s) of heterogeneity (Lipsey & Wilson, 2001; Shelby & Vaske, in press). Our comparative analyses highlighted some of these sources (a) changes in use conditions (e.g., opening day vs. rest of season, high use vs. low use days), (b) management actions, and (c) species sought (e.g., deer vs. elk, salmon vs. trout). Combining comparative and meta-analytic techniques enhances theoretical/empirical advancement, and facilitates understanding practical applications of a concept.

The single-item 9-point scale works well in field studies where only a limited number of questions can be asked, and can be used in surveys mailed to participants after leaving the setting. The type of methodology (i.e., on-site vs. mailed survey) had no effect on the reported level of crowding in the studies examined here. The single-item crowding measure is also easy to interpret and compare across studies. The simplicity of the item leads investigators to report data in ways that can easily be compared.

Collapsing the scale at points 3 through 9 is conceptually intuitive (*not at all crowded* vs. some degree of crowding) and has been the traditional format for summarizing the variable (Heberlein & Vaske, 1977; Shelby & Heberlein, 1986; Shelby et al., 1989). Although at least three other summary statistics have been considered (e.g., percentages for scale points 5 through 9 [moderately to extremely crowded], means, medians), Vaske and Shelby (in press) demonstrated that the correlations between the four methods of reporting crowding exceed $r = .90$. These findings suggest that researchers and managers should use whichever method is most appropriate for understanding the data.

Because of its utility, we encourage continued use of the single-item crowding question. As we have stressed elsewhere (Shelby et al., 1989, Vaske & Shelby, in press), however, it is important to type the response scale exactly as shown in this article. Changing the alignment of the descriptive labels under the numbered response categories potentially changes the scale's meaning and yields non-comparable results. Researchers should also resist the temptation to modify the width of the response scale. In our literature search, some hunter and angler studies used 4 or 7 point scales and consequently, the findings could not be compared here.

Findings presented here are useful for advising wildlife managers about potential carrying capacity problems and highlight the value of multiple data sets. With no other studies with which to compare against a single finding, it is difficult to determine how crowded is

too crowded. The broader perspective offered by multiple studies or evaluation contexts makes the crowding measure useful for comparing areas and making rough carrying capacity determinations. The single-item crowding measure alone is not a perfect substitute for information about use levels, impacts, and evaluative standards that a more complete carrying capacity study can provide. Nevertheless, the measure is simple, fast, and inexpensive, which thereby allows researchers to easily gain insight about a potential study.

Notes

1. Ancillary analyses comparing perceived crowding reported in mail surveys vs. on-site surveys indicated no statistical differences between the two methodologies (t=–1.18, p=.252; r_{pbi}=.09, p=.412).
2. The proportion of respondents feeling crowded (responded 3–9 on the 9-point crowding scale) was coded as the effect size measure for each evaluation context. A standard error for each proportion, and an inverse variance weight were also coded. The formulas used in these analyses follow (see Lipsey & Wilson, 2001 for more information).

Effect Size Formula

$$ES_p = p = k / n \tag{1}$$

where p is the proportion of individuals feeling crowded, k is the number of individuals feeling crowded, and n is the sample size for the context.

Standard Error Formula

$$SE_p = \sqrt{\frac{p(1-p)}{n}} \tag{2}$$

Inverse Variance Weight Formula

$$w_p = \frac{1}{SE_p^2} = \frac{n}{p(1-p)} \tag{3}$$

Computing the Weighted Mean of the Effect Sizes

The weighted mean effect size was computed by the formula:

$$\overline{ES} = \frac{\sum (w_i ES_i)}{\sum w_i} \tag{4}$$

where w is the inverse variance weight, ES is the arithmetic mean for each context, and i represents each independent context.

Determining the Confidence Interval for the Proportion

The confidence interval was determined by calculating the standard error of the mean using the square root of the sum of the inverse variance weights (Hedges & Olkin, 1985).

$$\overline{ES} = \overline{ES} \pm z_{(1-\alpha)}\left(SE_{\overline{ES}}\right); SE_{\overline{ES}} = \sqrt{\frac{1}{\sum w_i}} \tag{5}$$

where $z_{(1-\alpha)}$ is the critical value for the *z* distribution (1.96 for $\alpha = .05$).

Analyzing for Homogeneity

The homogeneity of the effect size distribution was analyzed using the *Q* statistic:

$$Q = \sum w_i (ES_i - \overline{ES})^2 \quad (6)$$

where *df*=(# of evaluation contexts – 1) and the distribution is equivalent to a chi-square distribution. The null hypothesis is that the variability of the effect sizes is what would be expected from sampling error alone (a homogeneous distribution).

3. * indicates the article is a citation for data (see Tables 1 and 2).

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