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Potential for Conflict Index: Hunters' Responses to Chronic Wasting Disease

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Abstract

*A goal of human dimensions research is to provide input that will improve decision making regarding wildlife management. When communicating results to managers, it is imperative that human dimensions researchers provide clear statistical information and convey the practical implications of their findings. To assist this effort, this paper describes a formula for computing a Potential for Conflict Index (PCI) and presents a graphic technique for displaying results. The PCI values range between 0 and 1, where 0 suggests no conflict and 1 suggests maximum conflict. To illustrate computation and graphic display of the PCI, we present data from a study of Wisconsin deer (*Odocoileus *spp.) hunters' attitudes and behavior in response to chronic wasting disease (CWD). Results suggest that PCI facilitates understanding hunters' behavior (e.g., likelihood of hunting) and attitudes regarding management actions (e.g., herd eradication) in response to CWD. The PCI allows managers to better understand controversial issues and take proactive steps targeted at specific stakeholders to minimize conflict before implementing a policy. We encourage researchers to adopt the PCI technique or variations of it.* (WILDLIFE SOCIETY BULLETIN 34(1):44–50; 2006)

Key words

chronic wasting disease, human dimensions, hunting, potential for conflict index, PCI.

Human dimensions research is valuable for informed decision making regarding wildlife management. When communicating results to managers, however, researchers should provide clear statistical information and suggest the practical implications of their findings. A researcher's ability to communicate meaningful results is influenced by the complexity of the concepts investigated, types of measures used, and amount of information conveyed. One challenge to effective communication with managers is conveying the meaning of statistical analyses. Basic summary statistics, for example, describe variables in terms of central tendency (mean, mode, median), dispersion (e.g., standard deviation, variance, range), and form (e.g., modality, skewness) (Loether and McTavish 1976). Although these statistics can efficiently convey meaning, an accurate understanding of a variable's distribution requires considering all 3 of these indicators simultaneously. This task is compounded by the complexity of concepts (e.g., attitudes, behavioral intentions) and associated measurement scales used in human dimensions research.

Wildlife managers may dismiss results of human dimensions research when the practical meaning of results is not communicated properly. To facilitate applicability of human dimensions findings, Manfredo et al. (2003) developed a formula (potential for conflict index, PCI) and a graphical technique for displaying information about a distribution's central tendency, dispersion, and form. The approach requires little statistical training, minimizes effort required to process information, and increases comprehension.

In this paper we build on the work of Manfredo et al. (2003) by extending the PCI to a broader range of concepts (attitudes and behavioral intentions) used by human dimensions researchers. We use data from a study of Wisconsin hunters' attitudes and behavior in response to chronic wasting disease (CWD) to illustrate the methodology (Petchenik 2003, Vaske et al. 2004). Our goal is to contribute to the growing body of research that addresses the practical significance of social science findings (Kirk 1996, Robinson and Levin 1997, Gliner et al. 2001, Vaske et al. 2002).

Potential for Conflict Index

Human dimensions surveys commonly measure variables using response scales that have a neutral center point and an equal number of response options on either side. Numerical ratings are assigned in ordinal fashion with the center point receiving a value of 0. The PCI formula requires this form of measurement. In the initial development of PCI, Manfredo et al. (2003) asked respondents to evaluate the acceptability of several management actions regarding black bears (*Ursus americanus*) (e.g., capture and destroy a bear in a residential area) and measured responses on a 7-point scale of: highly acceptable (3), moderately acceptable (2), slightly acceptable (1), neither acceptable or unacceptable (0), slightly unacceptable (−1), moderately unacceptable (−2), and highly unacceptable (−3). Variable responses framed in this manner reflect an evaluation of the appropriateness of a given management action (e.g., capture and destroy the bear). As demonstrated in this paper, PCI can be used to characterize individuals' attitudes toward management (e.g., strongly favor to strongly oppose) or behavioral intentions regarding participation in an activity such as hunting (e.g., highly likely to highly unlikely). (Regarding hunting behavior, PCI refers to the extent to which conflict may exist among respondents regarding their likelihood to hunt under various hypothetical scenarios of CWD conditions [e.g., CWD prevalence, availability of CWD testing]).

Although the original formulation of PCI used a measurement scale of 7 response categories, the technique works with 3, 5, or 9

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response options. Limiting the response set to 3 choices (disagree [–1], neutral [0], agree [+1]), however, unnecessarily constrains the variance. Expanding the response set to 9 options may confuse survey respondents. We recommend measurement scales with 5 (illustrated here) or 7 (Manfredo et al. 2003) response categories.

The PCI describes the ratio of responses on either side of a rating scale's center point. The greatest potential for conflict (PCI = 1) occurs when there is a bimodal distribution between the response scale's 2 extreme values (e.g., 50% strongly support, 50% strongly oppose, 0% neutral). A distribution with 100% at any one point on the response scale yields a PCI of 0 and suggests no potential for conflict.

Computation of the PCI uses a frequency distribution and follows the formula:

$$\text{PCI} = \left[1 - \left|\frac{\sum_{i=1}^{na}|X_a|}{Xt} - \frac{\sum_{i=1}^{nu}|X_u|}{Xt}\right|\right] * \frac{Xt}{Z}$$

where: PCI = Potential for Conflict Index; X_a = an individual's "acceptable" (or "favor" or "likely") score; n_a = all individuals with acceptable scores; X_u = an individual's "unacceptable" (or "oppose" or "unlikely") score; n_u = all individuals with unacceptable scores;

$$Xt = \sum_{i=1}^{na}|X_a| + \sum_{i=1}^{nu}|X_u|$$

Z = the maximum possible sum of all scores = *n*extreme score on scale* (e.g., $Z = 2n$ for scale with 5 response options, $Z = 3n$ for scale with 7 response options); n = total number of subjects.

Following computation of the PCI, results can be displayed as bubble graphs to visually and simultaneously describe a variable's form, dispersion, and central tendency. The size of the bubble depicts the PCI and indicates degree of dispersion (e.g., extent of potential conflict regarding the acceptability of a management strategy). A small bubble suggests little potential conflict; a larger bubble suggests more potential conflict. The center of the bubble, which is plotted on the Y-axis, indicates the mean response (central tendency) to the measured variable. With the neutral point of the response scale highlighted on the Y-axis, it is apparent that respondents' average evaluations are situated above or below the neutral point (i.e., the action, on average, is acceptable or unacceptable). Information about a distribution's skewness is reflected by the position of the bubble relative to the neutral point (i.e., bubbles at the top or bottom of the graph suggest high degrees of skewness).

Methods

To illustrate the PCI technique, we used data from a study of deer (*Odocoileus* spp.) hunters' attitudes and behavior in response to CWD in Wisconsin (Petchenik 2003, Vaske et al. 2004). Chronic wasting disease is a transmissible spongiform encephalopathy (TSE) found in mule deer (*O. hemionus*), white-tailed deer (*O. virginianus*), and Rocky Mountain elk (*Cervus elaphus nelsoni*), (Williams and Young 1980, 1982, Schauber and Woolf 2003). The disease is similar to scrapie in sheep, mad cow disease, and a variant of Creutzfeldt–Jakob disease (vCJD) in humans (Williams et al. 2002). Deer and elk infected with CWD always die (Williams et al. 2002). Although human infection from CWD is very unlikely, the possibility of the disease being transmitted to humans cannot be entirely dismissed (Raymond et al. 2000, Belay et al. 2004). Although substantial research has been conducted on the pathology, epidemiology, and clinical signs of CWD (see Williams et al. 2002, Belay et al. 2004 for reviews), less is known about hunters' attitudes and behavior in response to the disease (Needham et al. 2004, Vaske et al. 2004).

License sales for Wisconsin's firearm hunting season for deer in 2002 declined 10.7% following discovery of CWD in the state (Heberlein 2004). In 2002 the Wisconsin Department of Natural Resources (WDNR) conducted a survey of resident hunters who participated in 2001 to examine their: 1) participation in the 2002 season, 2) behavioral intention to participate in the 2003 season under various hypothetical scenarios of CWD conditions (e.g., prevalence of CWD, availability of certified CWD testing), and 3) attitudes toward several alternatives for managing CWD (Petchenik 2003).

We mailed surveys to 1,500 residents statewide who hunted deer with a gun and an additional 600 deer hunters who lived in the counties where deer had tested positive for CWD. Of the 2,100 surveys initially mailed, 43 were undeliverable. Residents returned a total of 1,373 usable questionnaires, yielding a response rate of 67% (1,373/2,100 – 43). A nonresponse bias check indicated no differences between those who did and did not respond to the survey.

We weighted data to adjust for over-sampling of hunters who lived in the CWD-affected counties (see Vaske et al. 2004 for weighting details). After weighting, 90.8% of the hunters in the sample participated in the 2002 season (i.e., "hunted in 2002 season") and 9.2% dropped out. The 1.5% difference between this estimated 9.2% drop based on the survey data and the actual 10.7% decline in the number of licenses purchased was within statistical probabilities of occurring by chance (Vaske et al. 2004).

Results

For 3 of the hypothetical scenarios in the survey, we computed the likelihood ratings that people who hunted in 2002 would give up deer hunting (a behavioral intention) in 2003. These 3 scenarios were: 1) CWD has not been detected in respondents' hunting unit and a certified CWD test was available, 2) CWD has been detected in an adjacent hunting unit and testing is unavailable, and 3) CWD has been detected in their unit and testing is unavailable. To illustrate the PCI calculation (Table 1), we used the frequency distribution for the scenario where CWD was detected in respondents' hunting unit and testing was unavailable:

$$\sum_{i=1}^{nu}|X_u| = (|-2|*624) + (|-1|*71) = 1,319$$

$$\sum_{i=1}^{na}|X_a| = (2*54) + (1*35) = 143$$

$$Xt = 1,319 + 143 = 1,462$$

Table 1. Likelihood ratings of Wisconsin hunters in 2002 giving up deer hunting for 2003 season if CWD was detected in their hunting area and CWD testing was not available.

	Hunted in 2002 season	
Response scale[a]	**n**	**%**
Very unlikely	624	73
Somewhat unlikely	71	8
Unsure	77	9
Somewhat likely	35	4
Very likely	54	6
Total	861	100

[a] Scoring refers to the numbers used for the response categories in the survey: −2 = very unlikely, −1 = somewhat unlikely, 0 = unsure, 1 = somewhat likely, 2 = very likely.

n = total number of subjects = 861, PCI for "give up deer hunting in 2003" =

$$= \left[1 - \left|\frac{1,319}{1,462} - \frac{143}{1,462}\right|\right] * \frac{1,462}{(2*861)} = 0.17$$

Among respondents who participated in the 2002 season, the PCI for "give up deer hunting in 2003" was approximately 0.17. Vaske et al. (2004) estimated about half (52% ± 5%) of the hunters who participated in the 2001 season who did not participate in 2002 did not hunt because of CWD (i.e., "hunter dropouts in 2002 due to CWD"). The PCI for this group of individuals was 0.62 (Table 2). Given that the PCI ranges from 0 to 1, relative influence of CWD on hunting participation is evident when values for these 2 groups are contrasted (PCI = 0.17 versus 0.62). Similar comparisons of the group means (−1.37 versus 0.21), medians (−2.00 versus 0.00), or measures of dispersion and distribution do not necessarily lead to the same conclusion (Table 2).

Interpretation problems with traditional summary statistics can occur because of different dependent variables (e.g., reported participation versus behavioral intentions to participate) and associated measurement scales used in the analysis. Estimates for days of hunting participation, for example, have an intuitive appeal because the scale (e.g., 0–365 days per year) has meaning to both natural resource managers and researchers. Other dependent measures such as behavioral intention questions that are measured on 5-point scales sometimes lack this intuitive appeal (depending on how data are presented). If data are reported as percentages (e.g., 73% of hunters are very unlikely to quit hunting, Table 1), interpretation of the findings is straightforward. When that same variable is summarized as an average score, the arithmetic mean of −1.37 (Table 2) is less obvious because it implies that respondents are somewhere between very and somewhat unlikely to quit hunting. Since the PCI score is standardized to range between 0 and 1, the meaning may be more apparent.

Table 2. Descriptive statistics for Wisconsin hunters in 2002 and hunter dropouts in 2002 for likelihood of giving up deer hunting for 2003 season if CWD was detected in their unit and CWD testing was not available.

	Deer hunting participation in Wisconsin in 2002[a]	
Descriptive statistics	**Hunted in 2002 season**	**Hunter dropouts in 2002 due to CWD[b]**
PCI	0.17	0.62
Mean	–1.37	0.21
Median	–2.00	0.00
Standard deviation	1.19	1.66
Standard error	0.04	0.25
Skewness	1.78	–0.14
Kurtosis	1.94	–1.64

[a] Cell entries on scale from −2 "very unlikely" to +2 "very likely" except for PCI.

[b] See Vaske et al. 2004 for an explanation of how "hunter dropouts in 2002 due to CWD" was calculated.

To further enhance ease of understanding, conflict indices and variable means for the 3 scenarios are presented (Fig. 1). Visually, it can be seen (i.e., bigger bubbles) that people who dropped out in 2002 due to concerns about CWD had higher PCI values than hunters who continued to participate for all 3 scenarios. The center of each bubble represents the mean score (plotted on Y-axis) and suggests that those who hunted in 2002 were very unlikely to give up deer hunting in 2003 under any of the 3 scenarios. Location of the bubbles for this group suggests that the distributions were highly skewed. Mean scores for those who dropped out are closer to the neutral line, suggesting that many respondents in this group were unsure whether they would participate in 2003. Taken together, the mean and PCI measures suggest that irrespective of whether CWD is detected in a hunter's unit and testing is unavailable, there was little conflict (i.e., conflict among respondents regarding their likelihood to hunt) among people who hunted in 2002 that they would continue to hunt in 2003. Conversely, respondents who did not hunt in 2002 due to CWD were likely to hunt in 2003 if CWD was not detected in their unit and a test was available but were unsure about whether they would hunt if CWD conditions worsened (detected in unit, test unavailable).

The vertical separation of bubbles in Fig. 1 between those who hunted in 2002 and those who dropped out due to CWD suggests that the 2 groups differed statistically in their behavioral intentions for each of the 3 scenarios. This visual interpretation is by no means a substitute for statistical testing; rather, it facilitates interpretation of the results. For example, although the t-tests presented in Table 3 support the conclusion that the 2 groups differ statistically for each of the 3 scenarios, differences are more obvious when presented graphically as nonoverlapping vertical bubbles (Fig. 1). Bubbles that overlap, however, also may be statistically different but should be examined closely to interpret the practical implications.

Researchers have been increasingly concerned with developing and using measures that convey practical meaning to statistical relationships (Kirk 1996, Robinson and Levin 1997, Kirk 2001). A statistically significant outcome only indicates that it is likely there is a relationship between variables. It does not describe the extent (strength) of that relationship. Researchers, therefore, have argued that effect sizes should be reported in addition to tests of significance (e.g., Kirk 1996, Anderson et al. 2000, Gliner et al. 2001). An effect size is defined as the strength of the relationship between the independent variable and the dependent variable. One effect size indicator, the *point biserial correlation* (r_{pb}), can be computed indirectly from a t-test (Table 3). The r_{pb} is similar to

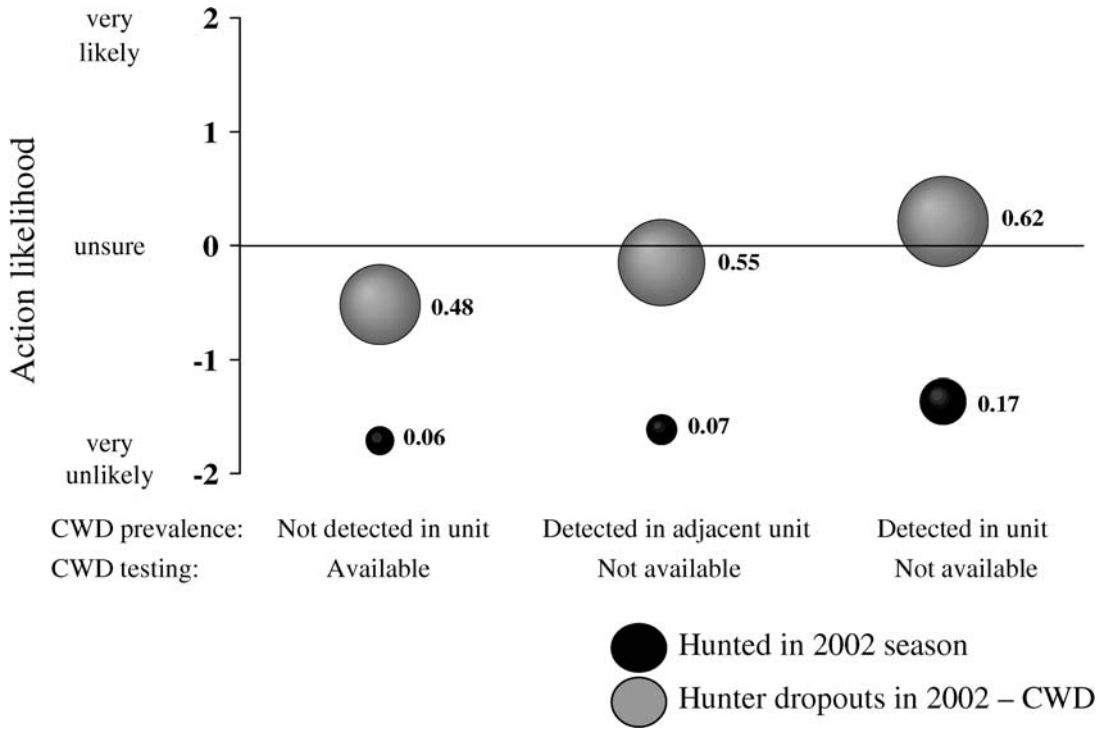

Figure 1. Graphic presentation of the Potential for Conflict Index for Wisconsin hunters' likelihood of giving up deer hunting for 2003 season under various levels of CWD prevalence and testing availability. Scores adjacent to each bubble represent the PCI. The center of each bubble is the mean likelihood of giving up deer hunting for 2003 season for each situation. Size of bubble indicates degree of potential conflict (i.e., bigger bubbles suggest more conflict).

the Pearson correlation (r) (See Cohen 1988:82, for details on converting between the 2 measures). Using guidelines from Cohen (1988) and Vaske et al. (2002), the strength of the relationship between hunting participation in 2002 and intention to hunt in 2003 can be characterized as medium or typical.

As a final step in our analyses, we examined the attitudes of the 2 groups (hunted in 2002 versus dropped out in 2002) regarding 4 CWD management alternatives. First, to control the spread of CWD, the WDNR established a management goal of eradicating the entire free-ranging deer population in a 661km^2 area where deer infected with CWD were found. We asked hunters if they favored or opposed this action on a 5-point scale of strongly oppose (−2) to strongly favor (+2). On average, both groups somewhat favored this action (Fig. 2). The PCIs suggested that this management action was slightly more controversial for respondents who hunted in 2002 (PCI = 0.42) compared to those who did not (PCI = 0.29).

Second, we asked respondents if they favored or opposed the WDNR severely reducing the deer herd in the eradication zone. Both groups somewhat favored this action, but there was a moderate amount of conflict (PCI = 0.41 and 0.44).

Third, we asked respondents if they favored or opposed the WDNR monitoring CWD and waiting for test results before pursuing management actions. Both groups, on average, somewhat favored this alternative and PCI measures revealed relatively minor conflict within each group (PCI = 0.16 and 0.30).

Finally, hunters rated their support for the WDNR doing nothing and letting CWD take its natural course. Both groups, on average, opposed this strategy, and there was a similar amount of conflict within each group (PCI = 0.26 and 0.38). Taken together, the visual display of respondents' attitudes toward each of the 4 management alternatives (Fig. 2) illustrates that: 1) the 2 groups did not differ much in their support or opposition for each management strategy, and 2) there was not overwhelming support or opposition for any of the management alternatives.

Discussion

If a goal of human dimensions research is to provide input for wildlife management decisions, it is imperative that researchers

Table 3. Differences between Wisconsin hunters in 2002 and hunter dropouts in 2002 for likelihood of giving up deer hunting for 2003 season under various levels of CWD prevalence and testing availability.

	Deer hunting participation in Wisconsin in 2002[a]				
CWD prevalence, testing availability	**Hunted in 2002 season**	**Hunter dropouts in 2002 – CWD[b]**	***t***	***P***	r_{pb}
Not detected in unit, test available	–1.71	–0.52	5.02	< 0.001	0.29
Detected in adjacent unit, test not available	–1.61	–0.15	6.40	< 0.001	0.31
Detected in unit, test not available	–1.37	0.21	6.16	< 0.001	0.27

[a] Cell entries are means on scale from −2 "very unlikely" to +2 "very likely."
[b] See Vaske et al. 2004 for an explanation of how "hunter dropouts in 2002 due to CWD" was calculated.

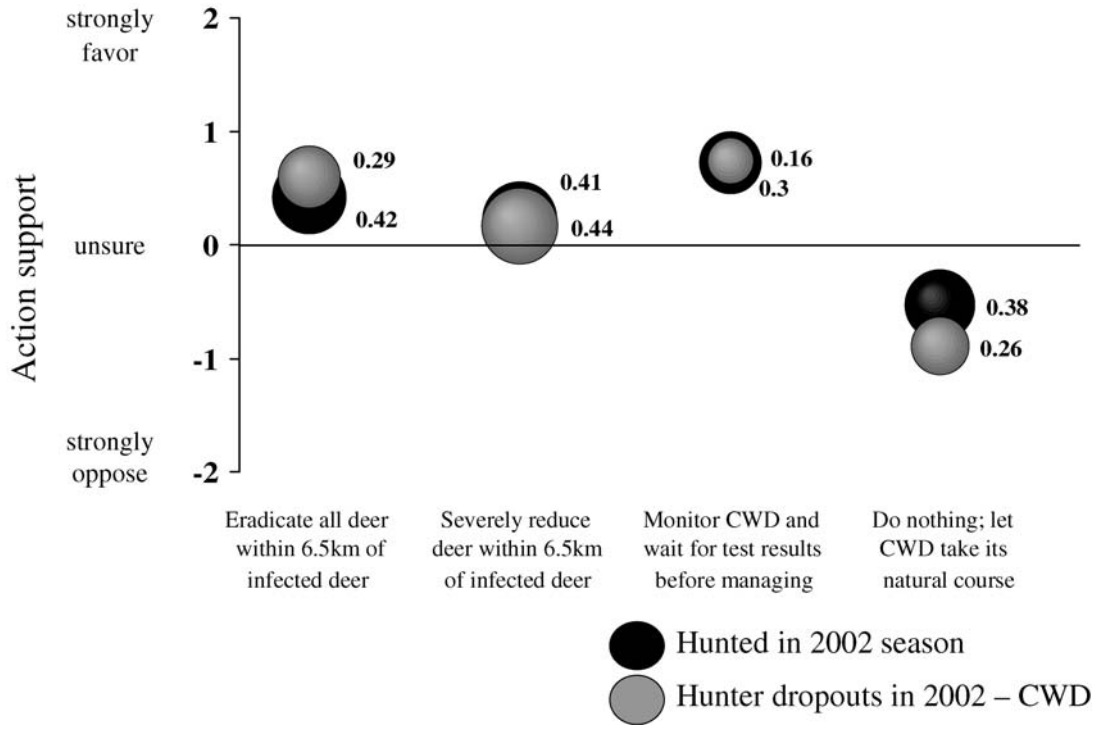

Figure 2. Graphic presentation of the Potential for Conflict Index for Wisconsin hunters' support of potential actions for managing CWD. Scores adjacent to each bubble represent the PCI. The center of each bubble is the mean support of the management action. Mean differences between 2002 Wisconsin deer hunters' and hunter dropouts in 2002 were not statistically significant for each action.

effectively communicate the statistical and practical implications of their findings. Researchers have suggested a variety of approaches (e.g., effect sizes, confidence intervals, odds ratios) as methods to replace or supplement tests of statistical significance (Kirk 1996, Robinson and Levin 1997, Kirk 2001, Vaske et al. 2002). We believe that PCI offers another alternative.

Although we support the use of at least one of these methods when presenting social science data, each has advantages and disadvantages. Effect sizes, for example, offer a standardized estimate of the magnitude of variable relationships and, therefore, comparisons of different variables in the same study or across studies are meaningful (Rosenthal 2000). Effect sizes, however, may not be sufficient for describing variation among groups of interest to managers.

Confidence intervals can provide more practical information than null hypothesis statistical tests by highlighting lower and upper bounds of what the true value of a parameter might be (Borenstein 1994). There are, however, disadvantages to confidence intervals. First, unless measurement values are familiar (e.g., days of hunting participation), confidence limits may not facilitate an interpretation of the findings. Kirk (1996) suggested reporting confidence intervals about a point estimate for familiar measures and reporting effect sizes for unfamiliar measures. Second, confidence limits in social sciences often are large, thus weakening the practical significance of findings (Cohen 1994). Third, arbitrary selection of a 95% confidence interval is no different than arbitrary selection of a significance level (e.g., $P < 0.05$, Feinstein 1998).

Odds ratios provide an indication of the likelihood of a relationship among variables by expressing findings in easily understandable terminology (Fleiss 1981). Odds ratios are, however, limited to dichotomous variables and converting continuous measures to dummy variables leads to a substantial loss of predicted variance and sample power (Cohen 1983). Furthermore, odds ratios do not have an upper limit and they grow rapidly when there are relatively few cases in a cell. Thus, large odds ratios may be misleading.

The PCI and related graphical approach to depicting practical significance represents an alternative strategy for communicating with managers. The PCI simultaneously combines information about central tendency and dispersion in an easy to assimilate graphic display. Although we believe the approach merits further empirical attention, more conceptual and methodological work should be undertaken. For example, what is the relationship between PCI and other effect size measures?

From an applied perspective, guidelines for interpreting conflict indices need to be proposed and empirically verified. Such guidelines might parallel those for interpreting effect sizes. Cohen (1988), for example, provides research examples from psychology to support his recommendations of small ($r = 0.1$), medium ($r = 0.3$), and large ($r = 0.5$) effect sizes. Vaske et al. (2002) have proposed similar guidelines (i.e., minimal, typical, substantial) for human dimensions research. The empirical question becomes one of determining comparable conventions for PCI.

For managers, PCI and the associated graphic display may assist in addressing conflict aside from simply being aware of whether an issue or management action is going to be controversial. A challenge for wildlife managers in Wisconsin, for example, was how to inform stakeholder groups and the general public of the rationale for implementing CWD management strategies such as herd eradication (Heberlein 2004). Communicating with stake-

holders about complex statistical findings from empirical data (e.g., standard deviation, skewness) is challenging and may be ineffective for mitigating controversy among competing interest groups. The PCI, however, is simple to understand because it is on a scale from 0 (no conflict) to 1 (high conflict). The graphic approach displays findings in a manner that is comprehensible for individuals with little or no statistical training (Manfredo et al. 2003).

The PCI can assist managers in understanding similarities and differences among groups. Our results suggested that PCI facilitated understanding behavior (e.g., likelihood of hunting) and attitudes of different hunting groups (did versus did not hunt in 2002) regarding management actions (e.g., herd eradication in response to CWD in Wisconsin). A similar regional study used PCI to examine hunters' responses to CWD and suggested that controversy regarding the disease and its management differed among hunting subgroups (Needham et al. 2004). Using PCI to understand potentially controversial issues allows managers to take preventative, proactive steps (e.g., education) targeted at specific stakeholders to minimize conflict before a management strategy is implemented.

Conclusion

We encourage researchers to explore possible applications and variations of the PCI methodology. (Once a researcher has obtained the frequency distribution for a variable, PCI is calculated using an Excel spreadsheet. Spreadsheets for 5- and 7-point scales can be obtained by contacting the lead author or by downloading from: http://www.cnr.colostate.edu/NRRT/people/jerryj.htm) Addressing the predictive validity of PCI would enhance statistical credibility and practical utility. Researchers are encouraged to examine the extent to which conflict actually emerges as a result of implementing a management action for which a high PCI value was observed. Such validation would assist wildlife managers in interpretation of PCI values. The ultimate utility of PCI and the associated graphic technique will depend on its effectiveness in understanding and applying human dimensions of wildlife findings.

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