Human Dimensions of Wildlife, 8:219–228, 2003

ISSN: 1087–1209 print / 1533-158X online
DOI: 10.1080/10871200390215632

Taylor & Francis
Taylor & Francis Group

The Potential for Conflict Index: A Graphic Approach to Practical Significance of Human Dimensions Research

MICHAEL J. MANFREDO
JERRY J. VASKE
TARA L. TEEL

Department of Natural Resource Recreation and Tourism
Colorado State University
Fort Collins, Colorado, USA

To facilitate the understanding and applicability of human dimensions findings, this article develops a formula for computing a Potential for Conflict Index (PCI) and a graphic technique for presenting the results. This approach (1) conveys information about a distribution's central tendency, dispersion, and form simultaneously; (2) uses a graphic display that allows easy assimilation of research findings; and (3) places the findings in the context of managerial concern. Computed values for PCI range from 0 to 1, where 0 indicates no conflict and 1 indicates maximum conflict. Data are presented from a recent wildlife values project to illustrate the computation and graphic display of the PCI for univariate and bivariate situations. Researchers are encouraged to adopt this approach or variations of it to improve the understandability of their research results.

Keywords *practical significance, descriptive statistics*

Introduction

The tradition of natural resource management in North America emphasizes the use of scientific information in decision making (see, for example, Decker, Brown, & Siemer, 2001; Manfredo, 2002). Although historically this tradition has focused on biological information, there is growing recognition that social science information can offer unique insights to natural resource problems. Unfortunately, social science information sometimes falls short of its potential for facilitating natural resource decisions. This situation can occur because of "understanding gaps" between managers and researchers. Differences in the day-to-day nature of the jobs,

Address correspondence to Tara L. Teel, Colorado State University, Fort Collins, Colorado 80523–1480, USA. E-mail: tteel@lamar.colostate.edu

experience, and disciplinary training between managers and researchers probably all contribute to the problem. Irrespective of the cause, however, it is clear that researchers must improve the applicability of their investigations if their goal is to inform management decisions.

To facilitate the understanding and applicability of human dimensions findings, this article develops a formula for computing a potential for conflict index and introduces a graphic technique for presenting univariate and bivariate research findings. Our goal is to contribute to a growing body of research that addresses the practical significance of empirical findings (Vaske, Gliner, & Morgan, 2002).

Problem

The task of human dimensions of wildlife research is to conceptualize, measure and interpret variables and their relationships in a way that bears meaning on problems of managerial or scientific interest. A researcher's ability to communicate the meaning of research is influenced by the complexity of the concepts investigated, the types of measures taken, and the amount of information conveyed. Pre-eminent among the challenges of effective communication, particularly with a practitioner audience, is conveying the meaning revealed in statistical procedures. While the statistics themselves are efficient in conveying meaning, their understanding typically requires a high level of technical training that is uncommon among a practitioner audience. Furthermore, as university-based postgraduate programs increasingly require students to apply newer and more advanced statistical techniques, the understanding gap between managers and researchers widens. The meaning of potentially useful studies can be dismissed due to failed communication. More broadly, the perception of the relevance of the human dimensions disciplines can be diminished. While we support the use of sophisticated, inferential statistical procedures, we also encourage researchers to explore ways of describing the meaning revealed in *basic*, *descriptive* statistical techniques. In this article, we introduce a technique to assist human dimensions researchers in conveying the meaning derived in their research.

At the most basic level, summary statistics describe the distribution of scores on a variable. These statistics reflect three characteristics: central tendency (mean, mode, median), dispersion (e.g., standard deviation, variance, range), and form (e.g., modality, skewness) (Loether & McTavish, 1976). Use of just one of these indicators is typically inadequate to attain an accurate understanding of a scoring distribution. In other words, an individual needs to look across all three indicators, a task requiring thoughtful examination. The magnitude of this task is compounded by the large number of measures typically used in human dimensions research to represent constructs of interest (e.g., attitudes, values, behaviors). We sought to simplify understanding by developing a technique that rapidly and accurately conveys information about the central tendency, dispersion, and form of a scoring distribution. The intent was to develop a technique that would require

little statistical training, minimize the effort required to process information presented, and increase its comprehension.

A Graphic Approach

Our approach displays information about the central tendency, dispersion, and form of a distribution in a single graphic representation that can accommodate multiple measures simultaneously. The technique also places findings in the context of managerial concern—the potential for conflict over the acceptability of a given management action.

Application of the technique begins with construction of a "Potential for Conflict Index" (PCI). The PCI indicates the ratio of scoring on either side of the center point on a rating scale. This might include the center points "neutral," "neither agree nor disagree," "neither acceptable nor unacceptable," or "neither support nor oppose." We assume that the greatest possibility for conflict occurs when there is a bimodal distribution between the two extreme values of the response scale (e.g., 50% strongly support, 50% strongly oppose, 0% neutral). In that case the index attains its highest possible value of 1. A distribution with 100% on one side of the neutral point will yield a PCI of 0 (i.e., no conflict).

The PCI formula requires a response scale in which there is a neutral center point with an equal number of response options on either side. Numerical ratings must be assigned in ordinal fashion with the center point receiving a value of 0. In the examples presented in this article, the scale was (3) Highly Acceptable, (2) Moderately Acceptable, (1) Slightly Acceptable, (0) Neither Acceptable nor Unacceptable, (−1) Slightly Unacceptable, (−2) Moderately Unacceptable, (−3) Highly Unacceptable. The index is computed using a variable's frequency distribution following the formula:

$$PCI = \left[1 - \left| \frac{\sum_{i=1}^{n_a} |X_a|}{Xt} - \frac{\sum_{i=1}^{n_u} |X_u|}{Xt} \right| \right] \times \frac{Xt}{Z}$$

where:

PCI = Potential for Conflict Index
X_a = an individual's "acceptable" (e.g., 1, 2, or 3) score
n_a = all individuals with acceptable scores
X_u = an individual's "unacceptable" (e.g., −1, −2, or −3) score
n_u = all individuals with unacceptable scores

$$Xt = \sum_{i=1}^{n_a} |X_a| - \sum_{i=1}^{n_u} |X_u|$$

Z = the maximum possible sum of all scores = $n \times$ *extreme score* (e.g., Z = 3n), where n = total number of subjects

Following computation of the index, the results are displayed as bubble graphs that visually describe dispersion, central tendency, and form. The size of the bubble shows the PCI and indicates the degree of dispersion (i.e., the degree of potential conflict over the acceptability of a management action). Small bubbles indicate less potential conflict; larger bubbles reflect more potential conflict. The center of the bubble, which is plotted on the Y-axis, represents the mean score (central tendency) on the variable. With the neutral point on the rating scale highlighted on the Y-axis, one can easily see whether, on average, respondents' evaluations lie above or below the neutral point (i.e., whether, on average, the action is acceptable or unacceptable). Finally, information about skewness within a distribution is evident by the position of the bubble relative to the neutral point (i.e., bubbles at either the top or bottom of the graph indicate high levels of skewness).

A Univariate Illustration

Data are presented from the Western Association of Fish and Wildlife Agencies "Wildlife Values in the West" Demonstration Project (Manfredo, Teel, & Bright, in press; Teel, Bright, & Manfredo, 2003) to illustrate the computation and display of the PCI. This study assessed wildlife value orientations, management action acceptability, and wildlife-associated recreation behaviors in six western states (i.e., Alaska, Arizona, Colorado, Idaho, North Dakota, South Dakota). For illustration purposes, we present results for the state of Alaska on a series of items dealing with bear management. Before responding to the items, subjects were presented with the following scenario:

> In some areas and during certain times of the year, bears have been known to wander into residential areas where they get into trash cans, storage sheds, and bird feeders. They can destroy vegetation and can pose a threat to both pets and humans. Some people feel the bears should be left alone or simply chased away. Others think the bears should be caught and relocated or destroyed. Still others feel that people who live near bear habitat should be educated about how to avoid problems with bears.

Subjects were then asked to rate the acceptability of five different management responses (e.g., leave the bear alone, capture and destroy the bear).

Table 1 shows Alaskan respondents' evaluations of the acceptability of "leave the bear alone" after it has been seen in residential areas. Frequencies and percentages as well as indicators of the distribution's central tendency, dispersion,

TABLE 1 Alaskan Respondents' Ratings of Acceptability of "Leave the Bear Alone"

Response scale	Scoring	Frequency	Percent
Highly unacceptable	−3	26	8
Moderately unacceptable	−2	31	9
Slightly unacceptable	−1	20	6
Neutral	0	15	4
Slightly acceptable	1	52	15
Moderately acceptable	2	90	26
Highly acceptable	3	108	32
Total		342	100
Descriptive statistics			
Mean	1.16		
Median	2.00		
Mode	3.00		
Standard deviation	1.96		
Variance	3.83		
Skewness	−.93		
Kurtosis	−.45		

and form are displayed. Using data from the frequency distribution, the potential for conflict index is computed as follows:

$$\sum_{i=1}^{n_u} |X_u| = (|-3| \times 26) + (|-2| \times 31) + (|-1| \times 20) = 160$$

$$\sum_{i=1}^{n_a} |X_a| = (3 \times 108) + (2 \times 90) + (1 \times 52) = 556$$

$Xt = 160 + 556 = 716$

n = total number of subjects = 342

$$\text{PCI for "Leave Bear Alone"} = \left[1 - \left|\frac{556}{716} - \frac{160}{716}\right|\right] \times \frac{716}{(3 \times 342)} = 0.31$$

The potential for conflict index for "leave the bear alone" was approximately 0.31. Similar computations for the other four management actions revealed the following indices: 0.39 for "capture and destroy the bear," 0.18 for "capture and relocate the bear," 0.10 for "use techniques designed to frighten the bear away," and 0.04 for "educate people who live near bear habitat on how to avoid

TABLE 2 "Potential for Conflict Indices" and Mean Scores for Alaskan Respondents' Ratings of Acceptability of Bear Management Actions[1]

Management action . . .	Conflict index	Mean score[2]
Leave the bear alone	0.31	1.16
Capture and destroy the bear	0.39	–0.91
Capture and relocate the bear to a new location in hopes that it will NOT return	0.18	1.54
Use techniques (for example, loud noises or rubber bullets) designed to frighten the bear away	0.10	2.02
Educate people who live near bear habitat on how to avoid problems with bears	0.04	2.62

[1] Data for this example were taken from the WAFWA "Wildlife Values in the West" Demonstration Project and used only the responses from individuals living in Alaska.
[2] The following scoring was used in the computation of means for these variables: "Highly unacceptable" = –3, "Moderately unacceptable" = –2, "Slightly unacceptable" = –1, "Neither" = 0, "Slightly acceptable" = 1, "Moderately acceptable" = 2, and "Highly acceptable" = 3.

problems with bears" (Table 2). Because the PCI ranges from 0 to 1, the results clearly indicate that "leave the bear alone" and "destroy the bear" are likely to be the most controversial among the actions presented to this sample of Alaskan residents. Frightening the bear was far less controversial, and education showed virtually no potential for conflict.

To enhance the ease of understanding, Figure 1 displays the conflict indices and variable means graphically. Visually, it is apparent that "leaving the bear alone" and "destroying the bear" have higher potential for conflict than the other actions (i.e., the bubbles are bigger). Leaving the bear alone is, on average, acceptable, while destroying the bear is not. Among the other actions, education and frightening are far more acceptable, and there is relatively little disagreement about these actions. Their distribution is very positively skewed. Relocation, overall, is acceptable, but this action has a higher conflict potential than either education or frightening techniques.

A Bivariate Illustration

Researchers have increasingly been concerned with developing and using measures that convey practical meaning to statistical relationships (Robinson & Levin, 1997). Statistical significance is not necessarily synonymous with "practical significance" (Vaske et al., 2002). Practical significance involves a value judgment made by the "consumer" of research (e.g., manager, researcher, stakeholder).

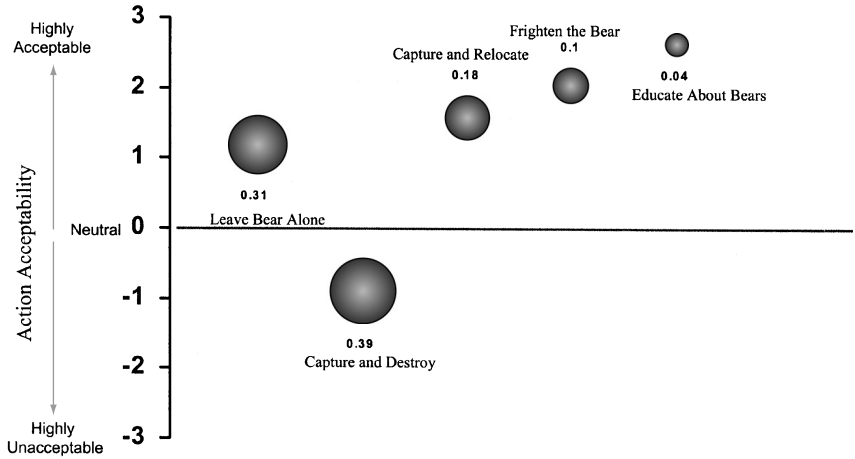

FIGURE 1 Univariate measures using the PCI and the graphic technique: Alaskans' ratings of acceptability of bear management actions. Numbers listed for each bubble in the graph represent the Potential for Conflict Index (PCI).

A descriptive statistical approach to bivariate relations should enhance the ability to draw conclusions about the practical significance of findings.

Our use of the PCI to convey the practical significance of a bivariate relationship focuses on a situation familiar to managers, the potential for conflict regarding the acceptability of a management action among subsegments of a population. This case involves a categorical independent variable and an interval level dependent variable. To demonstrate the utility of the PCI, we explored the relationship between wildlife value types and the acceptability of the management action "capture and destroy the bear." The value types were identified by scales measuring a protection-use wildlife value orientation and by general measures of societal values (see Manfredo et al., 2003 for details on how these measures were computed). For purposes of illustration, three of these value types were selected for comparison (i.e., "Traditionalists," "New Generation Utilitarians," and members of the "Protection-Neutral" category).

Table 3 shows tabular results for value type differences on the management action "capture and destroy the bear." The ANOVA F-Test indicates statistically significant differences among the three groups, $F(2, 326) = 17.9$, $p < .001$. Post hoc tests indicate that the Protection-Neutral group is statistically different from the other two value types with respect to the acceptability of capturing and destroying the bear.

Figure 2 shows the bubble graph depicting the conflict indices and group means for this analysis. Similar to the univariate graph, bubbles in this graph

TABLE 3 Results of Analysis of Variance for Mean Differences Across Value Types on the Bear Management Action "Capture and Destroy the Bear" for Alaskans[1]

Value type[2]	Percent of sample[3]	Mean[4]	Standard deviation	Standard error	PCI
Traditionalists	52	–0.48[a]	2.20	0.17	0.52
New Generation Utilitarians	34	–1.05[a]	1.85	0.17	0.30
Protection-Neutral	11	–2.06[b]	0.85	0.14	0.02

[1] $F(2, 326) = 17.9$, $p < .001$.
[2] See Manfredo et al. (2003) for details on how these classifications were developed and measured.
[3] Percentages do not add to 100 due to the omission of a segment of the sample (i.e., the focus for the purposes of this illustration were only upon these three value types).
[4] Means with different superscripts were statistically different using Scheffe's Post Hoc Test for mean differences.

show dispersion, and the center of the bubble is plotted as the mean on the Y-axis rating scale. It differs from the univariate situation, however, because an additional characteristic of the bubble is plotted on the X-axis—the sample group mean plus two times its standard error (i.e., the upper bound of the 95% confidence interval for the estimate of the population mean; Hays, 1994). The separation of bubbles

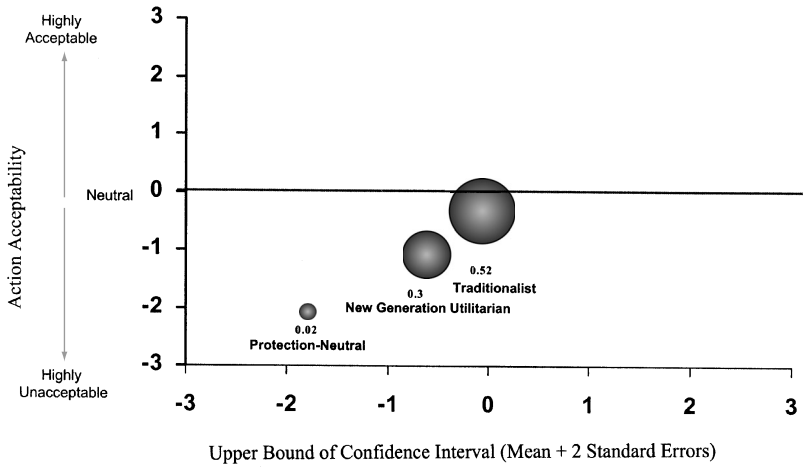

FIGURE 2 Bivariate distributions of the PCI and the graphic technique: Alaskan value types' ratings of acceptability of capture and destroy the bear. Numbers listed for each bubble in the graph represent the Potential for Conflict Index (PCI). ANOVA Results: $F(2, 326) = 17.9$, $p < .001$. Scheffe's Post Hoc Test indicated that the Protection-Neutral group is statistically different from the other 2 value types.

on the X-axis shows the practical separation of group means that have been tested for significant difference using an inferential statistical procedure (in this case, ANOVA).

The visual differences in Figure 2 among these groups are more revealing than the statistical differences indicated in analysis of variance. While all group means reveal that the action is unacceptable, there is considerable conflict within the Traditional Utilitarian group (i.e., large PCI and bubble), and, to a lesser extent, among New Generation Utilitarians. The Protection-Neutral group finds this action highly unacceptable, and there is a high degree of consensus (i.e., small bubble, low PCI). By examining the graph, the separation of scoring between the Protection-Neutral group and the other two value types is readily apparent. Because group means are plotted along with the upper bound of their confidence intervals, and because the PCI is an index of dispersion, it is relatively easy to surmise where statistically significant differences will be found (i.e., between groups with a noticeable degree of separation between bubbles). This visual interpretation is by no means a substitute for statistical testing; rather it guides one in interpreting the results. Small, nonoverlapping bubbles are likely to have both statistical and practical meaning. Bubbles that have statistical differences but have overlapping bubbles may require closer examination to interpret the practical implication.

Conclusion

If a goal of human dimensions research is to provide input for natural resource decision making, it is imperative that researchers communicate to managers about the practical implications of their findings. We have developed a descriptive statistical technique to assist in achieving that goal. We are encouraged by the fact that the technique has been well received in presentations we have made to the management community.

We recognize that variations on our approach are possible and encourage further exploration. We also encourage research that addresses the predictive validity of PCI indices, which would enhance the statistical credibility and practical utility of our approach. For example, if there is a high potential for conflict (i.e., a high PCI) associated with the acceptability of a given management action, does conflict actually emerge as a result of deciding to implement that action? This type of validation would assist managers in the interpretation of PCI values. Ultimately, however, the utility of this approach will be clarified by trial and error and through judgments about its practical utility.

References

Decker, D. J., Brown, T. L., & Siemer, W. F. (Eds.) (2001). *Human Dimensions of Wildlife Management in North America*. Bethesda, MD: The Wildlife Society.

Hays, W. L. (1994). *Statistics*, 5th Edition. Fort Worth, TX: Harcourt Brace.

Loether, J., & McTavish, D. G. (1976). *Descriptive and Inferential Statistics: An Introduction. A Selectively Combined Edition of Descriptive Statistics for Sociologists and Inferential Statistics for Sociologists*. Boston: Allyn and Bacon.

Manfredo, M. J. (Ed.) (2002). *Wildlife Viewing in North America: A Management Planning Handbook*. Corvallis, OR: Oregon State University Press.

Manfredo, M. J., Teel, T. L., & Bright, A. D. (in press). Why are public values toward wildlife changing? *Human Dimensions of wildlife.*

Teel, T. L., Bright, A. D., & Manfredo, M. J. (2003). *Regional results from the pilot phase of the research project entitled "Wildlife Values in the West."* (Project Rep. No. 55). Project Report for the Western Association of Fish and Wildlife Agencies. Fort Collins, CO: Colorado State University, Human Dimensions in Natural Resources Unit.

Robinson, D. H., & Levin, J. R. (1997). Reflections on statistical and substantive significance, with a slice of replication. *Educational Researcher, 26*, 21–26.

Vaske, J. J., Gliner, J. A., & Morgan, G. A. (2002). Communicating judgments about practical significance: Effect size, confidence intervals and odds ratios. *Human Dimensions of Wildlife*, *7*(4), 287–300.