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REPORTING RESULTS OF DATA ANALYSIS, PREPARING SCIENTIFIC MANUSCRIPTS, AND WEBSITE DEVELOPMENT EFFORTS

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Preparation of scientific manuscripts and use and presentation of statistics have been topics of several commentaries from previous journal Editors-in-Chief, and have been submitted as invited papers, so I would like to share my perspective as the current Editor-in-Chief (Editor) of *The Prairie Naturalist* (Journal). Because there is not complete consensus among the experts about when hypothesis testing versus information theoretic methods, or Bayesian versus frequentist methods are suitable, previous Editors have avoided presenting their perspectives (Thompson 2010). I also will avoid presenting my perspective as Editor. I will, however, present my perspective on several of these approaches and then offer some guidelines for presenting results of some commonly used statistical methods in the Journal. Further, I will also highlight several recurring issues related to improper manuscript formatting that I continue to encounter and then provide several potential solutions to minimize future occurrences and in turn, expedite the peer-review process.

Previous Editors have addressed the importance of exploratory analyses and descriptive statistics and the need to keep statistical analyses as simple as possible, all while keeping the focus on biology and management (Thompson 2010). Another recurring theme has been to focus on effect sizes rather than P-values for statistical tests. I think few people would disagree with this advice if kept in the proper context. The Journal publishes a wide range of Articles and Notes; some will require nothing more than simple models (e.g., means and confidence intervals), but others will require more complex models and model selection approaches. There has been considerable commentary in professional wildlife journals concerning the increased use of information theoretic (I-T) approaches, including concerns that it has become a widely misused statistical ritual in scientific journals (Thompson 2010). Most any statistical approach can be misused but all have value when used properly and in the proper context. There is a place for exploratory analyses and descriptive work in the Journal; descriptive statistics may be all that is necessary for some Research Notes and provide useful background before presenting results from more complicated statistical models (Thompson 2010). I firmly believe, however, that throughout the wildlife profession, our focus should be centered on rigorous studies that address a priori hypotheses through appropriate manipulative and observation study designs. Ideally, conducting simple experiments to directly evaluate research hypotheses is preferred. However, most of our research is exploratory (observational) because of its scale or context and information theoretic approaches can help provide stronger inference in these cases (Thompson 2010).

As Editor I will not insist on any particular approach because one size does not fit all. However, I will point out, with the help of reviewers and Associate Editors, when methods and interpretation are inappropriate. In the case where multiple approaches are acceptable, I am unlikely to request that an author change their approach to data analyses unless the current approach results in misleading conclusions or is overly complex and lengthy. Through the review and content editing processes, our Editorial Staff will try to make sure results are reported appropriately with a focus on wildlife biology and management. Problems with presentation of analyses in scientific papers often begin in the introduction section of a paper (Thompson 2010). At the end of the Introduction authors should clearly present their objectives, as well as a limited number of a priori hypotheses if applicable. On the other hand, lengthy lists of hypotheses tied to models in an information theoretic approach should instead be presented in the Methods section (Thompson 2010). It is surprising to me how many authors do not clearly state their study objectives. A statement of objectives is not the place to demonstrate creative writing; authors should simply state "our objectives were to ..." or "we evaluated support for the following hypotheses...." (Thompson 2010. These should be stated as scientific or research hypotheses, not statistical or null hypotheses (Thompson 2010). In the Methods section authors can justify how analyses will support or refute these hypotheses based on appropriate statistical approaches (Thompson 2010). When using information theoretic approaches or any approach based on a priori hypotheses authors should present evidence that these are valid hypotheses. Authors should clearly describe the extent to which the study was exploratory or confirmatory.

Traditional frequentist approaches like t-tests and analysis of variance test null hypotheses. Although results of these tests should usually be reported (test statistic value, df, and P-value) the primary focus should be interpretation of effects (Thompson 2010). Presenting treatment means, or their differences, and confidence intervals are effective ways to present effect sizes (Thompson 2010). For more complicated analysis of variance models authors should generally present model based means, such as least-squared means, rather than simple arithmetic means (Thompson 2010). Authors should emphasize estimated effects or parameters and their biological interpretation, and report test statistics and P-values in tables whenever possible or else parenthetically. Authors should try to avoid stand-alone, often meaningless, P-values by being specific about how things differed (e.g., parameter X was 10 % smaller than parameter Y [$P < 0.001$]; Thompson 2010). In the case of numerous comparisons that are presented graphically or in tabular format, citation of the figure or table is appropriate.

Many submitted papers continue to confuse the meaning of a P-value. As researchers, we should wonder why conditioning on the null hypothesis is desirable. Importantly, we also should note that the alternative hypothesis is never tested. The alternative gets support only by default – when the null is "rejected" or "significant" (Anderson 2010). The usual t-tests and analysis of variance (ANOVA) models are still useful in the analysis of experimental data. Results ruled "nonsignificant" in a null hypothesis testing (NHT) framework should not be taken to mean there is no effect or no difference (Anderson 2010). This is a very common mistake. A parallel issue exists when a simple model (e.g., one with only a few parameters) is selected by AIC_c and assigned a high weight (model probability). This result should not be taken to mean that larger models with additional effects and parameters are unimportant (Anderson 2010). With small samples only dominate effects can often be supported. As sample size increases, smaller effects can be identified (Anderson 2010).

Because information theoretic or other model selection approaches involve multiple models, presenting and interpreting results is a little more challenging (Thompson 2010). Key to an information theoretic approach is identification of a limited set of interpretable models that represent valid a priori hypotheses (Thompson 2010). While many researchers are trying to limit the number of models by carefully considering and reconsidering alternatives; there are others that seemingly give this little thought and hope the computer will sort out the important variables and relationships (Anderson 2010). As researchers, we should continue to encourage hard thinking about *plausible* alternatives. This focus should be on the science and alternatives that seem worthy of study. Then, the focus shifts to the *evidence* for each alternative (Anderson 2010). I contend that authors should think about alternative hypotheses more than the number of potential models to include in analyses. While most statistical software packages are capable of running hundreds (if not thousands) of models, I would contend that as researchers we would find it very challenging to develop hundreds or thousands of plausible scientific hypotheses. Further, there are cases where none of the models have merit. This can often be checked by an evidence ratio of a model with only an intercept vs. a global model or the AIC_c-best model (Anderson 2010).

Model selection approaches can be exploratory and use Akaike's Information Criteria (AIC) but should be clearly differentiated from an information theoretic approach to a priori hypothesis-based inference (Thompson 2010). Authors should clearly articulate the candidate models considered, preferably by presenting a limited number of models (e.g., the top models) in the results tables; when many models are considered, authors should list these in tables, appendices, or supplemental material or describe in text how variables were combined to form the candidate models (Thompson 2010). Authors should present support for the models, typically in a table that includes model name or description, the log-likelihood value, number of model parameters, selection criteria (e.g., AIC), differences from the top model (Δ_i), and Akaike weights (Thompson 2010). If there are many models, authors may consider presenting these results only for the competing models with some support. In almost all cases in addition to evaluating support for these hypotheses, authors should interpret effects in the supported model or use model averaging if there is model selection uncertainty (Thompson 2010). Interpretations of regression coefficients, odds ratios, and plots of predicted responses as a function of covariates are effective ways to evaluate model selection uncertainty. Authors should be clear about what they did and why. Interpretation of effects from supported models should focus on the biological significance of estimated effects and treat confidence intervals as measures of precision of the effects, not null hypothesis tests of no effect (Thompson 2010). Authors should interpret model support, or lack of support, to evaluate their hypotheses (Thompson 2010).

When using information-theoretic (I-T) approaches there are no "tests" and no dichotomous decisions concerning "significant" or "nonsignificant." However, Anderson (2010) noted that there are substantial advantages of I-T approaches over NHT. For example, the use of NHT and its P-values leaves an analyst without ways to (1) rank models, (2) treat observation studies, (3) model average effect size, (4) incorporate model selection uncertainty into estimates of precision, or (5) lessen model selection bias. Classic ANOVA tables have been used for the past 70–80 years; it is not surprising that better approaches have been discovered. Outside of one's "comfort zone" why would an analyst prefer an F-statistic and a P-value over an array of evidential quantities available under an I-T approach? There is no "power" of the test as there are no tests nor is there a valid concept of "power" following an analysis where the P-value is ruled "nonsignificant" (Anderson 2010). Statistical power should be reserved as a planning device for experiments.

Confidence intervals often are misused as if they can be used as a binary "test." That is, if the intervals "overlap" then "nonsignificant" is ruled; such judgments are incorrect (Anderson 2010). The correct approach is to examine the confidence interval of the *difference* between two estimates. Such intervals are often easy to interpret; however, a more rigorous measure of evidence can be had using simple evidence ratios. Some authors continue to use AIC_c to rank models and then "test" to see if the best model is "significantly" better than other models in the candidate set. Such mixing of test statistics and their P-values with I-T approaches is inappropriate and leads to serious inferential problems (Anderson 2010). Thus, one should use NHT tests or I-T methods throughout rather than mixing the two approaches. Importantly, "testing" or reporting null hypotheses that are obviously uninteresting or trivial ("silly nulls").

Akaike's Information Criterion should be used only when the sample size (n) is substantially larger than the number of parameters in the global model (K). Generally, one should usually use AIC_c unless n/K >40 (or in the case of overdispersion, use $QAIC_c$; Anderson 2010). Many papers use AIC_c only to rank models; inference is then made from this estimated "best" model. While this strategy is not incorrect, it fails to use the power of making formal inference from multiple models and the hypotheses they represent (Anderson 2010). Some authors use NHTs to assess the "significance" of a β–coefficient representing an interaction term in a linear or nonlinear regression analysis or an ANOVA model. A simple alternative is to compute an evidence ratio between 2 models: one with the interaction term and one without. This simple procedure avoids assumptions about the distribution of the test statistic under the null, the multiple testing problem, and the fact that the alternative (the importance of the interaction term) is never "tested "(Anderson 2010).

In the case where the top models are nearly tied in terms of empirical support and your goal is prediction, predictions should be made from each of the top models to calculate a weighted model-averaged prediction (Anderson 2010). In this case, the fact than one or two of the models does not contain a particular variable is immaterial. When trying to understand effects or relationships, and some variables don't appear in some of the top models, the answer is more difficult to determine with any generality (Anderson 2010). This being said, Anderson (2010) suggests focusing not on model averaging, but instead on the use of various evidence ratios. For example, he suggested considering the case where you believe that X1 and X4 are important and your attention is focused on X3 where you would like more evidence concerning its worth. Further, Anderson (2010) suggested examining 2 models: one with only X1 and X4 and the second model with X1 and X4 AND X3 and subsequently computing the model likelihoods for both models and take a ratio of these. He also noted that this evidence ratio gets directly at the importance of X3, given that X1 and X4 are in the model. Unlike the usual t-test of the regression coefficient for X3, the evidence ratio makes no assumption about the distribution of the test statistic being t-distributed, no concept of alpha (e.g., 0.05), and not worry that other tests have been performed on the data (the multiple testing problem; Anderson 2010). The evidence ratio is nice for exploring relationships with both variables and interaction terms.

In summary, authors should begin by clearly stating their study objectives. Authors should then report a priori hypotheses, and the Introduction should provide background as to why these are valid hypotheses (Thompson 2010). Authors should indicate if their approach is exploratory and explain the experimental design. Adequate explanations of experimental designs are often lacking from submitted manuscripts, but this is perhaps a topic for another column. Authors should use appropriate statistics and models and present some assessment of model plausibility and fit (beyond relative comparisons of model support; Thompson 2010). Authors should focus on the biological interpretation of effect size with test statistics and P-values reported in tables or parenthetically (Thompson 2010).

For the benefit of our members and future authors, we have developed a revised version of the manuscript submission guidelines, which are available as a PDF file on the website (http://www.sdstate.edu/wfs/GPNSS/TPN/submission-guidelines.cfm) and as a published manuscript in Volume 41, Issue 3/4. Our intention was to develop a detailed, consistent set of manuscript submission guidelines for the benefit of all potential authors in the future. I am surprised, however, at the number of improperly formatted manuscripts that I continue to receive. Fortunately, most of the "problems" I encounter are easily corrected by our Editorial Staff. Spending additional time addressing these issues, however, contributes to a delayed peer-review process. I believe strongly that properly formatting manuscripts prior to submission is the sole responsibility of the authors. I would encourage future authors to pay particular attention to formatting tables and figures, especially being mindful to use consistent font type/size throughout. Authors also should provide our Editorial Staff with an original version of all figure files (jpeg, tiff, bitmap formats) or Excel files of raw data to ensure that we can properly manipulate files as needed during latter stages of the peer review process (e.g., preparation of galley proofs). Future authors also are encouraged to thoroughly review the current submission guidelines to ensure that *all sections* of their manuscripts (including headings, subheadings, running heads, page numbering, title page, literature cited, list of figure files, table titles, etc.) strictly adhere to our formatting guidelines.

Though we have seen a slight increase in our 2010 manuscript submission rate, the current manuscript submission rate remains insufficient to support a quarterly publication of the Journal. Importantly, the future publication schedule of the Journal will continue to occur biannually (June and December) until manuscript submission rates can once again support a quarterly publication schedule. Our Editorial Staff will continue to work on restoring the quarterly publication schedule of the Journal, which will require increasing current manuscript submission rates. Additionally, increasing manuscript submission rates will aid in accomplishing our long-term objective of recognition and indexing of the Journal on the Intercollegiate Studies Institute (ISI) Web of Knowledge. We would encourage researchers throughout the Great Plains to submit their work for possible publication in the Journal. Importantly, I have been in communication with ISI Web of Knowledge to identify future efforts that our Editorial Staff can work on to aid in eventual ISI recognition and indexing of the Journal, including improving the timeliness of publication and providing greater access to information via our website

(http://www.sdstate.edu/wfs/GPNSS /TPN/index.cfm). We have minimized our peer review process to 2–3 months and have developed our new website, which provides access to previous publications and other GPNSS/Journal information. The Editorial Staff will continue to develop the website and will revisit the ISI Web of Knowledge during Fall 2011 in an effort to gain recognition and indexing of the Journal. We will continue to develop an electronic version of the quarterly Newsletter, which will be available to our members on the website. Further, we will continue to explore options that will allow GPNSS members to establish or renew existing memberships electronically.

We are pleased to inform our members that *The Prairie Naturalist* now offers an online publication option to manuscripts published in the Journal. Authors have the option of choosing to publish their work Open Access in addition to traditional print. Open Access Research Articles and Notes will be found in *The Prairie Naturalist* Current Publications or *The Prairie Naturalist* Archives. Open access will allow authors to have their work digitally downloaded directly from our website and made available to a larger audience. We have published our most recent Journal issue (Volume 42, Issue 1/2) as Open Access to provide authors with opportunities to examine the current format. Our Editorial Staff members are working to allow free access to abstracts of all Research Articles published in the Journal. The fee schedule for Open Access can be found in *The Prairie Naturalist* Page Charges (http://www.sdstate.edu/wfs/GPNSS/TPN/upload/Page-Charges-for-Publishing-in-The-Prairie-Naturalist.pdf).

Finally, I am pleased to announce the addition of several new members of our Editorial Staff, including Associate Editors Drs. Gary Larson, Lawrence Igl, and Kurt VerCauteren. We are seeking additional Associate Editors to serve on our Editorial Staff. Interested persons should forward a letter of interest and curriculum vitae directly to me. I am most easily reached via email (prairie.naturalist @sdstate.edu). As always, we will continue to provide our members with information updates in future issues of the Journal. I'm excited about the future of the Journal. Thanks everybody and I hope you enjoy this issue.

—Christopher N. Jacques
Editor-in-Chief

LITERATURE CITED

Anderson, D. R. 2010. Some important considerations when reporting the results of data analysis. 3 pp.

Thompson, F. R., III. 2010. Editor's Message – Application and Presentation of Statistics. Journal of Wildlife Management 74:617–619; 2010; DOI: 10.2193/2010-045