

REVIEW OF LEATHERBACK TURTLE EXPERT WORKING GROUP REPORT

By

W. Don Bowen

**External Review Conducted for the Center of Independent Experts
University of Miami**

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Executive Summary

- 1.** The National Marine Fisheries Service's Southeast Fisheries Science Center convened a Leatherback Turtle Expert Working Group (TEWG) to assess the status of leatherback turtles in the Atlantic Ocean. The TEWG met in November 2004, April 2005, October 2005, and March 2006 and produced an assessment of the Atlantic population in February 2007.
- 2.** I reviewed the TEWG assessment with particular attention to the adequacy, appropriateness, and application of the data, the methods used to assess the population, and to project population status and trends, and the research recommendations.
- 3.** The core of the current assessment is the estimation of the abundance and trends in the number of nests in six of the seven putative stocks. Using those estimates and data on adult sex ratio and the remigration interval of adult females, the TEWG also estimated the size of the adult population. Although there are recognized gaps and other problems with available data, the types of data used in the assessment are appropriate. The methods used to assess the trends and abundance of adults are appropriate and the assessment was carefully conducted, taking into account potential biases and uncertainty. The model results are presented in a clear and concise way and the conclusions with respect to trends are well supported.
- 4.** The conceptual model of the Atlantic basin-wide population is quite useful, but should appear much earlier in the assessment report. This re-organization would help guide the reader through the steps of the population assessment.
- 5.** Although synthesis of the Argos data on movements was a welcome effort, inferences that can be drawn from the resulting analysis are limited by the uneven number and distribution of tags deployed across the seven putative stocks and the lack of an overall study design.
- 6.** Much of the recommended research would go a long way to improving our understanding of the population dynamics of leatherback turtles in the Atlantic Ocean. However, the recommendations could be strengthened by taking a more critical view of the feasible research that would have the greatest impact on improving the assessment and presenting this in the context of a basin-wide research plan.
- 7.** There is a need for an integrated, international research plan on the dynamics of the species. While the better time series should be continued, key gaps in knowledge need to be addressed. A well-designed research plan for the entire meta-population (or structured population if preferred) should be developed to fill key gaps in knowledge that are needed to improve future assessments.

Background

The National Marine Fisheries Service's Southeast Fisheries Science Center convened a Leatherback Turtle Expert Working Group (TEWG) to assess the status of leatherback turtles in the North Atlantic Ocean. The leatherback is an endangered species and a recent Endangered Species Act Section 7 Consultation Biological Opinion for Highly Migratory Species (BiOp) completed in 2004, specifically required the Science Center to convene a leatherback TEWG by December 31, 2004 to assess the status of leatherbacks in the Atlantic Ocean. The TEWG met in November 2004, April 2005, October 2005, and March 2006 and produced an assessment report in February 2007.

The leatherback turtle is a large, long-lived and wide-ranging marine species. The conservation of this species is complicated by the ocean-scale distribution of the species, encompassing much of the Atlantic basin, including terrestrial, coastal, and pelagic habitats throughout various life stages, and crossing numerous political boundaries. Thus, effective population assessment and management require cooperation and action at multiple levels from local to international to estimate population parameters, incorporate fishery bycatch reduction, nesting habitat protection, in-water habitat protection, and the reduction of intentional take. The leatherback TEWG required extensive international participation because the majority of nesting (>90%) and foraging occurs outside of the United States.

Description of Review

This review is based on my reading of the draft assessment report of the Leatherback TEWG and focused on the following issues in the Statement of Work:

1. the adequacy, appropriateness, and application of data used in the assessment,
2. the adequacy, appropriateness, and application of methods used in the assessment,
3. the adequacy, appropriateness, and application of the methods used to project population status and trends, and
4. the research recommendations.

The documents provided for review are listed in Appendix A.

Summary of Findings

Adequacy, appropriateness, and application of data used in the assessment

The core of the current assessment is the estimation of the abundance and trends in the number of nests in each of the seven putative stocks and using those and other data to estimate the size of the adult population, again by stock. The genetic basis for these putative stocks is briefly reviewed, but stock structure is taken as a given rather forming a part of this population assessment. Nevertheless, there seems considerable empirical support for the assumed stock structure.

Several types of data are used to assess the status of the leatherback population. These include: adult sex ratio, counts or estimates of the number of nests, number of nests per female, and remigration interval of adult females. Given the biology of the leatherback turtle, these are appropriate, but not entirely adequate, as noted by the assessment team. More detailed studies of the number of females nesting would provide a firmer basis for estimating the rate of increase in the adult female population. Sex ratio is used to estimate the adult male component of the population, but these data come largely from stranded animals and may not be representative of the population as a whole. In the short-term, there seems to be little that can be done to improve these sex ratio estimates, but the team is well aware of the problems of using these data. Also, time series of sufficient quality and duration to estimate the rate of increase come from a subset of nesting sites and do not include all of the major sites. These are gaps in knowledge that cannot be rectified quickly. Therefore, I believe the assessment has been done with the best available data.

A large section of the report (pages 13-41) is devoted to a description of the available data on the number of leatherback turtle nests or females counted annually in each putative stock and at locations within stock over time. The description of these data vary greatly in the detail provided, which undoubtedly reflects that available to a large extent, but the authors appear to have exhaustively mined all sources to arrive at the best available description. There is a somewhat garbled sentence in the middle of page 33, beginning with “A least-squares criterion ...” and the formula for the angular transformation needs to be corrected. As the authors note, there are gaps in these data arising from the short, intermittent or non-existent monitoring of many breeding sites, including some of the largest in Africa. These gaps do hinder the assessment, but there is nothing that can be done to change this in the near term.

Data on coastal aerial surveys and strandings are presented in the assessment, but it is not clear how they contribute to our understanding of population status. In both cases, there is rather little analysis of these data. Stranding data are summarized by sex and area and over time, but as there are no questions stated in the text and no quantitative analyses of the data, it is not clear what the reader is meant to do with this information (exclusive of their use to estimate sex ratio presented earlier in the report). From the point of view of the assessment, changes in the size and sex composition of strandings over time might be used to infer changes in population size or composition. I realize there are problems here, but if the data cannot be used as a tool for assessment, perhaps they need not be included in this assessment.

Another type of data presented in the assessment is the movement of individuals based on Argos satellite locations. This is a useful and growing dataset used largely to link foraging and breeding areas and to examine the movements of individuals among breeding sites. These data contribute to our understanding of stock structure and the identification of leatherback turtle at-sea habitat. I applaud the attempt to synthesize all the data from diverse studies. This is a difficult undertaking and this assessment has made significant progress. I found judging the adequacy of the data and how they were used in the assessment was hampered by the lack of clearly stated goals for these studies. Each study seems to have been conceived in the narrow context of understanding the behaviour of females at a particular site. While this is not ideal, and clearly the assessment team has no control over how these studies were done, the data do not play a central role in this

population assessment. These data may play a larger role in the future and therefore it will be important to better plan and co-ordinate deployments to answer specific assessment questions.

Adequacy, appropriateness, and application of methods used in the assessment

This assessment used the data collected from breeding beaches to assess population changes over time. Given the biology of marine turtles, this approach is both sensible and necessary as the numbers of juveniles and adult males cannot be surveyed with any confidence. The TEWG explored several methods for detecting trends in adult female or nest counts. However, before applying those methods, a series of simulations using a stochastic model were performed to evaluate whether or not the various time series were adequate to determine the underlying true trend. Those simulations indicated that time series less than 10 years were not adequate for determining the true population growth rate. Given the wide variation in the quality of the data from different nesting beaches, this was a good approach that undoubtedly improved the accuracy of the overall assessment of trends. One point could be clarified here. Did the 10 years refer to the interval or the minimum number of counts (i.e., would 7 counts over a 15 year period still qualify for the analysis)?

Six of the seven putative stocks identified in the assessment contained nesting beaches with adequate quality time series (i.e., ≥ 10 yr of counts). Two approaches were then used to determine the trend in nest counts of each of these beaches: regression analyses and Bayesian modeling. In both cases, the models assumed that the underlying female population could be sufficiently modeled by the geometric population growth. I understand the basis for this assumption (i.e., the lack of an obvious asymptote in the counts), but it still seems to me that evaluating alternative assumptions based on how the data fit alternative models would be worth investigating. This is not a light undertaking and I am not suggesting that it should be done now, but future assessments could be strengthened by doing so. I would also like to see scatter plots of the better quality datasets used in drawing the conclusion about the lack of asymptotes. I expect those data are given in the various tables in the section of the report dealing with the annual nesting counts, but trends are difficult to see in tables. As the Bayesian model makes the same assumption about the lack of density dependence, including such plots seems rather important.

Two regression methods were used to assess trends: the first is the standard approach and the second is from work by Morris and Doak (2002; note Dennis et al. (1991) referred to in the text is not in the reference list). Although the two methods provide similar estimates, I notice that the Morris and Doak estimates have wider confidence limits than the standard log regression, presumably because there are fewer estimates of growth rate than there are counts and smoothing the data also shortens T (the length of the time series). For those who lack a copy of Morris and Doak, it might therefore be useful to draft text that speaks to the benefit of using this approach.

The approach to the construction of the Bayesian model seems reasonable with the two caveats mentioned earlier, namely the assumption about density-dependence and the assumption about geometric population growth. It is not that these are necessarily unreasonable assumptions given the data, only that the basis for the assumptions are not well documented in the assessment. On page 44, the TEWG concludes that “the visual inspection of the raw data indicated that the log-linear model was probably appropriate.” Again, it would be useful to include in the

assessment the plots of the raw data and the regression model fits so others could independently judge for themselves. This comment also applies to the Bayesian simulations referred to on page 44. Also, the decision by the TEWG to use a conversion of 5 nests per female is undoubtedly informed by data, but none are provided nor is the source of such data referenced. Doing so would be useful for the reader.

Table 17 provides the estimates from the regression and Bayesian models. One slight clarification would be useful. The table should explicitly state somewhere that T (the duration of the series) is also the number of counts used if true, or actually provide the number of counts used if this is not true. Also T is different for the two regression methods and this should be reflected in the table. Pages 44 and 45 really just restate what is clearly provided in Table 17. As such this text could be deleted.

The Discussion of the model results does a good job of summarizing the assumptions and identifying limitations of the analysis and possible sources of bias. However, I was somewhat concerned with the last sentence of the first paragraph, namely “The total population growth rate of a stock, therefore, may be drastically different from the one estimated in this analysis.” This sentence seemed to unfairly undermine the results of rather careful analyses. It certainly is true that juveniles and adult males may show different trends than the number of nests (the proxy for adult females), but the words “drastically different” seems too pessimistic. Perhaps some additional explanation for this conclusion could be included here to justify such a strong conclusion.

At-sea Movement

Satellite telemetry provides a rich source of information on the movements of turtles which can be used to link foraging areas and habitat use to stocks and to estimate rates of exchange both within and among stocks. However, as noted in the assessment, Argos locations are subject to error and the data must be filtered or corrected in some fashion prior to analysis to permit reliable inferences to be drawn. The assessment team has used several ad hoc filters, a standard approach to this problem. However, by using only Argos $LC > 1$, they have discarded much of the data. How much is not stated, but certainly a significant fraction of locations will not have been used. The resulting analysis works fine for this assessment, but future analyses should explore other published filters or approaches (i.e., state-space models) that use all of the data.

The assessment team used linear interpolation to fill in missing data. It would be useful to have some explanation for the time criteria used here and what fraction of the tracks had to be interpolated. Also, the caption of the Northern Caribbean assemblage in Figure 12 should be modified by inserting the word “animals” after the sample size of 3.

Overall, I applaud this first effort to synthesize the Argos data on movements. However, as recognized by the assessment team, inferences that can be drawn from this analysis are somewhat limited at this point by the uneven number and distribution of tags deployed across the seven putative stocks and the lack of an overall study design. Nevertheless, these data do illustrate the potential value of a well designed international effort to understand stock structure and habitat use.

Adequacy, appropriateness, and application of the methods used to project population status and trends

Although estimating trends in female numbers is difficult, estimating total adult population size presents even more of a challenge. The assessment provides a good overview of leatherback life history which provides the rationale for the approach to estimating the total adult population. I should note that, although terms are often taxon specific, the term “proportion neophytes” (page 49) is quite opaque. Is there not a more standard life history term, say, the concept of first breeder, that could be used in place of this term?

I liked the approach to estimating total adult population size. Essentially a spreadsheet population model was used to randomly generate the expected distribution of population sizes from three fundamental parameters describing leatherback population biology. My only question is why rounded values were used in Table 18 rather than the actual data? Using the actual count ranges would not change the conclusions drawn from the analysis, but the rationale for using rounded values should be stated more clearly (see page 51). It would also be useful to state why trends in total population size were not estimated. Presumably, this is because there are no time series estimates of sex ratio and remigration rates.

The section on threats to the population was a little disappointing. This may largely reflect the sparse and often qualitative nature of the data, but I found it difficult to place the estimates in a population context. There may be little that can be done at this point, but the team might give some thought about how to present these losses in the context of the impacts on leatherback dynamics in a future assessment. In some sense, Table 23 attempts to do this by ranking the seriousness of threats by rookery. However, I found it difficult to understand how the rankings were combined to produce an overall threat assessment. There does seem to have been a consistent algorithm used here.

Finally, I am puzzled by the notion of “artificial demographics” and why the team felt the term was useful. Like any other animal, the demography of leatherback turtles is influenced by both intrinsic and extrinsic factors, including food supply, predators, disease, and human exploitation (either directed or incidental). What the examples cited indicate is that it may often be possible to reasonably conserve a population without achieving global protection. Some life stages and demographic classes are more important to protect than others. This is not a new idea and it is hard to see why this is considered to represent artificial demographics. It seems to me that this section of the assessment should be entitled “Conservation Strategies”.

Comments on Recommendations

Much of the recommended research would go a long way to improving our understanding of the population dynamics of leatherback turtles in the Atlantic Ocean. However, I believe two key elements are missing from the list of things to do. First, there is a clear need for an integrated international research plan on the dynamics of the species. Clearly, the better time series should

be continued, but a well-designed research plan for the entire meta-population (or structured population if preferred) is needed to fill key gaps in knowledge. Second, I believe there are sufficient data to assess the relative sensitivity of leatherback dynamics to parameter uncertainty. This analysis could be valuable as a guide to direct scarce research dollars to the types of data that would have the greatest impact on improving the quality of the population assessment. For example, it is not immediately clear to this reviewer how further aerial or vessel-based surveys will contribute to an improved assessment. Similarly, the effect of egg poaching on population growth might be useful to know, but it seems unlikely that we could design a study to answer that question with any precision given the high hatchling mortality rates. In general, I think the recommendations could be strengthened by taking a more critical view of the feasible research that would have the greatest impact on improving the assessment and presenting this in the context of a basin-wide research plan. While I appreciate the difficulties associated with such a challenge, there is a real danger of not making the best use of resources in the absence of a well-thought out strategy for improving the assessment.

Conclusions and Recommendations

Overall, I was impressed with the careful and thorough assessment of the available data and the analyses of trends in numbers of nests and adult females. The method of estimating the total adult population also is carefully done and uses the best information. Nevertheless, I would **recommend** that scatter plots of the better quality datasets used in drawing the conclusion about the lack of asymptotes be included in the assessment. As the Bayesian model makes the same assumption about the lack of density dependence, including such plots will strengthen the report. From a reader's point of view, some re-organization would also strengthen the report. I **recommend** that the conceptual model of the Atlantic population be moved forward and appear immediately following the presentation of stock structure. I found this model quite useful. With this conceptual model up front, the data, methods of analysis, and the assessment results would be easier to follow. I also **recommend** a brief section in the report that more clearly identifies critical gaps in knowledge. This would naturally complement the section on research recommendations and would help to clarify and underscore the importance of recommended research.

There is a clear need for an integrated international research plan on the dynamics of the species. While the better time series should be continued, key gaps in knowledge need to be addressed. Thus I **recommend** that a well-designed research plan for the entire meta-population (or structured population if preferred) be developed to fill key gaps in knowledge. Second, I **recommend** that the relative sensitivity of leatherback dynamics to parameter uncertainty be explored as a guide to direct scarce research dollars to the types of studies that would have the greatest impact on improving the quality of the population assessment. Both of these recommendations are not meant to detract from the current assessment, but moving forward on these recommendations will pay dividends in the future.

Appendix A

Turtle Expert Working Group. An assessment of the leatherback turtle population in the Atlantic Ocean. Draft report February 2007. 114 p.

Consulting Agreement between the University of Miami and Dr. Don Bowen

January 31, 2007

Center of Independent Experts Review of Leatherback Turtle Expert Working Group Report

TEWG Overview

The National Marine Fisheries Service's (NMFS) Southeast Fisheries Science Center (SEFSC) convened a Leatherback Turtle Expert Working Group (TEWG) to assess the status of leatherback turtles in the North Atlantic Ocean. Scientists from NMFS, NGOs, academia, and foreign governments with expertise in leatherback biology and data analysis comprised this group. All members contributed their expertise to the group, with the goal of producing a draft report that assesses leatherback status in the Atlantic.

The TEWG concept was established by the SEFSC at the behest of NMFS in 1995 to assess the status of turtle species in the Atlantic. The first two TEWGs were convened to address loggerhead and Kemp's Ridley turtles (TEWG 1998, TEWG 2000). The leatherback TEWG was initiated to address the assessment of leatherbacks. Also, the recent Endangered Species Act Section 7 Consultation Biological Opinion for Highly Migratory Species (BiOp), completed in 2004, specifically required the SEFSC to convene a leatherback TEWG by December 31, 2004 to assess the status of leatherbacks in the Atlantic (Terms and Conditions 9.4a.). The TEWG met in November 2004, April 2005, October 2005, and March 2006.

The SEFSC has the lead for conducting stock assessments on Atlantic sea turtles, and assembled an international group of government scientists, academics, NGOs and industry representatives to assess the status of leatherbacks. The leatherback TEWG required more international participation than previous TEWGs, because the majority of nesting (>90%) and foraging occurs outside of the U.S. The location of major nesting assemblages in French Guiana/Suriname and western Africa required extensive cooperation with our European and South American counterparts that have established research programs in those areas.

CIE Review

The Center for Independent Experts (CIE) shall provide an independent peer review of the TEWG leatherback stock assessments. The reviewers shall be responsible for determining whether the best possible assessment was provided through the TEWG process. The reviewers' tasks are specified in the Terms of Reference (below).

The CIE shall appoint three reviewers. Required expertise includes quantitative skills and an understanding of the life histories of large, long-lived, highly migratory marine vertebrates, including but not limited to, sea turtles.

Each reviewer's duties shall occupy a maximum of 5 work days for reviewing the Leatherback TEWG draft report (approximate length 120 pages) and preparing their individual peer review report. The reviews will be conducted in the reviewers' home offices, so no travel is required. The reviews shall be completed in February 2007, with the due date depending on when the TEWG draft report is provided to the reviewers (see below for schedule).

Please contact Chris Sasso (TEWG Coordinator; 305-361-4279 or chris.sasso@noaa.gov) for additional details.

Review Tasks

The reviewers shall evaluate the draft North Atlantic assessment report of the Leatherback TEWG. Their primary responsibility is to ensure that assessment results are based on sound science. The reviews shall consider input data, assessment methods, and results. To assist in this determination, reviewers may request copies of background documents, such as references cited in the TEWG draft report. If a reviewer finds the assessment to be deficient, then he/she shall recommend remedial measures, including an appropriate approach for correcting and subsequently reviewing the assessment. The evaluation shall explicitly address the following Terms of Reference.

Terms of Reference

Each reviewer shall develop their own independent review report that addresses the following terms of reference.

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2. Evaluate the adequacy, appropriateness, and application of methods used in the assessment.
3. Evaluate the adequacy, appropriateness, and application of the methods used to project population status and trends.
4. Review research recommendations provided in the report and make any additional recommendations warranted.
5. Prepare a Peer Review Report as described in Annex 1, summarizing the CIE Reviewer's evaluation of the Leatherback TEWG report and addressing each Term of Reference, including a statement on whether the assessment was based on sound science, appropriate methods, and appropriate data.

Roles, Responsibilities, and Schedule

1. In January 2007, the CIE Reviewers shall be provided with the Leatherback TEWG report and supporting documents.
2. Each reviewer shall read the TEWG report.
3. No later than two weeks after receipt of the TEWG report, each reviewer shall provide a draft independent Reviewer's Report meeting the requirements specified above to the CIE¹. This report shall be addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson, via email to David.Sampson@oregonstate.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu. See Annex 1 for complete details on the report outline.
4. By February 12, 2007, the CIE shall provide the final reports to the NMFS COTR for acceptance.

¹ All reports will undergo an internal CIE review before they are considered final.