Review of
Stock Assessment of Loggerhead and Leatherback Sea Turtles
for UM/CIE

Robert Mohn **March, 2001**

Preamble

This contract contained itemized tasks and defined areas of focus:

Itemized tasks:

1. Reading and reviewing supplied documents.

2. Determining if the methods applied to estimate bycatch are appropriate given the available data. In this element, reviewers are expected to recommend improvements in (reported) methods for estimating the precision in estimates of bycatch. Reviewers are also expected to recommend improvements in data collection that could lead to more accurate and precise estimates of bycatch.

3. No later than March 5, 2001, submitting a written report of findings, analysis and conclusions. The report should be addressed to the "UM Independent System for Peer Reviews," and sent to Dr. David Die, UM, RSMAS, 46000 Rickenbacker Causeway, Miami FL 33149 (or via email to ddie@rsmas.miami.edu.

Areas of focus:

1. Assumptions made defining stock structure including their correspondence with genetic information
2. Application of serious injury criteria Documentation of F/PR
3. Estimation procedures for catch and mortality in longline fishery
4. Conclusions on stock status and impacts of fishery relative to stock recovery

Upon receipt of the documents, they were given a read through to familiarize myself with the contents and approaches. Then a second detailed review was taken with annotations. And finally, a third review was done extracting the annotations and constructing this report.

Further comments are required to put this review in context. The first is that my background is in stock assessment and modeling the dynamics of populations. This has two consequences, the first is that I do not have much experience in genetic stock definition or in assessing impacts of gear and my reviews of these areas will not be in depth. The second consequence is that many of my comments will be on the assessment aspects of the document in comparison to others I have reviewed or performed. Hopefully such a bias will not represent a serious impediment.

Another comment regards the difficulty in reviewing a stock, with which one is not familiar, outside of the assessment meeting. Many small questions for information or clarification, which could have been answered easily during a meeting, arose during the review.

Similarly, an assessment must be evaluated against the objectives of the analysis, in light of the data and analytical methods available. These are the sorts of questions that usually cleared up the first morning of an assessment review but often do not get written down. My conclusions will be predicated by my experience in stock assessment and these expectations may be at some variance to the expectations under "Section 7 of the Endangered Species Act".

We tend to use external experts during an assessment meeting rather than after. As mentioned above, the reviewer is brought up to speed more quickly. But the main reason is the spin-offs for the scientists preparing the assessment documents. Different points of view, analytical practices, a little dialog or even some specific analysis can lead to small, and occasionally more significant, breakthroughs that are not possible in a post-hoc review.

Numerous times, I wondered if all the data were presented, or if a slightly different presentation would not make it clearer to an outsider.

This report is structured as:

Preamble
Overview
Responses to itemized tasks and specific areas to be focused upon
Detailed observations

Overview:

The manuscripts are well prepared and conclusions seem to be well considered from the available analysis. No analytical errors were detected, but in some cases more information was required. The most serious deficiency was the lack of any formal error analysis. Separate stages of the analysis often contained considerations of uncertainty but the overall uncertainty was not addressed. The conclusions were that both loggerhead and Florida leatherback populations were increasing in the 1990s but it is impossible to assign an index of confidence to these observations. The South American leatherback analysis was based on 2 degrees of freedom and is much more speculative.

In several instances, where it would have been possible, attempts to link data with analysis and final results were not presented. This failure makes model validation and assessment of risk impossible. Although the analyses are consistent and apparently correct, it is not possible to ascertain the confidence that should be associated with the quantitative results. One example is in the stock projections (Figures 15-17 in the loggerhead stock assessment). The figures show responses in the number of nesting

females. The data from the meta-analysis (or a summary of it) could be plotted on top of the projections which would give a feeling for the performance of various scenarios (if one did not want to get into goodness of fit issues). Similarly, the appropriate stage of the modeled populations could be plotted with the SEAMAP data. If this were done data and results could be linked, at least visually. The several growth models were given without data as well. Several more examples of this problem will be given in the more detailed review. This is particularly important when no formal error analysis or model validation is presented as it allows the reader to visually ascertain model performance and data fit. It also affords a basis for selecting critical data and priorities for research.

Because a catch history usually represents the longest time series and most extensively distributed 'sampling', it tends to be the first element of an assessment. A comprehensive table summarizing catch, bycatch and other sources of mortality for each species is needed. It should include year, area, stage (from egg to carapace) of harvested or otherwise impacted products. Tables of secondary catch characteristics such as size distribution would be appropriate as well.

A stock synthesis type of model should be developed for the loggerhead stocks. In a single model the pieces that were presented in the submitted documents would be analyzed. This model should have the growth data, the catch curve analysis, reproduction and the data used in the meta-analysis integrated into a single framework which would allow a comprehensive error analysis. Bootstrapping, either parametrically using distributions or by re-sampling data/residuals, would work well to better estimate uncertainties. Also, when the propagation of uncertainty is joined with a sensitivity analysis critical portions of the model would be revealed and indicate priorities for future research. There are probably not enough leatherback data for such an analogous synthesis.

One of the practices consistent with the Precautionary Approach is not to bias the steps during the analysis, but rather accumulate uncertainties and then correct explicitly at the bottom line. In two instances (the range of population growth rates used in projections and the 50% mortality rate in longline impacts) it might appear that biases were introduced. Our (Canadian) industry is very sensitive to such perceptions. Although I may be identifying a problem which does not exist, thought it best to error on the side of caution and mention it.

Responses to itemized tasks and specific areas to be focused upon

1. Reading and reviewing supplied documents.

   Done.

2. Determining if the methods applied to estimate bycatch are appropriate given the available data. In this element, reviewers are expected to recommend improvements in (reported) methods for estimating the precision in estimates of bycatch. Reviewers

are also expected to recommend improvements in data collection that could lead to more accurate and precise estimates of bycatch.

As mentioned in the preamble, most of my recommended improvements are in the modeling, assessment of uncertainty and assembly of existing data. Except for the citation of Syrjala below, no recommendations are given concerning the precision of bycatch estimation, which is data rather than analytically limited.

3. No later than March 5, 2001, submitting a written report of findings, analysis and conclusions. The report should be addressed to the "UM Independent System for Peer Reviews," and sent to Dr. David Die, UM,RSMAS, 46000 Rickenbacker Causeway, Miami FL 33149 (or via email to ddie@rsmas.miami.edu.

   This deadline was not possible and the report was e-mailed a week late.

Areas of focus:

1. Assumptions made defining stock structure including their correspondence with genetic information

I am not qualified to make an expert appraisal of the genetic work. However, more discussion was required of the implications of the stock structure to management interventions and population analysis, and (if applicable) with respect to any Precautionary Approach used in Endangered Species management.

2. Application of serious injury criteria

The principal conclusion of these analyses was that the mortality was 50%, a somewhat higher figure than the Hawaiian study. More justification of the higher rate should be provided, or it could be construed as a bias in the analysis. Given the quality of these data, no more precision would be warranted. Although expensive, an enhanced program of telemetric tagging of hooked or entangled animals may be required. The projections are probably quite sensitive to this rate.

3. Estimation procedures for catch and mortality in longline fishery

These analyses, and the similar ICCAT analysis, were well carried out and are credible. One concern is the recently reported potential bias in the lognormal delta method.

4. Conclusions on stock status and impacts of fishery relative to stock recovery.

As observed above it is difficult to state with certainty the loggerhead status, and even more difficult for leatherbacks. The meta-analysis gives a strong indication that recovery

is taking place in the 1990s, excepting South American leatherbacks. The stock projections are less compelling and the authors have not tried to suggest otherwise.

Detailed observations

In this section a specific page and item is specified for comment.

Executive summary

pg-v "Authorized takes continue." Need long term catch history as opposed to bycatch – could lead to production model of proxy for virgin abundance and scaling to estimated population sizes; also need to compare to bycatch and other sources of mortality.

Throughout the documents there is a casual usage of terms catch, bycatch and take; confusing to outsider as to whether these are or are not referring to directed fisheries.

I Stock assessment of loggerhead…

Pg 5 'panmixia can lead to incorrect management decisions' what sort of incorrect decisions? How can they be avoided?

Status and trends

Need a structured summary table per species of Area, pop, dPop/dt, removals by type (directed, LL, strandings…).

In a couple of spots (e.g. Pg. 8) r is > 0, yet all scenarios have $\lambda = 1$ as most optimistic scenario – why is this apparent bias introduced? Again on Pg. 18, the choice of λ values may be restrictive in light of the positive r from the meta-analysis; could not the range be broadened to say 1.04 for periods after 1990. Or perhaps as an option, those scenarios that do not have a positive growth could be identified as less likely in the figures.

Pg 9 In-water surveys. Reported that all techniques reviewed "appeared to be feasible". Is there not anyway for these experts to assign a Delphi –like ranking to the various techniques? Or perhaps some of them could be linked to the meta-analysis. This is a good example where participation at the meeting by an expert from the UM/CIE with a few timely questions and answers might well yield much better results than post hoc review.

Pg 10 justification for using delta-Poisson instead of delta-lognormal. What is the 'model uncertainty' or sensitivity between the two approaches? Authors might want to look at the recent article by S.E. Syrjala "Critique on the use of the delta distribution for the analysis of trawl survey data. ICES Journal of Marine Science Vol 57:4 p831." in which the author finds that the delta tends to overestimate the mean.

Pg 12 The SEAMAP results were only used in a power test – what if they were linked to the meta-analysis? If not with a likelihood model, they could at least be plotted over the meta-analysis results to infer collaboration (as they do) or contradiction.

Stock assessment

Used Heppel model (which is unfortunately in press) having 5 stages pelagic juvenile, 2 benthic stages and two mature (breeding and non-breeding) Tables 10-14 summarize stage durations. Although not described, this appears to be a Leslie Matrix type model with unreported coefficients for fecundity at age and some sort of transition criteria for changing between breeding and non-breeding status. At least a summary of the model structure and details should be provided. When the survivorships of the stages are accumulated to the age of first reproduction about .15% survive (I only tried this for tables 11-12). Thus only a very small percentage of the population is reproductive (unreported fraction of which are non-breeding) and it would seem likely that results could be quite sensitive to assumptions on reproduction which may not be well supported by data.

Numerous von Bertalanffy plots are give in figures 7 and 8. However none of the underlying data nor indices of goodness of fit are given. The uncertainty in this stage of the process could and should be assessed and carried forward for model validation and assessment of uncertainty in projections. These data would seem to be amenable to a bootstrapping approach.

Pg 17 Nice to see data with regressions (Fig 11-12).

Pg 20 Population projections. What is the relationship between year zero in these projections and the calendar date, say1990? This paragraph calls them post-1990 projections. But in the post-1990 the lambda should be positive according to the meta-analysis. The labels in the projections should be cleaned up.

These figures (15-17) show some interesting dynamics that should have been commented on. As the authors mention there is a time delay equal to the large benthic stage duration before the TED affects the number of nesting females. What is the cause of the complex behavior of Model 2 in Figures 15 and 16? The stock seems to recover rapidly and then this recovery is reversed. Is the TED removed after a period of time? When model 1 and 2 are compared in Figure 16, the dynamics are again a bit puzzling. In model 1 (0.97 scenario) there is an initial boost before year 10 and then a second one in year 30 as presumably the increased survivors of the 1st bump become reproductive (age 30). This is not seen in Model 2 which has an age of maturity at 37. However if it were run for another 10 years it might well get the 2nd bump and its poor performance may be an artifact of the duration of the projection. It is also of interest that the divergence between the upper pairs of projections appears much greater than the lower pairs although in both cases the distinction is minimum and average size to stages.

Impacts on the populations

Needs a summary table with clarity on catch (if any) and bycatch by source (longline, trawls etc), etc. The columns of this table could also be weighted by the reproductive cost of each stage (a young pelagic juvenile is less valuable than a large benthic, etc,) to look at historical impacts to potential reproduction.

Finally an integrative, exploratory stock synthesis model should be developed to get at least a vehicle to ascertain uncertainty (and perhaps risk) at the various stages used to produce projections. It could address questions such as what is the relative importance of uncertainty in the growth models (Figs 7,8), the z calculations (Fig 12) and the meta-analysis uncertainty. Such a model could also assist in setting priorities for research. A simple approach using simulations is given in Miller, D.R. 1974. Sensitivity analysis and validation of simulation models. J. Theor. Biol. 48:345-360

II Stock assessment of leatherback…

II-5, 6 Could all these observations be collated into a summary table from which at least trends either temporal or geographic could be gleaned?

II-6 is there any growth data (von Bertalanffy) available? Also, what is the approximate age of first reproduction?

II-9 Inferences from nesting trends. The issue is not that the adult females are a small fraction of the population but rather are they representative and how much of a delay is there between events that effect juveniles and the time it takes to affect the breeders. Figure 8 seems to be improving with time, can it be 'effort' corrected to be more CPUE like?

II-11 strandings. Can these be corrected for effort to produce an index of abundance time series? They would seem potentially of more use in an area/season impact model, were one developed, than an assessment.

I-13 anthropogenic impacts. Again a summary table as recommended for loggerheads with time, area, gear, etc. Compilation of removals/losses for as long a period as possible. Is poaching the only catch and all others bycatch; was there once a fishery? Eggs only?

Table 1 is a good start but most models would need at least some growth and survivorship. Is a catch curve analysis possible? Is the growth data available to at least infer age at size for catch curve analysis?

III Assessment of the impact of the pelagic longline fishery…

Chapter. 1
These are the sorts of data that I requested to be in a tabular form above. It would also be important to know in addition to the number of turtles impacted, the number of turtles/number (or tonnage) of fish, and if possible # of turtles / unit effort. Figures 4-9

contain the data for these comparisons but the ratios are not produced. Although it may well be that they are too noisy to justify drawing any inferences, it would be interesting to see.

Chapter 2. There is no obvious trend in either series; Could the series have been extended to earlier than 1992, perhaps with specific factors for changes in fishing practice?

Chapter 4 – narrative on post capture mortality – interesting how few loggerheads are entangled relative to hooked. Is this true in other longline fisheries?

Chapter 5 Table 1 – can this be effort corrected?

Chapter 6 As above, the projections have time starting at zero which is not linked to calendar years. The responses in the projection for expanded TED's show a much longer delay and then a sharp onset. The onset and offset of the TED phase and then the onset/offset of the expanded phase should be stated – if this is what was done? The sharpness of the impact is a bit unexpected. Presumably an entire phase is affected and each year a few more of them become reproductive which should appear as smoother transitions. Why is this not the case? The projection figures require more explanation.

6 ICCAT WD SCRS/2000/97

The purpose of including this review with the turtle work was not clear. The method is exactly the same as for turtle bycatch with the main distinction being the pooling criteria. The mathematical foundations were presented a bit more clearly and the resultant uncertainties were of a similar magnitude to the turtle bycatch. Compare Figure 2 of ICCAT document to Figure 6 of the loggerhead assessment. Clarification of the importance of this to the turtle analyses should be presented.

Appendix 1 Meta-analysis of population trends of loggerhead and leatherback turtles

Results in section 7.1.3 have is an opposite sign from 7.1.2 – This could reflect a net migration between the two areas. Is this a possibility?

STATEMENT OF WORK

Consulting Agreement Between the University of Miami and Dr. Robert Mohn

General

The highly migratory species (HMS) longline fishery interacts with sea turtle populations. Whether the impact of this interaction hinders the ability of sea turtle populations to achieve recovery, has not been determined. To this end, the analyses evaluating the status of sea turtle stocks in the Western North Atlantic Ocean and estimates of mortality from the HMS longline fishery need to be reviewed independently.

Separate status reports for the loggerhead and leatherback sea turtles have been developed based on current information on stock structure. Estimates of catch and mortality for these sea turtle stocks have been developed and included in the status reports. The impact of these mortality estimates has been evaluated. If it is found that this mortality is affecting recovery trajectories and impeding recovery, reductions in mortality have to be developed and evaluated to ensure recovery. Recovery trajectories must be based on the existing criteria included in the current Recovery Plans for these stocks.

The South East Region (SER) must develop mitigation plans and a biological opinion on the effects of these plans on sea turtle recovery. As the mitigation plan and Biological Opinion may recommend changes to the fishery, the consultant shall review the analyses supporting the Mitigation Plans and Biological Opinion to determine whether they represent the best available science/information.

The consultant shall review the stock assessments for loggerhead and leatherback sea turtles, focusing on the following:

1. Assumptions made defining stock structure including their correspondence with genetic information;

2. Application of serious injury criteria;

3. Estimation procedures for catch and mortality in the longline fishery;

4. Conclusions on stock status and impacts of fishery relative to stock recovery.

The consultant shall conclude, in a written report, whether the analyses represent the best available scientific information on which to proceed with fishery management.

Specific

The consultant's duties shall not exceed a maximum total of nine (9) days- several days for document review and several days to produce a written report of the findings. The consultant may perform all review, analysis, and writing duties out of the consultant's primary location, as no travel is required.

The itemized tasks of the consultant include:

1. Reading and reviewing the following documents provided to the consultant:

    a. Documentation for F/PR review of post hooking mortality
    b. Assessment of the impact of the pelagic longline fishery on logerhead and leatherback sea turtles on the north Atlantic
    c. Stock assessment of loggerhead sea turtle of the Western North Atlantic
    d. Stock assessment of leatherback sea turtle of the Western North Atlantic
    e. Revised estimates of bluefin tuna dead discards by the US. Atlantic pelagic bluefin tuna fleet 1992-1999[1]

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Signed_____ Date_____

[1] This document is provided because the method of bycatch estimation is a general method used not only for sea turtles but also for other bycatch like bluefin tunas. The consultant is to comment on the method in general and on its application to sea turtles specifically.

ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report should be prefaced with an executive summary of findings and/or recommendations.

2. The main body of the report should consist of a background, description of review activities, summary of findings, and conclusions/recommendations.

3. The report should also include as separate appendices the bibliography of materials provided by the Center for Independent Experts and the center and a copy of the statement of work.

4. All other material provided to the reviewer must be added to the bibliography that can be returned as an appendix to the final report.

Please refer to the following website for additional information on report generation:
http://www.rsmas.miami.edu/groups/cimas/Report_Standard_Format.html