Review of Impacts of Potential Increases in Hawaii Shallow-set Swordfish Longline Effort on Sea Turtle Populations

for

Center for Independent Experts Independent System for Peer Review

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Executive Summary

The Hawaii Longline Association has proposed to expand the Hawaii-based shallow-set longline fishery, which will likely increase the level of sea turtle interactions. The potential impact of these increased interactions was examined using a modification of the approach detailed in Snover and Heppell (in press), developing a quasi-extinction risk index based on diffusion approximation called susceptibility to quasi-extinction (SQE). Results of the Snover (2008) study indicated that to minimize increased risks of quasi-extinction, mortalities of adult female (or 'equivalent') Japanese loggerheads should be less than 4, from Jamursba Medi the mortalities should be less than 3 adult females, and for the Costa Rica population, no adult females should be killed. The proposed interaction levels of the expanded fishery are 46 loggerheads and 19 leatherbacks. These levels are estimated to result in 2.51 adult female mortalities for loggerheads in Japan, 1.56 adult female mortalities for leatherbacks from Jamursba-Medi, and 0.12 adult female leatherbacks from Costa Rica.

The current report presents an independent review of the approaches used to estimate impacts of the expansion of the Hawaii-based shallow-set longline fishery, as presented in Snover (2008), and includes recommendations for improvements.

It is not clear whether the proposed 'expansion' of the longline fishery represents increased fishing of existing vessels, new vessels, a shift in vessels from the tuna to the swordfish fishery, an increase in fishing range, or extension of the fishing season. These may have different interaction rates (e.g. interactions are spatially and temporally dependent), while transfer of vessels from the tuna to the swordfish fishery may also result in differential interaction rates. These should be factored into the calculation of additional interactions and mortalities.

In general, the theoretical approach of Snover (2008) appears valid, and is based upon a body of literature and a peer-reviewed paper (Snover and Heppell, in press). However, a greater consideration of the uncertainty inherent in both the data and the parameters assumed is strongly recommended within the proposed extension of the Snover and Heppell approach (see below). While the method appears generally appropriate, I am concerned over some of the values presented in Snover (2008), which urgently need checking to ensure that the correct values were used in runs leading to management advice. In addition, the estimates are reliant on the time series of data available to derive population growth estimates, and assume status quo conditions in the future. They do not take into account, or down weight, recent data trends (e.g. strong recoveries in recent years, perhaps due to conservation efforts and management interventions, can be negated by historical declines), and managers should consider this. In turn, extensions of the original method, as presented by Snover (2008), require simulation testing to identify their robustness in the face of uncertainty.

A summary of the key specific findings and their associated recommendations against each reviewer Term of Reference, are as follows:

Review of background information on the diffusion approximation methods used to estimate quasi-extinction risks (Snover and Heppell, in press)

As noted, outputs from the diffusion approximation approach are strongly influenced by the data time series available, and to a lesser extent by the running sum selected across that time series. **Recommendation 1** is to examine the impact of the data time series available or estimated for each population by running retrospective analyses.

Application of methods as presented in Snover (2008)

A general comment is that the potential impacts of key parameter value assumptions on population status estimates in the face of uncertainty have largely been ignored. **Recommendations 2 and 3** are therefore to consider implementing the method within a Bayesian framework to encapsulate the uncertainty, or if a frequentist approach is maintained, sensitivity analyses should be performed to assess the impact of assumptions on population status estimates.

Population nesting abundance time series were extended as far as possible. However, all time series are less than 20 years in length. The findings of Snover and Heppell suggest that the approach will not perform as well when using time series of these lengths when compared to those of 20+ years, where QET=50%. This should be borne in mind, since all three populations have a time series of less than 20 years.

For leatherbacks in Jamursba-Medi, Papua, Indonesia, data available for 1981 and 1984-85 are not presented, despite being available. Although the gap in the time series would mean these data would not modify the population growth rate estimated, **recommendation 4** is to present these data to allow the manager to assess whether the decline seen in the data is continuous, or potentially a more recent phenomenon (and hence assess the impact on population growth rate).

For loggerheads within nesting sites in Japan, the historical time series (1990-1997) was estimated. These estimates had a significant effect on overall population growth rates. **Recommendation 5** is to run sensitivity analyses of the assumptions made to develop the time series, and consider approaches to weight the time series periods relative to the reliability of data.

Snover and Heppell (in press) indicate that when QET =50%, for time series of 20 years, a running sum of four years performed best. While all time series within Snover (2008) are less than this length, the impact of alternative running sum lengths on model outputs should be examined. **Recommendation 6** is to perform sensitivity analyses based on alternative running sum lengths to examine the impact of this assumption on outputs.

<u>TOR 2.1. Is the overall approach appropriately conservative for species listed on the Endangered Species list?</u>
The use of QET=50% for the timescales selected links well with the IUCN red list criteria definitions. Timescales used are consistent with those applied in Snover and Heppell (in press), and represent plausible and conservative values.

Snover (2008) modifies the approach used by Snover and Heppell (in press), taking the mean of bootstrapped runs and developing a correspondingly new SQE level. Without re-running the assessment with the peer-reviewed approach used by Snover and Heppell (i.e. a 90% cut-off and SQE=0.4), the overall conservativeness of the modified approach cannot be judged. **Recommendation 7** is to re-run analyses using the peer-reviewed approach of Snover and Heppell (in press).

Snover (2008) uses point estimates for inputs, while point-estimate outputs often represent the mean values of distributions. A more precautionary approach would be to use appropriate intervals of these distributions as inputs and outputs. For example, use of extreme values for post-interaction mortality rate might represent a more conservative approach. In practice, this should only be considered if these values are considered biologically and practically plausible. Ultimately, as Snover notes, the level of precaution is a decision for managers to make, based upon the best available evidence. **Recommendation 8 is therefore** to identify and agree the parameter values or parameter ranges, and associated uncertainty, in the light of agreed levels of precaution. This will require a meeting of scientists, managers and stakeholders to resolve.

<u>TOR 2.2 Do the methods used to determine 'adult equivalents' appear adequate?</u>
In order to convert juvenile loggerhead interaction rates to adult female equivalents, the upper level of the mean reproductive value range was taken. This corresponded with the value selected by (Pacific Islands Regional Office (PIRO). For leatherbacks, the estimate selected was consistent with available data and again is the value recommended by PIRO, although the low number of individuals sampled means the value should be considered uncertain.

Taking the upper value of the reproductive range for loggerheads will mean greater mortalities for a given interaction. This can be viewed as a precautionary approach. For both species, uncertainty could easily be incorporated within a Bayesian framework, or sensitivity analyses performed to identify the likely impact on the population. **See recommendations 2 and 3**.

Sex ratio estimates are also required for the calculation. None of the sex ratio estimates for loggerheads presented in Table 3 of Snover (2008) are for populations in the Pacific. The ratio selected for this species (0.65) is based upon a document submitted by PIRO to the Western Pacific Regional Fishery Management Council (WPRFMC), although the logic and discussions behind the choice of this value are not presented in Snover (2008). The same sex ratio is used for leatherbacks, which appears generally lower than ratios presented in Table 3. Clarification of the selection of this sex ratio is needed, since it has a considerable effect on estimates of potential mortality from the fishery – perhaps a greater effect than the uncertainties inherent in the estimation of SQE values. Choosing a point estimate for the sex ratio seems inappropriate, given a) the range of sex ratio estimates presented in Table 3 and b) the impact of temperature on sex ratio, which will be very different between nesting locations around the world. If taking a precautionary approach, the use of a sex ratio more skewed towards females would seem appropriate. **Recommendation 9** is therefore to examine the sensitivity of model outputs, in particular with respect to interactions within the fishery, to uncertainty within the sex ratio for loggerheads and leatherbacks used within the model.

TOR 2.3 Are methods used to determine population specific takes appropriate?
Comparing the value of N_0 presented in Snover (2008) within Table 4, and that which I have roughly estimated from figures 1 and 2, using a 3 year running sum, suggests that the values presented in Table 4 need reviewing:

Species	Location	N_0	
		Figures 1 and 2	Table 4
Leatherbacks	Jamursba-Medi	7800	1515
	Costa Rica	325	335
Loggerheads	Japan	12500	2915

If the values given in Table 4 were used within the analysis, under-estimation of N_0 will have significant impacts on estimates of $\hat{\mu}$, and small populations will be more impacted by additional takes than larger ones. Therefore, current estimates for leatherbacks in Jamursba-Medi and loggerheads in Japan need to be revisited. Managers should not consider the quasi-extinction risks estimated for these populations until the calculations are confirmed.

Using time series data estimated from Figures 1 and 2 of Snover (2008), I derived an estimate of $\hat{\mu}$ for the Jamursba-Medi leatherback population of -0.023, rather than the value of -0.037 presented in Table 4. **Recommendation 10** is therefore for the values of N_0 for Jamursba-Medi and Japan populations, and the estimated value of $\hat{\mu}$ for Jamursba-Medi to be checked and confirmed as a matter of urgency.

The approach to split the species interaction mortality by nesting population appears to be based upon the best information available, being recent genetic studies. However, interactions by population will change over time as any population-specific decreases or increases occur, which cannot be factored into the current analysis. I strongly support the recommendation of Snover (2008) that 'it is advisable to periodically assess the status of the populations interacting with the longline fisheries.'

The assumptions made when estimating the proportion of interactions of the Jamursba-Medi population with the Hawaii longline fishery - taking the midpoint of 38-100% range, i.e. 69% - ignores the variability represented by this range. **Recommendation 11** is therefore to examine the impact of changes in the proportions of interactions of Jamursba-Medi leatherback turtles on the population specific takes for this population and that of Costa Rica.

TOR 2.4 Is the range of allowed adult female anticipated mortalities appropriately conservative for the status of the populations?
The sensitivity of the 1-SQE metric needs to be considered, given uncertainty within the data and input values, and hence uncertainty around SQE values. Given that variability, small changes in SQE may not be detectable in practice. **Recommendation 12** is therefore to test the usefulness of 1-SQE for management through simulation.

Methods used to calculate the values in Figure 3 and Table 5 of Snover (2008) are critical to the estimated population-specific additional adult female anticipated mortality values. The parameter values used are discussed above. Issues raised over the point estimates used for parameters, and corresponding recommendations, are also relevant.

Calculations suggest no additional mortalities should occur from the Costa Rica leatherback population. An absolute precautionary approach would be to limit the likely additional total mortalities (and hence interaction levels) to this level. Figure 3 suggests that current mortality levels resulting from fishery interactions lead to a SQE of 1 for this population, suggesting current mortality levels are too high. Pragmatically, this is unrealistic given the additional sources of pressure on the nesting beaches that are unrelated to fishing, which cannot be separated easily within this approach. It also ignores the fact that recent mitigation measures (the use of circle hooks within the fishery, for example) are expected to notably reduce incidental mortalities. This will not be considered within the diffusion approximation approach, given that it is based upon historical time series. Again, continued monitoring of population levels is required.

The shallow gradients of curves for Japan and Jamursba Medi suggest that impacts of fishery expansion on the populations are likely low and that other sources of mortality (or historical mortality levels) are driving perceived population declines. *If* calculations are correct and the approach is robust, how many additional interactions must occur before the fishery is considered to cause a significant problem for populations? This does not aim to set an upper target for turtle interactions, but indicates whether proposed fishery expansions are conservative, or near a potential limit. **Recommendation 13** is therefore to identify levels of interactions that lead to significant population pressures, if the approach is found to be robust (see recommendation 12).

Introduction

The Hawaii Longline Association has proposed to expand the Hawaii-based shallow-set longline fishery, which will likely increase the level of sea turtle interactions. There is very little demographic information for these populations except for time series of nesting beach census data so a relatively simple population viability assessment approach was taken using diffusion approximation on these time series.

Snover and Heppell (in press) present a quasi-extinction risk index based on diffusion approximation called susceptibility to quasi-extinction (SQE) that can be used to classify populations based on relative risks. Using population simulations, they show that the method is robust in assessing actual risk (in terms of a binary assessment of at risk or not at risk) for a population based on nesting beach census data, assuming that current conditions remain the same over the time period of the projection. As they use long time frames of three generations (following IUCN criteria), they clarify that SQE values are primarily useful as an index for comparing populations and assessing the impacts of increased mortalities by comparing SQE values between perturbed and non-perturbed populations.

This technique was applied to nest census data for Pacific loggerheads and leatherbacks to assess the population-level impacts of increased mortality resulting from the Hawaii Longline Association's (HLA) proposed expansion of the Hawaii-based shallow-set longline fishery. Anticipated increases in SQE for turtle populations from mortalities associated with this fishery were estimated. As the SQE index is based on nest census data, only units of adult females are considered and the turtles interacting with the fishery are converted to adult female 'equivalents' by assuming a 65% female sex ratio and mean reproductive values of 0.41 for loggerheads and 0.85 for leatherbacks. Nesting data from Japan (loggerheads), Jamursba Medi, Papua, Indonesia (leatherbacks) and Costa Rica (leatherbacks) were used.

Results of this study indicated that to minimize increased risks of quasi-extinction, mortalities of adult female (or 'equivalent') Japanese loggerheads should be less than 4, from Jamursba Medi the mortalities should be less than 3 adult females, and for the Costa Rica population, no adult females should be killed. The proposed interaction levels of the expanded fishery are 46 loggerheads and 19 leatherbacks. These levels are estimated to result in 2.51 adult female mortalities for loggerheads in Japan, 1.56 adult female mortalities for leatherbacks from Jamursba-Medi, and 0.12 adult female leatherbacks from Costa Rica.

The manuscript presenting the SQE index has received full peer review and is now in press with Ecological Applications. The specific application of SQE to determining appropriate take levels for protected marine turtle population has not received a full peer review; and as these analyses are designed to be a general tool for managers to assess how different levels of fishery interactions may impact the extinction risk of marine turtle populations, a CIE review is warranted.

This document represents the individual CIE Reviewer Report on the results of the desk-based review of the document detailing the application of SQE to Pacific turtle populations, at the request of the Center for Independent Experts (see Appendix 1).

The author was provided with three documents (see bibliography) to perform this work.

This review was undertaken by Dr Graham Pilling at Cefas (Lowestoft, UK) during the period 20th October to 7th November 2008. The documentation provided (see bibliography) was reviewed at Cefas, and this report to CIE completed during that period.

Summary of findings

The document of Snover (2008) is based upon the approach described in the peer-reviewed paper by Snover and Heppell (In press). Both these documents are reviewed here, but effort has been concentrated on the document of Snover (2008).

Below, my summary of findings is presented against each of the Terms of Reference (Appendix 1). Within these sections, observations and recommendations are developed. Numbered recommendations (in bold) refer to the correspondingly numbered items within the conclusions and recommendations section of this report.

I have two initial comments:

- A definition of 'interaction' of turtles with the fishery is not provided. This may range from the sighting of a turtle in the vicinity of the line, through to hooking of a turtle on the line. I have assumed 'interaction' to mean direct physical interaction with the gear, based upon the text in Ryder et al. (2006) that states "this broader designation could include factors other than hooking and would also extend to sub-lethal effects."
- It is not clear whether 'expansion' of the longline fishery represents increased fishing of existing vessels in current seasons and locations, an expansion of vessel numbers, any shift in vessels from the tuna to the swordfish fishery, an increase in fishing range, or extension of the fishing season. Expansion of range and season will result in different interaction rates (since these are known to be spatially and temporally dependent), while transfer of vessels from the tuna to the swordfish fishery may also result in differential interaction rates. These should be factored into calculations of additional interactions and mortalities.

1. Review of background information on the diffusion approximation methods used to estimate quasi-extinction risks (Snover and Heppell, in press)

Given that the paper has been accepted for publication, I did not dwell upon the review of this document. Rather I used it to gain the necessary understanding of the underlying approach used within Snover (2008).

The diffusion approximation approach has been well reviewed in the scientific literature as a method to assess the status of vulnerable species for which information is sparse. The approach described by Snover and Heppell extends this to encapsulate some of the uncertainty around estimates, and overall it appears a logical approach.

A drawback with the diffusion approximation approach is that the outputs are strongly influenced by the data time series available, and to a lesser extent by the running sum selected across that time series. These issues will be raised in respect to the document of Snover (2008) below. Regarding the time series issue, it would be useful if the authors ran a 'retrospective' analysis to see how the length and trends within the time series data affect model outputs. **See recommendation 1**.

It would also be useful to see how many of the proposed simulated populations were discarded based on the rule that the dominant eigenvalue, λ, was $0.9 \leq \lambda \leq 1.1$. This would indicate whether the range was highly restrictive given the parameter value distributions selected or, in turn, whether those parameter value distributions were potentially inappropriate.

2. Application of methods as presented in Snover (2008)

I have some general comments on the approach presented in Snover (2008), which do not neatly fit within the specific questions to be addressed (sections 2.1 to 2.4). These are detailed here.

To develop the estimates of potential additional mortalities, and the long-term effects on populations in Snover (2008), a number of key assumptions were required to parameterise various aspects of the model. The impacts of these assumptions on population status estimates have largely been ignored. These areas are highlighted under each of the terms of reference below. **See recommendations 2 and 3**.

As noted under Term of Reference 1 above, the average population growth rate used within the modeling approach is strongly influenced by the time series of data used within the model. Snover (2008) attempts to extend the time series of information from populations as far as possible, which is appropriate since Snover and Heppell (in press) indicate that the method works better with as long a time series as possible. In Snover (2008), all populations are estimated to have a negative growth rate that (along with its associated variance) is assumed consistent into the future. The time series of information is therefore critical:

- For leatherbacks in Jamursba-Medi, Papua, Indonesia, data available for 1981, and 1984-85 are not presented, although they are available. Hitipeuw et al. (2007) note that "Comparing these data with previous records of nesting activity from 1981 to 2001 indicates that, although there are indications of a long-term decline, this population has not been depleted to the extent found at other major rookeries in the Pacific". The data presented in Figure 1 of Snover (2008) suggests a notable decline, but without the earlier data it is difficult to tell whether this decline is 'real', or a feature of the time window of data presented. **See recommendation 4**.

- The method used to estimate the historical time series (1990-1997) for loggerheads in Japan assumes a constant proportionality of nesting sites being represented in data from that period. This estimated period shows a decline, and the STAJ data (1998 onwards) shows a period of increasing population size. Addition of the estimated historical time series therefore has a significant effect on the overall estimate of population growth rate across the period, changing it from (likely) positive to slightly negative. While the overall effect may ultimately be minimal, the impact of assumptions required to develop the historical time series should be examined. **See recommendation 5**.

Despite efforts to extend the time series, those for each population are less than 20 years in length. The findings of Snover and Heppell suggest that the approach will not perform as well when using time series of these lengths when compared to those of 20+ years, where QET=50%. This should be borne in mind.

The results of Snover and Heppell (in press) indicate that when QET =50%, for time series of ~15 years the model performs no worse when a running sum of three years is used compared to two or four years. However, where a time series of 20 years is available, simulations suggested a running sum of four years performed better (see Figure 7 of that paper). Two out of the three time series have lengths between 15 and 20 years. One assumes that there is a transition between 15 and 20 years, and hence the impact of alternative running sum lengths on model outputs should be considered for the data sets used in Snover (2008). **See recommendation 6**.

As a general comment, it would have been useful to have the data in tabulated form to allow the methods to be tested separately, and some sensitivity runs performed as part of this review. When doing some of the evaluations discussed below, I have estimated population nesting numbers from the graphs presented and hence values will not be identical to those presented within the paper.

Further issues are raised below under each of the specific areas specified in the Terms of Reference.

2.1. <u>Is the overall approach appropriately conservative for species listed on the Endangered Species list?</u>

The use of QET=50% for the timescales defined for each species seems appropriate, as it is links well with the IUCN red list criteria definitions. The timescales used are consistent with those applied in Snover and Heppell (in press). While the long time period considered for QET for loggerheads (100 years) is highly uncertain, given the lack of knowledge on age to maturity for Pacific populations, the use of an extended period for QET could be considered a conservative approach for species listed on the Endangered Species list. While there is uncertainty in the lifecycle of leatherbacks (table B1 of Snover and Heppell (in press) gives potential values from 0.65-0.9), the value of 0.9 selected gives the longest three generation time period, and hence can also be considered to be conservative.

The approach used by Snover and Heppell (in press) took the view that a >90% chance of dropping below the QET was considered appropriate, and if > 40% of bootstrap runs fell below QET within the time period considered (SQE), the population was at risk. Snover (2008), however, takes the mean value of the parametric bootstrap based on 'ease of interpretation', but does not present analyses using the peer-reviewed approach as a comparison. I found the description somewhat unclear, but my understanding is that use of the mean value from the bootstrap replaces the 90% chance of falling below QET – i.e. if the mean value falls below QET in >75% of runs (the new SQE), the population is at risk. If this interpretation is correct, it is also difficult to identify whether this is a more conservative approach than that presented in Snover and Heppell, since the SQE value increases from ~40% to 75% of runs. Without re-running the assessment with the approach used by Snover and Heppell (i.e. a 90% cut-off and SQE=0.4), the overall conservativeness of the alternative approach presented in Snover (2008) cannot be judged. **See recommendation 7**.

Snover (2008) presents point estimates for inputs, while point-estimate outputs often represent the mean values of distributions. A more precautionary approach would be to use appropriate intervals of these distributions as inputs and outputs. For example, the extreme values for post-interaction mortality rate (i.e. 26.2% for loggerheads and 33.1% for leatherbacks) might be used within the analysis, rather than the mean value. In practice, this should only be considered if these values are considered biologically and practically plausible. Ultimately, as Snover notes, the level of precaution is a decision for managers to make, based upon the best available evidence. **See recommendation 8**.

2.2. Do the methods used to determine 'adult equivalents' appear adequate?

As turtles interacting with longlines are often juveniles, these need to be converted to their 'adult equivalents'. The estimation of female adult equivalents requires two main steps: the estimation of reproductive values (incorporating survival rates, fecundity rates, age and growth rates), and sex ratios.

For loggerhead turtles data from the fishery where lengths were taken (likely to be only those individuals brought on board or alongside, which might represent a sample biased towards juveniles) indicated that the majority of individuals interacting with the fishery are juveniles. The upper level of the mean reproductive value range was taken. This corresponded with the value selected by PIRO. For leatherbacks, the estimate presented (85% adult equivalents) seems consistent with the available data and again is the value recommended by PIRO. However, the low number of individuals sampled within the size range presented to develop this value means it should be considered uncertain.

The number selected for reproductive value will affect the overall potential impact of additional fishing on the turtle populations. Taking the upper value for loggerheads will mean greater mortalities for a given interaction. This can be viewed as a precautionary approach. For both species, the uncertainty could easily be incorporated within a Bayesian framework, or sensitivity analyses performed to identify the likely impact on the population. **See recommendations 2 and 3**.

An area of uncertainty is the assumptions made over the sex ratio to estimate adult female equivalents. None of the sex ratio estimates for loggerheads presented in Table 3 of Snover (2008) are for populations in the Pacific, the closest being east coast of America. The ratio selected for this species (0.65) is based upon a document submitted by PIRO to the WPRFMC, although the logic and discussions behind the choice of this value are not presented in Snover (2008). The same sex ratio is used for leatherbacks, which appears generally lower than the ratios presented in Table 3 for Pacific populations. However, information is not presented on the number of leatherback individuals studied to develop the tabulated sex ratio estimates. It is therefore difficult, for example, to identify whether the TEWG (2007) estimate in Table 3 (57-87% female), which is the closest to the value used within the modelling approach, has a greater influence on the overall estimate selected due to a greater sample size, or because it represents the most recent sex ratio estimate developed.

Clarification of the selection of the sex ratio value is needed, since it has a significant effect on the estimates of potential takes from the fishery – perhaps a greater effect than the uncertainties inherent in the estimation of SQE values. Choosing a point estimate for the sex ratio seems inappropriate, given a) the range of sex ratio estimates presented in Table 3 and b) the impact of temperature on sex ratio, which will be very different between nesting locations around the world. In turn, assuming status quo sex ratio in the future is unlikely to be robust, given potential changes in this value in relation to climate change, etc. Indeed, if taking a conservative approach, the use of a sex ratio more skewed towards females should be considered. **See recommendation 9**.

2.3. Are methods used to determine population specific takes appropriate?

I have some concerns over the numbers used to estimate the QET for each population, given the data presented. Comparing the value of N_0 presented in Snover (2008) within Table 4, and that which I have roughly estimated from Figures 1 and 2, using a 3 year running sum, suggests that the values presented in Table 4 need reviewing:

Species	Location	N_0	
		Figures 1 and 2	Table 4
Leatherbacks	Jamursba-Medi	7800	1515
	Costa Rica	325	335
Loggerheads	Japan	12500	2915

If the values given in Table 4 were used within the analysis, under-estimation of N_0 will have significant impacts on estimates of $\hat{\mu}$ given the formulation of Equation 7, and as noted by the author small populations will be more impacted by additional takes than larger ones. Therefore, current estimates for leatherbacks in Jamursba-Medi and loggerheads in Japan need to be revisited. Managers should not consider the quasi-extinction risks estimated for these populations until the calculations are confirmed.

Using time series data estimated from Figures 1 and 2 of Snover (2008), I derived an estimate of $\hat{\mu}$ for the Jamursba-Medi leatherback population of -0.023, rather than the value of -0.037 presented in Table 4. Although this difference may result from the fact I have estimated the time series data, rather than using the true numbers, given that I obtained similar numbers to those in Table 4 for the other populations, this value should be checked. **See recommendation 10**.

The approach to split the species interaction mortality by nesting population appears to be based upon the best information available, being recent genetic studies. However, the interactions by population will change over time as any population-specific decreases or increases occur, which cannot be factored into the current analysis. I strongly support the recommendation of Snover (2008) that “it is advisable to periodically assess the status of the populations interacting with the longline fisheries.”

The assumptions made when estimating the proportion of interactions of the Jamursba-Medi population with the Hawaii longline fishery - taking the midpoint of

38-100% range, i.e. 69% - ignores the variability represented by this range. In light of the fact that the approach of SQE aims to incorporate probabilistic assumptions, and the impact of the assumed point estimates on population-specific takes, this assumption warrants further study. **See recommendation 11**, as well as **recommendations 2 and 3**.

2.4. <u>Is the range of allowed adult female anticipated mortalities appropriately conservative for the status of the populations?</u>

The use of 1-SQE has some theoretical merit, given that it takes into account the level of potential threat to a population. However, the sensitivity of this metric needs to be considered, given the uncertainty within the data and input values, and hence uncertainty around SQE values. A small change in SQE of 1-10% that can specifically be attributed to relatively low levels of additional mortality from longliners may not be detectable in practice. For example, the range of SQE presented in Table 6 for Jamursba-Medi leatherback 95% CIs for current and potential future mortalities overlap considerably, although those for other populations do not. Snover (2008) correctly notes that the exact value for the percentage change in 1-SQE is a management decision. This decision needs to be based on more information than is presented in the paper. Indeed, the efficacy of the approach needs to be simulation tested to identify whether 1-SQE is a sensitive metric to examine additional mortalities, and what level the % change in this metric should be. **See recommendation 12**.

Obviously, the methods used to calculate the values in Figure 3 and Table 5 of Snover (2008) are critical to the estimated population-specific additional adult female anticipated mortality values. The parameter values used are discussed in section 2.2, and these discussions are not repeated here. The issues over the point estimates used for parameters, and the corresponding recommendations, are also relevant.

Given the existing calculations suggest that essentially no additional mortalities should occur from the Costa Rica leatherback population each year, an absolutely precautionary approach would be to limit the likely additional total mortalities (and hence interaction levels) to this level, as chance may allow two unobserved mortalities to both come from this population. Indeed, Figure 3 suggests that <u>current</u> mortality levels resulting from fishery interactions lead to a SQE of 1 for this population, and hence the view could be taken that current interaction levels are too high. Pragmatically, this is unrealistic given the additional sources of pressure on the nesting beaches that are unrelated to fishing. It also ignores the fact that recent mitigation measures (the use of circle hooks within the fishery, for example; Gilman et al, 2007) are expected to notably reduce incidental mortalities. This will not be considered within the diffusion approximation approach, given that it is based upon historical time series. Again, continued monitoring of population levels is required.

In addition, given the shallow gradients of the curves for Japan and Jamursba Medi, it suggests that the impact of expansion of the fishery on the populations is low and that other sources of mortality (or historical mortality levels) are driving perceived population declines. A question therefore is, *if* the calculations are correct and the approach is found to be robust, how many additional interactions, and hence mortalities, must occur before the fishery is considered to cause a significant problem for the populations? Obviously this does not aim to set an upper target for turtle interactions, but will allow the manager to see whether the proposed results of fishery expansions are conservative, or near a potential limit. **See recommendation 13**. This links with **recommendation 12**.

Conclusions and Recommendations

This report contains a critical review of the methods used to determine conservative interaction levels for marine turtle populations as presented in Snover (2008), and includes recommendations for improvements.

In general, the theoretical approach appears valid, and is based upon a body of literature and a peer-reviewed paper. However, a greater consideration of the uncertainty inherent in both the data and the parameters assumed is strongly recommended (see below). While the method appears generally appropriate, I am concerned over some of the values presented in Snover (2008), which urgently need checking to ensure that the correct values were used in runs leading to management advice. In turn, the extensions of the method presented in Snover (2008) require simulation testing to identify their robustness in the face of uncertainty.

The recommendations from this reviewer are:

Recommendation 1: Examine the impact of the data time series available or estimated for each population on results, by running retrospective analyses.

Recommendation 2: Given the uncertainty in parameter values within the model, a Bayesian approach, which can encapsulate uncertainty within model inputs and hence outputs, should strongly be considered.

Recommendation 3: If a frequentist approach is maintained, sensitivity analyses should be performed to assess the impacts of assumptions made during the parameterisation of the model on future population status, and hence management advice.

Recommendation 4: Show all consistent historical data available from the populations, even if they are not used within the model runs.

Recommendation 5: Given uncertainty in the historical time series for loggerheads nesting in Japan, and the effect on overall population growth rate estimates, sensitivity analyses for the data assumed in the historical period should be performed. See also recommendation 1. In addition, consider approaches to weight time series periods relative to the reliability of data.

Recommendation 6: Given the results presented in Snover and Heppell (in press), sensitivity analyses should be performed based on alternative running sum lengths to examine the impact of the settings used on model outputs.

Recommendation 7: Re-run the analyses using the peer-reviewed approach of Snover and Heppell (in press), with results based upon 90% of bootstrap distributions.

Recommendation 8: There is a need to identify and agree the parameter values or parameter ranges, and associated uncertainty, in the light of agreed levels of precaution. This will require a meeting of scientists, managers and stakeholders to resolve.

Recommendation 9: Examine the sensitivity of model outputs, in particular with respect to interactions within the fishery, to uncertainty in the sex ratio value for loggerheads and leatherbacks used within the model.

Recommendation 10: Given the uncertainty over the accuracy of values of N_0 for Jamursba-Medi and Japan populations presented, and the estimated value of $\hat{\mu}$ for Jamursba-Medi, these values should be checked and confirmed as a matter of urgency.

Recommendation 11: Examine the impact of changes in the proportions of interactions of Jamursba-Medi turtles (rather than taking just the mid-point of the wide range identified) on the population specific takes for this population and that of Costa Rica.

Recommendation 12: Given the level of uncertainty around estimates of SQE, the usefulness of 1-SQE for management should be simulation tested.

Recommendation 13: Identify levels of interactions that lead to significant population pressures, *if* the approach is found to be robust (see recommendation 12).

Bibliography

Primary documentation

Snover, M.L. (2008). Assessment of the population-level impacts of potential increases in marine turtle interactions resulting from a Hawaii Longline Association proposal to expand the Hawaii-based shallow-set fishery. PIFSC Internal Report IR-08-010

Snover, M.L. and Heppell, S.S. (In press). Application of diffusion approximation for risk assessments of sea turtle populations. Ecological Applications.

Summary of The Endangered Species Act provided by Snover, M.L. on 24/10/08

Additional documentation used by the reviewer

Dennis, B., Munholland, P.L., and Scott, J.M. (1991). Estimation of growth and extinction parameters for endangered species. Ecological Monographs 61:115-143.

Gilman, E., Kobayashi, D., Swenarton, T., Brothers, N., Dalzell, P. and Kinan-Kelly, I. (2007). Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. Biological Conservation 139: 19-28

Holmes, E.E. and Fagan, W.F. (2002). Validating population viability analyses for corrupted data sets. Ecology 83: 2379-2386.

Ryder, C.E., Conant, T.A., and Schroeder, B. (2006). Report of the Workshop on Marine Turtle Longline Post-Interaction Mortality. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/OPR-29, 36 p.

Yntema, C.L. (1979). Incubation temperature and sex ratio in hatchling loggerhead sea turtles. J. Morphol. 17: 159.

Appendix 1. Statement of work

Statement of Work for Dr. Graham Pilling

External Independent Peer Review by the Center for Independent Experts

Impacts of Potential Increases in Hawaii Shallow-set Swordfish Longline Effort on Sea Turtle Populations

Project Background:

The Hawaii Longline Association has proposed to expand the Hawaii-based shallow-set longline fishery, which will likely increase the level of sea turtle interactions. There is very little demographic information for these populations except for time series of nesting beach census data so a relatively simple population viability assessment approach was taken using diffusion approximation on these time series.

Snover and Heppell (in press) present a quasi-extinction risk index based on diffusion approximation called susceptibility to quasi-extinction (SQE) that can be used to classify populations based on relative risks. Using population simulations, they show that the method is robust in assessing actual risk (in terms of a binary assessment of at risk or not at risk) for a population based on nesting beach census data, assuming that current conditions remain the same over the time period of the projection. As they use long time frames of 3 generations (following IUCN criteria) they clarify that SQE values are primarily useful as an index for comparing populations and assessing the impacts of increased mortalities by comparing SQE values between perturbed and non-perturbed populations.

This technique was applied to nest census data for Pacific loggerheads and leatherbacks to assess the population-level impacts of increased mortality resulting from the Hawaii Longline Association's (HLA) proposed expansion of the Hawaii-based shallow-set longline fishery. Anticipated increases in SQE for turtle populations from mortalities associated with this fishery were estimated. As the SQE index is based on nest census data, only units of adult females are considered and the turtles interacting with the fishery are converted to adult female 'equivalents' by assuming a 65% female sex ratio and mean reproductive values of 0.41 for loggerheads and 0.85 for leatherbacks. Nesting data from Japan (loggerheads), Jamursba Medi, Papua, Indonesia (leatherbacks) and Costa Rica (leatherbacks) were used.

Results of this study indicated that to minimize increased risks of quasi-extinction, mortalities of adult female (or 'equivalent) Japanese loggerheads should be less than 4, from Jamursba Medi the mortalities should be less than 3 adult females, and for the Costa Rica population, no adult females should be killed. The proposed interaction levels of the expanded fishery are 46 loggerheads and 19 leatherbacks. These levels are estimated to result in 2.51 adult female mortalities for loggerheads in Japan, 1.56 adult female mortalities for leatherbacks from Jamursba-Medi, and 0.12 adult female leatherbacks from Costa Rica.

The manuscript presenting the SQE index has received full peer review and is now in press with *Ecological Applications*. The specific application of SQE to determining appropriate take levels for protected marine turtle population has not received a full peer review; and as these analyses are designed to be a general tool for managers to assess how different levels of fishery interactions may impact the extinction risk of marine turtle populations, a CIE review is warranted.

Overview of CIE Peer Review Process:

The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work (SoW), including the Terms of Reference (ToR), to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SoW which includes the expertise requirements, ToR, statement of tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SoW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SoW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the ToR producing a CIE independent peer review report as a deliverable. At times, the ToR may require a CIE reviewer to produce a CIE summary report. The Office of Science and Technology serves as the Contract Officer's Technical Representative (COTR) for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact.

Requirements for CIE Reviewers:

Three CIE reviewers shall conduct an independent peer review in accordance with the Statement of Work (SoW). The CIE reviewers shall have strong quantitative expertise in the population dynamics including critical analysis in stock assessment and alternative methods for improving stock assessment methods using limited datasets such as are typically available for protected species. It is desirable to have one CIE reviewer with experience in population dynamics or ecology of sea turtles.

Each CIE reviewer shall have the ability to conduct the necessary pre-review preparations, desk review (no travel is necessary), and completion of the peer review report in accordance to the ToR and schedule of milestone and deliverables specified herein, and the number of days for each CIE reviewer shall not exceed 14 days.

The CIE reviewers shall have the requested expertise necessary to complete an impartial peer review and produce the deliverables in accordance with the SoW and ToR as stated herein (refer to the ToR in Annex 1).

(1). Strong quantitative expertise in the population dynamics including population viability assessment methods using limited datasets such as are typically available for protected species. Knowledge of diffusion approximation methods as they apply to quantifying quasi-extinction risks would be helpful.

(2). An understanding of the difficulties inherent in marine turtle research, nesting beach monitoring and the interpretation of these data

(3). As this analysis was driven by immediate needs of management in preparing an EA/EIS and in an ESA section 7 consultation, an understanding of endangered species regulations that drive these management needs would also be helpful

Statement of Tasks for CIE Reviewers:

The CIE reviewers shall conduct necessary preparations prior to the peer review, conduct the peer review, and complete the deliverables in accordance with the ToR and milestone dates as specified in the Schedule section.

<u>Prior to the Peer Review</u>: The CIE shall provide the CIE reviewers' contact information (name, affiliation, address, email, and phone) to the Office of Science and Technology COTR no later than the date as specified in the SoW, and this information will be forwarded to the Project Contact.

<u>Pre-review Documents</u>: Approximately two weeks before the peer review, the Project Contact will send the CIE reviewers the necessary documents for the peer review, including supplementary documents for background information. The CIE reviewers shall read the pre-review documents in preparation for the peer review (see tentative list below).

1) Snover, M.L. and S.S. Heppell. In press. Application of diffusion approximation for risk assessment of sea turtle populations. Ecological Applications.
2) Snover, M.L. 2008. Assessment of the population-level impacts of potential increases in marine turtle interactions from a Hawaii Longline Association proposal to expand the Hawaii-based shallow-set fishery. NOAA/NMFS/Internal Report IR-08-010.

This tentative list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process. Furthermore, the CIE reviewers are responsible for only the pre-review documents that are delivered to them in accordance to the SoW scheduled deadlines specified herein.

Desk Peer Review:

The primary role of the CIE reviewer is to conduct an impartial peer review in accordance to the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service (NMFS) management decisions.

Terms of Reference:

CIE reviewers shall conduct an independent peer review addressing each of the following Term of Reference:

(1). Background information on the diffusion approximation methods used to estimate quasi-extinction risks has been peer reviewed and is found in the Snover and Heppell (in press) document. Comments and criticisms on this document are welcome but should not be the focus of the reviews.

(2). An application of the methods presented in the Snover and Heppell (in press) document is contained in the Snover (2008) report which is being used by the Pacific Islands Regional Office in a section 7 consultation to determine conservative interaction levels for marine turtles in the Hawaii-based shallow-set fishery. The peer review reports should contain an assessment of this report, including input on the following questions:

- Is the overall approach appropriately conservative for species listed on the Endangered Species list?
- Do the methods used to determine 'adult equivalents' appear adequate?
- Are the methods used to determine population specific takes appropriate?
- Is the range of allowed adult female anticipated mortalities appropriately conservative for the status of the populations?

(3) Overall, the reports should contain a critical review of the methods used to determine conservative interaction levels for marine turtle populations as presented in the Snover 2008 internal report, including recommendations for improvements.

Independent CIE Peer Review Reports:

The primary deliverable of the SoW is for each CIE reviewer shall be to complete and submit an independent CIE peer review report in accordance with the ToR, and this report shall be formatted as specified in the attached Annex 1. The report will be sent to Mr. Manoj Shivlani, CIE lead coordinator, via email to shivlanim@bellsouth.net and Dr. David Die, CIE regional coordinator, via email to ddie@rsmas.miami.edu.

Schedule of Milestones and Deliverables:

Each CIE Reviewer shall complete the independent peer review in accordance with the following schedule of milestones and deliverables.

October 16, 2008	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
October 20, 2008	The Project Contact will send the background documents and report to the CIE Lead Coordinator and CIE reviewers
October 21- November 7, 2008	Each reviewer shall conduct an independent peer review
November 7, 2008	Each reviewer shall submit draft CIE independent peer review reports to the CIE
November 21, 2008	CIE will submit CIE independent peer review reports to the COTR
December 21, 2008	The COTR will distribute the final CIE reports to the Project Contact

Acceptance of Deliverables:

Each CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, which shall be formatted as specified in Annex 1. Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the CIE reports to the COTR (William Michaels via William.Michaels@noaa.gov at the NMFS Office of Science and Technology by the date in the Schedule of Milestones and Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

Key Personnel:

Contracting Officer's Technical Representative (COTR):

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Bud Antonelis, 808/944-2170, Bud.Antonelis@noaa.gov

Request for Changes:

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the Contractor within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect any approved changes. The Terms of Reference (ToR) and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

ANNEX 1

Format and Contents of CIE Independent Reports

1. The report should be prefaced with an Executive Summary with concise summary of goals for the peer review, findings, conclusions, and recommendations.

2. The main body of the report should consist of an Introduction with
   a. Background
   b. Terms of Reference
   c. Panel Membership
   d. Description of Review Activities

3. Summary of Findings in accordance to the Term of Reference

4. Conclusions and Recommendations in accordance to the Term of Reference

5. Appendix for the Bibliography of Materials used prior and during the peer review.

6. Appendix for the Statement of Work

7. Appendix for the final panel review meeting agenda.

8. Appendix for other pertinent information for the CIE peer review.

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

Cefas