Center for Independent Experts Review

Draft Shortnose Sturgeon Status Review Report

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1. Executive Summary

a. Impetus and goals for the review

The subject of this peer review is a status review report for shortnose sturgeon (*Acipenser brevirostrum*) that is being prepared for the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) by a team of Federal and state biologists. Shortnose sturgeon was listed as an "endangered species threatened with extinction" under the Endangered Species Preservation Act on March 11, 1967. Shortnose sturgeon as a species remained on the endangered species list with the enactment of the ESA.

NMFS initiated this shortnose sturgeon status review in July 2007 to update the biological information on the status of the species. The status review will compile and analyze the best available information on the status of and threats to the species; it will also consider if shortnose sturgeon should be identified and assessed as Distinct Population Segments (DPSs) (see 61 FR 4722; February 1, 1996).

The scientific and commercial information presented in the status review report should contain essential factual elements upon which NMFS can base our ESA listing determination (endangered, threatened or not warranted). NMFS is required to use the best available scientific and commercial data in making determinations and decisions under the ESA. As such, it is critical that the status review contain the best available information relevant to the status of, and factors and threats affecting, shortnose sturgeon and that all scientific findings are both reasonable, and supported by valid information contained in the document. Accordingly, NMFS requires a peer review that focuses on the factual information and scientific validity of the status review report along with the application and interpretation of the available data in making conclusions and recommendations found in the Status Review Report.

b. Main conclusions and recommendations

(1) If a DPS framework is required for this species, the DPS scheme proposed is well-defended based on the first criterion, population discreteness, thanks to a wealth of genetic data recently available from two separate portions (mitochondrial DNA and nuclear DNA) of the shortnose sturgeon genome. The DPS scheme is not nearly as well justified on its second criterion, significance, but there is a paucity of information on the kind of characteristics that could be assessed as to whether significant differences among DPS actually exist.

(2) The extinction risk analysis suffers from circularity in its logical framework. Perhaps more importantly, the thresholds chosen to classify populations as "endangered" or "threatened" appear arbitrary and are not defended. Moreover, although the resultant classifications are highly conservative, they do not appear realistic inasmuch as robust populations such as that occurring in the Hudson River are defined as having a greater than 50:50 chance of heading towards extinction within 25 years. This judgment seems

unduly pessimistic given the pronounced recovery and enormous relative abundance of this population.

c. Interpretation of the findings with respect to conclusions and management advice

The DPS scheme proposed should satisfy the requirements of the distinct population policy (61 FR 4721), but it is encouraging that the SRT recognizes the wisdom of actually managing the species as discrete population units.

The extinction risk analysis and resultant classification into "endangered" and "threatened" statuses is highly conservative and probably unrealistic in its cautiousness, but to err in that direction is preferred to erring in the opposite direction and will cause the species no harm.

2. Introduction

a. Background (from the Executive Summary of the Status Review Report)

The National Marine Fisheries Service (NMFS) initiated a status review for the shortnose sturgeon (*Acipenser brevirostrum*) in 2007 (72 FR 67712; November 30) to determine if the Endangered Species Act (ESA) listing classification (50 CFR 17.11-17.12) was accurate. The shortnose sturgeon was listed as an "endangered species threatened with extinction" under the Endangered Species Preservation Act on March 11, 1967. Shortnose sturgeon remained on the endangered species list with the enactment of the ESA in 1973. The status of the shortnose sturgeon was last examined in 1987; however the status review report was never finalized. Subsequently in 1994, the status of the shortnose sturgeon in the Androscoggin and Kennebec Rivers was assessed in response to a petition to de-list the population. NMFS determined that delisting was not warranted based on a number of factors. The shortnose sturgeon Recovery Plan was finalized in 1998; it identified 19 populations based on the fish's strong fidelity to natal rivers.

NMFS is charged with conducting a periodic assessment of a species' status: the assessment is called a "5-year review" and it is required by ESA section 4(2). A 5-year review analyzes available information relative to the definitions of endangered and threatened and in the context of the ESA listing factors as outlined in section (4)(a)(1)[1]. Normally, a 5-year review focuses on new information since the last status review. The scope of a 5-year review varies depending on the species, situation, date and scope of the recovery plan, and geographic range of the species. Jointly, the Northeast (NER) and Southeast (SER) regions anticipated the 5-year review for the shortnose sturgeon would

[1] The five factors given in section 4(a) (1) of the ESA are the following: a) the present or threatened destruction, modification, or curtailment of [a species'] habitat or range; b) overutilization for commercial, recreational, scientific, or educational purposes; c) disease or predation; d) the inadequacy of existing regulatory mechanisms; or e) other natural or manmade factors affecting its continued existence.

be more complex given the pre-ESA listing coupled with the dated status reports and recovery plan, and with recent advances in genetics that greatly assist in understanding population structure.

To assist NMFS, a team of experts on shortnose sturgeon biology and life history was identified and invited to participate as members of the status review team (SRT). The SRT was a nine member team comprised of state and federal biologists that provided both data as well as individual expert opinions to ensure that this status review report (SRR) provides the best available information. This SRR presents a summary of published literature and other currently available scientific information regarding the biology and status of the shortnose sturgeon, as well as an assessment of existing regulatory mechanisms and current conservation and research efforts that may yield protection. Notably, when species- or genera-specific information was not available for the shortnose sturgeon, the SRT considered threat information from knowledge about other sturgeon species.

The SRT reviewed information on a river-by-river basis, summarizing published information regarding abundance and distribution (both historic and current), river-specific natural history and habitat information, threats to the riverine system per the ESA listing factors, and current and recommended research. A summary of existing regulatory authorities relative to sturgeon was drafted, as well as a synopsis of ongoing take permitted under ESA section 10 and a current inventory of shortnose sturgeon at research facilities. This assessment allowed the SRT to then evaluate the status of each riverine population via a four-step extinction risk analysis. First, the SRT assessed population health. Next, criteria were determined to warrant thresholds for an endangered or threatened status specific to shortnose sturgeon. The SRT then populated a "threats matrix" wherein ESA listing factors were assessed on a river by river basis relative to impacts to shortnose sturgeon. Finally, the SRT validated their assessment by comparing population health with the threats.

Through the course of examining each ESA factor, the SRT concluded that some of the ESA factors were likely impacting the species status more than others. To balance this disparity, the SRT weighted the influence of each ESA factor in their threats analysis: impacts to habitat and from overutilization were weighted more than competition, inadequacy of regulatory mechanisms or other man-made factors. The threats that most depreciate the viability of sturgeon populations were: 1) dams, 2) dredging, 3) poor water quality, and 4) bycatch. In every river, the threat from the present or threatened destruction, modification or curtailment of habitat was far greater than any other category. The SRT then examined the relationship of population health with threats for each riverine population.

Per the guidance of the distinct population policy (61 FR 4721), the SRT examined life history information and migration data and results of genetic analysis of population structure to determine if shortnose sturgeon should be considered as a single species across their range or as a group of individual populations The SRT concluded that both the discrete and significance thresholds of the DPS policy were met and concluded that

the species is comprised of five separate and markedly different distinct populations in the United States: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast Rivers.

Under the framework of five distinct populations, the SRT compressed the results of the extinction risk analysis to evaluate the status of each segment. The SRT realized that some rivers within each population were likely of greater biological significance than others as they appeared to function as sources for other rivers. Hence, the SRT concluded these rivers to be biologically integral to the viability of each distinct population segment and the contribution of these rivers were considered when assessing the status of each distinct population segment. Utilizing the population health score, the SRT determined thresholds for threatened and endangered populations. Finally the relationship of population health to threats was graphed: a consistent inverse relationship of health to threats was apparent for all populations.

The SRT concluded that all shortnose sturgeon populations meet the ESA listing threshold: three populations met the criteria for endangered, and two met the criteria for a threatened status. The SRT concluded that the following population segments were in danger of extinction: Connecticut & Housatonic Rivers, Delaware River & Chesapeake Bay, and the Southeast Rivers. In contrast, the Hudson River and Gulf of Maine populations were not in danger of extinction; however, the SRT concluded that both had a 50% chance to become so within 25 years and therefore these population segments met the criteria for threatened status. Hence, the SRT recommends that NMFS continue to apply the provisions of the ESA to all five populations of the shortnose sturgeon while recognizing the improved status of the Hudson and Gulf of Maine populations since the original listing in 1967.

b. Terms of Reference

CIE peer review of the Shortnose Sturgeon Status Review Report

Evaluate the adequacy, appropriateness and application of data used in the Shortnose Sturgeon Status Review Report.

1. In general, does the Status Review Report include and cite the best scientific and commercial information available on the species and its habitats, including threats to the species and to its habitat?
2. Where available, are opposing scientific studies or theories acknowledged and discussed?
3. Are the scientific conclusions sound and derived logically from the results?

Evaluate the recommendations made in the Shortnose Sturgeon Status Review Report.

1. Concerning distinct population segments, is the species delineation supported by the information presented and currently available?
2. Are the results of the Extinction Risk Analysis supported by the information presented?

3. Review the research recommendations made in the Status Review Report and make any additional recommendations, if warranted.

3. Review of the Information used in the Status Review Report (as outlined in the table of contents in the Status Review Report)

Life History (p.26)

The terminology concerning pre-adult life stages is unclear, consistent with an odd history of usage for sturgeons. In this section, there are subheadings for "juveniles," "young-of-year juveniles," and "yearling and juveniles." Technically, for fishes, any post-larval stage preceding reproductive maturity might be considered juvenile. But for clarity's sake, for most fishes, juvenile is reserved for young-of-year, with yearling following young-of-year after December 31st, and subadult the variously long stage between the end of the second year and adult. Unfortunately, for sturgeons, juvenile = subadults was used in the literature (e.g., papers by Dovel) and this usage has stuck. "Juvenile" is used loosely throughout this status review document. I advocate using the normal fishery biology terms for greater clarity.

Spawning Behavior (p.29)

Concerning the Connecticut River, the report states "*Long duration style spawning appears to work well for shortnose sturgeon in this river because there are no predators that follow spawning females and eat eggs as they are spawned (Kynard, in press).*"

I haven't seen this manuscript and don't know how this absence of predators was verified, but I know that the Connecticut River contains normal complements of potential egg eaters, such as yellow perch, white perch, sunfishes, suckers, and fallfish. The statement seems unlikely.

Spawning periodicity and sex ratio at the spawning ground (p.29)

"*Males spawn 1 to 2 years after reaching maturity and females may spawn up to 5 years after maturing (Dadswell 1979).*"

How is maturity being defined here—wouldn't age at first spawning be the marker for maturity?

Overwintering (p.31)

"Fishes" is used incorrectly here, for the plural of fish rather than for the diversity of fish. But this raises a minor stylistic comment. Throughout "fish" is used when most journals would insist on "individual" or "specimen."

Water quality and contaminants (p.82)

This is a good, thorough review of this topic. But I'm not convinced water quality has been all that important in influencing shortnose sturgeon populations. At a simplistic level, it's interesting that the largest populations occur in rivers with high, long-term levels of contaminants, namely the Hudson and Delaware Rivers. The evidence is better for the Chesapeake now serving as poor sturgeon habitat due to a different water quality issue, low oxygen levels.

Bycatch (p.92)

More could be made of the high sensitivity of sturgeons to bycatch, due to their life history demographics. Good sources include:

Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. Environmental Biology of Fishes 48:399-405.

Gross et al. 2002. Sturgeon conservation: insights from elasticity analysis. American Fisheries Society Symposium 28:13-30.

Poaching (p.93)

I believe this threat is exaggerated. My impression is that shortnose sturgeon are not targeted but that they occasionally appear by accident in net gear or on the hook. At this point the fisherman may not know what they've caught and innocently keep it, or they may know and keep it anyway. I had one shore angler off Manhattan describe seeing shortnose sturgeon caught occasionally (I saw a photo to verify the ID) and that the other anglers who frequented the location thought they were sharks.

Maine Rivers (p.117)

Passagassawakaeg River near Belfast means *place where they spear sturgeon* in an Indian dialect. This is a small system that might have been more likely to host shortnose sturgeon than Atlantic sturgeon.

Cook, D. 2007. Above the Gravel Bar: The Native Canoe Routes of Maine. Polar Bear & Co., Solon, Maine.

Merrimack River (Habitat) (p.140)

"*In three years of telemetry and gillnetting, however, no shortnose sturgeon was ever detected upstream of river km 35, even through habitat suitable to complete the entire life history appeared abundant in this reach just below the dam, suggesting the Merrimack River shortnose sturgeon's present life history is genetically predisposed to exist in a shorter reach of river*."

Genetic predisposition in this context is enormously speculative. How do you know there isn't just something that shortnose sturgeon don't like about this short reach? Genetics don't need to factor into this.

Connecticut River (Habitat) (p.154)

Alosids should read *alosines* (Olney 2003: American Fisheries Society Symposium 35:xiii-xv).

Spiral fish ladder: what was its height?

Hudson River (Historic Distribution and Abundance) (p.165)

It might be worthwhile to mention there is a deep pool on the tributary Rondout River where the Wallkill meets it, called the "Sturgeon Pool."

Hudson River (Current Distribution and Abundance) (p.168, 171, 173)

"*Another Hudson River Generating Companies' survey began in 1984, and samples upper New York harbor for over-wintering juvenile striped bass from November to March. Shortnose sturgeon were rarely taken in this survey until 2004; catches have been low but consistent since then (Normandeau Associates, personal communication). We attribute recent use of the harbor area to greatly improved water quality since the 1990s when major sewage treatment plants came online in the city*."

I disagree with this statement. Historically, dissolved oxygen decreases because of sewage were a problem in the Hudson during warm months, not during winter. Also, the large changes in water quality in the Hudson were seen shortly after 1972 when the Clean Water Act was passed, not in the mid-to-late eighties. Yes, there may have been a local improvement when the North River Plant went on-line in for primary treatment in 1986, but all other anadromous species passed this reach before then without apparent difficulty. Moreover, the congeneric Atlantic sturgeon clearly migrated through this reach during much warmer spring and summer months as they returned to the river to spawn and then to outmigrate. The sudden appearance of shortnose sturgeon in New York Harbor during winter may or may not be related to increased densities in the river, but I do not think water quality was a factor in this.

Hudson River (Foraging) (p.170)

The role of zebra mussels as a food source for shortnose sturgeon in the Hudson River deserves further consideration. In addition to Haley's (1996) observations, there were persistent anecdotal accounts in the studies by Bain et al. that shortnose sturgeon often had bellies full of zebra mussels (known by feel and expulsion from vent).

The rapid increase in population size of shortnose sturgeon in the Hudson is unprecedented for sturgeons worldwide. Beyond protection via the ESA, a likely cause is the recovery of the upper Hudson following the Clean Water Act, which reopened spring and summer spawning and nursery habitat. But it may be that the ready availability of >500 billion edible bivalves (estimate by David Strayer) exposed on the river bottom has also helped this recovery along.

Hudson River (Recreational fishery bycatch) (p.174)

I've also heard that shortnose sturgeon were frequently caught in the recreational shad fishery at the federal dam at Troy, but it's my understanding this shad fishery was closed in 2008.

Hudson River (Competition and predation) (p.175)

I don't think we have any firm data on this, but non-native channel catfish have become a major presence in the Hudson River. As a deeper-water bottom feeder, it is possible they are competing for food with shortnose sturgeon.

Delaware River (Ship strikes) (p.197)

Paragraph contains some redundancies.

Winyah Bay System (Historic Distribution and Abundance) (p.267)

When was this single specimen captured?

4. Review of the Findings Made in the Status Review Report

a. DPS considerations

I am yet to be convinced that DPS designation is a useful management action for this species. It seems to me more like a rationale for the exercise of triage in recovery efforts, something I am not comfortable with. Notwithstanding my own viewpoint, though, I recognize this was part of the authors' task, and I do believe that overall, the DPS designation process applied was reasonable.

Mitochondrial DNA (p.38)

"*number of haplotypes and haplotype diversity appear to be correlated with sample size*" (Table 1) (p.39)

This is not true (if the two collections with only 4 and 5 specimens are ignored, as they should be). I ran this and found that $r = 0.32$ and $P > 0.05$.

p.40

"*Wirgin et al. (unpubl. manuscript and studies summarized within) and Quattro et al. 2002 either explicitly or implicitly indicate that glaciation and deglaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The glaciated region of the current shortnose sturgeon range extended south to the Hudson River. There is a high prevalence of haplotypes restricted to portions north and south of this region and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation.*"

Given the high level of detail in this report and the notion of "significance" that may be applied in the DPS process, in which biological characteristics that may have evolved allopatrically might be of relevance, why not provide a synopsis of the zoogeographic history proposed in Waldman et al. (2002)? That is (briefly), that shortnose sturgeon show similar haplotypic diversity in recently recolonized, previously glaciated rivers as they do in populations in never-glaciated rivers. This contrasts with Atlantic sturgeon,

which show a sharp dropoff in haplotypic diversity between populations in never-glaciated rivers and glaciated rivers (from the Hudson northward).

The pattern in Atlantic sturgeon from the Hudson northward is steady dimunition of haplotype numbers to monomorphism in the Saint John and St. Lawrence Rivers, which is indicative of a stepwise northward recolonization from southern refugia (Delaware River and south), with sequential founder effects along the way.

The maintenance of haplotypic diversity of shortnose sturgeon among populations from the Hudson to the Saint Johns, together with haplotypes unique to that region, indicates that these rivers were recolonized from a northern refugium, most likely, Georges Bank.

Nuclear DNA

In general, this work appears well performed and thoroughly analyzed. I like that the 96 microsatellite markers were tested for inheritance in this polyploidy species. The use of STRUCTURE software also is a plus in that it is a clean empirical analysis with no a priori assumptions, yet it supported other analyses performed.

p.51

"*Additional sampling and analysis of the mitochondrial genome is needed for the Merrimack River population.*"

This information gap could easily have been avoided—why weren't these specimens made available to the Wirgin lab?

p.53

Assignment tests where specimens are reassigned rather than using a jackknifing technique or division into training and test sets tend to be optimistic in their predictions.

Comparing patterns of mtDNA and nDNA variation in shortnose sturgeon (p.53)

I feel there was unusually high concurrence in the results from analysis of these two separate genomes. This, of course, provides reassurance of the overall genetic signal.

Genetics and DPS Designations in Shortnose Sturgeon (p.54)

Both mtDNA and nDNA indicated less differentiation among southeastern river populations, a finding that the authors interpreted as support for a Southeast DPS that includes numerous populations. I agree that such an interpretation is reasonable, but it's worth noting that the large stocking of shortnose sturgeon of Savannah River ancestry in the Savannah River, together with findings that stocked individuals moved out of that system in substantial numbers, may have decreased genetic differences among populations if these individuals reproduced outside of the Savannah River. They also may have decreased diversity within the Savannah.

It was estimated that descendents of these Savannah hatchery crosses comprised at least 39% of the adult shortnose sturgeon population in the Savannah River (Smith et al. 2002b). Recaptures of relatively small numbers of marked descendents of these hatchery

crosses have been reported in the Cooper River and Winyah Bay and a larger number from the Ogeechee River (Smith et al. 2002a). These references are in the status review.

Demographics, Movement, and Genetic Diversity (p.55)
"*The mtDNA and nDNA studies performed to date suggest that dispersal is a very important factor maintaining these high levels of genetic diversity*."

I'm not sure what's being said here and why it follows from the data sets. Is the high level of genetic diversity referred to total genetic diversity or within-population genetic diversity? This should be made clearer.

"*If the distance to North Carolina (or elsewhere) rivers that could support a reproducing population exceeds the migration distance for sturgeon inhabiting the southeast or Delaware River/Chesapeake Bay metapopulations, supplementation (under the guise of research) may be a plausible restoration strategy*."

Do you really want to state "under the guise of research."?

"*Accordingly, to ensure the long-term survival of populations, conservation actions should not be blindly based on available habitat and structural isolation. In this era of rapid environmental change and sea-level rise, this may be especially pertinent for the shortnose sturgeon that requires upstream migration through freshwater or species at their range margins*."

Is sea-level rise of a few inches or a foot really likely to affect such a deepwater species? What is "structural isolation?" What does "migration through . . . species at their range margins" mean?

Table 5 (p.56)
It would be useful to provide sample sizes here. The low number of alleles shown for the Cape Fear River collection is due to its very small sample size, but this is not apparent from the table.

Figure 11 (p.57)
The symbols for the numerous rivers are hard to distinguish on this figure. Could acronyms for the river names be used instead?

Table 8 (p.66)
It is good that so many nDNA AMOVA scenarios were tried. Which one is optimal is not entirely clear given the relatively minor differences among them, but the usual criteria for choosing does narrow down to the few the authors highlight.

Table 9 (p.68)
The overall resolution level obtained, 58.6%, would have been higher if only known populations were included and the tiny Cape Fear River population excluded. That is, the

Penobscot and Chesapeake could have been dropped as likely components of other source populations. This also applies to Table 11.

Figure 18a (p.71)

Notwithstanding the differences in the collections included, the UPGMA and Neighbor-Joining dendrograms generated by the mtDNA and microsatellite data, respectively, were largely in agreement. Congruence provides robust support for clustering of Maine rivers and for the Delaware with the Chesapeake collections. The one major disagreement is in the position of the Saint John population. Given the general rule of clustering by geography, the Saint John is an exception in that it groups with the Merrimack for nDNA and the Hudson for mtDNA (but note that mtDNA analysis was not performed for the Merrimack collection). Geography would have predicted that the Saint John would cluster with populations in Maine. I don't have a good explanation for this, but it could be related to some stochastic commonality in DNA sequences.

There are some other anomalies worth mentioning. For the mtDNA tree, the Saint John/Hudson cluster groups oddly with southern populations, whereas the two populations do the expected for nDNA, being positioned with northern populations.

Markedly Separated Based on Physiological or Behavioral Factors (p.73)

This section is weak, due to the absence of research on this topic, and the authors appear to be reaching here for something to backup a judgment of significance. A lot of weight is given to this Parker (2007) study but it is not described. Can an adequate description be provided?

"*Other differences in shortnose sturgeon life history and migratory patterns have been confirmed on at least a regional basis. For example, growth occurs more rapidly in southern rivers but shortnose sturgeon attain larger maximum sizes and live longer in northern rivers.*"

Both the differences in growth rate and the combination of maximum age and size would be expected along a latitudinal gradient. The issue, though, is, are these differences purely genotypic, purely phenotypic, or a mix (as I would expect, and at what relative contributions?)? A simple common garden experiment would resolve this. If the differences are completely or largely phenotypic, they have little or no significance in a DPS context.

Discreteness Conclusion (p.73)

"The SRT conclusions about the discreteness of the 12 populations are based on the

1) genetic analyses that suggest that the majority of the populations are statistically significant from one another using both mtDNA and nDNA markers;

2) larval dispersal patterns of shortnose sturgeon appear to differ by river system; and

3) regional differences in life history characteristics such as growth and maximum age."

Items (2) and (3) are only weakly supported. Item (1) seems ironclad.

Significant Gap in the Range of the Taxon (p.74)
"*Given that the geographical extent of each DPS is relatively large, the loss of a DPS would create a significant gap in the range of the taxon*."

Although I agree that loss of the Hudson River population would be a blow to the species, the Hudson is only about 80 miles from the Connecticut River, so I'm not so sure the above statement has merit based on geography alone.

Management Units for Recovery Planning (p.75)
"*Although the SRT is recommending the designation of five DPSs for shortnose sturgeon, the SRT also recommends that individual river populations within each DPS be considered distinct management/recovery units for any future recovery planning purposes*."

I'm really glad to see the above statement in which a commitment is made to manage the species at the level of individual river populations. I believe it also supports my view that there is not much practical utility in a DPS process for sturgeons.

b. Extinction Risk Analysis

Assessing extinction risk in a quantifiable, objective fashion is not a simple task. Overall, I think the approaches used were (for the most part) reasonable and were applied with considerable care and thought, but I have reservations about the details.

Risk of Extinction Method
The procedure is well-outlined in the report. The four-step process essentially marries population health with a matrix of threats for each river, viewed in Figure 34. Aside from some more minor quibbles, I have one philosophical reservation about this analysis, the danger of circularity. The Assessment of Threats section considers historical and present threats, in addition to potential future threats. *Threat*, itself, is a futuristic concept; if a threat didn't occur in the past and isn't occurring now, it's not a past or at-this-moment concern (but it could be in the future). However, what are considered threats that have actually occurred in the past have already influenced population sizes (e.g., dams), so they are in a sense already accounted for in the current population health assessment. That is, in the absence of those forces, which are believed to be detrimental to the population, the population would now be larger. (If not, then these forces should not be worried about in the future). From that point of view, population health estimates are underestimates because these populations have already withstood some of these threats.

It would be cleaner logically and I believe more useful to separate past and current population drags from other, future threats that could be new factors in decreasing

population abundance. But that would require a crystal ball. One way out of this loop would be to change the terminology to something like "present and historical population-limiting factors" and "potential threats."

Specifically:

Demographic values (p.298)

I'm not convinced it's wise to add points for observations of early life stages, either eggs and larvae or juveniles (I assume this means YOY here). There is wide variation in the ease of sampling among rivers and in funding levels and amount of effort applied to surveying early life stages. Even strong efforts could miss them, so an absence of proof of the presence of these stages does not mean they are not there. However, I realize this is a conservative framework that will result in a lower score for populations where these stages have not been found, with conservatism being a good idea in an extinction risk analysis.

Step Two: Definition of Threatened and Endangered and Listing Thresholds (p.300)

The assignation of population health scores to ESA status (Endangered: Population health score less than 9. Threatened: Population health score equal to or greater than 9) appear ultra-conservative. Moreover, these choices are not defended in the report. Why this threshold?

Step Three: Assessment of Threats (p.300)

I believe some of the factors used have little or no value in an extinction risk context and that they could be disposed with, thereby simplifying the exercise. Factor D (The inadequacy of Existing Regulatory Authorities, Laws and Policies) did not vary across 29 geographic locations. Why include this—no information is added? Factor C (competition, predation, disease) also adds little value. Neither competition nor disease scored differently in the matrix. Predation did vary by one point, but I'm not sure how this was assessed. For example, why does the Altamaha score a 2 for predation and the Ogeechee a 1? There was no backup for this in the river synopses; moreover, the Altamaha review states that "Competition, disease and predation effects are not known and do not appear to be a significant issue in this system" and the Ogeechee review states "Competition, disease and predation do not appear to be a significant issue in this system."

The low value of Factors C and D were recognized by giving them low (5%) weights, but I think they'd be better left out. The Factor C definition acknowledges that little data exist for it and I doubt this will change, especially on the river-specific basis needed to render this factor meaningful.

RAMAS

RAMAS is a well known and oft-used software package. Looking at Appendix 1 which provides more detail on the RAMAS analysis, I agree that 80 females is a reasonable threshold for quasi-extinction. But the author translated that value into 17 adults (based

on data from the Connecticut River). Isn't it likely though that a population that fell to that level would be composed mainly of adults because of chronic year-class failures?

Results of Extinction Risk Analysis and Status of each DPS (p.305)
The results obtained were consistent with the methods applied.

Penobscot River (p.305)
Population health score = 4. This is a tough call. Yes, adults suddenly became abundant in this river but there is an excellent chance that these are completely derived from the Kennebec. Unless these individuals seen in the Penobscot spawned there, it's technically not a "population" in the reproductive sense and might better be scored a zero.

Merrimack River (p.306)
Given how vagile the Kennebec system population seems to be and how they move as far north along the coast at least as far as the Penobscot, the possibility should be examined that Penobscot specimens also reach the Merrimack, which is only marginally farther from the Kennebec than the Penobscot.

Hudson River (p.308)
"*The SRT believed that the loss of the Hudson River population would mean extinction of the entire DPS*."

This would appear to be a trivial statement given that it has to be true by default if the Hudson is defined as its own DPS.

"*Contaminants still pose threats as heavy metals were detected in shortnose sturgeon, along with PCBs (28 ppm in flesh, higher in internal organs) and dioxins.*"

Can contaminants really be considered "threats" given that this population increased greatly over the past four decades in the presence of these contaminants (and in concentrations that have been decreasing over time)?

Delaware and Chesapeake DPS (p.308)
It might be worth making some distinctions between the likely nature of the original population divisions between Chesapeake Bay and the Delaware River and the present divisions. Today, there is no evidence that shortnose sturgeon reproduce in Chesapeake Bay tributaries. Genetic results indicate that shortnose sturgeon caught in the open waters of Chesapeake Bay are derived from the Delaware River. This may represent a modern enhanced opportunity to feed in the Chesapeake Bay via the Chesapeake & Delaware Canal corridor. Prior to its reconfiguration as a sea level canal in 1927, it is likely that populations of shortnose sturgeon in tributaries of Chesapeake Bay were genetically discrete from the Delaware River population and that Delaware River specimens were far less likely to reach Chesapeake Bay because of the considerable geographic barrier posed by the Delmarva Peninsula.

Delaware River (p.309)

"*Although estimated abundance appears to be stable (but not increasing), the recent recapture of 168 shortnose sturgeon originally caught and tagged as adults in the 1980s suggests that older fish comprise a substantial portion of the population.*"

Taken at face value, and given the longevity of the species, I don't see why this statement is true.

c. Evaluation of Non-regulatory Conservation Measure

Partnerships (p.328)

"Partnerships" is a term that is being used loosely here, but one can argue that any efforts that help conserve sturgeons in general, and sturgeon rivers in particular, represent partnerships. To this end, programs that help conserve sturgeons such as Caviar Emptor (Pew and Natural Resources Defense Council) could be listed. There also are many, many more watershed-specific conservation organizations within the range of shortnose sturgeon that were not listed (e.g., Kennebec Coalition, Merrimack River Watershed Council, Connecticut River Watershed Council, Housatonic Valley Association, just to name a few in New England). Some are very limited and local, others larger and more ambitious. This is a judgment call for the report authors, but they could certainly extend the short list included, if desired. Also, the American Littoral Society recently attempted some sturgeon research in the Delaware Bay.

d. Research Recommendations

Future Research Objectives to Address (p.320)

Future research recommendations provided in the document for wild populations were broad and reasonable. But it's not clear if this section is a digest of the original NMFS (1998) list, a highlighting of the most important items, an augmentation, or something else. Specifically:

Genetic Assessments: Beyond the topics listed, the Wirgin Lab and collaborators will be examining estimated effective population sizes in relation to census sizes.

Surveys and Presence/Absence Studies: I believe more could be made of statistical techniques to evaluate the probability of extirpation of individual populations that take advantage of irregular and incidental catches.

A good fisheries example based on sturgeon is included in:

Grogan, C.S., and J. Boreman. 1998. Estimating the probability that historical populations of fish species are extirpated. North American Journal of Fisheries Management 18:522-529.

Designating Critical Habitat: Shouldn't spawning habitat be mentioned? This is likely to be far more limited in size than feeding habitat. Might be worth mentioning that

designating critical habitat is really a two-stage process, we need to first recognize and define it, and after it is characterized, to map it.

5. Summary of findings made by CIE peer reviewer

I found this report to be carefully prepared, ambitious in its scope, inclusive of a high level of detail, and thoughtful in its conclusions. For the most part, I made no comments on sections I agreed with. A number of mostly minor suggestions were made in reference to background information. More substantive findings appear below in item 6.

6. Conclusions and Recommendations (based on the Terms of Reference in Annex I)

Evaluate the adequacy, appropriateness and application of data used in the Shortnose Sturgeon Status Review Report.

1. In general, does the Status Review Report include and cite the best scientific and commercial information available on the species and its habitats, including threats to the species and to its habitat?

Yes, the report is quite thorough and complete. Not only does it reference almost all the pertinent literature, but it also includes a wealth of anecdotal observations, which are valuable in understanding such a relatively rare and cryptic species.

2. Where available, are opposing scientific studies or theories acknowledged and discussed?

Yes.

3. Are the scientific conclusions sound and derived logically from the results?

I believe the scientific conclusions are sound and are derived logically from the results.

Evaluate the recommendations made in the Shortnose Sturgeon Status Review Report.

1. Concerning distinct population segments, is the species delineation supported by the information presented and currently available?

The SRT is fortunate that, unlike as in the 1998 document, there is an abundance of genetic information on shortnose sturgeon populations, from two discrete portions of the genome, and that they show highly congruent signals. Rather thorough statistical analysis of these data sets supports the DPS scheme proposed. However, the "significance" aspect of the DPS scheme is only weakly supported, through no fault of the SRT, because there has been little research on the characteristics of the species that might demonstrate significance.

2. Are the results of the Extinction Risk Analysis supported by the information presented?

For the most part, but I have two serious reservations. One is about the linkage of threats with present-day abundances. Current abundances are partly the products of ongoing conditions, which in this analysis are termed "threats." Thus, it is not surprising that there is a high correspondence between present stock status and threats, but "threats" normally is a forward looking, futuristic concept. I believe there is a need to rethink this analysis and either subdivide threats into historical and present conditions versus future conditions (i.e., threats), or to change the terminology accordingly.

The second reservation concerns the process used in determining the thresholds used in the section titled **Definition of Threatened and Endangered and Listing Thresholds.**

The following definitions are provided:

- *An "**endangered species**" is defined as "any species which is in danger of extinction throughout all or a significant portion of its range."*
- A "***threatened species**" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."*

These definitions are then quantified based on the opinion and judgment of the SRT.

- **Endangered** is defined as any shortnose sturgeon DPS which is in danger of extinction throughout all or a significant portion of its range within the DPS.
- **Threatened** is defined as any shortnose sturgeon DPS which has a greater than 50% chance to become an endangered species within 25 years throughout all or a significant portion of its range within the DPS.

Given the above, there is no rationale provided for the thresholds chosen between these two levels, nor is any consideration given to a possible lower level of concern.

- Endangered: Population health score less than 9.
- Threatened: Population health score equal to or greater than 9.

This strikes me as an important omission and critical flaw in this process. The choice of 9 as the line between threatened and endangered seems extremely conservative. I recognize that it is better to err on the side of conservatism in managing rare species. But by the criteria included in the report, the Hudson River population, which now appears to number more than 60,000 individuals over many age classes, would be considered to have a greater than 50% chance of becoming an endangered species within its DPS (the Hudson alone) within the next 25 years. If I

interpret this correctly, by having a greater than 50% chance of becoming endangered, from the definition provided of "endangered," the Hudson population is being deemed of having a greater than 50% probability of becoming extinct in less than 25 years!

This assignment of a threshold of 9 or greater implying "threatened" and thus, in effect, "endangered" within 25 years does not match the reality of the robustness of the now comparatively huge Hudson River shortnose sturgeon population. Even if not a single new individual were born over the next 25 years, and there is no reason to think that would occur in this environmentally recovering river, shortnose sturgeon would still not be extinct in the Hudson in 25 years.

If anything, one could make a serious case for delisting the Hudson River population of shortnose sturgeon. I am not advocating that, but I do suggest that the threshold for endangered and threatened be revisited by the SRT.

3. Review the research recommendations made in the Status Review Report and make any additional recommendations, if warranted.

The research recommendations made in the report are reasonable. There is some lack of clarity in the report on the relationship between the new discussion of research and the original and nearly exhaustive itemized list of research recommendations made in NMFS (1998). This should be rectified. Some of the 1998 recommendations have been partly to largely addressed, others, little or not at all. Perhaps this would be good framework to clarify the relationship between these sections.

None of the newly listed research items deal with ecology and abundance. I'm not sure how to approach this but the new evidence that shortnose sturgeon will move through marine waters more than once believed could reflect an actual increase in such movements coincident with increasing population abundances, i.e., a density-dependent effect.

Another research area that received scant attention in this report is the feasibility and desirability of supplementation of populations with hatchery-produced individuals and the stocking of hatchery-produced individuals to repopulate rivers in which shortnose sturgeon have been extirpated. I am not in favor of any stocking of this type, but it seems odd that the pros and cons of such a traditional management action were not addressed in the status report.

7. Appendices

a. Bibliography of all material provided

(1) Draft Status Review of Shortnose Sturgeon *Acipenser brevirostrum.*

(2) Revised shortnose sturgeon status review references

(3) Statement of Work

b. Statement of Work

Attachment A: Statement of Work for Dr. John Waldman

Project Background:

The subject of this peer review is a status review report for shortnose sturgeon (*Acipenser brevirostrum*) that is being prepared for the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) by a team of Federal and state biologists.

NMFS has Endangered Species Act (ESA) jurisdiction of species listed at 50 CFR 223.102 and 224.101. The U.S. Fish and Wildlife Service (USFWS) adds species under NMFS jurisdiction to its official list (List), published at 50 CFR 17.11 (for animals) and 17.12 (for plants). Shortnose sturgeon was listed as an "endangered species threatened with extinction" under the Endangered Species Preservation Act on March 11, 1967. Shortnose sturgeon as a species remained on the endangered species list with the enactment of the ESA.

NMFS initiated this shortnose sturgeon status review in July 2007 to update the biological information on the status of the species. The status review will compile and analyze the best available information on the status of and threats to the species; it will also consider if shortnose sturgeon should be identified and assessed as Distinct Population Segments (DPSs) (see 61 FR 4722; February 1, 1996).

If it is determined that the species meets the requirements to be divided into DPSs, NMFS in turn considers each DPS independently for listing consideration under the ESA. That is, each DPS is reviewed and may or may not be proposed for listing under the ESA as threatened or endangered. It is not uncommon for the various DPSs to be listed differently (i.e., one DPS may be listed as endangered; another as threatened). Listing or reclassifying each DPS separately allows NMFS to protect and conserve species and the ecosystems upon which they depend before large-scale decline occurs; it may also allow for more timely and less costly protection and recovery on a smaller scale.

As part of the status review, NMFS assembled a Status Review Team (SRT) consisting of Federal and state biologists to compile and review the best available commercial and scientific information on shortnose sturgeon and to present its factual findings to NMFS Service in a Status Review Report. The SRT was to compile the best available information rather than re-analyze or conduct new analyses or modeling. The SRT also summarizes ongoing protective efforts in the Status Review Report, to determine to what degree these protective measures abate risks to the shortnose sturgeon.

The scientific and commercial information presented in the status review report should contain essential factual elements upon which NMFS can base our ESA listing determination (endangered, threatened or not warranted). NMFS is required to use the best available scientific and commercial data in making determinations and decisions under the ESA. As such, it is critical that the status review contain the best available information relevant to the status of, and factors and threats affecting, shortnose sturgeon and that all scientific findings are both reasonable, and supported by valid information contained in the document. Accordingly, NMFS requires a peer review that focuses on the factual information and scientific validity of the status review report along with the application and interpretation of the available data in making conclusions and recommendations found in the Status Review Report.

Overview of CIE Peer Review Process:

NMFS Office of Science and Technology (OST) 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) herein, to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The OST 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 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. Further details on the CIE Peer Review Process are provided at http://www.rsmas.miami.edu/groups/cie/cieprocess.htm

Requirements for CIE Reviewers:

CIE shall provide four CIE reviewers to conduct a desk peer review (i.e., without travel requirement) of the Shortnose Sturgeon Status Review Report to ensure that its contents can be factually supported and that the methodology and conclusions are scientifically valid. Although there shall be four CIE reviewers in total, the composition of the reviewers may be divided between reviewers with expertise in shortnose sturgeon and reviewers with expertise in other sturgeon species or sturgeons in general. Specifically, it is strongly preferred that as many as two of the four CIE reviewers shall have the combined expertise specific to shortnose sturgeon to conduct the scientific peer review in the following categories;

1. Life history and population dynamics of shortnose sturgeon
2. Shortnose sturgeon genetic, physiological, behavioral, and/or morphological variation throughout the species' range;
3. Habitat requirements of shortnose sturgeon;
4. Predation and disease affecting shortnose sturgeon;
5. Regulatory mechanisms for managing the species;
6. Other natural or man-made impacts affecting shortnose sturgeon;
7. Propagation of shortnose sturgeon; and
8. Conservation actions including restoration efforts and recovery activities for shortnose sturgeon.

Additionally, if specific expertise in shortnose sturgeon cannot be obtained, all four of the CIE reviewers may have more broad expertise in other sturgeon species or sturgeons in general. These reviewers shall have the combined expertise to conduct the scientific peer review in the following categories;

1. Life history and population dynamics of sturgeon species;
2. An understanding of sturgeon genetics, physiology, and behavior;
3. Sturgeon habitat requirements;
4. Predation and diseases affecting sturgeon species;
5. Regulatory mechanisms for managing sturgeon species;
6. Other natural or man-made impacts affecting sturgeons;
7. Sturgeon propagation; and
8. Conservation actions including restoration efforts and recovery activities that have benefited sturgeon species.

Familiarity with ESA is also highly desirable. Each reviewer will be supplied with the Status Review Report prepared by the SRT. Any of the reports and papers cited in the Status Review Report will be made available to the reviewers upon their request.

Each reviewer's duties shall not exceed a maximum of seven work days. Each reviewer shall analyze the Status Review Report and develop a detailed report in response to the ToR (see Annex I). The reviewers shall conduct their analyses and writing duties from their primary locations. Each written report is to be based on the individual reviewer's findings. See Annex II for details on the report outline.

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).

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.

Prior to the Peer Review: 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.

Pre-review Documents: 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.

- A copy of the Shortnose Sturgeon Status Review Report, the document to be reviewed. The draft citation follows:

  Shortnose Sturgeon Status Review Team. 2008. Status Review of shortnose sturgeon (*Acipenser brevirostrum*). Report to National Marine Fisheries Service, Northeast Regional Office. [Date completed]. [xxx] pp.

- Access to an electronic copy of most reference documents cited in the Shortnose Sturgeon Status Review Report.

- Electronic access to the Endangered Species Act text at: http://www.nmfs.noaa.gov/pr/laws/esa/text.htm

- Electronic access to "Recognition of Distinct Vertebrate Population Segments (DPS) Under the Endangered Species Act (FWS and NMFS) (61 FR 4722; February 7, 1996)" at: http://www.nmfs.noaa.gov/pr/pdfs/fr/fr61-4722.pdf

This 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 reviewers shall conduct their analyses and writing duties from their primary locations as a "desk" review. Each written report is to be based on the individual reviewer's findings and no consensus report shall be accepted.

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 (refer to the ToR in Annex 1).

Terms of Reference: The Terms of Reference (ToR) for the CIE peer review are attached to the SoW as Annex 1. Up to two weeks before the peer review, the ToR may be updated with minor modifications 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.

Please see Annex 1 attached.

Independent CIE Peer Review Reports:

The primary deliverable of the SoW is each CIE reviewer shall 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 2.

Schedule of Milestones and Deliverables:

The CIE review and milestones shall be conducted in accordance with the dates below;
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13 October 2008	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
29 October	The Project Contact will send the CIE Reviewers the pre-review documents
17 November	Each reviewer shall conduct an independent peer review
8 December	CIE shall submit draft CIE independent peer review reports to the COTRs
19 January 2009	CIE will submit final CIE independent peer review reports to the COTRs
12 February	The COTRs 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 2. The report shall be sent to Manoj Shivlani, CIE lead coordinator, via shivlanim@bellsouth.net and to Dr. David Sampson, CIE regional coordinator, via david.sampson@oregonstate.edu. Upon review and acceptance of the CIE reports by the CIE, the 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:

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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:

Terms of Reference

CIE peer review of the Shortnose Sturgeon Status Review Report

Evaluate the adequacy, appropriateness and application of data used in the Shortnose Sturgeon Status Review Report.

1. In general, does the Status Review Report include and cite the best scientific and commercial information available on the species and its habitats, including threats to the species and to its habitat?
2. Where available, are opposing scientific studies or theories acknowledged and discussed?
3. Are the scientific conclusions sound and derived logically from the results?

Evaluate the recommendations made in the Shortnose Sturgeon Status Review Report.

1. Concerning distinct population segments, is the species delineation supported by the information presented and currently available?
2. Are the results of the Extinction Risk Analysis supported by the information presented?
3. Review the research recommendations made in the Status Review Report and make any additional recommendations, if warranted.

ANNEX 2:

Format and Contents of CIE Independent Reports

The report should follow the outline given below. It should be prefaced with an Executive Summary that is a concise synopsis of goals for the peer review, findings, conclusions, and recommendations. The main body of the report should provide an introduction that includes a background on the purpose of the review, the terms of reference and a description of the activities the reviewer took while conducting the review. Next, the report should include a summary of findings made in the peer review followed by a section of conclusions and recommendations based on the terms of reference. Lastly the report should include appendices of information used in the review (see outline for more details).

1. Executive Summary
    a. Impetus and goals for the review
    b. Main conclusions and recommendations
    c. Interpretation of the findings with respect to conclusions and management advice

2. Introduction
    a. Background
    b. Terms of Reference
    c. Description of activities in the review

3. Review of Information used in the Status Review Report (as outlined in the table of contents in the Status Review Report)

4. Review of the Findings made in the Status Review Report
    a. DPS considerations
    b. Extinction Risk Analysis
    c. Evaluation of Non-regulatory Conservation Measure
    d. Research Recommendations

5. Summary of findings made by the CIE peer reviewer

6. Conclusions and Recommendations (based on the Terms of Reference in Annex I)

7. Appendices
    a. Bibliography of all material provided
    b. Statement of Work
    c. Other