Review of Status of Atlantic Bluefin Tuna (*Thunnus thynnus*) under the Endangered Species Act

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Executive Summary

- Many of the terms of reference asked whether there was significant information or data missing and it can be concluded that all of the main literature and current information available for Atlantic Bluefin Tuna (ABFT) was made available and considered.
- There is now a great deal of evidence from many different sources that support the notion that the spawning grounds in the Mediterranean and the Gulf of Mexico support separate populations of ABFT. They do this to a sufficient degree that under the provisions of the Endangered Species Act (ESA) it is possible to conclude that the eastern and western stocks as defined by ICCAT can be considered as separate Biological Population Segments.
- Given that conditions across ocean and sea basins are changing through climate change defining specific geographical areas as essential fish habitat should not be expected to remain static. Nevertheless, given the current information available the important habitats, especially in relation to spawning, were able to be distinguished, particularly for the western ABFT stock.
- Disease and predation are not expected to constitute a significant threat to the sustainability of ABFT.
- Other natural and man-made effects (climate change, oil exploration, etc) may well influence the extent of the useable habitat for ABFT. While the impact of the recent oil spill is predicted to have been minor when spread over the next decade the effects of climate change could be more pervasive. How well the ABFT will be able to adapt to such changes remains speculative, but the regulations now exist that catches should be able to be prevented from adding to any negative effects in a synergistic manner.
- The effects of aquaculture are expected to remain minor for the western stock. While the advent of aquaculture/farming in 1997 certainly led to problems and issues with the eastern stock, recent innovations in compliance and regulation should now prevent the eastern aquaculture ventures from leading to negative impacts on the stock.
- The conservation measures that have been put in place with the intent of protecting the ABFT from unnecessary impacts have greatly increased since 2008. In the western stock there was already an array of protective measures and compliance with regulations and catch limitations was already high. Many of the changes have had the most effect in the eastern stock, which now stands a chance of rebuilding to become much more productive again. Great detail is given of the implementation and dates of the various conservation and other fishery regulations. This detail was necessary to be convincing that the behaviours that had caused the eastern stock such difficulties are now being eliminated and managed. Without such controls the risk of stock collapse in the east was becoming very real.
- The extinction risk analyses conducted present the information in a manner that is simple to understand. The examples given illustrate that even with catches greater than the current projected catches within the recovery plans the probability of extinction in the next three decades remains small. Given that management can now be adaptive to negative changes in stock size by reducing catches still further, the conclusion that extinction probabilities are very small is valid.
- The Status Review Report (SRR) develops clear discussions of available evidence for all five lines of argument identified in the ESA for making a determination. The

conclusions drawn all appear valid and caveats are given where appropriate. The uncertainty that exists with respect to many of the ideas is represented in a fair manner and there is no hiding from remaining difficulties.

- In general, the SRR provides a balanced, detailed review of the issues and the lines of evidence for whether or not the ABFT is at risk of extinction.

Background

Statement and History of the Problem

The Atlantic Bluefin Tuna (*Thunnus thynnus*), is an iconic fish species living in the Atlantic Ocean and Mediterranean Sea that has been exploited for thousands of years. It is known as a highly migratory species (HMS) because it can rapidly travel long distances between spawning ground and foraging grounds, both up and down as well as across the Atlantic and throughout the Mediterranean. It is a very fast predatory fish that can attain sizes in excess of three meters in length weighing up to 900 kg (Fromentin & Powers, 2005). Economically it has always been important in the Mediterranean but recently it has grown in significance. Having once been fed to Roman legions, more recently, with the development of a large sushi-sashimi market in Japan, the demand for high-quality, well treated fish has greatly increased. The extremely high prices that can be paid for the best quality fish has led to disagreement and some discord between the many different fishing entities and more recently non-government organizations with an interest in this species. Atlantic Bluefin Tuna (ABFT) is managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). As a classic highly migratory species the early expectation was that despite its extensive geographical distribution ABFT would constitute a single panmictic stock. Nevertheless, originally primarily for convenience, ICCAT manages ABFT as two separate stocks; a large stock in the eastern Atlantic and Mediterranean and a smaller stock in the western Atlantic, with an imposed boundary at 45°W. Surprisingly for such a mobile species, evidence is now accumulating that there is quite significant population sub-structuring so that the separation of the east and western Atlantic populations now makes biological sense as well as being convenient from a regulatory viewpoint. This is despite evidence of extensive mixing between the two management stocks across the Atlantic.

The biology and population dynamics of ABFT is complex. This highly mobile species does not appear to be completely fixed in its abundance and distribution. In the Mediterranean there is evidence of long term variation in population abundance with a cycle of about 120 years (Ravier & Fromentin, 2002), with shorter oscillations in availability of about 20 years. In addition, in the last 60 years significant fisheries for ABFT arose and then disappeared. Off Norway, Germany, Denmark, and Sweden a fishery developed in the very early 1950s (up to a maximum catch of about 15,000 tonnes) but became very minor by the late 1960s and stopped altogether in the early 1980s. Off Brazil, a fishery of about 12,000 tonnes came and went in the 1960s (Fromentin & Powers, 2005, their Fig. 2, p285). Such behaviours make the interpretation of population fluctuations seen in fisheries data more difficult. Nevertheless, ICCAT attempts to generate stock assessments for both the eastern and western stocks every two years. The stock assessments are open to critical review and develop as the understanding of the biology of the species improves. There are recognized and critical sources of uncertainty relating to the fisheries data, in particular there are uncertainties concerning recent total catches and catch at size that lead the alternative assessments being made that compare the outcomes from reported catches and those from estimated catches. These uncertainties occur mostly in the eastern stock where reported catches expanded in the 1980s reaching a peak of about 50,000 tonnes in 1996. At that time total allowable catches (TACs) were introduced as a means of controlling catches but significant levels of catch are

considered to have been unreported (Fig. 1). ICCAT's Standing Committee on Research and Statistics (SCRS) provides the stock assessments and transmits the management advice to the Commission.

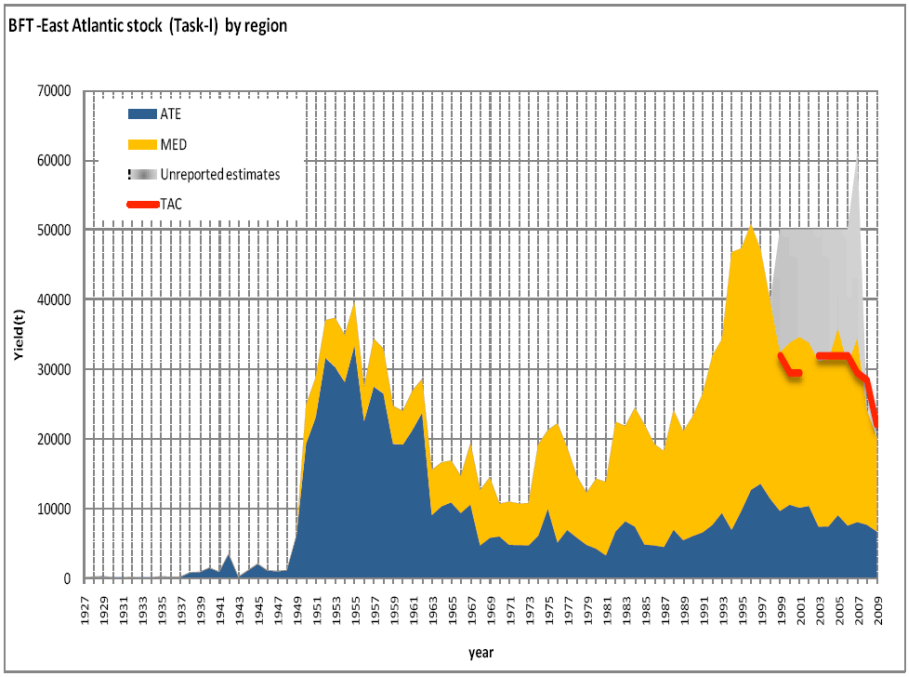

Figure 1. (copied directly from Figure 2 in ICCAT, 2010) The Eastern Atlantic and Mediterranean ABFT reported and estimated catches by area. The grey shaded area above the red line denoting the TAC by year is an approximate estimate of unreported catch, which at times was considered to be much more than 20,000 tonnes.

Since the mid-1990s, the SCRS has highlighted that the eastern stock of ABFT was over-exploited and made recommendations for the catches to be significantly reduced. Unfortunately, at least with the Eastern stock, the management advice from the SCRS on advisable levels of TAC were often not accepted by the Commission who tended to set higher catch levels than those recommended as sustainable. For example, in 1999 and 2000 the TACs set were 32,000t and 29,500t respectively, whereas the scientific advice was for a TAC of 25,000t. In addition, in 2008, the assessment group were led to conclude that "significant underreporting has occurred in 2006 and 2007" with catches more likely to be 50,000t. With continued over-catching of recommended TACs in the eastern stock, in the 2008 assessment the SCRS were led to state "Unless the Plan is adjusted to impose greater control over the fisheries by improving compliance and to further reduce fishing mortality rates (especially on larger fish), it will most likely lead to further reduction in spawning stock biomass with an increasing risk of fisheries and stock collapse (ICCAT, 2008, p.33). They also repeated a statement from the 2006 assessment that "…the management scenarios which have potential to address the declines and initiate recovery are those which (in combination) close the Mediterranean to fishing during spawning season and decrease mortality on small fish through minimum size of 20 or 30 kg." (ICCAT, 2008, p33). Finally, in its advice for the management of the eastern stock the SCRS wrote: "SCRS has evaluated a number of alternative management scenarios which might be used to achieve the recovery of this stock

with a higher probability. All these scenarios involve a time-area closure including partial or full closure during the spawning season as well as much lower catches (TAC including all sources of fishing mortality) during the next few years (~15,000 t). The long-term gain resulting from these actions could lead to catches of 50,000 t or more with substantial increases in spawning biomass. For a long lived species such as bluefin tuna, it will take some time (> 10 years) to realize the benefit." (ICCAT, 2008, p 37). Unfortunately, the Commission did not take the scientific advice but instead developed a schedule of declining TACs beginning with a TAC of 22,000 t in 2009 declining to 18,500t in 2011. While this was a substantial reduction over the catches current at that time the disparity between the TACs set and the scientific advice was disturbing for many organizations. Both Monaco and the USA led proposals to significantly reduce catches in the eastern stock but neither was successful.

An independent review of ICCAT operations in 2008 (Hurry *et al*., 2008, p.2) concluded that: "The judgement of the international community will be based largely on how ICCAT manages fisheries on bluefin tuna (ABFT). ICCAT CPCs' performance in managing fisheries on bluefin tuna particularly in the eastern Atlantic and Mediterranean Sea is widely regarded as an international disgrace and the international community which has entrusted the management of this iconic species to ICCAT deserve better performance from ICCAT than it has received to date." [CPCs are Contracting Party or Fishing Entity]. This is a very strong statement and reflects the importance placed upon the successful management of Atlantic Bluefin Tuna. The outcome of the 2008 assessment and the disjunction between the best scientific advice and the management outcomes led to many people and organizations becoming more concerned over the fate of ABFT and it appears the petition to list ABFT as endangered or threatened is a reflection of that concern.

However, after this divergence between the scientific advice and the management outcomes, many things began to improve markedly following 2008. Numerous regulations were put in place from 2008 onwards to reduce over-capacity, improve compliance, and catch reporting, and prevent the expansion of farming capacity. Most importantly, the TAC for 2010 was decreased from 19,950t to 13,500t, a level which the 2010 assessment predicted would likely lead to some stock increases if continued to 2013, and the remainder of the rebuilding plan was implemented.

It should be noted that while there remains uncertainty in the western stock assessment, there have been no serious problems with catch reporting, the gathering of statistics, or general compliance. This may be a reflection of there being far fewer international participants in the fishery, and each has strong fisheries legislation and data gathering capacity. The United States, for example, has legislated to abide by the ICCAT recommendations. As stated in the Review: "…the bluefin tuna fishery is managed under the dual authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and the Atlantic Tunas Convention Act (ATCA). ATCA authorizes the Secretary of Commerce to implement the binding recommendations of ICCAT" (ABTSRT, 2011, p56). The Western stock is not without its problems. The assessment models predict that it has been at a low and stable spawning stock biomass since the early 1980s when catches were greatly reduced owing to the introduction of restrictive TACs. There remains great uncertainty with respect to many aspects of the recruitment dynamics in the west, including uncertainty over the age at maturity, whether spawning occurs anywhere other than the Gulf of Mexico, and the form of

the stock recruitment relationship. Two different relationships are used in an attempt to capture the model uncertainty but one predicts that the stock is in a relatively healthy state while the other predicts that the stock is overfished and that overfishing is still occurring.

The National Marine Fish Service (NMFS) received a petition from the Center for Biological Diversity to list ABFT as endangered or threatened according to the definition in the U.S.A. Endangered Species Act (ESA). Greatly simplified, their position was that "Already on a path toward extinction, the western Atlantic bluefin tuna population will be devastated by the ongoing oil spill in the Gulf of Mexico. ……. Commercial fishing for Atlantic bluefin tuna populations, in combination with a rapidly changing ocean environment, is likely to drive bluefin tuna to extinction." (CBD, 2010, p. i). The petition included a detailed exposition of the life history, biology and fishery for the ABFT along with an analysis of the risks to which the species is exposed.

The NMFS followed procedures and generated a 90-day finding on the petition concluding that: "We find that the petition presents substantial scientific information indicating the petitioned action may be warranted." (NMFS, 2010, p.57431). This is what led them to generate the Status Review (ABTSRT, 2011) being considered by this present review.

As stated in the fourth paragraph of the Terms of Reference of this review (Appendix 2): "The ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range," and a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." A species may be determined to be threatened or endangered due to any one of the following factors:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific or educational purpose;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; and
(5) other natural or manmade factors affecting its continued existence."

The arguments presented in both the original petition and the Status Review made in response are structured around addressing these five concerns.

For jurisdictional reasons, because the call is to the USA ESA, the primary interest, for practical reasons, is in the western stock, but all parts of the population were considered.

Review Activities

- The primary documents were provided by NMFS on an FTP site, which was organized into two directories, one for the Petition and Background Literature the other for the literature cited in the Stock Review Report. This was helpful in finding a path through the multitude of documents. In addition, a few documents were downloaded from the ICCAT website (www.ICCAT.org).
- Reading through the Petition, the 90-day Finding and then the Status Review Report and, where required for more details, the associated primary literature.

Summary of Findings

Introduction

Each of the terms of reference will be addressed in turn. The Status Review Report (hereafter referred to as the SRR) will be considered along with those other literature sources as required.
An important point to note is that the literature is beginning to recognize that the biology and geographical distribution of the various life stages is not static through time. This has implications for definitions of essential fish habitats but potentially also for the recruitment dynamics and success.

There is uncertainty in almost all aspects of the biology and fishery information for ABFT. For both the eastern and western stocks the Catch-at-Age (CAA) matrix, which is a vital component of the Virtual Population Analysis (VPA) at the heart of the assessment is highly uncertain because the catch-at-size data are fragmentary and collected at a different scale to that required of the Catch-at-Age data. Fundamentally, it is the lack of representative aging samples, especially for larger fish, that requires the use of translating catch-at-size information into catch-at-age that leads to this problem. Improvements have been made to the methods used to calculate the CAA matrix, and the growth curve for the western stock has recently been updated, but nevertheless, the CAA matrix remains uncertain. ICCAT still uses a length slicing method to allocate ages to sizes, and this neglects significant variation in the size at age of the fish involved. Apart from the improved western growth curve, Restrepo *et al*'s (2010) approach also provided an improved means of allocating catch at age from size data but that has still to be implemented.

There are uncertainties about the total catches and the catch-at-size in the eastern stock due to the increased use of cage fattening, the delays in reporting catch statistics until the fish are finally landed, and the underreporting of catches through much of the 1990s to the mid-2000s. This has led to the production of more than one catch series for use in the stock assessments, that is both the reported catches and the others with estimated catches.

ABFT are known to have long term fluctuations (over decades and hundreds of years) and has been observed in the last 50 - 60 years to be discovered, fished and then disappear from off Brazil and off Norway, so even large scale reductions in abundance in an area could be due to geographical changes in distribution rather than stock issues. For example, the inability of the US fishery to achieve its allocated TAC in recent years has been attributed to spatial variation in availability rather than reductions in stock size. This was possible because there have been no associated signs of reduced spawning biomass in the Gulf of Mexico as would be expected if the stock off the eastern US coast reflected abundances within the Gulf of Mexico. In the west, depending on the stock recruitment relationship used, the stock is either almost at its target (i.e. it is not overfished nor is there overfishing), or, it is badly overfished and severe over-fishing is occurring (the bootstrap estimates for the former suggest that there is a positive probability that the stock could be both overfished and overfishing is occurring, whereas for the latter, there is no probability that the stock is not overfished and only a very slight

probability that the overfishing is no longer occurring). Unfortunately, one of the conclusions for the western stock assessment was that it did not capture all of the uncertainty in the projections or the data. Mixing between the stocks across the Atlantic is variable between years and areas and also varies by the age of the fish. The stock assessments do not take account of the degree of mixing and so the conclusion is made that the assessments do not capture the full degree of uncertainty that is present in the data used or the structural assumptions made in the assessments.

Further examples of uncertainty will be explored below under each of the terms of reference for this review, however, it should be noted that the underlying uncertainty about the dynamics of the stocks and their interactions, influences the confidence with which any of the conclusions obtained from the analyses and stock assessments can be held.

1. ***Is the information regarding the life history and population dynamics of the species the best available? If not, please indicate what information is missing and if possible, provide sources.***

The SRR refers to and analyses the implications of the many articles published with regard to ABFT biology. Recent work includes the improved growth estimates by Restrepo *et al*., (2010) as well as verbal reports from Barbara Block and co-workers, whose work on the electronic tagging of tunas and other large pelagic fish in the Atlantic is continuing and has advanced beyond her important initial report (Block *et al*, 2005). These and others indicate that the SRR team was using the most up to date material available and there is nothing important that appears to be missing.

While the material used appears up to date so that the information regarding the life history and population dynamics is complete, there remains a degree of inconsistency within the report over such things as the age/size of maturity in the western stock. For the eastern stock the age at maturity is taken to be between 3 and 4 years of age. Corriero *et al*. (2005) demonstrated that in the eastern stock the expected length at median sexual maturity (L_{50}) was 103.6 cm fork length, and that ~80% of fish in the 50% mature size class (100-104 cm FL) were aged 3 and the remainder were aged 4. On the other hand, in the western stock reports are given of it being from age 8 – 15 years of age, and this uncertainty is reflected in the SRR.

Baglin (1982) considered that the earliest age at which western Atlantic bluefin tuna mature was age 6 and many conclude they would be considered fully mature by the age of 8, at a weight of 135 kg. With the new growth curve from Restrepo *et al* (2010), which predicts older ages for some of the larger fish, this alters the apparent age of full maturity to age 9. This is consistent with reports of size frequency data from longline fisheries in the Gulf of Mexico that suggests fish younger than age 9 (140 kg) rarely visit the spawning grounds. Earlier, it was concluded from observations: “Probably the first spawning of western Atlantic bluefin tuna occurs most frequently at age 5, but more research is required to establish this.” (Mather et al, 1995, p 97). The ICCAT SCRS has pointed out that such different ages of maturity between the two stocks seems unlikely given the similarity in growth, but could possibly arise if smaller western fish spawn outside the Gulf of Mexico in an as yet unknown location or if there is a juvenescent subpopulation in the Mediterranean. So the situation in the western stock is confused and this is reflected in the SRR.

Under the definition of Essential Fish Habitats the SRR (page 5) includes:

- "Juveniles (<231 cm FL): In waters off North Carolina, south of Cape Hatteras, to Cape Cod. Please refer to Figure 2.2 for detailed EFH map.
- Adults (≥231 cm FL): In pelagic waters off the central Gulf of Mexico and the Mideast coast of Florida. North Carolina from Cape Lookout to Cape Hatteras, and New England from Connecticut to the mid-coast of Maine. Please refer to Figure 2.3 for detailed EFH map."

This has an implicit definition of the size at maturity, presumably the size at 50% maturity, being 231 cm fork length for the Western ABFT. According to the latest growth curve for the Western ABFT (Restrepo *et al.*, 2010) this equates to an age of approximately 14 years. At an age of 9 western ABFT would be approximately 187 cm. While it is recognized that there is confusion in the literature it may have been helpful to have adopted the standard of 9 years old (length ~187cm) as the age/size at maturity within the Gulf of Mexico and pointed out that there are ambivalent reports from outside the Gulf. This ambivalence arises because the size at maturity on the spawning grounds is not necessarily the size at maturity within the population as a whole. Then, in an attempt to reduce confusion, it would have been possible to point out that the essential fish habitat definition was aimed at primarily the very large mature fish. Despite the confusion in the literature over the size at maturity, this does not greatly affect the conclusions in the report. If anything, it makes the conclusions slightly more conservative, as a younger age at maturity would increase the spawning biomass in the calculations and hence increase the predicted recruitment levels.

The adoption of the new growth curve by the SCRS has been recognized by the SRR team. Restrepo *et al*'s (2010) paper is remarkable for including much of the data on which the analyses are made making it simple to repeat the work. If this was a strategy for avoiding arguments it is very effective and possibly aided in its rapid acceptance. It was influential in a number of ways. Because the populations are aged through determining the age-at-length and then subdividing the length distribution data from catches into their expected ages (length-slicing) a new growth curve influences the age composition of catches. Because the new curve predicted somewhat shorter lengths than the old, this implied there were more older fish in the western population, which implied the fishing mortality rates must have been lower than previously inferred.

2. ***Does the information on ABFT genetics, physiological, behavioral, and/or morphological variation presented for the species' range represent the best available information? If not, please indicate what information is missing and if possible, provide sources.***

The ICCAT 2010 assessment occurred in September 2010 and the SRR team had access to all the most recent documents regarding life history attributes and other details of the species biology and population dynamics. The essential details for addressing the five criteria under which to judge whether a species can be declared endangered or threatened were all reviewed adequately.

The use of material regarding the species genetics, physiology, behavior, and/or morphological variation are presented in more detail in different specific terms of reference below. Thus, for example, the genetics work that has been done recently was considered in detail when examining the delineation of distinct population segments required by the ESA, and the physiological work was discussed in detail when considering environmental factors that might threaten damage to the ABFT range and habitat.

3. Based on the information presented, are the conclusions regarding species, subspecies, or distinct population segment delineations supported by the information presented? If not, please indicate what information is missing and if possible, provide sources.

The SRR concludes: "…the available information indicates that the western Atlantic and eastern Atlantic bluefin tuna population segments are discrete and significant. Consequently, the SRT concludes that the two populations qualify as two DPSs of bluefin tuna under the DPS policy." (ABTSRT, 2011, p.21).

Not surprisingly in a highly migratory species whose movements can vary from year to year and from age to age class the perceived stock structure is complex with even the broad indications generally used containing many caveats. Nevertheless, there is abundant evidence for a real separation between the eastern and western Atlantic populations and there is some evidence that the eastern stock may be separated into at least two sub-stocks. Even given the evidence there have also been indications that the stock boundaries have changed in recent history. Takeuchi et al (2009) describes the fishery off Brazil in the 1960s, which only lasted about 10 years and has not re-appeared. In their report, they also describe a similar event off Japan in the 1920s through the 1940s. Fromentin & Powers (2005) describe the fishery off the Nordic states that occurred in the 1950s and 1960s, which also disappeared. Ravier & Fromentin (2002) also highlight that in data from fish traps in the Mediterranean, dating back to 1600, there is evidence of long term variation in population abundance with a cycle of about 120 years, with shorter oscillations in availability of about 20 years. Thus, both stock size and location can be unstable.

Nevertheless, as evidence for the separation of east and western stocks:

- There are temporal differences in the spawning season with spawning of ABFT in the Gulf of Mexico being reported in April through to June, while in the Mediterranean spawning is reported to occur from May through to July.
- Electronic tagging (archival and popup) also support natal homing to spawn in the Mediterranean and the Gulf of Mexico with mixing of the two stocks in the Atlantic foraging grounds (Block *et al.,* 2005; and verbal report to the SRR Team).
- Genetic analysis of Young of the Year ABFT indicated population separations between the Gulf of Mexico and the Mediterranean. Some of the genetic results appear ambivalent as Carlsson *et al.* (2007) reported that while there was a significant difference between the Gulf of Mexico and the Eastern Mediterranean when using nuclear microsatellites, an analysis based on a mtDNA control region sequences found no significant differences between these two areas. This apparent inconsistency with all the other analyses was attributed to the relatively low sample size from the Eastern Mediterranean reducing the power of the statistical tests. Riccioni *et al*. (2010) provides other genetic evidence of population subdivision within the Mediterranean. Riccioni *et al* (2010) are also attributed with stating that the rates of spawning site

fidelity are 95.8% and 99.3% for the Mediterranean and Gulf of Mexico respectively. However, Riccioni *et al* (2010) actually attribute those figures to either Block *et al* (2005), Carlsson *et al* (2007), Teo *et al* (2007) or Boustany *et al* (2008), but a search of those papers did not reveal the origin of those percent values. Even though there is something incorrect about those particular numbers the consensus is that there is good genetic evidence for a genetic separation between the population spawning in the Gulf of Mexico and that spawning in the Mediterranean.

- Isotopic composition of otoliths, especially $\delta^{18}O$, identified that 94% of adult ABFT sampled in the Mediterranean Sea originated in that basin (Rooker, et al, 2008); this is evidence for natal homing.
- Tracing the organochlorine and polychlorinated biphenyl tracers indicated that while there was a high degree of mixing in the western foraging grounds the fish entering the Gulf of Mexico, presumably to spawn, suggested little or no mixing on the main western spawning grounds (Dickhut et al., 2009).

Evidence of sub-division in the east and in the west:

- Genetic analysis of Young of the Year ABFT found significant differences between the Eastern and the Western Mediterranean (Carlsson *et al.,* 2007). Riccioni *et al*. (2010) provide a detailed genetic analysis within the Mediterranean Sea and also demonstrated population sub-divisions.
- Numerous reports of the potential for spawning grounds outside the Gulf of Mexico. Mather et al (1995, p93) concluded that most fish aged 6 and above were mature and that "...the mature members of the 'small' bluefin group (less than 120 cm long) spawn in offshore waters north of the Gulf Stream, along with fish in the 'medium' size group, in May and June."
- Block (verbal report of work conducted with Reeb) presented evidence that the eastern stock was made up of eastern and western Mediterranean components and that the western stock had two distinct genetic populations, one from the Gulf of St. Lawrence the other in the Gulf of Mexico. She also noted that spawning behaviour had been recorded outside the Gulf of Mexico, east of the Bahamian Bank and Puerto Rico.

Given all of this information the SRR team were fully justified in concluding that the eastern and western subdivisions of the ABFT can be defined as distinct population segments. The data for sub-divisions within either the eastern or the western regions are less detailed, though the evidence is growing in the east. Importantly, for the purposes of the SRR, the western stock can validly be treated as a distinct population segment.

4. Information is presented in the report on ABFT habitat requirements. Is this information the best available information? If not, please indicate what information is missing and if possible, provide sources.

The information provided is up to date and detailed. In the presence of climate change there are potential problems with defining distinct geographical areas as representing the essential fish habitat for a highly migratory species. Some large changes in distribution have occurred over the last 50 years so it should be recognized that there needs to be a dynamic element to any area designated as essential fish habitat. However, the SRR presents up to date maps, but these can be expected to change. The team had up to date information from NASA on the

distribution of oil pollution within the Gulf of Mexico, which allowed estimates of the potential impact of the oil spill in the Gulf.

With respect to the effects of climate change the SRR team had access to the very latest pre-publication material (Muhling *et al.*, 2011). However, climate predictions all have a degree of speculation in them and, as Muhling *et al.* (2011, p.18) states clearly, the models used "…have a limited ability to resolve the regional western boundary current system (i.e., Yucatan Current, Loop Current, and Florida Current), which likely has a significant impact on the heat budget cycle of the GOM." This means that while changes can be expected in the larval distributions the details will need models with improved resolution. Muhling *et al.* (2011) point out that because stocks have appeared and disappeared (the Brazilian and Nordic fisheries are mentioned) then the paradigm of shared feeding grounds but two separate spawning grounds may be too narrow a view. While the causes of the changed distribution are not well understood they state they "… may suggest more plasticity in feeding grounds, and perhaps spawning grounds, than is currently assumed." (Muhling *et al.,* 2011, p18).

Other detailed findings were available, such as that presented by Johnson *et al*. (2008), which provided details of regulatory mechanisms and findings along the USA coast of the potential effects of coastal development, energy-related activities (including oil exploration), marine transportation, offshore dredging and disposal, the effects of water intake and discharge (the scale of some LPG processes can lead to massive intake and discharge rates), introduced species and aquaculture, and global effects. Such comprehensive studies are remarkable in their coverage of issues.

This all means that in the long term changes can be expected but it is unknown whether the ABFT will be able to adapt to changed circumstances and continue spawning in the Gulf of Mexico and or expand its spawning range into other areas.

5. ***Potential threats to ABFT from harvest, disease and predation, regulatory mechanisms that are used to manage the species and other natural or manmade impacts affecting ABFT (e.g., climate change, oil exploration, and related effects) are presented in the report. Is this information the best available information? If not, please indicate what information is missing and if possible, provide sources.***

The effects of disease and predation are reviewed well using recent work. The conclusion is well made that in the wild this is a minor problem but could be an issue with aquaculture/farming. Fortunately, most ABFT aquaculture ventures entail capturing wild fish and simply holding them for improved condition factor rather than attempting to raise them through a closed cycle involving larval rearing (though this is being attempted with the Pacific Southern Bluefin Tuna). The SRR contains much of the main literature relating to diseases in bluefin tuna. Predation, while it occurs in places, is not considered a major issue for the sustainability of the stocks. The conclusion that "The best available scientific and commercial information indicates that threats to bluefin tuna from predation and disease do not significantly affect the long-term persistence of bluefin tuna now or into the future." (ABFTSRT, 2011, p 55) appears well founded.

A bigger potential threat arises from harvests when they are conducted in an unregulated manner.

It is possible that the relatively unregulated fishing for ABFT off Brazil and the Nordic countries contributed to the demise of those stocks. However, as pointed out by Fromentin and Powers (2005, p 285): "…in the case if the Brazilian episode, questions remain as to how a long-lived fish such as ABFT could have been fished out within 6 years by a few number of longliners."

The SRR provides great detail as to how the western stock has fared under the regulation and harvest levels recommended by ICCAT. The key aspect for the western stock is in the statement "For the western Atlantic bluefin tuna fishery, compliance with ICCAT measures has typically been high." (ABFTSRT, 2011, p. 58). There do not appear to have been the problems with underreporting and over harvesting as experienced in the eastern stock, primarily because in the U.S.A. it has been legislated that management will follow the recommendation of ICCAT and there is good quality control in data collection and compliance. Quotas were introduced in the early 1980s, and it is possible that damage had already been done to this stock by fishing at too high a catch level. Nevertheless, in the western stock unregulated fishing in the future should not be a problem for the stock, and with the latest assessments detailing a recovery plan that meets the predictions of both the optimistic and the pessimistic assessment models the SRR demonstrates that over-harvesting and unregulated fishing should not be a problem for the western stock. As a final insurance the SRR points out that there is an emergency clause such that "…if SCRS detects a serious threat of stock collapse, ICCAT shall suspend all bluefin tuna fisheries in the western Atlantic for the following year." (ABFTSRT, 2011, p 58).

For the eastern stock there is no doubt that unregulated fishing (underreporting and excess catch) has been a big problem for ABFT. Up until 2008 the disjunction between the scientific advice on catch levels and the management outcomes was poor practice, but when there was serious underreporting of catch on top of this it led to significant stock reductions. The SCRS began to issue dire warnings, in the mid-2000s onwards, of the high and increasing risk of both fishery and stock collapse. This was combined with actions by different member states (Monaco and the USA) and the independent review of ICCAT performance. Finally, the Commission put in place procedures which improved compliance greatly and also reduced catches to those more in line with the scientific advice from the assessments. The management provisions for the eastern ABFT stock have been revisited each year since with improvements being implemented each year. Thus, while unregulated fishing has damaged the eastern stock, the member states and ICCAT appear now to have the fishing under control. New procedures (including an operational catch documentation scheme) have led to good levels of compliance and the use of observers on purses seines and tuna farms has improved the understanding of their contributions to the fishery. Now that the fishing is better regulated and the catches have been moderated and controlled it no longer appears that unregulated harvests will continue to be a problem for the eastern stock; although, of course, this depends on the continuance of good compliance with ICCAT recommendations and regulations.

Fromentin and Ravier (2005) present data illustrating long-term trends in abundance in the eastern stock of ABFT. This suggests that fisheries targets and control rules based around equilibrium notions of MSY are likely to be inappropriate, or at least difficult to achieve, especially if the target have been identified during a period of relatively high abundance. It is unknown whether this is the situation in the western stock but this is part of the reason for

having two assessments, one based on what might be termed an optimistic stock recruitment relationship (which concludes that stock is overfished and overfishing is likely to be occurring), and the second assessment based on a pessimistic stock recruitment relationship (which, because of the implied lower productivity, concludes that the western stock is close to its target and that it is not overfished nor is overfishing occurring). As the SRR states: "It is important to note that under any scenario, the agreed TAC is expected to support continued stock growth if compliance with agreed rules remains strong." (ABFTSRT, 2011, p 58).

6. Is the information presented on ABFT aquaculture/farming the best available? If not, please indicate what information is missing and if possible, provide sources.

ABFT farming/aquaculture is not yet a problem for ABFT in the western stock. Given the regulations within the Gulf of Mexico and elsewhere it should remain a minor issue in the west and the scale of any potential future operations would be limited.

In the eastern stock, farming has occurred since 1997 and it has been the source of a number of problems through the regulations not being adapted to account for farming practices. Catch reporting only had to occur once the fish were landed and this put the farming and fattening between the actual capture and reporting. This disturbed and damaged the time series of catch at length data in the eastern stock. In addition, it is assumed that catches for the farms were often the source of underreported fish. There have now been many changes in how information is provided. The catch documentation scheme has been extended to include farm operations and new regulations require reductions in both the fleet and farming capacity to more closely match the recommended harvests. While aquaculture/ farming was the source of some serious problems, these have been and continue to be addressed to prevent irregularities arising.

The information provided appears accurate, detailed, and up to date.

7. Conservation actions that have been implemented or are likely to be implemented in the future for ABFT are presented in the report. Are all of the conservation actions for the species included and considered in the list? If not, please describe which actions are missing and if possible, sources of information on these actions.

The conservation and management actions that have been implemented have been described in great detail in the SRR. Many have only been implemented recently. For example, as the SRR states: "The SCRS reiterated that the conservation and management measures adopted in 2006 and 2008 were expected to result in a rebuilding of the stock towards the Convention objective, but also noted that there has not yet been enough time to detect with confidence the population response to the respective management measures. Some of the available fishery indicators suggest the spawning biomass of western bluefin tuna may be slowly rebuilding." (ABFTSRT, 2011, p. 44).

As with all management and conservation measures an important aspect to their implementation relates to agreed measures of performance success. In the western stock many of the measures are already in place (e.g. no targeted fishing in the Gulf of Mexico, minimum size limits on capture) while in the eastern stock many new measures, mainly relating to

compliance) have actively been put in place recently. Thus, the banning of purse seines in the Mediterranean fishery for 11 months of the year is a recent innovation but its impact has yet to be seen.

The regulations, both fishery and conservation, are many and varied in the ABFT but the SRR provides a detailed summary of their intent and when they were implemented.

Marine Protected Areas or area closures are not generally effective with highly migratory species but there are seasonal closures and gear closures and these are detailed.

The level of detail given with respect to the fishery and conservation measures in the SRR is necessary. One of the greatest threats to the eastern ABFT stock was the unregulated fishing that occurred in the 1990s and early 2000s. It needed to be demonstrated that this had been stopped and what measures had been taken to prevent such neglectful behaviour from occurring again. The detail given for the western stock was also necessary to demonstrate that the intent and capability is already there and operational.

8. The extinction risk analysis that is performed in the status review report is based on data and associated projections from the most recent stock assessment for ABFT. Does this analysis consider all of the best available data and are the conclusions appropriate and scientifically sound? If not, please indicate what information is missing and if possible, provide sources.

The latest assessment is from Sept 2010 and the SRR team was undoubtedly assisted by the fact that ICCAT publishes its stock assessment models and makes them freely available on its website. This ensures that they receive a high level of critical appraisal. The methods used to examine likely outcomes and make population projections are standard and well executed. The detailed example given for the western ABFT stock of projecting a TAC of 2,250t forwards, initially appeared an odd choice instead of using the current TAC of 1,750t. But then it becomes clear that even with a TAC of 2,250t the probability of extinction remains low for decades. The detailed example in Figure 9.1 also illustrated the standard problem with such projections when they are projected too far into the future. The uncertainties begin to dominate so much that the median line becomes effectively meaningless.

The notion of dropping to two fish as a definition of extinction appears to be an exaggeration as the chance of those two fish finding each other in the ocean would appear to be slight. Nevertheless, even if the minimum is put to be perhaps 100 tonnes (which at an average of ~250kg a fish is still only ~400 fish) this would make almost no difference to the model predictions. The decision tables in Tables 9.1, 9.2, and 9.3 illustrate the outcomes very well. In the western stock, it is certainly helpful to separate the outcomes of the two recruitment scenarios, noting that the actual TAC for the coming years is set at 1,750t these analyses suggest a very low probability of stock reduction. One weakness of these simple projections is that there is no adaptation of management to changing circumstances. Thus, it would be expected that if the stock were detected to be declining the full expectation would be to decrease the regulated catch. There is no reason to believe that in the west such regulations would not be effective. This combined with the escape clause "…if SCRS detects a serious threat of stock collapse, ICCAT shall suspend all bluefin tuna fisheries in the western Atlantic

for the following year." (ABFTSRT, 2011, p 58), means that the probability of extinction will remain very small for the western stock (distinct population segment).

In the eastern stock, assuming the catches really have been controlled then the same outcomes are apparent. The SRR provides the necessary caveats with regard to the need for regulated catches to be adhered to, clearly stating that if management abandons existing rebuilding plans in favour of increased catches then there would be a significant risk of extinction. They could then conclude that if "…one were to assume existing levels of catch would be maintained through the rebuilding period (2018 for western bluefin and 2022 for eastern bluefin), then both stocks would have been projected to support much larger catches (close to the MSY) with a very low risk of extinction." (ABFTSRT, 2011, p. 85).

The use of standard Population Viability Analysis would be difficult with species with such high fecundity and unpredictable recruitment success. The use of the typical stock assessment approaches for projections is thus defensible. The use of Virtual Population Analysis (VPA) methods is possibly not optimal with catch-at-age data having such uncertainty associated with it, as well as the varied nature of the abundance indices available. ICCAT scientists are working to develop and use variants of the statistical catch-at-age models in an integrated assessment framework that can accept a varied range of input data. I would expect that in the 2012 assessment there will be comparisons with the VPA approach so that the SCRS can decide whether to move to an Integrated Assessment based on statistical catch at age methods rather than VPA methods. Other improvements and changes can be expected because stock assessment methods are not static. Thus, if there are improvements in the understanding of the mixing of the two main stocks in the mid-Atlantic, this may also be included in the assessment models. All such changes can be expected to alter the optimum recommended catches and this in turn will affect the probability of extinction. However, as long as the regulatory frameworks remains in place and the rebuilding strategies remain in place, then the management will be able to adapt to improved data and model structures and provide better management advice.

9. In general, are the scientific conclusions in the report sound and interpreted appropriately from the information? If not, please indicate why not and if possible, provide sources of information on which to rely.

This is the key term of reference in this present review. Overall, the SRR provides a clear review of the most recent literature, not forgetting the older sources, relating to the five main subjects that the ESA requires for a determination. The SRR team do not place reliance on any single piece of work to draw its conclusions and they do not shy away from including work that appears to provide complications and even potential inconsistencies (for example, there is some of the genetic work on separation between the Mediterranean and the Gulf of Mexico that appears to suggest that the eastern Mediterranean is not greatly different from the Gulf of Mexico, although the majority of evidence is consistent with there being a real difference). Their conclusions with respect to the distinct population segment, with respect to the possible effects of disease and predation, the effects of changes to essential habitats, and the effects of other natural or man-made factors were all clearly argued and valid conclusions were drawn.

More difficult was the combination of over-utilization combined with inadequacy of existing regulatory mechanisms. While it was simple to list the details of compliance in the western stock, the remaining uncertainties of the two main assessments led to widely diverging views as to the current stock status. In the eastern stock, on the other hand, there was clear evidence of wide-scale over-catching and underreporting during the 1990s and early 2000s, which added a different kind of uncertainty. Nevertheless, the SRR lists in detail all the problems and then it lists all the solutions that have been implemented. By including the caveats that the recent management decisions relating to the rebuilding strategies for both stocks must be adhered to over the next period, they were justified in concluding that over-catch and inadequacy of regulation was not a problem for the western stock and should no longer be a problem for the eastern stock.

With the probability of extinction calculations, again the assumptions and approaches used were appropriate and constituted the best available. The coverage and range of scenarios considered covered the possibilities and in the end the conclusions that the extinction risk was minor is justified from the arguments and evidence.

A key aspect of the SRR is the detailing of the changed regulations and compliance framework in the eastern stock. The lack of control over catches and the lack of compliance with regulations appears to have been the biggest threat to ABFT for the years through the 1990s up to the mid-2000s. Without the changes listed and adopted, the SRR would not have been able to conclude that the risk of extinction was low for the eastern stock. Because of the adherence of the management of the western stock to the advice from ICCAT, plus the addition of the emergency clause in the management options now available (to shut the fishery in the case of unexpected or rapid stock decline) then the conclusion is valid that the risk of extinction for the western stock (DPS) is low.

10. Where available, are opposing scientific studies or theories acknowledged and discussed? If not, please indicate why not and if possible, provide sources of information on which to rely.

In a number of aspects of the biology and population dynamics there is uncertainty and a lack of consensus. For example, the age at maturity in the western stock remains uncertain and the variation in stock dynamics that arises from the discovery and apparent extinction of stocks off Brazil and the Nordic states increases uncertainty of expected stock dynamics. But the SRR does not avoid such uncertainties and it does a balanced job of presenting the evidence for an array of authors about such issues.

The number of areas where there is significant uncertainty has been recognized, and ICCAT, with agreement from member states, has instigated a research program that will attempt to address some of these sources of uncertainty. Section 10 in the SRR is brief but, using the ICCAT research plan, it does identify those areas that will be receiving attention by the collection of biological samples aimed at clarifying such things as the stock structure, age and growth, maturity, habitat utilization, and feeding ecology.

Thus, the SRR does not pretend that there are no uncertainties and it attempts to present a balanced view of the alternatives available. All of the major sources of evidence have been presented and the summary in the SRR appears to accurately reflect the current situation.

11. In general, is the best scientific and commercial data available for ABFT presented in the report?

The data used in the report appears to be the same as that used in the 2010 assessment and so it constitutes the latest and most accurate data available. In addition, the information from the Gulf of Mexico concerning the extent of the oil pollution event appears to be completely up to date. The documents and publications used in the discussions of the various factors needed for the discussion of the requirements of the ESA include both very recent and the necessarily fundamental papers. It would be reasonable to conclude that the best available data and the most valuable contributions to the discussions are included in the SRR.

Conclusions/Recommendations

- Many of the terms of reference asked whether there was significant information or data missing and it can be concluded that all of the main literature and current information available for ABFT was made available and considered.
- There is now a great deal of evidence from many different sources that support the notion that the spawning grounds in the Mediterranean and the Gulf of Mexico support separate populations of ABFT. They do this to a sufficient degree that under the provisions of the ESA it is possible to conclude that the eastern and western stocks as defined by ICCAT can be considered as separate Biological Population Segments.
- Given that conditions across ocean and sea basins are changing through climate change defining specific geographical areas as essential fish habitat should not be expected to remain static. Nevertheless, given the current information available the important habitats especially in relation to spawning were able to be distinguished, particularly for the western ABFT stock.
- Disease and predation are not expected to constitute a significant threat to the sustainability of ABFT.
- Other natural and man-made effects (climate change, oil exploration, etc) may well influence the extent of the useable habitat for ABFT. While the impact of the recent oil spill is predicted to have been minor when spread over the next decade the effects of climate change could be more pervasive. How well the ABFT will be able to adapt to such changes remains speculative, but the regulations now exist that should prevent catches from adding to any negative effects in a synergistic manner.
- The effects of aquaculture are expected to remain minor for the western stock. While the advent of aquaculture/farming in 1997 certainly led to problems and issues with the eastern stock recent innovations in compliance and regulation should now prevent the eastern aquaculture ventures from leading to negative impacts on the stock.
- The conservation measures that have been put in place with the intent of protecting the ABFT from unnecessary impacts have greatly increased since 2008. In the western stock there was already an array of protective measures and compliance with regulations and catch limitations was already high. Many of the changes have had

most effect in the eastern stock, which now stands a chance of rebuilding to become much more productive again. Great detail is given of the implementation and dates of the various conservation and other fishery regulations. This detail was necessary to be convincing that the behaviours that had caused the eastern stock such difficulties are now being eliminated and managed. Without such controls the risk of stock collapse in the east was becoming very real.

- The extinction risk analyses conducted present the information in a manner that is simple to understand. The examples given illustrate that even with catches greater than the current projected catches within the recovery plans the probability of extinction in the next three decades remains small. Given that management can now be adaptive to negative changes in stock size by reducing catches still further, the conclusion that extinction probabilities are very small is valid.
- The SRR develops clear discussions of available evidence for all five lines of argument identified in the ESA for making a determination. The conclusions drawn all appear valid and caveats are given where appropriate. The uncertainty that exists with respect to many of the ideas is represented in a fair manner and there is no hiding from remaining difficulties.
- In general, the SRR provides a balanced, detailed review of the issues and the lines of evidence for whether or not the ABFT is at risk of extinction.

Appendix 1: Bibliography of Materials Provided

Primary Documents: All obtained from the NOAA FTP site unless otherwise stated. FTP site: https://www.nero.noaa.gov/nero/dropoff/BluefinTuna/. A number of other articles and reports were read but only those referred to in this present review are listed.

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ICCAT (2008) Report of the 2008 Atlantic Bluefin Tuna Stock Assessment Session. (*Madrid, Spain – June 23 to July 4, 2008). 247pp.*

ICCAT (2010) Report of the 2010 ICCAT Bluefin Data Preparatory Meeting (*Madrid, Spain – June 14 to 19, 2010*) 67pp.

ICCAT (2010) Report of the 2010 Atlantic Bluefin Tuna Stock Assessment Session. (*Madrid, Spain – September 6 to 12, 2010). 132pp*. (PDF obtained from http://www.iccat.org/en /Assess.htm on 10 Apr 2011)

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NMFS (2010) Listing Endangered and Threatened Wildlife and Plants; 90-day finding on a petition to list Atlantic Bluefin Tuna as Threatened or Endangered under the Endangered Species Act. *Federal Register* **75 (182)** 57431:57436.

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Appendix 2.

Attachment A: Statement of Work for Dr. Malcolm Haddon

Statement of Work

External Independent Peer Review by the Center for Independent Experts

Status of Atlantic bluefin tuna (*Thunnus thynnus*) under the Endangered Species Act

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: NOAA's National Marine Fisheries Service (NMFS) was petitioned to list Atlantic bluefin tuna (*Thunnus thynnus*) under the Endangered Species Act (ESA) on May 24, 2010. As required, NMFS reviewed the petition and made a positive 90-day finding determining that the information in the petition and otherwise available to the agency indicated that the petitioned action may be warranted. As a result of the positive finding, the agency was required to conduct a review of the status of the species to determine if listing under the ESA is warranted.

NMFS organized a status review team (SRT) consisting of federal employees to assemble the facts. In so doing, the team was instructed to organize and review the best available scientific and commercial information on Atlantic bluefin tuna and to then present its factual findings to the agency in a status review report. The report did not need to be based on consensus, and opposing individual viewpoints were welcomed as long as the viewpoints were sound and based on science. Further, the report was not to contain any listing advice or to reach any ESA listing conclusions – such synthesis and analysis is solely within the agency's purview. NMFS will use the status review report to develop a final ESA determination and will publish its finding in the *Federal Register* on or before May 24, 2011.

NMFS is required to use the best available scientific and commercial data in making determinations and decisions under the ESA. The first question that must be addressed is what the appropriate species delineation is for consideration of conservation status. The ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range," and a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." A species may be determined to be threatened or endangered due to any one of the following factors:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific or educational purpose;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; and
(5) other natural or manmade factors affecting its continued existence.

The scientific and commercial information contained in the status review report will likely contain essential factual elements upon which the agency may base its ESA determination. Accordingly, it is critical that the status review report contain the best available information on the species and the threats, that all relevant information is identified and included, and that all scientific findings be both reasonable, and supported by valid information contained in the document. Therefore, the CIE reviewers will conduct a peer review of the scientific information in the status report on Atlantic bluefin tuna based on the Terms of Reference (ToRs) attached in **Annex 2**.

Requirements for CIE Reviewers: The CIE shall provide three experts to conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Two CIE reviewers shall have working knowledge and recent experience in fisheries population dynamics, one of which should have expertise in stock assessment and life history of bluefin tuna. The third CIE reviewer shall have expertise in extinction risk analysis. It is desirable that the extinction risk analysis expert be familiar with applications in fisheries, particularly highly migratory species. It is expected that each reviewer's report shall reflect his/her area(s) of expertise. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: The CIE reviewers shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project

Contact is responsible for providing the CIE reviewers with the background documents, reports, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Each CIE reviewer will be supplied with the status review report prepared by the status review team. Any of the reports and papers cited in the status review report will be made available to the consultants upon their request.

Please note that information associated with the Status Review document is to remain strictly confidential until the Status Review is posted to the NMFS website and/or the Federal Register by NMFS, requiring that each CIE reviewer not to share or discuss the contents of the Status Review Document and related material.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and status review report provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
3) No later than 18 April 2011, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Sampson david.sampson@oregonstate.edu. Each CIE

report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

21 March 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
22 March 2011	NMFS Project Contact sends the CIE Reviewers the status review report and background documents
28 March - 11 April 2011	Each reviewer conducts an independent peer review as a desk review
18 April 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
2 May 2011	CIE submits the CIE independent peer review reports to the COTR
9 May 2011	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Science Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall be completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,

(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and regional Science Director.

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the peer review of

Status of Atlantic bluefin tuna (*Thunnus thynnus*) under the Endangered Species Act
Provide a scientific peer review of the status review report on Atlantic bluefin tuna (ABFT) in accordance to the following terms of reference.

1. Is the information regarding the life history and population dynamics of the species the best available? If not, please indicate what information is missing and if possible, provide sources.
2. Does the information on ABFT genetics, physiological, behavioral, and/or morphological variation presented for the species' range represent the best available information? If not, please indicate what information is missing and if possible, provide sources.
3. Based on the information presented, are the conclusions regarding species, subspecies, or distinct population segment delineations supported by the information presented? If not, please indicate what information is missing and if possible, provide sources.
4. Information is presented in the report on ABFT habitat requirements. Is this information the best available information? If not, please indicate what information is missing and if possible, provide sources.
5. Potential threats to ABFT from harvest, disease and predation, regulatory mechanisms that are used to manage the species and other natural or manmade impacts affecting ABFT (e.g., climate change, oil exploration, and related effects) are presented in the report. Is this information the best available information? If not, please indicate what information is missing and if possible, provide sources.
6. Is the information presented on ABFT aquaculture/farming the best available? If not, please indicate what information is missing and if possible, provide sources.
7. Conservation actions that have been implemented or are likely to be implemented in the future for ABFT are presented in the report. Are all of the conservation actions for the species included and considered in the list? If not, please describe which actions are missing and if possible, sources of information on these actions.
8. The extinction risk analysis that is performed in the status review report is based on data and associated projections from the most recent stock assessment for ABFT. Does this analysis consider all of the best available data and are the conclusions appropriate and scientifically sound? If not, please indicate what information is missing and if possible, provide sources.
9. In general, are the scientific conclusions in the report sound and interpreted appropriately from the information? If not, please indicate why not and if possible, provide sources of information on which to rely.
10. Where available, are opposing scientific studies or theories acknowledged and discussed? If not, please indicate why not and if possible, provide sources of information on which to rely.
11. In general, is the best scientific and commercial data available for ABFT presented in the report?

All information associated with the Status Review document is to remain strictly confidential until the Status Review is posted to the NMFS website