CIE review report

Status of Atlantic bluefin tuna (*Thunnus thynnus*) under the ESA

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May 2011

1. Executive Summary

This report reviews the Status Review Report of Atlantic Bluefin Tuna (Thunnus thynnus), prepared by the Atlantic Bluefin Tuna Status Review Team for the National Marine Fisheries Service in response to a petition for listing Atlantic bluefin tuna under the Endangered Species Act.

The report references most of the relevant literature known to this reviewer; some very minor additions are suggested. Conclusions about habitat, population biology, distinct population segment and non-fishing threats are scientifically justified and supported.

There are gaps in the extent to which the information has been analysed to exhaustively assess the trends in biomass and extinction risk under current ICCAT regulations. In particular, the implication of alternative hypotheses of mixing of the two stocks and the consequences that this might have on a) the accuracy of the current ICCAT assessment and b) calculations of extinction risk of the Western Stock under the low recruitment hypothesis, should be explored.

2. Background

NOAA's National Marine Fisheries Service (NMFS) was petitioned to list Atlantic bluefin tuna (*Thunnus thynnus*) under the Endangered Species Act (ESA) in May 2010. Following a 90 day positive finding, the agency convened a Status Review Team to review of the status of the species to determine if listing under the ESA is warranted.

3. Reviewer's role

The Team has prepared a Review, which was required to be peer reviewed. This report presents one peer review report of the Review. The peer review is required to be impartial.

4. Summary of findings

4.1.TOR 1 (life history)

Information presented in the Review on life history is accurate. A key element to the life history discussion revolves around migration and exchange rates between the eastern and western populations. Spawning site fidelity appears to be reasonably well supported through genetic and tagging studies (Carlsson et al, 2006, Block et al, 2005) as well as the phenomenon of natal homing.

However, all these studies were conducted in very recent times, and certainly after the major reduction in range triggered by the major fishing in the 1950s and 1960s. There appears to be only one study cited that examined the movement of tagged fish prior to this time (Takeuchi et al, 2009). Given that some of the arguments made later for the robustness of ICCAT management of the western stock, and some of the evidence presented here particularly for juveniles (Dickhut et al 2009), as well as the evidence presented by fishermen that the western stock may be moving northwards, it is important that the historical pre-exploitation behaviour of the stock is understood. For instance, is it possible that the strong natal homing that is apparently now evident is learned from a sub-population of adults that were restricted to the proximity of their spawning grounds precisely because the large adults (eg in the Brazilian fishery of the 1950s) were removed?

Given the strong restriction of the range of this species, with catches in the northeast, mid and southern Atlantic being virtually eliminated by the end of the 1980s, it is surprising that the Review does not comment further on this aspect of their biology.

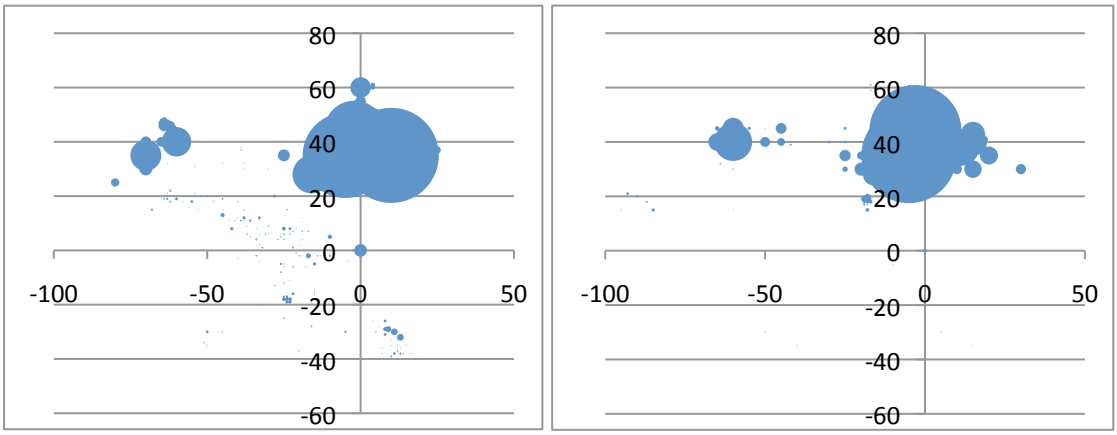

Figure 1 ICCAT catch data plotted by latitude (y axis) and longitude (x axis) for the 1980s (left) and 1990s (right).

The assumption of a common mean generation time for both western and eastern components is not consistent with the determination of different ages at first spawning (approximately age 4 in the east and age 9 in the west) in both the literature reported on page 11-12 and by ICCAT. Although ICCAT is quoted to regard this disparity as being "unlikely", it should be reflected in mean generation time for the two stocks – eg 14 years for the western stock and 26 years for the western stock.

The method of calculation of generation time should be specified in the Report (page 12).

4.2.TOR 2 (genetics, physiology, behaviour)

This question overlaps with the first question. The most intriguing information was that presented by Block (Reeb and Block) to the Review, that there is evidence from microsatellite data of there being two genetically distinct populations in the west and two in the Mediterranean. Other evidence presented also suggests that there may be more spawning sites, particularly in the past, which supports the hypothesis that the current

restriction to two major water bodies for spawning represents a response to range contraction.

Linking with my comment above about previous range distribution, it is surprising that the Review does not discuss the suggestion of the historical existence of 3 stocks made by Fromentin (2009[1]) which supports the comments made by Barbara Block to the review. This paper is also important in that it discusses linkages between east and west Atlantic, and historical distribution and behaviour of tuna, and it should be referenced.

The existence of an eastern Mediterranean stock would further support the argument for discreteness, but I am not convinced yet that a substantial argument could be made from available data on the discreteness of the two stocks in the Mediterranean. Therefore, I support the discreteness conclusion in the Review (pending later comments on the importance of understanding the level of mixing of these two stocks on feeding grounds in the Atlantic).

4.3.TOR 3 (distinct population segment)

The evidence for separation, homing, and spawning fidelity strongly supports the assumption of at least two separate stocks for Atlantic bluefin tuna. Some of the evidence (including Fromentin and Block, referenced above) supports further division into genetic units, but this is not strongly supported scientific evidence. As identified in the Review, the population structure of the species (particularly its micro-structure) remains poorly understood and requires further investigation, and it does not yet support the definition of further subunits as DPS.

Although it is clear that there are two genetically distinct stocks, it is also clear that there is significant mixing between the stocks, particularly the younger ages on feeding grounds off the east coast of the USA. Given this situation, it becomes important to understand the extent of mixing, and the implications for this mixing, on stock structure. This is not explained adequately in the current version of the Review document.

Some of the most important data are those presented on page 17 and at the end of page 20, apparently from Riccioni et al (2010), that the rates of spawning site fidelity are 95.8% for the Mediterranean and 99.3% for the Gulf of Mexico. The meaning of these statistics is not explained in the Review, but it is critical to understanding some of the later comments in the report. Firstly, the reference in Riccioni et al (2010) to these two percentages is misleading, and has lead to the attribution of these percentages to Block et al (2005) and Teo et al (2007). The source of the data is Rooker et al (2008), and this should be corrected in the Review. Rooker's actual results are reproduced from the paper below (bullets are the author's)

Percentage contribution of "western population" and standard deviation (SD) around estimated proportion per region and size category:

- *Gulf of Mexico [giant: 99.3% (SD 1.7%), n=42];*

[1] Fromentin, J.-M. 2009. Lessons from the past: investigating historical data from bluefin tuna fisheries. Fish and Fisheries 10:197-216.

- *Mediterranean Sea [giant: 4.2% (SD 3.1%), n=94; medium: 4.2% (SD 4.4%), n=38];*
- *Gulf of St Lawrence [giant: 100% (SD 0.0%), n=38];*
- *Gulf of Maine [giant: 94.8% (SD 5.3%), n=72];*
- *Mid Atlantic Bight [giant: 64.9% (SD 21.9%), n=12; medium: 55.7% (SD 10.4%), n=56; school: 42.6% (7.2%), n=86]*

Firstly, it is clear from these results and those of Dickhut et al (2009) and Block et al (2005) that there is significant mixing in the region of the mid-Atlantic Bight (MAB), and that a large proportion of the juvenile and medium-sized fish caught off the eastern USA are from the Mediterranean. Secondly, the Gulf of Mexico (GOM) and Mediterranean data are the origin of the quoted 99.3% and 95.8% rates respectively. However, while it might be implied from the text that "spawning site fidelity" means the rate of return to the spawning site, what is actually presented in Rooker et al's data is the percentage of the animals that originate from the western population.

This has profound implications for the later conclusions of the Review, in particular the stock assessment of western bluefin tuna (noted in Rooker et al as an issue) and the assumption in section 6.4.3 that "*Given the mixing between the stocks, improved stock conservation in the east can be expected to benefit the western stock as well*".

A useful summary of the available evidence is given in SCRS (2008b, p 6).

Western samples (Mid-Atlantic bight)						*Eastern samples (Mediterranean)*					
Location	*CFL (cm)/age*	*n*	*East*	*West*	*Std*	*Location*	*Age*	*n*	*East*	*West*	*std*
MAB	69-119	46	0.62	0.38	0.12	Med	age 10	94	0.957	0.043	0.032
MAB	120-151	50	0.56	0.44	0.10	Med	age 5-9	38	0.955	0.045	0.045
MAB	185+	34	0.17	0.83	0.12						
GOM	age 10+	42	0.01	0.99	0.02						
Gulf Maine	age 10+	72	0.02	0.98	0.03						
Gulf SL	age 10+	39	0.00	1.00	0.00						

This report does, however, include a reference that does not appear in the Review that suggests that the maximum likelihood analysis of Rooker et al may be over-estimating the contribution of western fish to the Mediterranean: *A potential problem is that the maximum likelihood composition estimator can be biased when the stocks differ greatly in local abundance, with the near-zero contributor tending to be overestimated (Millar 1987[2])" (SCRS, 2008b[3]).*

4.4.TOR 4 (habitat requirements)

The information on habitat requirements is adequate, although I would have preferred there to be more discussion of the historical range and habitat for the species. This is provided in

[2] MILLAR, R.B. 1987. Maximum likelihood estimation of mixed stock fishery composition. Can. J. Fish. Aquat.Sci. 44: 583-590.

[3] ICCAT. REPORT OF THE 2008 ATLANTIC BLUEFIN TUNA STOCK ASSESSMENT SESSION *(Madrid, Spain – June 23 to July 4, 2008)*

the numerous source documents, in particular the 2008 ICCAT symposium, but some greater discussion of historical, and therefore perhaps more natural pre-exploitation distribution, would inform the discussion of the mixing and migrations expected under conditions of stock improvement or climate change.

4.5.TOR 5 (threats)

The threats from disease, oil/gas exploration and predation are clear, well-researched and presented. I have found no major gaps in the information that would suggest that the major threats to the population are other than from harvesting.

Under the heading of threats from harvest I enter a discussion of the stock assessments. The stock assessments conducted by ICCAT are unsatisfactory, in that the long-term quality of the data are poor, and significant assumptions have to be made about catch at age. Note that Table 5.6 in the review is illegible, and should be replaced, and even then it is impossible to interpret without reference to the 2010 ICCAT stock assessment document.

The stock assessment for the eastern stock is uncertain, but the best given the level of available data and fits to the CPUE data are not particularly poor. Strangely, although the Review does present the ICCAT assessments in some detail, it does not discuss alternative assessments of status, such as MacKenzie et al (2009[4]). This should be rectified.

The assessment of the western stock also displays reasonable fits to the CPUE data, but it is disappointing that the Review did not explore the implications of the mixing models more thoroughly. Despite the clear evidence presented (in the Review and above) of mixing between the two stocks on the current fishing grounds off the eastern USA, and historically off Brazil and Norway (although Takeuchi et al's 2009 paper is very sketchy on detail, and does not strongly support its conclusions with evidence), there appears to be no consideration of alternative hypotheses of catch origin and mixing in the ICCAT assessments beyond the preliminary analyses conducted in 2008. No updates to this exploration were conducted in 2010 (although apparently the Review team used the MAST assessment software to explore the consequences of oil spill mortalities in Figure 6.1), so the implications for these hypotheses on the stock assessment should at least be acknowledged and reported here.

An extract from the 2008 STOCK ASSESSMENT REPORT[5] is shown below to demonstrate that all but one of the models would have significant impacts on interpretation of the status and trends in the western stock, and only one would have a significant impact on interpretation of the eastern stock. These impacts would flow through to the projections, to the expectation that the ICCAT TACs would deliver the management objectives, and to calculations of extinction risk.

[4] MacKenzie, B.R., H. Mosegaard, and A.A. Rosenberg. 2009. Impending collapse of bluefin tuna in the northeast Atlantic and Mediterranean. Conservation Letters 2:25-34.
[5] http://www.iccat.es/Documents/Meetings/Docs/2008_BFT_STOCK_ASSESS_REP.pdf

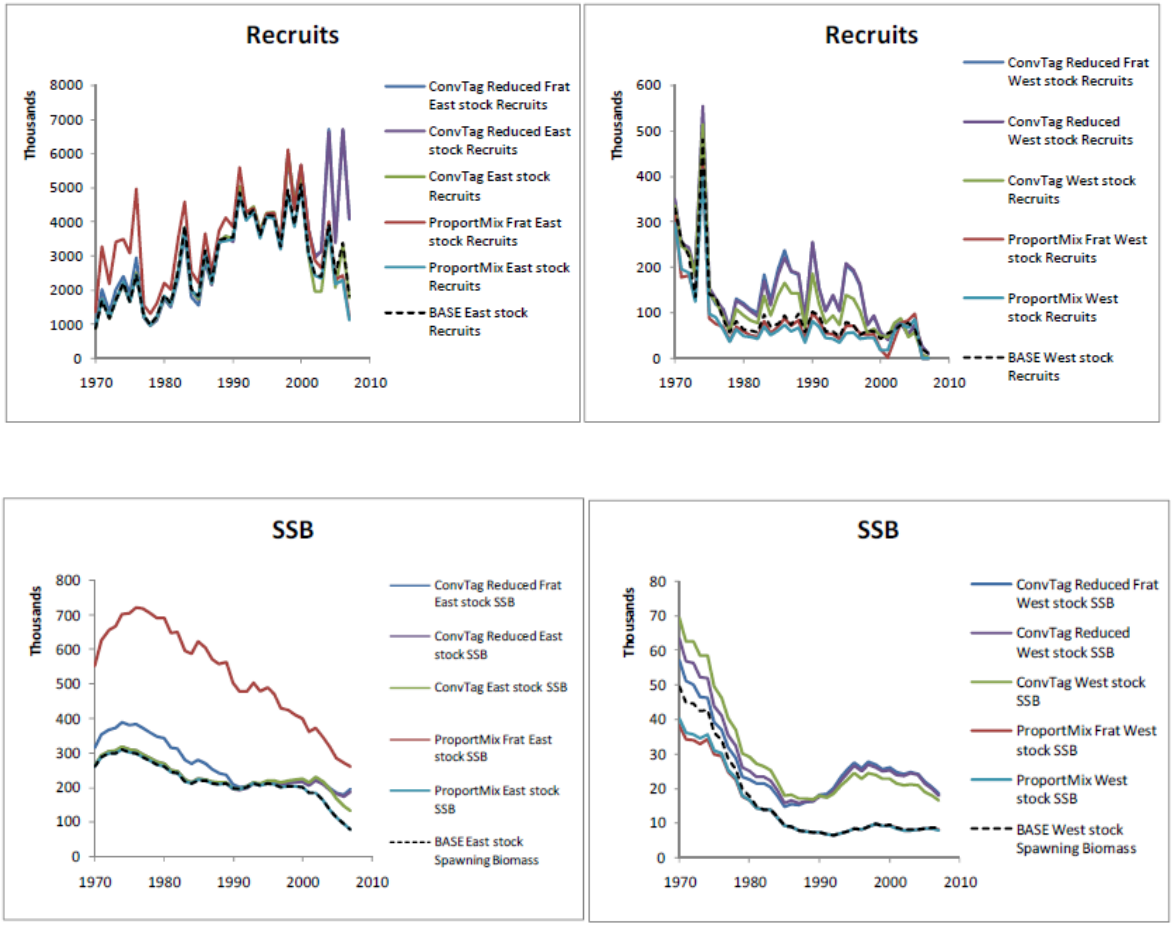

Figure 2 Recruitment (age 1; top) and SSB (bottom) estimates for the eastern (left) and western (right) populations of bluefin tuna for the five scenarios compared to the corresponding base cases without mixing (dashed line). From the 2008 ICCAT bluefin tuna stock assessment report, figures 39 and 40.

4.6.TOR 6 (aquaculture)

The review of ranching is reasonable. In respect of nutrient pollution, my information is that the farms are keen to avoid this and have put sufficient measures in place which have been alluded to in the report e.g. controlled feeding regimes based on monitoring feeding behaviour and optimal stocking levels to avoid pathogens. Farm operators also seek to avoid waste because feed species are of high value: sardine, mackerel, anchovy and so on. Furthermore, they seek to avoid local eutrophication because bluefin are very susceptible to low oxygen levels.

In section 6.5.2 the reference to Annex 8 should be replaced with paragraph 26 of Recommendation 08-05. Recommendation 08-05 will be superseded by Rec 10-04 in September.

Note that there is concern about the methodologies used to quantify the amounts of tuna, with a longer term view to standardise and enshrine the best practice system in the regulatory framework. This of course feeds through to the assessments.

4.7.TOR 7 (conservation actions)

Manipulative conservation actions appear sensible, particularly the use of weak hooks in the Gulf of Mexico longline fisheries. Directed fishing on tuna in the Gulf of Mexico is prohibited under ICCAT Recommendation 2010-03. The listening sessions are interesting primarily from the point of view of the potential for increasing CPUE in the eastern US fisheries, and the relative catches of different size classes of fish inshore and offshore.

Most conservation actions are based on limiting the catch of BFT in both the east and west. The status of the stocks is very different; although there has been significant over-fishing of the eastern stock in recent years, the 2010 assessment estimates SSB to be at 57% of the highest level. For the western stock, the estimate is 29% of the highest level (1970).

There are significant uncertainties, however: the extent and impact of mixing (explored only in 2008) and, for the western stock, the stock-recruit relationship. Uncertainties for the eastern stock are mostly to do with accurate estimation of catch and catch at age, model fitting, and implementation error. However, given the relative states of the stock (in the latest assessments) and the improvement in compliance our concern here should be mostly on the western stock.

A very significant concern attends the calculation of the impact of current catch levels on the western stock, in that two alternative stock recruit relationships are offered. Discrimination between these two relationships is necessary for the future understanding of the current state of the western stock. The extent to which the estimates of early recruitment are correct; are wrong, because of errors in the catch and CAA data; or are no longer tenable due to a change in environmental conditions, needs to be established. It is interesting that this effect cannot be produced by the early Japanese catches around Brazil, because the VPA is set from 1970 onwards. It is also interesting that the change in predicted recruitment dynamics coincides with a similar (but opposite) change in recruitment in the eastern stock (around 1975). Finally, any argument that the high recruitment scenario is unrealistic in the current environmental conditions is belied somewhat by the size of the 2003 cohort.

Until these various alternative explanations of the recruit series are explored, and at the moment the SCRS considers them “equally likely”, it would be precautionary to manage the fishery in respect of the high recruitment hypothesis, because this hypothesis presents the most pessimistic view of the stock, and would require the highest input of recovery action. If the high recruitment hypothesis was followed, and found to be in error, the consequences for the stock would be positive. If the low recruitment hypothesis was followed, and found to be in error, the consequences for the stock could be significant.

The 2010 ICCAT assessment suggested that for the high recruitment assumption the stock was severely depleted and overfishing was occurring (F/Fmsy=1.8, B/Bmsy=0.2). Depletions of this level are of concern because recruitment may start to be impaired. It also found that, as reported in the Review (page 46), even a zero TAC would be unlikely to rebuild the stock within the rebuilding timeframe, but that a TAC of 1100 t or less was expected to end overfishing and initiate rebuilding. A constant catch equal to a TAC of 1750 t (i.e. that set for the 2011 and 2012 fishing seasons) delivered only a 41% probability that the fishing mortality rate would have dropped, by 2019, to less than the level that would eventually produce the maximum sustainable yield for a given constant level of catch in the high

recruitment[6] scenario (see the far right hand side of "1750" row in the middle table of Figure 4).

Given the importance of this issue, and although it is discussed in the Review, it would be much clearer if the six important SCRS tables were included, BFTW-Table 1 and Table 13 in REPORT OF THE 2010 ATLANTIC BLUEFIN TUNA STOCK ASSESSMENT SESSION (Madrid, Spain – September 6 to 12, 2010)[7], and the same figure for fishing mortality rate, which only appears as Table 14 in REPORT OF THE 2010 ATLANTIC BLUEFIN TUNA STOCK ASSESSMENT SESSION (Madrid, Spain – September 6 to 12, 2010), below:

Low recruitment scenario (two-line)

TAC	2011	2012	2013	2014	2015	2016	2017	2018	2019
0 mt	67.8%	98.4%	99.4%	99.4%	99.8%	100.0%	100.0%	100.0%	100.0%
250 mt	66.8%	98.2%	98.8%	98.8%	99.8%	99.8%	100.0%	100.0%	100.0%
500 mt	66.0%	98.0%	98.8%	98.8%	99.0%	99.8%	99.8%	100.0%	100.0%
750 mt	65.6%	97.4%	98.4%	98.0%	98.8%	99.0%	99.4%	99.6%	100.0%
1000 mt	64.6%	97.0%	97.6%	97.0%	98.2%	98.8%	99.0%	99.0%	99.4%
1250 mt	63.8%	96.4%	97.0%	96.2%	97.8%	98.2%	98.4%	98.4%	98.8%
1500 mt	63.2%	96.2%	96.4%	95.2%	95.8%	97.0%	97.6%	97.4%	97.6%
1750 mt	61.6%	95.2%	95.4%	93.2%	93.6%	94.0%	94.4%	95.0%	95.8%
2000 mt	60.6%	94.8%	94.6%	90.4%	91.0%	91.8%	92.0%	92.4%	92.6%
2250 mt	59.6%	94.4%	93.2%	87.4%	87.8%	86.8%	86.4%	86.6%	86.2%
2500 mt	58.8%	93.2%	91.4%	84.2%	81.8%	81.2%	81.2%	78.6%	78.2%
2750 mt	57.6%	92.8%	88.6%	78.4%	76.4%	74.0%	73.4%	69.6%	68.0%
3000 mt	56.4%	91.2%	86.4%	74.0%	69.0%	66.2%	62.4%	59.8%	56.8%
3250 mt	54.6%	89.6%	83.2%	68.2%	62.2%	57.4%	53.0%	48.2%	44.0%
3500 mt	54.2%	87.2%	79.0%	61.4%	55.4%	49.0%	43.6%	38.2%	34.0%

High recruitment scenario (Beverton-Holt)

TAC	2011	2012	2013	2014	2015	2016	2017	2018	2019
0 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
250 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
500 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
750 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1000 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1250 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1500 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1750 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2000 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2250 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2500 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2750 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3000 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3250 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3500 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Combined recruitment scenarios (low and high equally probable)

TAC	2011	2012	2013	2014	2015	2016	2017	2018	2019
0 mt	33.9%	49.2%	49.7%	49.7%	49.9%	50.0%	50.0%	50.0%	50.0%
250 mt	33.4%	49.1%	49.4%	49.4%	49.9%	49.9%	50.0%	50.0%	50.0%
500 mt	33.0%	49.0%	49.4%	49.4%	49.5%	49.9%	49.9%	50.0%	50.0%
750 mt	32.8%	48.7%	49.2%	49.0%	49.4%	49.5%	49.7%	49.8%	50.0%
1000 mt	32.3%	48.5%	48.8%	48.5%	49.1%	49.4%	49.5%	49.5%	49.7%
1250 mt	31.9%	48.2%	48.5%	48.1%	48.9%	49.1%	49.2%	49.2%	49.4%
1500 mt	31.6%	48.1%	48.2%	47.6%	47.9%	48.5%	48.8%	48.7%	48.8%
1750 mt	30.8%	47.6%	47.7%	46.6%	46.8%	47.0%	47.2%	47.5%	47.9%
2000 mt	30.3%	47.4%	47.3%	45.2%	45.5%	45.9%	46.0%	46.2%	46.3%
2250 mt	29.8%	47.2%	46.6%	43.7%	43.9%	43.4%	43.2%	43.3%	43.1%
2500 mt	29.4%	46.6%	45.7%	42.1%	40.9%	40.6%	40.6%	39.3%	39.1%
2750 mt	28.8%	46.4%	44.3%	39.2%	38.2%	37.0%	36.7%	34.8%	34.0%
3000 mt	28.2%	45.6%	43.2%	37.0%	34.5%	33.1%	31.2%	29.9%	28.4%
3250 mt	27.3%	44.8%	41.6%	34.1%	31.1%	28.7%	26.5%	24.1%	22.0%
3500 mt	27.1%	43.6%	39.5%	30.7%	27.7%	24.5%	21.8%	19.1%	17.0%

[6] Incidentally, why are these scenarios referred to as "recruitment recruitment scenario" in the report? Is this a search/replace problem?

[7] http://www.iccat.es/Documents/Meetings/Docs/2010_BFT_ASSESS_REP_ENG.pdf

Figure 3 Kobe II matrix of the chance that the spawning biomass will meet or exceed the convention objectives (MSY level) for a given constant level of catch and recruitment scenario (low, high and combined); from Table 13 in the 2010 bluefin tuna stock assessment report.

TAC	2011	2012	2013	2014	2015	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
250 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
500 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
750 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1000 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1250 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1500 mt	99.6%	99.6%	99.6%	99.4%	99.4%	99.4%	99.4%	99.4%	99.4%
1750 mt	98.8%	98.8%	98.8%	98.6%	98.6%	98.8%	98.8%	98.8%	98.8%
2000 mt	96.4%	96.4%	96.4%	96.6%	96.0%	95.8%	96.0%	96.6%	96.6%
2250 mt	90.2%	91.8%	91.6%	91.4%	91.2%	90.4%	90.4%	91.4%	91.6%
2500 mt	78.8%	82.4%	81.2%	80.2%	79.0%	77.0%	78.0%	81.6%	79.8%
2750 mt	63.6%	67.0%	65.2%	66.0%	65.0%	62.2%	61.0%	63.4%	61.6%
3000 mt	47.8%	51.4%	49.0%	48.4%	46.6%	43.6%	41.4%	43.0%	41.8%
3250 mt	34.4%	37.2%	33.8%	32.8%	29.4%	25.4%	23.8%	26.2%	23.6%
3500 mt	21.4%	25.4%	18.2%	17.4%	15.2%	13.6%	12.2%	13.0%	12.2%

High recruitment scenario (Beverton-Holt)

TAC	2011	2012	2013	2014	2015	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
250 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
500 mt	99.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
750 mt	96.6%	98.4%	98.6%	98.8%	98.8%	99.2%	99.2%	99.4%	99.6%
1000 mt	75.6%	85.2%	88.8%	91.6%	93.0%	93.4%	95.4%	97.0%	98.6%
1250 mt	40.4%	53.6%	60.0%	67.2%	71.4%	74.6%	80.6%	87.2%	89.8%
1500 mt	13.8%	25.6%	30.6%	38.4%	44.0%	47.6%	53.2%	63.6%	67.6%
1750 mt	4.6%	8.2%	10.4%	14.2%	18.0%	22.2%	26.6%	38.6%	41.0%
2000 mt	1.4%	3.2%	4.2%	4.6%	7.0%	9.0%	12.4%	17.4%	19.6%
2250 mt	0.6%	1.0%	1.2%	2.2%	2.6%	3.2%	5.0%	7.4%	9.4%
2500 mt	0.2%	0.2%	0.2%	0.6%	1.2%	1.4%	1.4%	3.4%	3.8%
2750 mt	0.0%	0.2%	0.2%	0.2%	0.2%	0.2%	0.8%	1.4%	1.4%
3000 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.2%	0.2%	0.2%
3250 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
3500 mt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Combined recruitment scenarios (low and high equally probable)

TAC	2011	2012	2013	2014	2015	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
250 mt	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
500 mt	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
750 mt	98.3%	99.2%	99.3%	99.4%	99.4%	99.6%	99.6%	99.7%	99.8%
1000 mt	87.8%	92.6%	94.4%	95.8%	96.5%	96.7%	97.7%	98.5%	99.3%
1250 mt	70.2%	76.8%	80.0%	83.6%	85.7%	87.3%	90.3%	93.6%	94.9%
1500 mt	56.7%	62.6%	65.1%	68.9%	71.7%	73.5%	76.3%	81.5%	83.5%
1750 mt	51.7%	53.5%	54.6%	56.4%	58.3%	60.5%	62.7%	68.7%	69.9%
2000 mt	48.9%	49.8%	50.3%	50.6%	51.5%	52.4%	54.2%	57.0%	58.1%
2250 mt	45.4%	46.4%	46.4%	46.8%	46.9%	46.8%	47.7%	49.4%	50.5%
2500 mt	39.5%	41.3%	40.7%	40.4%	40.1%	39.2%	39.7%	42.5%	41.8%
2750 mt	31.8%	33.6%	32.7%	33.1%	32.6%	31.2%	30.9%	32.4%	31.5%
3000 mt	23.9%	25.7%	24.5%	24.2%	23.3%	21.9%	20.8%	21.6%	21.0%
3250 mt	17.2%	18.6%	16.9%	16.4%	14.7%	12.7%	11.9%	13.1%	11.9%
3500 mt	10.7%	12.7%	9.1%	8.7%	7.6%	6.8%	6.1%	6.5%	6.1%

Figure 4 Kobe II matrix of the chance that the fishing mortality rate will be less than the level that would eventually produce the maximum sustainable yield for a given constant level of catch and recruitment scenario (low, high and combined); from Table 14 in the 2010 bluefin tuna stock assessment report.

In the section 6.4.3 Summary and Evaluation, given the above discussion there is one statement which is not well supported by the evidence.

"Given the mixing between the stocks, improved stock conservation in the east can be expected to benefit the western stock as well." There is no evidence that eastern BFT contribute to the western spawning stock. There is some evidence that western fish contribute to eastern spawners, a situation of considerable concern given the relative sizes of the two stocks (but note that as indicated above the extent of this mixing may be over-

estimated). There is very strong evidence that eastern BFT contribute to the catches that are made on the eastern US seaboard, particularly MAB. Thus to the extent that improved stock status in the east would increase the number of eastern fish in the MAB fishery, and reduce the proportion of the TAC that was western stock fish, then this statement is correct; if the statement is meant to imply that eastern fish will contribute to the western spawning population, the statement is incorrect. However, this complex logic, if it was meant by the authors, should be explained more fully.

There is a distinction to be made, obviously, between growth of the western population and recovery according to management objectives. The evidence points to the continued growth of the western stock with current catch levels, but a potential failure of the recovery objectives in the case of the high recruitment scenario.

This points to an omission in the Review, that of a consideration of whether ICCAT decision rules are capable of avoiding significant harm from harvesting of tuna. The rebuilding plans presented in ICCAT Recommendations 2010-03 (western Atlantic BFT) and 2010-04 (eastern Atlantic BFT) make reference to an "MSY target" but the decision rule only refers to a limitation on the rate at which the TAC can be increased (2010-03, paragraph 4: No adjustment to the annual TAC or the 20-year rebuilding period shall be considered unless SCRS advice indicates that the TAC under consideration will allow the MSY target to be achieved within the rebuilding period with a 50 percent or greater probability). In particular, no limit reference point is defined, although ICCAT has discussed the idea (Appendix 6 to ANNEX 4.3 of ICCAT 2010) that "*Conservation ("limit") reference points should be used to constrain harvesting within safe biological limits within which stocks can produce MSY. Management ("target") reference points should be used to meet management objectives".* Further discussion and recommendations on this issue was presented in the ICCAT performance review (Hurray et al, 2010[8]).

4.8.TOR 8 (extinction risk)

The Review states that projections were conducted exactly as specified in SCRS 2010. Further details are lacking, but should be added since this is a critical part of the work. In particular, the Review states that in the low recruitment scenario it is assumed that "*future recruitment will fluctuate about the average level estimated since the 1980s unless the spawning biomass falls below historical lows, in which case recruitment decreases linearly with spawning biomass*". However, SCRS (BFT STOCK ASSESSMENT REPORT) states "*The constant level of recruitment is defined as the geometric mean recruitment over the years 1976-2006, a period over which recruitment was relatively constant*". The differences between these two time periods should be clarified. For the high recruitment scenario, the Review states that it uses the SR relationship over the whole time period from 1970, which is consistent with the SCRS.

The SCRS is explicit about recruitment variability, which is as important as the actual recruitment relationship in terms of estimating extinction probability. For both the low and

[8] Hurry, G.D., M. Hayashi, and J.J. Maguire. 2008. Report of the Independent Review International Commission for the Conservation of Atlantic Tunas (ICCAT)

high recruitment scenarios SCRS states that the standard deviation of recruitment variability for each bootstrap replicate was set equal to the maximum likelihood estimate (~0.43). This information is omitted from the Review. One assumes therefore that fitting to both the hockey stick (2-line) and Beverton Holt resulted in the same variance estimate. If this is true it should be confirmed.

It would be useful to see the extinction risk calculations done under a strict bootstrapping projection of the low recruitment situation, rather than an assumed variance estimate.

Finally, there needs to be some discussion of the implications of the alternative hypotheses of stock structure, and in particular mixing, on the calculations of extinction risk. At the moment this is entirely lacking and is necessary particularly given the current state of the western stock.

4.9.TOR 9 (soundness of conclusions)

In general the report is comprehensive in its use of scientific papers on biology, migration and threats from disease, pollution etc.

The general scientific conclusions are sound based on available information, but more detail should be included in respect of

- historical range changes
- the consequences of alternative hypotheses of mixing on the stock assessment
- likely trends in biomass under current ICCAT regulations
- calculations of future extinction risk projections

4.10. TOR 10 (opposing studies)

Some opposing, and additional, scientific studies have been identified above.

4.11. TOR 11 (best scientific information)

My assessment is that there are no major gaps in the information provided in the Review, but there are gaps in the extent to which the information has been analysed to exhaustively assess the trends in biomass and extinction risk under current ICCAT regulations. In particular, the implication of alternative hypotheses of mixing of the two stocks and the consequences that this might have on a) the accuracy of the current ICCAT assessment and b) calculations of extinction risk of the Western Stock under the low recruitment hypothesis, should be explored.

Appendix 1: Materials for review

Status Review Report of Atlantic Bluefin Tuna (Thunnus thynnus), prepared by the Atlantic Bluefin Tuna Status Review Team for the National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Appendix 2: Statement of Work

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.

Support Personnel:

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Key Personnel:

NMFS Project Contact:

Kimberly Damon-Randall,
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kimberly.damon-randall@noaa.gov Phone: 978-282-8485

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