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INTERPRETATION OF THE U.S. NATIONAL RESEARCH COUNCIL'S REPORT ON "AN ASSESSMENT OF ATLANTIC BLUEFIN TUNA"

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SUMMARY

The NRC's report on "An Assessment of Atlantic Bluefin Tuna" (NRC 1994) is scientifically relevant to the assessment and management of Atlantic bluefin tuna.

NOAA's interpretation of the report is that:

1) While mixing rates between the western and eastern Atlantic are small, mixing should be taken into account in resource assessments;
2) Although existing genetics data are consistent with a single inter-breeding Atlantic population, assessing and managing bluefin tuna as western and eastern units is appropriate, so long as mixing is taken into account.
3) The abundance of mature bluefin in the western Atlantic has not changed significantly since 1988, but the abundance is still low relative to the 1970s. Abundance of mature fish in the west may be significantly bolstered (by as much as 50%) by migration from the east, which implies that recruitment from spawning in the west may be even poorer than indicated by previous SCRS assessments.

NOAA believes that the assessment methods used by the NRC have merit and should be pursued in future assessments.

RESUME

Le rapport du *National Research Council* (NRC) sur "l'Evaluation du Thon Rouge de l'Atlantique" (NRC 1994) est scientifiquement relatif à l'évaluation et à la gestion du thon rouge de l'Atlantique.

Le rapport a été interprété par la *National Oceanic and Atmospheric Administration* (NOAA) de la façon suivante :

1. Même si les taux de mélange entre l'Atlantique Est et Ouest sont faibles, le mélange devrait être pris en compte dans les évaluations des ressources ;
2. Bien que les données génétiques existantes soient cohérentes avec un stock unique consanguin dans l'Atlantique, l'évaluation et la gestion du thon rouge par unités distinctes entre l'Est et l'Ouest sont appropriées tant que le mélange est pris en compte.
3. L'abondance de thons rouges matures dans l'Atlantique Ouest n'a pas changé de manière significative depuis 1988 mais elle reste faible par rapport aux années soixante-dix. L'abondance de poissons matures à l'Ouest peut être soutenue (d'environ 50%) par la migration de l'Est, ce qui implique que le recrutement à partir de la reproduction dans l'Ouest serait encore plus faible que ce qui avait été indiqué les précédentes évaluations du SCRS.

La NOAA considère que les méthodes d'évaluation utilisées par le NRC sont intéressantes et que l'on devrait continuer à les utiliser dans les futures évaluations.

RESUMEN

El informe del NRC (US National Research Council) sobre "Una evaluación sobre el Atún Rojo Atlántico" (NRC), es científicamente relevante para la evaluación y gestión del atún rojo atlántico.

La interpretación del NOAA sobre el informe es que:

1. Si bien las tasas de mezcla entre el Atlántico oeste y este son escasas, debería tenerse en cuenta la mezcla en las evaluaciones del recurso;
2. Aunque los datos sobre genética existentes son coherentes con una única población atlántica intercruzada, la evaluación y ordenación del atún rojo en unidades oeste y este es adecuada, siempre que se tome en cuenta la mezcla.
3. La abundancia de atún rojo maduro en el Atlántico oeste no ha cambiado de forma significativa desde 1988, pero la abundancia es aún baja en relación a los años 70. La abundancia de peces maduros en el oeste puede estar significativamente reforzada (tanto como en un 50%) por la migración procedente del este, lo que implica que el reclutamiento de reproductores en el oeste podría ser aún más escaso de lo que indican las evaluaciones anteriores del SCRS.

NOAA opina que los métodos de evaluación utilizados por NRC son valiosos y deberían proseguir en futuras evaluaciones.

Introduction

On August 31, 1994, the National Research Council (NRC) issued a report entitled "An Assessment of Atlantic Bluefin Tuna." This scientific report is relevant to ICCAT's management of Atlantic bluefin tuna. NOAA's preliminary technical evaluation and interpretation of the report is given below. It takes account of deliberations during an information dissemination meeting on the report, convened by the NRC, in Irvine, California, 11 October 1994. Participation in the information dissemination meeting included members of the NRC Committee, and representatives of NOAA, the fishing industry and conservation groups. NOAA's preliminary technical evaluation and interpretation of the NRC Report is consistent with deliberations at the information dissemination meeting.

NOAA believes that the NRC report is a valuable contribution to scientific understanding of the Atlantic bluefin tuna. The report is comprehensive in scope, covering important issues about the biology and ecology of Atlantic bluefin tuna. It emphasizes a serious lack of biological and ecological data and it makes many recommendations for future research. In addition, the report address Atlantic bluefin tuna stock assessments. The NRC finds that are most pertinent to short term management considerations for Atlantic bluefin tuna generally fall into three categories: mixing, population structure, and population trends.

Mixing

The NRC concludes that tagging data and microconstituent analysis indicate some mixing between fisheries of the western and eastern Atlantic. The NRC rejects a parasite study that had been used to infer movement between the western and eastern Atlantic fisheries. The NRC uses the tagging data to estimate mixing rates. While these rates are only a few percent per year, the NRC concludes they should be taken into account in resource assessments (i.e., by using mixing models).

NOAA concurs that mixing should be taken into account, although it does not necessarily view the NRC's specific estimates of mixing rates as the most appropriate for use in future stock assessments. Because of time constraints, the NRC estimates were not based on all existing tagging data. As noted by the NRC, their mixing rate estimates are dependent on several assumptions which may not be valid. Recent analyses of the tagging data by Turner and Powers (1994), Porch et al.(1994) and Punt and Butterworth (1994), using different sets of data and assumptions, give different results. Furthermore, another analysis (Porch 1994) concludes that the accuracy and precision of available data are such that different mixing rates with grossly different abundance trends cannot be discriminated. These results were not available for peer review by the NRC at the time they conducted their study. NOAA believes the NRC's mixing rate estimates are useful to demonstrate the potential importance of taking account of even relatively small rates of mixing in resource assessments and management. But more analysis is needed to determine the best estimates of mixing rates based on all pertinent data. This conclusion was accepted by participants in the 11 October 1994 NRC information dissemination meeting.

Population Structure

The NRC concludes that although genetics data are sparse, they are consistent with a single (interbreeding) population. This conclusion is also consistent with evidence of mixing, since only a very low exchange rate between spawning grounds is required to prevent genetic differentiation. Even populations that have been isolated for long periods of time (i.e., since the last ice age) may not differentiate genetically (apparently this is the case for several North Atlantic herring populations). This means that the available genetics data cannot be used to evaluate the possibility that the population dynamics of bluefin tuna of Gulf of Mexico and Mediterranean Sea origin are essentially independent. Information is needed on the likelihood that fish spawn on the spawning ground of their origin. No such information exists.

Faced with inconclusive evidence on the degree of interdependence of bluefin tuna of western and eastern Atlantic origin, but with the knowledge of some mixing, ICCAT established separate western and eastern Atlantic management units, commonly referred to as stocks. The intent was to be conservative by implementing management regimes for both groups of fish. This approach would protect both western and eastern Atlantic bluefin if more conclusive data in the future established a high degree of independence in their population dynamics (Brown and Parrack 1985).

The NRC report did not explicitly address the issue of stocks in the context of management units. Although the NRC concludes that the available genetic evidence, although sparse, is consistent with a "single stock hypothesis," they note that other information is either incomplete or inadequate to address the issue. The NRC goes on to conduct and recommend resource assessments that explicitly take account of mixing between the western and eastern Atlantic fisheries, which NOAA interprets as an improvement over the ICCAT two stock (for management purposes) approach. At the 11 October information dissemination meeting, the NRC Committee made it clear that they rejected a two stock approach that ignored mixing, but that management units for the western and eastern Atlantic, taking account of mixing, is consistent with their report.

NOAA agrees with the view that emerged from the 11 October information dissemination meeting, that western and eastern Atlantic management units are still appropriate, as long as mixing is taken into account, as recommended by the NRC. And, as a practical matter, two management units have at least some utility for allocating access to the resource between western and eastern Atlantic participants in the fisheries.

Population Trends

The NRC conducted its own assessment of western and eastern Atlantic bluefin tuna using the ICCAT Standing Committee on Research and Statistics' (SCRS) database obtained from the National Marine Fisheries Service. In doing so, they found inconsistencies in U.S. rod and reel abundance indices, which led to the discovery and correction of input errors in some 1992 data. NOAA acknowledges that there were data input errors in the SCRS assessment. Steps have been taken to improve handling of these data and reduce the risk of future errors.

The NRC used an assessment model that takes account of mixing between the eastern and western Atlantic. In addition, the NRC used different statistical methods to standardize U.S. abundance indices, which had a particularly important effect on the 1983 U.S. Rod and Reel index. The NRC's standardization lowers the 1983 index.

The NRC assessment of the recent abundance and biomass of mature (defined as age 8+ for the purposes of this discussion) fish in the western Atlantic is higher than the SCRS assessment. The NRC reports the ratios of 1993 abundance and biomass to 1975 and 1988 abundance and biomass. After examining assessment model output files obtained from the NRC, it was determined that the ratios reported in the NRC report (their Table 4-8) were mislabeled, which was acknowledged by the NRC at the 11 October information dissemination meeting. In addition, biomass ratios appear to have been calculated with a mismatch of mid-year weights at age with beginning of year numbers of fish. These problems are resolved in Table 1. The NRC's general conclusions are not affected. Using a mixing rate of 2% per year from east to west up to age 6 and 1% from west to east for all ages (NRC Case 1), the NRC assessment indicates the abundance of mature fish in 1993 is 29% of the 1975 levels and 110% of the 1988 level. SCRS reported ratios of 15% and 79%, respectively. Without mixing (NRC Case 7), the NRC assessment gives 1993/1975 and 1993/1985 abundance ratios of 24% and 102%, which are also higher than the SCRS assessment. Other NRC model runs (e.g., NRC Case 2 with higher rates of mixing) are even more optimistic, although they are less likely. Overall, the NRC concludes that abundance of mature fish has not changed significantly since 1988. Figure 1a indicates trends in abundance for NRC Cases 1, 2 and 7; Figure 1b gives the remaining cases.

NOAA agrees that the methods used by the NRC to calculate abundance indices have merit, and should be explored further in future assessments. These changes appear to account for some of the increased abundance indicated by the NRC assessments (see the ratios above for no mixing), but unfortunately an apparent miscommunication between NOAA and NRC lead to an error when the NRC recoded SCRS data for their assessment. Since this error was only recently discovered, its effect is not yet known, although it will probably reduce the difference between the NRC and SCRS results. Given the uncertainty inherent in resource assessments, NOAA agrees that the available evidence does not indicate a significant change in abundance of mature fish since 1988. On the other hand, abundance of mature fish in the West is much lower than it was during the 1970's, and there is no firm evidence that a recovery has begun.

Although the NRC assessment of mature fish in the West (which is the primary focus of the NRC report) is higher than the SCRS assessment, the abundance of this group of fish does not tell the whole story about the status of Atlantic bluefin tuna. NOAA obtained unpublished assessment model output files from the NRC. NOAA's interpretation of these files is as follows. The assessment model output files give estimates of recent recruitment in the west that are much poorer (zero in several years) than estimated by SCRS (Figure 2). If fish produced in the West and East are reproductively isolated (which cannot be evaluated using available information), then the abundance of western spawners must still be declining sharply according to NOAA's interpretation of the NRC assessment model outputs. This might explain the poor recruitment (at age one) in the West. At the 11 October information dissemination meeting, the NRC indicated that about half of the mature fish in the western Atlantic may be of eastern Atlantic origin, according to their assessment. In addition, the mature (defined for the East as 5+ for the purposes of this discussion) population abundance in the eastern Atlantic has declined precipitously according to the model outputs (Figure 3). While recruitment in the East has not yet suffered a declining trend, recruitment failure is inevitable if the abundance of mature fish continues to decline. The conclusion that the western Atlantic bluefin is heavily dependent on the East primarily reflects the inclusion of mixing in the NRC's assessments.

In order to interpret the management implications of a resource assessment, it is appropriate to make projections of population size into the future. Such projections have been used by ICCAT as a basis of recent management decisions. The usefulness of projections was generally acknowledged at the 11 October information dissemination meeting, but several difficulties were noted with respect to projections based on mixing models. A "first order approach," assuming constant mixing rates and constant recruitments for both the West and East (using recent average values) was discussed. While this approach is probably optimistic (because it ignores the possible effects of a declining number of spawning age fish in the East on recruitment, as well as the possibility that the number of actual spawners in the West may

also be declining), it may be useful to help put the NRC's assessments in perspective. Therefore, NOAA conducted deterministic population size projections using this first order approach, based on the NRC Case 1 assessment (with 2% mixing from the East and 1% mixing from the West), assuming constant catch for both the west and east at recent reported levels. The projections indicate that recent catch levels are not sustainable for either the West or the East, but NOAA does not believe these results are applicable to management, because of the limitations of the NRC assessment discussed above. In addition, the NRC assessment is already out of date in that there are more recent catch data. NOAA is also concerned about the unexplained difference between the NRC and SCRS assessment for the eastern Atlantic. The NRC assessment for the East is more pessimistic, with or without mixing.

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Table 1. Corrected ratios of spawning numbers (N(8+)) and spawning stock biomass (SSB) for the western Atlantic based on output tables from the NRC peer review of bluefin tuna. Note that N(8+) ratios were incorrectly tabulated in Table 4-8 of the NRC report. SSB (mixed) matches the values reported for SSB in Table 4-8, but erroneously mixes beginning of year (BOY) population numbers with mid-year weights at age. SSB (mid-year) projects BOY numbers to the mid-year and multiplies by mid-year weights, using the standard SCRS procedure.

	N(8+) - corrected		SSB (mixed)		SSB (mid-year)	
	93/88	93/75	93/88	93/75	92/88	92/75
Case 1	109.8%	28.7%	100.0%	24.5%	92.2%	21.8%
Case 2	129.9%	50.0%	126.3%	45.7%	122.6%	43.8%
Case 3	108.8%	30.8%	102.8%	27.4%	99.7%	25.7%
Case 4	110.8%	30.4%	98.3%	25.3%	86.9%	21.3%
Case 5	110.4%	28.9%	100.3%	24.6%	92.2%	21.8%
Case 6	110.0%	30.7%	102.9%	27.0%	98.3%	25.0%
Case 7	102.1%	23.6%	87.9%	19.1%	75.6%	15.5%
Case 8	126.5%	54.5%	125.9%	50.8%	124.7%	49.7%
SCRS	78.5%	14.7%	58.8%	10.4%	44.3%	7.3%

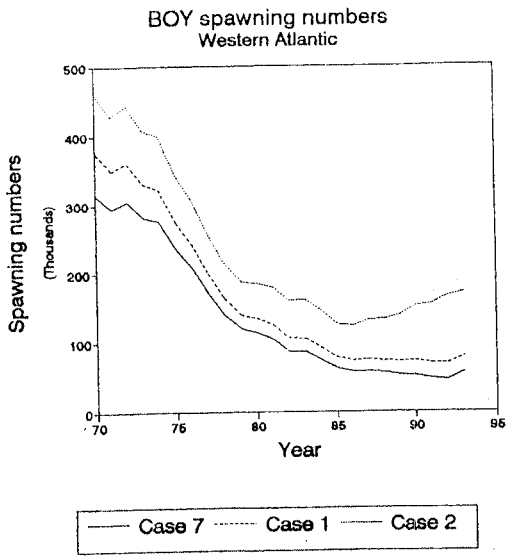

Figure 1a.

"BOY" means beginning of year.

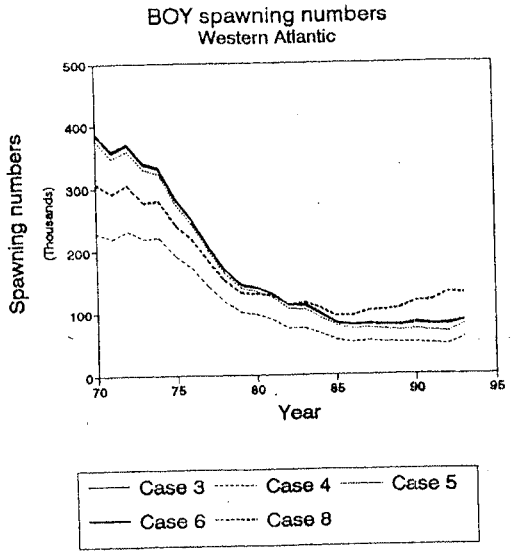

Figure 1b.

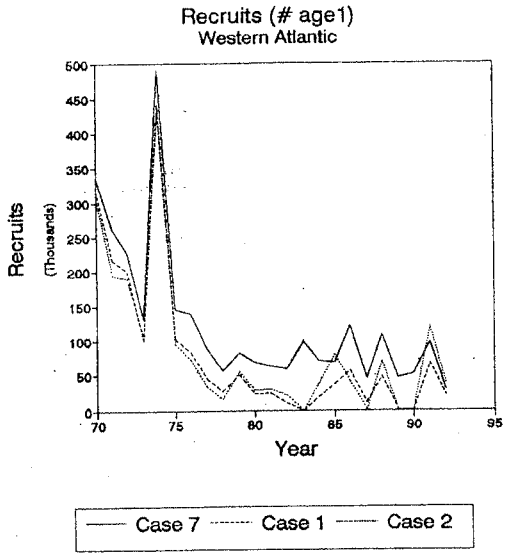

Figure 2a.

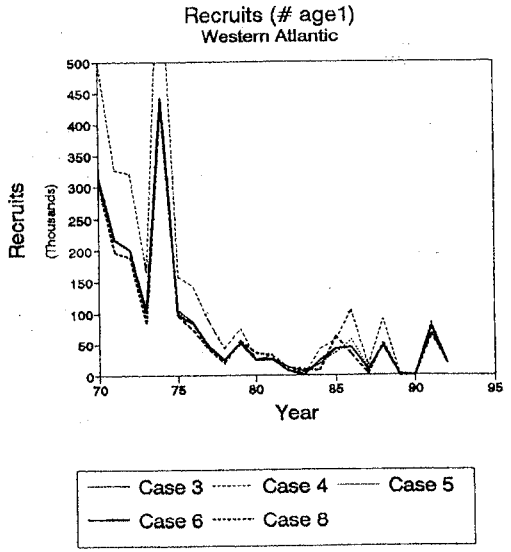

Figure 2b.

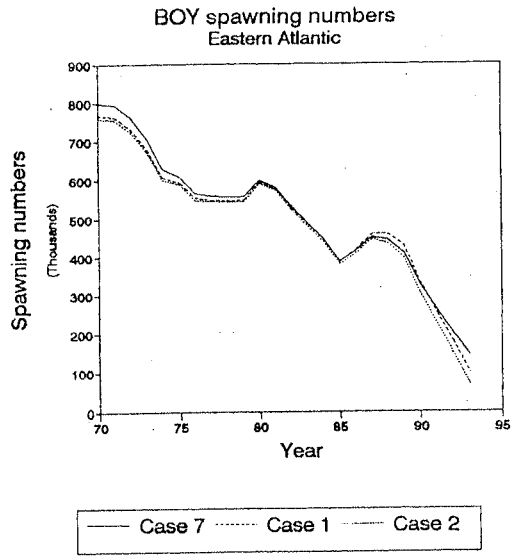

Figure 3a.

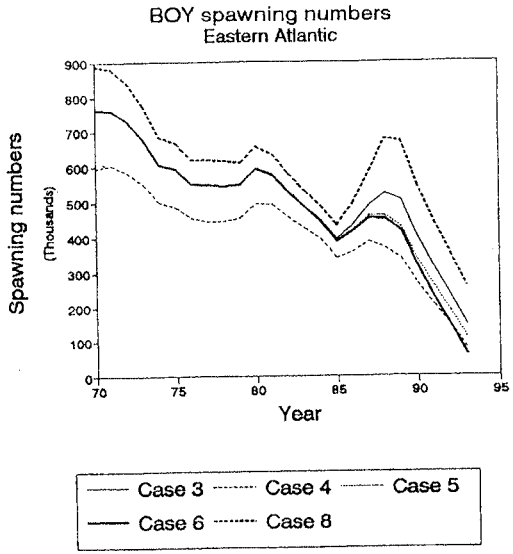

Figure 3b.