

AN UPDATED STOCHASTIC SPAWNER/RECRUIT RELATIONSHIP FOR NORTH ATLANTIC ALBACORE

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SUMMARY

This analysis updates the results obtained in 1979 (SCRS/79/86). The most recent data available are used. Confidence intervals are estimated for Ricker spawner-recruit relationships fit to data for the North Atlantic albacore fishery. For each case examined, the probability of very low recruitment levels is estimated.

RESUME

La présente analyse met à jour les résultats obtenus en 1979 (SCRS/79/86), à partir des données les plus récentes dont l'on dispose. L'intervalle de confiance est estimé pour les rapports géniteur/recrue de Ricker ajustés à des données sur la pêcherie de germon de l'Atlantique nord. On estime pour chaque cas le degré de probabilité d'un niveau très faible du recrutement.

RESUMEN

Utilizando los datos más recientes, este análisis actualiza los resultados obtenidos en 1979 (SCRS/79/86). Se estiman los intervalos de confianza en las relaciones reproductor-recluta ajustadas a los datos de la pesquería de atún blanco del Atlántico Norte. En cada uno de los casos estudiados se estima la posibilidad de que se den niveles de reclutamiento muy bajos.

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INTRODUCTION

North Atlantic albacore spawner/recruit (SR) relations have been carefully examined in recent years (Bard, 1977, 1978; Bard and Gonzalez-Garces, 1979; Bartoo, 1979, 1980). General conclusions indicate that parent stock indices (P) are much lower (about 1/5 or less) than the pre-1957 values and that recruitment index (R) values show an apparent declining trend with increasing variation.

In 1979 analyses were presented (Bartoo, 1980) which stochastically treated the data and estimated confidence bands around maximum likelihood SR relations, based on the Ricker (1975) SR model. The current analysis updates the previous results using the most accurate data currently available.

DATA, TREATMENT AND ANALYSIS

Based on results and conclusions in Bartoo (1980), the spawner or parent stock size indicator used here is the CPUE of longline from North Atlantic adult albacore as estimated by Shiohama (1980; Table 1). No smoothing or treatment of this data set was done.

The index of recruitment used is the CPUE of "Bonites" or age 2 fish (Bard, 1974) captured by the French-Spanish troll fishery (Table 1). This CPUE was calculated from catch in numbers and effort in fishing days as reported by Bard and Gonzales-Garces (1980). No smoothing or treatment of this data was done.

The estimation of a maximum likelihood Ricker SR relation and confidence intervals about the SR relation was done using a Monte-Carlo or simulation analysis as described in Bartoo (1980).

The simulation analysis involved generating a series of "new" or simulated sets of R values corresponding to the observed P values. The new R values were generated as random deviates distributed normally with mean μ and

variance σ^2 . To each new set of data points (each point an observed P value and a new R value), a single Ricker SR curve was fit. This procedure was repeated 1000 times for each of two different hypotheses on the values of μ and σ^2 . At the end of each 1000 repetitions, distributions of expected R values from the fitted SR curves for each P were generated. These empirical distributions can be interpreted as probability distributions and hence the loci of the probability distributions as confidence bands on the location of the mean expected SR curve.

The simulation analysis requires that the μ and σ^2 of R, which vary with P, be defined in order to generate the new data sets. To closely approximate the actual μ and σ^2 of observed R values, the data were segmented into groups for which μ and σ^2 appeared similar. For instance in Figure 1, one group of data might be interpreted as the points at low P values, say 0.7 to 1.6, which appear more variable than points at higher P values. For two cases, different data groupings (Figure 1), the following means and standard deviations were estimated:

Spawning Years Grouped	R Distributed With	
	μ	σ
Case 1: 1964-1976	11.89	7.80
1958-1963	11.51	3.44
1957	5.66	1.52 ¹
Case 2: 1971-1975	6.88	3.84
1961-1970, and 1976	14.42	7.02
1958-1960	10.21	4.12
1957	5.66	1.52 ¹

For each case new R values were generated with μ 's and σ 's as noted above.

¹ σ associated with the 1957 R value is estimated using the relative values of R for 1954, 1955, 1956, and 1957 from Figure 2, Bard and Gonzales-Garces (1980).

RESULTS

The results of the simulation analysis for Case 1 are shown in Figure 2. The maximum likelihood SR relation shows a maximum mean expected recruitment index value of 9.0 at a parent stock index level of about 2.9. This indicates that the 1977 parent stock index level of 0.71 is about 1/4 the size needed to produce maximum recruitment and is about 1/7 the size of the parent stock index level (4.78) observed in 1957. Figure 2 shows the 90%, 80% and 60% confidence bands about the mean expected SR relation. Note that the confidence bands are skewed upward with tighter bands shown below the SR relation than above.

The probability that the recruitment will drop below some threshold value, for a given parent stock index level, given the relations shown in Figure 1, is shown in Figure 3. Given a P index of 0.71 (1977 value) there is about a 21% chance that the measured recruitment will drop below 2.6, approximately the lowest value observed (1974).

The simulation results of Case 2 are shown in Figure 4. This grouping of the data produces a mean expected SR relation which peaks at a lower P index level than the relation shown in Case 1, 1.9 versus 2.9 but declines more rapidly from a peak R value of 10.5 as opposed to the value of 9.0 in Case 1. The 90%, 80% and 60% confidence bands are shown in Figure 4. These bands conform relatively well to the mean SR relation. Under this case the parent stock index reduction from the 1957 level, is the same as Case 1, although the parent stock levels needed for the peak R level is somewhat less.

The probability that the recruitment will drop below some threshold value, given a parent stock index level and given the relations shown in Figure 4 is presented in Figure 5. Under Case 2 the probability that the observed R index will be lower than 2.6 given a P index value of 0.71 is about 7%. This analysis assumes that the P index chosen reflects the parent stock density.

DISCUSSION

The addition and revision of data has changed the quantitative results presented last year (Bartoo, 1980) however the qualitative conclusions remain the same. Assuming that the parent stock index accurately reflects the spawning stock size, at the current parent stock index level there is a real probability between 8% and 21% that an observed recruitment index value will be lower than the lowest value recorded in the fishery to date. The most recent value for the recruitment index (Table 1) has the effect of slightly widening the confidence intervals at lower P values, although the mean SR relation is not shifted noticeably by the point.

These results appear consistent with those of previous analysis.

Table 1. Parent stock indices (1) and recruitment indices (2).

<u>Catch Year</u>	(1) Adult CPUE	(2) Age 2 CPUE
1957	4.78	21.76
1958	3.02	12.23
1959	2.21	5.66
1960	2.37	5.98
1961	1.79	14.80
1962	1.54	6.85
1963	1.74	15.98
1964	1.38	11.50
1965	1.14	10.97
1966	1.16	8.76
1967	1.37	12.91
1968	1.52	11.53
1969	1.14	3.26
1970	1.34	19.84
1971	0.93	15.53
1972	0.90	18.06
1973	1.02	3.35
1974	1.06	2.43
1975	0.80	7.72
1976	1.40	10.97
1977	0.71	9.95
1978		30.64

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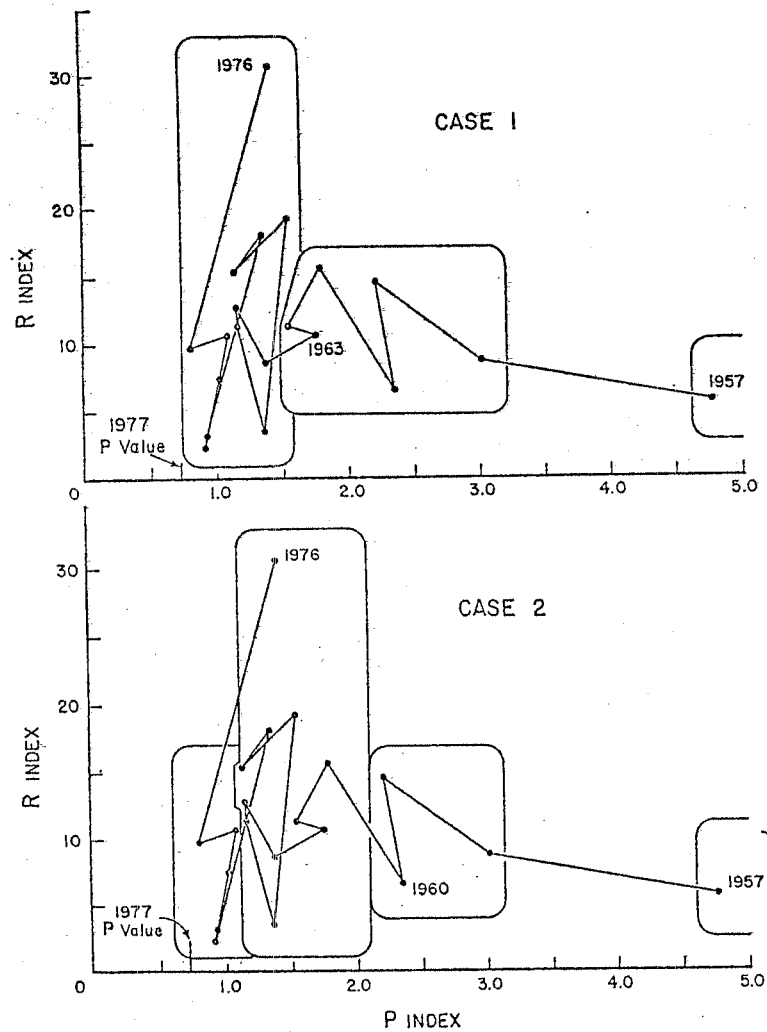


Figure 1. Paired recruitment (R) index and parent stock (P) index data by spawning year for North Atlantic albacore showing grouping of data used in cases 1 and 2 (see text).

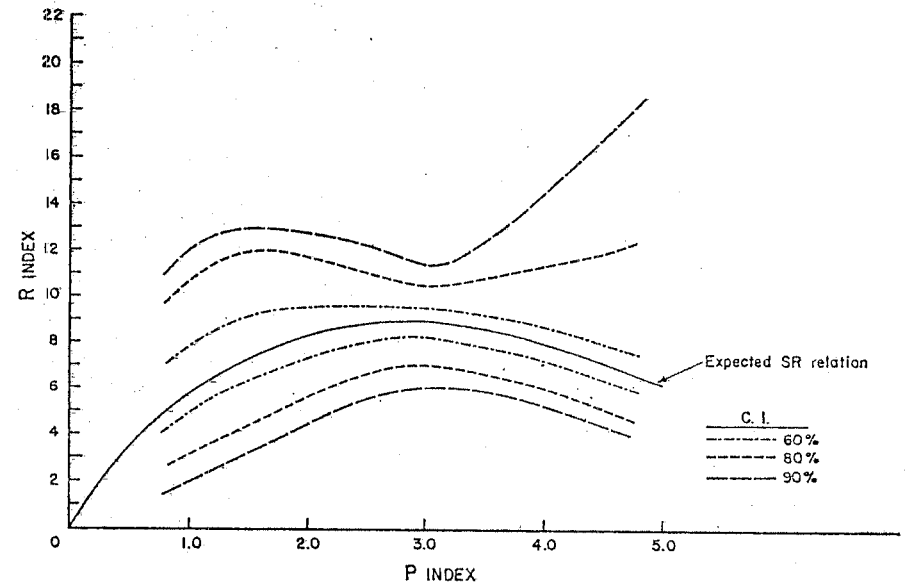


Figure 2. Mean expected spawner-recruit (SR) relationship of case 1 and 60%, 80%, and 90% confidence intervals (CI) on the SR relationship. P index is the parent stock index; R index is the recruitment index.

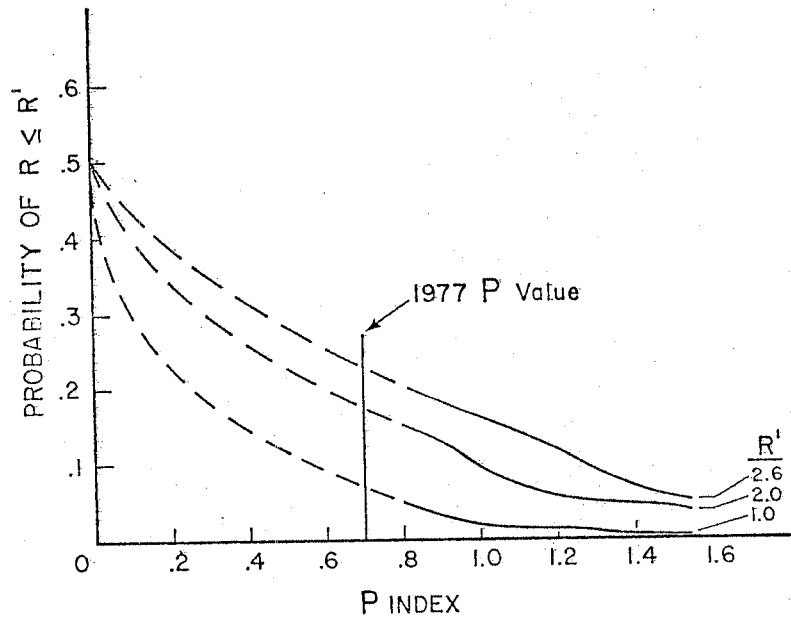


Figure 3. Probability that the observed recruitment index value, R , will be smaller than or equal to some recruitment index value, R' , at any given parent stock index level, P , given case 1 simulation confidence bands (Figure 2; see text).

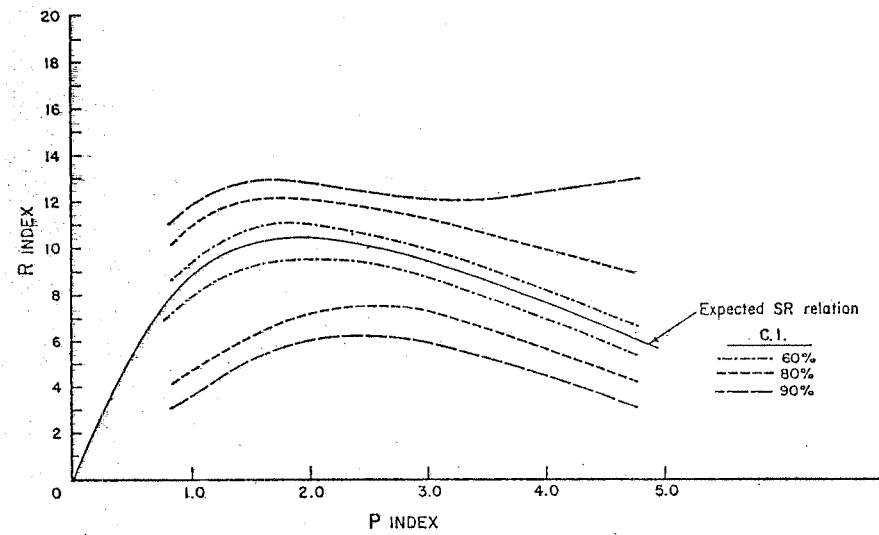


Figure 4. Mean expected spawner-recruit (SR) relationship of case 2 and 60%, 80%, and 90% confidence intervals (CI) on the SR relationship. P index is the parent stock index; R index is the recruitment index.

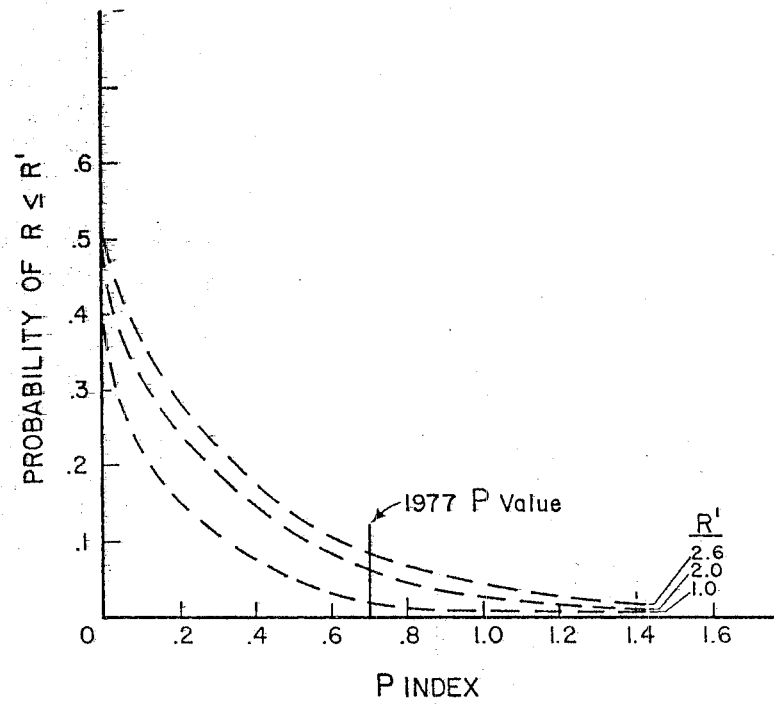


Figure 5. Probability that the observed recruitment index value, R , will be smaller than or equal to some recruitment index value, R' , at any given parent stock index level, P , given case 2 simulation confidence bands (Figure 4; see text).