Is pooling MARMAP chevron trap data justifiable for Black Sea Bass (Centropristis striata) in the South Atlantic region?

Jimmy Hull and Frank Hester

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Prepared by

Captain Jimmy Hull[1] Frank Jay Hester, PhD[2]

Abstract

The South Atlantic Fishery Management Council assumes for management purposes that there is single black sea bass stock that ranges from Cape Hatteras to south Florida. The scientific validity of this assumption was tested using MARMAP chevron trap data from 2009 and 2010. When the survey area was divided at 32° N on the suggestion of MARMAP and based on the exploitation pattern a two sample t-test indicated it is highly improbable ($P<0.000$) that samples from the southern and the northern area were from the same population. Black sea bass fishermen from the northern area reported high numbers of small fish in 2009. These appear in the MARMAP data for that year but do not appear in the MARMAP or catch data for the southern area suggesting the possibility of differential recruitment among areas. The implications for management are discussed.

Introduction

The fishery for black sea bass in the South Atlantic Region extends from Cape Hatteras on the north to southern Florida, and is assumed to be a single homogeneous management unit. Exploitation of this resource has differed between the northern and the southern parts of this range with landings historically being two to three fold higher to the north and separated from the south by an area of lower landings between the South Carolina border and Georgia and northern Florida. Whether this separation is due to bottom topography and oceanographic conditions or to lesser fishing efforts is undetermined, but from the MARMAP chevron trap data the former seems to be a factor.

[1] F/V Denise Ann

[2] Scientific Advisor to Southeastern Fisheries Association East Coast Fisheries Section

Biological data and information from the fishermen indicate that although some inshore and offshore movement is common, extensive north-south movement is rare or unknown (Moe 1966; Beaumariage 1969; Parker et al. 1977; Ansley and Harris 1981; Rudershausen et al. 2010). Since most of the fish in the landings are less than five years old, one question is how the stock responds to differential fishing mortality and whether there may be evidence supporting two management units with a separation around 32° N. latitude.

The desirability of fishery independent data for fishery management is widely recognized but too often not achieved. Some such data are available for some SEDAR assessments, but often are too few to allow making statistically rigorous conclusions. An exception may be in the case of black sea bass for SEDAR 25 wherein a more intensive sampling and ageing collection in 2009 and 2010 by the MARMAP chevron trap surveys resulted in a total of 750 and 1667 otolith samples being collected and aged.

Data

The MARMAP group kindly made available to us the aged samples for 2009 and 2010. This part of the data base for the chevron trap contained entries for:

Year	Latitude	Total Length	Calendar Age	Fractional Age

(Depth and abundance not included)

To this we added 'Region' defined as north or south of 32° N latitude.

We also received from MARMAP a data file for 7672 sample entries for the years 1990 through 2010) that contained 7672 entries for:

Year	Duration	Latitude	Longitude	Depth	Abundance	Weight

(No ages were included)

For a more detailed account of the operation, sampling methodology and definitions please refer to SEDAR25-DW03 (Bacheler *et al*, 2011).

We used the former data set for between area comparisons for the two years for which we had age and location data. We used the latter data set to evaluate the distribution of black sea bass within the MARMAP sampling area.

Results

A) Long MARMAP data series - no aged samples.

We divided the area at 32° N on the suggestion of MARMAP. We plotted catch in number vs. latitude (Fig. 1) to see how good a separation exists between the north and the south. The MARMAP chevron trap survey sampling all years combined was more intensive in the northern

portion than in the south (5334 vs. 2347); however, sampling effort does extend south to about 27° N. On average black sea bass were not taken in about 60-percent of the samples.

There are two areas where sampling was conducted but black sea bass were (essentially) absent as indicated by the zero catches for the occupied stations. One is the long stretch from central Georgia to about Melbourne, Florida. This area was not sampled for most of the stretch from 28° to 30° and we know black sea bass occur there since our boats are based there. The other gap in catches is at 32° near Savannah, Georgia. This is the area where the Savannah River enters the Atlantic and may be a logical division. The question then becomes should the southern area include the catches off Georgia between 31 and 32 degrees? For this paper the decision was that it should.

The second use we put the longer data series to was to look at the size distribution of fish within area and year. To do this we calculated the average weight of the fish in each sample by dividing the reported weight of the catch by the number reported caught. Two trends were apparent: The average weight increase with depth (Fig. 2) and the average weight increases with time between regions (Fig. 3). The fact that average weight shows an annual trend that is not apparent for either weight or number alone deserves additional study. When number, weight and average weight are split between the northern and southern areas are examined (Fig. 4) some differences are apparent that suggest the area effect for calculating CPUE might best be re-examined.

B) Short 2009 and 2010 MARMAP age data series.

There are enough MARMAP age samples for 2009 and 2010 to allow a good comparison of the age structure between areas in each of these two years. If mixing in the stock is homogeneous there should be no statistical difference in the mean age between the two areas in 2009 or in 2010. A simple two-sample t-test (Table 1.) indicates there are differences for both years and these data as analyzed do not support pooling into a single homogenous management unit (Fig. 5). An examination of the age distribution among years and areas supports the information from the fishermen that a unusually large group of fish entered the black sea bass trap fishery in the northern area in 2009 (Fig. 6a & 6b) and was still present in 2010, whereas this was not observed in the fishery or the MARMAP data for the southern area.

Discussion

The Life History Group at the Data Workshop looked at biological parameters for age and growth and did find apparent differences between areas but these differences have been rejected without statistical analyses. On the other hand, MARMAP collected a large number of otoliths samples for ageing for 2009 and 2010. These numbers are large enough to allow a meaningful statistical comparison between the age distribution of fish in the northern area and those in the southern area. However, it needs to be noted that there are problems with the

coverage and MARMAP methodology that require additional work[3]. Also, the selectivity of the chevron trap may obscure longer term adjustments in fish density among areas if north-south movements occur with older fish. Since these are MARMAP data MARMAP people should do the final analysis, however, preliminary testing indicates that a significant differences in age structure exists between north and south with a geographical division placed at 32° N.

In addition to scientific samples the fishermen from North and South Carolina and report an increased abundance of fish in 2009 that did not occur off Florida. The MARMAP data indicate what appears to be a strong year class passing into the northern area in 2009 and 2010 and not in the south. We did not have age data for earlier MARMAP surveys and indeed there may be little available, but this one example from 2009 and 2010 brings the question of recruitment synchrony in the combined area into question. The evidence so far strongly suggests that the assumption of a single uniform pool of fish for the SEDAR 25 assessment is not supported by the science.

Conclusions

Resistance from SEDAR to consider more than one management unit was voiced during the Data Workshop meeting. One objection was that there should be no consideration of changes in a "standard" assessment[4]. A second and more compelling concern is the amount of work that would have to be done to re-do the indices and re-age the catches to prepare the AW for a split assessment. On the other hand if the fish in the north and in the south do not react in the same way to the fisheries in the two areas, or are separated in distance enough that recruitment success may not coincide in the two areas, managing the stock as a single unit may be riskier than managing as two units.

We do not suggest that the split is based on genetic differences. Prior working groups have acted on the assumption that there is a single genetically identifiable management unit and that there is complete and rapid interchange through coastwise migration when in reality the fishermen and the Data Workshop know that there is little evidence for coastwise movement for BSB. The accepted assumption of a single management unit has not been tested until now and the tests suggest that the hypothesis of coastwise mixing should be examined more closely.

[3] A heavily redacted version of the Life History Report is in the Data Workshop Report. The actual results are best seen in the Life History Working Group Report and the PowerPoint presentation of the Life History WG to the DW Plenary of Tuesday April 26, 2011. Neither is readily available from the SEDAR Website but should be in the SAFMC Archives.

[4] Black sea bass were originally scheduled for an "update assessment" which would mean only adding new catch and length/age data to the 2005 update and rerunning the Beaufort Assessment Model. However, the resource had already had one update and it was decided that a new assessment was warranted. This decision was modifies to having a "standard" assessment that seems to have been an assessment in which the procedures were set by the analysts, proceeding were not transparent, and public input was restricted..

Recommendations

1. As a minimum compromise the other indices of abundance could be reformulated into two separate regions and compared. If there is a consistent difference between areas the precedent with red drum in SEDAR 18 should be followed and separate assessments for two management units considered.

2. In general, data should be treated whenever possible by accepted and reproducible statistical methods. The Council receives advice from the Scientific Committee and SEDAR that is translated into quotas which are more precise than the supporting data and its analyses deserve. Some precision might be retained in the earlier stages if the data were questioned more thoroughly in the onset and statistical tests used to justify pooling, rounding and substitutions rather than relying on "eyeballing"[5].

3. Interactions and significant factors in the data analysis should not be ignored for expediency.

4. Management units should be based on other factors as well as genetic differences.

References

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analysis of previous results. Florida DENR Technical Series 59:38p

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Parker, R.O., Jr., R.B. Stone, C.C. Buchanan. 1977. Artificial reefs off Murrells Inlet, South Carolina. Marine Fisheries Review 41:12-24.

Rudershausen, P.J., J.A. Buckel, T. Burgess. 2010. Estimating discard mortality of black sea bass (*Centropristis striata*) and other reef fish in North Carolina using a tag-return approach. Combined Final Report: NC SeaGrant FRG 07-FEG-01 and 09-FEG-04. 33p.

[5] The SEDAR assessment process is surprisingly lax on deciding whether data should be pooled and whether trends exist in data sets. Usually as statement is inserted to the effect that two data sets are similar. This has seldom withstood statistical scrutiny.

TABLES

TABLE 1

Results for: 2010

Two-Sample T-Test and CI: Calendar Age, Region

```
Two-sample T for Calendar Age

Region    N  Mean  StDev  SE Mean
North   957  3.20   1.19    0.039
South   692  3.01   1.04    0.039


Difference = mu (North) - mu (South)
Estimate for difference:  0.185131
95% CI for difference:  (0.077003, 0.293259)
T-Test of difference = 0 (vs not =): T-Value = 3.36  P-Value = 0.001  DF = 1592
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Results for: 2009

Two-Sample T-Test and CI: Calendar Age, Region

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Two-sample T for Calendar Age

Region    N  Mean  StDev  SE Mean
North   611  2.70   1.19    0.048
South   129  3.30   1.27     0.11


Difference = mu (North) - mu (South)
Estimate for difference:  -0.598561
95% CI for difference:  (-0.839294, -0.357828)
T-Test of difference = 0 (vs not =): T-Value = -4.91  P-Value = 0.000  DF = 178
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Section 2 - FIGURES

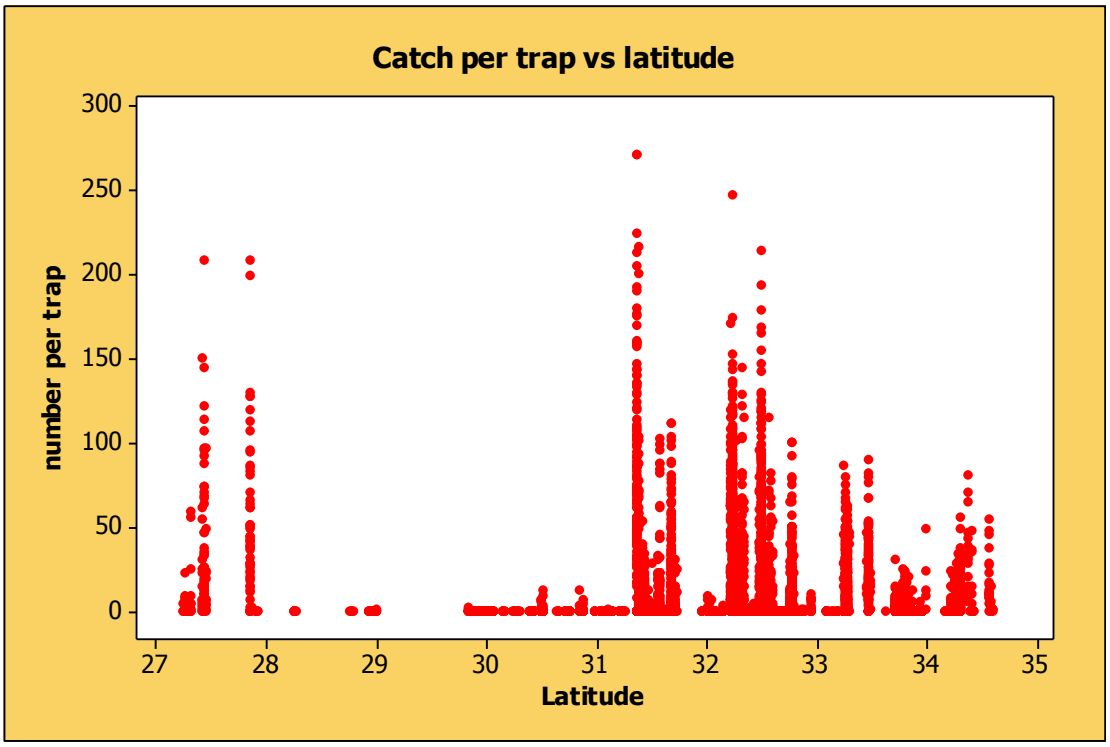


Figure 1.Catch per trap all sets all years vs. latitude showing the distribution of effort and the distribution of positive stations from central Florida 27 degrees to Cape Hatteras approx. 35 degrees.

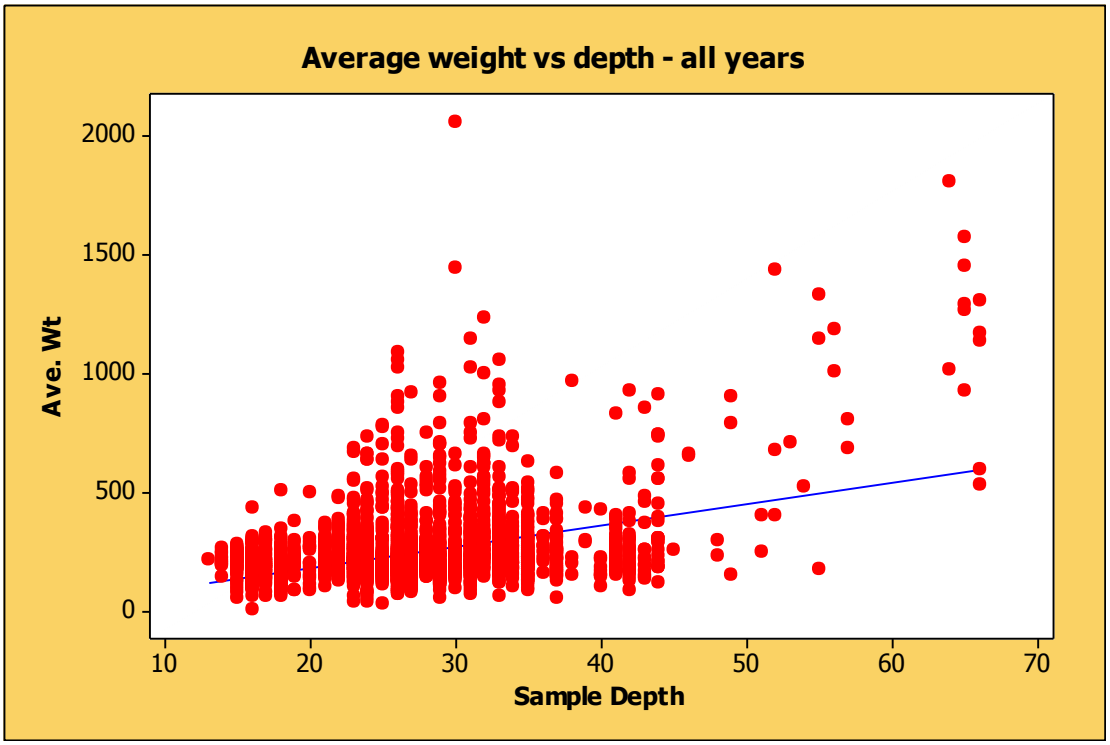


Figure 2. Average weight of sample vs. depth

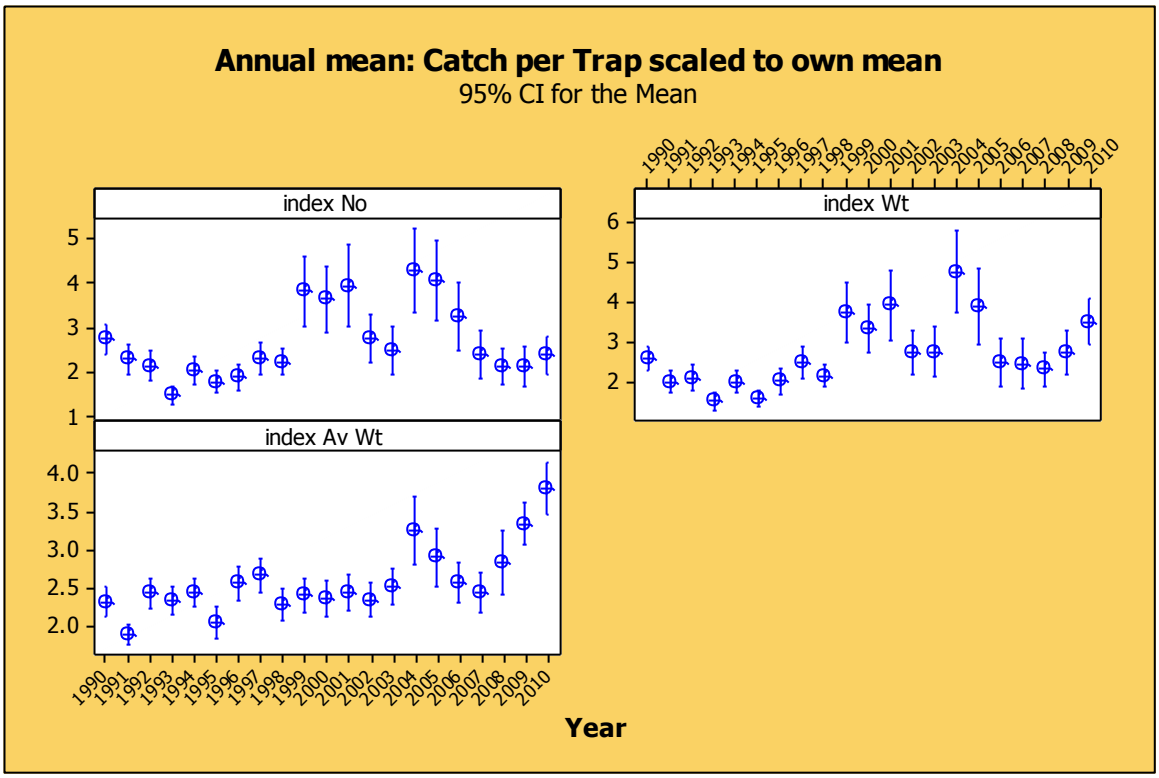
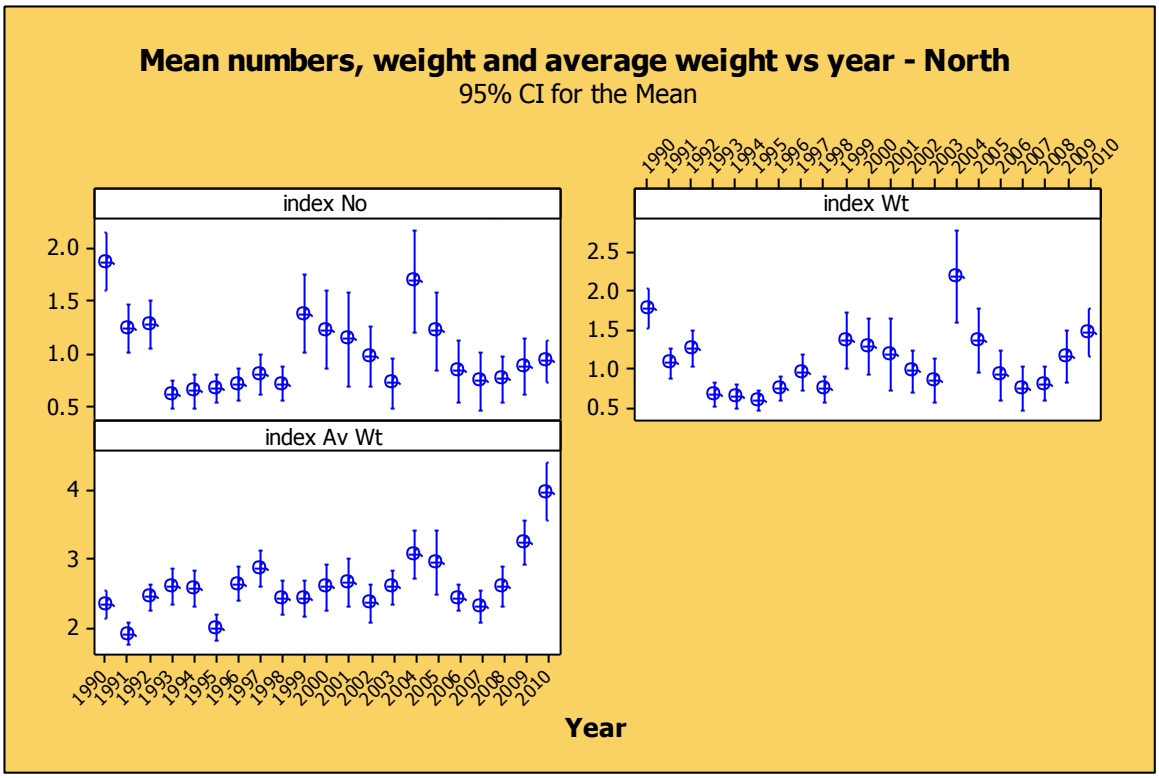


Figure 3. Annual time series of MARMAP chevron trap catches (positive catches) of black sea bass for all areas and years,; average number of fish per trap (top left), weight of fish per trap (top right) and average weight of fish per trap from weight/number (bottom panel)



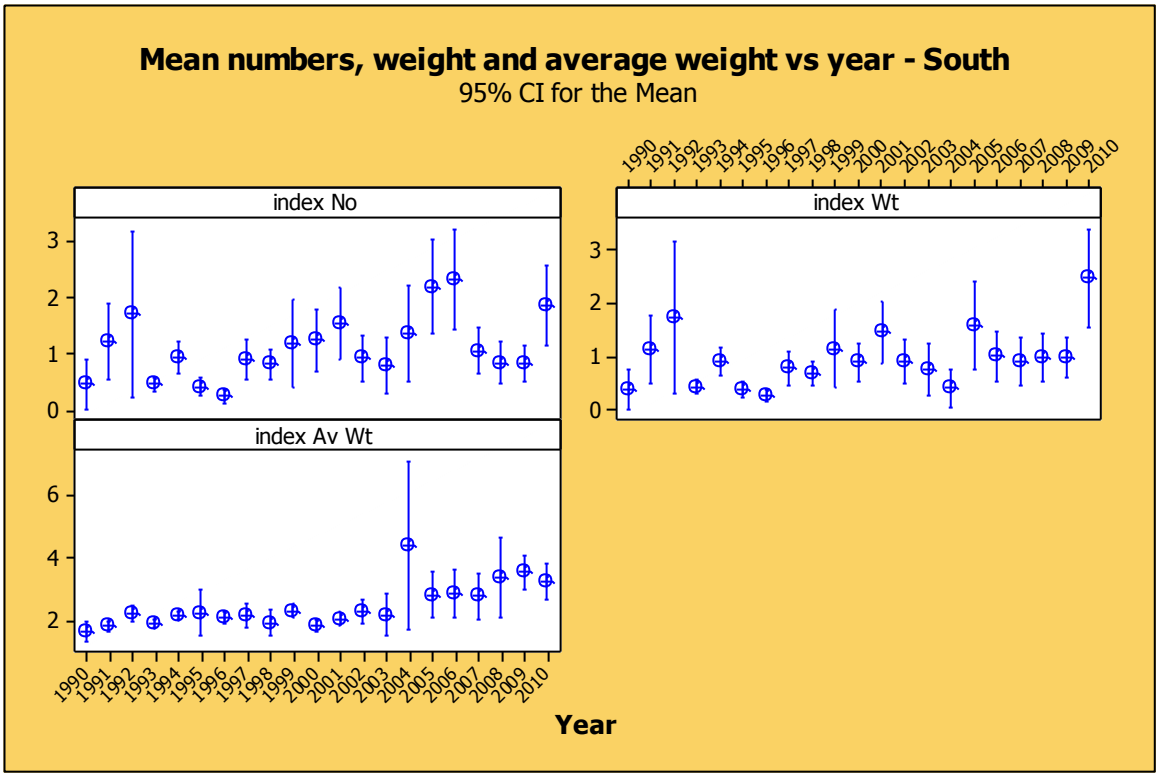


Figure 4. Annual time series of MARMAP chevron trap catches (positive catches) of black sea bass as in Fig. 3 but separated into northern (top figure)and southern (bottom figure) regions.

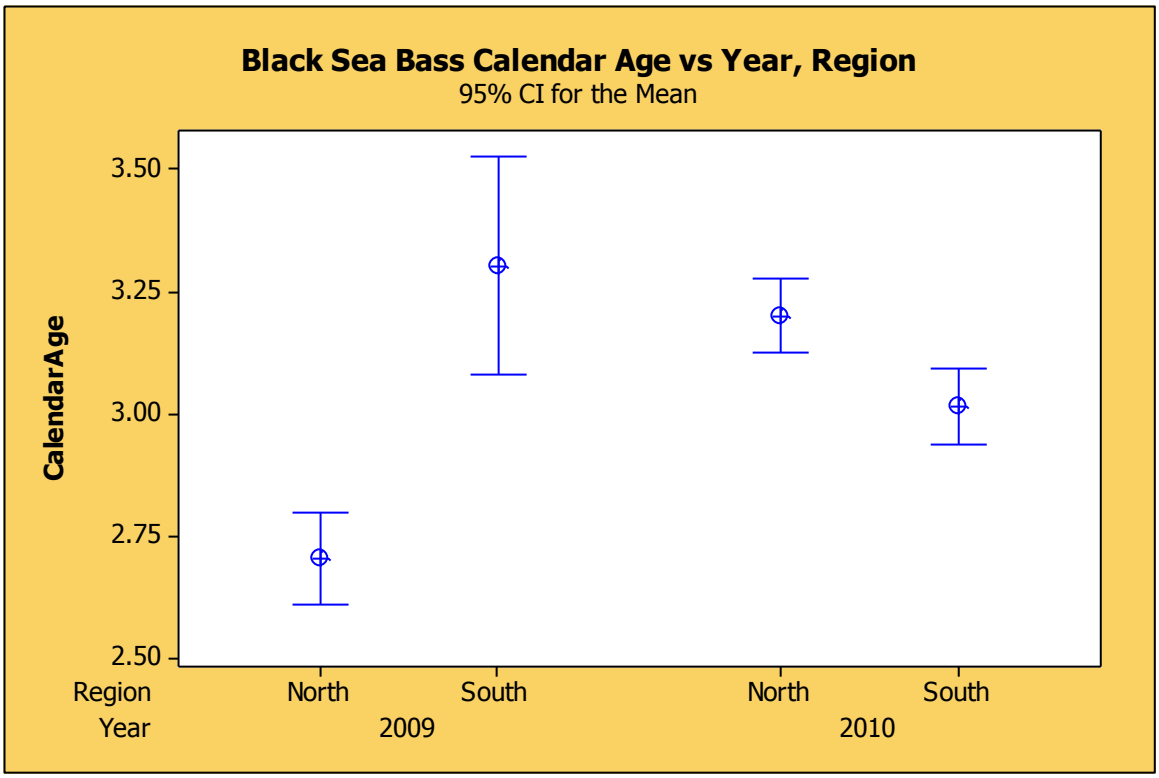


Figure 5. The difference in mean age of black sea bass by Region taken in 2009 and 2010 MARMAP chevron trap surveys.

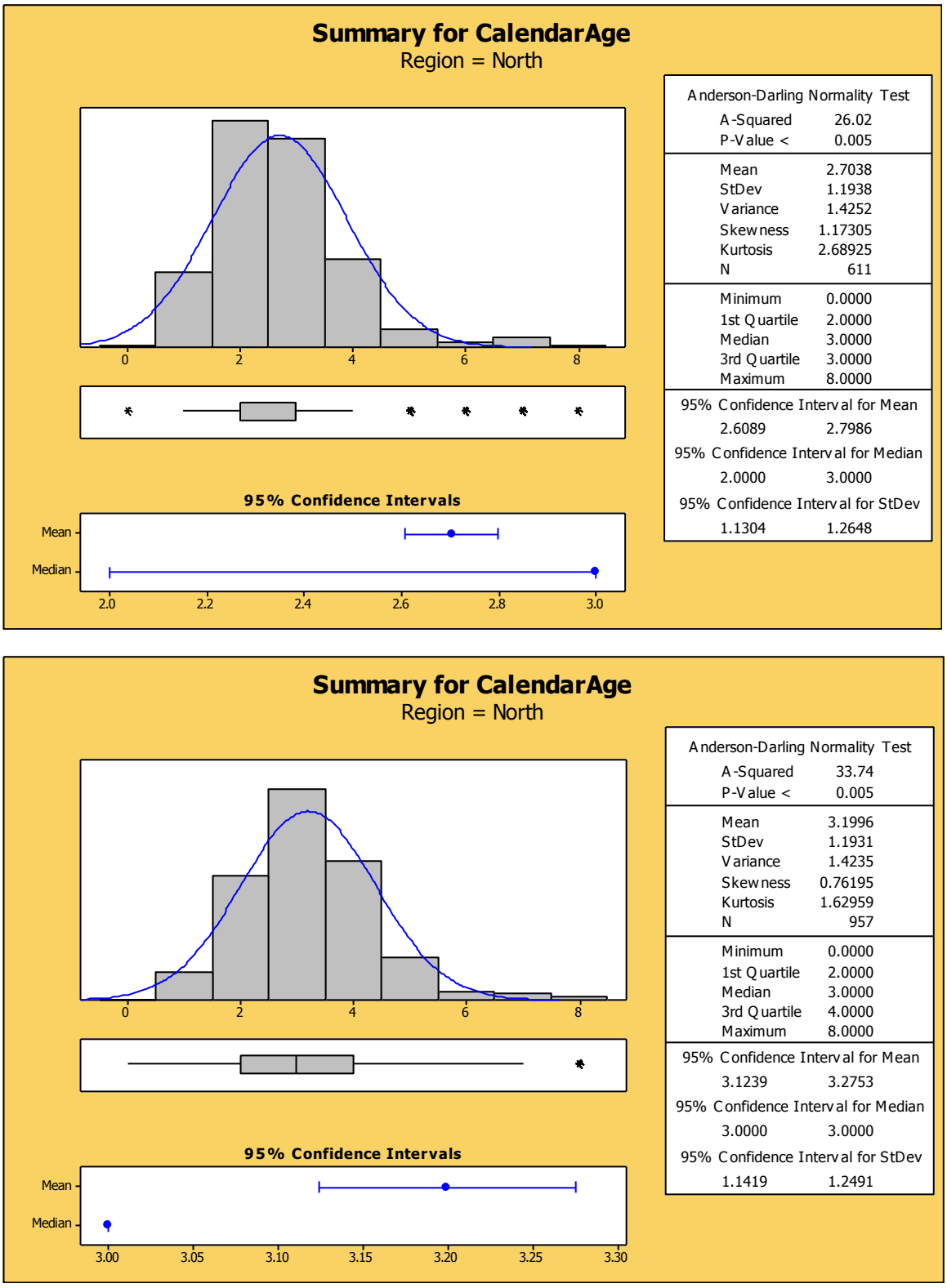
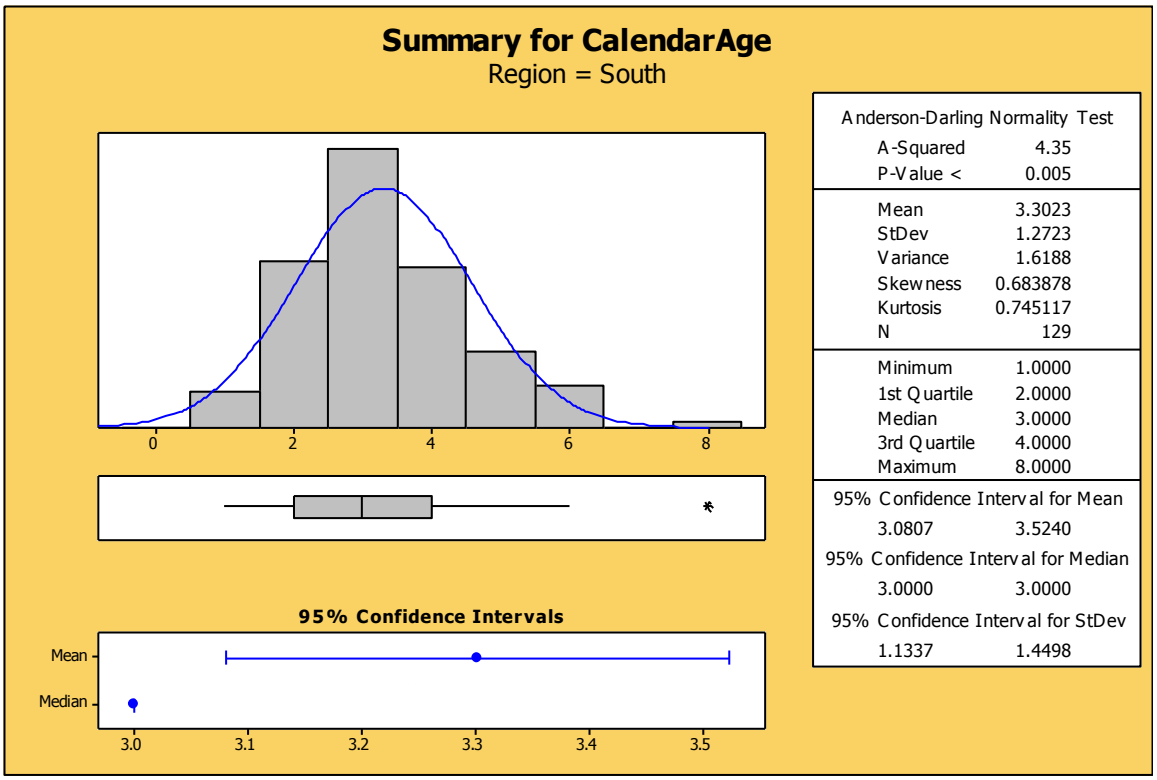


Figure 6a . Graphical display of calendar age distribution from MARMAP chevron trap samples north region 2009 top panel, 2010 bottom panel.



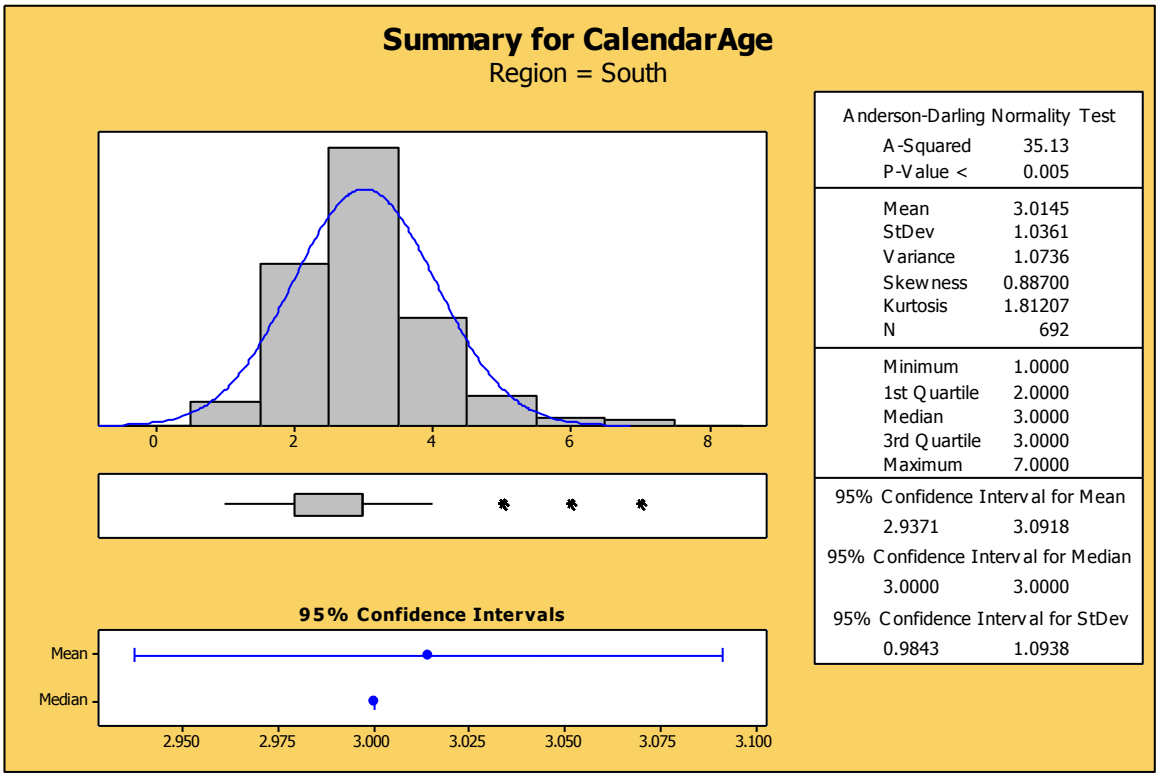


Figure 6b. Graphical display of calendar age distribution from MARMAP chevron trap samples north region 2009 top panel, 2010 bottom panel.