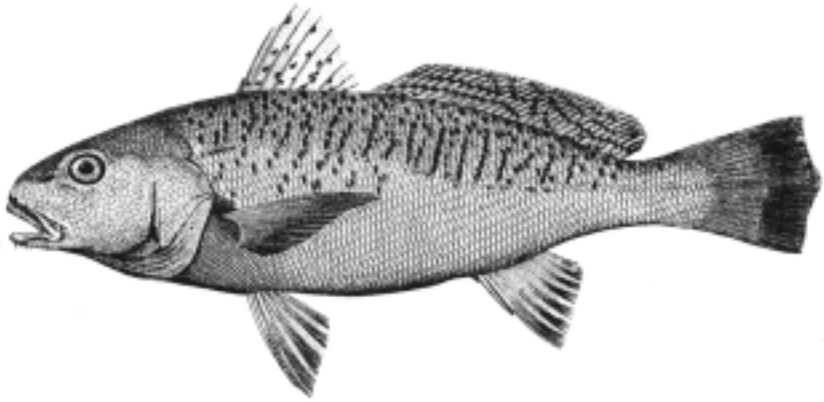
Stock Assessment Report No. 03-02
of the

Atlantic States Marine Fisheries Commission

Terms of Reference & Advisory Report
for the Atlantic Croaker Stock Assessment Peer Review



October 2003

Working towards healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015

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Conducted on
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Preface

Summary of the Commission Peer Review Process

The Stock Assessment Peer Review Process, adopted in October 1998 by the Atlantic States Marine Fisheries Commission, was developed to standardize the process of stock assessment reviews and validate the Commission's stock assessments. The purpose of the peer review process is to: (1) ensure that stock assessments for all species managed by the Commission periodically undergo a formal peer review; (2) improve the quality of Commission stock assessments; (3) improve the credibility of the scientific basis for management; and (4) improve public understanding of fisheries stock assessments. The Commission stock assessment review process includes evaluation of input data, model development, model assumptions, scientific advice, and review of broad scientific issues, where appropriate.

The Stock Assessment Peer Review Process report outlines four options for conducting a peer review of Commission managed species. These options are, in order of priority:

1. The Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) conducted by the National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC) or the Southeast Data and Assessment Review (SEDAR) conducted by the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC).

2. A Commission stock assessment review panel composed of 3-4 stock assessment biologists (state, federal, university) will be formed for each review. The Commission review panel will include scientists from outside the range of the species to improve objectivity.

3. A formal review using the structure of existing organizations (i.e. American Fisheries Society, International Council for Exploration of the Sea, or the National Academy of Sciences).

4. An internal review of the stock assessment conducted through the Commission's existing structure (i.e. Technical Committee, Stock Assessment Committee).

Twice annually, the Commission's Interstate Fisheries Management Program (ISFMP) Policy Board prioritizes all Commission managed species based on species Management Board advice and other prioritization criteria. The species with highest priority are assigned to a review process to be conducted in a timely manner.

In November 2002, the Atlantic croaker stock assessment was prioritized for a SEDAR peer review. A review panel was convened of stock assessment biologists and representatives from the fishing community and non-government organizations. Panel members had expertise in Atlantic croaker life history and stock assessment methods. The SEDAR review for the Atlantic croaker stock assessment was conducted October 8-9, 2003 in Raleigh, North Carolina.

Purpose of the Terms of Reference and Advisory Report

The Terms of Reference and Advisory Report provides summary information concerning the Atlantic croaker stock assessment and results of the SEDAR review to evaluate the accuracy of the data and assessment methods for this species. Specific details of the assessment are documented in a supplemental report entitled Atlantic Croaker Stock Assessment Report for Peer Review. To obtain a copy of the supplemental report please contact the Commission at (202) 289-6400.

Acknowledgments

Thanks are due to the many individuals who contributed to the Commission's Atlantic croaker Stock Assessment Peer Review. Special thanks are extended to the Atlantic Croaker Peer Review Panel (Dr. Steve Bobco, Old Dominion University, William Goldsborough, Chesapeake Bay Foundation, Najih Lazar, Rhode Island Division of Environmental Management Marine Fisheries Section, Dr. Tom Miller, Chesapeake Biological Laboratory, Dr. Jim Nance, NOAA Fisheries NMFS SEFSC, Dr. Paul Nitschke, NOAA Fisheries, NMFS NEFSC, Lee Paramore, North Carolina Division of Marine Fisheries, Dr. Stephen Smith, Bedford Institute of Oceanography, Dr. Elizabeth Wenner, South Carolina Department of Natural Resources, Geoffrey White, Atlantic States Marine Fisheries Commission, William T. Windley, Jr., Maryland Saltwater Sportfish Association) for their hard work in reviewing the meeting materials and providing advice on improvements to the Commission's Atlantic croaker stock assessment. The Commission would like to extend its appreciation to the members of the Atlantic Croaker Technical Committee and Stock Assessment Subcommittee for development of the Atlantic Croaker Stock Assessment Report for Peer Review (Stock Assessment Peer Review Report 03-002 Supplement) and specifically to the following members for presenting this report at the Peer Review meeting: Dr. Janaka DeSilva (Florida Fish and Wildlife Commission), and Dr. Eric Williams (National Marine Fisheries Service, Beaufort Laboratory).

Special appreciation is given to the staff dedicated to the performance of the peer review and finalization of peer review reports, specifically – Dr. Lisa Kline, Dr. John Merriner, and Nancy Wallace.

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Terms of Reference for the Atlantic croaker Peer Review

1. **Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessments (i.e. was the best available data used in the assessment).**

The Atlantic croaker stock assessment used commercial and recreational landings data, the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) bottom trawl indices, Marine Recreational Fisheries Statistics Survey (MRFSS) CPUE index, and Southeast Area Monitoring and Assessment Program (SEAMAP) nearshore trawl survey indices.

The commercial landings data used in the assessment did not include landings from aggregate, unculled ("scrap") bait fisheries nor were discard data estimated. Unculled bait landings data are only available from North Carolina and indicated that this fishery could account for a substantial amount (2-50%) of additional landings not accounted for in the directed fishery landings, particularly prior to 1996. The Panel expressed concern both over whether unculled bait landings data are available from other states and the magnitude of these landings for other states. The Panel recommends that the North Carolina unculled bait fishery data be evaluated and the landings updated to include these landings. The possibility of applying the North Carolina proportions to other states to estimate their unculled fish landings should also be explored. The unculled bait fishery consists of primarily small fish compared to other commercial landings and may require a revised or new selectivity curve in the model. The Panel also recommends that at-sea observer data be evaluated for inclusion of discard/bycatch data in the model.

The Panel agreed that the MRFSS recreational landings for the period 1981 to present were the best available data. The Panel noted that as the ratio of commercial to recreational landings for the period 1981-present was used to hindcast earlier recreational landings, changes in the commercial removals (see above) will require re-estimation of recreational landings for the 1973 to 1980 time period. The Panel agreed with the validity of the recreational landings and the method of extending these data back to 1973.

The model used NMFS NEFSC fall bottom trawl survey indices from 1982 to the present. The survey is a stratified random survey design extending back to 1963. The assessment used a survey index derived from the application of a delta lognormal model to the NEFSC bottom trawl data, as opposed to stratified mean estimates. A comparison of the delta lognormal estimates with stratified mean estimates on assessment results indicated substantial differences. The Panel noted that these differences were not addressed in the assessment report and was not confident in the use of the Delta lognormal model. The Panel recommends that the time series be extended back to 1973 and an evaluation be conducted to better understand the differences between the lognormal and stratified mean estimates.

The Panel accepted the SEAMAP nearshore trawl data and the MRFSS CPUE index as the best data available. The Panel accepted the definition of croaker trips as consisting of a suite of species.

The final stock assessment model did not include trawl survey data from the Virginia Institute of Marine Science (VIMS). The VIMS trawl survey is believed to reflect dynamics of young croaker. The Panel noted that although the inclusion of the VIMS trawl survey might not be appropriate in an unstructured surplus production model, the VIMS time series may provide important information for the current assessment model. The Panel recommends further investigation of the inclusion of the VIMS trawl survey in the model since this survey covers the full time period and areas not covered by other survey indices included in the model.

The assessment model uses a growth curve derived only from North Carolina data and applies this growth curve to all areas included in the model. The Panel agrees that the North Carolina growth curve is the best available. However, the Panel expressed concern that the North Carolina growth parameters were being applied across the entire latitudinal range of the stock and over the entire period of the assessment. Given the wide latitudinal range of this species, and the wide range of abundances observed in the stock, the Panel recommends the investigation of spatial and interannual variability in growth.

Several different methods of calculating natural mortality (M) were evaluated in the stock assessment. The model used a constant M of 0.3 from the mid-point of the range of estimates. The Panel accepted the approach for calculating M as the best available, but recommends the development of age-specific mortality estimates.

The Atlantic croaker stock assessment is not an age based method. Work is currently being conducted to standardize ageing methods for Atlantic croaker. The Panel recommends that the Commission conduct an ageing workshop to develop approved standard ageing protocols to improve coastwide consistency in ageing data. The Panel also support continued collection of age samples from fisheries-independent surveys and length samples from the MRFSS in order to improve future Atlantic croaker assessments.

2. **Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks.**

The model used was a forward projection age-structured production model with the age structure generated by the model and not included as input data to the model. The model was run separately for the mid-Atlantic region (North Carolina and north) and the south Atlantic region (South Carolina to Florida). The regions were separated due to a lack of observations of older fish (age 3+) in the southern region and differences in the temporal patterns in fishery-independent survey indices in the southern area, which indicated that dynamics may be different in the two regions. The Technical Committee indicated that performance of the mid-Atlantic model was acceptable, whereas that of the south Atlantic model was not wholly acceptable. There was extensive Panel discussion of the justification and implications of the separation of croaker into two management units. One view suggested the separation reflected a recognition of a lack of knowledge regarding the dynamics of croaker in the southern part of the species range. An extension of this view implies that the separation reflects a "culling" of the data so that the strength of the signal in the mid-Atlantic is not masked by differences in indices in the southern portion of the range. An alternative view is that there is indeed some functional stock structure that underlies the decision to develop separate models. An extension of this view implies the

potential for different reference points in the two components. Overall, the Panel did not believe that data were available to support either view. The Panel recommends investigation of the distribution and movement of croaker by age and season, and a comparison of life history parameters over the full distribution of croaker to address these uncertainties and provide full justification for a spatially explicit model. The Panel recommends tagging (artificial tags or natural tags such as otolith microchemistry/genetics) studies be conducted to address the justification for regional assessments.

The model for the Mid-Atlantic region used commercial and recreational landings from 1973 to the present, while the survey indices used in the model only extended back to 1982. The Panel expressed concerns with starting the model in 1973 with landings data only and not taking advantage of the available survey tuning indices. During the review, the Panel requested a comparison model run using the NMFS NEFSC bottom trawl survey data from 1973 to the present. This analysis provided some indication of differences in scale between the full series and the partial series used in the assessment. The Panel recommends re-running the model using the full series of NMFS NEFSC fall bottom survey data. The Panel also recommends the evaluation and possible inclusion of the VIMS trawl survey data.

The base model assumed that the SSB in 1973 was equal to 0.75 SSB (virgin biomass) from the Beverton-Holt analysis. The Panel was concerned about the validity of this assumption. The Panel recommends that the assessment readdress this assumption once the full time series of survey data is included in the model.

The model assumes that the fisheries-independent survey indices are more precise than the fisheries-dependent data and recruitment deviation estimates and, therefore, provided higher weights to these surveys. The Panel did not find compelling evidence to support the weightings applied. The Panel noted that these weighting factors may not be optimum and could strongly impact model results. The Panel recommended an exploration of the consequences of different weighting factors.

The assessment included an age structured production model only. This required development of an algorithm to generate an age structure for the population. The Panel recommends a comparison of non-age assessment models, such as the Collie-Sissenwine catch-survey and a delay difference model, to understand the implications of this age structure on derived reference points and stock advice.

The Panel accepted selectivity curves used for both commercial and fisheries-independent indices as the best available. The Panel recommends the evaluation of culling the larger fish out of the survey indices to better match the assumed selectivity.

The Panel noted that the assessment model relies on a single renewal function – specifically a Beverton and Holt stock- recruit function. The Panel noted that there has been dramatic variation in croaker abundance over the time period. In weakfish, a related sciaenid fish, similar variation in abundance has induced density-dependent changes in fecundity. If similar biological changes, or environmentally induced changes to potential stock productivity have occurred in croaker, the

assumption of a constant renewal function may be questionable. The Panel recommended an evaluation of changes in maturity and fecundity within the stock.

3. **Evaluate the adequacy and appropriateness of the Technical Committee's recommendations of current stock status based on biological reference points.**

The Atlantic Croaker Technical Committee had concerns with recommending and evaluating reference points for the south Atlantic model at this time. Given the lack of data to estimate movement between the two regions, and the poor model fits, estimates of Fmsy and SSBmsy for the South Atlantic may be incorrect. The Panel accepted this conclusion regarding the southern region.

The benchmarks for the mid-Atlantic region listed in the stock assessment report were corrected as follows:

F threshold - Fmsy
Biomass threshold - 0.7 SSBmsy
F target – 0.75 Fmsy
Biomass target – SSBmsy

These benchmarks are based on Restrepo et al. (1998) and are standard for other managed species. The Panel noted that these benchmarks are appropriate given the model.

Stock status determination was only provided for the Mid-Atlantic region, with F2001 = 0.98 Fmsy, and SSB2001 = 1.76 SSBmsy. Based upon the recent trends in survey indices, many members of the Panel accepted that the stock was not overfished; however, full consensus was not reached. However, given the lack of precision associated with the F estimates and the problems noted earlier with the model and landings data the Panel could not determine if overfishing is occurring. The Panel recommends that if the high degree of uncertainty in current F's continues, a more conservative target be evaluated so that management action to meet the target F may not place the stock in danger of simultaneously exceeding the limit F.

Given the major concerns with the landings data and abundance indices used in the model, the Panel expressed concern with use of the current Atlantic croaker stock assessment for management purposes. The Panel recommends that the Atlantic Croaker Technical Committee resolve the issues in research recommendations 1-7 and update the assessment.

4. **Develop recommendations for future research for improving data collection and the assessment.**

The Panel recommends that the Atlantic Croaker Technical Committee resolve the issues in research recommendations 1-7 during the development of an updated assessment.

1. Issue: Commercial landings did not include all removals from the population.
   - Evaluate North Carolina unculled bait ("scrap") fishery data and include in the commercial landings.

- Evaluate the potential of applying the North Carolina unculled bait fishery data to other states.
- Consider at-sea observer data for discards and bycatch.

2. Issue: The model used catch data from 1973 to the present but tuning indices were only used from 1981 to the present.
   - Extend the NMFS NEFSC bottom trawl survey data to 1973 for inclusion in the model.
   - Evaluate the difference between the Delta lognormal and stratified mean estimates from NMFS NEFSC bottom trawl survey.
   - Evaluate the VIMS survey data for possible inclusion in the model.

3. Issue: The base model assumed that the SSB in 1973 was equal to 0.75 SSB (virgin biomass) from the Beverton-Holt analysis.
   - Re-evaluate after inclusion of the full time series of NMFS NEFSC and VIMS trawl survey data.

4. Issue: The model assumes that the fisheries-independent survey indices are more precise than the fisheries-dependent data and model recruitment estimates and, therefore, provided higher weights to these surveys.
   - Evaluate the consequences of alternative weighting schemes.
   - Provide detailed justification for the final choice of weighting scheme.

5. Issue: Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).
   - Investigate the distribution and movement of croaker by age and season.
   - Compare life history parameters over the full distribution of croaker.

6. Issue: The assessment included an age structured production model only. This required development of an algorithm to generate an age structure for the population.
   - Compare non-age assessment models, such as the Collie-Sissenwine catch-survey and a delay difference model, to understand the implications of this age structure on derived reference points and stock advice.

7. Issue: Determination of overfishing/overfished were based on point estimates only.

   - Estimate the error distribution for current estimates of F, and reference points.
   - Determine whether, given error distributions determined above, target F and threshold F could be distinguished from estimates derived from the assessment model.
   - Consider revising F target reference point relative to the previous bullet.

The following research recommendations are lower priority, long-term research issues. These recommendations will provide improvements to future assessments.

8. Issue: Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).

- Conduct tagging and otolith microchemistry studies to address the justification for regional assessments.

9. Issue: Difficult to understand what component of the population the surveys were tracking.
   - Include maps of fishery and survey areas in future reports.

10. Issue: A single growth curve based on data from North Carolina was applied over all years and for whole area.
    - Evaluate the applicability of the North Carolina growth curve to all areas (spatial variability).
    - Investigate interannual variability in growth.

11. Issue: A single natural mortality estimate was used for all ages and years.
    - Develop age-specific M for inclusion in the model.

12. Issue: Trends in the recruitment deviations may indicate temporal bias in the recruitment model.
    - Assess whether changes in potential population reproductive capacities have changed by quantifying patterns in the maturity ogive and size- and age-dependent fecundity.
    - Assess whether density dependent shifts in age- or condition-dependent timing of age at maturity have occurred as in other sciaenids.
    - Assess whether temporal patterns in recruitment slope or asymptote have occurred.

13. Issue: There are no standard protocols for ageing of Atlantic croaker.
    - Conduct a workshop to develop and approve ageing standards for Atlantic croaker.
    - Continue collection of coastwide age samples from fisheries-independent surveys and length samples from the MRFSS.

14. Issue: Selectivity curves were used for both commercial and fisheries-independent indices.
    - Evaluate culling of the larger fish out of the survey indices to better match the assumed selectivity.

Atlantic Croaker Advisory Report

Status of Stocks

The Atlantic croaker stock status for the South Atlantic region is unknown at this time. The South Atlantic region makes up a relatively small component of the total stock biomass. Stock status determination in terms of overfishing is also unknown for the mid-Atlantic region. Given that the forward projection age-structured production model did not account for a likely significant source of removals by the scrap fishery along with questions on biomass indices noted in the full Peer Review Panel Terms of Reference Report, the Panel could not determine if overfishing is occurring. Based upon the recent trends in survey indices, many members of the Panel accepted that the stock was not overfished; however, full consensus was not reached.

Stock Identification and Distribution

Genetic studies indicate a single genetic stock of Atlantic croaker on the Atlantic coast and separate, weakly differentiated stocks in the Atlantic and Gulf of Mexico.

Management Unit

The management unit for Atlantic croaker is the entire Atlantic coast from Delaware to Florida.

Landings

Commercial landings for Atlantic croaker exhibited three periods of peak landings: 1955-1959, 1975-1980, and 1995 to the present (Figure 1). The highest landings were in 1977 at 13,532 mt. The current period of elevated landings is more than seven years. Low levels of harvest were evident during the 1960s and 1970s. The commercial harvest has been dominated by North Carolina and Virginia since 1950.

The commercial landings data did not include landings from aggregate, unculled ("scrap") bait fisheries or discard data. Unculled bait landings data are only available from North Carolina and indicated a substantial amount of additional landings not accounted for in the model (2-50%), particularly prior to 1996. There is uncertainty whether unculled bait landings data are available from other states and the magnitude of these landings.

Recreational landings are from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS). From 1981-2002, recreational landings of Atlantic croaker (Type A+B1 in numbers) from Massachusetts through Florida have varied between 2.8 million fish (1981) and 13.2 million fish (2001), with landings showing a strong linear increase over this period (Figure 2). Average landings for the period 1981 – 1990 were 6.0 million fish, while more recent landings averaged 10.8 million fish. The increased landings in recent years have been at the northern range of the fishery (Massachusetts to North Carolina).

Data and Assessment

The Atlantic croaker stock assessment used commercial landings from NOAA general canvas reports for all states, including the east coast of Florida. No data from the scrap fishery were included in the assessment model. No observer data were evaluated to quantify discards. Biological samples were from state surveys from North Carolina since 1982, Virginia since 1989, and limited age/weight data from Maryland since 1999. Recreational landings data from 1981 to the present were from the MRFSS. A fishery dependent survey index of the MRFSS CPUE index was also used in the assessment.

Fishery independent surveys included the National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) fall bottom trawl indices from 1982 to the present, and Southeast Area Monitoring and Assessment Program (SEAMAP) nearshore trawl survey indices from 1989 to the present.

The assessment model used a deterministic age-structured surplus production model to explain the population dynamics of Atlantic croaker, where the population in successive years was linked using a Beverton-Holt stock recruitment relationship. For modeling purposes, the Atlantic croaker population was divided into two geographic regions: mid-Atlantic (all states north of and including North Carolina) and south Atlantic (all states south of and including South Carolina).

Biological Reference Points

No biological reference points have been determined for the South Atlantic region. The benchmarks for the mid-Atlantic region listed in the stock assessment report were corrected as follows:

F threshold - F_{msy}
Biomass threshold - 0.7 SSB_{msy}
F target – 0.75 F_{msy}
Biomass target – SSB_{msy}

These benchmarks are based on Restrepo et al. (1998) and are standard for other managed species.

Fishing Mortality

The lack of inclusion of the landings in the scrap fishery in the assessment implies that removals were not fully accounted for in the model. Consequently, this suggests that estimates of F produced in the model have unknown biases. Given the lack of inclusion of all removal and questions on biomass indices, the Panel did not accept the fishing mortality estimates provided in the Atlantic Croaker Stock Assessment Report for Peer Review (include publication number here).

Recruitment

The lack of inclusion of the landings in the scrap fishery in the assessment implies that removals were not fully accounted for in the model. Consequently, this suggests that estimates of recruitment produced in the model have unknown biases. Given the lack of inclusion of all removal and questions on biomass indices, the Panel did not accept the recruitment estimates provided in the Atlantic Croaker Stock Assessment Report for Peer Review (include publication number here) and suggests that trends in recruitment estimated by the model should be interpreted in relative terms.

Spawning Stock Biomass

The lack of inclusion of the landings in the scrap fishery in the assessment implies that removals were not fully accounted for in the model. Consequently, this suggests that estimates of spawning stock biomass produced in the model have unknown biases. Given the lack of inclusion of all removals and questions on biomass indices, the Panel did not accept the spawning stock biomass estimates provided in the Atlantic Croaker Stock Assessment Report for Peer Review (include publication number here).

Bycatch

Bycatch and discard information was not included in this stock assessment for commercial fisheries. Recreational discards were accounted for in the assessment.

Sources of Information

Atlantic States Marine Fisheries Commission. 2003. Atlantic Menhaden Stock Assessment Report for Peer Review. ASMFC Stock Assessment Peer Review Report No. 03-02 (Supplemental). Washington, DC.

Restrepo, V.R., G.G. Thompson, P.M. Mace, W.L. Gabriel, L.L. Low, A.D. MacCall, R.D. Methot, J.E. Powers, B.L. Taylor, P.R. Wade, and J. F. Witzig. 1998. Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Tech. Memo. NMFS-F/SPO-31. 56 p.

Figure 1. Atlantic coastal commercial landings of Atlantic croaker (metric tons), 1950-2001.

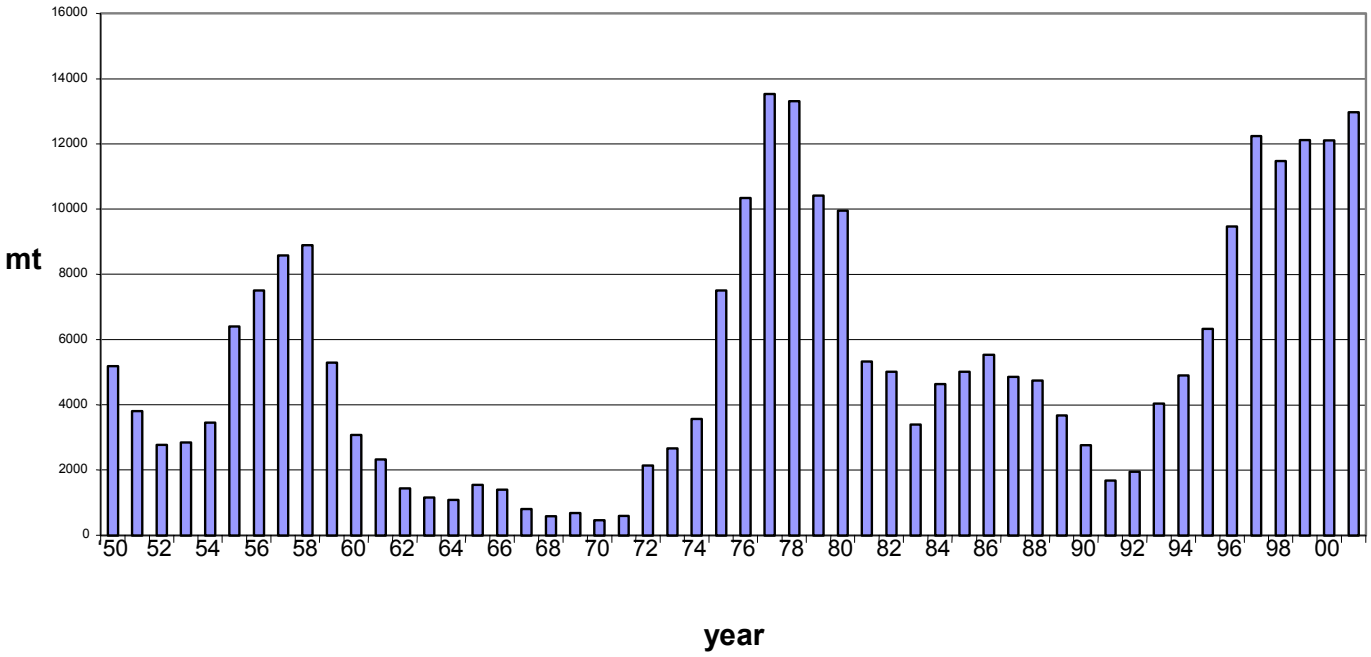

Figure 2. Recreational Landings (Type A+B1 in numbers) of Atlantic croaker