

Technical Committee Report

Horseshoe Crab

Delaware Bay/Shorebird Issues

Prepared by:

Horseshoe Crab Technical Committee

Presented to:

Horseshoe Crab Management Board

June 2003

The Horseshoe Crab Technical Committee met near Philadelphia on March 22 and 23, 2003, to discuss horseshoe crab and shorebird issues in Delaware Bay, and to review products of the Stock Assessment Subcommittee. Below is a summary of the meeting.

U.S. F&WS Shorebird TC Report

Overall, the HSC TC supported the work of the Shorebird TC. It deferred judgement to the Shorebird TC on all shorebird issues and made several comments below with regard to horseshoe crab issues in the report. At its meeting, the HSC TC reviewed select sections of the report (Sections 3.0, 4.10, 4.11, 7.5, 7.6, 7.7, 8.0) and the conclusions/recommendations. The peer review report was not available for review by the HSC TC. Unless stated otherwise below, the TC thought the sections it reviewed presented a reasonable summary.

4.11: The TC felt this section was a reasonable summary. However, they noted that the HSC SAS used an alternative analysis to the one referred to in Table 4.2 of the report.

7.6: The TC had concerns that the positive conclusion regarding beach nourishment may have been too strong. There are still questions about from where to draw sand and whether continual replenishment has a detrimental effect on near shore juvenile populations.

8.2: It is not clear what the numbers in the last sentence represent. The TC suggested that the numbers in the text and in Table 8.2, particularly for Port Mahon, be clarified.

8.3: The TC found the conclusions difficult to weigh without seeing a summary table of the data. It suggested that a request be made to obtain the raw data used in this section in order to evaluate the reports conclusions.

The TC had several comments about the Conclusions section:

Shorebird Population Trends: The TC found that this section was confusing as it tried to summarize a great deal of information. It would be better if this portion of the conclusions was expanded and clarified.

Shorebird Population Threats: The TC found that the phrase in the last sentence, “relative to the early 1990s” implies that it is known that there was more abundance of eggs in the early 1990s relative to recent years.

The TC had several comments about the Recommendations section. Generally, the TC made note that it is important to make the distinction between short term and long term management measures. Also, the several TC members noted that there may be dissention on part of the recommendations.

Direct Management 1.:

- The phrase “Because crabs caught in Delaware Bay can be landed in New York and Virginia” is not entirely correct. More appropriately, the statement should portray that crabs that are part of the Delaware Bay population could be harvested in federal waters and landed in states other than New Jersey and Delaware.
- The TC noted that this management measure might not result in more eggs on the beach in the short term and that there may better ways to do that.

- While the TC and SAS did not necessarily agree with a 66% reduction, they recognize that the Shorebird TC conducted their analysis and 66% is their best judgement.

Direct Management 3.: The TC suggested that if beach nourishment is to be used, then further research into the use of near shore habitat by juvenile horseshoe crab populations is needed in order to avoid negative impacts.

Smith/Millard Letter and SAS's DE Bay Stock Status Interim Report

At the last HSC Board meeting in February, Smith and Millard entered into the record their letter that served as commentary on the status of the horseshoe crab stock with focus on DE Bay. The authors intended for this letter to fill an information gap that had previously been filled by alarming claims regarding the horseshoe crab population with little or no technical justification. The Board directed the SAS and TC to review that letter. Since that time, the letter and its contents have evolved into an interim stock status report for Delaware Bay. This most recent SAS report is attached as Appendix A.

The TC supported the interim report and its conclusions. The general conclusion of the report and the TC was that there is no indication of a horseshoe crab population crash. The TC suggested that current harvest limits (as defined in Addendum I) are sufficient for horseshoe crab populations. However, if there is a greater need of abundance to support shorebird populations, then further management actions may be appropriate.

In order to fill information gaps between stock assessments, the TC tasks the SAS to conduct annual interim reports to include the latest findings from the past year's research. The TC discussed the issue of timing of the report. Ideally, the interim report would be ready by late winter (February). This timing would provide the Management Board the information before the start of that year's horseshoe crab season. However, in order to have the report ready for February additional funds for a part-time worker and modifications and improvements to the custom data input software will be necessary.

New Jersey/Delaware Letters and Proposed Actions

New Jersey and Delaware each submitted letters to the Board at its last meeting in February. The letters outlined the states' concerns regarding horseshoe crab egg availability for migratory shorebirds. They listed emergency measures that they were expecting to implement and also asked the Board to consider capping coastwide harvest at the 2001 levels for all jurisdictional waters. The Board tasked the TC to review the letters and proposed actions.

One of the measures listed as bullets raised concern for the TC, "Limit disturbance on shorebirds exerted by researchers to further allow the shorebirds to feed unmolested." The TC stressed the importance of balancing the value of research with the impact of research on the resource. The TC wants to avoid a situation where important horseshoe crab research is inhibited.

The TC came to consensus that the lack of 300K crabs harvested in the Delaware Bay region may lead to localized depletion in other areas. For example, Massachusetts obtains about 80K

crabs per year from Delaware Bay. Less crabs coming from DE Bay may increase harvest in MA waters. Similarly, Maryland and Virginia could increase harvest to compensate for the lack of harvest in DE Bay, in which case recruitment into the Bay may be affected. However, it is not known whether this may harm the population and there are still harvest caps in place in each jurisdiction.

New York has concerns about capping its quota at its 2001 harvest level. Its quota for that year was cut due to an earlier overage. The consensus of the TC was that a blanket cap at the 2001 level was not acceptable coastwide, but each state should individually look at its past landings and evaluate the situation to determine if additional restrictions may be needed.

SAS's Draft Terms of Reference for 2004 Stock Assessment

The SAS drafted new Terms of Reference for the upcoming stock assessment. The TC reviewed the document and suggested minor editorial changes. The Board should move to approve or disapprove the document (Appendix B).

In order for the SAS to ensure that they receive from the states all pertinent information, it recommended that letters be sent out to the Board and TC members in each member jurisdiction. The letters would serve as a formal request for information and set a deadline of August 1, 2003. There was concern that all relevant data was not made available for the last stock assessment.

Coordinated Delaware Bay-wide Horseshoe Crab Egg Survey

The idea of a coordinated Delaware Bay-wide egg survey has been discussed by the TC at several meetings. At present there are several independent surveys (not all focused on abundance) taking place around the Bay with different methodologies. The TC agrees that a coordinated survey would produce more useful data than the fragmented approach currently in place. However, the TC and SAS determined that a coordinated survey would entail significant effort and expense.

Dave Smith has prepared a proposal for the survey, which he estimated would cost \$120K. The intention of the proposal is to initiate a new baywide sampling regime as opposed to piecing together existing surveys. The baywide survey would not expand on current efforts, but would seek to calibrate old data (i.e. New Jersey's) so that data were not lost. The TC and SAS support the Shorebird TC's recommendation for such monitoring and felt it was important to recognize the relevance of this survey for better understanding the horseshoe crab-shorebird interaction issue. However, this survey would not be essential to the HSC stock assessment. The TC and SAS endorse and will assist in the development of the methodology, in addition to providing other technical advice.

Biomedical Survey

The Biomedical Working Group was tasked to redistribute the survey regarding horseshoe crab utilization in the biomedical industry. The survey has been modified and endorsed by the TC. The TC suggested sending out surveys to request information for 2001, 2002, and 2003 to collect

past data and to give the biomedical companies a heads up that we will be asking for this information for every year. The question of from who should the cover letter be addressed came up. The TC also suggested changing the FMP to require states to solicit the information asked for in the survey from biomedical companies within its territory and to make the recommendation that states require the transfer of crabs used in the biomedical industry to the bait industry. The most recent biomedical survey is attached as Appendix C.

Changes to the FMP in anticipation of the next Addendum/Amendment

Both the Board and TC have raised several issues regarding outdated monitoring requirements and language in the FMP. They questioned the relative importance of Monitoring Component A, specifically the portion that requires that, “Each state must characterize a portion of the commercial catch based on prosomal width by sex.” The SAS reported that that information is not currently essential to their work. However, the TC and SAS encourage states to continue characterizing the commercial catch. The SAS will need maturity data from the commercial catch in the future to run its full stock assessment model. Once a technique is developed to obtain this information completely and accurately, reporting of maturity will be required of states.

At its last meeting, the Board also raised an issue regarding Monitoring Component F. It asked whether states should be required every year to monitor spawning habitat. This component is required annually by the FMP as currently written. However, the TC recognizes that the original intent was to identify spawning habitat for conservation and permit review purposes. Therefore, if a state is confident with its knowledge of potential and actual spawning habitat, then no more monitoring is required. However, the TC reminds states to remain aware of changes in habitat use over time.

The TC also reviewed several other portions of the FMP and discussed other areas that need updating. The TC chair and staff have made note of those areas.

Potential Uncounted Harvest of Horseshoe Crabs

At the last TC meeting in February, concern was raised about harvest of horseshoe crabs for curio/live trade and personal harvest for use as bait. The group had little sense of what extent either practice was occurring. Bob Unsworth (TC member) looked into the issue and found that these harvests are being counted toward the overall harvest and they seem to occur at a very small scale.

Virginia Tech Horseshoe Crab Research

Virginia Tech will receive an earmark of \$633 K from this year’s NMFS budget to conduct horseshoe crab-related research. Presently, the Virginia Tech team is proposing six projects: 1) (a) annual trawl survey for third year with new partners and new gear working toward coastwide expansion; (b) continue exploring methodologies for accurately identifying newly recruited females; 2) continue aerial videography to get spawning counts; 3) study of spawning habitat loss over time (focussed on DE Bay); 4) acoustic tracking of HSCs in deep water pilot study; 5)

shorebird study using exclosures to get at whether HSC eggs are a limiting resource; and 6) population modeling to figure out population dynamics give HSC life history. The TC will be providing feedback on the proposed projects to Virginia Tech.

Alternative Bait Workshop 2003

New Jersey has provided funds to the ASMFC to conduct another alternative bait workshop. The workshop will likely be held in late summer/early fall with participants from along the coast and from a variety of backgrounds. TC members will be asked to help in the development of the workshop. One potential shortcoming is the lack of funding to implement any agreed upon alternatives resulting from the workshop.

RECENT TRENDS IN HORSESHOE CRAB SPAWNING ACTIVITY IN DELAWARE BAY

Atlantic States Marine Fisheries Commission
Horseshoe Crab Stock Assessment Subcommittee

May, 2003

Introduction

The ASMFC Horseshoe Crab Stock Assessment Subcommittee outlined a stock assessment framework that states (Millard et al. 2000) that the long-term stock assessment will be based on biological reference points and driven by data from a coastwide benthic survey targeted to horseshoe crabs. In the short-term the stock assessment must rely on trends in indices of spawning biomass and stock size from existing surveys. Here, we discuss recent results from the Delaware Bay spawning survey, the Delaware trawl surveys, and interpretation of data from Delaware Bay egg surveys.

Important findings from the spawning survey (Smith and Bennett 2003):

Since 1999, a survey of spawning activity has been conducted in a rigorous and consistent manner throughout the Delaware Bay and throughout the spawning season (Smith et al. 2002a, Smith and Bennett 2003). Data that have resulted from the survey have been precise (CV<10%; Smith and Bennett 2003) and shown to have sufficient statistical power to detect biologically meaningful declines (Smith et al. 2002a). At this time, the Delaware Bay spawning survey is the most important source of information to gauge status and trends in horseshoe crab spawning biomass. Data and annual reports from the spawning survey are available to the public through internet at <http://www.lsc.usgs.gov/aeb/2065/index.asp>

Baywide Trends— At the baywide scale, spawning activity has been relatively stable, and we can rule out all but modest changes in baywide spawning activity (Fig. 1). Based on baywide spawning activity over the past 4 years we can rule out changes in excess of 7 to 8% per year or in excess of a 22% declines or 26% increases over the past 4 years. While baywide spawning has been stable, spawning activity in New Jersey appears to have been more stable than in Delaware. When examining data at the beach scale, the data suggest a slight decline on Delaware beaches and it is not clear if increases on some of New Jersey beaches are sufficient to compensate. On the whole, spawning activity in Delaware Bay over the past four years has been either stable or declining slightly.

Spatial and Temporal Distribution of Spawning within Delaware Bay— Concentrations of spawning activity shifted from one area to another, which could explain why certain areas of the bay experienced declines but spawning activity throughout the bay remained relatively stable. Although spawning tended to peak in late-May, in some years spawning activity was more uniformly distributed over May and June and in some years spawning activity was more peaked. Thus, to draw valid conclusions about population-level changes in spawning, both temporal and spatial variation needs to be taken into account.

Results from the Delaware Trawl Survey

APPENDIX A

We have reanalyzed the Delaware trawl data with a model which better fits the data than was used in the original assessment. A simple linear regression does not provide a good fit to the data as indicated by examination of residuals (Fig. 2). We examined the fit of a segmented regression model. The segmented regression model fits multiple straight lines (or segments), which join at points somewhere along the range of observed x . The join points are estimated along with the regression parameters. Based on graphs of residuals, the fit of a two-segment regression model was good, much better than a straight line or polynomial (Fig. 3). The join point was estimated to be 1994. All parameters are significantly different than zero except for the post-1994 slope ($t=-1.24$, 9 df, $p=0.25$).

This analysis confirms the visual impression from these data that the dramatic decline occurred in the early 1990s. However, since the mid 1990s, the pattern has been much less certain. We conclude that these data suggest no significant trend since 1994.

Available Data on Egg Densities

Although a rigorous baywide survey of egg densities has been discussed (ASMFC 1998) and preliminary work on survey design has been published (Smith et al. 2002b, Pooler et al. 2003), at this time there are no egg surveys for which we would place a high value for managing a baywide population. Published literature suggests that egg densities show high natural variation and a sometimes-weak correlation to spawning biomass (Smith et al. 2002b, Pooler et al. 2003).

Because of the high natural variation in egg densities, localized analyses of egg densities can lead to different, possibly competing, conclusions. Botton et al. (1994: Table 4) reported that in 1990 surface egg densities on NJ beaches ranged from 3 to 721 thousand per m of shoreline. In contrast, Smith et al. (2002b: Table 2) reported that in 1999 surface egg densities on NJ beaches ranged from 18 thousand to 1.2 million per m of shoreline. If Sea Breeze is eliminated because of its anomalous morphology (its unique morphology mobilizes high quantities of eggs to the surface), the densities ranged from 18 to 750 thousand. The egg densities in 1990 and 1999 are comparable in magnitude, yet the spawning stock size was most likely reduced in 1999 when compared to 1990. The egg data do not reflect this change in spawning stock size, and we attribute this to the high variability inherent in surveys assessing surface egg densities.

Conclusions

The purpose of this analysis was to examine recent data available since the preliminary stock assessment work completed by the subcommittee in 1998. We found that the HSC stock most likely did undergo a decline in the late 1980s and early 1990s, coincident with an increase in harvest pressure. Our review suggests that since 1994 the decline has abated. Trawl data from Delaware since 1994 show no significant trend. The spawner survey in place since 1999 indicates a stable to slightly declining spawning population. Available egg survey data do not illuminate any significant baywide trends.

Cited

Atlantic States Marine Fisheries Commission (ASMFC). 1998. Interstate fishery management plan for horseshoe crab. Fishery Management Report No. 32. Atlantic States Marine Fisheries Commission, Washington, DC.

Botton, M. L., R. E. Loveland, and T. R. Jacobsen. 1994. Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. *Auk* 111:605-616.

APPENDIX A

Pooler, P. S., D. R. Smith, R. E. Loveland, M. L. Botton, and S. F. Michels. 2003. Assessment of sampling methods to estimate horseshoe crab (*Limulus polyphemus*) egg density in Delaware Bay. Fisheries Bulletin 101:(*in press*).

Millard, M.J., D.R. Smith, S. Michels, J. Brust, and J. Berkson. 2000. Stock assessment of Atlantic coast horseshoe crabs: a proposed framework. Horseshoe Crab Stock Assessment Committee, Report to the Atlantic States Marine Fisheries Commission, Washington, D.C.

Smith, D. R., P. S. Pooler, B. L. Swan, S. Michels, W. R. Hall, P. Himchak, and M. Millard. 2002a. Spatial and temporal distribution of horseshoe crab (*Limulus polyphemus*) spawning in Delaware Bay: implications for monitoring. Estuaries 25(1):115-125.

Smith, D. R., P. S. Pooler, R. E. Loveland, M. L. Botton, S. F. Michels, R. G. Weber, and D. B. Carter. 2002b. Horseshoe crab (*Limulus polyphemus*) reproductive activity on Delaware Bay beaches: interaction with beach characteristics. Journal of Coastal Research 18:730-740.

Smith, D.R. and S. Bennett. 2003. Horseshoe crab spawning activity in Delaware Bay: a preliminary report on 2002 and a comparison from 1999 to 2002. Report to the Atlantic States Marine Fisheries Commission Horseshoe Crab Technical Committee. (available at <http://www.lsc.usgs.gov/aeb/2065/index.asp>)

APPENDIX A

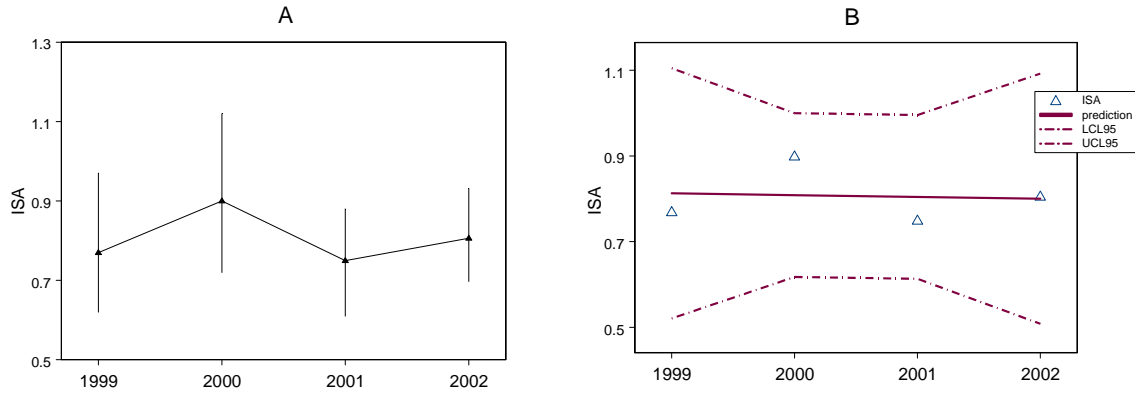


Figure 1. A) Baywide index of spawning activity (ISA) from 1999 to 2002. Vertical bars show 90% confidence intervals. B) Baywide ISA shown as triangles with a fitted regression line (solid line) and 95% confidence intervals (dashed lines).

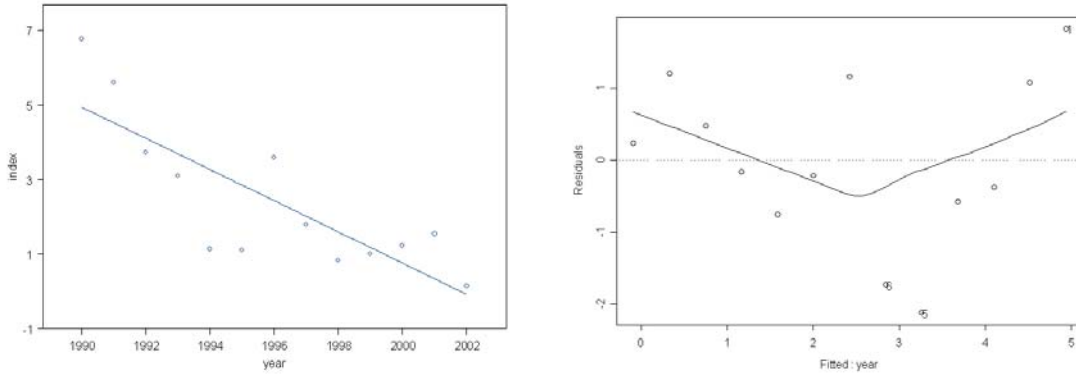


Figure 2. Simple linear regression line through the Delaware 30 ft. trawl survey data on the left panel. Residuals from the regression are on the right panel showing a lack of fit.

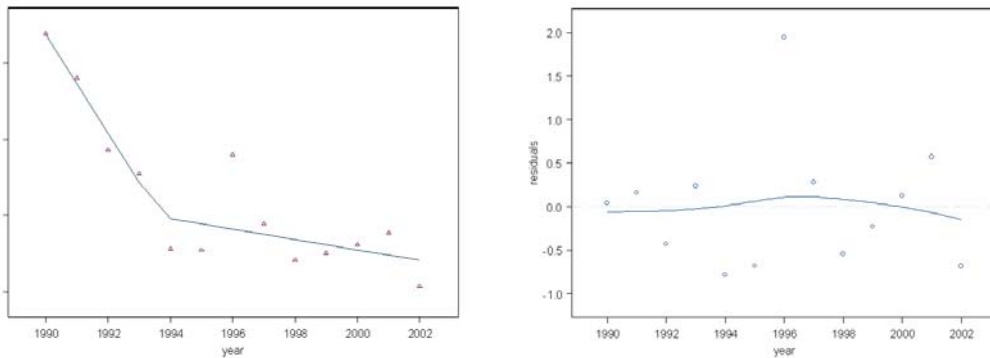


Figure 3. Segmented regression lines through Delaware 30 ft. trawl survey data on the left panel. Residuals from the regression are on the right panel showing improved fit over simple linear regression and the presence of an influential observation at year = 1996.

APPENDIX B

Terms of Reference for the 2004 Horseshoe Crab Stock Assessment

1. Review the data sets through 2002 (including egg, juvenile, and adult data) used in the horseshoe crab stock assessment and evaluate the relevance and effectiveness of each in assessing the status of the horseshoe crab stock.
2. Assess the relative status of the horseshoe crab stock throughout the Atlantic coast of the United States based upon analysis of state and federal trawl surveys, spawning counts and egg count survey data.
3. Review and develop research and other recommendations that would be beneficial to manage the horseshoe crab stock at the single species and multispecies levels.

APPENDIX C

6	Fishing gear utilized to collect horseshoe crabs?	<p>Trawl: _____</p> <p>Dredge: _____</p> <p>Hand Harvest: _____</p> <p>Other (specify): _____</p>
7	Number or percent of horseshoe crabs culled at sea and reason for rejection (if applicable).	<p>Due to injury: _____</p> <p>Due to death: _____</p> <p>Due to small size: _____</p> <p>Other (specify): _____</p> <p>Not applicable</p>
8	Number or percent of horseshoe crabs culled at the dock by the vendor/your company and reason for rejection (if applicable).	<p>Due to injury: _____</p> <p>Due to death: _____</p> <p>Due to small size: _____</p> <p>Other (specify): _____</p> <p>Not applicable</p>
9	Number of horseshoe crabs transported to bleeding location?	
10	<p>Number or percent of horseshoe crabs transported to bleeding location but not selected for bleeding, and reason for not being selected?</p> <p>(Rejected at bleeding location.)</p>	<p>Due to injury: _____</p> <p>Due to death: _____</p> <p>Due to small size: _____</p> <p>Other (specify): _____</p>

APPENDIX C

11	Disposition (number or percent) of horseshoe crabs transported to bleeding location but not bled?	<p>Returned to water: _____</p> <p>Entered bait market: _____</p> <p>Other (specify): _____</p> <p>Not Applicable: _____</p>
12	Number or percent of male and female horseshoe crabs bled.	<p>Male: _____</p> <p>Female: _____</p>
13	Disposition (number or percent) of bled horseshoe crabs.	<p>Returned to water: _____</p> <p>Entered bait market: _____</p> <p>Other (specify): _____</p> <p>*If any crabs were returned to water, please proceed to questions 14 and 15. *If no crabs were returned to the water, please proceed to the open-ended questions section.</p>
14	Condition of holding environment for bled horseshoe crabs prior to release?	<p>Average holding/transportation time: _____</p> <p>Holding/transportation conditions</p> <p>-Refrigeration used (Y/N): _____ (if yes, what temperature?)</p> <p>-Moisture maintenance used (Y/N): _____ (if yes, what humidity?)</p>
15	Location where horseshoe crabs were released following bleeding, if different from question 4 (be specific)?	

