REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN FOR **HORSESHOE CRAB** **(Limulus polyphemus)**

2000 FISHERY

Prepared by:

The Horseshoe Crab Plan Review Team

Stewart Michels, Delaware Department of Natural Resources and Environmental Control
Paul Perra, National Marine Fisheries Service
Eric Schrading, U.S. Fish and Wildlife Service
Carrie Selberg, ASMFC

April 2002

REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN FOR HORSESHOE CRAB (*Limulus polyphemus*)

I. Status of the Fishery Management Plan

The framework for managing horseshoe crabs along the Atlantic coast was approved in October 1998 with the adoption of the Interstate Fishery Management Plan for Horseshoe Crabs (FMP). The FMP required the States of Maryland, Delaware and New Jersey to maintain their existing horseshoe crab harvest reduction strategies, and required all states to implement certain horseshoe crab research and monitoring programs in an effort to facilitate future management decisions.

In February 2000, the Horseshoe Crab Management Board approved Addendum I to the FMP. Addendum I established a state-by-state cap on horseshoe crab bait landings at 25 percent below the reference period landings (RPL's), and *de minimis* criteria for those states with a limited horseshoe crab fishery. Those states with more restrictive harvest levels (Maryland and New Jersey) were encouraged to maintain those restrictions to provide further protection to the Delaware Bay horseshoe crab population, recognizing its importance to migratory shorebirds. Addendum I also recommended that the National Marine Fisheries Service (NMFS) prohibit the harvest of horseshoe crabs in federal waters (3-200 miles offshore) within a 30 nautical mile radius of the mouth of Delaware Bay, as well as prohibit the transfer of horseshoe crabs in federal waters. A horseshoe crab reserve was established by NMFS in the area recommended by ASMFC on March 7, 2001. NMFS may consider developing a proposal to prohibit the transfer of horseshoe crabs in federal waters in 2002; however, homeland security issues with the United States Coast Guard may make adequate enforcement impractical.

In April 2001, the Horseshoe Crab Management Board approved Addendum II to the FMP. The purpose of Addendum II was to provide for the voluntary transfer of harvest quotas between states to alleviate concerns over potential bait shortages on a biologically responsible basis. Voluntary quota transfers require Technical Committee review and Management Board approval.

II. Status of the Stock

The status of the stock is unknown. The Stock Assessment Committee (SAC) and the Peer Review Panel (PRP) concluded that there was inadequate information for a coastwide stock assessment. Information is not available to establish biological reference points, fishing mortality rates, or recruitment estimates. The Technical Committee and PRP, based on their assessment of the available data, recommended a conservative, risk-averse management approach. This recommendation was based on localized population declines, increased catch and effort, slow maturation, susceptibility of spawning crabs to harvest, population resiliency, and the need for a superabundance of horseshoe crab eggs in the Delaware Bay.

It is still too early to draw conclusions about spawning activity using the Delaware Spawning Surveys because the time series is too short. So far, no trend is apparent. Similarly, surface (0 - 5 cm) egg density sampling in New Jersey showed no appreciable changes in egg densities since 1999 (Kathy Clark (NJ DEP) pers. comm.). However, conclusions about population trends for a species such as horseshoe crabs should not be made on such short time series'.

III. Status of the Fishery

Bait Fishery

Reported coastwide horseshoe crab bait landings have declined each year since adoption of the FMP (Figure 1). These commercial landings are a significantly decrease from the reference period. Some states, particularly in the Delaware Bay region, have substantially reduced commercial effort by establishing criteria to limit permit eligibility. Preliminary coastwide bait landings for 2001 are 1,012,417 horseshoe crabs. This equates to over a 66% decrease relative to the RPL's adopted under Addendum I. Under Addendum I, the states of Maryland and New Jersey were encouraged to maintain their more restrictive (>25%) harvest regulations. New Jersey adopted a state quota of 297,680 crabs in September 2001 - about 50% below the state's RPL's. Maryland maintained its harvest restrictions until August 2000 when, with the Technical Committee and Management Board's approval, regulations were changed to reduce the targeting of female crabs. Maryland 2001 landings were 72% below the state's RPL's.

Although horseshoe crab bait landings have declined in recent years, large-scale bait shortages were not apparent in 2001. This may be partially attributed to the use of bait bags in the whelk (conch) pot fishery. A study conducted by Fisher and Fisher (2000) showed no significant difference in whelk catch between conch pots baited with a whole female crab or two whole male crabs versus a half of female or two halves of male crabs placed in mesh bait bags. As a result, the State of Virginia required the use of bait bags in their whelk pot fishery. Free bait bags have been distributed to whelk potters in several Mid-Atlantic States through a partnership with the Ecological Research and Development Group (ERDG), the states of Delaware, Maryland, New Jersey and Virginia. In addition, ERDG, in partnership with NOAA/NMFS, will provide over 7,000 bait bags to conch fishermen in New York, Connecticut, Rhode Island and Massachusetts this year.

Biomedical Fishery

The horseshoe crab continues to be an important resource for research and manufacture of materials used for human health. Scientists have used horseshoe crabs in eye research, surgical sutures, wound dressing development, and detection of bacterial endotoxins in drugs and intravenous devices. In addition, horseshoe crab blood is beneficial in cancer research; the Limulus Amoebocyte Lysate could lead to controlled cancer therapy. Substances in horseshoe crab blood may have the potential for diagnosing leukemia. According to a recent press release by the National University of Singapore, researchers have successfully cloned the enzyme that clots the blood of the horseshoe crab. A patent for the compound, called factor C has been filed in the United States. This effort may further aid in the conservation of horseshoe crabs.

The Technical Committee and Plan Review team developed and distributed biomedical questionnaires in 1998 and 2000 to monitor changes in the biomedical fishery. Results from the 2000 questionnaire suggested that the number of crabs bled increased less than 1%; however, the number of animals rejected for bleeding increased by about 9.5%. Nearly 25% of the crabs landed for biomedical purposes were rejected for use, with about 45% of these rejected due to injury. Recognizing that some mortality occurs during the harvest and bleeding process, the Biomedical Ad Hoc Work Group felt that it was appropriate for biomedical companies (at their choosing) to use crabs from the bait fishery for bleeding purposes and return them to the bait fishery. Crabs handled in this manner count against the state's annual bait quota and reduce overall horseshoe crab mortality.

IV. Status of Assessment Advice

A coastwide quantitative horseshoe crab stock assessment has not been completed. A review of the available data by the stock assessment subcommittee (SAC) was completed in August 1998, and reviewed by an external peer review panel (PRP) in October 1998. Both groups concluded that there was inadequate data to conduct a coastwide stock assessment.

The SAC and PRP advised a conservative, risk-averse approach to the management of the horseshoe crab, and identified research needs to facilitate future assessments. Although the FMP maintained the risk-averse management initiated in NJ, DE, and MD, failure to cap harvest in other states resulted in a redistribution of landings and negated conservation efforts. Further, the failure of some states to require mandatory reporting by the 1999 fishing season hampered the development of strategies to reduce exploitation. The adoption of Addendum I provided a table of reference period landings and recommended a 25% state-by-state reduction in bait landings. A 40% reduction in RPL was realized in 2000 and preliminary data suggest a 66% reduction was realized in 2001.

The SAC has proposed a framework for assessing the Atlantic coast horseshoe crab population (ASMFC 2000). The framework recommends a catch-survey method be used to assess the East Coast horseshoe crab population. This method employs survey data and harvest numbers to relate the number of adults and recruits (individuals that will mature the following year) present in year t to the number of adults available to the fishery in year $t+1$, and permits the estimation of catchability and abundance of adults and recruits. Application of this model is dependent upon a long-term survey to reliably monitor recruit and adult horseshoe crab relative abundance, and the proportion of recruit and adults in the commercial landings. As such, a formal quantitative stock assessment probably remains 5 to 10 years away once a reliable survey is fully implemented.

V. Status of Research and Monitoring

The Horseshoe Crab FMP set forth an ambitious research and monitoring strategy in 1999 in an effort to facilitate future management decisions. Despite limited time and funding there were many accomplishments. These accomplishments were largely made possible by forming partnerships between state, federal and private organizations, and the support of over a hundred public volunteers. Statistically robust spawner and egg count surveys were designed and in some areas implemented in the Delaware Bay. The U.S. Fish and Wildlife Service agreed to coordinate the coastwide horseshoe crab tagging program. A horseshoe crab benthic survey design workshop was conducted in July 1999 and the U.S. Geological Survey - Biological Resources Division (USGS-BRD) initiated a genetics project to evaluate whether or not regional horseshoe crab populations exist along the Atlantic coast.

State Challenge Fund Research

Since this time, the SAC has identified a potential model for a future quantitative stock assessment and developed a prioritized list of research and monitoring needs. With these needs in mind, the states of New Jersey, Delaware and Maryland contributed $125,000 (with 50% match by the Fish and Wildlife Foundation) to initiate:

1). A pilot trawl survey study;
2). Horseshoe crab stock identification/delineation;
3). Development of criteria for identifying new recruits;
4). The feasibility of aerial videography to monitor horseshoe crab spawning.

Researchers from Virginia Polytechnic Institute (VPI) and State University initiated the pilot trawl survey in 2001 to identify factors affecting horseshoe crab distribution and abundance and to develop protocol for a full-scale trawl survey. Results from this survey revealed that depth, topography (troughs) and time of day were important factors in determining horseshoe crab abundance. Further, low CV's ($\leq$0.20) were achievable at relatively low sample sizes (. 55 stations). The results from this pilot survey were extremely encouraging, with costs estimates for conducting such a survey much lower than expected.

Stock identification/delineation work is being conducted by the USGS-BRD. Samples are still needed from New York, North Carolina, South Carolina and the Yucatan. Work should be completed by the end of 2002, but portions of the project should be published sooner.

Researchers from VPI have also been working on the development of criteria to identify horseshoe crabs newly recruited to the spawning population using 200 captive crabs. Development of a non-lethal biopsy technique is slowly progressing. Problems associated with identifying the pre-molting condition are hampering development of a rapid assessment technique. Work is continuing in 2002.

The feasibility of night aerial videography to augment the current Delaware Bay spawning survey was investigated by researchers from Virginia Tech. Successful use of this technique would allow for coverage in areas inaccessible to volunteers and potentially provide a method to validate spawning survey results. Numerous camera and lens configurations were considered. The optimal configuration could provide an index of spawner coverage (i.e. area versus actual counts). Researchers are currently seeking funding and further guidance, but are prepared to field test in May 2002.

Spawning Surveys

The Delaware Bay horseshoe crab spawning survey has been annually conducted following the modified design developed during an ASMFC workshop in 1999. The survey is being conducted through a unique partnership between various state and federal agencies, a biomedical company, conservation groups, and numerous private citizens. The spawning survey coordinator is being funded by the state of Delaware using Atlantic Coastal Grant funds, the state of New Jersey provides staff for data entry and verification, the state of Maryland has contributed volunteers, and the USGS-BRD completes the annual data analysis. The survey is currently providing an estimate of female spawner abundance with good CVs (<14%) and should serve as a good tool to monitor horseshoe crab population using the Delaware Bay. This work does lack permanent funding and is funded through the partnerships and short term funding each year.

Egg Studies

Egg density studies continue in the Delaware Bay, although sampling methodologies differ between the states of Delaware and New Jersey. The State of Delaware funded a study to further refine egg-sampling methodologies in 2001. Delaware anticipates sampling horseshoe crab eggs (0-5 cm and 5-20 cm) in 2002; however, available funding may not be sufficient to ensure complete sample coverage. The State of New Jersey anticipates sampling surface (0-5 cm) egg densities on eight beaches in 2002. The New Jersey egg sampling effort lacks a long-term funding source necessary to insure its continuation.

A study to estimate horseshoe crab fecundity is being conducted by a graduate student from Delaware State University in cooperation with the Delaware Division of Fish and Wildlife. An estimate of average fecundity is necessary to evaluate how variable fishing mortality may affect horseshoe crab egg production. Female horseshoe crabs have been collected from the Delaware Bay and egg extractions are underway.

Tagging Studies

The USFWS continues to maintain an "800" telephone number for reporting horseshoe crab tag returns and assists interested parties in obtaining tags. In addition, the Service will continue a study in Delaware in 2002 to determine horseshoe crab movement, spawning frequency and site fidelity. Results from last year's work revealed that one-third of tagged crabs were resighted at the same beach within three weeks of being tagged. Tagged females were observed spawning up to five times and males were observed spawning up to ten times during the study period. The more intensive sampling being conducted in 2002 should improve our understanding of spawning behavior.

Additional tagging work continues to be conducted by biomedical companies and other parties involved in outreach and spawning surveys. In some cases, the tagging efforts would benefit by establishing clearly defined objectives and insuring better coordination among researchers.

Alternative Bait and Trap Design

University of Delaware researchers have isolated the compound from horseshoe crabs that attracts American eel and small predatory snails (a surrogate for whelk). Development of a suitable matrix for the compound is underway and some field-testing has been conducted. The compound would serve as a bait extender, until a cost-effective synthetic version could be produced. Significant progress is being made toward developing a synthetic attractant.

Researchers at the Virginia Institute of Marine Science are continuing work on modified trap design, and methods to incorporate surf clam waste and hemolymph (byproduct from the lysate industry) into a suitable matrix for whelk bait. Further field trials are expected in the early summer of 2002. The successful use of these innovations could further reduce horseshoe crab exploitation.

VI. Status of Management Measures and Issues

NMFS Activities:
The NMFS implemented a Final Rule (effective 3/7/2001) to prohibit fishing for horseshoe crabs and limit possession of them in the exclusive economic zone (EEZ) (per the recommendation of Addendum I of the FMP) encompassing a 30 nautical mile (nm) radius (in a shape roughly equivalent to a rectangle) seaward from the midpoint of the territorial sea line at the mouth of Delaware Bay.

Development of regulations to prohibit transfer at sea of horseshoe crabs and to improve Federal permitting and reporting of horseshoe crab landings are under review.

Shorebird:
The US Fish and Wildlife Service formed the Shorebird Technical Committee in 2001 with the purpose of providing technical advice to the Board on how horseshoe crab management action might affect shorebird populations. This Committee is comprised of shorebird experts and a representative of the horseshoe crab Technical Committee and Stock Assessment Subcommittee. The immediate task of this group is to produce a peer-reviewed report that synthesizes current literature and data on the status of shorebirds in the Delaware Bay and to determine their energetic dependency on horseshoe crab eggs. They currently have completed the terms of reference for their work and are finalizing an outline for the report and the list of peer reviewers.

VII. Current State by State Implementation of Compliance Requirements

Currently, there are no compliance issues for any ASMFC states in regards to their horseshoe crab programs. The landings for all states except New York are below the allotted quota. New York has deducted previous overages from the 2002 quota and has implemented a system that should prevent them from landing more than their quota in the future. All states have implemented the necessary monitoring components of the plan. The plan review team (PRT) is concerned that some states are using trawl survey data in place of characterizing their fishery. The PRT has referred this issue to the stock assessment subcommittee for input on whether or not the information collected in this component of the plan is necessary for future stock assessments. ME, NH, PA, DC, PRFC, NC, SC, GA and FL have requested and qualify for *de minimis* status. Please see the PRT report on State Compliance for detailed information on each state's program.

VIII. Recommendations by the Plan Review Team

Live Trade:
The Florida annual report outlined increasing marine life collection taking place in their state. At this time the PRT does not believe the landings for marine life collection to be a problem but asks that all states include any of this activity in their annual state compliance reports so the PRT may monitor the situation.

Funding for Research and Monitoring Activities:
The PRT strongly recommends that the benthic trawl survey should be funded for 2002 or as soon as possible to provide the necessary information for future stock assessments. A long-term benthic sampling program for horseshoe crabs has been repeatedly identified as a critical stock assessment need. The pilot trawl study conducted in 2001 clearly showed that this project could provide a statistically reliable estimate of horseshoe crab relative abundance at a relatively low cost. A long-term funding source should be sought to support this work. The PRT is aware of an initiative seeking congressional funding for a 5-year project to implement the horseshoe crab benthic trawl survey, among other valuable research. The PRT recommends that the Board consider supporting this initiative as a method to fund this important research need.

The Technical Committee has recognized the need for reconvening the horseshoe crab tagging subcommittee. This need is supported by the PRT, recognizing the potential benefits to defining management units, gleaning life history information and the potential for estimating mortality and determining stock size. The PRT recognizes that a number of tagging efforts are underway along the coast, some of which lack clearly defined objectives. The tagging subcommittee in coordination with the stock assessment subcommittee should identify existing tagging efforts and methods, determine the appropriate tag type and procedures, and investigate the feasibility and determine the objectives of a coordinated coastwide tagging effort.

The PRT recommends that the Technical Committee, working with the PRT, resurvey the biomedical companies in an effort to monitor mortality associated with the biomedical fishery. The Commission would reevaluate potential restrictions on biomedical harvest if mortality exceeds 57,500 horseshoe crabs per year. Previous surveys have provided valuable information in the past.

Habitat Delineation:
The PRT recommends that states continue to improve habitat delineation in their states including categorizing the spawning importance on different beaches. Several states have continued this work and are providing valuable results while others have not continued to do this work.

Law Enforcement:
The Law Enforcement Committee has raised concerns with the reporting requirements as outlined in Addendum I. This Addendum requires each state to submit a detailed form similar to the one used for striped bass which asks for information on the number of hours spent on horseshoe crab enforcement as well as other information. The state law enforcement programs do not routinely collect the information as outlined in the report and collecting this information would increase time and money spent on horseshoe crab reporting, but not necessarily improve regulation enforcement. The Law Enforcement Committee questioned how this information was going to be used.

The Plan Review Team reviewed their concerns and recommends that the law enforcement reporting requirements be changed. The original intent of this requirement was to ensure that the horseshoe crab regulations were being enforced in all of the states and that the ASMFC was made aware of any problems with enforcement. The Plan Review Team suggests replacing the detailed form currently used with a general description of horseshoe crab law enforcement issues to include the following: significant law enforcement violations, any regulations that law enforcement are finding unenforceable, as well as a general description of how the horseshoe crab regulations are enforced in that state. This would be included in each State's annual state compliance report. The Plan Review Team believes that the following description in Connecticut's annual report is a good example:

> *"Two commercially licensed fishers reporting horseshoe crab landings by gear types prohibited from harvesting crabs were sent verbal and written warnings that further harvest would result in fines. All other law enforcement incidents involving horseshoe crabs in 2001 were related to conflicts with shellfish harvest. One licensed commercial oysterman was arrested for possession of horseshoe crabs out of the open season. The two arresting shellfish enforcement officers, CT DEP Director of Marine Fisheries and a CT DEP Fisheries Biologist testified at his court hearing where he was found guilty and fined. In addition to town shellfish enforcement officers, 10 CT DEP Conservation Officers are assigned to law enforcement duties in the marine district."*

The Plan review team recommends an addendum to the FMP, which changes this reporting requirement for law enforcement. Appendix I of this report has suggested language if the Board wishes to pursue this matter.

IX Literature Cited.

ASMFC Horseshoe Crab Stock Assessment Subcommittee. 2000. Stock Assessment of Atlantic Coast Horseshoe Crab: A Proposed Framework.

Fisher, D. and B. Fisher. 2000. Reducing horseshoe crab as bait in the Virginia conch pot fishery (poster). College of William and Mary – Virginia Institute of Marine Science / Virginia Sea Grant.

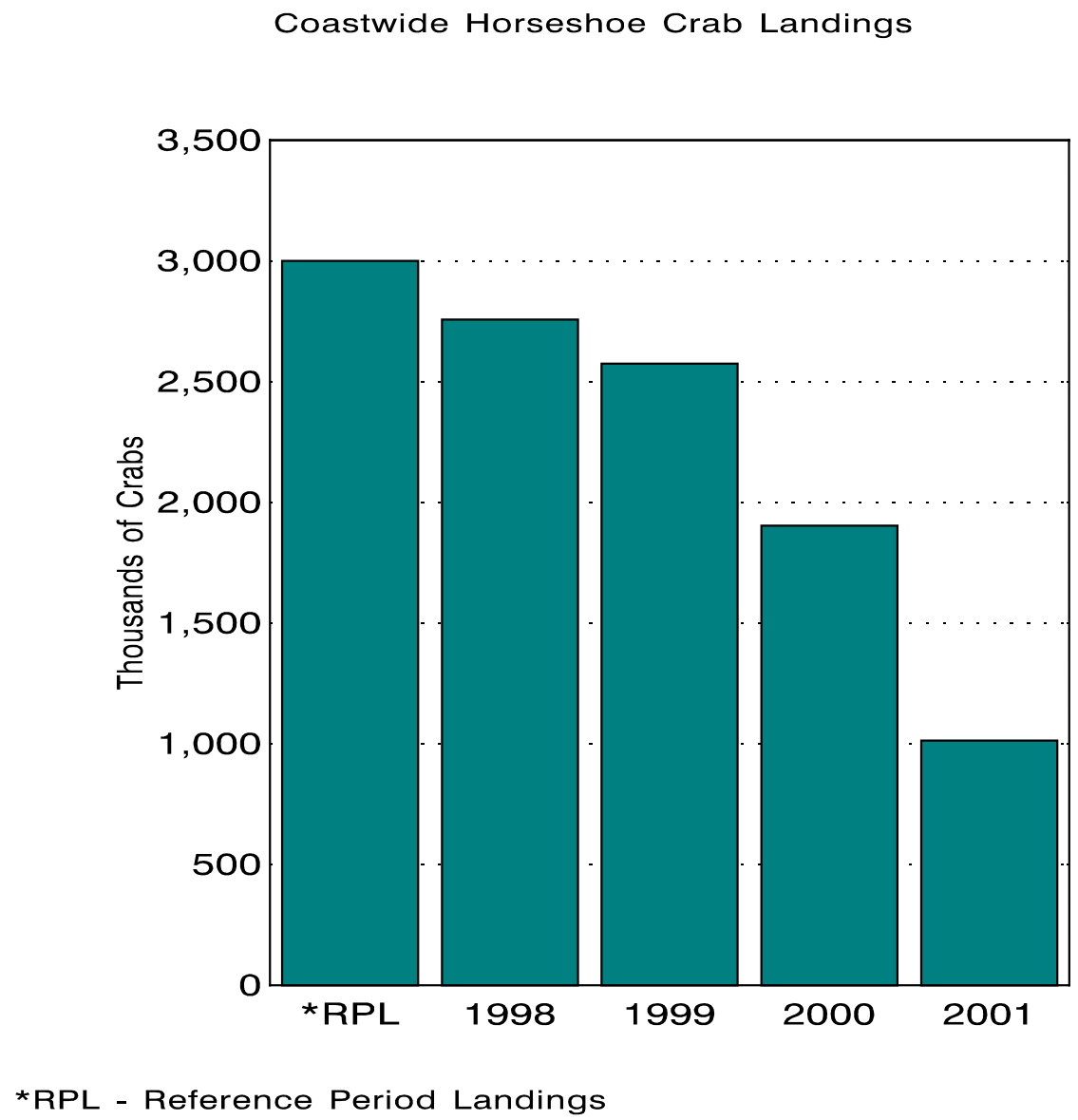

Figure 1. Coastwide horseshoe crab landings expressed as number of crabs (thousands).

Appendix I: Suggested Addendum III language

Addendum III to the
Atlantic States Marine Fisheries Commission
Fishery Management Plan for Horseshoe Crab

1. INTRODUCTION

In February 2000, the Horseshoe Crab Management Board approved Addendum I to the Horseshoe Crab Fishery Management Plan. Addendum I established a state-by-state cap on horseshoe crab bait landings at 25 percent below the reference period landings beginning in 2000, *de minimis* criteria for those states with a limited horseshoe crab fishery, and law enforcement reporting requirements. Law Enforcement programs in the Atlantic Coast States do not routinely collect the information outlined in Addendum I. This addendum changes the reporting requirements to better suit the state programs while providing the information that the ASMFC needs to evaluate enforcement of horseshoe crab regulations in the Atlantic Coast States.

2. STATEMENT OF PROBLEM

Addendum I requires each state to submit an annual law enforcement report which follows the form outlined in this addendum. The Law Enforcement Committee (LEC) raised concerns with the reporting requirements as outlined. The law enforcement report requires each state to submit a form detailing information on the number of hours spent on horseshoe crab enforcement as well as other information not routinely collected. Completion of the law enforcement report contained in Addendum I would increase time and money spent reporting on horseshoe crabs but not necessarily improve the enforcement of horseshoe crab regulations. The LEC questioned the value and applicability of this information given the increased time and financial burdens associated with collecting this information. The original intent of the Addendum I reporting requirement was to ensure that the horseshoe crab regulations were being enforced in all jurisdictions and that the ASMFC was made aware of any problems with enforcement.

3. LAW ENFORCEMENT REPORTING REQUIRMENT CHANGES

Addendum III requires all states to include a law enforcement section in their annual report to the ASMFC due on February 1 of each year. This section should have a general description of law enforcement issues including the following: significant law enforcement violations, any regulations that law enforcement personnel are finding unenforceable, as well as a general description of how the horseshoe crab regulations are enforced in the jurisdiction. This replaces all law enforcement reports as outlined in Addendum I.