



ECONOMIC ASSESSMENT OF MID-ATLANTIC HORSESHOE CRAB AND DEPENDENT FISHERIES INCLUDING A QUALITATIVE DISCUSSION OF THE POTENTIAL EFFECTS OF ADDENDUM IV

FINAL REPORT

February 8, 2008

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Atlantic State Marine Fisheries Commission

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ACKNOWLEDGEMENTS

Industrial Economics, Incorporated (IEc) would like to acknowledge those who provided assistance with this report, including Peter Himchak, New Jersey, Department of Environmental Protection; Roy Miller and Scott Newlin, Delaware Department of Natural Resources & Environmental Control; Kim McKown, New York State Department of Conservation; Howard King and Michael Luisi, Maryland Department of Natural Resources; Jack Travelstead and Stephanie Iverson, Virginia Marine Resource Commission; Michael Cahall, Julie Marie Defilippi, and Geoff White; Atlantic Coastal Cooperative Statistics Program.

IEc would especially like to thank the processors, dealers, and fishermen for their willingness to provide information, including Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs; representatives of American Eel Depot, Medomak Fisheries, and Sea Star Distribution; Fred Layton, Sam Veech, Will Terri, Charles Givens, Dan Tusing, Leonard Voss, Harold Jenkins, Jeff Eustler, Gerhard Peemoeller, Harry Jenkins, Vaughn Pruitt, Freddy Baylor, and Bates Cleary.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

SECTION 1: INTRODUCTION

Current Management of the Horseshoe Crab Fishery *1*

Organization of the Report *3*

SECTION 2: DATA SOURCES

Primary Data Sources *5*

Supplemental Data Sources *8*

SECTION 3: RAW RESULTS BASED ON FISHERY DATABASES

Estimates of Total Reported Landings and Ex-Vessel Revenue *10*

Estimates of Reported Ex-Vessel Revenue by Fishery and State *12*

Evaluation of Broader Fishing Effort Using State Datasets *26*

SECTION 4: POTENTIAL IMPACTS OF ADDENDUM IV ON THE MID-ATLANTIC HORSESHOE CRAB AND DEPENDENT FISHERIES

New Jersey *30*

Delaware *30*

Virginia *30*

SECTION 5: REGIONAL ECONOMIC IMPACT ANALYSIS

Regional Economic Analysis Using IMPLAN *32*

Scoping Level Analyses of Processors and Distributors *42*

REFERENCES

APPENDIX A: CRAB BAIT LANDINGS FROM LATEST HORSESHOE CRAB FISHERY MANAGEMENT PLAN

APPENDIX B: LANDINGS AND EX-VESSEL REVENUE ESTIMATES USED FOR ESTIMATION OF BROADER FISHING EFFORT

EXECUTIVE SUMMARY

In response to growing concern over the horseshoe crab population and its ecological role in Delaware Bay, the Horseshoe Crab Management Board approved Addendum IV to the Interstate Fishery Management Plan for Horseshoe Crab in May 2006. The action prohibits directed harvest and landing of horseshoe crabs in New Jersey, Delaware, Maryland, and Virginia from January 1 through June 7, for a two-year period beginning October 1, 2006. Additionally, female horseshoe crabs cannot be harvested in New Jersey and Delaware from June 8 through December 31, resulting in a moratorium on female horseshoe crab harvest in those states for the two-year period.¹

In an effort to evaluate the potential economic impacts of Addendum IV, the Atlantic State Marine Fisheries Commission (ASMFC) contracted Industrial Economics, Incorporated (IEc) to conduct an economic assessment of the horseshoe crab and dependent fisheries, including American eel and conch, for the states most likely affected by the Addendum IV management measures: Delaware, Maryland, New Jersey, New York, and Virginia. Specifically, ASMFC requested that IEc employ trip-based data to characterize the following for each fishery and state:

- Total and average (per harvester) landings and ex-vessel revenue for the most recent five years for which data is available;
- Key harvest periods for each species; and
- The relative importance of the three species compared to the total fishing effort of the harvesters.

In addition, ASMFC requested that IEc perform a regional economic assessment of the horseshoe crab fishery using IMPLAN, an input/output model designed to assess the level of regional economic activity that supports horseshoe crab fishing (i.e., the economic effects associated with activities that lie “upstream” from fishing, such as the purchasing of fishing gear).

We worked with Atlantic Coastal Cooperative Statistics Program (ACCSP) and the state fishery managers to obtain trip ticket and dealer data for Delaware, Maryland, New Jersey, New York, and Virginia from 2000 to 2006. Unfortunately, the data are subject to much uncertainty and potential reporting gaps that may lead to underestimating the level of

¹ Caldwell, Megan, ASMFC, Memorandum to Industrial Economics, Request for Proposals: Evaluation of the Social and Economic Effects of a Horseshoe Crab Harvest Closure on the Horseshoe Crab Fishery and Other Fisheries, December 4, 2006.

activity for these fisheries.² In addition, given that Addendum IV provisions took effect on October 1, 2006, these data will not likely reveal the impacts of the Addendum on the horseshoe crab and dependent fisheries. Ideally, to assess the economic impacts of Addendum IV, we would evaluate activity data for at least a full year under the new requirements; however, these data are not yet available.

To support this effort, we also contacted harvesters and processors to better understand each fishery and to gain insight on potential impacts of Addendum IV on their operations.

Because of the uncertainty surrounding the data, this report presents an economic analysis of the horseshoe crab and dependent fisheries from three perspectives: 1) using best available landings and ex-vessel revenue information; 2) applying a regional impact analysis model that presents upstream impacts on the economy; and 3) presenting economic information provided by fish processors and fishermen.

RESULTS

HORSESHOE CRAB

- Using a National Marine Fisheries Service (NMFS) dataset provided by ACCSP, we estimate that harvesters in the five study states landed approximately 1 million pounds of horseshoe crab in 2006. In total, these landings resulted in reported ex-vessel revenues of approximately \$470,000. Virginia accounts for the highest quantity of total reported ex-vessel revenues at \$278,000 in 2006.
- We estimate reported ex-vessel revenues per harvester at approximately \$4,800 in 2006. These values represent a decline from previous years. New Jersey saw large drop in horseshoe crab landings and ex-vessel revenues from 2005 to 2006, which is likely the result of the voluntary statewide moratorium (effective May 15, 2006) on horseshoe crab fishing.
- Based on the available data, the peak horseshoe crab fishing season appears to be in May and June for most states. Given that many of Addendum IV restrictions prohibit horseshoe crab harvest during May and early June, these management actions likely prevent the harvesting of horseshoe crabs during the peak season.
- An analysis of Maryland state data (2004) showed that 63 percent of the State's horseshoe crab harvesters reported that horseshoe crab associated ex-vessel revenues exceed ten percent of their total revenue.
- An analysis of Virginia state data (2005) showed that 18 percent of State's horseshoe crab harvesters reported horseshoe crab associated ex-vessel revenues exceed ten percent of their total revenue.

² Given the incomplete nature of the trip-level data due to various levels of underreporting at the state and federal level, it was our original intent to devise a methodology to extrapolate these data out to a wider estimate of fishery revenues and landings using the professional judgment of state fisheries managers and/or fishermen and processors. Unfortunately, because of the uncertain nature of the data gaps, these sources were unable to provide estimates from which we could base extrapolations.

AMERICAN EEL

- Using NMFS data, we estimate that American eel harvesters in the five study states landed approximately 710,000 pounds of eels in 2006.³ In total, these landings resulted in reported ex-vessel revenues of approximately \$1.5 million in 2006, which represents an increase over previous years.
- We estimate reported ex-vessel revenues at approximately \$7,000 per harvester in 2006, which represents a slight decline (4 percent) from 2005. In general, reported ex-vessel revenues per harvester have increased throughout the decade.
- Based on discussions with eel distributors, the reported revenues and landings available in the NMFS consolidated data set likely reveal underreporting in the American eel fishery.
- The data show multiple peak harvest periods with efforts concentrated in April through May and September through October.
- An analysis of Maryland (2004) and Virginia state data (2005) showed that, respectively, 47 percent and 45 percent of the States' eel harvesters reported that eel associated ex-vessel revenues exceed ten percent of their total revenue.

CONCH

- Using NMFS data, we estimate that harvesters landed approximately 1.7 million pounds of conch in 2006, which is down from previous years. In total, these landings resulted in reported ex-vessel revenues of \$2.3 million in 2006, which represents an increase from 2004 and 2005, but an overall decrease from 2000.
- We estimate reported ex-vessel revenues at approximately \$8,700 per harvester in 2006, which again represents an increase from 2004 and 2005, but an overall decrease from 2000.
- Based on discussions with a conch processor, the reported revenues and landings available in the NMFS consolidated data set likely reveal underreporting in the conch fishery.
- In general, the peak harvest season for conch is May, although harvesters reported significant landings and ex-vessel revenues for March, April, November, and December. Reported landings and ex-vessel revenues were typically lowest in August.

³ It is important to note that in this document, we report ex-vessel revenues for the entire horseshoe crab, American eel, and conch fisheries as reported to federal and state databases. Given uncertainties in the data, we do not separate out landings/revenues of eel or conch achieved without the use of horseshoe crab as bait (e.g., conch dredging). Because of its rolled up nature, it was difficult to identify how fishermen typically operate from the information available in the NMFS consolidated dataset. This approach allows ASFMC to evaluate quality of data in the NMFS consolidated dataset without manipulation.

- An analysis of Maryland state data (2004) showed that 31 percent of the State's conch harvesters reported that conch associated ex-vessel revenues exceed ten percent of their total revenue, which may indicate that conch are relatively important to these fishermen.
- An analysis of Virginia state data (2005) showed that 18 percent of the State's conch harvesters reported that conch associated ex-vessel revenues exceed ten percent of their total revenue.

QUALITATIVE DISCUSSION ON THE EFFECTS OF ADDENDUM IV

As mentioned above, Addendum IV took effect on October 1, 2006, and thus the available data (through 2006) would not likely reveal the full economic impacts of the new restrictions. However, interviews with fishermen provided some insight into the ongoing impacts of Addendum IV, including:⁴

- From our discussions with harvesters, it appears that Addendum IV (along with the voluntary state moratorium in New Jersey) has had the significant effects on fishermen in New Jersey and Virginia. For those conch and eel harvesters that rely on horseshoe crabs as bait, the reduction in supply of horseshoe crabs resulting from the moratoriums has led to an increase in bait prices, which in turn, has forced harvesters to use less bait in each pot. The result has been a decrease in productivity.
- In Delaware, the fishermen generally acknowledged that Addendum IV has decreased the availability of horseshoe crabs; however the impact on the harvesters has been softened by focusing the majority of their efforts on other species, such as striped bass, flounder, and blue crab.
- Finally, a conch processor in Virginia maintains that Addendum IV's 2:1 male to female sex ratio requirement in Virginia waters east of COLREGS line has effectively eliminated the directed dredge fishery (and some additional bycatch) operations in this area because harvesters could not catch enough males to meet the new requirement. The processor also reports that the decline in this fishery forced him to purchase more horseshoe crabs from outside Virginia than in past years.

REGIONAL ECONOMIC ANALYSIS USING IMPLAN

This analysis presents an overview of the regional economic and employment contribution of the horseshoe crab fishery to the economies of Virginia, Maryland, Delaware, New Jersey, and New York. Using expenditure information provided by harvesters as inputs to the IMPLAN model, we estimated the contribution of horseshoe crab fishing activity to the economies of the five states in our study area in 2006. Because the IMPLAN model is static in nature, it captures these economies at one point in time. Accordingly, it does not

⁴ Efforts to contact fishermen and processors in the various states and fisheries proved to be a challenge. IEc made contact with five fishermen (mix of horseshoe crab, American eel, and conch) from New Jersey, two from Delaware (horseshoe crab, eel, conch), one from Maryland (horseshoe crab), and four from Virginia (horseshoe crab and conch). Rick Robbins of Bernie's Conch and Chesapeake Bay Packing/Bernie's Conchs, a conch processor, also provided information. We were unable to make contact with processors or fishermen from New York.

specifically address any impacts that may have occurred to the fishery as a result of Addendum IV.⁵

Since horseshoe crab is often caught and used as bait by the same fishermen, the resulting overall revenues for the fishery appear small when examined separately from dependent fisheries such as conch and eel. As such, per vessel operating expenditures, which range from \$10,000 to \$50,000 depending on the state, appear large relative to per vessel fishery revenues, which ranged from \$100 to \$3,500 in 2006.

Regardless of profitability, the horseshoe crab fishing industry has an impact on the regional economy through operating expenditures, as well as income by owners, captains, and crew. The IMPLAN analysis estimates that the total regional economic impacts range from \$2.7 to \$4.7 million across the five-state region. The largest regional economic impacts are anticipated in Virginia (\$1.1 million to \$1.8 million), while the smallest impacts are anticipated in Delaware (\$0.3 million to \$0.5 million).

Direct employment associated with horseshoe fishing activity was assumed to be 1.2 full time equivalents per vessel. Not surprisingly, this employment constitutes the majority of employment associated with this industry. Regional demand from the horseshoe crab fishery however, may provide employment for an additional nine to 18 employees across various industries.

SCOPING ANALYSIS OF PROCESSORS

Since IMPLAN estimates effects on “upstream” activities, it does not measure the economic impact of the horseshoe crab fishery on downstream activities, such as processing and distribution. As part of this effort, IEc interviewed several processors and distributors for the American eel and conch fisheries. Their insight can help provide additional context on the economic assessment of the horseshoe crab and the dependent fisheries, including:

- Based on estimates of annual purchases of eels and conchs by processors, it is likely that the data presented in this report underestimate total landings and ex-vessel revenues.
- Discussions with eel dealers suggest that 15 to 20 major distribution firms operate on the Atlantic Coast. Their operations vary considerably, with some dealing to overseas markets and other dealing to local restaurant distributors.
- Discussions with conch processors suggest that the industry includes at least 12 companies, located from Virginia to Massachusetts. Conch processors typically purchase horseshoe crabs (to be sold later as bait) and conch from harvesters throughout the Atlantic Coast, extending beyond the boundaries of this study.

⁵ Because the modeling results are linear in nature, they could be used to understand how partial reductions in horseshoe fishing activity would be experienced in the regional economy. For example, if a 50 percent reduction in fishing harvest is expected, 50 percent of the regional economic impacts could be assumed to result in the short term, assuming no substitution or reabsorption of fishing activity occurs.

SECTION 1: INTRODUCTION

Despite their name, horseshoe crabs (*Limulus polyphemus*) are not crabs, but instead more closely related to spiders. The species has existed between 200 and 400 million years and play a vital role in the ecology of the mid-Atlantic. Their eggs serve as a significant food source for migrating shorebirds (including the red knot, whose populations have been in decline) and finfish. Horseshoe crabs are also critical to commercial interests. In particular, horseshoe crab are the primary source of bait for the American eel (*Anguilla rostrata*) and conch fisheries.^{6,7} The species is also important to the biomedical industry, which uses the animal's blood in the detection of contaminants in patients, drugs, and other medical supplies.

As a result of a lack of long-term data on commercial landings and stock abundance, the total number of horseshoe crabs is relatively unknown; however, annual landings of horseshoe crab were historically significant. “From the 1850s to the 1920s, between 1.5 and four million horseshoe crabs were harvested annually for fertilizer and livestock feed. By the 1960s, only 42,000 horseshoe crabs were reported to be harvested annually.” More recently, “findings from beach spawning surveys conducted in the Delaware Bay region over the last seven years suggest that spawning activity remains stable or has slightly declined at a rate of three percent or less per year”.⁸

CURRENT MANAGEMENT OF THE HORSESHOE CRAB FISHERY

The goal of the Interstate Fishery Management Plan for Horseshoe Crab (FMP) includes “management of horseshoe crab populations for continued use by: current and future generations of the fishing and non-fishing public (including the biomedical industry, scientific and educational research); migratory shorebirds; and, other dependent fish and wildlife (including federally listed (threatened) sea turtles).”⁹ Under Addendum I, the

⁶ Conch is colloquial term for whelk and similar organisms. In this report, conch refers to member of the Strombidae family. Common members of the family fished off the Atlantic coast include knobbed (*Busycon carica*), channeled (*Busycon canaliculatum*), and lightning whelk (*Busycon contrarium*).

⁷ Eel fishermen tend pots during the warmer months using approximately 3,000-6,000 female horseshoe crabs for bait over the harvesting season. The primary conch-harvesting season runs from March until late June. A female horseshoe crab can be used to bait three to four conch pots. Male horseshoe crabs are smaller, and are half as effective in baiting conch pots as female horseshoe crabs. For more information on the use of horseshoe crab as bait in these fisheries, see Manion, M., R. West, and R. Unsworth, Industrial Economics, Incorporated, *Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery*, Prepared for Division of Economics, U.S. Fish and Wildlife Service, April 7, 2000.

⁸ Atlantic States Marine Fisheries Commission, *Interstate Fishery Management Plan for Horseshoe Crab Fishery*, December 1998.

⁹ Atlantic States Marine Fisheries Commission, *Interstate Fishery Management Plan for Horseshoe Crab Fishery*, December 1998.

Management Board implemented state-by-state horseshoe crab landing quotas, while under Addendum III the Board further restricted harvest in New Jersey, Delaware, and Maryland. Most recently, Addendum IV imposed additional limits on the horseshoe crab fisheries for a period of two years (from October 1, 2006 to September 30, 2008), including:

- Prohibiting directed harvest and landing of all horseshoe crabs in New Jersey, Delaware, and Maryland from January 1 through June 7.
- Prohibiting landing of female horseshoe crabs in New Jersey and Delaware from June 8 through December 31.
- Limiting New Jersey and Delaware's harvest to 100,000 horseshoe crabs per state per year.
- Prohibiting the landing of horseshoe crabs in Virginia from federal waters from January 1 through June 7.
- Mandating that no more than 40% of Virginia's annual quota may be harvested east of the COLREGS line.
- Mandating that horseshoe crabs harvested east of the COLREGS line and landed in Virginia must be comprised of a minimum male to female ration of 2:1.¹⁰

In addition to Addendum IV, New Jersey and Delaware initiated statewide moratoriums on horseshoe crab fishing, although the Delaware moratorium was overturned by court decision.¹¹

In an effort to evaluate the potential economic impacts of Addendum IV, the Atlantic State Marine Fisheries Commission (ASMFC) contracted Industrial Economics, Incorporated (IEc) to conduct an economic assessment of the horseshoe crab and dependent fisheries, including American eel and conch, for the states most likely affected by the Addendum IV management measures: Delaware, Maryland, New Jersey, New York, and Virginia. Specifically, ASMFC requested that IEc employ trip-based data to characterize the following for each fishery and state:

- Total and average (per harvester) landings and ex-vessel revenue for the most recent five years for which data is available;
- Key harvest periods for each species; and
- The relative importance of the three species compared to the total fishing effort of the harvesters.

¹⁰ Atlantic States Marine Fisheries Commission, *Addendum IV to Interstate Fishery Management Plan for Horseshoe Crab*, June 2006.

¹¹ Peter Himchak, Personal Communication, New Jersey Department of Environmental Protection, Division of Wildlife, January 2008.

In addition, ASMFC requested that IEc perform a regional economic assessment of the horseshoe crab fishery using IMPLAN, an input/output model designed to assess the level of regional economic activity that supports horseshoe crab fishing (i.e., the economic effects associated with activities that lie “upstream” from fishing, such as the purchasing of fishing gear).

We worked with Atlantic Coastal Cooperative Statistics Program (ACCSP) and the state fishery managers to obtain trip ticket and dealer data for Delaware, Maryland, New Jersey, New York, and Virginia from 2000 to 2006. Unfortunately, the data are subject to much uncertainty and potential reporting gaps that may lead to underestimating the level of activity for these fisheries.¹² In addition, given that Addendum IV provisions took effect on October 1, 2006, these data will not likely reveal the impacts of the Addendum on the horseshoe crab and dependent fisheries. Ideally, to assess the economic impacts of Addendum IV, we would evaluate activity data for at least a full year under the new requirements; however, these data are not yet available.

To support this effort, we also contacted harvesters and processors to better understand each fishery and to gain insight on potential impacts of Addendum IV on their operations.

Because of the uncertainty surrounding the data, this report presents an economic analysis of the horseshoe crab and dependent fisheries from three perspectives: 1) using best available landings and ex-vessel revenue information; 2) applying a regional impact analysis model that presents upstream impacts on the economy; and 3) presenting economic information provided by fish processors and fishermen.

ORGANIZATION OF THE REPORT

This report is organized by the following sections:

- Summary of fishery-specific data provided by the ACCSP. The data include fishing activity information obtained from the National Marine Fisheries Service, ACCSP’s SAFIS dealer reports, and state-collected datasets.
- Results based upon the three data sources. These estimates reflect fishery activity reported to the datasets.
- Next, we discuss potential impacts of Addendum IV based on qualitative discussions with fishermen, processors, and state fisheries managers.
- Finally, we present potential regional impacts of the horseshoe crab dependent fisheries through two analyses:

¹² Given the incomplete nature of the trip-level data due to various levels of underreporting at the state and federal level, it was our original intent to devise a methodology to extrapolate these data out to a wider estimate of fishery revenues and landings using the professional judgment of state fisheries managers and/or fishermen and processors. Unfortunately, because of the uncertain nature of the data gaps, these sources were unable to provide estimates from which we could base extrapolations.

- We employ a regional impact analysis model (IMPLAN) to identify the impact of fishing activity on related industries (e.g., gear suppliers); and
- We provide scoping level industry analyses of the American eel and conch processing and distribution based on information provided by processors.¹³

¹³ In this report, the term “processor” includes entities that process, pack, and/or distribute horseshoe crab, American eel or conch.

SECTION 2: DATA SOURCES

The key component to estimating the potential economic impacts of the management actions implemented under Addendum IV is availability of reliable data for the affected fisheries. Currently, states collect varying amounts of fishery-related information. Some states require the mandatory reporting of activity by fishermen and/or dealers for all fisheries, while others may not. In addition, mandatory requirements vary by fishery within each state. For example, Virginia requires harvesters to report landings for all fisheries. New Jersey has only recently (2007) enacted mandatory reporting for the eel fishery, but does not require reporting for the conch fishery. In addition, some states require mandatory dealer reporting (e.g., Maryland), while other do not require dealers to report their purchases (e.g., Delaware). Given the patchwork nature of state and federal data collection efforts, accessing reliable data on horseshoe crab and dependent fisheries is challenging. This section summarizes IEC's data collection efforts and describes the data sources used for the economic assessment, along with their limitations.

PRIMARY DATA SOURCES

For our primary data collection effort, IEC obtained several data sets from the ACCSP, a state-federal partnership program that aims to integrate fisheries data from the Atlantic states into a single management system.¹⁴ ACCSP provided three separate data sets for use in this assessment.

- **National Marine Fisheries Service (NMFS) consolidated data set:** NMFS compiles all available data on landings and ex-vessel revenue from state and federal sources, including fishermen reports and dealer-based data. NMFS consolidates these data and removes duplicate entries to create a unified set. NMFS provides these data to ACCSP in the form of a monthly roll up by fishery and year. These data provide the best current estimate of removals from the ocean available to ACCSP.¹⁵ We use this information to develop the raw estimates of ex-vessel revenue presented in Section 3.
- **Virginia and Maryland fishermen report data:** Virginia and Maryland require mandatory trip-based reporting for all fishing trips. ACCSP acquired these data directly from Virginia Marine Resources Commission (VMRC) and the Maryland Department of Natural Resources (MDNR). Virginia and Maryland require all

¹⁴ For more information on ACCSP, see <http://www.accsp.org>.

¹⁵ Geoffrey White, ACCSP, Personal Communication, November 29, 2007.

licensed commercial harvesters to submit reports of daily catch on a monthly basis. In addition, all licensed Maryland Horseshoe crab fishermen must record daily landings on a state issued permit card, which is returned to MDNR at the end of the fishing season. We employ these data to estimate, for those fishermen who fish horseshoe crab, American eel, and conch, the percentage of effort/revenue attributed to these species with respect to their total fishing effort (i.e., compared to the revenue generated from fishing “other” non-horseshoe crab dependent species).

- **Standard Atlantic Fisheries Information System (SAFIS):** SAFIS is a real-time, web-based dealer reporting system for commercial landings on the Atlantic coast. Still a work in progress, ACCSP is working with states to implement this system. We employ SAFIS data to develop price estimates in cases where estimates from fishermen were not available (e.g., determining the price of “other” species caught by fishermen participating in the horseshoe crab dependent fisheries).

LIMITATIONS OF PRIMARY DATA SETS

The primary data sets described above represent the best available data from state and federal sources; however, significant limitations in data may reduce their explanatory value, including:

- **Reporting requirements vary from state to state.** The variation in reporting requirements likely leads to significant underreporting of landings and revenues for some states. Until recently, many states have focused on tracking landings and revenue through harvester-based reporting. Exhibit 1 presents the reporting requirements for both fishermen and dealers for each state based on discussions with state fishery managers.

EXHIBIT 1 STATE REPORTING REQUIREMENTS FOR HORSESHOE CRAB, AMERICAN EEL,
AND CONCH FISHERIES IN THE MID-ATLANTIC

STATE	FISHERY	MANDATORY FISHERMEN REPORTING (DATE INITIATED)	MANDATORY DEALER REPORTING (DATE INITIATED)
New York	Horseshoe Crab	✓ (2001)	No mandatory reporting
	American Eel	✓ (2003) ^a	✓ (2003) ^a
	Conch	No mandatory reporting	No mandatory reporting
New Jersey	Horseshoe Crab	✓ (1993)	No mandatory reporting
	American Eel	✓ (2007)	No mandatory reporting
	Conch	No mandatory reporting	No mandatory reporting
Delaware	Horseshoe Crab	✓ (2000)	No mandatory reporting
	American Eel	✓ (1999)	No mandatory reporting
	Conch	✓ (1993)	No mandatory reporting
Maryland	Horseshoe Crab	✓ (1980s)	✓ (2004)
	American Eel	✓ (1980s)	✓ (2004)
	Conch	✓ (1980s)	✓ (2004)
Virginia	Horseshoe Crab	✓ (1993)	✓ (2007)
	American Eel	✓ (1993)	No mandatory reporting
	Conch	✓ (1993)	✓ (2007)
Source: State Fisheries Administrators.			
^a As required by the New York food fish license.			

Discussions with state fisheries managers, fishermen, and processors suggest that harvester-based reports may not provide the most comprehensive data coverage because of difficulties inherent in enforcement. Dealer-based reporting, which has recently been mandated in Maryland for all fisheries and in Virginia for horseshoe crab and conch, likely results in more comprehensive data collection, because it is easier for states to enforce reporting rules across relatively few dealers. Note that neither New Jersey nor Delaware require mandatory dealer reporting for the horseshoe crab and dependent fisheries.¹⁶

- **The level of underreporting due to noncompliance or illegal harvest present in the NMFS consolidated data set is unclear.** Because the NMFS consolidated dataset is derived from a variety of federal and state sources, it is not possible to

¹⁶ In addition, NOAA Fisheries Northeast Region launched SAFIS for federally permitted seafood dealers in May 2004. All federally permitted dealers are required to report to this database.

uncover individual state data gaps. This makes the process of extrapolating revenues for the total fishery extremely difficult.

- **The NMFS consolidated information covers the years 2000 through 2006.** Given that Addendum IV provisions took effect on October 1, 2006, these data will not reveal the impacts of the Addendum on the horseshoe crab and dependent fisheries. Ideally, to assess the economic impacts of Addendum IV, we would evaluate at least an entire year's worth of data under new requirements; however these data are not yet available.
- **The availability of SAFIS dealer information varies by state and year.** ACCSP is currently working to bring new states into the database. However, NOAA Fisheries Northeast Region launched SAFIS for federally permitted seafood dealers in May 2004. Thus, SAFIS likely contains more comprehensive federal information in comparison to state data.
- **The Virginia and Maryland fishermen report data is limited to only those that hold state permits.** Vessels that hold only federal permits are excluded from the analysis of broader fishing effort. In addition, the Maryland data were only available through 2004.

SUPPLEMENTAL DATA SOURCES

To supplement the primary data sources, we also examined *2007 Review of The Fishery Management Plan in 2006 for Horseshoe Crab*, which was prepared by the ASMFC Horseshoe Crab Plan Review Team. This document provides estimates of commercial horseshoe crab landings from 1998 to 2004 (and preliminary estimates for 2005 and 2006).¹⁷ Appendix A provides the estimates of the number of individuals harvested as presented in the *2007 Review*.

We also contacted stakeholders in the horseshoe crab and dependent fishing, including:

- **State Fisheries Administrators:** IEC contacted the relevant state fishery administrative commissioners for information on state reporting requirements, number of state permitted fishermen, and additional information regarding the fisheries. We also asked the state fishery managers to estimate the level of underreporting prevalent in each fishery, but this proved to be a difficult task.
- **Fish Processors:** IEC contacted fish processors to gain a better understanding of the relationship between processors and suppliers (fishermen), processor revenues, and the impact of Addendum IV on typical business practices.

¹⁷ Note that the *Review* document presents horseshoe crab landings in terms individuals, which is consistent with the Interstate Fishery Management Plan. However, the NMFS consolidated data set presents catch in terms of weight (pounds). States may use different conversion factors to convert from number of individuals to pounds of horseshoe crab.

- **Fishermen:** IEc conducted phone interviews with fishermen recommended by ASMFC committees, processors, and state fisheries managers to provide information on:
 - Current fishery operations in each state and the extent to which the Addendum IV management actions may have affected these operations;
 - The use and relative importance of horseshoe crabs as bait for the conch and eel fisheries;
 - Currently available bait substitutes and corresponding effectiveness for the dependent fisheries; and
 - The extent to which federal and state data fully capture the activity and ex-vessel value for each fishery.

SECTION 3: RAW RESULTS BASED ON FISHERY DATABASES

In this section, we present the preliminary results of the economic analysis of the horseshoe crab, American eel, and conch fisheries. Landings and ex-vessel revenues presented in this section reflect the data provided by ACCSP, specifically the NMFS consolidated data set. To estimate reported ex-vessel revenue, we summarized the information into annual and monthly data sets by fishery and state. All reported ex-vessel revenues have been adjusted for inflation.¹⁸

ESTIMATES OF TOTAL REPORTED LANDINGS AND EX-VESSEL REVENUE

Based solely on the information available in the NMFS consolidated data set, the horseshoe crab, American eel, and conch fisheries reported total landings of approximately 3.5 million pounds corresponding to ex-vessel revenues of \$4.2 million dollars for 2006. Exhibits 2 and 3 present total reported landings and ex-vessel revenues, respectively, for the three fisheries from 2000 through 2006. Over this period, reported landings fluctuated, but rise to a peak in 2003 at 10.0 million pounds, and then, declined to 3.5 million pounds by 2006. All states reported declines in total landings from 2005 to 2006. Over this same period, reported ex vessel revenues were highest at \$5.3 million in 2003 and lowest at approximately \$3.0 million in 2004. In general, the fluctuations in reported revenue are mirrored at the state level, although New York has seen a steady increase in reported ex-vessel revenue over time.¹⁹

¹⁸ Unless specified, dollar figures in the report have been inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

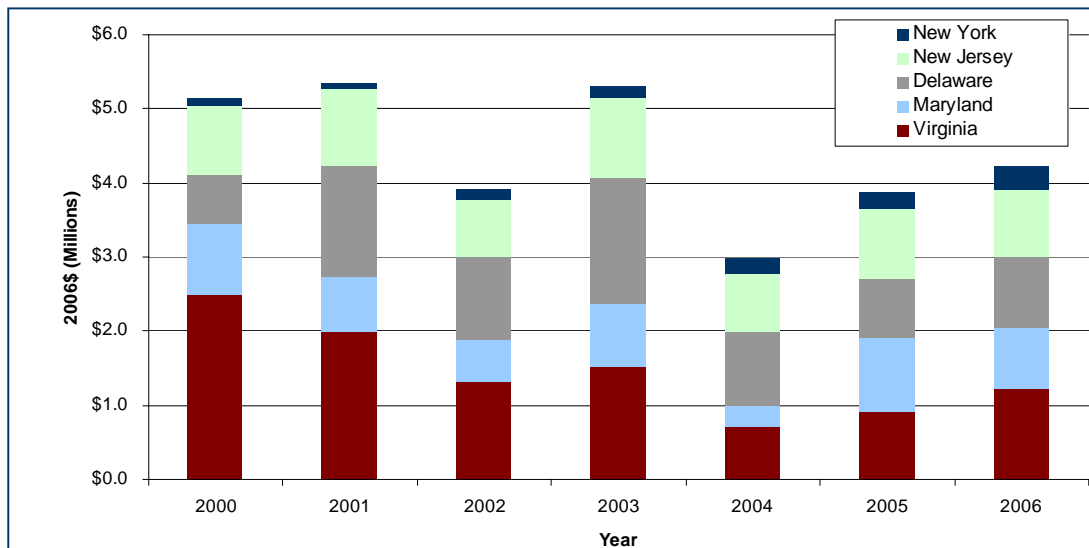
¹⁹ It is important to note that in this document, we report ex-vessel revenues for the entire horseshoe crab, American eel, and conch fisheries as reported to federal and state databases. Given uncertainties in the data, we do not separate out landings/revenues of eel or conch achieved without the use of horseshoe crab as bait (e.g., conch dredging). Because of its rolled up nature, it was difficult to identify how fishermen typically operate from the information available in the NMFS consolidated dataset. This approach allows ASFMC to evaluate quality of data in the NMFS consolidated dataset without manipulation.

EXHIBIT 2 TOTAL REPORTED LANDINGS FOR THE HORSESHOE CRAB, AMERICAN EEL, AND CONCH FISHERIES 2000 THROUGH 2006 (POUNDS)

STATE	2000	2001	2002	2003	2004	2005	2006
New York	170,420	164,157	288,684	354,980	277,057	453,379	441,924
New Jersey	1,813,228	1,667,966	1,573,947	1,831,538	1,227,925	1,148,999	785,437
Delaware	1,663,891	3,686,659	3,071,949	3,759,798	2,046,510	1,430,551	1,106,030
Maryland	1,326,661	1,305,714	1,225,165	1,498,157	506,228	958,299	742,538
Virginia	3,239,385	2,765,113	1,871,366	2,553,038	1,399,611	1,546,720	402,085
Total	8,213,584	9,589,610	8,031,111	9,997,511	5,457,331	5,537,948	3,478,013

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

EXHIBIT 3 TOTAL REPORTED EX-VESSEL REVENUE FOR THE HORSESHOE CRAB, AMERICAN EEL, AND CONCH FISHERIES 2000 THROUGH 2006^a



STATE	2000	2001	2002	2003	2004	2005	2006
New York	\$91,910	\$81,691	\$145,500	\$157,171	\$211,266	\$220,653	\$339,954
New Jersey	\$941,249	\$1,024,488	\$770,711	\$1,075,935	\$781,864	\$938,503	\$916,245
Delaware	\$664,142	\$1,506,159	\$1,117,860	\$1,701,293	\$996,115	\$794,502	\$951,273
Maryland	\$961,273	\$736,962	\$564,811	\$847,531	\$292,103	\$997,621	\$826,805
Virginia	\$2,484,919	\$1,993,554	\$1,317,156	\$1,521,724	\$699,409	\$917,292	\$1,212,061
Total	\$5,143,493	\$5,342,855	\$3,916,038	\$5,303,654	\$2,980,758	\$3,868,570	\$4,246,338

^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

ESTIMATES OF REPORTED EX-VESSEL REVENUE BY FISHERY AND STATE

The section presents the results of the preliminary economic assessment for each fishery and state. We provide estimates of the following information:

- The number of active licensed fishermen permitted by the states to participate in the fishery from 2000 through 2007.²⁰
- Total landings and ex-vessel revenue for each fishery and the average revenues per participant in each fishery from 2000 to 2006, as reported in the NMFS consolidated data set; and
- Seasonal variation in ex-vessel revenues, as reported in the NMFS consolidated data.

HORSESHOE CRAB FISHERY

Exhibit 4 presents the number of active participants in the horseshoe crab fishery by state from 2000 through 2007. In general, the number of active horseshoe crab harvesters has declined since 2000.²¹ New Jersey reports that the number of horseshoe crab licenses issued was stable from 2000 to 2006, although several harvesters chose not to renew their licenses in 2007 because of the state moratorium on horseshoe crab fishing.

EXHIBIT 4 ESTIMATED NUMBER OF ACTIVE STATE HORSESHOE CRAB HARVESTERS 2000 THROUGH 2007

STATE	2000	2001	2002	2003	2004	2005	2006	2007
New York ^{a,b}	n/a	322	330	311	306	329	337	348
New Jersey ^a	34	34	34	34	34	34	34	n/a
Delaware Hand/Shore Permits ^c	55	53	42	54	19	26	15	18
Delaware Dredge Permits	5	5	5	5	5	5	4	3
Maryland ^a	11	13	10	11	7	6	8	5
Virginia	17	32	39	47	36	36	42	36

^a Reflects the number of state licenses issued.
^b Includes only resident licenses. New York issued between 10 and 13 non-resident horseshoe crab licenses per year between 2001 and 2007.
^c The number of active participants may exceed the number of horseshoe crab licenses issued. Delaware permits commercial eel fishermen to collect crabs from shore for personal use without a horseshoe crab shore collect license.

n/a = not available

Source: State Fishery Administrators.

²⁰ IEc requested state permit information from the State Fisheries Administrators.

²¹ Only New York reports a rise in the number of permits issued; however, the New York State Department of Conservation did not provide estimates of the number of permitted harvesters actively participating in the horseshoe crab fishery.

Reported Horseshoe Crab Landings and Ex-vessel Revenue

Exhibits 5 and 6 presents horseshoe crab landings and ex-vessel revenue, respectively, as reported in the NMFS consolidated data set from 2000 through 2006 by state.²² Reported horseshoe crab landings have declined from a high of approximately 3.3 million pounds in 2000 to a low of approximately 1 million pounds in 2006. New Jersey reported a substantial decline in landings (97 percent) from 2005 to 2006, which may indicate impacts of the Addendum IV and State moratoriums. Virginia reported 76 percent decline in horseshoe crab landings from 2005 to 2006. Conversely, New York reported moderate increase in horseshoe crab landings during the same time period. The total reported ex-vessel revenue for the horseshoe crab fishery in 2006 was approximately \$471,000. This level is down from a high of approximately \$895,000 in 2000. New Jersey shows a significant decline (97 percent) in reported ex-vessel revenue from 2005 to 2006. Other states also show declines in ex-vessel revenues in 2006. Maryland reports a decline of 70 percent to approximately \$67,000 from its peak in 2001 of approximately \$271,000; Delaware reports a decline of 76 percent to approximately \$75,000 from its peak in 2000 of approximately \$309,000. Virginia and New York show modest increases in reported ex-vessel revenue from 2000 to 2006.

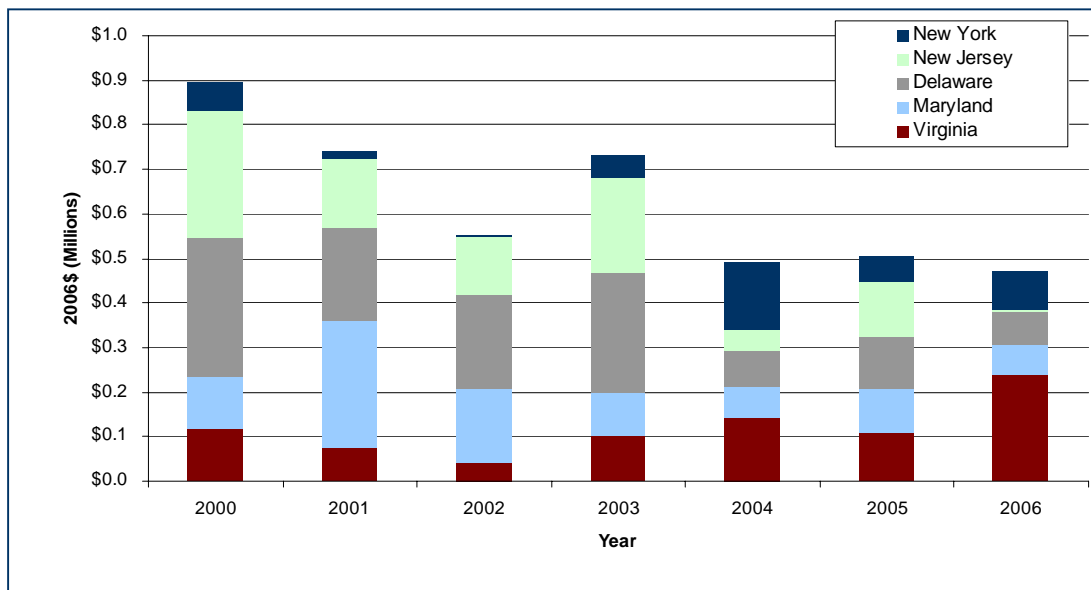
EXHIBIT 5 HORSESHOE CRAB LANDINGS (POUNDS) 2000 THROUGH 2006

STATE	2000	2001	2002	2003	2004	2005	2006
New York	74,716	14,920	5,832	138,831	145,080	160,626	173,345
New Jersey	1,098,980	725,942	691,572	367,553	123,269	330,714	9,141
Delaware	1,339,590	965,207	1,130,190	1,316,536	366,715	457,614	348,656
Maryland	426,957	425,700	692,992	425,477	369,917	431,129	387,270
Virginia	400,233	145,428	101,014	257,609	487,482	451,656	105,953
Total	3,340,476	2,277,197	2,621,600	2,506,006	1,492,463	1,831,739	1,024,365

Source: NMFS Consolidated Data Set courtesy of ACCSP.

²² Based on a comparison with estimated landings found in the *2007 Review* (See Appendix A), the reported revenues and landings available in the NMFS consolidated data set likely reveal underreporting. For example, the NMFS consolidated data estimates landings approximately 106,000 pounds in 2006 for Virginia, which at two pounds per crab (a conversion used by Virginia MRC), yields approximately 53,000 individuals; however, preliminary information from the *2007 Review* estimates Virginia landings in 2006 at approximately 156,000 individuals.

EXHIBIT 6 TOTAL REPORTED EX-VESSEL REVENUE FOR THE HORSESHOE CRAB FISHERY
2000 THROUGH 2006^a



STATE	2000	2001	2002	2003	2004	2005	2006
New York	\$63,613	\$16,231	\$2,013	\$50,850	\$153,284	\$60,071	\$87,796
New Jersey	\$287,008	\$153,451	\$130,296	\$212,097	\$46,673	\$124,595	\$3,474
Delaware	\$308,806	\$207,753	\$209,225	\$267,674	\$82,479	\$112,507	\$74,824
Maryland	\$118,842	\$286,774	\$167,890	\$98,248	\$68,863	\$102,253	\$66,910
Virginia	\$116,412	\$74,873	\$41,085	\$101,673	\$141,871	\$106,932	\$237,931
Total	\$894,681	\$739,082	\$550,509	\$730,543	\$493,171	\$506,358	\$470,935

^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

Exhibit 7 presents average reported ex-vessel revenue per participant in the horseshoe crab fishery by state for 2000 through 2006. To develop these estimates, for each state we divide ex-vessel revenues from Exhibit 6 by the number of active participants in the fishery as presented in Exhibit 4.²³ The overall average reported ex-vessel revenue in 2006 was approximately \$4,800 per harvester, which represents a decline in revenue of nearly 38 percent since 2000. New Jersey horseshoe crab harvesters underwent the largest decline from nearly \$8,500 per fishermen in 2000 to just approximately \$100 per harvester in 2006, with the significant drop in average ex-vessel revenue coming from 2005 to 2006, which may indicate impacts of the Addendum IV and state moratoriums. State fishermen in

²³ Since we were unable ascertain the number of active participants in the New York horseshoe crab fishery, we omit New York from this analysis.

Delaware, Maryland, and Virginia also showed declines in average revenue over the time period, although not to the extent of the harvesters in New Jersey.

EXHIBIT 7 AVERAGE REPORTED EX-VESSEL REVENUE PER ACTIVE PARTICIPANT IN THE HORSESHOE CRAB FISHERY 2000 THROUGH 2006^a

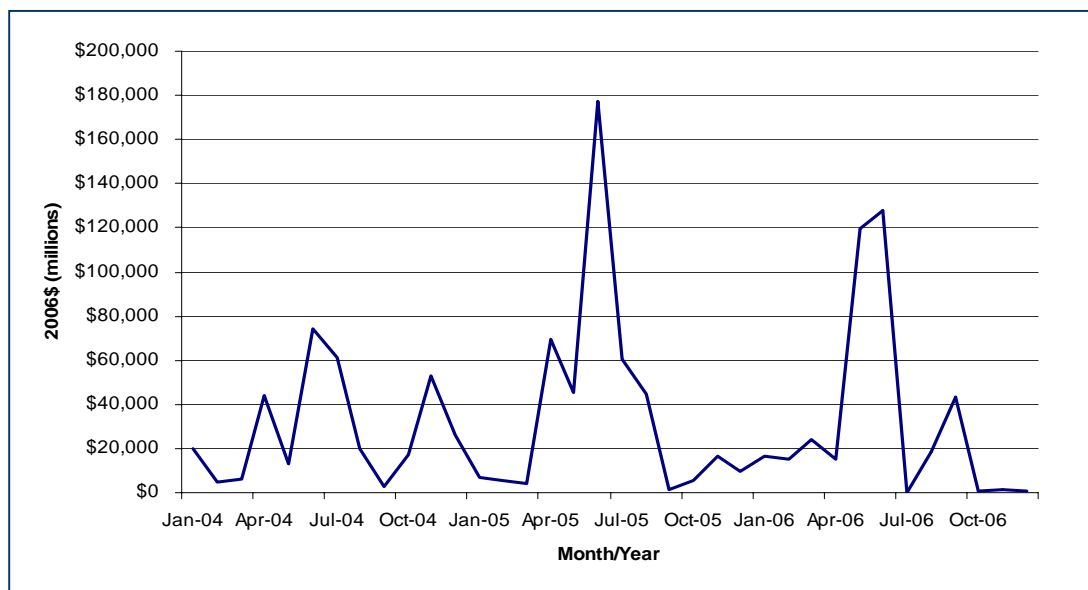
STATE	2000	2001	2002	2003	2004	2005	2006
New Jersey	\$8,441	\$4,513	\$3,832	\$6,238	\$1,373	\$3,665	\$102
Delaware ^b	\$5,615	\$3,920	\$4,982	\$4,957	\$4,341	\$4,327	\$4,988
Maryland	\$10,804	\$22,060	\$16,789	\$8,932	\$9,838	\$17,042	\$8,364
Virginia	\$6,848	\$2,340	\$1,053	\$2,163	\$3,941	\$2,970	\$5,665
Average Per Harvester	\$7,647	\$5,599	\$4,404	\$5,004	\$5,137	\$4,964	\$4,757
^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.							
^b Discussions with fishermen indicate that Delaware horseshoe crab harvesters that hold dredge permits also hold hand/shore permits. We employ only the number of hand/shore permits to prevent double counting.							
Source: IEC analysis of NMFS consolidated data set courtesy of ACCSP and State Fishery Administrators.							

Seasonal Variation in Ex-vessel Revenue

Addendum IV prohibits landing of female horseshoe crabs in New Jersey and Delaware from June 8 through December 31, and prohibits directed harvest in New Jersey, Delaware, and Maryland from January 1 through June 7. In addition, Addendum IV prohibits the landing of horseshoe crabs in Virginia from federal waters from January 1 through June 7. Exhibit 8 shows horseshoe crab ex-vessel revenue by month from 2004 to 2006, as reported in the NMFS consolidated data set. June was the highest month for reported ex-vessel revenue across all three years. Within each year, monthly revenues declined, as the weather turned colder in the fall and winter. Compared to previous years, total reported ex-vessel revenue from October through December 2006 declined significantly, which may reflect the effective date of Addendum IV (October 1, 2006).²⁴

²⁴ Note that the NMFS consolidated data set contains \$87,611 in ex-vessel revenues that are not assigned to a particular month for New York in 2006. We omit these data from this analysis.

EXHIBIT 8 REPORTED HORSESHOE CRAB EX-VESSEL REVENUE BY MONTH FROM 2004 TO 2006



Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

Exhibit 9 presents a monthly snapshot of reported horseshoe crab ex-vessel revenue by state in 2006. The grey boxes represent the peak in reported ex-vessel revenue for each state. Virginia vessels reported the highest ex-vessel revenue of approximately \$116,000 in June. In addition, New Jersey only reported ex-vessel revenues during April, which is likely the result of the passage of the statewide moratorium on horseshoe crab harvest, which went into effect on May 15, 2006. Note that only Virginia vessels reported ex-vessel revenue after the effective date of Addendum IV.

EXHIBIT 9 2006 REPORTED HORSESHOE CRAB EX-VESSEL REVENUE BY MONTH

STATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
New York ^a	n/a	n/a	n/a	\$119	\$59	n/a	\$7	n/a	n/a	n/a	n/a	n/a
New Jersey	n/a	n/a	n/a	\$3,474	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Delaware	\$1,244	\$7,571	\$18,486	\$1,260	\$35,745	\$10,518	n/a	n/a	n/a	n/a	n/a	n/a
Maryland	n/a	\$1,384	n/a	\$2,584	\$13	\$1,547	\$197	\$18,282	\$42,903	n/a	n/a	n/a
Virginia	\$15,304	\$6,172	\$5,831	\$7,561	\$84,110	\$115,678	\$40	n/a	\$485	\$422	\$1,436	\$892
Total	\$16,548	\$15,127	\$24,317	\$14,998	\$119,927	\$127,743	\$244	\$18,282	\$43,388	\$422	\$1,436	\$892

^a The NMFS consolidated data set contains \$87,611 in ex-vessel revenues that are not assigned to a particular month for New York in 2006. We omit these data from this exhibit.

n/a = no data reported for this month

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

AMERICAN EEL FISHERY

Exhibit 10 presents the number of active participants in the American eel fishery by state from 2000 through 2007. In general, the number of active American eel harvesters has declined since 2000. Virginia and Maryland show significant declines in the number of harvesters from 2006 to 2007, which may reflect the impact of more stringent management measures under Addendum IV. New Jersey shows an increase in the estimated number of harvesters participating in the American eel fishery.

EXHIBIT 10 ESTIMATED NUMBER OF ACTIVE STATE AMERICAN EEL HARVESTERS 2000 THROUGH 2007^a

STATE	2000	2001	2002	2003	2004	2005	2006	2007
New Jersey ^b	45	41	45	45	48	50	51	58
Delaware	42	33	27	32	32	24	27	25
Maryland ^c	70	60	59	55	53	55	68	49
Virginia	95	73	61	76	66	65	66	46

^a In New York, American eel fall under the general food fish license. Based on information provided by the New York Department of Conservation, we unable to determine the number of eel harvesters in New York.

^b In New Jersey, American eel fall under the Miniature Fyke permit. The number of fishermen in New Jersey who specifically target American eel under this permit is unclear; however the New Jersey Department of Environmental Protection, Division of Wildlife, based on new reporting requirements, estimates that approximately 29 percent of fishermen holding Miniature Fyke permits actively fish for American eel. The estimates in this table reflect the full number of Miniature Fyke licensed multiplied by 0.29.

^c Reflects the number of state licenses issued.

Source: State Fishery Administrators. Peter Himchak, Personal Communication, New Jersey Department of Environmental Protection, Division of Wildlife, January 2008.

Reported American Eel Landings and Ex-vessel Revenue

Exhibits 11 and 12 present American eel landings and ex-vessel revenue, respectively, as reported in the NMFS consolidated data set from 2000 through 2006.²⁵ Reported American eel landings have fluctuated from a high of approximately 820,000 pounds in 2003 to a low of approximately 530,000 pounds in 2004. In 2006, the states reported total American eel landings of approximately 710,000 pounds. Maryland, Delaware, and New Jersey reported moderate increases in American eel landings from 2005 to 2006. Only Virginia reported a substantial decline in American eel landings (approximately 25 percent) during this time period.

²⁵ Based on discussions with eel processors, the reported revenues and landings available in the NMFS consolidated data set likely reveal underreporting in the American eel fishery. For example, New York ex-vessel revenues appear extremely low. A New York-based processor reported annual purchases and sales of approximately 264,000 pounds of eel. It is likely that a substantial portion of these New York-based purchases is not accounted for in these estimates. In addition, the degree to which underreporting is prevalent across the states is unclear.

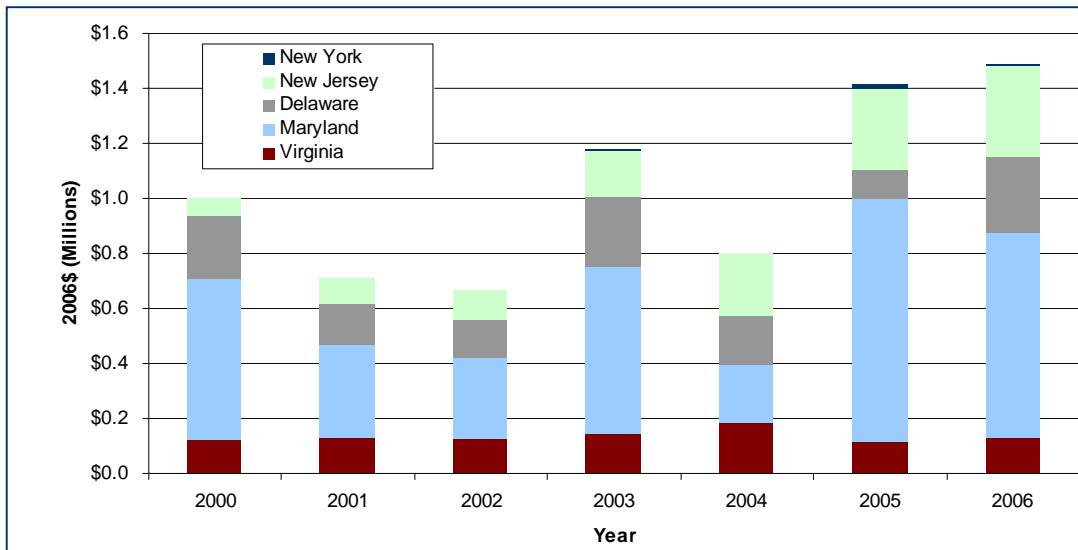
The total reported ex-vessel revenue for the American eel fishery in 2006 was approximately \$1.5 million, up from approximately \$1.0 million in 2000. In general, reported ex-vessel revenue varied between a low of approximately \$664,000 in 2002 to its high in 2006. For most years, Maryland vessels were responsible for a high percentage of reported American eel ex-vessel revenue, with approximately 50 percent in 2006. Only minimal ex-vessel revenues were reported for New York vessels during this time period.

EXHIBIT 11 AMERICAN EEL LANDINGS (POUNDS) 2000 THROUGH 2006

STATE	2000	2001	2002	2003	2004	2005	2006
New York	1,108	15	161	393	2,988	8,493	3,927
New Jersey	45,393	57,700	64,600	100,701	120,129	148,118	158,917
Delaware	119,180	120,634	89,803	155,515	137,484	107,167	120,462
Maryland	399,794	415,938	292,396	436,563	126,482	456,900	342,450
Virginia	150,926	136,466	103,087	124,800	141,126	71,604	81,879
Total	716,401	730,753	550,047	817,972	528,209	792,282	707,635

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

EXHIBIT 12 TOTAL REPORTED EX-VESSEL REVENUE FOR THE AMERICAN EEL FISHERY 2000 THROUGH 2006



STATE	2000	2001	2002	2003	2004	2005	2006
New York	\$3,103	\$34	\$262	\$1,432	\$1,795	\$14,287	\$3,368
New Jersey	\$65,720	\$92,435	\$108,112	\$168,873	\$225,281	\$301,900	\$333,843
Delaware	\$223,374	\$143,357	\$132,040	\$251,636	\$178,318	\$102,129	\$275,150
Maryland	\$584,746	\$341,396	\$296,480	\$605,618	\$209,702	\$882,185	\$744,861
Virginia	\$124,533	\$129,866	\$127,025	\$148,384	\$185,664	\$116,070	\$129,084
Total	\$1,001,476	\$707,088	\$663,918	\$1,175,944	\$800,760	\$1,416,572	\$1,486,306

^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

Exhibit 13 presents average ex-vessel revenue per participant in the American eel fishery by state for 2000 through 2006.²⁶ To develop these estimates, for each state we divide ex-vessel revenues from Exhibit 12 by the number of active participants in the fishery as presented in Exhibit 10. The overall average reported ex-vessel revenue in 2006 was approximately \$7,000 per harvester, which represents an increase in revenue of approximately 76 percent since 2000. Over the time period, average reported ex-vessel revenue increased for American eel harvesters in all states, with highest gain of nearly 450 found in New Jersey. In general, harvesters from Maryland and Delaware showed the highest average reported ex-vessel revenues, while Virginia American eel harvesters displayed the lowest average reported ex-vessel revenue.

EXHIBIT 13 AVERAGE REPORTED EX-VESSEL REVENUE PER ACTIVE PARTICIPANT IN THE AMERICAN EEL FISHERY 2000 THROUGH 2006^a

STATE	2000	2001	2002	2003	2004	2005	2006
New Jersey	\$1,460	\$2,255	\$2,402	\$3,753	\$4,693	\$6,038	\$6,546
Delaware	\$5,318	\$4,344	\$4,890	\$7,864	\$5,572	\$4,255	\$10,191
Maryland	\$8,354	\$5,690	\$5,025	\$11,011	\$3,957	\$16,040	\$10,954
Virginia	\$1,311	\$1,779	\$2,082	\$1,952	\$2,813	\$1,786	\$1,956
Average Per Harvester	\$3,974	\$3,416	\$3,458	\$5,654	\$4,024	\$7,302	\$7,011

^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

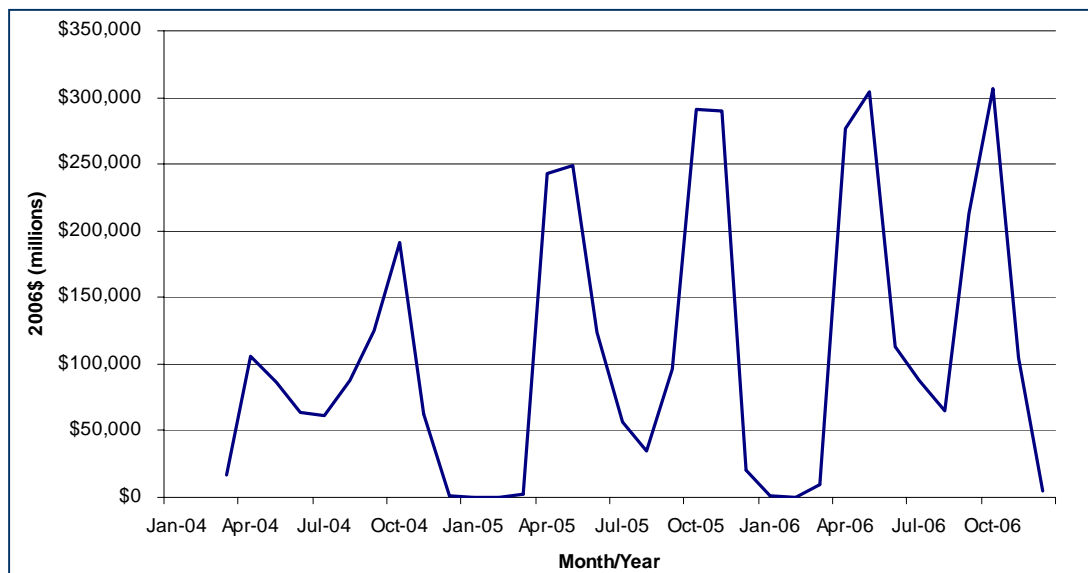
Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP and State Fishery Administrators.

²⁶ Since we were unable ascertain the number of active participants in the New York eel fishery, we omit New York from this analysis.

Seasonal Variation in Ex-vessel Revenue

Exhibit 14 shows American eel ex-vessel revenue by month from 2004 to 2006, as reported in the NMFS consolidated data set. Each year shows multiple peak harvest times, principally in October and May. Reported ex-vessel revenues were minimal during the months of January and February.²⁷

EXHIBIT 14 REPORTED AMERICAN EEL EX-VESSEL REVENUE BY MONTH FROM 2004 TO 2006



Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

Exhibit 15 presents a monthly snapshot of reported American eel ex-vessel revenue by state in 2006. The grey boxes represent the peak in reported ex-vessel revenue for each state. Since fishermen typically retain stores of bait, any economic impact of the Addendum IV moratorium on the American eel fishery would likely not appear during this time period.²⁸ New Jersey, Delaware, and Virginia fisheries reported the highest ex-vessel revenues during the month of October (note: Addendum IV was in effect at this time). Additional data from 2007 would be required to understand the dynamics of Addendum IV on the American eel fishery.

²⁷ Note that the NMFS consolidated data set contains \$8,498 in ex-vessel revenues that are not assigned to a particular month for New Jersey in 2005. We omit these data from this analysis.

²⁸ Discussions with fishermen indicate that they freeze horseshoe crabs for use as bait throughout the fishing season.

EXHIBIT 15 2006 REPORTED AMERICAN EEL EX-VESSEL REVENUE BY MONTH

STATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
New York	\$300	\$175	\$103	\$547	\$421	\$579	\$136	\$54	\$530	\$117	\$244	\$162
New Jersey ^a	\$9	n/a	n/a	\$25,904	\$53,948	\$27,270	\$15,295	\$3,774	\$80,012	\$81,535	\$44,846	\$1,250
Delaware	\$696	n/a	\$1,567	\$36,250	\$60,089	\$1,041	\$7,205	\$6,932	\$55,008	\$90,416	\$16,534	\$108
Maryland	n/a	n/a	\$3,341	\$187,333	\$178,509	\$77,036	\$61,477	\$52,877	\$51,179	\$97,708	\$34,411	\$990
Virginia	\$22	\$7	\$4,939	\$26,069	\$11,840	\$6,576	\$3,697	\$1,336	\$26,564	\$37,192	\$8,924	\$1,918
Total	\$1,027	\$182	\$9,950	\$276,103	\$304,807	\$112,502	\$87,810	\$64,973	\$213,293	\$306,968	\$104,959	\$4,428

n/a = no data reported for this month

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

CONCH FISHERY

Exhibit 16 presents the number of active participants in the conch fishery by state from 2000 through 2007. In general, the number of active conch harvesters has declined since 2000.²⁹ Virginia, Maryland, and the Delaware dredge fisheries show significant declines in the number of harvesters from 2006 to 2007, which may reflect the impact of more stringent management measures under Addendum IV.

²⁹ The New York State Department of Conservation did not provide estimates of the number of permitted harvesters actively participating in the conch fishery.

EXHIBIT 16 NUMBER OF ACTIVE STATE CONCH HARVESTERS 2000 THROUGH 2007

STATE	2000	2001	2002	2003	2004	2005	2006	2007
New York ^{a,b}	n/a	237	269	292	276	272	266	262
New Jersey ^c	132	137	129	136	125	132	125	112
Delaware Pot Fishery	25	28	28	23	17	14	17	14
Delaware Dredge Fishery	13	20	19	21	17	31	29	14
Maryland ^b	19	18	18	27	19	15	29	15
Virginia	107	139	106	103	83	80	81	49

^a Includes only resident licenses. New York issued between 12 and 16 non-resident horseshoe crab licenses per year between 2001 and 2007.

^b Reflects the number of state licenses issued.

^c In New Jersey, conch fall under the conch/lobster/fish pot permit. The number of fishermen in New Jersey who specifically target conch under this permit is unclear; however the New Jersey Department of Environmental Protection, Division of Wildlife estimates that approximately 50 percent of fishermen holding these permits actively fish for conch. The estimates in this table reflect the full number of conch/lobster/fish pot permit multiplied by 0.5.

Source: State Fishery Administrators. Peter Himchak, Personal Communication, New Jersey Department of Environmental Protection, Division of Wildlife, January 2008.

Reported Conch Landings and Ex-Vessel Revenue

Exhibit 17 and 18 present conch landings and ex-vessel revenue, respectively, as reported in the NMFS consolidated data set from 2000 through 2006 by state.³⁰ Reported landings have declined since a high of 6.7 million pounds in 2003 to a low of 1.7 million pounds in 2006. From 2005 to 2006, every state reported declines in landings. The total reported ex-vessel revenue for the conch fishery in 2006 was approximately \$2.3 million dollars, down from a high of approximately \$3.8 million in 2001; however, total reported ex-vessel revenue has trended upward since 2004. Maryland and Virginia vessels reported declines in ex-vessel revenue of approximately 94 percent and 64 percent, respectively from their peak seasons. Both New York and Delaware reported significant increases in ex-vessel revenue (nearly 900 percent and 360 percent, respectively) since 2000, while New Jersey's ex-vessel revenue remained relatively constant over the time period.

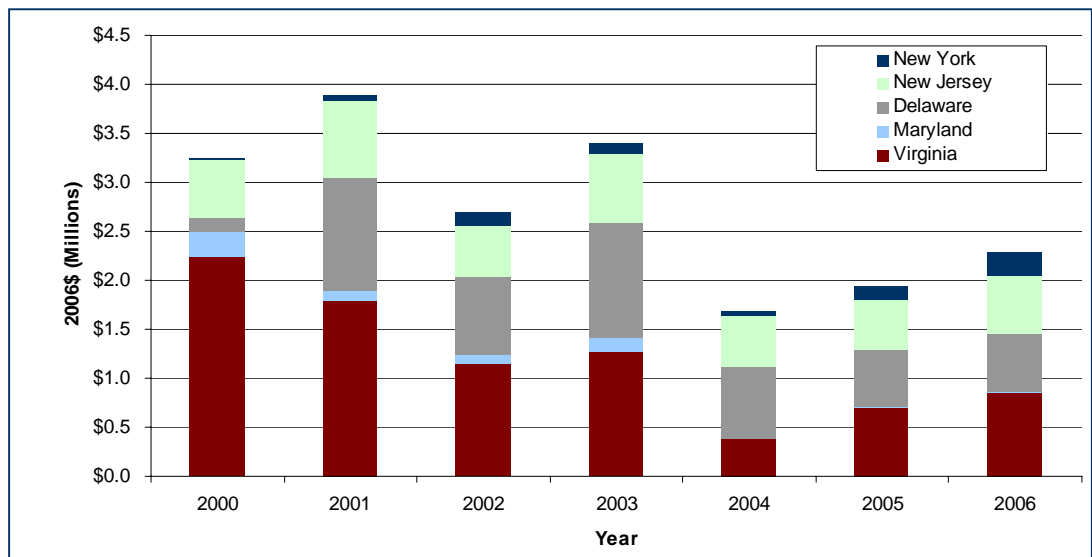
³⁰ Based on discussions with a conch processor, the reported revenues and landings available in the NMFS consolidated data set likely reveal underreporting in the conch fishery. For example, 2006 conch landings in the NMFS consolidated data set total approximately 1.7 million pounds for the Mid-Atlantic. One processor reports purchases of approximately 1.7 million pounds of conch in 2006. Given that at least six other processors are known to exist in the Mid-Atlantic, it is likely that conch landings (and ex-vessel revenue) are underreported; however, the degree to which underreporting is prevalent across the states is unclear. Processor information provided by Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, December 5, 2007.

EXHIBIT 17 CONCH LANDINGS (POUNDS) 2000 THROUGH 2006

STATE	2000	2001	2002	2003	2004	2005	2006
New York	94,584	149,221	282,678	215,731	128,989	284,259	264,652
New Jersey	668,859	884,333	817,849	1,363,312	984,527	670,167	617,379
Delaware	205,120	2,600,821	1,851,951	2,287,751	1,542,311	865,771	636,912
Maryland	499,910	464,079	239,770	636,107	9,829	70,270	12,817
Virginia	2,688,226	2,483,219	1,667,265	2,170,629	771,003	1,023,460	214,253
Total	4,156,707	6,581,660	4,859,464	6,673,533	3,436,659	2,913,927	1,746,013

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

EXHIBIT 18 TOTAL REPORTED EX-VESSEL REVENUE FOR THE CONCH FISHERY 2000 THROUGH 2006



STATE	2000	2001	2002	2003	2004	2005	2006
New York	\$25,194	\$65,426	\$143,225	\$104,889	\$56,187	\$146,295	\$248,790
New Jersey	\$588,521	\$778,602	\$532,303	\$694,965	\$509,910	\$512,008	\$578,928
Delaware	\$131,962	\$1,155,049	\$776,595	\$1,181,982	\$735,318	\$579,866	\$601,299
Maryland	\$257,685	\$108,793	\$100,441	\$143,665	\$13,538	\$13,182	\$15,034
Virginia	\$2,243,974	\$1,788,814	\$1,149,045	\$1,271,666	\$371,875	\$694,290	\$845,046
Total	\$3,247,336	\$3,896,685	\$2,701,611	\$3,397,167	\$1,686,828	\$1,945,640	\$2,289,097

^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

Exhibit 19 presents average reported ex-vessel revenue per participant in the conch fishery by state for 2000 through 2006.³¹ To develop these estimates, for each state we divide ex-vessel revenues from Exhibit 18 by the number of active participants in the fishery as presented in Exhibit 16. The overall average reported ex-vessel revenue in 2006 was approximately \$8,700 per harvester, which represents a decline in revenue of nearly 24 percent since 2000. In general, average reported ex-vessel revenues fluctuated during the time period. For example, Virginia conch harvesters reported an average of nearly \$21,000 per fishery participant in 2000, which declined to a low of nearly \$4,500 in 2004, and has since rebounded to approximately \$10,400 per vessel in 2006. Maryland harvesters experienced a marked decline from nearly \$13,600 to only approximately \$500 per harvester from 2000 to 2006.

EXHIBIT 19 AVERAGE REPORTED EX-VESSEL REVENUE PER ACTIVE PARTICIPANT IN THE CONCH FISHERY 2000 THROUGH 2006^a

STATE	2000	2001	2002	2003	2004	2005	2006
New Jersey	\$4,458	\$5,683	\$4,126	\$5,110	\$4,079	\$3,879	\$4,631
Delaware ^b	\$5,278	\$41,252	\$27,736	\$51,391	\$43,254	\$18,705	\$20,734
Maryland	\$13,562	\$6,044	\$5,580	\$5,321	\$713	\$879	\$518
Virginia	\$20,972	\$12,869	\$10,840	\$12,346	\$4,480	\$8,679	\$10,433
Average Per Harvester	\$11,475	\$12,102	\$9,614	\$11,755	\$6,913	\$7,541	\$8,671

^a Dollar amounts inflated to 2006 dollars using U.S. Department of Commerce, Bureau of Economic Analysis, Table Implicit Price Deflators for Gross Domestic Product.

^b Discussions with fishermen indicate that Delaware conch harvesters that hold dredge permits often hold conch pot permits. When we estimate average reported ex-vessel revenue, we employ whichever permit class has the most participants in a given year to prevent double counting.

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

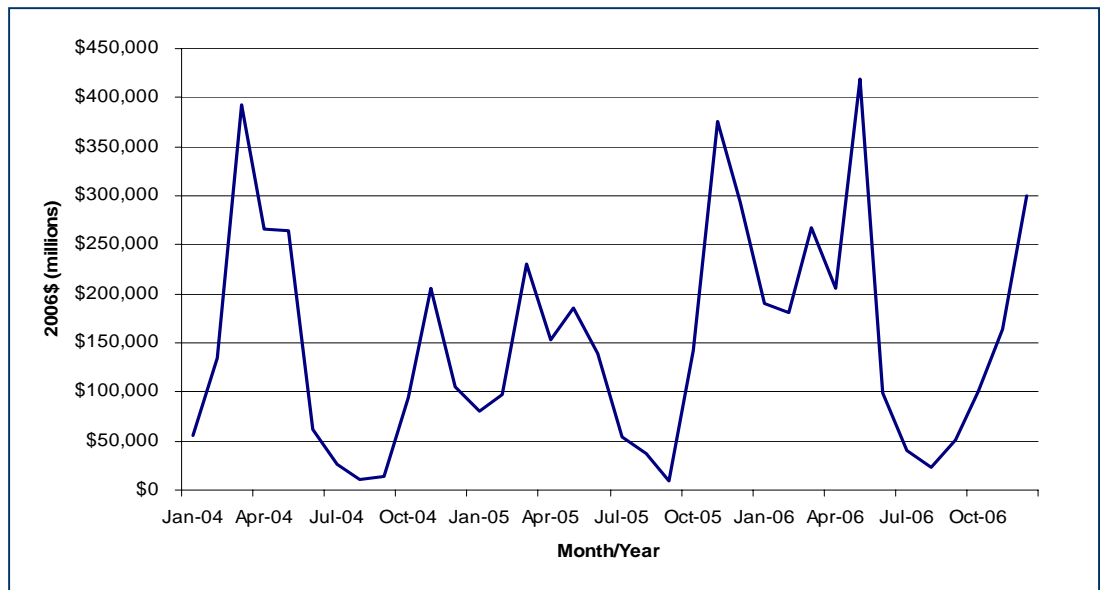
Seasonal Variation in Ex-vessel Revenue

Exhibit 20 demonstrates conch ex-vessel revenue by month from 2004 to 2006, as reported in the NMFS consolidated data set. In general, the peak harvest month for conch is May; additional months with high ex-vessel revenues include March, April, November, and December. Reported ex-vessel revenue was typically the lowest in August.³²

³¹ Since we were unable ascertain the number of active participants in the New York conch fishery, we omit New York from this analysis.

³² Note that the NMFS consolidated data set contains ex-vessel revenues for New York that were not assigned to a particular month, including \$36,275 in 2004, \$118,925 in 2005, and \$69,657 in 2006. We omit these data from this analysis.

EXHIBIT 20 REPORTED CONCH EX-VESSEL REVENUE BY MONTH FROM 2004 TO 2006



Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

Exhibit 21 presents a monthly snapshot of reported conch ex-vessel revenue by state in 2006. The grey boxes represent the peak in reported ex-vessel revenue for each state. Similar to the assessment of American eel data above, any economic impact of the Addendum IV moratorium on the conch fishery would likely not appear during this time period, due to the storage of bait. In fact, the Virginia conch fishery reported the highest ex-vessel revenues during the month of December (note: Addendum IV was in effect at this time). Additional data from 2007 would be required to understand the dynamics of Addendum IV on the conch fishery.

EXHIBIT 21 2006 REPORTED CONCH EX-VESSEL REVENUE BY MONTH

STATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
New York ^a	\$55	\$7	n/a	\$91	\$3,616	\$16,786	\$42,616	\$30,283	\$35,055	\$26,000	\$20,763	\$3,861
New Jersey	\$24,291	\$41,607	\$94,342	\$53,339	\$193,053	\$28,537	\$8,929	\$1,543	\$45,617	\$54,285	\$20,977	\$12,408
Delaware	\$11,815	\$22,214	\$61,408	\$38,298	\$208,570	\$63,324	\$30,336	\$19,606	\$2,242	\$30,416	\$81,408	\$31,662
Maryland	n/a	\$24	\$880	\$3,046	\$1,137	\$1,996	\$1,061	\$1,553	\$1,853	\$1,856	\$1,151	\$477
Virginia	\$153,417	\$117,744	\$111,114	\$110,838	\$15,847	\$4,621	\$525	\$94	\$1,498	\$13,506	\$59,907	\$255,935
Total	\$189,523	\$181,589	\$267,744	\$205,521	\$418,607	\$98,478	\$40,851	\$22,796	\$51,210	\$100,063	\$163,443	\$300,482

^a The NMFS consolidated data set contains \$69,657 in ex-vessel revenues that are not assigned to a particular month for New York in 2006. We omit these data from this exhibit.

n/a = no data reported for this month

Source: IEc analysis of NMFS consolidated data set courtesy of ACCSP.

EVALUATION OF BROADER FISHING EFFORT USING STATE DATASETS

Harvesters who participate in the horseshoe crab, American eel, and conch fisheries typically fish for other species as well. These “other” species vary by location, but may include crab, groundfish, finfish, and lobster. For example, discussions with Maryland horseshoe crab fishermen revealed that they often divide their fishing efforts between horseshoe crab and gillnetting for species such as flounder and striped bass.

To estimate the extent to which the fishermen rely on horseshoe crab and dependent fisheries versus other species for their livelihood, we estimate the percentage of total annual revenue associated with each of the horseshoe crab dependent species in comparison to their total reported revenues using Maryland and Virginia trip-based data obtained through ACCSP.³³ In an effort to avoid potential impacts of Addendum IV, we evaluated the Virginia state data from 2005, since it was the last dataset available before Addendum IV took effect. In addition, we employed 2004 Maryland harvester data, as it was the most recent data available.

In order to estimate the importance of the horseshoe crab and dependent fisheries to individual harvesters, we first identified horseshoe crab, American eel, and conch landings for harvesters who fish these species during the year. For those identified, we estimated ex-vessel revenues using price information reported by fishermen during our discussions. Next, for these harvesters, we identified landings in which they harvested other species. Using price information derived from the SAFIS database entries for Maryland and Virginia for the respective data years, we then estimated the total revenues of each harvester. Finally, for each harvester, we compared ex-vessel revenues associated with horseshoe crab, American eel, and conch to the total ex-vessel revenues during the time period.

Exhibit 22 presents the results of this analysis. For each state and species (horseshoe crab, American eel, or conch), we estimate the number and percentage of harvesters whose ex-vessel revenues associated with these species equals or exceeds ten percent of their total ex-vessel revenues. It is likely that the species represent an important revenue stream for these harvesters. Management measures that restrict or prohibit catch may affect these fishermen, as they may be most dependent on these fisheries for their livelihood. For those that fall below this threshold, the horseshoe crab, American eel, or conch catch represents a smaller fraction of their overall catch (and may even represent bycatch). Consequently, these fishermen are less likely to rely on horseshoe crab dependent fisheries, which may imply that they may be more readily able to absorb losses associated with more stringent management measures.³⁴

³³ The NMFS consolidated dataset does not allow for the identification of individual vessels or harvesters, which prohibited the use of these data for this analysis.

³⁴ We selected a ten percent threshold after an initial evaluation of the data revealed a break in the data centered around ten percent of total ex-vessel revenue.

**EXHIBIT 22 NUMBER AND PERCENTAGE OF MARYLAND AND VIRGINIA HORSESHOE CRAB
DEPENDENT HARVESTERS WHOSE EX-VESSEL REVENUES FROM SPECIES OF INTEREST
EXCEED 10 PERCENT OF THEIR TOTAL EX-VESSEL REVENUES**

STATE (DATA YEAR)	SPECIES	NUMBER OF HARVESTERS IDENTIFIED IN STATE DATA	NUMBER OF HARVESTERS WHOSE EX-VESSEL REVENUES FROM THE SPECIES EXCEED 10% OF TOTAL REPORTED EX- VESSEL REVENUE	PERCENTAGE OF HARVESTERS WHOSE EX- VESSEL REVENUES FROM THE SPECIES EXCEED 10% OF TOTAL REPORTED EX-VESSEL REVENUE
Maryland (2004)	Horseshoe Crab	8	5	63%
	American Eel	34	16	47%
	Conch	13	4	31%
Virginia (2005)	Horseshoe Crab	34	6	18%
	American Eel	65	29	45%
	Conch	77	14	18%

Source: IEc analysis of Maryland and Virginia state fisheries data courtesy of ACCSP.

The results show that, although few in number, 63 percent of Maryland’s horseshoe crab harvesters reported ex-vessel revenues that exceed ten percent of their total revenue. In Virginia, only 18 percent of horseshoe crab harvesters reported revenues that exceed this threshold. American eel harvester from Maryland and Virginia reported similar to one another, with 47 percent and 45 percent, of harvesters reporting ex-vessel revenues that exceed the ten percent threshold, respectively. For Maryland’s conch harvest, 31 percent of fishermen reported ex-vessel revenues that exceed ten percent of their total revenue, while only 18 percent of Virginia conch harvested reported the same condition. Appendix B provides the landings and ex-vessel revenues (in total and per harvester) for each of the three species of interest and other species harvested by the fishermen.

While this analysis may provide an indication of the relative importance of each of the horseshoe crab dependent fisheries for individual harvesters, several important caveats should be noted:

- This analysis provides only a snapshot of one year in time for the two states. Individual harvesters’ reliance on specific fisheries may change over time.
- It is unclear whether these results are typical for the other states examined in this analysis. Differences between the state fisheries (e.g., species typically targeted, gear usage, management measures) prevent us from extrapolating results to the other states in this study.

- Prices were estimated based on both discussions with fishermen and analysis of the SAFIS database, which reflect best estimates of price during the year of sale. Transaction based pricing information (which may be available through dealer-based datasets) may provide better estimates of ex-vessel revenue for use in this analysis.

SECTION 4: POTENTIAL IMPACTS OF ADDENDUM IV ON THE MID-ATLANTIC HORSESHOE CRAB AND DEPENDENT FISHERIES

Addendum IV to the Horseshoe Crab Fisheries Management Plan imposed additional limits on the horseshoe crab fisheries for a period of two years (from October 1, 2006 to September 30, 2008), including:

- Prohibiting directed harvest and landing of all horseshoe crabs in New Jersey, Delaware, and Maryland from January 1 through June 7.
- Prohibiting landing of female horseshoe crabs in New Jersey and Delaware from June 8 through December 31.
- Limiting New Jersey and Delaware's harvest to 100,000 horseshoe crabs per state per year.
- Prohibiting the landing of horseshoe crabs in Virginia from federal waters from January 1 through June 7.
- Mandating that no more than 40% of Virginia's annual quota may be harvested east of the COLREGS line.
- Mandating that horseshoe crabs harvested east of the COLREGS line and landed in Virginia must be comprised of a minimum male to female ration of 2:1.³⁵

In addition to Addendum IV, New Jersey and Delaware initiated statewide moratoriums on horseshoe crab fishing, although the Delaware moratorium was overturned by court decision.³⁶

Given that Addendum IV provisions took effect on October 1, 2006, the data available for analysis will not likely reveal the full impacts of the Addendum on the horseshoe crab and dependent fisheries. Ideally, to assess the economic impacts of Addendum IV, we would evaluate at least a full year under the new requirements; however, these data are not yet available.

As part of this effort, IEc conducted interviews with fishermen, processors, and state fisheries managers, to better understand an entire years worth of data under new requirements. In addition, these interviews provided some insight into the ongoing impacts

³⁵ Atlantic States Marine Fisheries Commission, *Addendum IV to Interstate Fishery Management Plan for Horseshoe Crab*, June 2006.

³⁶ Peter Himchak, Personal Communication, New Jersey Department of Environmental Protection, Division of Wildlife, January 2008.

of Addendum IV. This section presents a brief qualitative summary of the ongoing impacts of Addendum IV on Mid-Atlantic fisheries based on these discussions.³⁷

NEW JERSEY

IEc interviewed fishermen who currently participate in the American eel and conch fisheries, some of whom participated in the horseshoe crab fishery before the statewide moratorium. As expected, the fishermen report the Addendum IV and statewide moratoriums limited their ability to fish for both American eel and conch due to a reduction in the quantity of bait available in the market. For those fishermen who typically purchase horseshoe crabs from dealers, the price of has increased substantially. The fishermen reported that out of state horseshoe crabs have reached prices as high as \$3.00 per female, which is up substantially from past prices (as low as \$0.50 per female in the 1980s). Due to the higher bait prices, fishermen have been forced to cut back on quantity of bait used in each pot, which has had negative effect on yields. In general, the fishermen spoke to the ineffectiveness of alternative baits, particularly in the conch fishery. They report that substitute or artificial baits help extend the effectiveness of horseshoe crab bait, but do not function as a direct substitute.

Due the changes in the market, several conch pot fishermen have considered switching to conch dredging, since it does not require horseshoe crabs as bait; however, none of the fishermen we spoke with had changed fishing methods at that time. Rather than changing how they fish, several fishermen indicated that they were shifting effort away from conch and eel, and focusing their efforts on gillnet fishing, particularly striped bass and flounder.

DELAWARE

IEc conducted interviews with horseshoe crab, American eel, and conch fishermen. The fishermen indicated that in the conch fishery, they typically alternate between conch potting and dredging operations. Dredging permits them to harvest conch without using horseshoe crab bait. In addition, dredging allows them to harvest horseshoe crab as bycatch. The fishermen generally acknowledged that Addendum IV decreased availability of horseshoe crabs; however, the impact on them has been softened by focusing the majority of their efforts on other species, such as striped bass, flounder, and blue crab.

VIRGINIA

IEc conducted interviews with conch fishermen and a large conch processor in Virginia. According to the fishermen, Addendum IV has significantly reduced their ability to catch horseshoe crabs for use as bait for personal use, which has increased the need to purchase

³⁷ Efforts to contact fishermen and processors in the various states and fisheries proved to be a challenge. IEC made contact with five fishermen (mix of horseshoe crab, American eel, and conch) from New Jersey, two from Delaware (horseshoe crab, eel, conch), one from Maryland (horseshoe crab), and four from Virginia (horseshoe crab and conch). Rick Robbins of Bernie's Conch and Chesapeake Bay Packing/Bernie's Conchs, a conch processor, also provided information. We were unable to make contact with processors or fishermen from New York.

bait. Similar to the fishermen in New Jersey, the Virginia conch fishermen report prices as high as \$2.30 per female. As a result of the bait shortage, some have tried using dogfish as an alternative, but it has proven to be far less effective, finding that it requires three pounds of dogfish to replace a half female or whole male horseshoe crab to catch the equivalent quantity of conch.

A large conch processor provided us with extensive information regarding his operations.³⁸ As part of normal operations, conch processors purchase horseshoe crabs to sell them back to fishermen for bait. For this processor, horseshoe crabs represented 11.4 percent of all sales in 2007. The conch processor has identified a 39% decline in the number of horseshoe crabs purchased in Virginia from 2006 to 2007. The processor attributes this decline to Addendum IV, specifically the 2:1 male to female sex ratio requirement in areas east of the COLREGS line. He maintains that the directed dredge fishery operating in these waters could not catch enough males using dredge gear to meet the Addendum IV requirement.³⁹ This effectively eliminated directed horseshoe crab dredge fishery in Virginia, which in 2006 was his number one supplier of horseshoe crabs. For similar reasons, Addendum IV effectively eliminated the offshore gillnet bycatch fisheries, although the horseshoe crab production in this fishery was substantially lower than the directed dredge fishery. Finally, the processor posits that the elimination of these fisheries will prevent Virginia from fully utilizing its horseshoe crab quota in 2007.⁴⁰

³⁸ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communications, December 5, 2007 and January 14, 2008.

³⁹ Since male horseshoe crabs are the first to arrive and last to leave spawning areas, their availability to different fishing is determined by timing and location. Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, January 14, 2008.

⁴⁰ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communications, December 5, 2007.

SECTION 5: REGIONAL ECONOMIC IMPACT ANALYSIS

This analysis presents an overview of the regional economic and employment contribution of the horseshoe crab fishery to the economies of Virginia, Maryland, Delaware, New Jersey, and New York in 2006. Because the model used to conduct this analysis is static in nature, it captures these economies at one point in time. Accordingly, it does not specifically address any impacts that may have occurred to the fishery as a result of Addendum IV.

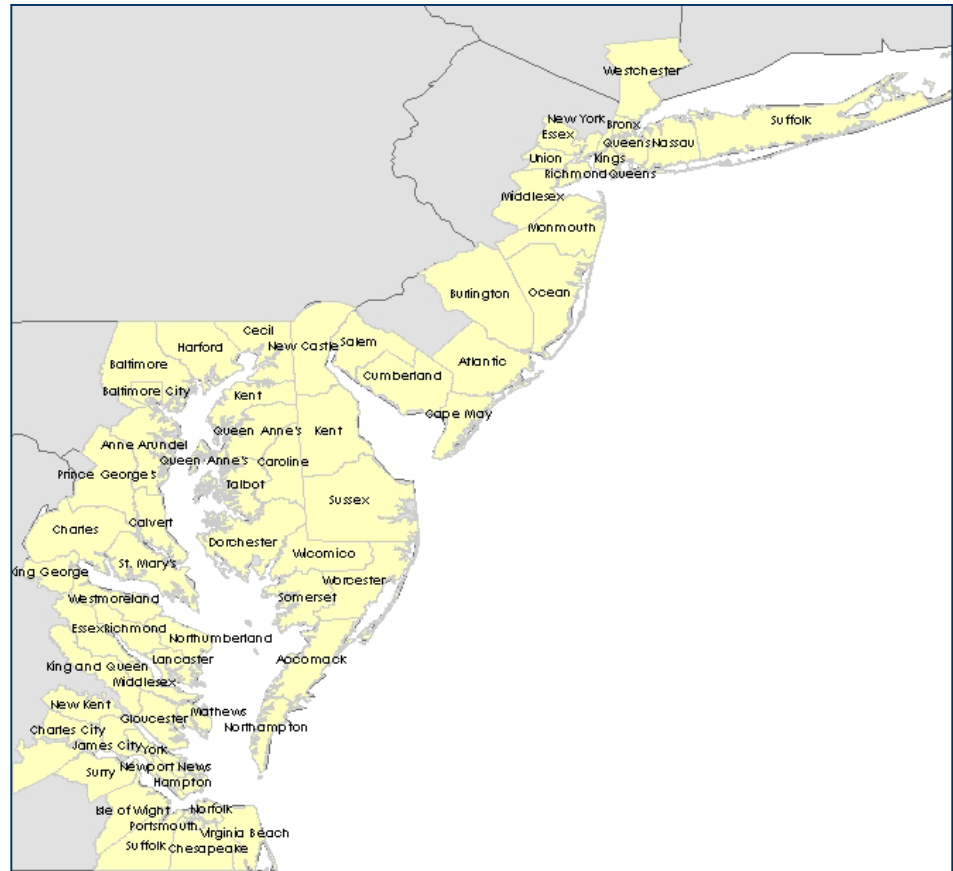
This analysis begins with horseshoe crab harvesting activities and assesses the level of regional economic activity that supports this fishing activity, i.e., the analysis assesses the "upstream" economic effects. As such, the regional economic modeling effort does not capture the "downstream" regional economic impacts associated with dealers or processors, nor does it account for any potential contributions that this fishery has to American eel or conch fisheries. The analysis does include a qualitative, scoping-level analysis of the processing industries for American eel and conch and at conclusion of this section.

REGIONAL ECONOMIC ANALYSIS USING IMPLAN

Expenditures by horseshoe crab fishermen include fuel, boats and boat repair, dock space rental, oil, refrigeration, pots, net replacement and repair, wire, line, buoys, gloves, and clothing, among others. In addition to direct expenditures, owners, captains, and crew receive compensation for work on fishing boats. This income is, in general, spent locally on various goods and services, including groceries and household items. Purchase of all of these goods and services within the local economy results in secondary effects on related sectors in coastal areas, such as businesses that supply goods to bait shops. In turn, these suppliers must purchase from their suppliers, triggering a series of additional indirect effects on the economy. The sum of all of the direct and indirect expenditures within the local economy represents the total contribution of the horseshoe crab sector to the overall regional economy.

This analysis relies on regional economic modeling to estimate the regional economic impacts of the horseshoe crab industry. The study area for this analysis was defined as the coastal counties within Virginia, Maryland, Delaware, New Jersey, and New York. Exhibit 23 presents the study area for this analysis.

EXHIBIT 23 STUDY AREA FOR REGIONAL ECONOMIC IMPACTS ANALYSIS



THE IMPLAN MODEL

This analysis utilizes a software package called IMPLAN to estimate the total economic effects of the horseshoe crab fishery in the five Mid-Atlantic States identified by ASMFC. IMPLAN is commonly used by state and federal agencies for policy planning and evaluation purposes. The model draws upon data from several federal and state agencies, including the Bureau of Economic Analysis and the Bureau of Labor Statistics.⁴¹ To group related industries into sectors, IMPLAN utilizes the categories defined by the U.S. Office of Management and Budget's North American Industry Classification System (NAICS) code. IMPLAN translates initial changes in expenditures into changes in demand for inputs to affected industries. These effects can be described as direct, indirect, or induced, depending on the nature of the change.

⁴¹ The IMPLAN model is owned and maintained by the Minnesota IMPLAN Group, Inc. (MIG). Information in this section is compiled in part from: *IMPLAN Professional, User Guide, Analysis Guide, Data Guide, and Impact Analysis Software*, Minnesota IMPLAN Group, Inc., 1999-2004.

- **Direct effects** represent changes in output attributable to a change in demand or a supply shock. These are specified initially by the modeler (e.g., the change in recreation expenditures on goods and services, by sector).⁴²
- **Indirect effects** are changes in output of industries that supply goods and services to those that are directly affected by the initial change in expenditures.
- **Induced effects** reflect changes in household consumption, arising from changes in employment (which in turn are the result of direct and indirect effects). For example, changes in employment in a region may affect the consumption of certain goods and services.

These categories are calculated for all industries and aggregated to determine the regional economic impacts associated with the horseshoe crab industry.

METHODS

The specific production functions and tradeflows associated with the fishing industry are not particularly well represented in the generic IMPLAN model.⁴³ The horseshoe crab industry in particular is not well suited to IMPLAN because horseshoe crab is often caught and used as bait by the same fishermen, never being bought and sold, and thus never being captured in overall revenues for the horseshoe crab fishery. Thus, this analysis combines revenue information with data on expenditures and fishing income as a basis for understanding regional economic impacts of the industry. This analysis generally follows the methodology used by Steinback et al (forthcoming 2008) to assess the regional economic importance of the American lobster fishery.⁴⁴ To estimate the regional economic impacts of horseshoe crab fishing activity, we took six analytic steps:

- 1) **Collect primary data.** We collected data from a sample of fishermen on their horseshoe crab-related expenditures, including fuel, boats and boat repair, dock space rental, oil, refrigeration, pots, net replacement and repair, wire, line, buoys, gloves, and clothing. We attempted to isolate expenditures related to horseshoe crab fishing alone, but recognize that some data (such as for fuel or boat repairs) may include expenditures that also support fishing activity for other fisheries. Per vessel

⁴² Output is the value of all good and services produced.

⁴³ At least two detailed efforts have been undertaken recently in the mid-Atlantic region to capture the regional economic impacts of the commercial fishing industry using custom-built versions of IMPLAN that incorporate landings data and regional product flows. See for example, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, "Northeast Region Commercial Fishing Input-Output Model," NOAA Technical Memorandum NMFS-NE-188, April 2006; Kirkley, James, "Assessing the Economic Importance of Commercial Fisheries in the Mid-Atlantic Region: A User's Guide to the Mid-Atlantic I/O Model," Prepared for the Northeast Fisheries Science Center, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Undated.

⁴⁴ Steinback, Scott, Richard B Allen, and Eric Thunberg. "The Benefits of Rationalization: the Case of the American Lobster Fishery," Forthcoming publication in Marine Resource Economics, 2008.

expenditures, which range from \$10,000 to \$50,000 depending on the state, are presented in Exhibit 24.⁴⁵

- 2) **Calculate industry-wide operating expenditures.** We multiplied the per vessel horseshoe crab fishing expenditures by the number of fishing vessels in the fleet, and used these as the inputs to IMPLAN. In IMPLAN, the regional purchase coefficients (RPCs) for goods were applied to these expenditures where appropriate, removing the value of imports from the regional economic accounts prior to calculating impacts.
- 3) **Calculate fishermen income.** Next, we estimated owner, captain and crew income and inserted it into the modeling context, following Steinback et al. Because profit and compensation information were not available for this fishery, we estimated wages and income using employee compensation and proprietary income as a percentage of total revenues, as developed for the small bottom trawl fishing sector in the Northeast Region Commercial Fishing Input-Output Model (NERIOM).⁴⁶ These wage and income estimates, estimated as 36 percent of revenues for proprietary income, and 16 percent for crew, are presented in Exhibit 25.
- 4) **Classify expenditures and income into IMPLAN Codes.** Next, we classified all direct expenditures by industry sector using NAICS codes, which we then translated into IMPLAN codes using IMPLAN's data sectoring system. For income and wages, we used the Personal Consumption Expenditure (PCE) activity database to allocate expenditures across the economy. The industry descriptions, selected PCEs, and associated NAICS and IMPLAN codes are presented in Exhibit 26.
- 5) **Run IMPLAN.** We then entered the operating expenditure and income expenditure data into IMPLAN in subsequent runs, then combined the outputs.
- 6) **Add industry-wide revenues.** In the final step, we added the industry revenues associated with the industry to the total regional impact estimates, again following Steinback et al. Direct employment associated with horseshoe fishing activity was assumed to be 1.2 full time equivalents per vessel.⁴⁷

⁴⁵ Note that the number of vessels was not available for the New York Horseshoe Crab industry. The number of vessels is assumed to be the average of Virginia, Maryland, Delaware, and New Jersey.

⁴⁶ National Oceanic and Atmospheric Administration, National Marine Fisheries Service, "Northeast Region Commercial Fishing Input-Output Model," NOAA Technical Memorandum NMFS-NE-188, April 2006.

⁴⁷ This was calculated as one full-time owner/operator plus one crewmember at two days per week for a seven-month fishing season.

**EXHIBIT 24 ANNUAL EXPENDITURES BY HORSESHOE CRAB INDUSTRY, PER VESSEL
(INPUTS TO IMPLAN MODEL)**

Expenditure Type	Virginia		Maryland		Delaware		New Jersey		New York	
	Low	High	Low	High	Low	High	Low	High	Low	High
Net Repair/ Replacement	\$800	\$1,000	\$800	\$1,000	\$400	\$400	\$700	\$800	\$700	\$800
Fuel	\$6,000	\$10,000	\$6,000	\$10,000	\$1,500	\$2,500	\$4,500	\$7,500	\$4,500	\$7,500
Oil	\$40	\$50	\$20	\$40	\$20	\$30	\$20	\$40	\$20	\$40
Refrigeration	\$3,000	\$6,000	\$3,000	\$6,000	\$3,000	\$6,000	\$3,000	\$6,000	\$3,000	\$6,000
Dredge Repair	\$90	\$90	\$100	\$100	\$50	\$50	\$80	\$80	\$80	\$80
Boat payments/ boat repair	\$6,800	\$28,000	\$6,800	\$28,000	\$3,400	\$14,000	\$5,700	\$23,300	\$5,700	\$23,300
Buoy Systems, wire, line, rubber gloves, clothes, pot replacement	\$3,900	\$3,900	\$1,200	\$1,200	\$900	\$900	\$2,000	\$2,000	\$2,000	\$2,000
Dock Space Rental	\$800	\$800	\$1,000	\$1,000	\$900	\$900	\$900	\$900	\$900	\$900
Total	\$21,400	\$49,800	\$18,900	\$47,300	\$10,200	\$24,800	\$16,900	\$40,600	\$16,900	\$40,600

Sources: Personal communications with horseshoe crab fishermen in affected states.

EXHIBIT 25 INCOME AND WAGES FOR HORSESHOE CRAB INDUSTRY, 2006\$ (INPUTS TO IMPLAN MODEL)

	Virginia	Maryland	Delaware	New Jersey	New York
Horseshoe Crab Fishery Revenues (2006)	\$237,931	\$66,910	\$74,824	\$3,474	\$87,796
Proprietary income percent	36%	36%	36%	36%	36%
Employee compensation percent	16%	16%	16%	16%	16%
Proprietary income (2006)	\$85,346	\$24,001	\$26,839	\$1,246	\$31,492
Employee compensation (2006)	\$37,498	\$10,545	\$11,792	\$548	\$13,837

Sources: NMFS consolidated dataset courtesy of ACCSP, and "Commercial Fishing Production Functions," Small Bottom Trawl sector, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, "Northeast Region Commercial Fishing Input-Output Model," NOAA Technical Memorandum NMFS-NE-188, April 2006.

EXHIBIT 26 CLASSIFICATION OF EXPENDITURES BY INDUSTRY SECTOR AND IMPLAN CODE

EXPENDITURE TYPE	NAICS CODE	SECTOR DESCRIPTION	IMPLAN CODE
Net Repair/ Replacement	314999	All Other Miscellaneous Textile Product Mills. This U.S. industry comprises establishments primarily engaged in manufacturing textile products (except carpets and rugs; curtains and linens; textile bags and canvas products; rope, cordage, and twine; and tire cords and tire fabrics) from purchased materials. Includes fishing nets made from purchased materials.	103
Fuel	32411	Petroleum Refineries. This industry comprises establishments primarily engaged in refining crude petroleum into refined petroleum. Includes gasoline made in petroleum refineries.	142
Oil	324191	Petroleum Lubricating Oil and Grease Manufacturing. This U.S. industry comprises establishments primarily engaged in blending or compounding refined petroleum to make lubricating oils and greases and/or re-refining used petroleum lubricating oils.	145
Refrigeration	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing. This U.S. industry comprises establishments primarily engaged in (1) manufacturing air-conditioning (except motor vehicle) and warm air furnace equipment and/or (2) manufacturing commercial and industrial refrigeration and freezer equipment.	278
Dredge Repair	36611	Ship Building and Repairing. This U.S. industry comprises establishments primarily engaged in operating a shipyard. Shipyards are fixed facilities with dry-docks and fabrication equipment capable of building a ship, defined as watercraft typically suitable or intended for other than personal or recreational use. Activities of shipyards include the construction of ships, their repair, conversion and alteration, the production of prefabricated ship and barge sections, and specialized services, such as ship scaling. Includes dredge building and ship repair.	393
Boat payments/boat repair	441222	Boat Dealers. This U.S. industry comprises establishments primarily engaged in (1) retailing new and/or used boats or retailing new boats in combination with activities, such as repair services and selling replacement parts and accessories, and/or (2) retailing new and/or used outboard motors, boat trailers, marine supplies, parts, and accessories.	401
Buoy Systems, wire, line, rubber gloves, clothes, pot replacement	451110	Sporting Goods Stores. This industry comprises establishments primarily engaged in retailing new sporting goods, such as bicycles and bicycle parts; camping equipment; exercise and fitness equipment; athletic uniforms; specialty sports footwear; and sporting goods, equipment, and accessories. Includes fishing supply stores (e.g., bait).	409
Dock Space Rental	71393	Marinas. This industry comprises establishments, commonly known as marinas, engaged in operating docking and/or storage facilities for pleasure craft owners, with or without one or more related activities, such as retailing fuel and marine supplies; and repairing, maintaining, or renting pleasure boats.	478
Employee Compensation	n/a	This category includes expenditures by crew members who received compensation from the horseshoe crab industry. The IMPLAN sector selected utilizes the Personal Consumption Expenditure activity database.	PCE: Households 25k-35k
Proprietary Income	n/a	This category includes expenditures by proprietors within the horseshoe crab industry. The IMPLAN sector selected utilizes the Personal Consumption Expenditure activity database.	PCE: Households 75k-100k

RESULTS

As stated above, this analysis presents an overview of the contribution of the horseshoe crab fishery to the economies of the five states in our study area in 2006. As such, it does not specifically address any impacts that may have occurred to the fishery as a result of Addendum IV.

As noted above, horseshoe crab is often caught and used as bait by the same fishermen. As a result, overall revenues for the fishery appear small when examined separately from dependent fisheries such as conch and eel. As such, per vessel operating expenditures, which range from \$10,000 to \$50,000 depending on the state, appear large relative to per vessel fishery revenues, which ranged from \$100 to \$8,500 in 2006.

Regardless of profitability, the horseshoe crab fishing industry has an impact on the regional economy through operating expenditures, as well as income by owners, captains, and crew. Results of the IMPLAN analysis are presented in Exhibits 27 and 28. Total regional economic impacts are anticipated to range from \$2.7 to \$4.7 million across the five-state region. The largest regional economic impacts are anticipated in Virginia (\$1.1 million to \$1.8 million), while the smallest impacts are anticipated in Delaware (\$0.3 million to \$0.5 million).

As stated above, direct employment associated with horseshoe fishing activity was assumed to be 1.2 full time equivalents per vessel. Not surprisingly, this employment constitutes the majority of employment associated with this industry. Regional demand from the horseshoe crab, however, provides employment for an additional nine to 18 employees across various industries.

CAVEATS AND NOTES

As noted above, this analysis presents an overview of the regional economic and employment contribution of the horseshoe crab fishery to the five coastal states in the study area in 2006. It does not specifically address any impacts that may have occurred to the fishery as a result of Addendum IV. However, because the modeling results are linear in nature, they could be used to understand how partial reductions in horseshoe fishing activity would be experienced in the regional economy. For example, if a 50 percent reduction in fishing harvest is expected, 50 percent of the regional economic impacts could be assumed to result in the short term, assuming no substitution or reabsorption of fishing activity occurs.

There are two important caveats relevant to the interpretation of IMPLAN model estimates, generally, and within the context of this analysis. The first is that the model is static in nature and measures only those effects resulting from a specific policy change (or the functional equivalent specified by the modeler) at one point in time. Thus, IMPLAN does not account for posterior adjustments that may occur, such as the subsequent re-employment of workers displaced by the original policy change. In this analysis, this caveat suggests that the long-run net output and employment effects resulting from changes in the horseshoe crab

fishery are smaller than those estimated in the model, which will lead to an upward bias in the estimates.

A second caveat to the IMPLAN analysis is related to the model data. The IMPLAN analysis relies upon input/output relationships derived from 2004 data, which is the most recent data available. If significant changes have occurred in the structure of the economies of the affected areas over the previous four years, the results may be sensitive to this assumption. However, the magnitude and direction of any such bias are unknown.

EXHIBIT 27 REGIONAL ECONOMIC IMPACTS OF THE HORSESHOE CRAB FISHERY, REVENUE (2006\$)

INDUSTRY	VIRGINIA		MARYLAND		DELAWARE		NEW JERSEY		NEW YORK		TOTALS	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Horseshoe crab fishing (2006 revenues)	\$237,931	\$237,931	\$66,910	\$66,910	\$74,824	\$74,824	\$3,474	\$3,474	\$87,796	\$87,796	\$470,935	\$470,935
AC- refrigeration- and forced air heating	\$126,000	\$252,000	\$24,000	\$48,000	\$57,000	\$114,000	\$102,000	\$204,000	\$78,000	\$156,000	\$387,000	\$774,000
Motor vehicle and parts dealers	\$60,100	\$235,600	\$11,900	\$46,100	\$14,000	\$54,600	\$40,300	\$161,600	\$30,500	\$122,000	\$156,800	\$619,900
Domestic Trade	\$116,900	\$176,300	\$32,000	\$48,800	\$17,100	\$22,300	\$33,200	\$55,100	\$66,500	\$106,900	\$265,700	\$409,400
Wholesale trade	\$78,800	\$132,400	\$17,600	\$29,300	\$9,700	\$16,200	\$74,800	\$128,700	\$59,100	\$99,800	\$240,000	\$406,400
Petroleum refineries	\$48,600	\$81,600	\$1,400	\$2,300	\$12,800	\$21,500	\$37,100	\$62,700	\$1,300	\$2,200	\$101,200	\$170,300
Gasoline stations	\$53,900	\$89,500	\$6,700	\$11,100	\$6,200	\$10,200	\$21,200	\$35,500	\$7,100	\$11,700	\$95,100	\$158,000
Owner-occupied dwellings	\$32,000	\$49,500	\$8,200	\$11,800	\$8,500	\$12,000	\$13,000	\$26,700	\$14,600	\$23,600	\$76,300	\$123,600
Other amusement- gambling- and recreation industries	\$35,700	\$36,800	\$8,500	\$8,700	\$17,800	\$18,100	\$31,600	\$32,700	\$24,000	\$24,400	\$117,600	\$120,700
Real estate	\$21,200	\$39,800	\$4,800	\$8,300	\$5,000	\$8,600	\$10,600	\$22,600	\$9,700	\$18,500	\$51,300	\$97,800
Management of companies and enterprises	\$12,900	\$27,500	\$1,300	\$2,600	\$1,900	\$4,000	\$7,900	\$17,200	\$6,500	\$14,000	\$30,500	\$65,300
All others	\$285,900	\$467,000	\$71,300	\$109,800	\$66,500	\$98,400	\$179,100	\$332,700	\$148,200	\$242,800	\$751,000	\$1,250,700
TOTAL	\$1,109,900	\$1,825,900	\$254,600	\$393,700	\$291,300	\$454,700	\$554,300	\$1,083,000	\$533,300	\$909,700	\$2,743,400	\$4,667,000

Source: IMPLAN analysis.

EXHIBIT 28 EMPLOYMENT IMPACTS OF THE HORSESHOE CRAB FISHERY (INDIVIDUALS)

INDUSTRY	VIRGINIA		MARYLAND		DELAWARE		NEW JERSEY		NEW YORK		TOTALS	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Horseshoe Fishery employment	50.4	50.4	9.6	9.6	22.8	22.8	40.8	40.8	30.9	30.9	154.5	154.5
Motor vehicle and parts dealers	0.6	2.4	0.1	0.4	0.1	0.5	0.3	1.3	0.2	1.0	1.3	5.6
AC- refrigeration- and forced air heating	0.5	1.1	0.1	0.2	0.2	0.4	0.3	0.6	0.3	0.5	1.4	2.8
Wholesale trade	0.5	0.9	0.1	0.2	0.0	0.1	0.4	0.7	0.3	0.5	1.3	2.4
Gasoline stations	0.8	1.4	0.1	0.1	0.1	0.1	0.2	0.4	0.1	0.1	1.3	2.1
Other amusement- gambling- and recreation industries	0.6	0.7	0.1	0.1	0.2	0.2	0.4	0.4	0.3	0.3	1.6	1.7
Food services and drinking places	0.3	0.5	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.7	1.1
General merchandise stores	0.2	0.3	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.4	0.7
Real estate	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.2	0.6
Hospitals	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.3	0.6
Other Federal Government enterprises	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6
All others	4.4	0.1	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	58.8	58.8	20.9	11.0	23.5	24.5	42.8	44.7	32.4	33.8	163.3	172.7

Source: IMPLAN analysis. Direct employment associated with horseshoe fishing activity was assumed to be 1.2 full time equivalents per vessel.

SCOPING LEVEL ANALYSES OF PROCESSORS AND DISTRIBUTORS

Since IMPLAN estimates effects on “upstream” activities, the economic impacts of management measures on downstream activities, such as processing and distribution are not captured in the regional impact analysis presented above. As part this effort, IEc interviewed several processors and distributors for the American eel and conch fisheries. The section summarizes information obtained from the processors and provides additional context regarding the regional impacts of horseshoe crab on the dependent fisheries. In addition, the information from processors may provide insight into the quality of NMFS consolidated data presented in Section 3.

AMERICAN EEL DISTRIBUTORS

Eel fishermen generally sell their catch to dealers who distribute and sell the product to retail providers, bait shops, restaurant distributors, or export markets. Fishermen may also sell live eels directly to bait shops.⁴⁸ Estimates on the number of distributors vary, but discussions with eel dealers suggest that 15 to 20 major distribution firms operate on the Atlantic Coast. Companies in this industry are diverse. Some sell eel exclusively, while others participate as distributors of various seafood products.

The dealers we interviewed were reluctant to discuss revenues and costs, but were willing to supply some information on their operations.⁴⁹ Our interviews with three eel dealers suggest that considerable variation exists in the eel market. One dealer in New York reported annual sales of approximately 264,000 pounds of eel, of which approximately 80 percent is exported to China. The remaining is sold locally to restaurants and other distributors. A second dealer from Maine purchases eels in bulk from eel fishing associations and reports annual sales of approximately 600,000 pounds.⁵⁰ Of this total, half is sold overseas (mainly Asia) and half is sold to restaurant distributors. The third dealer from Maryland reported annual sales of approximately 360,000 pounds, all of which is sold to local restaurant distributors.⁵¹

Assuming that the dealers interviewed represent the range of industry participants, annual sales on the Atlantic Coast average approximately 408,000 pounds of eel per distributor. With 15 to 20 major distributors, we estimate that Atlantic Coast distributors would

⁴⁸ For a full description of the market for American eel, see Manion, M., R. West, and R. Unsworth, Industrial Economics, Incorporated, *Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery*, Prepared for Division of Economics, U.S. Fish and Wildlife Service, April 7, 2000.

⁴⁹ Unfortunately the eel dealers we interviewed were unable to provide insight on the role horseshoe crab as bait for the eel pot fishery. Previous IEc research attributes 15 percent of total horseshoe crab landings (on entire Atlantic Coast) wind up as bait for the eel potting fishery. Manion, M., R. West, and R. Unsworth, Industrial Economics, Incorporated, *Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery*, Prepared for Division of Economics, U.S. Fish and Wildlife Service, April 7, 2000.

⁵⁰ While operations in Maine is not the focus of the report, the distributor indicated that his firm buys a portion of eels from the Mid-Atlantic region.

⁵¹ The respondents indicated that the majority of eels are purchased from fishermen or eel fishing associations. Eel fishing associations are more common in areas where there are fewer eel harvesters, which allow the fishermen to pool resources and sell eel in bulk quantities.

purchase between 6.1 million and 8.2 million pounds from harvesters annually. Assuming an estimated ex-vessel price of \$3.00 per pound (as reported by the fishermen), the resulting ex-vessel revenues for harvesters could range from \$18.3 million to \$24.6 million per year for the entire Atlantic Coast. The lack of data on the eel market hinders our ability to attribute a portion of these revenues to just the Mid-Atlantic States highlighted in this report. However, given the disparity between the estimates of ex-vessel revenues presented here, compared to those in Section 3, it is reasonable to assume that significant underreporting occurs in the eel fishery.

CONCH PROCESSORS

Once landed, conch in-shell are sold to processors who prepare the conch meat for sale to wholesale markets. Processors remove the shell and extract the meat inside, which may be sold as cooked or fresh (raw) product.⁵² Discussions with processors indicate that the conch processing industry includes at least 12 companies, located from Virginia to Massachusetts.⁵³ A typical processor employs between 10 and 50 full time seasonal employees.⁵⁴

Conch processors depend largely on the conch pot fishery for product. One processor reports that the conch processors also participate as buyers in the horseshoe crab fishery in order to supply harvesters with bait for the conch pot fishery. Horseshoe crabs are purchased from hand harvest, dredge, and various bycatch fisheries. This processor reports that his conch suppliers (fishermen) use approximately 110,000 to 150,000 horseshoe crabs annually.⁵⁵

The trade in horseshoe crabs and conch occurs throughout the Atlantic Coast. For example, one processor located in Virginia reports purchasing conch from Virginia, Delaware, and Massachusetts, and purchasing horseshoe crabs from North Carolina, Virginia, Delaware, and New York. He also reports that Massachusetts and New York conch processors typically purchase conch and horseshoe crabs from fishermen throughout the region.⁵⁶

The conch processor we interviewed owns one operation and manages exports for a second operation. He provided detailed information on conch revenues and horseshoe crab purchases. Since products commonly move back and forth between the companies, the processor indicates that it is best to evaluate their combined operations. Total combined

⁵² For a full description of the market for conch, see Manion, M., R. West, and R. Unsworth, Industrial Economics, Incorporated, *Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery*, Prepared for Division of Economics, U.S. Fish and Wildlife Service, April 7, 2000.

⁵³ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, December 5, 2007. Mr. Robbins provided IEc with extensive information on the conch processing industry. In addition to providing information on his two conch processing companies (he owns one and manages export operations at the other), he provided additional information on other processors in Virginia.

⁵⁴ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, September 14, 2007.

⁵⁵ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, December 5, 2007.

⁵⁶ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, December 5, 2007.

annual revenues from his conch sales averaged \$3.7 million from 2005 to 2007, with a low in 2005 of \$2.5 million and high of \$4.4 million.⁵⁷ Sales of raw yellow conch meat (caught using pot gear and thus employing horseshoe crabs as bait) average \$3.2 million during same time period, with a low of \$1.9 million in 2005 and a high of 3.7 million in 2007. The reliance on yellow conch meat sales highlights the importance of the conch pot fishery and horseshoe crab fisheries for these companies. The processor reports that for one of the companies, 95 percent of total revenues are generated by conch and bait sales, which are primarily horseshoe crabs.⁵⁸

The processor also provided general information on two other conch-processing companies in Virginia. Including his own facilities, combined sales of conch and horseshoe crabs at the four facilities in Virginia totaled approximately \$8.7 million, with an average of nearly \$2.2 million per company.⁵⁹ Assuming this average is typical for conch processing companies in the Mid-Atlantic, which includes at least 6 more conch processing companies, we estimate total annual sales from combined conch and horseshoe crab in the Mid-Atlantic would be approximately \$22 million.⁶⁰

⁵⁷ These estimates include both raw yellow and white conch meat. White conch meat, which comes from the knobbed whelk is caught in the both the pot and dredge fisheries; however yellow conch meat, which is derived from smooth whelk, is solely dependent on the pot fishery (and thus, horseshoe crabs for bait. Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, December 8, 2007.

⁵⁸ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, December 8, 2007.

⁵⁹ Rick Robbins, Chesapeake Bay Packing/Bernie's Conchs, Personal Communication, September 14, 2007.

⁶⁰ To the extent that operations at conch processors vary, this estimate may overestimate or underestimate conch and horseshoe crab sales.

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APPENDIX A | CRAB BAIT LANDINGS FROM LATEST HORSESHOE CRAB FISHERY MANAGEMENT PLAN

REPORTED COMMERCIAL HORSESHOE CRAB BAIT LANDINGS BY JURISDICTION (INDIVIDUALS)

Jurisdiction	Reference Period Landings (RPL)	Addendum I Quota ^a	Addendum III Quota ^a	Addendum IV Quota ^a	1998	1999	2000	2001	2002	2003	2004	Preliminary 2005	Preliminary 2006
ME	13,500	13,500	13,500	13,500	13,500	1,500	1,391	100	150	98	0	0	0
NH	350	350	350	350	200	350	180	0	120	0	0	0	0
MA	440,503	330,377	330,377	330,377	400,000	545,715	272,930	134,143	138,613	125,364	69,436	73,740	171,646
RI	26,053	26,053	26,053	26,053	-	26,053	13,809	3,490	3,896	5,824	6,030	8,280	15,274
CT ^b	64,919	48,689	48,689	48,689	34,583	45,050	15,921	11,508	32,080	13,386	23,788	15,240	25,280
NY	488,362	366,272	366,272	366,272	352,462	394,026	628,442	129,074	177,271	134,264	142,279	155,108	172,381
NJ	604,049	453,037	150,000	100,000	241,456	297,680	398,629	261,239	281,134	113,940	46,569	87,250	3,444
PA	-	0	0	0	75,000	0	0	0	0	0	0	0	-
DE	482,401	381,801	150,000	100,000	479,634	428,980	248,938	244,813	298,318	356,380	127,208	154,269	146,070
MD	613,225	459,919	170,653	170,653	114,458	134,088	152,275	170,653	278,211	168,865	161,928	169,821	136,733
PRFC	-	0	0	0	-	0	0	0	0	0	0	0	0
DC	-	0	0	0	-	0	0	0	0	0	0	0	0
VA	203,326	152,495	152,495	152,495	1,015,700	660,840	145,465	48,880	42,954	106,577	94,713	97,957	155,704
NC	24,036	24,036	24,036	24,036	21,392	28,084	14,973	9,130	12,906	24,387	9,437	7,337	6,288
SC	-	0	0	0	-	0	0	0	0	0	0	0	0
GA	29,312	29,312	29,312	29,312	-	29,312	0	0	0	0	0	0	0
FL	9,455	9,455	9,455	9,455	200	19,446	10,462	0	200	1,628	0	0	283
TOTAL	2,999,491	2,275,296	1,471,192	1,371,192	2,748,585	2,600,914	1,903,415	1,013,030	1,265,843	1,050,693	681,388	768,982	833,103
Pct. Reduction Relative to RPL					8.4	13.3	36.5	66.2	57.8	65.0	77.3	74.4	72.2
Pct. Reduction Relative to Quota I							16.3	55.5	44.4	53.8	70.1	66.2	63.4
Pct. Reduction Relative to Quota III											53.7	47.7	43.4

Source: Atlantic State Marine Fisheries Commission, *2007 Review of The Fishery Management Plan in 2006 for Horseshoe Crab*, April 2007.

**APPENDIX B | LANDINGS AND EX-VESSEL REVENUE ESTIMATES USED
FOR ESTIMATION OF BROADER FISHING EFFORT**

**EXHIBIT B-1 TOTAL LANDINGS OF SPECIES OF INTEREST IN COMPARISON TO OTHER SPECIES
HARVESTED**

STATE	SPECIES OF INTEREST	TOTAL LANDINGS OF SPECIES OF INTEREST (POUNDS)	TOTAL LANDINGS OF OTHER SPECIES (POUNDS)	TOTAL LANDINGS (POUNDS)	PERCENTAGE OF LANDINGS ATTRIBUTED TO SPECIES OF INTEREST (BY WEIGHT)
Maryland (2004)	Horseshoe Crab	520,911	720,318	1,241,229	42%
	American Eel	194,075	2,597,918	2,791,993	7%
	Conch	58,387	1,820,360	1,878,747	3%
Virginia (2005)	Horseshoe Crab	66,046	4,550,820	4,616,866	1%
	American Eel	81,308	5,269,692	5,351,000	2%
	Conch	235,158	7,153,075	7,388,233	3%
Source: IEC analysis of Maryland and Virginia state fisheries data courtesy of ACCSP.					

**EXHIBIT B-2 LANDINGS OF SPECIES OF INTEREST IN COMPARISON TO OTHER SPECIES HARVESTED
PER FISHERMEN**

STATE	SPECIES OF INTEREST	LANDINGS OF SPECIES OF INTEREST PER HARVESTER (POUNDS)	LANDINGS OF OTHER SPECIES PER HARVESTER (POUNDS)	TOTAL LANDINGS PER HARVESTER (POUNDS)	PERCENTAGE OF LANDINGS ATTRIBUTED TO SPECIES OF INTEREST (BY WEIGHT) PER HARVESTER
Maryland (2004)	Horseshoe Crab	65,114	155,148	220,262	30%
	American Eel	5,708	76,409	82,117	7%
	Conch	4,491	140,028	144,519	3%
Virginia (2005)	Horseshoe Crab	1,943	133,848	135,790	1%
	American Eel	1,251	81,072	82,323	2%
	Conch	3,054	92,897	95,951	3%

Source: IEC analysis of Maryland and Virginia state fisheries data courtesy of ACCSP.

EXHIBIT B-3 TOTAL EX-VESSEL REVENUES OF SPECIES OF INTEREST IN COMPARISON TO OTHER SPECIES HARVESTED

STATE	SPECIES OF INTEREST	TOTAL EX-VESSEL REVENUE OF SPECIES OF INTEREST (2006\$)	TOTAL EX-VESSEL REVENUE OF OTHER SPECIES (2006\$)	TOTAL EX-VESSEL REVENUE (2006\$)	PERCENTAGE OF EX-VESSEL REVENUE ATTRIBUTED TO SPECIES OF INTEREST
Maryland (2004)	Horseshoe Crab	\$335,607	\$684,384	\$1,019,992	33%
	American Eel	\$620,016	\$2,321,918	\$2,941,935	21%
	Conch	\$68,394	\$2,640,091	\$2,708,485	3%
Virginia (2005)	Horseshoe Crab	\$39,957.83	\$4,179,505.61	\$4,219,463	1%
	American Eel	\$251,623.80	\$4,982,231.62	\$5,233,855	5%
	Conch	\$266,839.19	\$6,767,615.66	\$7,034,454	4%

Source: IEC analysis of Maryland and Virginia state fisheries data courtesy of ACCSP.

**EXHIBIT B-4 EX-VESSEL REVENUES OF SPECIES OF INTEREST IN COMPARISON TO OTHER SPECIES
HARVESTED PER FISHERMEN**

STATE	SPECIES OF INTEREST	EX-VESSEL REVENUE OF SPECIES OF INTEREST PER HARVESTER (2006\$)	EX-VESSEL REVENUE OF OTHER SPECIES PER HARVESTER (2006\$)	TOTAL EX-VESSEL REVENUE PER HARVESTER (2006\$)	PERCENTAGE OF EX-VESSEL REVENUE ATTRIBUTED TO SPECIES OF INTEREST PER HARVESTER
Maryland (2004)	Horseshoe Crab	\$41,950.89	\$85,548.06	\$127,499	33%
	American Eel	\$18,235.77	\$85,589.17	\$103,825	18%
	Conch	\$5,261.11	\$203,083.91	\$208,345	3%
Virginia (2005)	Horseshoe Crab	1175.230294	122926.6357	\$124,101.88	1%
	American Eel	3871.135318	76649.71722	\$80,520.87	5%
	Conch	\$3,465.44	\$87,891.11	\$91,356.59	4%
Source: IEC analysis of Maryland and Virginia state fisheries data courtesy of ACCSP.					