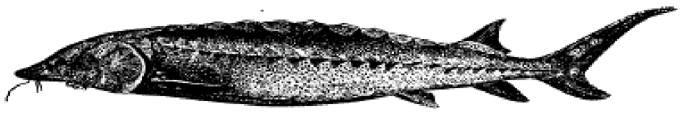
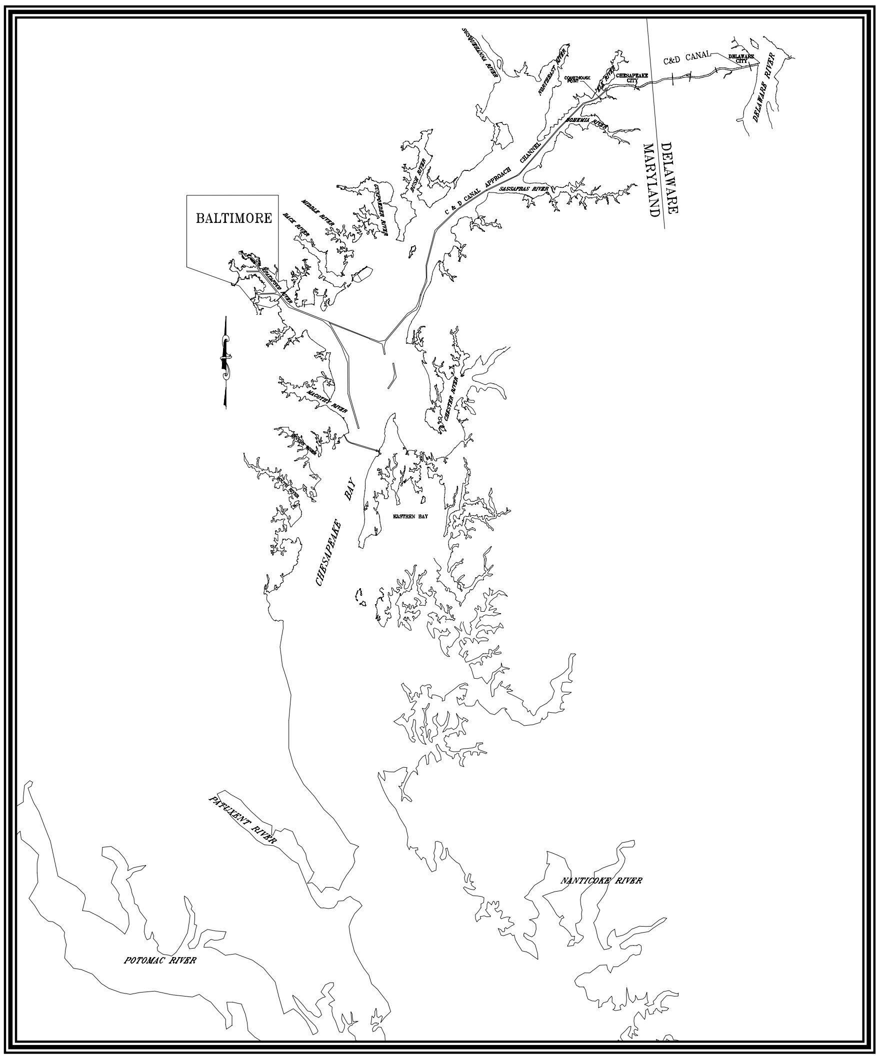
Draft Biological Assessment on the Potential Impacts of Dredging and Dredged Material Placement Operations on Shortnose Sturgeon in the Chesapeake Bay, Maryland



October 2003



U.S. Army Corps of Engineers, Baltimore District

Biological Assessment On The Potential Impacts Of Dredging And Dredged Material Placement Operations On Shortnose Sturgeon In The Chesapeake Bay, Maryland

OCTOBER 2003

Prepared for:

U.S. Army Corps of Engineers, Baltimore District
10 S. Howard Street, Baltimore, MD 21201

Prepared by:

MARYLAND ENVIRONMENTAL SERVICE
2011 Commerce Park Drive, Annapolis, MD 21401

Under Contract to:

EA Engineering, Science, and Technology, Inc.
15 Loveton Circle, Sparks, MD 21152

EXECUTIVE SUMMARY

Section 7 (a) (2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 et. seq.) requires every Federal agency, in consultation with and with the assistance of the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), to ensure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any Federally listed species or to result in the destruction or adverse modification of critical habitats. The shortnose sturgeon (SNS) is a Federally listed endangered species; coordination of their protection is the responsibility of NMFS. Due to an increased number of SNS captured during the USFWS Reward Program in the Chesapeake Bay in 1996 and 1997, NMFS requested that the U.S. Army Corps of Engineers (the Corps), Baltimore District (CENAB) and Philadelphia District (CENAP) prepare a Biological Assessment (BA) of the potential impacts of dredging and dredged material placement activities in the upper and middle reaches of the Chesapeake Bay on SNS. CENAB prepared an interim BA that evaluated dredging activities and alternatives in the Chesapeake Bay which was submitted to NMFS in November 2000. It included field studies and data on SNS and Wild Atlantic Sturgeon (WAS) captures through March 11, 2000. On October 29, 2002, NMFS indicated to the Corps that they had reviewed the interim BA and requested updates of information collected since its submittal. This BA includes information on the USFWS completed gillnet, telemetry, and genetic studies as well as Reward Program information available to date.

This BA updates the information presented in the Interim BA and assesses the potential impacts of dredging in the upper Chesapeake Bay and placement of dredged material in the upper and middle Chesapeake Bay on the SNS. It includes details on all placement options being considered within the Chesapeake Bay and Baltimore Harbor as well as details on dredging equipment and activities. This BA discusses options that include open-water sites, upland placement sites, island creation/restoration; and beneficial uses that typically focus on habitat creation and restoration, recycling or construction use. The assessment assumes that CENAB will need to dredge and find placement alternatives for up to 4.5 million cubic yards (mcy) [3.4 million cubic meters (mcm)] of dredged material annually for the next 20 years. It also assumes that most activities will need to take place during the period of October 1 through March 31 to comply with typical time-of-year restrictions imposed on Chesapeake Bay dredging activities. The analysis includes potential impacts of all kinds of dredging activities, although mechanical bucket and clamshell dredges are the most commonly used equipment within the upper bay.

Upon review of this Biological Assessment, NMFS will issue a determination on whether dredging in the upper Chesapeake Bay and dredged material placement activities in the upper and middle Chesapeake Bay are likely to place SNS in jeopardy or may adversely impact their habitat.

Based upon historical life history information, contemporary and ongoing studies of SNS within Chesapeake Bay and its tributaries, dredging mechanics, and placement site configurations detailed in this document, several conclusions about SNS with respect to bay dredging activities can be made. Although the recent Biological Opinion (BO) for the Washington Aqueduct (NMFS 2003) states that SNS may still be spawning in the Potomac River, field studies have not yet verified this assertion. Additionally, if spawning is still occurring in the Potomac River, it would not be affected by dredging or placement activities in the mainstem of the Chesapeake Bay. Although SNS have been captured below the Conowingo Dam, no SNS spawning activity has been document in the Susquehanna River and it is very likely that SNS are no longer spawning in the Chesapeake Bay. This is supported by genetic analyses. Any spawning activity that may still be occurring in the upper bay is miles from maintenance dredging activities in the Federal Navigation Channels and any currently proposed placement sites. Therefore, dredging activities within the Chesapeake Bay are not expected to affect spawning or early life stages of SNS.

Genetic analysis indicates that the SNS that were caught in the Chesapeake Bay are not a distinct population segment separate from the Delaware River population. This has also been supported by USFWS telemetry studies of SNS using the Chesapeake and Delaware (C&D) Canal (USFWS 2000b) indicating that the SNS captured in the Chesapeake Bay were similar to the Delaware River population. The Delaware River population is known to be relatively stable and self-sustaining, if not increasing (Hastings 1987). Latest estimates indicate population numbers in the thousands, with ongoing study of the feeding grounds and some study of spawning grounds. Wirgin et al. 2002 indicated that abundances of some populations, including the Delaware River population, may have rebounded to levels that could permit population-level endangered species delisting. Gillnetting studies have not collected any SNS. Reward Program captures have been recorded from a variety of depths, but very few collections have been made at depths similar to those in the Federal navigation channels [50 feet (ft) [15.2 meters (m)].

Although SNS have been collected in the general vicinity of the southern approach channels to the C&D Canal, and one was captured near the Tolchester Channel, none have been documented using the navigation channels (other than the C&D Canal) with either passive capture techniques or telemetry. Based upon this data, it appears that SNS are transients within the Baltimore Harbor Approach Channels and any utilization is probably incidental. Except for one deep area within the Susquehanna River Channel, SNS were generally found in shallower waters during the warmer months. Time-of-year dredging restrictions (October 1 to March 31) that are required for Bay and C&D Canal dredging would restrict dredging activities during the period when SNS are likely to be at the greatest depths and would be protective of the species.

Although SNS and WAS have been collected near some of the existing or proposed placement sites, no sturgeons have been collected within the proposed footprints of any site except one WAS caught in the G-East area of the existing Pooles Island site. Based upon these observations, it appears that SNS are transients to the existing and proposed dredged material placement sites within the Chesapeake Bay.

Most dredging activities of the Federal Navigation Channels in the upper reaches of the Chesapeake Bay are conducted with mechanical dredges (clamshell dredge), which have been documented to be the least likely to impact sturgeon based upon activities in other areas. Sturgeon have been captured within clamshell buckets and released alive and unharmed. Sturgeon observers were utilized during recent dredging operations to comply with NOAA restrictions for hopper dredging activities conducted from January to March at Courthouse Point. There were no observed takes of sturgeon during that operation or during five respective seasons of CENAP dredging activities in the upper Chesapeake Bay utilizing a bucket dredge. CENAB used observers during the 2002/2003 placement season (December 1 – January 29) while conducting maintenance dredging in the Baltimore Harbor Approach Channels by bucket dredge. There were no observed takes of sturgeon during these activities.

Negligible impacts to SNS are expected due to the small number of SNS found by the USFWS Reward Program, the lack of SNS utilization of the Federal channels or proposed placement areas, and the absence of SNS taken during dredging operations in the upper Chesapeake Bay based upon observer data. Based upon activities in other areas, incidental takes of sturgeon may be possible and an Incidental Take Permit (ITP) would likely be required for future dredging activities in the Chesapeake Bay. An ITP of three fish per year was set for the dredging of the C&D Canal Northern Approach Channel, which was number that NMFS indicated would not likely have a negative impact on the status of the SNS in the area. Therefore, incidental takes of this magnitude, if set for the current dredging operations, are not expected to have a negative impact on SNS in the Chesapeake Bay or the Delaware River.

BIOLOGICAL ASSESSMENT
OF THE POTENTIAL IMPACTS OF
DREDGING AND DREDGED MATERIAL PLACEMENT OPERATIONS
ON SHORTNOSE STURGEON
IN THE CHESAPEAKE BAY, MARYLAND

AUGUST 2003

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

1.0 INTRODUCTION: PURPOSE AND NEED FOR BIOLOGICAL ASSESSMENT (BA)

Section 7 (a) (2) of the Endangered Species Act (ESA) (16 U.S.C. 1531 *et. seq.*) requires every Federal agency, in consultation with and with the assistance of the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), to ensure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any Federally listed species or to result in the destruction or adverse modification of critical habitats. Due to an increased number of shortnose sturgeon (SNS) captured during the USFWS Reward Program in the Chesapeake Bay in 1996 and 1997, NMFS requested that the U.S. Army Corps of Engineers (the Corps), Baltimore District (CENAB) and Philadelphia District (CENAP), prepare a Biological Assessment (BA) of the potential impacts of dredging in the upper bay and dredged material placement activities in the upper reaches of the Chesapeake Bay on SNS.

The SNS is a Federally listed endangered species; coordination of their protection is the responsibility of NMFS. The U.S. Department of the Interior (USDOI) originally listed the SNS as an endangered species in March 1967 (32 FR 4001). The SNS remained on the Federal Endangered Species List with enactment of the ESA of 1973. Upon review of this BA, NMFS will issue a determination on whether dredging in the upper Chesapeake Bay and dredged material placement activities in the upper and middle Chesapeake Bay are likely to place SNS in jeopardy or may adversely impact their habitat.

2.0 SECTION 7 CONSULTATION PROCESS

For the Corps and other Federal agencies, implementation of the ESA to protect SNS centers on the Section 7 consultation process. Section 7 requires the Corps to consult with NMFS or USFWS, as appropriate, on all actions that may affect Federally listed threatened or endangered species. The goal of the consultation is to ensure that the effects of an action are not likely to jeopardize the continued existence of listed species or their habitat.

When the consultation process identifies a "may affect" situation, steps are taken to minimize the adverse impacts to endangered and threatened species and their habitats and to evaluate and consider the needs of the Federally listed species early in the planning process. If a jeopardy situation is identified, reasonable and prudent alternatives, if available, are incorporated to allow continuance of the activity without jeopardizing the listed species [50 CFR 402.14(H)(3)]. A Biological Assessment is the evaluation of potential effects, both direct and indirect, of the proposed action on such species and habitat.

2.1 INITIATION AND HISTORY OF CONSULTATION

For the Corps, the first step of the process is consultation to request a list of Federally protected species and designated critical habitat in the area of the proposed action. In practice, the USFWS and NMFS frequently identify listed species and critical habitats when responding to Corps public notices for Federal projects and permit applications. When no listed species or habitat is present in the area, the NMFS or USFWS will advise the Corps that no further consultation action is required. If listed species are present in the proposed action area, the Corps is required to prepare a Biological Assessment (50 CFR 402.12). When the proposed action area contains no listed species, but contains critical habitat or species proposed for listing, the Corps is required to consult with NMFS or USFWS.

On March 9, 1997, coordination letters were sent to the USFWS and NMFS requesting information on the presence of listed or proposed for listing rare, threatened, or endangered species found within the Kent Island/Site 104 area (a proposed placement area). The response letter from the USFWS [Appendix B of U.S. Army Corps of Engineers (USACE) 1999] stated that shortnose sturgeon (*Acipenser brevirostrum*), a Federally listed endangered species, had been documented off western Kent Island, south of the Bay Bridge, in May 1996 by USFWS.

The USFWS letter also cited wild Atlantic sturgeon (*Acipenser oxyrinchus*), which has been recorded in the area, as a species of concern. On May 29, 1997, NMFS and USFWS were petitioned by the Biodiversity Legal Foundation to determine the merits of the wild Atlantic sturgeon (WAS) candidacy for Rare, Threatened, and Endangered (RTE) listing. According to the Federal Register dated September 21, 1998, NMFS and USFWS determined from a 1-year study that listing Atlantic sturgeon in the U.S. was not warranted.

The summary statement provided by USFWS indicated that, except for occasional transient individuals, no other Federally listed or proposed for listing endangered or threatened species are known to exist in the project impact area and, therefore, no further Section 7 consultation was required with the USFWS. However, USFWS recommended contacting NMFS because they are the lead Federal agency for formal Section 7 requirements for the shortnose sturgeon (SNS).

The Federal response letter from the NMFS (Appendix B of USACE 1999) mentioned that while their agency is responsible for a number of endangered and threatened species, including sea turtles and several marine mammals in the upper Chesapeake Bay, NMFS believes it unlikely that the proposed action would adversely affect these species. The NMFS stated that their agency could not accurately determine the current status of the SNS.

By letter dated December 16, 1997 (Appendix B of USACE 1999), the NMFS indicated that CENAB should prepare a Biological Assessment (BA) to comply with Section 7 of the Endangered Species Act of 1973, as amended. In this letter, the NMFS indicated that it "*would investigate options that would permit the proposed project* (which specifically referred to Site 104 at the time) *to remain on schedule while still meeting the requirements of the endangered species act.*" To this purpose, CENAB prepared an interim BA that included a more thorough evaluation of dredging activities and alternatives in addition to Site 104. The interim BA was submitted to NMFS in November 2000 and included field studies and data on SNS and WAS captures through March 11, 2000. On October 29, 2002, NMFS wrote that they had reviewed the interim BA and requested updates of information collected since its submittal (Appendix F). This BA includes information on the USFWS completed gillnet, telemetry, and genetic studies, as well as Reward Program information available to date.

This BA will update the information presented in the Interim BA and assess the potential impacts of dredging in the upper Chesapeake Bay and placement of dredged material in the upper and middle Chesapeake Bay on the SNS. Figure 1 presents the placement options currently being considered by CENAB for placement of up to 4.5 million cubic yards (mcy) [3.4 million cubic meters (mcm)] annually of dredged material. Over a period up to 20 years, dredging and placement activities are proposed to take place during the period of October 1 through March 31 for all the alternatives, except Site 104, Deep Trough (north of Bloody Point), and Deep Trough (south of Bloody Point). The proposed window for placement at these sites is October 15 – March 31. Material would be dredged from the Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel Eastern Extension, Swan Point Channel, Tolchester Channel, and the Chesapeake & Delaware (C&D) Canal southern approaches (Figure 2). Dredging of these channels since 1983 has been performed by clamshell dredge, cutterhead with a hydraulic pipeline, or hopper dredge. It is anticipated that dredging would most likely be performed by clamshell dredge, although there is a possibility that the material could be placed by hydraulic clamshell or hopper dredge. The dredged material placement options are summarized in Chapter 5. This BA discusses options that include open-water sites, upland placement sites, island creation/restoration, and beneficial uses that typically focus on habitat creation and restoration, recycling, or construction use.

Figure 1. Placement Options

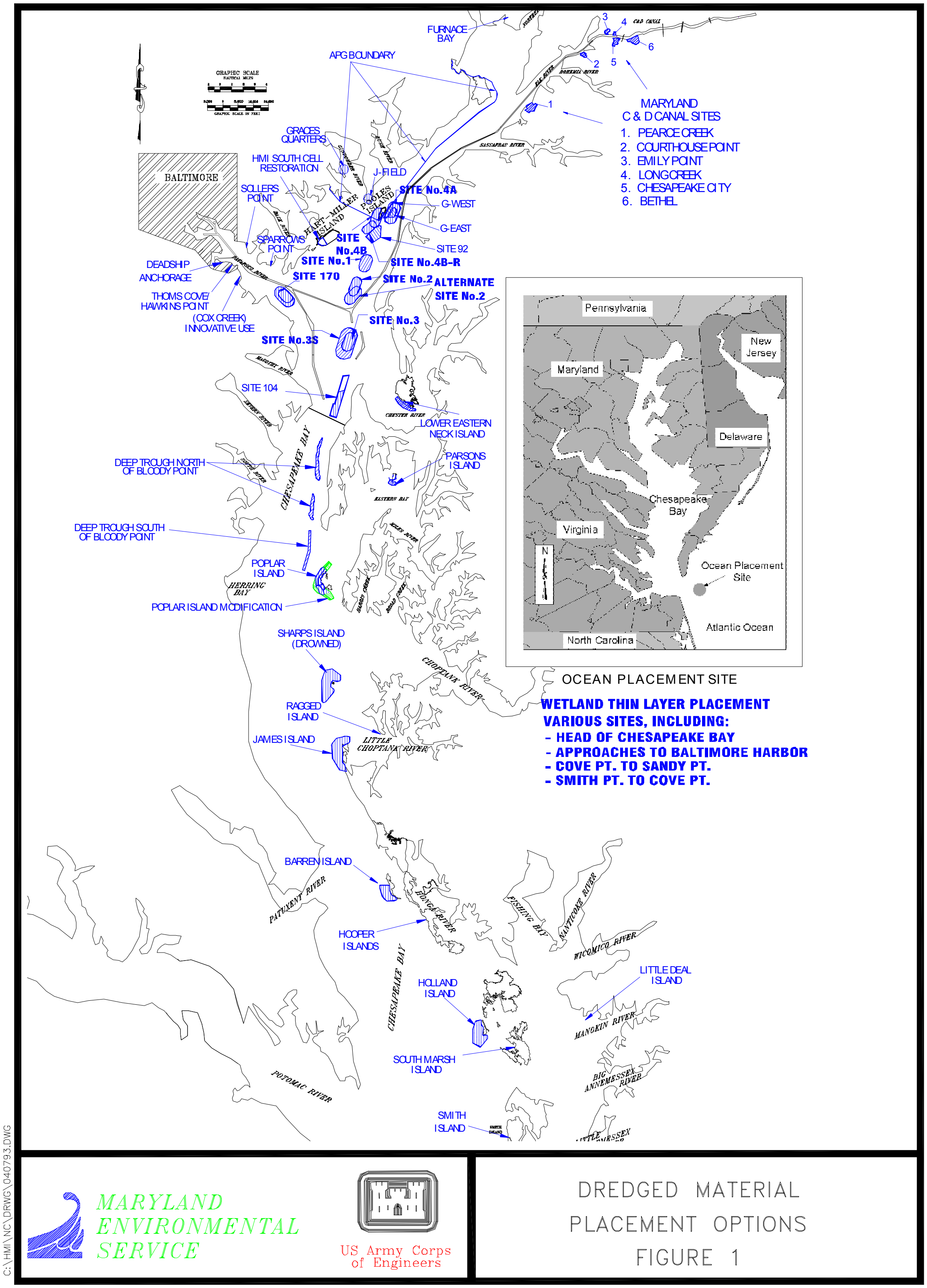
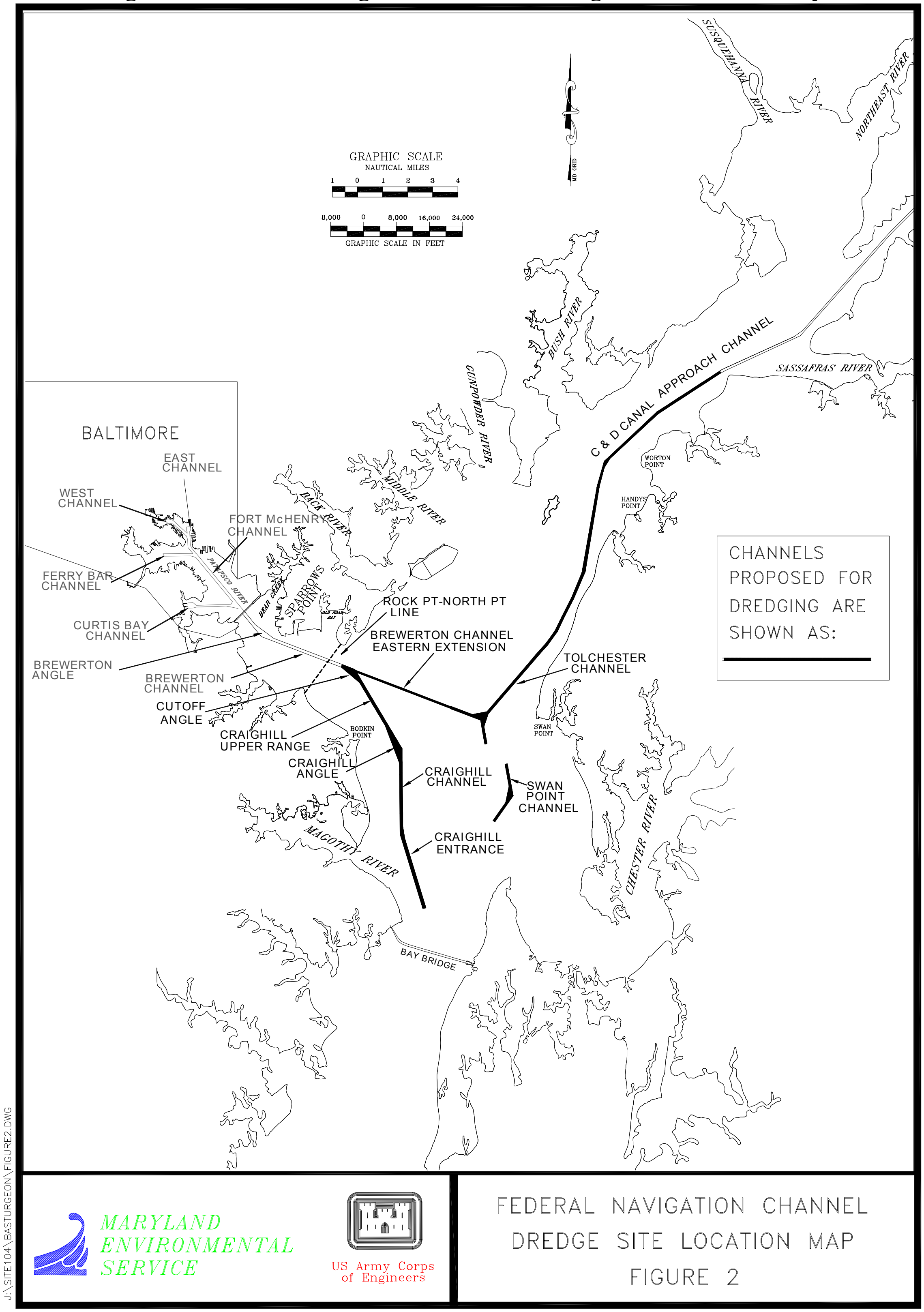


Figure 2. Federal Navigation Channel Dredge Site Location Map



2.2 BIOLOGICAL ASSESSMENT

A BA is the compilation of information prepared by or under the direction of the Federal agency proposing the action (in this case CENAB) concerning listed and proposed species, designated and proposed critical habitat that may be present in the proposed action area, and the evaluation of potential effects, both direct and indirect, of the action on such species and habitat (50 CFR 402.02). The specific contents are at the discretion of CENAB and will depend upon the nature of the proposed activity. However, it is prudent to include the minimal information requirements to initiate a formal consultation in the BA (see Section 2.4).

CENAB is to use the final BA in determining whether a conference or formal consultation is required under 50 CFR, §402.10 or 402.14, respectively. If the final BA indicates that there are no species or critical habitat present that are likely to be adversely affected by the proposed action, and the NMFS concurs, then formal consultation is not required. If the final BA indicates that the action is not likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat, and the NMFS or USFWS concurs, then a consultation is not required.

Biological Assessments are submitted to the NMFS for review. The NMFS will concur or nonconcur in writing within 135 days. The NMFS may use the Biological Assessment in: determining whether to request the Federal agency to initiate formal consultation or a conference; formulating a biological opinion; or formulating a preliminary biological opinion.

2.3 INFORMAL CONSULTATION

Informal consultation is an optional procedure that includes all discussions, correspondence, etc., between the NMFS and Corps aimed at assisting the Corps in determining whether formal consultation or a conference is required. To complete an informal consultation, the NMFS provides the Corps with written concurrence that the proposed action is not likely to adversely affect listed species or critical habitat or advises the Corps that formal consultation and/or a conference is required. This communication from NMFS describes the basis for the determination.

2.4 FORMAL CONSULTATION

Formal consultation is required when the proposed action may affect endangered or threatened species. It can be initiated with a written request from the Corps and submission of the BA. The BA should include descriptive materials on the following:

- the proposed action;
- the specific area that may be affected;
- listed species or critical habitat that may be affected;
- the manner in which the listed species or habitats may be affected and any cumulative effects;

- other relevant reports; e.g., Biological Assessments, Environmental Assessments, Environmental Impact Statements; and

- other relevant information.

The NMFS will review all relevant information provided, evaluate the current status of the listed species and/or critical habitat, and evaluate the effects of the proposed action and cumulative effects on the listed species and/or critical habitat. The NMFS then formulates a Biological Opinion (BO) as to whether the proposed action, taken together with cumulative effects, is likely to jeopardize the continued existence of listed species and/or result in the destruction or adverse modification of critical habitat (a "jeopardy" biological opinion) or is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat (a "no jeopardy" biological opinion). If a jeopardy determination is made, the work cannot proceed without an exemption [50 CFR §402.15(c)].

2.5 INCIDENTAL TAKE

The ESA language recognizes that some actions may result in incidental take of individuals of Federally listed species. In those cases where the NMFS concludes that the proposed action, or the implementation of any reasonable and prudent alternative, and the resultant incidental take of listed species will not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat, the NMFS will provide a statement concerning the incidental taking of the species with the biological opinion.

The incidental take statement will do the following:

- specify the permissible impact, i.e., the amount or extent of such incidental taking of the species;

- specify the reasonable and prudent measures considered necessary or appropriate to minimize such impact;

- set forth the terms and conditions (including, but not limited to, reporting requirements) that must be complied with by the Corps to implement the measures; and

- specify the procedures to be used to handle any individuals of a species actually taken.

Reasonable and prudent measures, along with the terms and conditions that implement them, are not supposed to alter the basic design, location, scope, duration, or timing of the action or prudent alternatives and are to involve only minor changes [50 CFR §402.14(I)(2)]. Without the Section 7 consultation and the Incidental Take Statement, any incidental taking of listed species would be subject to prosecution (Henwood 1990).

3.0 HISTORICAL AND CURRENT STATUS OF SNS IN THE CHESAPEAKE BAY

SNS have been documented in the Chesapeake Bay since the 1600s, when settlers first colonized America. Historical records indicate that SNS were commonly found to inhabit the Potomac River in Maryland in the 1800s (Uhler and Lugger 1876). Few SNS have been reported in the Chesapeake Bay since the last known resident populations were considered extirpated in the 1970s (Dadswell et al. 1984). There is, however, a documented resident population in the Delaware River (Hastings et al. 1987).

When SNS were found in the bay over the last 20 years, it was generally believed that they were infrequent transients, non-resident adults that had traveled through the Inland Waterway, or C&D Canal, from the Delaware Bay into the Chesapeake Bay. Prior to 1998, no juveniles or spawning activity had been observed in the Chesapeake Bay for decades, leading to the assumption that a distinct population segment, or resident population, did not exist in the Chesapeake Bay. Speculation has been that overfishing, loss of habitat, and spawning impediments such as the Conowingo Dam have contributed to their decline or extirpation. At present, the continued existence of SNS in the Chesapeake Bay remains uncertain. However, genetic assessments of the SNS, captured from the Reward Program, in the Chesapeake Bay have indicated that those specimens analyzed are genetically similar to the Delaware River population that is currently stable (Wirgin et al. 2002).

NMFS has been reviewing SNS catches in the Chesapeake Bay as a result of the USFWS Reward Program that was initiated in 1996 (Section 3.1.2). This program has resulted in the reporting and documentation of SNS as incidental bycatch in gillnets, pound nets, catfish traps, fyke nets, hoop nets, and eel traps of watermen in the Chesapeake Bay. With the documented incidence of more than an occasional transient SNS, NMFS requested a formal Section 7 consultation and BA regarding impacts to SNS from the Baltimore Harbor and Channels: Maryland 42-foot and 50-foot Federal Navigation Project on December 16, 1997. The purpose of the consultation and BA was to collect data on the potential occurrence of a resident population of SNS in the Chesapeake Bay. NMFS encouraged collection of information to determine whether or not SNS in the Chesapeake Bay constitute a geographically and genetically distinct population from the Delaware Bay.

Data collection by the USFWS, funded by CENAB and CENAP, was initiated in December 1997. The program was initially expected to last 2 years; however, at the request of USFWS, the Corps provided extra funding to extend the project for an additional 6 months, through June 2000. The objectives, methods, and results from the study are discussed in detail in Section 3.1.4

Based upon the SNS captures under the Reward Program, the Chesapeake Bay SNS were listed as a distinct population segment in the Final SNS Recovery Plan (NMFS 1998). The Final Recovery Plan recommended that genetic characterization of SNS found in the Chesapeake Bay be performed and that NMFS review the distinct population segment (DPS) structure of this species on the basis of genetic results.

The request for a Formal Section 7 consultation was made by the NMFS before the initiation of the 2½-year Corps-sponsored field data collection program. This provided the opportunity for the Districts to include the NMFS suggestions in the study. The NMFS agreed to conduct consultations as needed in the interim and to make determinations with information available at that time.

On January 26, 1999, NMFS issued a BO concerning impacts to endangered SNS from maintenance dredging (using a hopper dredge) of the C&D Canal and the Northern Approach Channel to the C&D Canal in Maryland and Delaware (NMFS 1999). Based on their review of available data and the CENAP Break Out Biological Assessment, NMFS concluded that the project was not likely to jeopardize the continued existence of SNS that inhabit the project area in the upper Chesapeake Bay. The NMFS authorized an incidental take allowance of three SNS for this project. No sturgeon have been taken in the subsequent dredging and placement. Dredging has occurred annually since 1998 with either a clamshell dredge and/or hopper dredge.

The NMFS agreed to consider an "interim" Biological Assessment of dredging and dredged material placement operations in the upper Chesapeake Bay prior to the completion of the 2½-year study. On November 13, 2000, the Corps submitted an interim BA to NMFS for their consideration. The data though March 10, 2000 were included in this interim BA, as well as literature and other data collection efforts in this area and along the Atlantic seaboard. Several SNS Biological Assessments for dredging activities were used as references.

On August 29, 2002, NMFS emailed CENAB in response to their plans to dredge the Craighill Entrance, Craighill Channel, Craighill Upper Range, and Cutoff Angle approach channels in October of that year. The National Oceanic and Atmospheric Administration (NOAA) responded that, in prior letters to CENAB (dated October 1997; January 1998; December 2000), they indicated that if a mechanical/clamshell dredge was used in CENAB maintenance dredging, SNS were not likely to be adversely affected. However, new information had arisen that indicated sturgeon might be taken in these types of dredges. NOAA referred to an Atlantic sturgeon that was killed in the Cape Fear River in a bucket and dredge operation, and within the last year, an Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and released unharmed during dredging operations in the Kennebec River. NOAA wrote, "*…while these takes were Atlantic sturgeon, the similarity of the species, distribution, and behavior, indicated that SNS could be taken as well. Endangered species takes of this kind are not authorized without an Incidental Take Statement. While the impacts to SNS from mechanical bucket dredging are expected to be less than those from other types of dredges (e.g., hopper and hydraulic pipeline), the potential for taking SNS with this type of dredge exists. Furthermore, dredging in the Delaware River and Kennebec River have incorporated mechanical dredging time of year restrictions due to the presence of SNS.* NOAA recommended that measures be taken to minimize impacts to SNS during the dredging. Specifically, they recommended that dredging take place from September to November. If this was not possible and mechanical dredging must occur over the December to March period (or a hydraulic dredge used), NOAA recommended that the Corps initiate formal consultation with NOAA Fisheries so that the impacts of dredging on SNS during that time could be assessed. NOAA further stated that regardless, if the Corps *"plans to use mechanical dredging in the Chesapeake Bay in the future and NOAA Fisheries determines that SNS may be taken during these operations, it will be necessary to engage in formal consultation for all the Baltimore Harbor Channels to assess the impacts to SNS and provide an Incidental Take Statement."* (Carrie McDaniel, Appendix E).

On October 29, 2002, NOAA stated that they had reviewed the interim BA and requested updates of new information collected since its submittal. Specifically, NMFS requested updates to the dredging and SNS studies, all details related to the proposed project and dredging impacts to the SNS, including discussions of time-of-year restrictions that prohibit dredging from December through July. NOAA stated that if the dredging in the upper Chesapeake Bay cannot be accomplished during the preferred time period, formal consultation would be necessary (Kimberly Damon-Randall, Appendix F).

Information was obtained regarding recent dredging activities and the use of sturgeon observers during dredging operations. CENAP used trained observers during dredging activities at Courthouse Point from January to March 1998. Dredging at Courthouse Point was conducted with a hopper dredge and there were no observed takes of sturgeon during this operation. For the past five seasons (1998/1999 – 2002/2003), at NMFS direction, CENAP has used the Corps dredging inspectors and dredge crew to observe for sturgeon during dredging activities. Dredging was conducted with a bucket dredge and there were no observed takes of sturgeon (personal communication with Walter DePrefontaine, CENAP). CENAB was not required to use sturgeon observers over the same period of time, but did use observers for the 54-day period (December 5, 2002 – January 27, 2003) while conducting maintenance dredging in the outer channels by bucket dredge during the 2002/2003 placement season (personal communication with Kevin Mainquist, CENAB). There were no observed takes of sturgeon during the dredging (personal communication with Jeff McKee, CENAB).

On July 15, 2003, NMFS released a BO for SNS in the Potomac River in the District of Columbia relative to the Washington Aqueduct National Pollutant Discharge Elimination System (NPDES) permit (NMFS 2003). The Potomac River BO found no conclusive evidence that SNS are currently spawning in the Potomac River, but has requested further study in the area. The BO also concluded that if SNS are still utilizing the Potomac River, the project might adversely affect individuals, but is not likely to jeopardize the continued existence of the species. The BO, therefore, included an incidental take statement (ITS) for the project relative to SNS in the Potomac.

3.1 PREVIOUS STUDIES

Due to their believed extirpation from the Chesapeake Bay, few studies have been conducted of the SNS in the area until recently. The studies conducted in the last few years are discussed in the following paragraphs. A review of WAS catches within the Chesapeake Bay is also provided in the following paragraphs where appropriate as supplemental information for SNS because of their overlap in habitat range. The WAS is not listed as a Federally endangered or threatened species. The following paragraphs list and discuss aquatic sampling conducted in and around channels and dredged material placement sites.

3.1.1 Aberdeen Proving Ground Study – Upper Bay Around Pooles Island and the Gunpowder River

The USFWS conducted a field study of SNS with the U.S. Army Aberdeen Proving Ground (APG) in conjunction with the Corps-funded Sturgeon Study (Section 3.1.4). Data collection was initiated in early Summer 1997 and ended June 29, 2000 (USFWS 2003). The study in the Aberdeen area used gillnets set in 12-20 feet (ft) [3.6-6.1 meters (m)] of water in the mainstem of the Chesapeake Bay around Pooles Island and in the Gunpowder River. The nets were generally set as day and overnight sets year round, and consisted of 300- and 400-ft (91- and 122-m) lengths with 4-, 5-, or 6-inch (in.) [10.2-, 12.7-, or 15.2-centimeter (cm)] mesh. No SNS were collected in approximately 1,417 hours of gillnetting through June 29, 2000 (Appendix B, USFWS 2000 Report, Table 3). According to USFWS, four Atlantic sturgeon were captured by the gillnets within the boundaries of placement area G-East (this was actually determined to be Area G-West); one was captured in commercial drift gillnets during this study in an area identified as Aberdeen around Pooles Island and another at Site 92. The USFWS designated boundaries were actually larger than the actual or proposed placement site boundaries. APG performed this study to fulfill their responsibility to document and manage any RTE species that exist within their boundaries.

3.1.2 USFWS Atlantic Sturgeon and SNS Reward Program

The USFWS is currently conducting a field study of Atlantic sturgeon and SNS populations in the Chesapeake Bay in cooperation with the Chesapeake Bay Program (CBP) and Maryland Department of Natural Resources (MDNR) through a reward program. This program offers a reward of $25 for each live hatchery reared Atlantic sturgeon and $100 for each live SNS and WAS reported and documented as incidental bycatch by commercial or recreational watermen. Since SNS are endangered species, handling of the fish, including tagging and measuring, was performed by USFWS. However, in May 2002, USFWS was informed by NMFS that they could no longer handle any SNS caught through the Reward Program because it was not listed in their permit with NMFS. The permit states that only USFWS may capture sturgeon via gillnets and tag them, and are not able to use watermen to capture the SNS. Since May 2002, USFWS identifies whether the species is SNS and records its capture location before releasing it, but does not tag or record measurement information. As of the writing of this document, the permit is currently under discussion between the State of Maryland and the NMFS (USFWS 2003).

SNS Reward Program catches in the upper Chesapeake Bay above the Bay Bridge and in the middle Chesapeake Bay south of the Bay Bridge are shown in Figures 3 and 4, respectively. WAS Reward Program catches are shown in Figures 5 and 6. Figure 7 presents a map of licensed pound net locations in the Chesapeake Bay. Details of these collections can be found in Section 3.1.4.3.

Figure 3. SNS Reward Program Catches in the Upper Bay Above the Bay Bridge (Last Updated September 30, 2003)

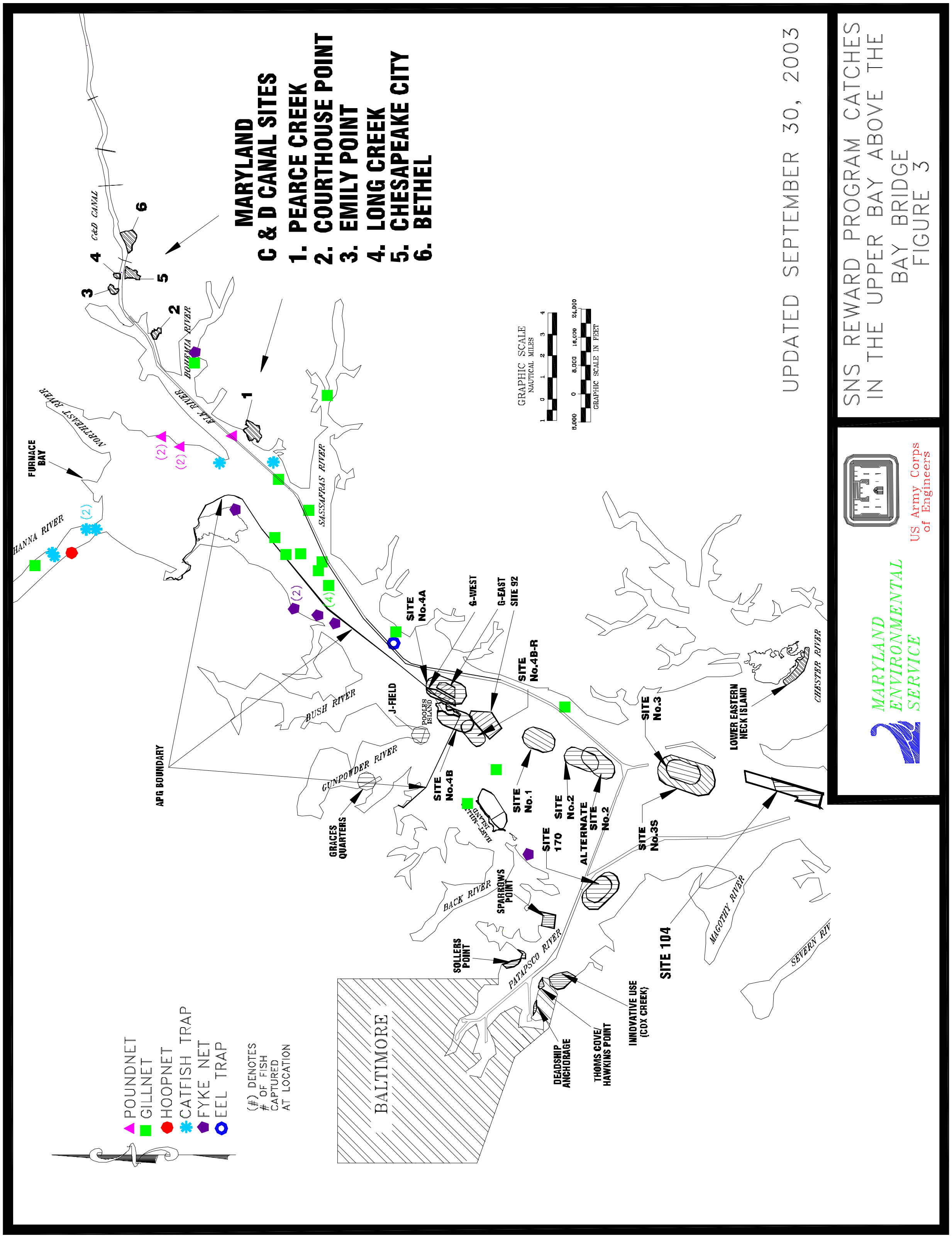


Figure 4. SNS Reward Program Catches in the Mid Bay South of the Bay Bridge (Last Updated September 30, 2003)

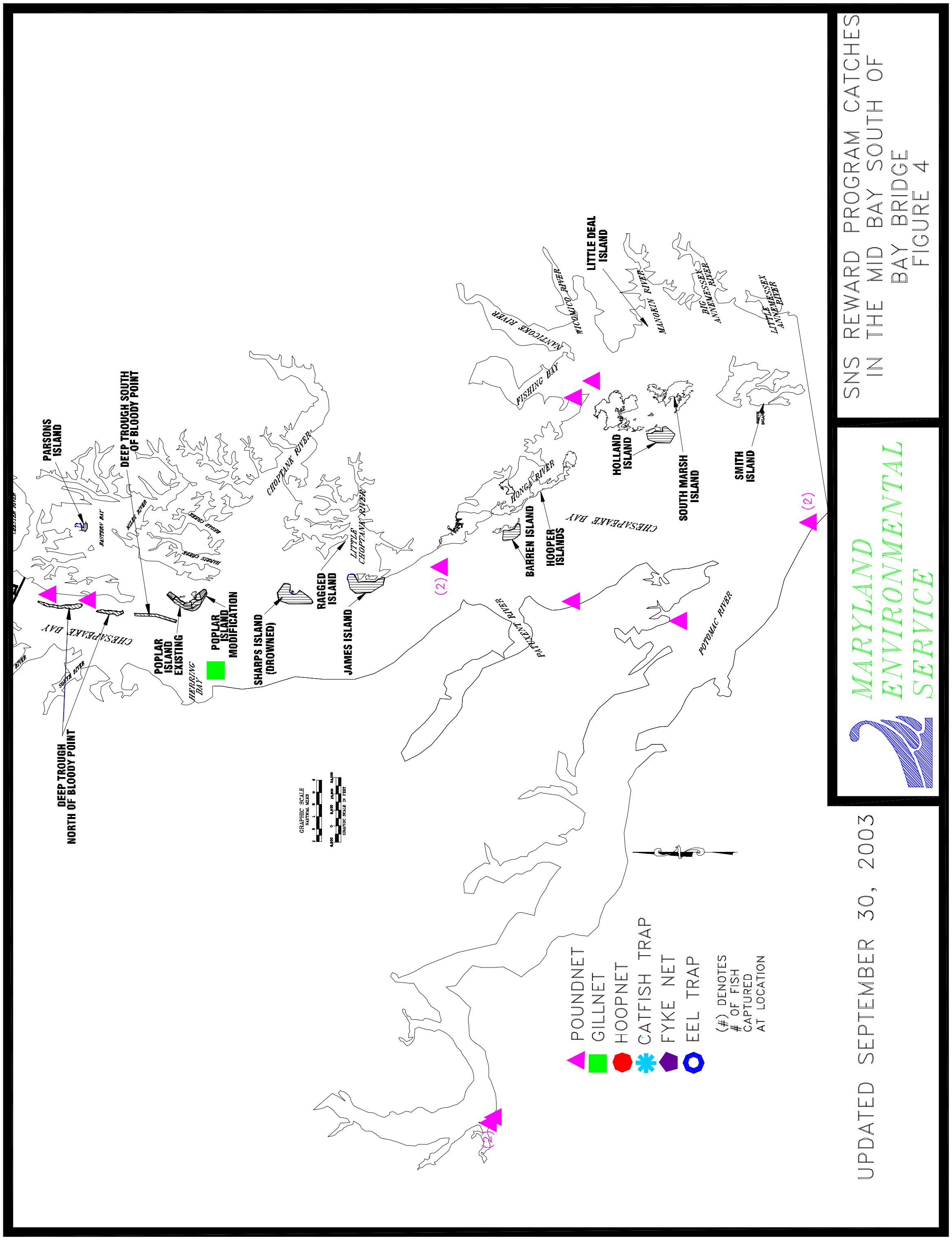


Figure 5. Wild Atlantic Sturgeon Reward Program Catches in the Upper Bay Above the Bay Bridge (Last Updated September 30, 2003)

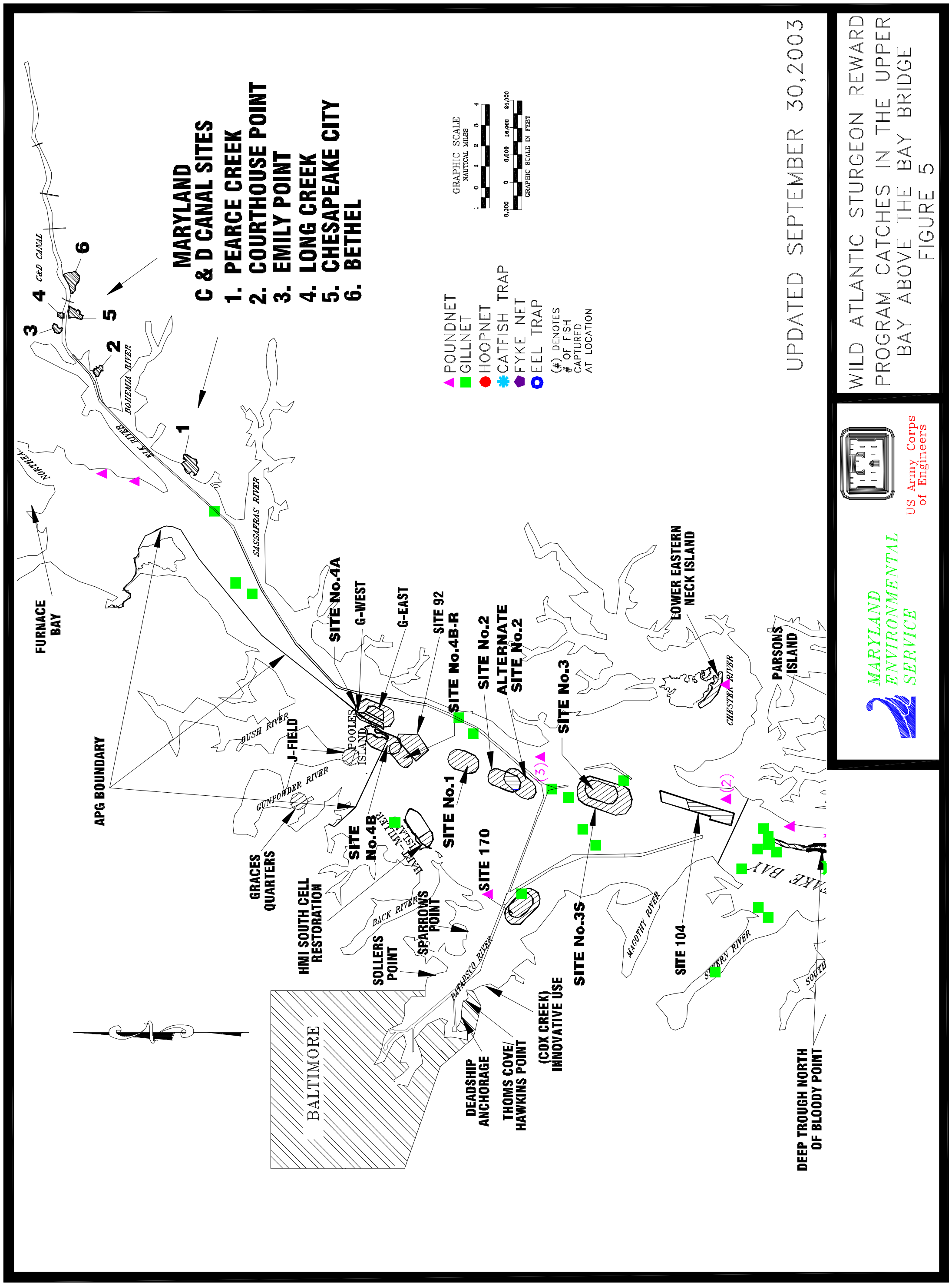


Figure 6. Wild Atlantic Sturgeon Reward Program Catches in the Mid Bay South of the Bay Bridge (Last Updated September 30, 2003)

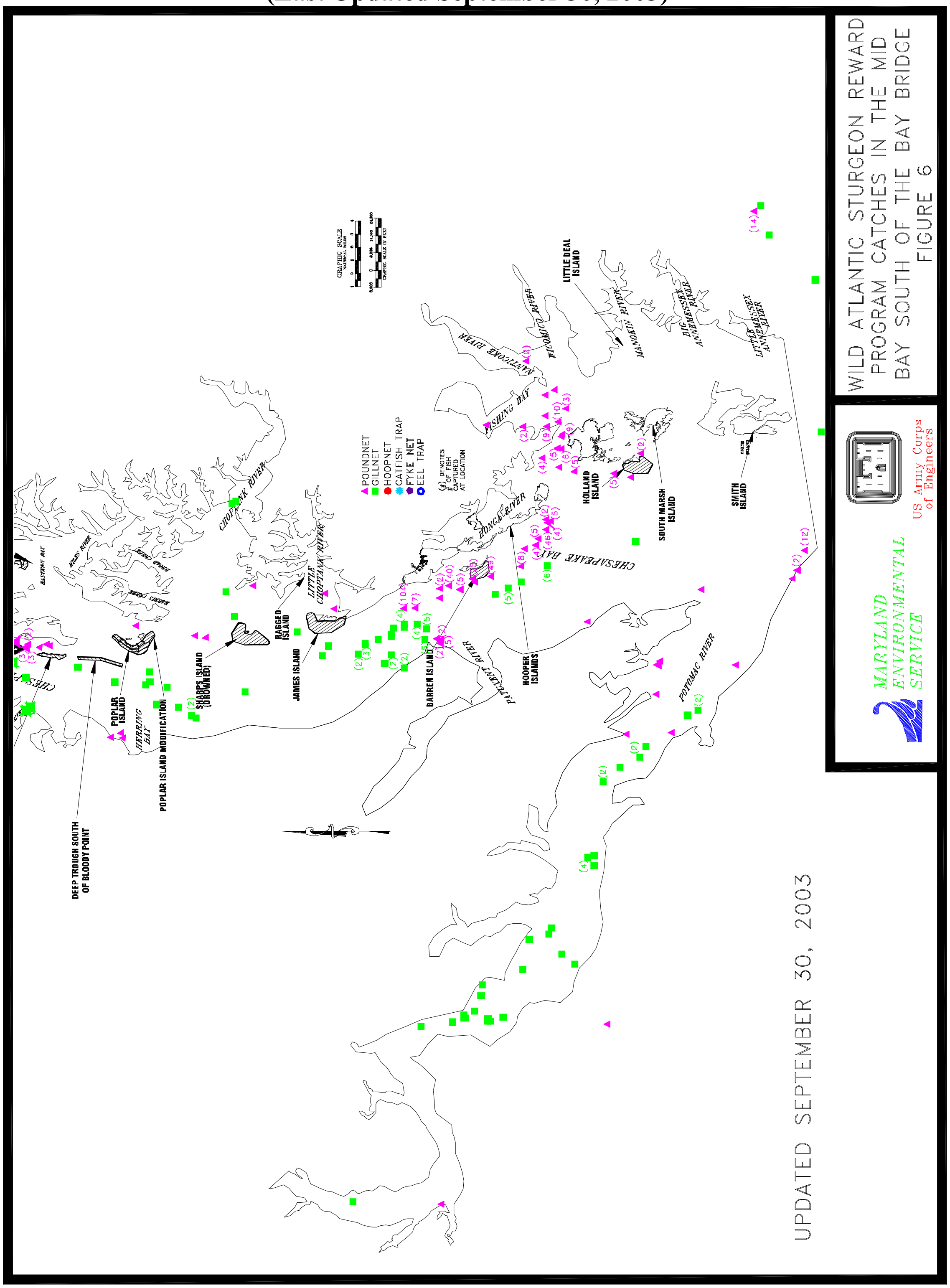
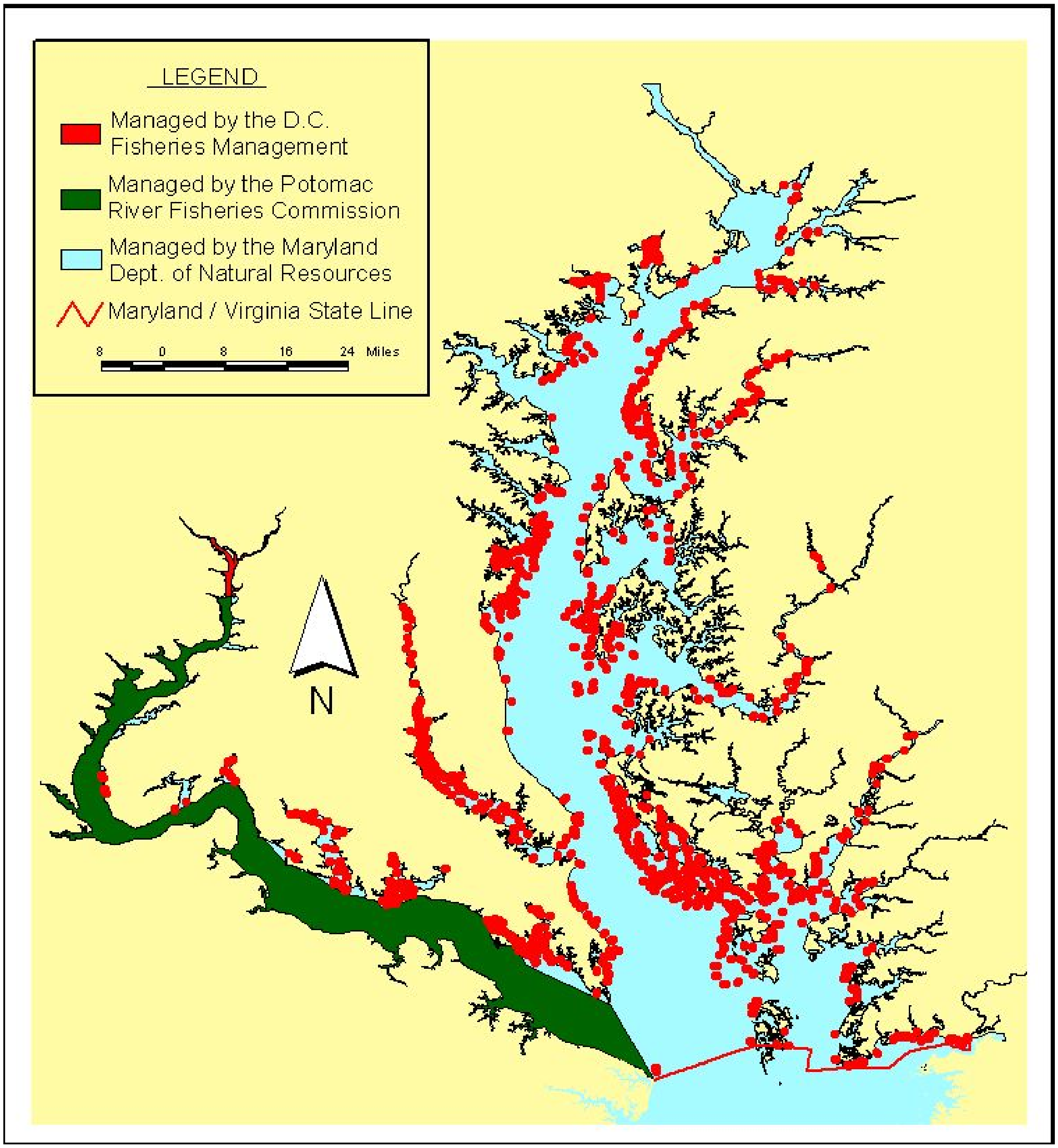


Figure 7. Map of Licensed Pound Net Locations in the Chesapeake Bay (MDNR 2003)



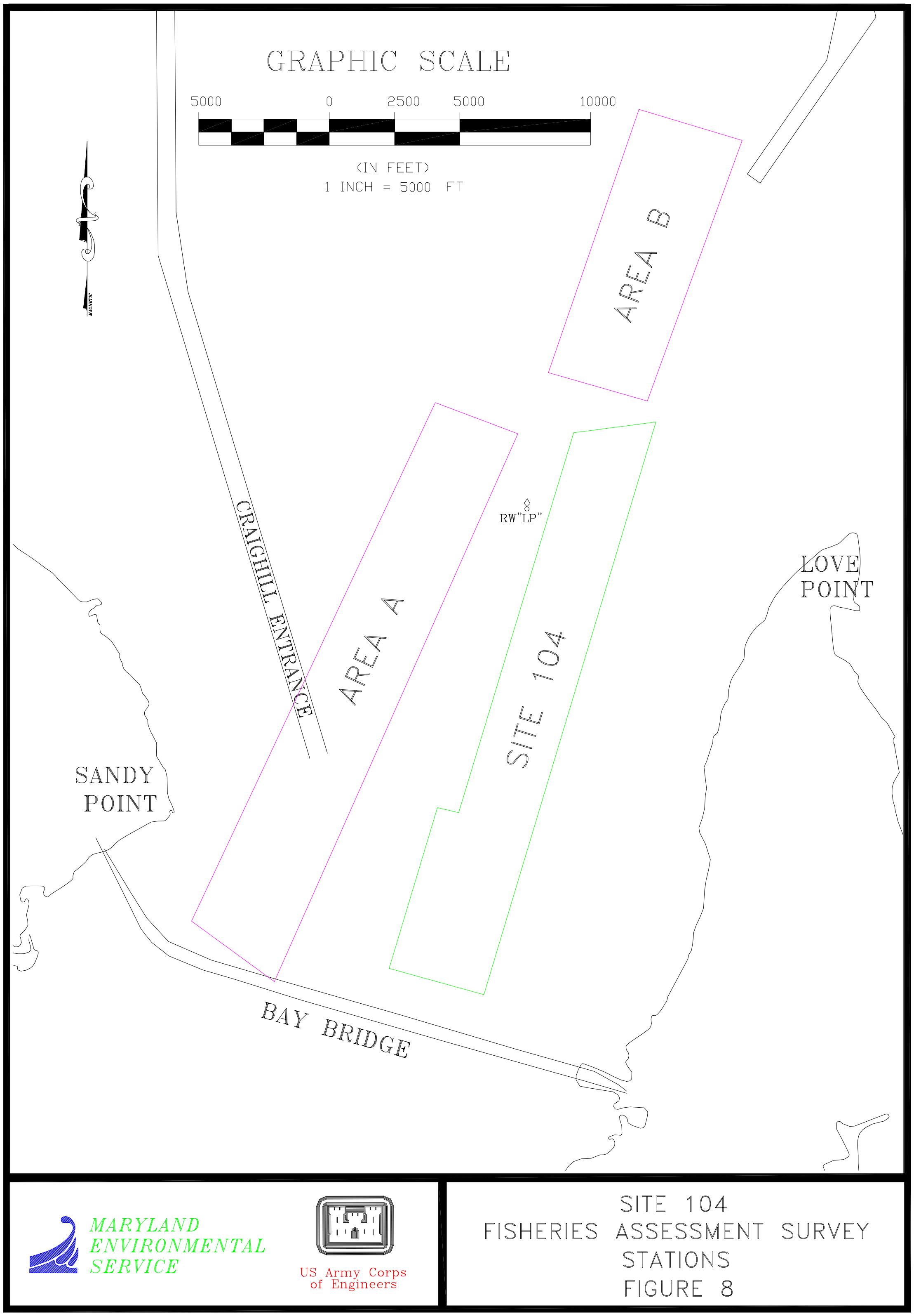
3.1.3 Other Fisheries Studies

The following paragraphs list and discuss aquatic sampling conducted in and around dredged material placement sites in the Chesapeake Bay and Potomac River. Prior to the Reward Program, there was no recent documentation of SNS in Maryland waters despite extensive and long-term sampling with seines (striped bass juvenile index: 1954-2003), trawls (blue crab population assessments: 1980-2003), and gillnet and pound net surveys (various: 1972-2003).

3.1.3.1 Fish Population Characterization Conducted in and Around Site 104

Fish abundances and distributions were evaluated in Site 104 and two reference areas, A and B (Figure 8), as part of a sampling program conducted during the day and night, during four different seasons of the year (July 1996 to April 1997) and at varying depths (Miller 1998). The fisheries cruises were conducted during the months of July, October, and December 1996 and April 1997. A total of 28 deployments of multi-panel, anchor-set gillnets, 24 mid-water trawls, and 128 bottom trawls were performed to determine the composition of the fish community within and around Site 104. The gillnets were generally set during the day, and consisted of 150-ft (45.7-m) length with a 3-, 4-, 5-, 6-, 7-, and 8-in. (7.6-, 10.2-, 12.7-, 15.2-, 17.8-, and 20.3-cm) mesh. Bottom trawls consisted of a 26-ft (7.9-m) head rope, 1.5-in. (3.8-cm) stretch mesh netting, and a 0.5-in. [13-millimeter (mm)] stretch mesh liner to retain small samples. No shortnose or Atlantic sturgeon were captured during the study by either method in Site 104 or in reference areas A and B during the study period.

Figure 8. Site 104 Fisheries Assessment Survey Stations

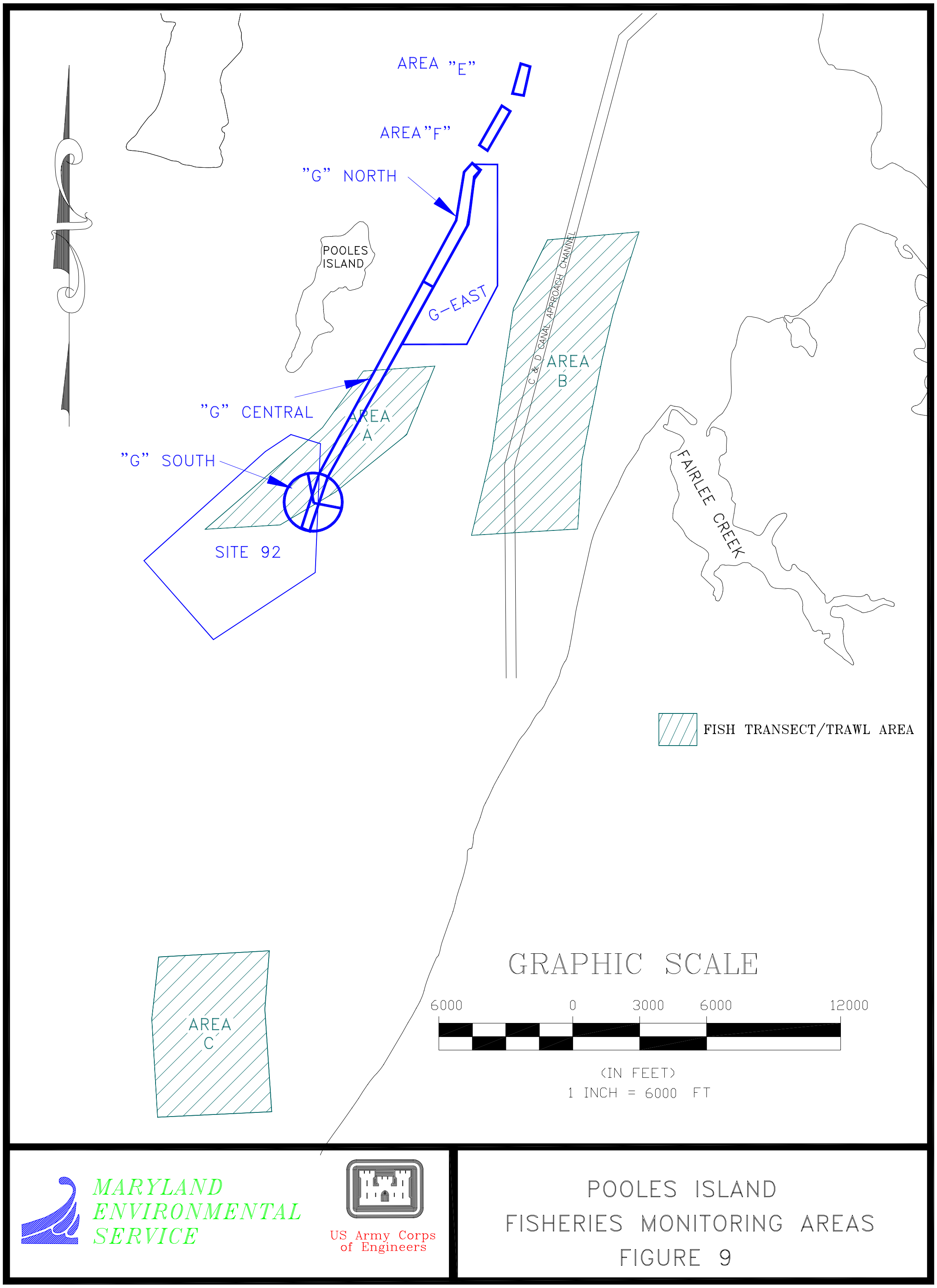


3.1.3.2 Fish Population Characterization Conducted Before, During, and After Open Water Dredged Material Placement in the Upper Bay

Eight fish characterization studies have been performed in the Pooles Island area on proposed and existing dredged material placement sites and reference areas to collect baseline data for planned actions and to monitor placement actions. The studies conducted between 1992 and 1997 included mid-water and bottom trawls along with acoustic surveys quarterly each year (Figure 9, MES 1997a). In addition to the above-mentioned annual studies, anchored gillnets were used in several sites quarterly from July 1996 to April 1997. The nets were generally set during the day, and consisted of 150-ft (45.7-m) length with a 3-, 4-, 5-, 6-, 7-, and 8-in. (7.6-, 10.2-, 12.7-, 15.2-, 17.8-, and 20.3-cm) mesh. A charter boat angling survey was also conducted in Summer and Fall 1996. The objectives of the angling and fish characterization studies were to characterize the abundance, diversity, changing community structure, and seasonal abundance of the fish populations in proposed and actual placement sites and nearby reference areas. Data collected were used to calculate catch per unit effort, length frequency distributions, diel changes in use of sites, and depths of water at the sites. Changes in these parameters over time were also described if placement was implemented at the study sites.

No SNS were captured during the eight studies (166 hours of gillnetting, 79 hours of bottom trawl, 38 hours of mid-water trawl sampling) conducted to characterize the upper Chesapeake Bay reference areas and proposed and actual placement sites since 1992. One Atlantic sturgeon was captured during the 1996/1997 gillnetting study. This fish was captured in July 1996 by gillnet setting in Reference Area B between Pooles Island and Fairlee Creek (Figure 9) (Miller 1998). It was 34.2 in. (870 mm) long and weighed 147 ounces (oz) [4,173 grams (g)]. According to Bain (1997), the corresponding age range would be from 6 to 11 years and the individual would be considered a late juvenile. A late juvenile of this size class according to Bain (1997) would not be of spawning age.

Figure 9. Pooles Island Fisheries Monitoring Areas

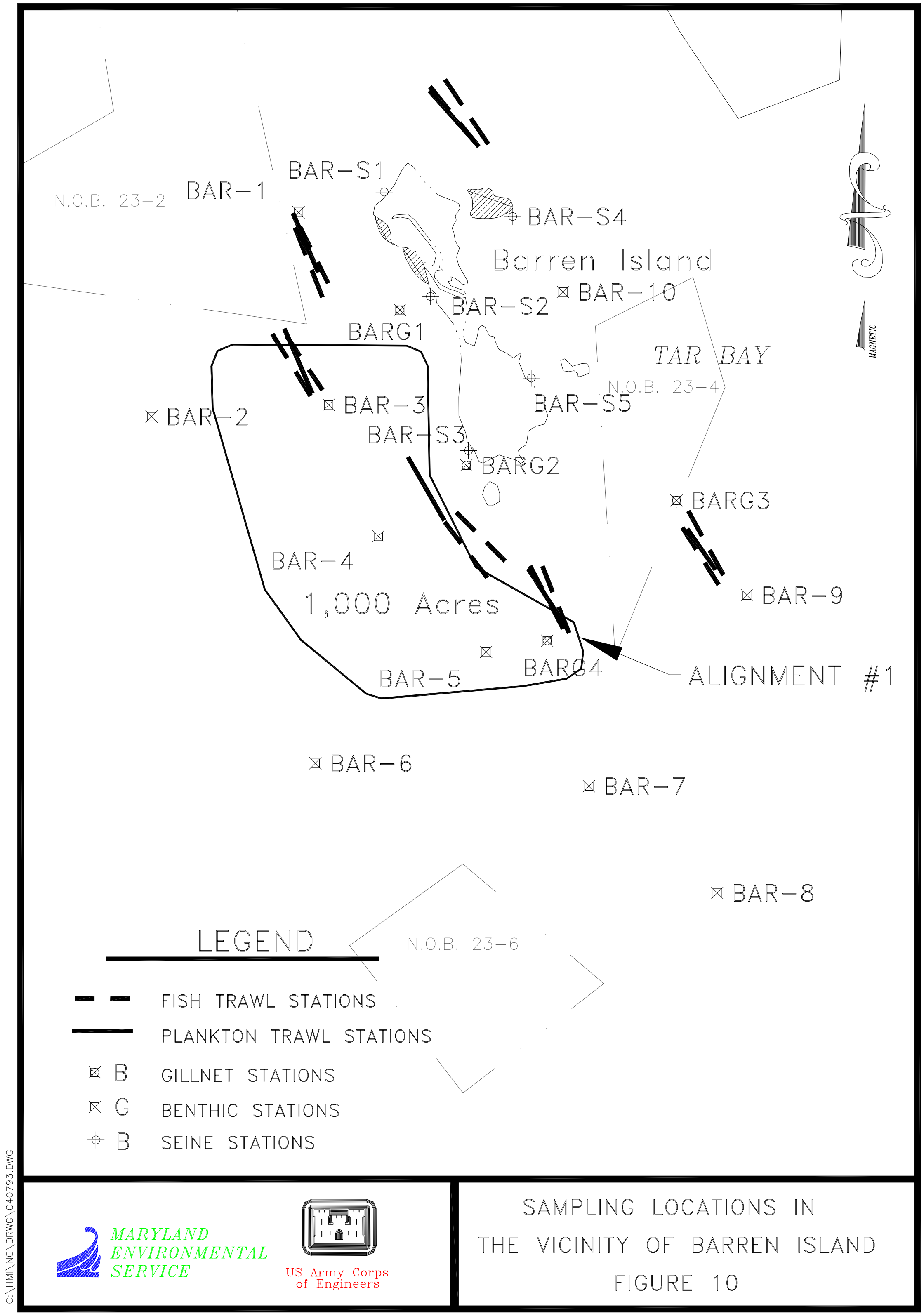


3.1.3.3 Barren Island Fisheries Studies

The Maryland Port Administration (MPA) implemented fisheries studies of Barren Island in Summer 2002 to document aquatic resources around the island remnants (Figure 10). Three sampling techniques—bottom trawl, beach seining, and gillnetting—were employed at 15 locations within and adjacent to proposed dike alignments for a habitat restoration project at the site. Six bottom trawl locations were sampled using two consecutive, parallel otter trawl tows, spaced several hundred feet apart. The gear employed was a 16-ft (4.9-m) semi-balloon otter trawl with a 0.75-in. (1.9-cm) liner. Trawling was conducted from 3 hours before until 3 hours after high tide. Five beach seine locations were sampled using a 100-ft (30.5-m) by 4-ft (1.2-m) seine with 0.25-in. (0.64-cm) mesh. Two consecutive hauls were conducted at each of the five sites for a combined shoreline distance of approximately 196.8 ft (60 m).

Gillnetting was conducted at four locations using 200-ft (61-m) experimental gillnets with five panels of different mesh size ranging from 0.75-in. (1.9-cm) to 2.5-in. (6.4-cm) square mesh. One net per station was deployed as fixed gear overnight for at least 12 hours. A total of 32 species, representing 19 families, were collected (EA 2003a). Plankton sampling was conducted at six locations, utilizing the same basic stations as the fisheries (trawl) locations. Two consecutive, but separate 5-minute tows were conducted. One tow was conducted at the water surface, and one tow was conducted at the bottom. The gear utilized were two 8.2-ft (2.5-m) long, conical plankton nets with 1.6-ft (0.5-m) mouth openings, made from 505-micron mesh. These were mounted side-by-side on a rigid metal towing frame and sled, and 0.3-gallon (gal) [1-liter (L)] plastic collection jars were screwed into the threaded cod ends. Larvae of six fish species were found in the plankton collections. No fish eggs were found; this is typical of late summer as most fish spawn in the spring. No SNS or WAS were captured during the sampling at Barren Island. Additional seasonal fisheries studies at Barren are underway to further characterize the fish community.

Figure 10. Sampling Locations in the Vicinity of Barren Island

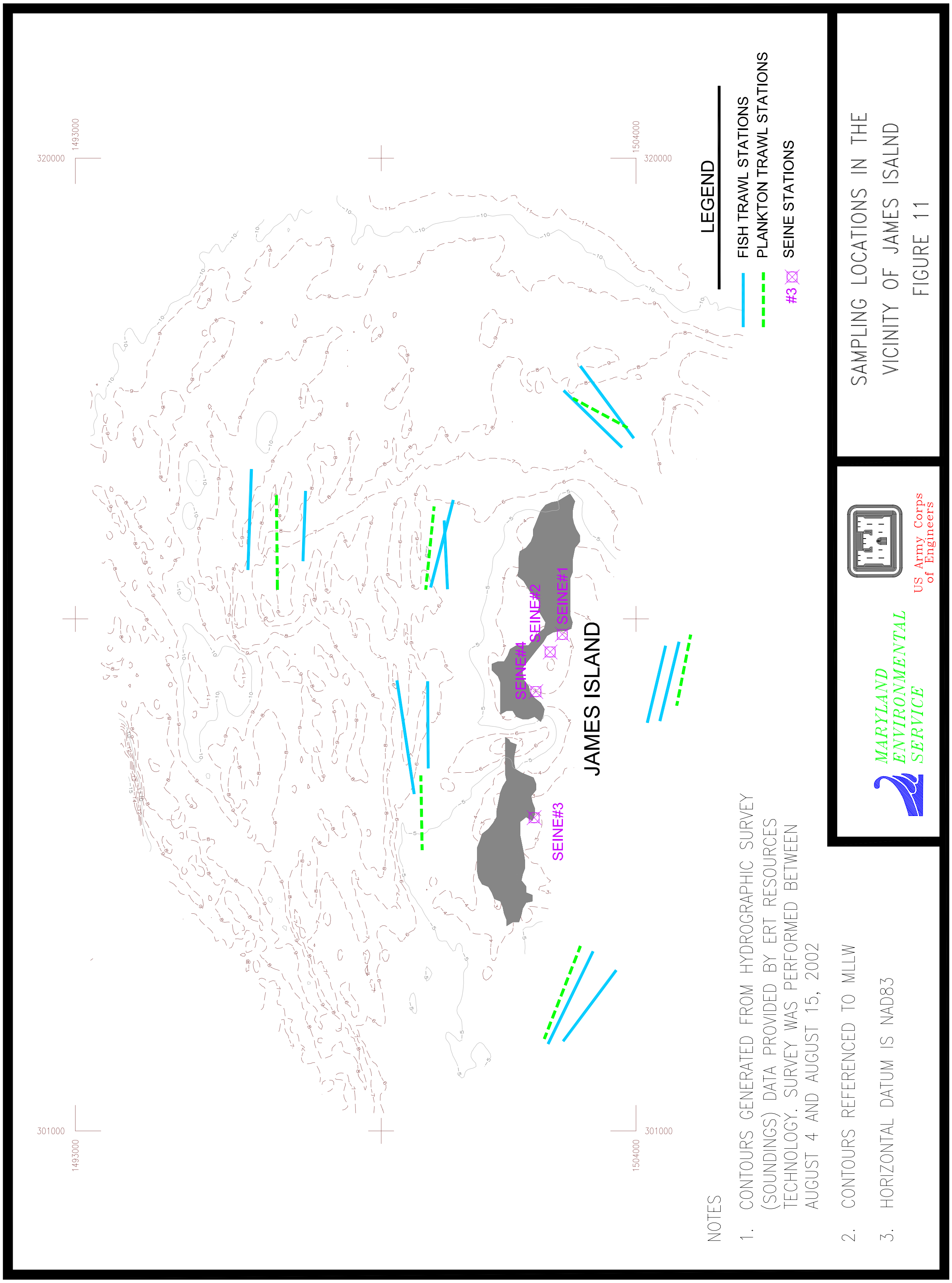


3.1.3.4 James Island Fisheries Studies

Site-specific fisheries and aquatic sampling took place during Summer 2002 and Fall 2002 at James Island to characterize the fish community in and around the proposed alignments for a habitat restoration project at this site (Figure 11). MPA sponsored the fisheries studies. Plankton was sampled at six stations in the Summer 2002 survey. Two 5-minute tows, one at the bottom and one at the surface, were conducted at each of six stations. Eggs of four species, larval forms of seven species, and seven species of macrozooplankton were collected. For the fisheries study, four areas of the shore zone were sampled using a beach seine, and six areas inside and outside the proposed alignments were sampled using a bottom trawl. Two 5-minute otter trawl tows were conducted at each of the six locations around James Island for a total of 1,968.5 ft (600 m) of bottom area sampled at each location. A total of 20 species representing 15 families were collected during the sampling (EA 2003b). No SNS or WAS were collected during the Summer 2002 sampling.

Surveys were also conducted in Fall 2002, using the same methods, benthic and fisheries stations as the Summer 2002 surveys. Plankton sampling yielded larvae of three fish species and eggs of one species. In addition to bottom trawl and beach seine sampling, gillnet sampling was conducted in Fall 2002. Gillnetting was conducted at four stations within and adjacent to the proposed alignments. One net per station was deployed overnight for at least 12 hours (EA 2003e). Fall 2002 sampling efforts yielded 26 species of fish and one crab. No SNS or WAS were observed during this survey.

Figure 11. Sampling Locations in the Vicinity of James Island



3.1.3.5 Hart-Miller Island Fisheries Studies

Site-specific fisheries and aquatic sampling took place at Hart-Miller Island (HMI) (Figure 12) to characterize the fish community in and around the existing containment facility by Milsaps and Tsai (1984). Otter trawl and beach seine sampling were conducted in February 1983. The otter trawl used was 24.9 ft (7.6 m) with 0.2-in. (0.6-cm) mesh at the cod end. Trawling lasted for 5 minutes and covered approximately 2,018 ft (615 m). Otter trawl efforts yielded four species, and beach seining yielded two species of fish. Bottom trawl sampling conducted in March 1984 occurred at eight stations. The bottom trawl was 24.6 ft (7.5 m) wide and 0.2 in. (0.5 cm) at the cod end; the trawl was towed for 5 minutes. Bottom trawl efforts in March 1984 yielded four species of fish. Otter trawl efforts in December 1987 were conducted using a 15- to 18-ft (4.5- to 5.5-m) otter trawl with a 1.5-in. (3.8-cm) bar mesh. The trawl was towed for 5 minutes at four stations on either side of Hart-Miller Island and yielded three species of fish. Similar otter trawl sampling was conducted in December 1988 and December 1989 and yielded five species and four species of fish, respectively (MES 2000). Gillnetting was not conducted during these sampling efforts. No SNS or WAS were collected during the sampling.

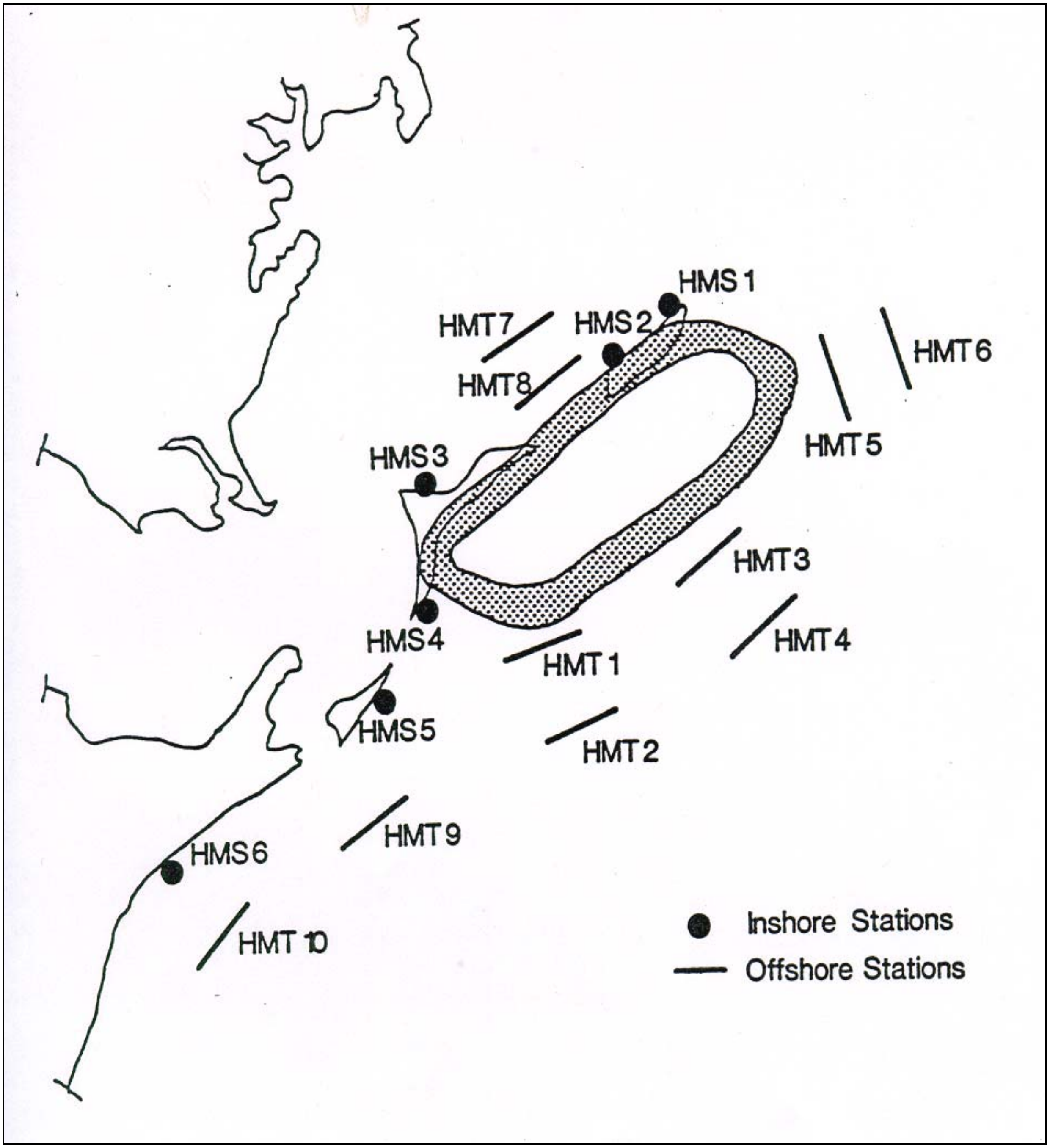
3.1.3.6 Curtis Bay Fisheries Studies

Fisheries and aquatic sampling took place in the Curtis Bay area (Figure 13) in order to characterize the fish community in the vicinity by Dames and Moore (1976). Otter trawl sampling was conducted in December 1970 and February 1971 in the Curtis Bay area using a 25-ft (7.6-m) semi-balloon otter trawl with a 0.5-in. (1.3-cm) stretch mesh woven liner with a 0.25-in. (0.64-cm) diameter opening, and was towed for 5 minutes. Efforts yielded four species in the December 1970 tow and zero species in the February 1971 tow. Otter trawl and beach seine sampling were conducted in December 1975. Two otter trawl samples were taken near Curtis Bay in the Patapsco River using the same methods as above; this effort yielded four species. Beach seine efforts conducted in the vicinity of Curtis Bay yielded three species (MES 2000). Gillnetting was not conducted during these sampling efforts. The Curtis Bay sampling locations are in the vicinity of Thoms Cove/Hawkins Point, Fairfield Amoco, and Dead Ship Anchorage. No SNS or WAS were collected during the sampling.

3.1.3.7 Site 170 Fisheries Studies

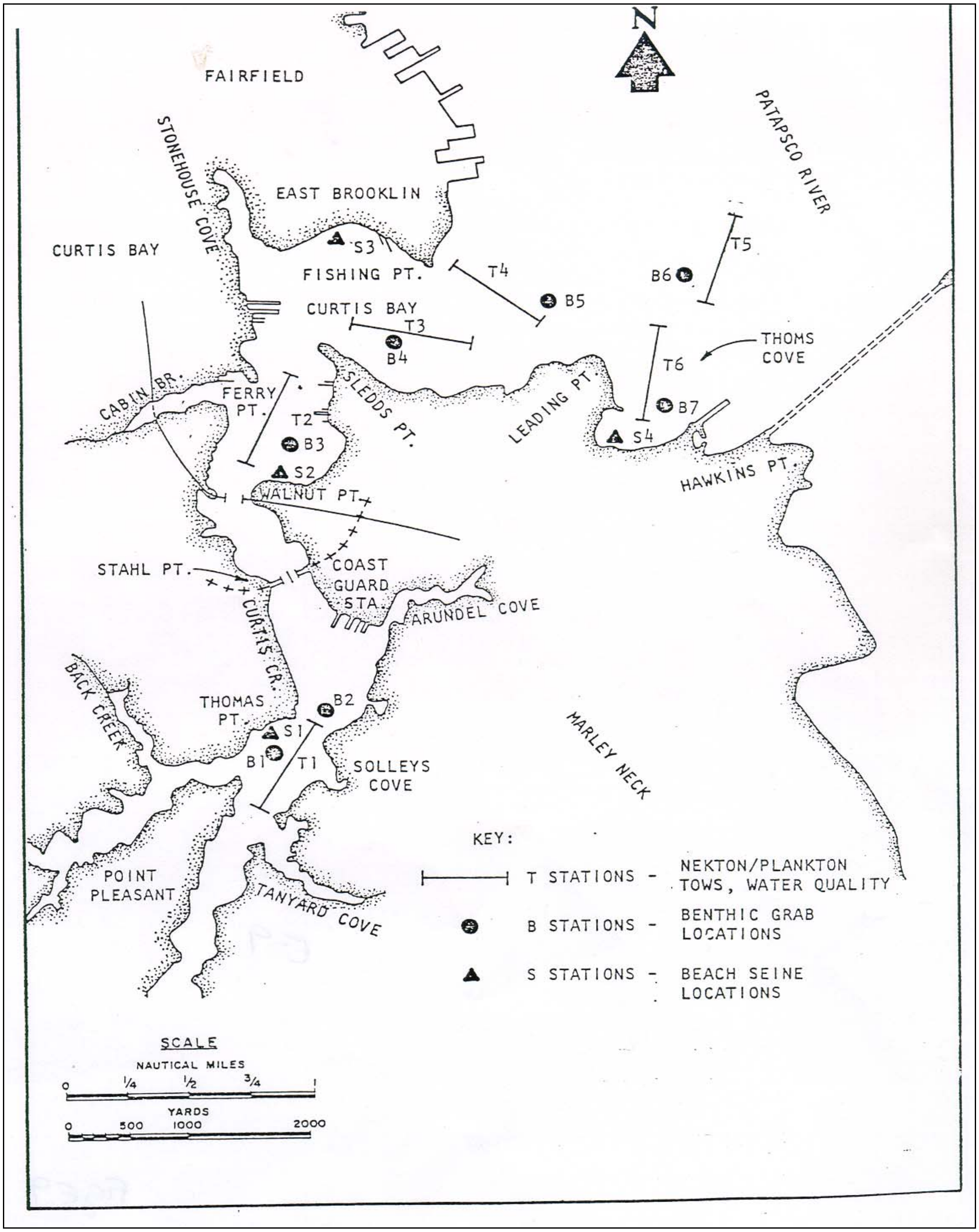
Fisheries and aquatic sampling performed by Hirshfield and Hixson (1981) took place in the vicinity of Site 170 (Figure 14) in order to characterize the fish community. Otter trawl sampling was conducted at two stations in December 1970 and February 1971 using a 25-ft (7.6-m) semi-balloon otter trawl with a 0.5-in. (1.3-cm) stretch mesh woven liner that had a 0.25-in. (0.64-cm) diameter opening and was towed for 5 minutes. Six species of fish were collected in December 1970 and three species were collected in February 1971 (MES 2000). Otter trawls conducted in December 1980 yielded three species of fish while sampling conducted in February and March 1981 each yielded one species of fish (Hirshfield and Hixson 1981). No SNS or WAS were collected during the sampling.

Figure 12. Sampling Locations in the Vicinity of HMI



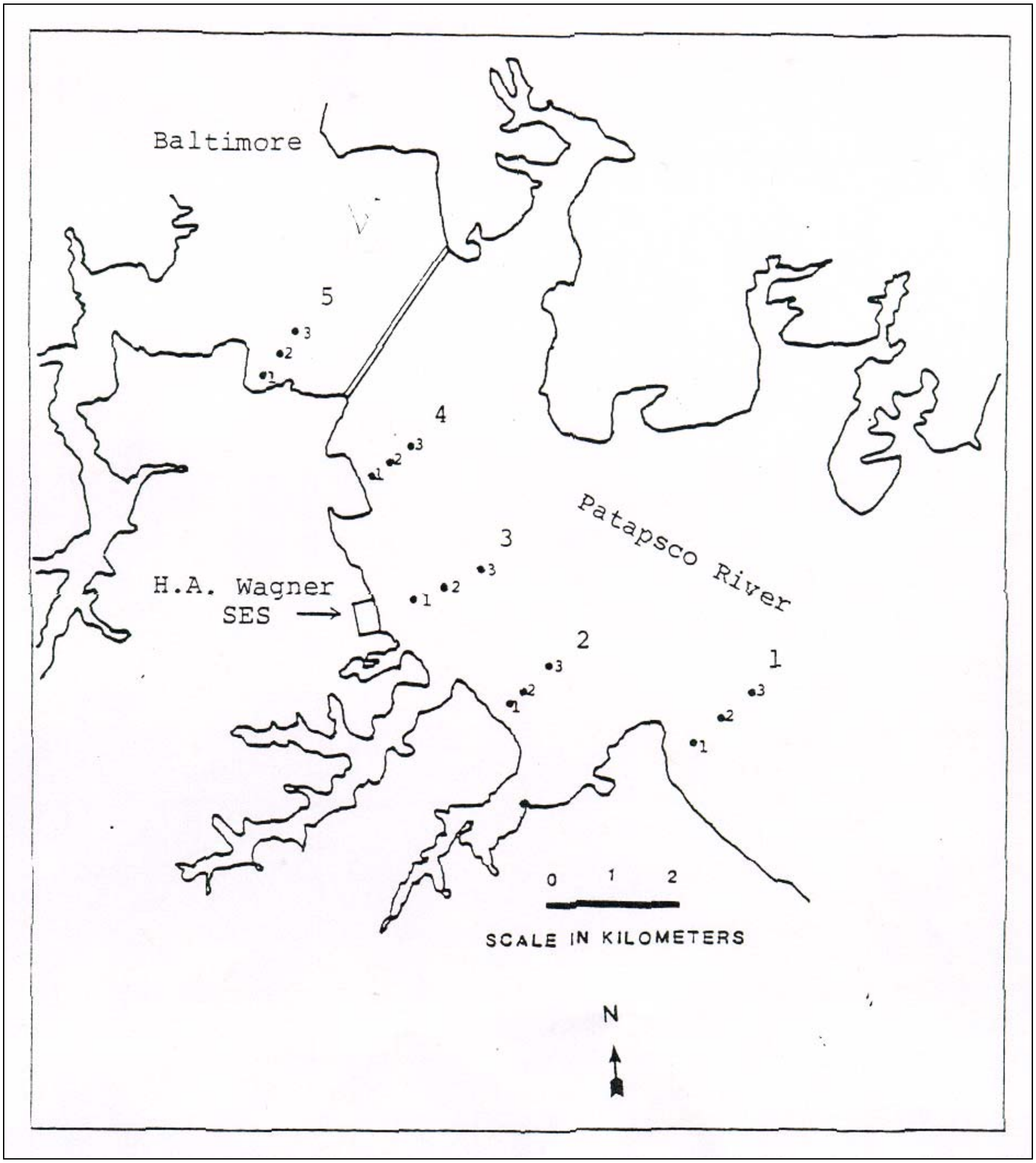
Inshore Stations = Beach Seine Sampling Stations
Offshore Stations = Otter Trawl Sampling Stations
Source: Millsaps and Tsai 1984

Figure 13. Sampling Locations in the Curtis Bay Area



Source: Dames and Moore 1976.

Figure 14. Sampling Locations in the Vicinity of Site 170



Source: Hirshfield and Hixon 1981.

3.1.3.8 Deep Trough North of Bloody Point Fisheries Studies

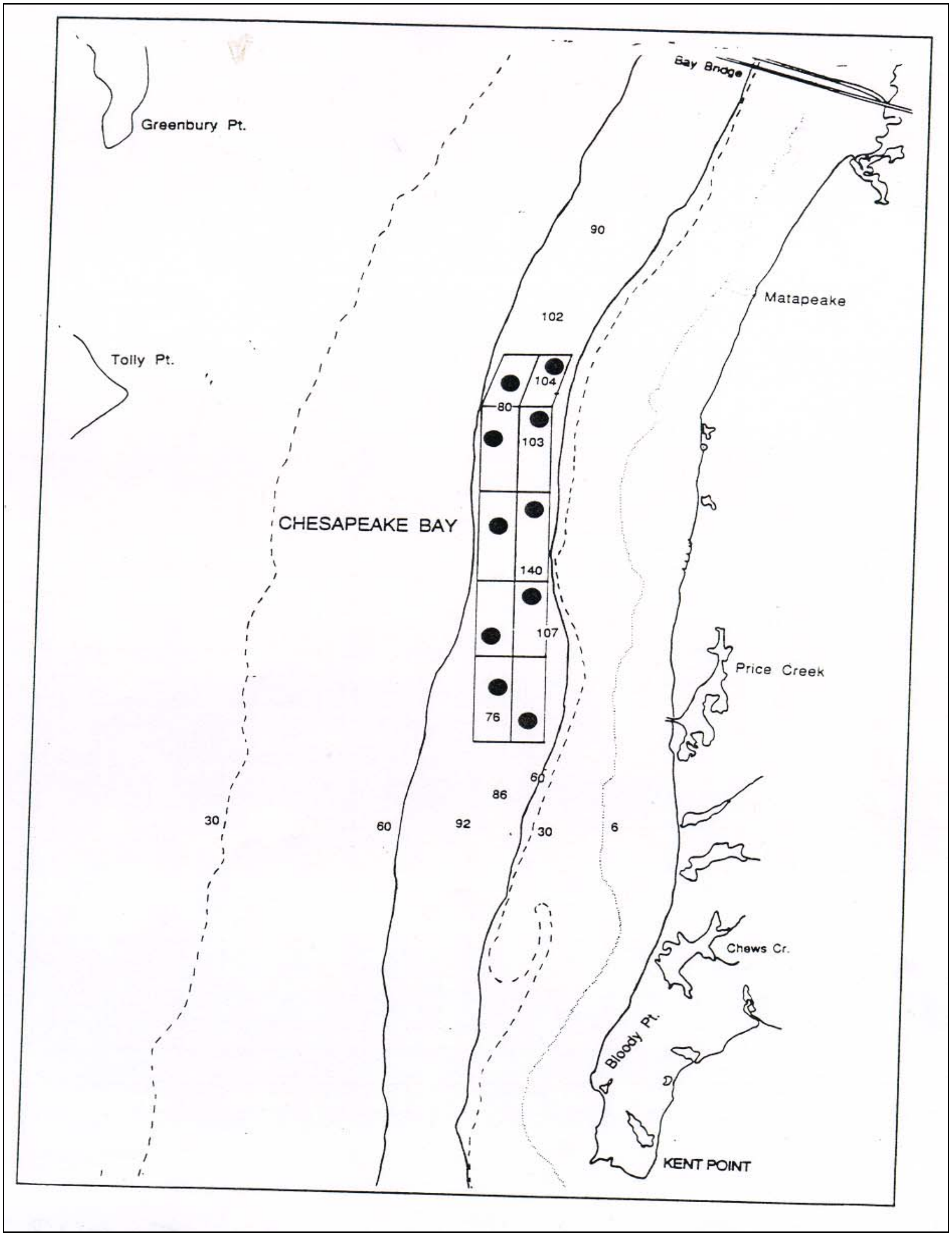
Site-specific fisheries and aquatic sampling performed by Versar, Inc. (1990) took place at Deep Trough (north of Bloody Point) in order to characterize the fish community in and around this site (Figure 15). Otter trawl sampling was conducted in December 1982 and January, February, and March 1983 using a 30-ft (9.1-m) wide head rope and a 0.25-in. (0.64-cm) bar mesh cod end liner. The trawl was towed on the bottom for 10 minutes. Three stations were outside of Deep Trough (north of Bloody Point), two were located just west, and one was located to the east (MES 2000). Otter trawling was also conducted in December 1983, and February and March 1984. No sampling was conducted in January 1984 due to heavy ice cover.

Drift gillnets were fished near bottom in the Deep Trough (north of Bloody Point) in 80 to 100 ft (24.4-30.5 m) of water. Sampling was done once a month during March 1983 and five times a month in December 1982, January 1983, and February 1983. Four or five mesh sizes were used and approximately 1,000 yd^2 (836 m^2) of mesh were fished. The nets were drifted during the last hour before the change of tides. Five species of fish were collected in the December 1982 gillnetting effort. Two species were collected in the January and February 1983 surveys. No fish were collected in the March 1983 gillnetting effort (MES 2000). No SNS or WAS were observed during these surveys.

3.1.3.9 Poplar Island Fisheries Studies

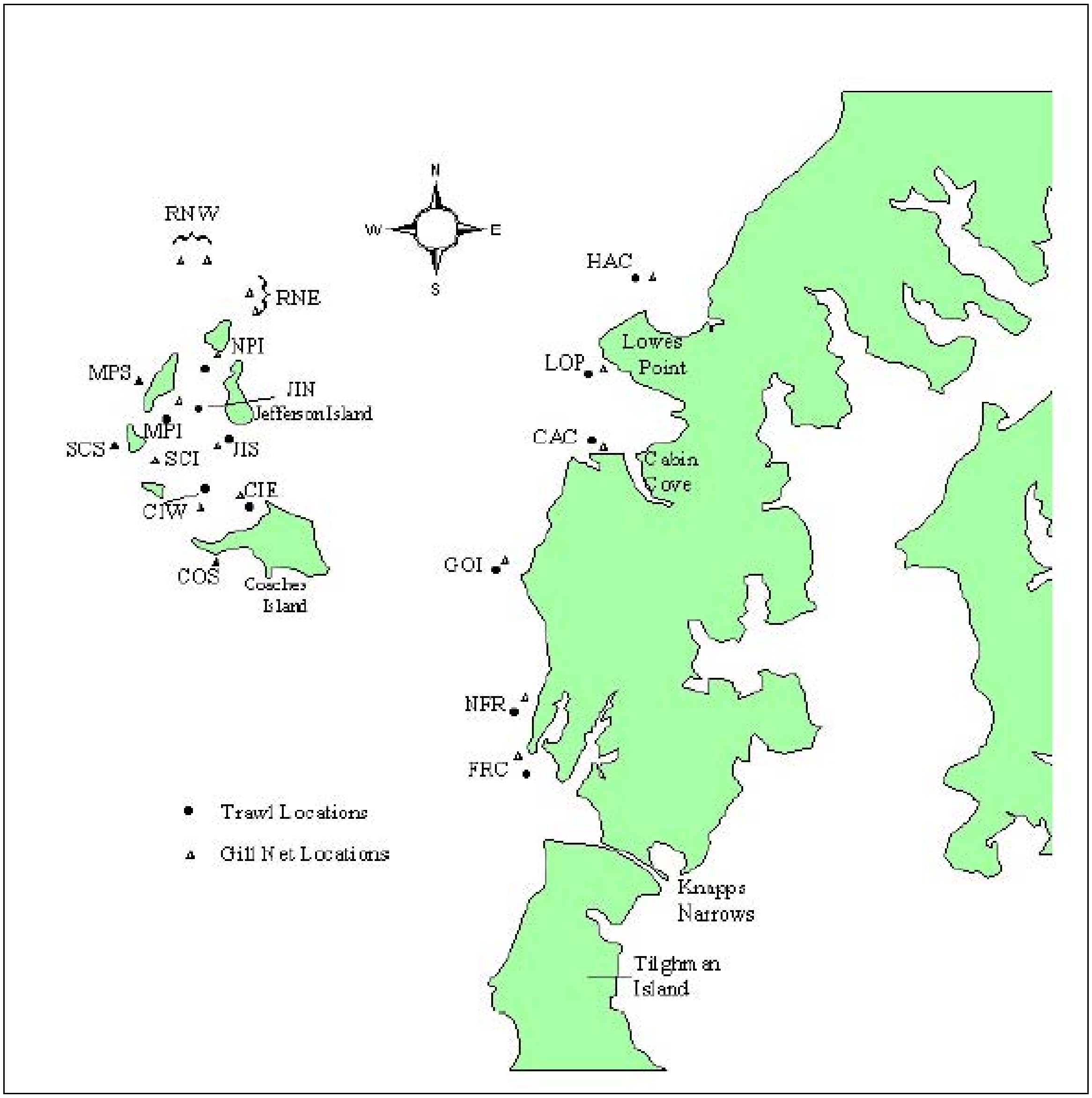
Baseline fisheries monitoring was performed at the Poplar Island Environmental Restoration Project (PIERP) site in 1994-1995. Seasonal monitoring of ichthyoplankton in 1994-1995 showed an increasing trend of juvenile, eggs, and larvae collected in spring and summer months (EA 2002). EA also conducted beach seine, otter trawl, and gillnetting over four seasons in the vicinity of the site. The gears were the same as those described for Barren and James Island sampling (Sections 3.1.3.3 and 3.1.3.4). Sampling was also conducted by NOAA in 2001 (Figure 16) utilizing gillnets and bottom trawls, throw traps, and crab pots to collect nekton in proximal waters of PIERP at many of the same stations as the previous EA study. Gillnets were set during the evening for 12 to 14 hours in Poplar Harbor, near created fishing reefs at the northern end of the site, and at reference sites. Together, a total of 11 species were collected at these sites by gillnet. Trawls were pulled for approximately 656 ft (200 m) at these locations and yielded a total of 12 species of fish and 5 decapod species. Throw traps were used to collect nekton samples in shallow areas containing submerged aquatic vegetation (SAV) (MES 2002a). Crab pots yielded only blue crabs (*Callinectes sapidus*). No SNS or WAS were observed during the 1994-1995 baseline survey or the NOAA 2001 survey.

Figure 15. Sampling Locations in the Deep Trough North of Bloody Point



Source: Versar Inc. 1990.

Figure 16. Sampling Locations in the Vicinity of Poplar Island



Source: Meyer (NOAA) 2001.

3.1.4 Determining the Status of SNS in the Upper Chesapeake Bay

As part of the Section 7 consultation process to determine the status of shortnose and Atlantic sturgeon within the Chesapeake Bay, a 2½-year sampling program was developed by the USFWS in consultation with the NMFS and funded by CENAB and CENAP.

3.1.4.1 Objectives

The objectives of the 2½-year survey were to:

- Determine whether the Chesapeake Bay supports a resident SNS population, or if SNS found in the Chesapeake Bay are transients from the Delaware River via the C&D Canal;

- Assess the genetic composition of Chesapeake Bay SNS and compare with the Delaware River and Hudson River stock; and

- Determine WAS and SNS use of the shipping channels and proposed and existing dredged material placement sites.

3.1.4.2 Methods

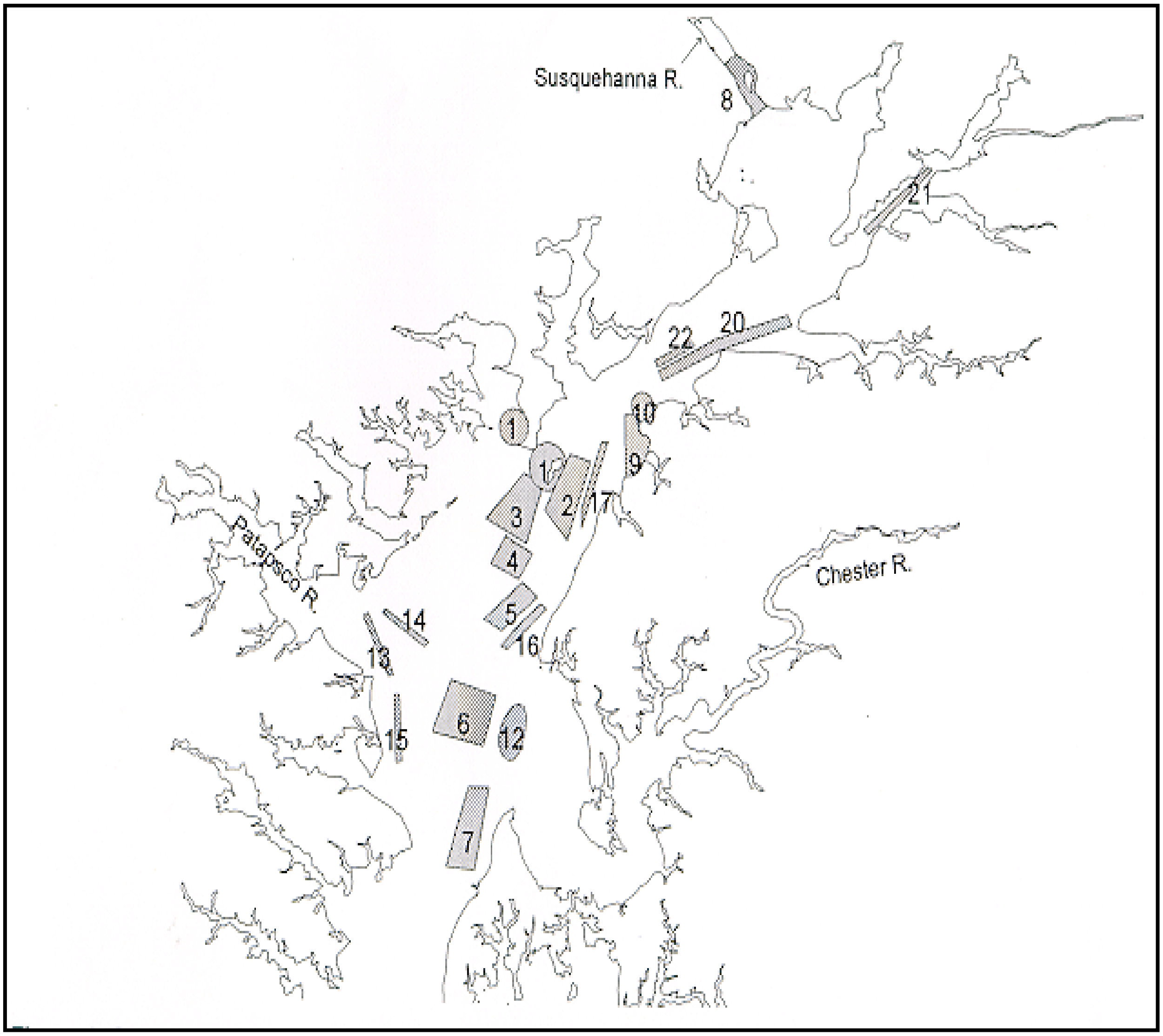
The methods used to evaluate the objectives outlined above include anchored gillnets, telemetry, genetic testing, and water quality assessments.

Field sampling for this study was initiated in December 1997 in the Chesapeake Bay, using anchored experimental gillnets [4-, 5-, or 6-in. stretch mesh (10.2-, 12.7-, or 15.2-cm)] set during daytime and overnight in 19 sample locations. The 19 sample locations were determined by the NMFS based on proposed dredged material placement sites and shipping channels. The figure for these sample locations was obtained from USFWS (Figure 17). It should be noted that several of the USFWS sampling sites are larger than the actual placement area or channel boundaries, even though they are referred to by the placement area or channel name. Sampling was performed during the fall, winter, and spring for both shortnose and Atlantic sturgeon. Summer sampling was performed in areas that did not become hypoxic/anoxic during the summer months. The larger sites, such as Site 104, were subdivided based upon their size and other ecological features. Shipping channels were also divided into sampling sections and sampled similarly to the above-mentioned proposed or existing placement sites. Depth and water quality parameters such as temperature, conductivity, salinity, and dissolved oxygen were recorded. Bycatch species were also enumerated and recorded.

Sonic tags were fitted on 16 SNS captured in the Chesapeake Bay, as a part of the Reward Program, and 35 SNS captured in the Delaware River. Once fitted, the sonic tags allowed USFWS personnel to track SNS movements in the Chesapeake Bay biweekly using a portable hydrophone and digital receiver. In addition, movement of SNS between the Chesapeake Bay and the Delaware River via the C&D Canal was monitored by stationary continuous automatic sonic tag loggers located at Chesapeake City and Reedy Point. None of the 16 Chesapeake Bay sonic tags are still active (USFWS 2003).

In order to determine whether a distinct population of SNS exists within the Chesapeake Bay as part of the study, a small tissue sample was clipped from the caudal fin of each tagged shortnose sturgeon upon capture. After collection, the tissue samples were sent for DNA analysis at which point they were compared to tissue samples from established stocks of SNS from the Hudson, Delaware, and Savannah River populations. The target for the Chesapeake Bay of 30 SNS was achieved; 33 specimens were analyzed. Genetic studies were also performed on a small number of SNS (4 fish) from the Potomac River to determine whether a distinct population existed in this river system.

Figure 17. USFWS/USACE Gillnet Sampling Stations*



Source: USFWS 2003.

1. Aberdeen Proving Grounds
2. G-East
3. Site 92
4. Site 1 (Tolchester West)
5. Site 2 (Tolchester Brewerton Angle)
6. Site 3 (Site 171)
7. Site 104
8. Mouth of Susquehanna River
9. Worton Point
10. Worton Deep
12. Swan Point Channel
13. Craighill Channel Upper Range
14. Craighill Channel
15. Brewerton Channel Extension
16. Tolchester Channel South
17. Tolchester Channel North
20. C&D Approach of Still Pond Creek
21. C&D Approach of Bohemia River
22. Shad Battery Shoal

* These sites are only approximate locations. The numbered boxes above are not site boundaries.

3.1.4.3 Results

Since the initiation of the sampling program, some preliminary conclusions were made by USFWS (1999) and NMFS (1999) about the seasonal distribution of the SNS in the upper Chesapeake Bay as a result of investigations and the USFWS Reward Program. NMFS reported in their BO (1999), concerning impacts to endangered SNS from maintenance dredging of the C&D Canal and the Northern Approach Channel to the C&D Canal in Maryland and Delaware, that it is likely that SNS spawn in the Potomac River and, possibly, below the Conowingo Dam in the Susquehanna River. NMFS drew this conclusion based on the occurrence of SNS within freshwater reaches of the Potomac River, the capture of adult SNS below the Conowingo Dam in mid to late April, and the capture of six possible juvenile SNS in the upper Chesapeake Bay (Worton Point to the Bohemia River).

3.1.4.3.1 Reward Program Results

The Reward Program has documented 54 SNS caught (of which 49 are non-multiple captures) as of September 30, 2003 (actual capture dates ranged from April 4, 1996 to September 30, 2003; Appendix A: Table A-1). The SNS catches by year are shown in Table 1. The SNS were caught using gillnets (19 fish), pound nets (18 fish), catfish traps (8 fish), fyke nets (7 fish), a hoop net (1 fish), and an eel trap (1 fish) (Figures 3 and 4). Capture depths were available for 39 percent (19 fish) of the fish captured. The recorded capture depths ranged from 4 ft (1.2 m) (fyke net) to 60 ft (18.3 m) (catfish trap) in the Susquehanna River.

Table 1. Number of Shortnose Sturgeon Captured by Year

Year	1996	1997	1998	1999	2000	2001	2002	2003	Total
Number of SNS Caught	7	10	12	4	9	5	3	4	54

Of the 54 fish captured, 20 were captured in the winter (December-February) at depths of 8-60 ft (2.4-18.3 m) (when recorded) [however, most were in the 10- to 18-ft (3- to 5.5-m) range and the only 60-ft (18.3-m) captures were in the mouth of the Susquehanna River], 30 in the spring (March-May) in 4-25 ft (1.2-7.6 m) (when depths were recorded), 4 in the summer (June-August) at depths up to 60 ft (18.3 m), and none in the fall (September-November) (Table 2). Actual capture dates ranged from December 5 to June 12 over the 7-year monitoring period.

Table 2. Summary of SNS Reward Program Catches by Season and Depth of Capture

	Spring	Summer	Fall	Winter
Time of Year	**March-May**	**June-August**	**September-November**	**December-February**
Number of SNS	27	4	0	20
Depths in which SNS were caught	4-25 ft (1.2-7.6 m)	Up to 60 ft (18.3 m)	N/A	8-60 ft* (2.4-18.3 m)

* SNS captured at 60 ft (18.3 m) were in the Susquehanna River; the average depth for these catches was about 18 ft (5.5 m).

Thirty-two (32) of the SNS were caught in the far upper Chesapeake Bay, near the Sassafras River and into the Bohemia and Susquehanna Rivers (Figure 3). Of the 32 fish captured in this area, 20 were captured in the winter (December-February) in 8-60 ft (2.4-18.3 m) [60 ft (18.3 m) in the Susquehanna River], 13 in the spring (March-May) in 4-25 ft (1.2-7.6 m), and 3 in summer (June) in depths up to 60 ft (18.3 m) in the Susquehanna River. The other 11 SNS were collected at points south of the Sassafras River area. Eight of these fish were captured in the vicinity of Worton Point, Hart-Miller Island, Black Marsh, and south of Tolchester. The remaining 14 SNS were captured south of the Bay Bridge in the vicinity of Kent Island, Holland Point (near Herring Bay), north of Barren Island, Fishing Bay (near the Nanticoke River), and the Potomac River (Figures 3 and 4). To date no SNS have been found within the placement alternatives under consideration. However, 5 SNS were captured in the vicinity of the southern approach channels to the C&D Canal and near the Tolchester Channel. The only designated "possible" SNS juveniles were captured in the upper Chesapeake Bay from the Worton Point area to Veasey's Cove in the Bohemia River, APG west of Delphs Creek, and APG Sandy Point during the period of February to April 1998 only.

Four of the SNS were captured in the Susquehanna River [Two at depths of 60 ft (18.3m) (catfish traps)] and one was captured at Holland Point near Herring Bay at 32 ft (4.8 m) (gillnet). The remaining 16 SNS were captured in gillnets between Veasey's Cove in the Bohemia River to south of Tolchester at depths ranging from 8 to 25 ft (2.4 to 7.6 m). The majority of the captures during the winter months were at depths of 12-18 ft (3.6-5.5 m). Eight SNS were captured during Winter 1997/1998 at depths of 12-25 ft (3.6-7.6 m) in the upper Chesapeake Bay near Howell and Grove Points.

As with the SNS, most of the WAS were also caught using pound nets, drift gillnets, gillnets, crab pots, and trawls (Appendix A: Table A-2). Figure 5 shows the Wild Atlantic Sturgeon Reward Program catches above the Chesapeake Bay Bridge through September 30, 2003. Of the 584 captured, 99 percent were captured below the Chesapeake Bay Bridge (Figure 6). To date, the USFWS Reward Program has documented the capture of three WAS in the vicinity of or in one of the bay channels. Specifically, one fish was captured in the southern approach channel to the C&D Canal by gillnet (near Grove Point), one fish in the connecting channel between the Tolchester and Brewerton Eastern Extension channels, and one fish in the vicinity of the Tolchester Channel. There were several captures (77 fish) of WAS in pound nets in the vicinity of Barren Island, some within the footprint of a potential placement alternative. There were also 9 captures of Atlantic sturgeon near Holland Island, but not in the footprint for the proposed restoration site. Figure 7 shows the licensed pound net locations in the Chesapeake Bay which offers some explanation for the density and pattern of WAS catches seen in Figures 5 and 6.

While it is probable that the gear type in which the SNS were captured influences both the location and depth of the recorded capture locations in the USFWS Reward Program data, it can be deduced from this information that sturgeon are using waters of 4-60 ft (1.2-18.3 m) in at least the months of December through June each year. SNS are known to overwinter in deep, channel sections of rivers (NMFS 1999). Thus, it is probable that the Howell to Grove Point section of the upper Chesapeake Bay provides overwintering habitat for SNS due to the depth. The extent to which SNS use the shipping channel in this region is unknown. Four of the SNS were captured in the general vicinity of the southern approach channels to the C&D Canal and one was captured near the Tolchester Channel. However, many more have been captured in shallower waters.

SNS Reward Program capture data by month is plotted over the 7-year monitoring period in Figure 18. Eight SNS were captured in December at 12- to 25-ft (3.6- to 7.6-m) depths (when recorded). The SNS were captured near Howell Point (4 fish) at depths of 12-14 ft (3.6-4.3 m), near APG, at Grove Point at 25 ft (7.6 m) at the mouth of the Sassafras River and south of Tolchester. During January, 4 SNS were captured at depths of 10-32 ft (3-9.8 m). Two of the SNS were captured at Howell Point at depths of 10 ft (3 m) and 12-14 ft (3.6-4.3), one was captured north of Millers Island (near HMI), and another at Holland Point near Herring Bay at 32 ft (9.8 m). During February, 8 SNS were captured at depths ranging from 8 to 60 ft (2.4-18.3 m). These fish were captured in the Susquehanna River [3 SNS, 2 at depths of 60 ft (18.3 m)], in the Bohemia River at 8 ft (2.4 m), and in the Sassafras River at 18 ft (5.5 m). Captures also occurred between Grove Point and APG [13 ft (4 m)], at APG and Cherry Tree Point [12 ft (3.6 m)], and between HMI and Pooles Island [17 ft (5.2 m)].

During spring (March-May) a total of 30 SNS were captured at depths ranging from 4 to 25 ft (1.2-7.6 m) (only 4 capture depths were recorded). During March, 7 SNS were captured at locations in the Susquehanna River (2 fish), the Bohemia River [1 fish at 4 ft (1.2 m) depth] at Turkey Point [25 ft (7.6 m)], and at the mouth of the Potomac River in Ophelia, Virginia (3 fish). The month of April had the largest captures of SNS (16 fish) during any month of the year. Only 2 capture depths were recorded for this period [4-6 ft (1.2-1.8 m)]. During April, the SNS were more widely distributed than in prior months (December-March), most likely moving to begin warmer season foraging activities. The SNS ranged from the Black Marsh area (north of the Patapsco River) to the Susquehanna River. One SNS was also captured near St. Mary's in the Potomac River and another north of Barren Island. By May, the SNS captures (5 fish) were found south of the Bay Bridge at locations off Kent Island (2 fish), north of Barren Island (1 fish), at Cedar Point Hollow (1 fish), and in the Potomac River (2 fish). One SNS was captured upstream at the mouth of Potomac Creek while the other was captured at the mouth of the Potomac River near Ophelia, Virginia.

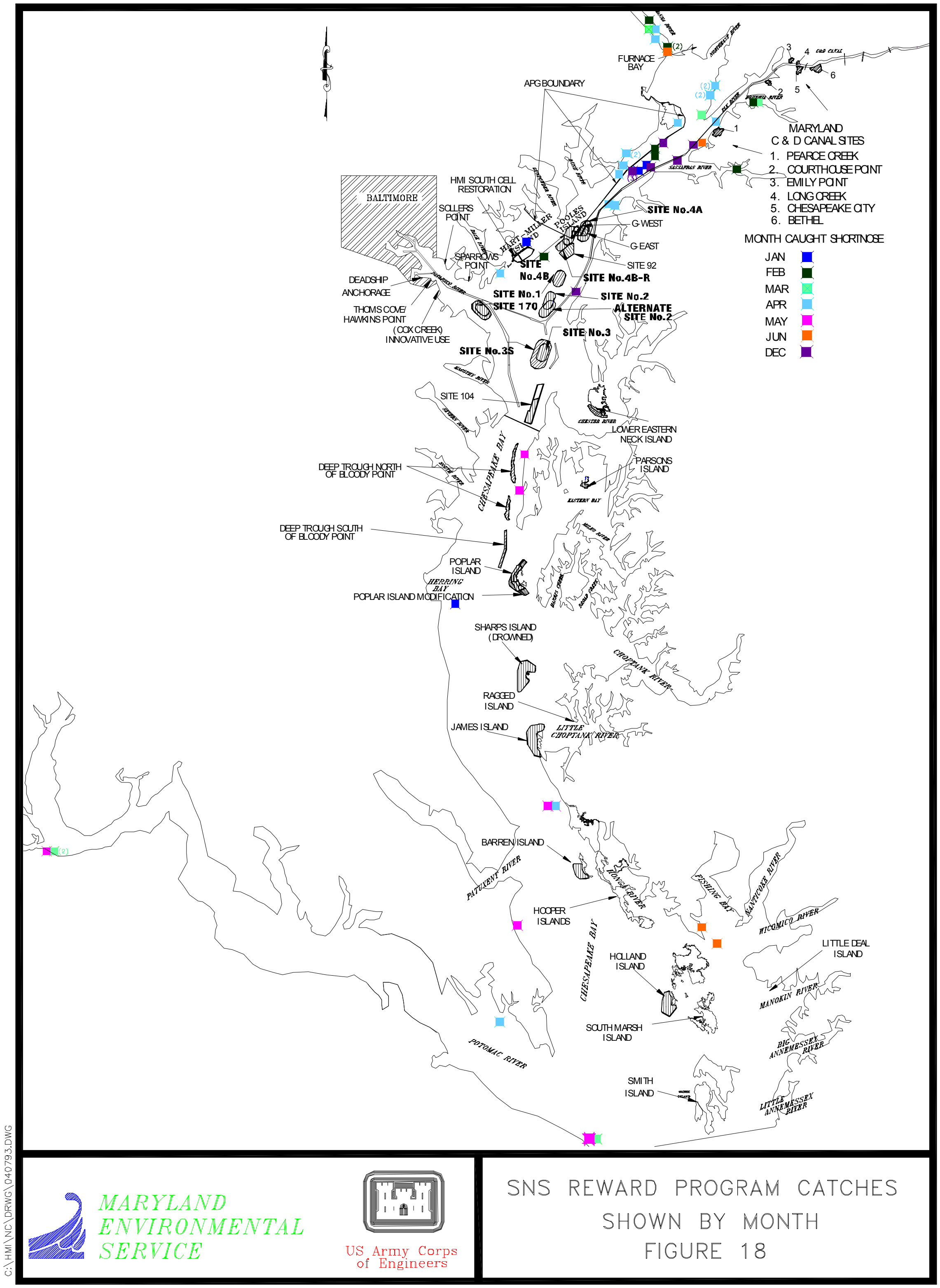
During summer (June-August), only 4 SNS were captured with all captures occurring during the month of June. The captures locations varied with 2 SNS located in the upper Chesapeake Bay [Susquehanna River (60 ft [18.3 m]) and Turkey Point] and 2 in the vicinity of Fishing Bay.

No SNS were captured during the fall (September-November).

Of the 54 SNS captured, 6 were identified as "possible juveniles" with lengths ranging from 15.1 to 18.8 in. (384 to 478 mm). These fish were captured during the period of February 26 to April 23, 1998, in gillnets, fyke nets, and eel traps. The fish were captured in the upper Chesapeake Bay in the Bohemia River at Veasey's Cove (2 fish) at depths of 4-8 ft (1.2-2.4 m), at APG West of Delphs Creek (1 fish), at APG Sandy Point (1 fish), and at Worton Point (2 fish).

Length data from the Reward Program captures indicates that the largest SNS were generally captured in the middle Chesapeake Bay around the Potomac River mouth through the Barren Island area.

Figure 18. SNS Reward Program Catches by Shown by Month*



* Markers show approximate locations. Multiple catches in the same location have been offset for visual clarity.

3.1.4.3.2 USFWS Gillnetting Results

No SNS were collected at any of the 19 sampling sites in the USFWS/USACE gillnet study, including the proposed placement options and channels, in approximately 10,661 hours of gillnetting through the end of the study on June 29, 2000 (USFWS 2000b). A total of 14 Atlantic sturgeon (11 wild, 2 hatchery, and 1 unknown) were captured during sampling (Appendix B, Table 2). Of the 11 WAS captured, coordinates show that a total of 3 were captured within proposed placement boundaries (Figure 19). Of the 3 fish located in the proposed placement site boundaries, 2 were located in Upper Bay Island Site 4A (1 within the island footprint–July 1998 and 1 within the G-West footprint–October 1998) and 1 was located in Site 104 (March 2000) (Table B-2). It does not appear from the coordinates given by USFWS for this study that any of these WAS catches were within the boundaries of the channels proposed for dredging. However, there were 2 fish located in the immediate vicinity of the Craighill Upper Range in July 1998 (Appendix B, Table 14). Similar studies in the Potomac River yielded no SNS or WAS in 4,667 hours of gillnetting in the Middle Potomac River and near Little Falls (NMFS 2003).

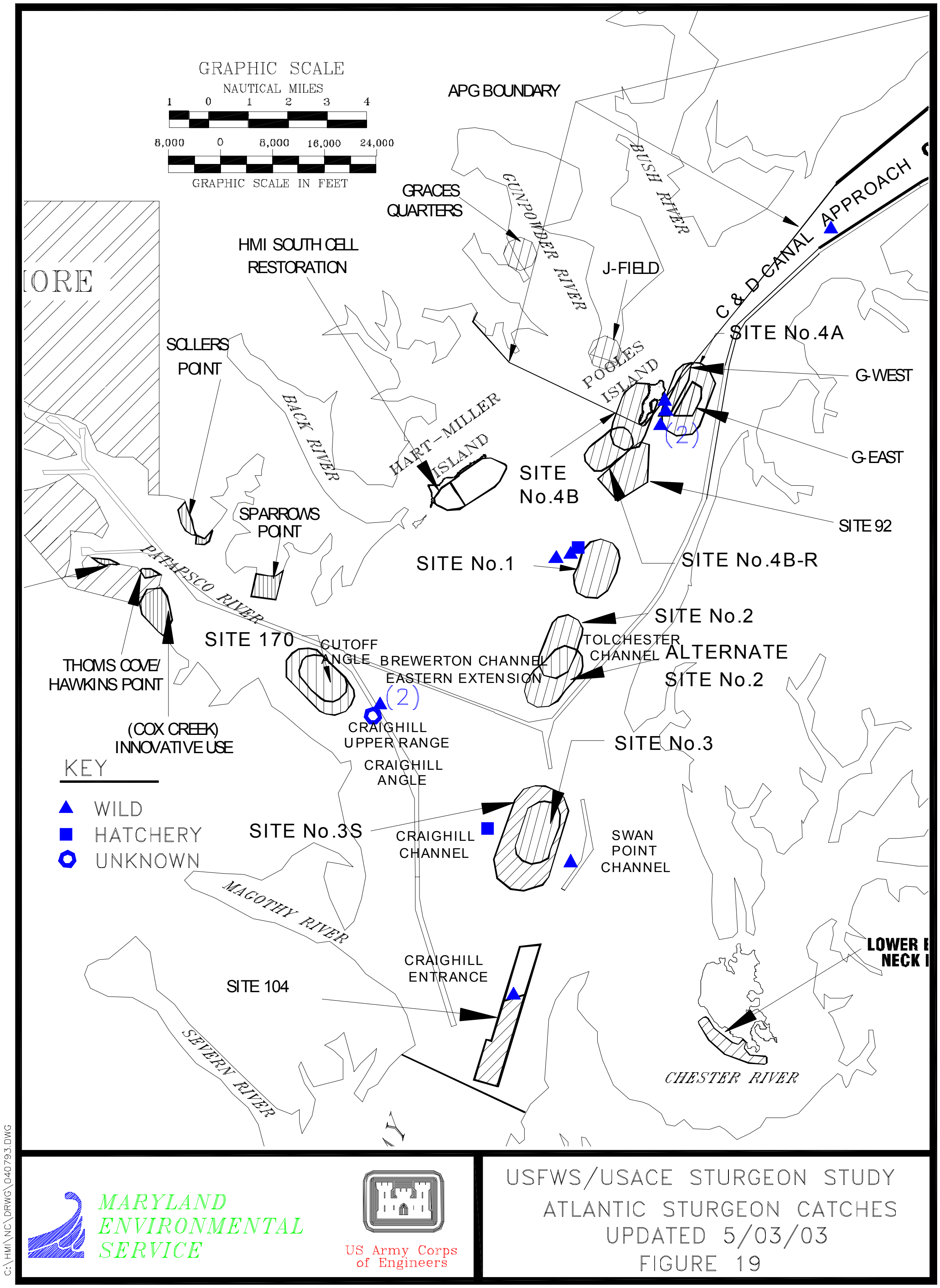
3.1.4.3.3 USFWS Telemetry Results

Telemetry information from five SNS tracked in the upper Chesapeake Bay from April to July 1998, the early part of the feeding season, indicates SNS use the Worton Point to Howell Point section of the upper Chesapeake Bay. Four fish were tracked south and southeast of Pooles Island in water depths of approximately 20 ft (6.1 m). Based on foraging patterns exhibited by SNS in other northeast river systems, SNS in this system are likely to be widely dispersed and actively feeding during the summer. Productive reaches of the upper Chesapeake Bay (e.g., near the saltwater/freshwater interface and channel areas bordering mud flats or emergent macrophyte beds) are potential feeding areas (NMFS 1999).

The USFWS tracked one Chesapeake Bay tagged SNS in the C&D Canal in July 1998 that was later tracked in the Delaware River, indicating that the sturgeon may move between the Delaware River and Chesapeake Bay, possibly to access productive feeding areas in either the Chesapeake or Delaware Bays (Figure 20). Another Chesapeake Bay tagged SNS was tagged in the middle of the bay and was found 101 days later in the Delaware River. This SNS was not detected in the C&D Canal; however, the monitoring equipment at Chesapeake City had malfunctioned for about 3 weeks after this sturgeon was tagged.

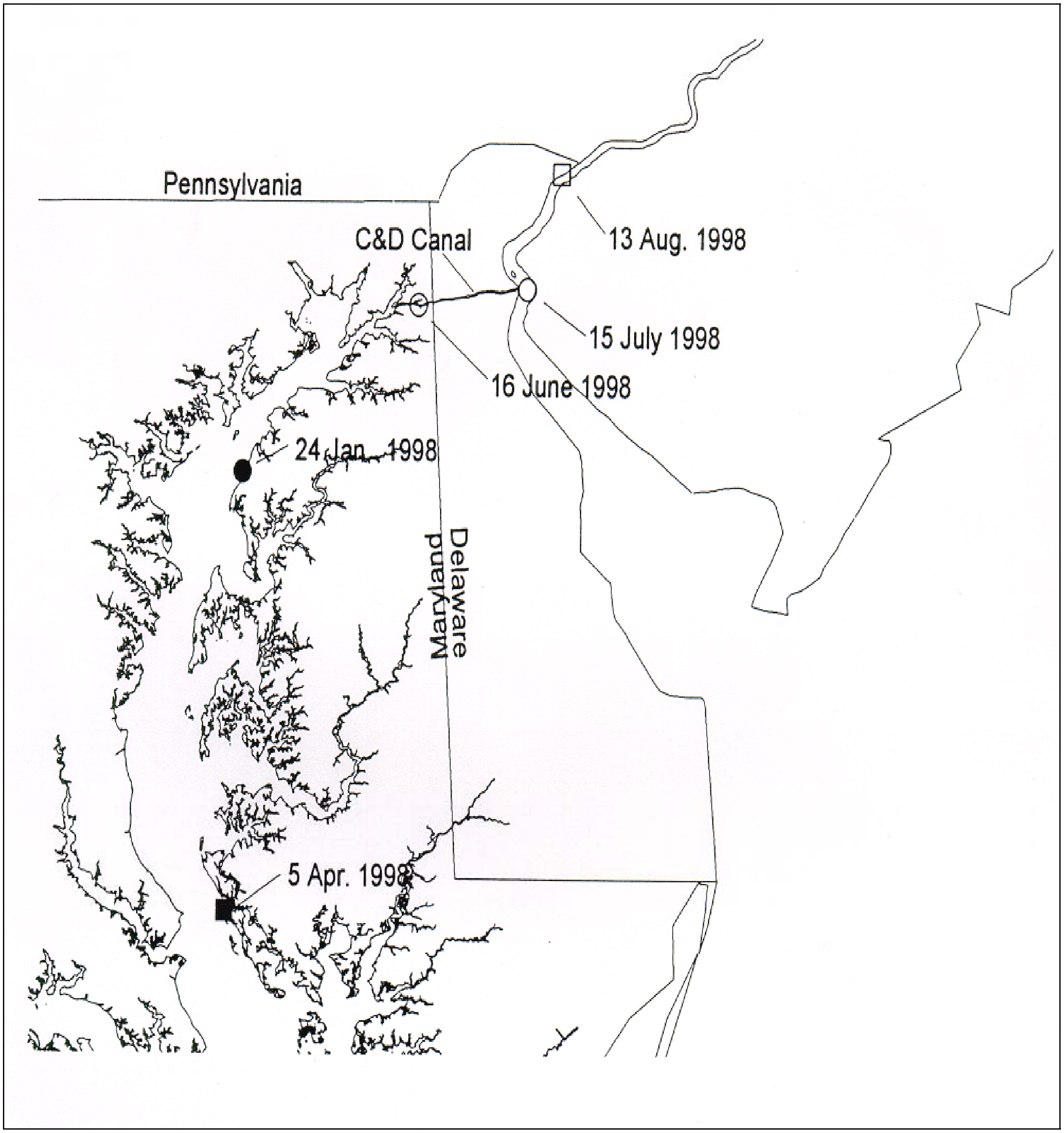
USFWS (2000b) reported that movement of SNS in the Chesapeake Bay did not appear to follow any specific pattern. Distances moved by SNS in this study ranged from 0 to 3.5 miles (mi) [0 to 5.7 kilometers (km)] per day.

Figure 19. USFWS/USACE Sturgeon Study, Atlantic Sturgeon Catches



Source: USFWS 2000.

Figure 20. Tag and Release Locations (Closed Symbols) of Two Shortnose Sturgeon in the Chesapeake Bay That Were Located by Telemetry (Open Symbols) in the Delaware River



Source: USFWS 2000.

3.1.4.3.4 Genetic Study Results

Polymerase chain reaction (PCR) and direct sequencing genetic analysis was performed by Dr. Ike Wirgin of the New York Medical School under contract to the USFWS to define the East Coast genetic population structure of SNS. In total, 424 SNS were characterized and collected directly from rivers with the exception of five fish from the Savannah River (offspring of five different years of hatchery production, each of which used newly caught brood stock for the Savannah River). River systems represented in the study included the St. Johns River, Kennebec River, Androscoggin River, Upper and Lower Connecticut River, Hudson River, Delaware River, Chesapeake Bay, Potomac River, Cape Fear River, Pee Dee River, Cooper River, Savannah River, Ogeechee River, and Altamaha River. In the mid-Atlantic region, 33 tissue samples were collected in the Chesapeake Bay, 56 from the Delaware River, and 4 from the Potomac River (Wirgin et al. 2002).

The results indicate that the Chesapeake Bay samples exhibited six haplotype frequencies that were almost identical to the haplotype frequencies exhibited in the Delaware River (eight haplotype frequencies). Additionally, the four haplotype frequencies seen in the fish sampled from the Potomac River were observed in the larger Chesapeake Bay and Delaware River collections (Wirgin et al. 2002).

Wirgin et al. offered four hypotheses for the absence of statistical different in haplotype frequency or the presence of unique haplotypes between the Delaware and Chesapeake Bay populations. These were divided into whether it is accepted that SNS still reproduce in the Chesapeake Bay.

"If assumed that SNS do spawn in the Chesapeake Bay, then the similarity can be explained by:

1) *a high degree of gene flow between Delaware River and Chesapeake Bay populations, i.e., they form a single stock or 'metapopulation'*
2) *recent recolonization of one by the other, or*
3) *historically high reproductive discreteness with present-day similarity by chance, i.e., stochastic lineage change occurred in parallel."*

"If SNS are assumed to be reproductively extinct in the Chesapeake Bay, then

4) *it is likely that the specimens found there and analyzed in the study were part of the Delaware River's reproductive stock and move seasonally into the Chesapeake Bay."*

Wirgin et al. (2002) favored the 4th hypothesis: "*Construction of the C&D Canal in 1829 reduced the distance (around the Delmarva Peninsula) from the Delaware Bay side of the Canal to the Chesapeake Bay side, by approximately 370 miles. However, the original canal contained locks, which may have hampered or disallowed sturgeon movements through it. But in 1927, the locks were removed and the Canal was brought to sea level (it was subsequently enlarged in 1975). Thus, even if SNS in the Delaware River and Chesapeake Bay were prehistorically discrete, the primary geographic barrier was diminished in historical times."*

Nineteen (19) distinct population segments were hypothesized in the NMFS Recovery Plan (1998) along the East Coast; however, empirical data supporting this structuring is limited. Twelve (12) of these population segments were sampled by Wirgin et al. 2002. The results indicated that most estuaries and rivers currently harboring SNS and identified as distinct population segments within the NMFS Recovery Plan (NMFS 1998) contain genetically distinct populations, with the important exception of the Chesapeake Bay and Delaware River. These two river collections were genetically distinct from their nearest neighbor to the north and south, respectively, but not from each other.

The Wirgin et al. (2002) study strongly supported the designation of distinct population segments for SNS in most Atlantic Coast rivers. If warranted, *"these results also would allow for imposition of distinctly different management regimes for populations that exhibit differing trends in population abundance."* The authors further stated, *"While some populations remain at or near historically low levels (Merrimack and Cape Fear Rivers) abundances of others (Kennebec, Hudson and Delaware Rivers) may have rebounded to levels that could permit population-level endangered species delisting."*

4.0 BIOLOGY AND ECOLOGY OF SHORTNOSE STURGEON

Studies on resident populations of SNS have been conducted since the 1980s in the Delaware River in Delaware, the Hudson River in New York, the Cape Fear River in North Carolina, the Kennebec/Androscoggin River System in Maine, the Connecticut and Merrimack Rivers in Massachusetts, and the Ogeechee, Altamaha, and Savannah Rivers in Georgia. These population studies were reviewed and summarized to supplement SNS information for the Chesapeake Bay region.

4.1 GENERAL LIFE HISTORY AND SEASONAL DISTRIBUTION

4.1.1 Introduction

The scientific name for the SNS is *Acipenser brevirostrum*. *Acipenser* is Latin for sturgeon and *brevirostrum* means short snout. LeSueur (1818) originally described the species from a specimen taken from the Delaware River (Dadswell et al. 1984). Vernacular names include shortnosed sturgeon and little sturgeon (Saint John River, New Brunswick, Canada), pinkster and roundnoser (Hudson River), bottlenose or mammose (Delaware River), salmon sturgeon (Carolinas), and soft-shell or lake sturgeon (Altamaha River) (Dadswell et al. 1984). It is commonly confused with the Atlantic sturgeon (*Acipenser oxyrinchus*), which has overlapping habitat. The taxonomy for the SNS is listed below. The distinguishing characteristics of the Atlantic sturgeon and SNS are listed in Table 3.

Taxonomy

Class: Osteichthyes
Order: Acipenseriformes
Family: Acipenseridae
Genus: *Acipenser*
Species: *brevirostrum*

Table 3. Distinguishing Characteristics of Atlantic and SNS

Characteristic	Atlantic Sturgeon *Acipenser oxyrinchus*	Shortnose Sturgeon *Acipenser brevirostrum*
Maximum length	> 9 ft (2.7 m)	4 ft (1.2 m)
Snout	Longer and more sharply pointed*	Shorter and blunter
Mouth	Width inside lips < 55% of bony interorbital width	Width inside lips > 62% of bony interorbital width
Bony plates	2-6 bony plates (at least pupil size) along base of anal fin	No row of bony plates along the base of anal fin
Habitat/Range	Anadromous; spawn in freshwater but primarily lead a marine existence	Anadromous; spawn at or above head-of-tide in most rivers. Aside from seasonal migrations to estuarine waters, rarely occurs in the marine environment

* Snout length and sharpness is more pronounced in older individuals.
Source: NMFS (1998).

4.1.2 Biology of the Shortnose Sturgeon

SNS inhabit rivers, estuaries, and nearshore marine waters (Dadswell et al. 1984). SNS are anadromous, migrating to fresh water to spawn. Movement of SNS is usually restricted within their natal river or estuary. Most of the year, SNS are found at or below the saltwater/freshwater interface until the spawning migration begins, at which time SNS move into freshwater reaches.

Freshets, substrate character, and flows are all documented factors influencing SNS spawning (Gilbert 1989). SNS spawn at most once a year between February and May depending on latitude (Dadswell 1979). Temperature is also a major factor in determining spring migration. Spawning generally occurs between 48 and 59°F (9 and 15°C) in freshwater areas. After spawning, the adults move to deep overwintering sites that are sometimes adjacent to the spawning grounds (Dadswell 1979).

Fertilized eggs of SNS are adhesive and demersal (on the bottom) (Bain 1997). SNS eggs hatch 8 to 16 days after fertilization at approximately 63°F (17°C) (Washburn and Gillis Assoc. 1981). Fertilized eggs strongly adhere to rough-surfaced substrata within 1 minute of fertilization (Washburn and Gillis Assoc. 1981). Two days after hatching, the yolk-sac fry seek concealment and avoid light (Buckley and Kynard 1981). Twelve days after hatching, the yolk sac is completely absorbed and the fry start feeding on zooplankton (Buckley and Kynard 1981).

Development of SNS life stages is described in Section 4.2.5.

Spawning occurs in upper, freshwater areas, while feeding and overwintering activities may occur in both fresh and saltwater habitats. Suitable and/or critical habitat for the SNS in the

Chesapeake Bay is currently unknown, due to their infrequent detection in the bay. Spawning habitat has not been identified in the Chesapeake Bay. If this habitat is consistent with the preferred substrate and water quality conditions in other East Coast populations, spawning habitat would consist of relatively fresh water high up in a river system that has a relatively high velocity and gravelly to gravelly-sand and sandy mud substrates (MES 1998). Habitat degradation or loss (resulting, for example, from dams, bridge construction, channel dredging, and pollutant discharges) and mortality (for example, from impingement on cooling water intake screens, dredging, incidental capture in other fisheries, and predation) are principal threats to the species' survival (NMFS 1998).

SNS landings have been recorded from the Indian River, Florida to the Saint John River in New Brunswick, Canada. SNS distribution in the Chesapeake Bay is not well documented historically, but they were thought to have been extirpated in the Chesapeake Bay since the 1970s (Dadswell et al. 1984). In a 1973 Resource Publication, the Bureau of Sport Fisheries and Wildlife cited pollution and overfishing, including bycatch in the shad fishery, as principal causes of the species' decline (USDOI 1973). At the time, SNS were thought to be "gone in most of the rivers of its former range" but "probably not as yet extinct." More than a century of extensive fishing for sturgeon contributed to the decline of both Atlantic and SNS populations along the East Coast. Since there are few confirmed historical reports of SNS captures and because fishermen and scientists did not distinguish between Atlantic and SNS in scientific reports and landing records, there are no reliable estimates of historic population sizes.

Robert W. Hastings (Hastings et al. 1987) documented the closest known population of SNS to the upper Chesapeake Bay in 1981-1984 to occur in the Delaware River between Trenton, New Jersey, and Philadelphia, Pennsylvania. Further documentation of SNS populations and seasonal distributions have been described based on works from Dadswell (1979 and et al. 1984), Hastings (1983), Dovel and Edmunds (1971), Kynard (1997), Hall et al. (1991), Flournoy et al. (1992), Smith et al. (1992), O'Herron et al. (1993), Bain et al. (2002), Collins and Smith (1993 and 1997), Rogers and Weber (1995a and 1995b), Savoy and Shake (1992), Squires and Smith (1979), Kieffer and Kynard (1993), and Buckley and Kynard (1981) along the Atlantic Coast from South Carolina to New Brunswick, Canada. Seasonal distribution of SNS appears to be dependent upon life stage, reproductive state and latitude.

4.1.3 General Life History

The life history of SNS is not fully understood. SNS populations have been documented by Dadswell et al. (1984) to occur in rivers, estuaries, and nearshore marine waters. No known populations occur between the Delaware River population and the Cape Fear River, North Carolina population (Kynard 1997). However, historical records do indicate that SNS were commonly found to inhabit the Potomac River in the Chesapeake Bay in the 1800s (Uhler and Lugger 1876). At present, the continued existence of a distinct SNS population in the Chesapeake Bay remains uncertain. Although SNS have recently been captured in the Chesapeake Bay, genetic studies by Wirgin et al. (2002) have shown that the SNS captured in the Chesapeake Bay are not significantly different from the Delaware River population, and the four SNS analyzed from the Potomac River were also related to the Chesapeake and Delaware River population. This is further supported by the USFWS tracking of three SNS tagged in the Chesapeake Bay that moved through the C&D Canal into the Delaware River.

Kynard (1997) found most SNS adults to have limited movements and a restricted home range within their river and estuary. Rare individuals that are occasionally captured at sea near the coast could represent emigrants that colonize new rivers and maintain gene flow among populations (Kynard 1997). It is not known how far juveniles migrate from their home range. The NMFS (1998) speculated that juveniles or young adults will travel through aquatic systems outside of their home range. Information provided in the Final SNS Recovery Plan (1998) states that SNS are not known to participate in distinct coastal migrations.

4.1.4 Shortnose Sturgeon Distribution Patterns Along the Atlantic Coast

Adult SNS in the Merrimack River, Hudson River, Saint John River, and the Connecticut River exhibit a pattern of freshwater amphidromy (i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life), while use of marine waters is limited to the estuaries of their natal rivers (Bain 1997, Buckley and Kynard 1981, and Taubert 1980). SNS that exhibit amphidromy remain in fresh water for years, but each year some fish spend time in saltwater. Kynard (1997) noted that SNS adults use saline waters the least near the center of their range (Merrimack River in Massachusetts to the Delaware River). The Connecticut River is unique to other aquatic systems, because it supports two distinct populations. Buckley and Kynard (1981) documented a group of SNS as landlocked between Turners Falls Dam and Holyoke Dam, while another group was distributed below the Holyoke Dam to Long Island Sound. In the Saint John Estuary in New Brunswick, Canada, it was documented by Dadswell (1979) that during summers of high river flow (i.e., reduced estuarine salinity), summer abundance peaks of SNS were displaced seaward. The opposite situation was documented in summers with reduced river flows (Dadswell 1979).

SNS along the southern Atlantic Coast exhibit a life history pattern of anadromy. Anadromy is different from amphidromy in that during most of the year SNS are found at or below the freshwater-saltwater interface until the spawning migration begins, at which time SNS move into freshwater reaches. Kynard (1997) speculates that this variability may reflect bioenergetic adaptations to latitudinal differences between fresh- and salt-water habitats for thermal and foraging suitability.

The Hudson River population is reported by Bain et al. (2000) to support the largest population of SNS in the United States, and the system may harbor the most individuals of the species.

4.1.5 Migration and Movement

Movement patterns in SNS vary with fish size and home river location. Juvenile SNS generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the reach above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Adult SNS exhibit freshwater amphidromy, or will move back and forth between fresh water and saltwater for non-reproductive purposes, in some rivers in the northern part of their range, but are generally estuarine anadromous in southern rivers (Kieffer and Kynard 1993). While SNS are occasionally collected near the mouths of rivers, they are not known to migrate along the coast (Dadswell et al. 1984). Spawning migrations are apparently triggered when water temperature warms to above 46°F (8°C) (Dadswell et al. 1984).

Consequently, spring spawning migrations occur earlier in southern systems than in northern ones: December-January (Lower Savannah River: Collins et al. 2002), January-March (Altamaha River: Gilbert and Heidt 1979, Rogers and Weber 1995a; Savannah River: Hall et al. 1991; Pee-Dee/Waccamaw Rivers: Dadswell et al. 1984; Cape Fear River: Moser and Ross 1993), late March (Delaware River: O'Herron et al. 1993), and April-May (Hudson River: Dovel 1979, Bain et al. 2000; Holyoke Pool: Taubert 1980; Androscoggin/Kennebec Rivers: Squiers 1982; Merrimack River: Kieffer and Kynard 1996). In the lower Connecticut and Saint John Rivers, most of the ripening SNS migrate to their spawning grounds in August-October and overwinter there (Dadswell 1979; Buckley and Kynard 1985). Kieffer and Kynard (1993) hypothesized that these adults migrate in fall to avoid long upstream migrations during high discharge periods in spring. In the Altamaha River, Rogers and Weber (1995a) documented upstream movement of most adults to suspected spawning grounds in autumn (late November – early December). A second spawning migration occurred in that system during mid-winter (late January – early February).

The Delaware River SNS population has been characterized by Hastings et al. (1987) and O'Herron et al. (1993). These studies have documented a significant SNS population in the Delaware River from Philadelphia, Pennsylvania, to Trenton, New Jersey. Recapture data suggest that sturgeon utilize the area from Roebling to Trenton annually as residents, and possibly as a nursery from July through December. Hastings et al. (1987) reported that SNS occurrence in the river downstream of Florence appears to be restricted by poor water quality during the summer months. They also reported overwintering activity of SNS in the upper tidal Delaware River near Trenton, New Jersey. In late March, SNS were observed to move upstream into the non-tidal portion of the river just above Trenton. Hastings et al. (1987) speculated that it was in this portion of the river where SNS spawning presumably occurs. After spawning, the SNS were documented utilizing the tidal portion of the river near Philadelphia, Pennsylvania. The annual movement patterns of SNS in the Delaware River have been compared to SNS in the Merrimack River (Hastings et al. 1987). It was found that SNS in the Delaware River, like the SNS in the Merrimack River, spend most of the year in one area, leaving only to move upriver and spawn or to move briefly downstream to a saline reach in April after spawning.

Although genetic variation (that would preclude interbreeding) within and among SNS populations occurring in different river systems is not known, life history studies indicate that they are substantially reproductively isolated (Kynard 1997) and, therefore, should be considered discrete. This assertion is supported by recent DNA studies in the major river systems of the Eastern Seaboard (Wirgin et al. 2002). SNS are known to occur in 19 different river systems from New Brunswick to Florida. While their biology and movement patterns have been studied to varying degrees in each system, differences in life history and migratory patterns have been confirmed on at least a regional basis. For example, SNS grow faster in the south but attain larger adult sizes at the northern part of their range. Seasonal movement patterns and spawning locations of SNS also appear to vary with latitude. In northern rivers, fish move to estuarine locations in summer, presumably to feed on seasonally abundant invertebrate prey. However, in southern rivers, estuarine residence, which occurs in winter, appears to last longer. Finally, numerous tagging and telemetry studies have been undertaken to better understand SNS habitat use and seasonal distribution patterns throughout their range. Few recaptures of tagged fish in adjacent river systems have been documented with the exception of the Chesapeake and Delaware Bays, as they are connected by the C&D Canal. Available tagging data suggest that migration between river systems is low compared to other anadromous species.

Based on the above biological and ecological differences and the lack of recaptures of sturgeon from adjacent river systems, the Shortnose Sturgeon Recovery Team (SSRT) (which is comprised of experts from academia, state and federal resources agencies) considered SNS from different river systems to be substantially reproductively isolated. The loss of a single SNS population segment may risk the permanent loss of unique genetic information that is critical to the survival and recovery of the species. The SSRT, therefore, recommends that each SNS population be managed as a distinct population segment for the purposes of Section 7 of the Endangered Species Act. Under this policy, actions that could adversely affect a distinct population segment will be evaluated in terms of their potential to jeopardize the continued existence of an individual population segment (as opposed to the existence of SNS rangewide). The SSRT recommends that the NMFS review the distinct population segment structure of the SNS (NMFS 1998).

4.1.6 Freshwater, Estuarine, and Overwintering Habitat

Freshwater habitat use by SNS varies with life stage, latitude, and season. Kynard (1997) documented congregations of foraging juveniles and adult SNS in freshwater streams dominated by slow river velocities and large sand shoals. Kynard (1997) speculated that these conditions favor the substrate for freshwater mussels, which are a major food item for adults. Kynard (1997) also noted that juveniles in the Saint John, Hudson, and Savannah Rivers were commonly associated with sand and mud substrates in deep channels. In the Connecticut River, use of channel and shoal areas varied among individuals. Dadswell (1979) reported that juveniles occupy depths in excess of 9 meters in river channels in the northernmost range.

Estuarine habitat use by juvenile and adult SNS is generally concentrated at the freshwater-saltwater interface. The substrate consists generally of mud and sand, and vegetation is often present (Kynard 1997). However, substrate preference appears to vary depending on salinity and geographic location. Larvae and juveniles are epibenthic and occupy the deep channel areas where currents are strong (Dadswell et al. 1984). Adults in the northern rivers are found in shallower water in summer [6.6-32.8 ft (2-10 m)] and in deep water in the winter [32.8-98.4 ft (10-30 m)] (Gilbert 1989). Depth of capture seldom exceeds 32.8 ft (10 m) but this may be attributed to the type of fishing gear used (Dadswell et al. 1984). Gilbert (1989) speculated that SNS, prior to migration to their spawning grounds, tend to occupy the deepest parts of rivers or estuaries where suitable oxygen and salinity levels are present.

Overwintering sites in the Saint John River generally occur in deep areas [32.8-98.4 ft (10-30 m)] of river channels, and halocline regions of the lower estuary (Dadswell 1979). Pre-spawning adults move to deep overwintering sites that are sometimes adjacent to the spawning grounds (Dadswell et al. 1984). Overwintering adults occupy a variety of salinity regimes depending on latitude. Kynard (1997) reported occurrence of SNS in salinity ranges from 0 to 21 ppt depending on geographic location. Connecticut River juveniles and adults have been documented to overwinter in deep water channel habitats within or immediately downstream of the summer range in the river. Dadswell (1979) found that SNS in the Saint John River overwinter in discrete estuarine lakes. In addition, Dadswell (1979) found that when high river discharge pushed the salt wedge downriver, SNS were found in the downstream reaches mostly during spring and fall.

4.1.7 Longevity, Light, and Predators

Shortnose sturgeon may live on average 30 to 40 years depending on location along the Atlantic Coast. The oldest female captured and recorded was 67 years old (USACE 1997a). Sturgeon have few natural aquatic predators since they are one of the largest fish in most rivers within their distribution range. The only record of predation on larval or juvenile shortnose was documented in the Androscoggin River, Maine, when 24 juveniles were found in yellow perch stomachs (Dadswell et al. 1984). Humans have been the most significant predators of adult sturgeon.

Estimates of total instantaneous mortality rates (Z) are available for several river systems. Dadswell (1979) estimated Z to be between 0.12 and 0.15 for SNS (ages 14 through 55) in the Saint John River, New Brunswick, Canada. The fishing mortality rate (F) for the Saint John River was estimated to be 0.012, which would result in a natural mortality rate (M) of 0.11 to 0.14. Taubert (1980) estimated the instantaneous mortality rate to be 0.12 for adult SNS in the Holyoke Pool portion of the Connecticut River. It is likely that the fishing mortality rate was very low in this population, so the natural mortality rate was probably very close to the instantaneous mortality rate. Total mortality for the Pee Dee-Winyah River in South Carolina was estimated at 0.08 to 0.12 (Dadswell et al. 1984). All of the above estimates were based on catch curves that were adjusted for gillnet selectivity and effort. Total instantaneous natural mortality (M) for SNS in the Connecticut River estuary was estimated to be 0.13 (Savoy and Shake 1992).

Light appears to play a major role in the amount of activity observed for SNS (Dadswell et al. 1984). Dadswell found that tagged sturgeon appeared to remain more or less stationary in deep water during daylight, but at night they moved into shallow water or extensively up or downstream. Richmond and Kynard (1995) found that most activity of larvae, juveniles, and adults appears to occur at night.

4.2 GENERAL SPAWNING AND DEVELOPMENT

4.2.1 Spawning Habitat and Timing

Spawning is influenced by substrate and flow (Gilbert 1989). SNS spawn at most once per year between February and May depending on the river system (Dadswell et al. 1979). It is speculated that upstream spawning location may be an important component of reproductive success for SNS (Kynard 1997). Section 4.1.2 discusses the importance of temperature in migration and spawning. In the Savannah River, SNS probable spawning sites were identified in narrow channels and sharp bends having sunken logs and a hard sand-clay bottom with gravel and swift currents [15.7-23.6 in./sec (40-60 cm/sec)] (Hall et al. 1991). Spawning movements have also been documented during the fall in the Merrimack (Kieffer and Kynard 1993) and Altamaha Rivers (Rogers and Weber 1995a). After spawning, the adults move downstream to forage.

4.2.2 Physical Factors Affecting Spawning Success

High river flows during the normal spawning period can cause unacceptably fast bottom water velocities and prevent females from spawning. This situation was observed in the Connecticut

River in early May 1983 and 1992 when flow was higher than normal and temperature was lower than normal, but still adequate for spawning based on historical ranges (Buckley and Kynard 1985; Kynard 1997). Buckley and Kynard (1985) speculated that the reproductive rhythm of females may be under endogenous control and suitable river conditions must be available or endogenous factors prevent females from spawning. Thus, reproductive success can also depend on river conditions during the spawning season.

Kynard (1997) speculates that adults have a behavioral drive to reach a historical spawning area that can be located 125 mi (200 km) upstream or farther. When a dam blocks the spawning migration, Kynard (1997) found that females apparently move as far upstream as they can and may or may not spawn in the reach below the dam. Moser and Ross (1993) documented the disruption of spawning migrations by dams and incidental gillnet capture, which they speculate prevent these fish from ever reaching their spawning grounds.

4.2.3 Spawning Populations in the Chesapeake Bay

There are no documented spawning populations in the Chesapeake Bay or the Potomac River. Speculation has been that overfishing, loss of habitat, and spawning impediments such as the Conowingo Dam have contributed to their decline or extirpation. Until the Reward Program, no young-of-the-year (YOY) [<18 in. (<45 cm)] SNS had been captured as evidence of spawning in the Chesapeake Bay. The Reward Program recovered six relatively small SNS which were just above or below the presumed <18 in. (<45 cm) YOY length [15 to 20.75 in. (38.1 to 52.7 cm)] during the period of February 26 to April 23, 1998. All were captured in the northern upper Chesapeake Bay (Worton Point to the Bohemia River). Given the slower growth pattern of northern SNS, these individuals could be YOY or small adults. Since all were found near the C&D Canal, it has been speculated that at least some of the fish found in the Chesapeake Bay may have come through the C&D Canal from the Delaware River. Genetic testing of the juvenile SNS subsequently revealed that they were from the Delaware River population (Wirgin et al. 2002).

The freshwater/saltwater interface in the Chesapeake Bay occurs on average approximately 18.6-24.8 mi (30-40 km) south of Havre de Grace, which is located at the mouth of the Susquehanna River (Schubel and Pritchard 1986), although this is highly variable and can be impacted greatly during freshets or droughts. In very high flow years, fresh or near-fresh water can extend well past Pooles Island, while in extreme drought years, salinities have reached 4 ppt at Havre de Grace. Literature from similar river systems indicates that spawning takes place as much as several hundred kilometers above the freshwater/saltwater interface. NMFS reported in their BO (1999) concerning impacts to endangered SNS from maintenance dredging of the C&D Canal and the Northern Approach Channel to the C&D Canal in Maryland and Delaware that it is likely that SNS spawn in the Potomac River and, possibly, below the Conowingo Dam in the Susquehanna River. Therefore, if spawning is still occurring in the Chesapeake Bay or the Potomac River, it is unlikely that spawning would occur within areas currently being evaluated for placement or the Federal navigation channels proposed for dredging.

Latitudinal trends of spawning time in other river systems indicate that spawning, if it occurs, would probably take place in late March to early April in the Chesapeake Bay. The Conowingo Dam, located at River Mile (RM) 10 [River Kilometer (RKM) 16] of the Susquehanna River, is an impediment to upstream migration in this system because its location prohibits use of the majority of habitat upstream (Kynard 1997). A Potomac River system spawning population has also been hypothesized. In this event, spawning would again occur some distance above the freshwater interface of the Potomac, which would be relatively far from the Port of Baltimore and areas currently being evaluated for placement and Federal navigation channels proposed for dredging.

4.2.4 Spawning Populations in the Delaware River

The Delaware River dam is located at RM 206 (RKM 331) on the Delaware River. O'Herron et al. (1993) found that during late March and April, spawning aggregations were found primarily between Scudders Falls [RM 137-143 (RKM 220-230)] and Trenton Rapids [RM 130-137 (RKM 210-220)]. Males were noted to appear in spawning areas for longer periods, while females were only present for a short time. Post-spawning males and females were found to move rapidly downstream into the Philadelphia area during April-May. Downstream movement appears to be a natural pattern timed to occur with increased river discharge (Kynard 1997). Many of the SNS tagged in Delaware by O'Herron et al. (1993) were found to return to overwintering sites within a few weeks. Temperature and salinity data for the catches in the Delaware were not included in the literature.

4.2.5 Development of Life Stages

Early growth of SNS is rapid. Young SNS begin to resemble adults by the time they are [0.8-1.2 in. (20-30 mm) in length (Dadswell et al. 1984), but they remain juveniles until they are 45-55 cm fork length depending on the latitude. Males may mature in 2-3 years in Georgia and up to 10-11 years in the northernmost part of their range. Females mature more slowly and also vary with latitude, requiring 6 years in the south and 13 years in the north (Gilbert 1989).

4.2.6 Feeding

Adult feeding migrations occur immediately after spawning. Foraging occurs in northern rivers when temperature exceeds about 45°F (7°C) (Kynard 1997). In southern rivers, SNS appear to fast in summer when temperatures exceed 82°F (28°C) (Flournoy et al. 1992; Rogers and Weber 1995b). SNS use their protuberant mouth to vacuum the bottom, extracting substrate as well as animals (Dadswell et al. 1984). All feeding of SNS seems to be either benthic or off plant surfaces. During late summer, feeding areas tended to be in deeper water [16.4-32.8 ft (5-10 m)], while during the fall and winter, feeding areas tended to be in deep freshwater areas [49.2-82.0 ft (15-25 m)] in the Hudson River and most southern drainages (Dadswell 1979). Juveniles have been found to feed primarily in the deep channels [32.8-65.6 ft (10-20 m)] over sandy-mud or gravel-mud bottoms (Dadswell et al. 1984). Juveniles feed mostly on benthic crustaceans and insect larvae, while adults feed largely on mollusks, polychaetes, and small benthic fish (Gilbert 1989). Dadswell et al. (1984) reported that SNS apparently feed mostly at night or on windy days when turbidity is high. Females in the St. John River fast for 8 months before spawning, whereas males continue feeding.

4.3 DISTRIBUTION, ABUNDANCE, AND HABITAT IN THE CHESAPEAKE BAY AND TRIBUTARIES

In 1996, Maryland DNR, in cooperation with the Chesapeake Bay Program (CBP) and USFWS, established a Sturgeon Reward Program (USFWS 1997) (See Section 3.1.2). Results of the Reward Program are described in detail in Section 3.1.4.3.1. In addition to the SNS captured in Maryland waters, Spells (1998, unpublished report) of the USFWS reported capture of an SNS at the mouth of the Rappahannock River as part of Virginia's Sturgeon Reward Program. This fish was identified as the first confirmed living SNS ever recorded in Virginia.

Results of the USFWS telemetry used to track sturgeon movement are presented in Section 3.1.4.3.3, and the findings of a genetic analysis performed by Dr. Ike Wirgin of the New York Medical School, under contract to USFSWS, are discussed in Section 3.1.4.3.4.

The USFWS also performed a gillnet study, described in Section 3.1.4.3.2, which did not yield information regarding distribution and abundance of SNS in the Chesapeake Bay, as no SNS were captured.

In order to assess the potential for reestablishing spawning populations of Atlantic sturgeon in the Chesapeake Bay, a team comprised of scientists from USFWS, University of Maryland, and the Chesapeake Bay Program released more than 3,000 hatchery raised and tagged juvenile Atlantic sturgeon in the Nanticoke River in July 1996 (Miller 1998). This study is described in Section 3.1.3.1.

4.3.1 Suitable and/or Critical Habitat in the Chesapeake Bay

Critical habitats were not identified in 1967 when the Department of the Interior first listed the SNS as endangered. NMFS (1999) preliminary conclusions find it likely that SNS spawn in the Potomac River and possibly below the Conowingo Dam in the Susquehanna River. Overwintering habitat has been theorized to occur from the Howell to Grove Point section of the upper bay (NMFS 1999).

Studies have shown that Atlantic sturgeon and SNS require slightly different habitat conditions at various stages of growth and development. Atlantic sturgeon usually occur in the Chesapeake Bay in depths between 3.3 and 82±ft (1 and 25± m) and tolerate a wide range of salinities (CBP 2002b). SNS usually occur in the Chesapeake Bay at depths between 3.3 and 39.4 ft (1 and 12 m) (Kieffer and Kynard 1993; Savoy and Shake 2000; Welsh et al. 2000) and tolerate slightly lower salinity ranges than the Atlantic sturgeon (CBP 2002b). Experiments preformed on YOY SNS demonstrated that they can tolerate salinities up to 15 ppt in their first year of life and up to 20 ppt after the first year of life (CBP 2002b). Experiments on Atlantic sturgeon YOY showed improved survival in salinities greater than or equal to 15 ppt. After the first year of life, Atlantic sturgeon could survive in coastal marine waters (Secor et al. 2000). Based on distributional evidence, by their second year of life, Atlantic sturgeon can tolerate salinities of 0-35 ppt, but SNS, even as adults, can only tolerate salinities less than 19 ppt (CBP 2002b).

Dissolved oxygen content of the inhabited waters can play a significant role in sturgeon growth and development (CBP 2002b). Niklitschek (2001) and Secor and Niklitschek (2001) documented behavioral and bioenergetic studies and found the following information. In laboratory testing, the Atlantic and SNS growth rates were significantly reduced at 40% oxygen saturation levels compared to the normal 70% saturation levels at temperatures of 68°F (20°C) and 81°F (27°C). Metabolic and feeding rates declined at oxygen saturation levels below 60%.

The same laboratory testing showed a preference by both Atlantic sturgeon and SNS for oxygen saturation levels at 70% or 100% rather than 40%. Based on this information, the Chesapeake Bay Program suggests a minimum of 60% oxygen saturation or 5 mg/L would protect sturgeon from adverse growth effects (CPB 2002b).

4.3.2 Reward Program Findings/Habitat Utilized in Chesapeake Bay

The majority (86% or 44 fish) of the SNS found in the Chesapeake Bay through the USFWS Reward Program have been captured in relatively shallow water [<25 ft (<7.6 m)], consistent with the gear type of the commercial watermen (primarily gillnets and pound nets). This is also consistent with some studies which have found that sturgeon tend to stay in the top 6.6 ft (2 m) of the water column when traveling, and come into shallow waters to feed (Moser and Ross 1993). Three SNS were captured in deep water in the Susquehanna River in catfish traps [60 ft (18.3 m) deep] located at the Railroad Bridge near Perryville. Three additional SNS were captured in the Susquehanna River in catfish traps or hoopnets in the vicinity of the I-95 Bridge; however, no capture depths were recorded. One SNS was found in a Federal navigation channel but not in a placement area. Of all the sturgeon captured in the USFWS Reward Program, only two WAS were found in Federal navigation channels.

4.3.3 Potential Spawning Habitat

Spawning habitat has not been identified in the Chesapeake Bay, but if this habitat is consistent with the preferred substrate and water quality conditions in other East Coast populations, spawning habitat would be in fresh water several hundred kilometers upstream where high velocity riffles and gravelly to gravelly-sand substrates are found (O'Herron et al. 1993). Richmond and Kynard (1995) maintain that the availability of spawning substrate with crevices is critical to survival of eggs and embryos. The NMFS has indicated that potential SNS spawning habitat could be the Susquehanna River or in the Potomac River. Temperatures at which SNS spawn would likely range from 48 to 59°F (9 to 15°C (Kynard 1997). If the Conowingo Dam [RM 10 (RKM 16)] has resulted in an impediment to spawning and if a Chesapeake Bay population of SNS exists, SNS would most likely spawn as close to the historical spawning grounds as possible. SNS studies in the Chesapeake Bay indicate thus far that the sturgeon found in the Chesapeake Bay are transient migratory individuals from the Delaware River population. If this is the case, then spawning is not likely to occur in the Chesapeake Bay, based on research performed in other systems. If spawning is still occurring in the Potomac River as is presumed in the recent BO for the Washington Aqueduct (NMFS 2003), it would not be affected by dredging or placement activities in the mainstem of the bay.

4.3.4 Potential Feeding Habitat

Also consistent with nearby East Coast populations, feeding habitat would be most important during April to October. Feeding is generally thought to be most important when water temperatures range between 45 and 82°F (7 and 28°C). A post-spawning feeding migration to foraging grounds generally occurs in April. In the initial post-spawning phase, feeding habitat would exist at or near the saltwater-freshwater interfaces of the mainstem and tributaries. Feeding habitat could exist in the shallows, as reported by Moser and Ross (1993) and in deeper channels later in the season, as reported by Dadswell et al. (1984). In the Delaware River, both channel and shoal areas are used for foraging (O'Herron et al. 1993). Adults in the Saint John estuary foraged on sand/mud or mud substrate in 16.4- to 32.8-ft (5- to 10-m) depths (Dadswell 1979). McCleave et al. (1977) reported that Kennebec and Androscoggin River adults foraged in Montsweag Bay in the summer in shallow and deep channels (salinity of 0-21 ppt).

During the month of April, SNS Reward Program data in the Chesapeake Bay indicated captures of SNS (16 fish) ranging from the Susquehanna River (I-95 bridge) to northwest of Barren Island and at the mouth of the Potomac River. Capture depths were not recorded. In May, the captures of SNS (5 fish) ranged from Kent Island to the mouth of Potomac Creek in the Potomac River. One SNS was also captured in Virginia at the mouth of the Rappahannock River during the month of May (Spells 1998, unpublished report). By June, the captures of SNS ranged from the Susquehanna River at recorded depths of 60 ft (18.3 m) to Hoopers Strait (Figure 18).

Telemetry information from five sturgeon tracked by the USFWS in the upper Chesapeake Bay from the early feeding season indicates SNS use the Worton Point to Howell Point section of the bay. Four fish were tracked south and southeast of Pooles Island in water depths of approximately 20 ft (6.1 m). Based on foraging patterns exhibited by SNS in other northeast river systems, SNS in this system are likely to be widely dispersed and actively feeding during the summer. Productive reaches of the upper Chesapeake Bay (e.g., near the saltwater/freshwater interface and channel areas bordering mud flats or emergent macrophyte beds) are potential feeding areas (NMFS 1999).

4.3.5 Potential Thermal Refuge Habitat

It has been reported that SNS utilize deeper areas, when these areas are not anoxic or hypoxic, and that overwintering occurs in deeper areas where water temperatures are warmer. The overwintering areas could be used for feeding, although benthic organism populations are typically reduced in the winter and most fish undergo decreased metabolic rates in colder, as well as very hot water temperatures. Suitable overwintering habitat is probably dependent upon salinity and temperature requirements primarily with availability of food organisms a secondary consideration. SNS Reward Program capture data indicated that during the month of December, the SNS (6 fish) ranged from south of Tolchester to Grove Point in the Elk River. Recorded depths ranged from 12 to 25 ft (3.6 to 7.6 m). By January, the SNS captures (4 fish) ranged from Holland Point to Howell Point at recorded depths ranging from 10 to 32 ft (3 to 9.8 m). In February, the SNS captures (7 fish) ranged from North of Millers Island to the Susquehanna River at recorded depths of 8 to 60 ft (2.4 to 18.3 m) (Figure 18). Using the NMFS BO (1999) that SNS overwintering habitat is likely to occur in the Howell Point to Grove Point region of the bay and the tracking results of the USFWS/USACE study, which tracked a sturgeon in January 1998 southeast of Pooles Island, most of the upper Chesapeake Bay, area north of the Bay Bridge, mainstem is potentially suitable as overwintering habitat for SNS.

4.3.6 Potential Migratory Pathways

It has been assumed in most of the resource agency coordination regarding SNS that Delaware River resident populations use the C&D Canal as a migratory pathway for movement into the Chesapeake Bay. Due to the variations in habitat needs, it is assumed that the Delaware River population would be most similar to a Chesapeake Bay population and/or that the Delaware River population is indeed the source of the Chesapeake Bay population. This has been supported by USFWS telemetry studies of SNS using the C&D Canal (USFWS 2000b) and genetic studies by Wirgin et al. (2002) indicating that the SNS captured in the Chesapeake Bay were similar to the Delaware River population.

Spawning and post-spawning migrations are well described in other estuaries. In estuaries similar to the Chesapeake Bay, spawning migrations generally are from overwintering habitats, deeper more saline waters, towards fresher upper river waters with fast currents. This migration occurs from January to March, with migration triggered by water temperatures of 45-48°F (7-9°C) and spawning also dependent upon water temperature [48-59°F (9-15°C)] (Kynard 1997). The migration can be extensive, often exceeding 125 mi (200 km). Males arrive at the spawning grounds initially and spend a relatively long period of time there; females arrive later and spend relatively little time (several days to a week). In the Delaware River, post-spawning migrations occur in April from the spawning ground to foraging areas, typically at or below the saltwater-freshwater interface. A more gradual migration occurs towards the overwintering areas in the late fall.

4.3.7 Potential Juvenile/Larval Habitat

Little information is available on larval and juvenile migration and development in the field. Jarvis et al. (2001) examined the effects of salinity on the growth of juvenile SNS in aquaculture. The juvenile SNS [age 16 months, mean weight 9.6 oz (273 g)] were reared at four salinities (0, 5, 10, and 20 ppt) for 10 weeks at 64°F (18°C). The study results indicated that the SNS reared at 0 ppt showed significantly more weight gain and greater feed conversion rates than the fished raised at all other salinities. Other laboratory studies indicate that newly hatched larvae go through a 2-day downstream migration to riverine habitats where they remain for approximately 1 year (Kynard 1997). A resumption of downstream movement takes place the following spring, at which time yearlings appear in estuarine habitats, completing migrations from spawning areas.

Collins et al. (2002) captured and implanted or attached acoustic transmitters to 15 juvenile SNS in the Lower Savannah River, Georgia – South Carolina during 1999-2000. The juveniles were located only between RM (measured from the mouth of the river) 19.4 and 29.5 (RKM 31.2 and 47.5), in salinities of 0.1 ppt to (briefly at high tide) 17.6 ppt, and at depths of 6.9 to 44 ft (2.1 to 13.4 m). The fish used two small areas very intensively. The fish moved upriver when water temperatures were above 72°F (22°C). They aggregated particularly at RM 29.5 (RKM 47.5) when temperatures were greatest, and the average salinity at this location was 0.1 ppt. When water temperatures were below 72°F (22°C), the fish moved downriver into Savannah Harbor and used approximately 1.2-mi (2-km), segments of the Front and Middle Rivers just upriver of their confluence at RM 19.6 (RKM 31.5). Here they encountered higher salinities (mean, 5.4 ppt) than during warm months. During the period of lowest water temperatures, the fish aggregated just inside the mouth of Middle River in a hole separated from the deeper Front River by a sill.

Based on other studies, habitat important to the larval and juvenile stages of SNS would be found above the saltwater/freshwater interface, on gravel/sand/mud substrate, and deeper channel areas [32.8-65.6 ft (10-20 m) deep] in freshwater rivers (Pottle and Dadswell 1979). Larvae and juveniles in the Delaware River population move upstream from deeper to shallower waters in the spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al 1984 and Hall et al. 1991). NMFS (1999) drew a similar conclusion based on the occurrence of

SNS within freshwater reaches of the Potomac River, the capture of adult SNS below the Conowingo Dam in mid to late April, and the capture of six juvenile SNS in the upper Chesapeake Bay (Appendix A; Table A-1).

5.0 PLACEMENT ALTERNATIVES UNDER CONSIDERATION

The Corps and the Maryland Port Authority (MPA) are responsible for maintaining, through periodic dredging, the 126 mi (202.8 km) of Federal Navigation channels that serve the Port of Baltimore. Of particular concern are the Chesapeake Bay approach channels in Maryland, which include the Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel Eastern Extension, Swan Point Channel, Tolchester Channel, and the southern approach channel to the C&D Canal (Figure 2). Continued maintenance dredging is required to maintain the efficiency and safety of the approach channels to the Port of Baltimore.

Currently, CENAB is preparing a dredged material management plan and programmatic Environmental Impact Statement (EIS) to evaluate the proposed placement of materials dredged from the approach channels to the Port of Baltimore within appropriate sites in the upper Chesapeake Bay. CENAB and MPA have both a short-term (5-10 years) and a long-term (20-year) need for additional dredged material placement capacity. The following sections describe the placement options being considered as a solution to the material placement needs that are expected to have an operational life span of 1-20 years. A no action alternative is also being considered.

Dredged material placed at the selected site(s) would be taken from the Craighill Entrance Channel, the Craighill Channel, the Craighill Upper Range, the Craighill Angle, the Cutoff Angle, the Brewerton Channel Eastern Extension, the Swan Point Channel, the Tolchester Channel, and the southern approach channels to the C&D Canal (Figure 2). No material will be taken to the placement site(s) from channels within Baltimore Harbor or the Patapsco River, except for Hart-Miller Island (HMI) and potentially Cox Creek, as they are confined placement facilities.

Dredged material placement activities are proposed for the October 1 to March 31 window for all the alternatives except Site 104, Deep Trough (north of Bloody Point), and Deep Trough (south of Bloody Point). The proposed window for placement at these sites is October 15 – March 31. This window was chosen to optimize dewatering abilities at containment sites and to limit adverse impacts to water quality, aquatic and benthic organisms, and commercial and recreational fisheries.

5.1 EXISTING SITES

5.1.1 Hart-Miller Island

The HMI Dredged Material Containment Facility is located in the upper Chesapeake Bay approximately 14 mi (22.4 km) due east of Baltimore City, near the mouth of the Back River in Baltimore County (Figure 21). Construction of HMI began by building a dike connecting the remnants of Hart and Miller Islands and encompasses approximately 1,100 acres [445.2 hectares (ha)] of bay bottom. The dike, which was completed in 1983, is approximately 29,000 ft (8,839 m) long and is divided into North and South Cells by a 4,300-ft (1,311-m) interior cross-dike. Placement of dredged material within HMI began in 1984 and continues presently. In 1988, the +18-ft (+5.5-m) MLLW (mean lower low water) dikes were raised to +28 ft (+8.5 m) MLLW to provide capacity for the completion of the Baltimore Harbor and approach channels

50-ft (15.2-m) deepening project, and in 1997 the North Cell dikes were raised to +44 ft (+13.4 m) MLLW to increase the available capacity within the site. This provided an estimated 30 mcy (23 mcm) of additional capacity.

The substrate is composed mainly of predominately fine-grained fluvial material consisting of sand, silt, and clay. The site is located in the oligohaline (0.5-5 ppt) portion of the Chesapeake Bay. According to the benthic index of biotic integrity (B-IBI) study conducted in 1996, the area surrounding HMI is not stressed. The B-IBI is a multiple-attribute index developed to identify the degree to which the benthic assemblage meets the Chesapeake Bay Program's Community Restoration Goals (Weisberg et al. 1997). No SNS were captured within the site, as it is a contained area. However, two SNS were captured in the northern and eastern vicinity of the existing facility in January and February 1999, respectively, in the Reward Program. An Atlantic sturgeon was also captured in the northern vicinity of HMI off Millers Island. This site was not sampled as part of the USFWS/USACE sturgeon study.

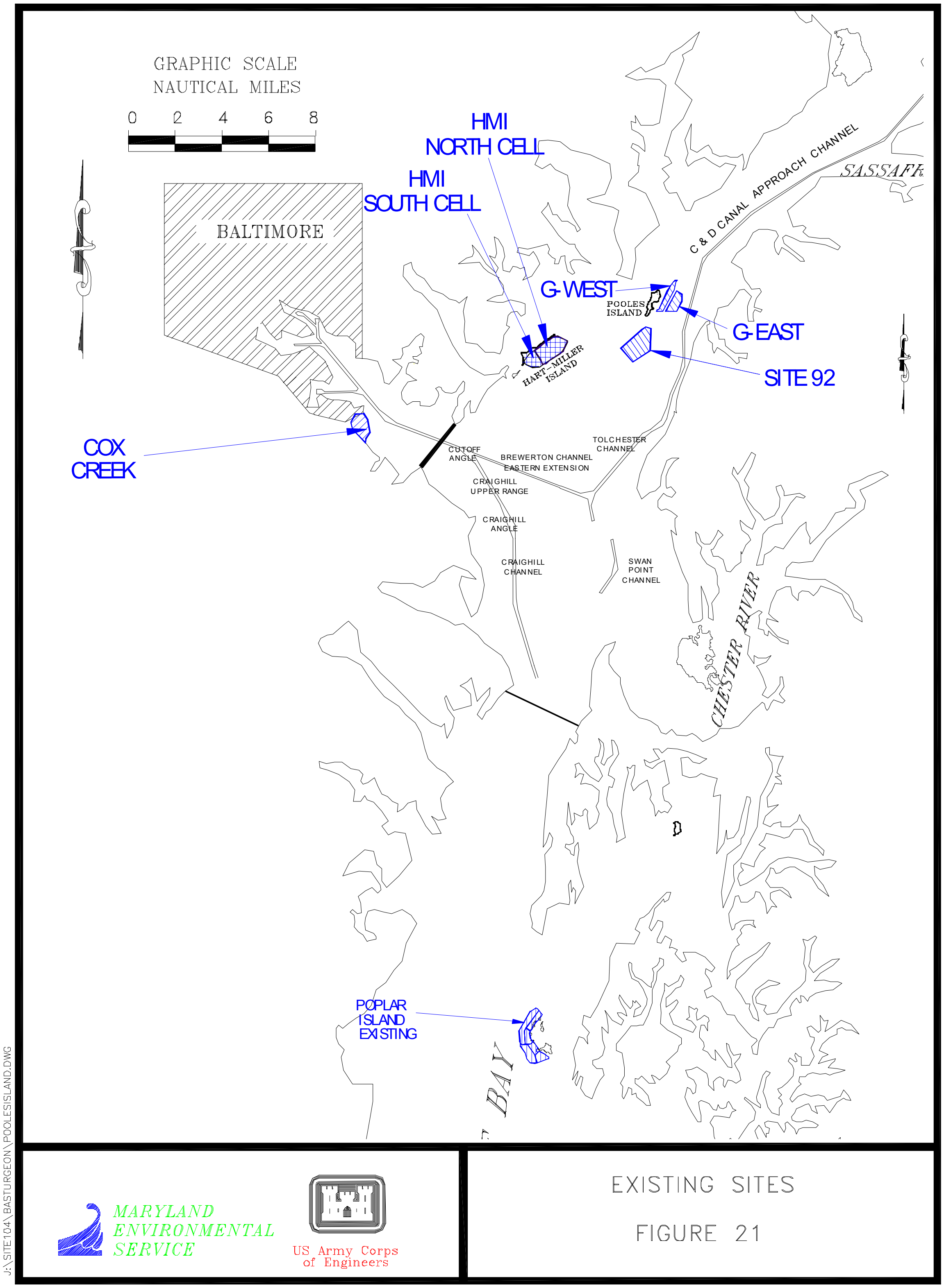
Table 4 presents a summary of water conditions in the area surrounding HMI.

Table 4. Hart-Miller Island Surrounding Water Conditions

Range of Bottom Conditions at 11 Hart-Miller Island Monitoring Stations		
Parameter	**September 1998**	**May 1999**
Temperature [°F (ºC)]	74.1-81.9°F (23.4-27.7°C)	60.4-64.6°F (15.8-18.1°C)
Depth [ft (m)]	3.3-16.4 ft (1.0-5.0 m)	3.3-14.1 ft (1.0-4.3 m)
Dissolved Oxygen (mg/L)	7.3-8.1	9.5-13.7
PH	6.8-7.1	7.4-7.8
Salinity (ppt)	7.5-8.1	4.1-6.4

Source: MDE (2000).

Figure 21. Location of Existing Sites



5.1.2 Poplar Island

The Poplar Island Environmental Restoration Project (PIERP) is located in the upper middle Chesapeake Bay approximately 34 nautical miles southeast of the Port of Baltimore and approximately 2.0 nautical miles northwest of Tilghman Island in Talbot County, Maryland (Figure 21). The current restoration plan, when fully implemented, will create a 1,140-acre (461-ha) restoration project and dredged material placement area within a 35,000-ft (10,500-m) perimeter dike. The site plan is to develop low and high marsh wetlands [550 acres (220 ha) in four cells] and upland [570 acres (228 ha) in two cells].

The dike on the western (upland) side of Poplar Island is authorized to be raised from the current (initial) elevation of 11.5 to 23.0 ft (3.5 to 7.0 m). The dike raising is expected to have no impact on water quality in the vicinity of Poplar Island, as the activity will occur upland and not in surrounding waters.

The waters surrounding Poplar Island are shallow [3-12 ft (0.9-3.6 m) MLLW] and are characterized as mesohaline (8-18 ppt). Data from six Chesapeake Bay Water Quality Monitoring Program stations (Segment 4), located either directly north or south of Poplar Island, were used for several water quality parameters in the area for all seasons (Table 5).

Table 5. Surficial [1.6 ft (0.5 m)] Water Quality Measurements From Segment 4 of the Chesapeake Bay*

Parameter	Spring	Summer	Fall	Winter
DO (mg/L)	10.7	8.5	8.4	11.1
PH	8.2	8.3	8.0	8.0
TDN (mg/L)	0.84	0.41	0.43	0.53
TDP (mg/L)	0.01	0.0170	0.0223	0.0109
TSS (mg/L)	6.32	7.3	5.8	5.7
Chlorophyll-*a* (µg/L)	12.14	16.8	11.8	7.94

* Values represent seasonal averages collected from 1995-2002.
Source: EA (2002).

Virginia Institute of Marine Science (VIMS) data shows no SAV in the waters surrounding Poplar Island or nearby Coaches or Jefferson Islands from 1994 to 2000. Small beds of SAV were noted between Poplar Island and Jefferson Island during a survey of the area by USFWS in Summer 2001. Benthic sampling conducted in October 2001 reported a mean total B-IBI score of 2.1 for 10 sampling locations. This did not meet the Chesapeake Bay Restoration Goal of a B-IBI score of 3.0 (EA 2002). Average plankton counts for Segment 4 indicated that the Poplar Island area exhibits typical plankton production for this reach of the Chesapeake Bay.

No SNS or WAS were captured in the vicinity of the PIERP site from the results of the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 8 nautical miles to the west of Poplar Island near Herring Bay and was captured by way of gillnet (Figure 4). One WAS was captured by pound net several miles to the east of Poplar Island, near Tilghman Island (Figure 6). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.1.3 Cox Creek

The Cox Creek site is located along the western shore of the Patapsco River approximately 7 mi (11.3 km) south of Baltimore's Inner Harbor and 3 mi (4.8 km) due south of Dundalk Marine Terminal, in northeast Anne Arundel County (Figure 21). The Dredged Material Containment Facility (DMCF) is within 3 mi (4.8 km) of the harbor channels. The 133-acre (53.8-ha) site is comprised of two adjoining properties: the CSX site and the Cox Creek site. Both sites were developed by CENAB and used as dredged material placement sites from 1961 through the mid 1980s. There are a total of 109.9 acres (44.5 ha) of non-tidal open water wetlands. Because the wetlands occur within the DMCF, they are not jurisdictional wetlands. With renovations, the DMCF has a potential capacity of approximately 6 mcy (4.6 mcm) of dredged material.

The Cox Creek cell, located on the northern portion of the DMCF, has a total of 61 acres (24.7 ha), of which approximately 60 acres (24.3 ha) are useable. The CSX cell, located at the southern portion of the site, has a total of 72 acres (29.1 ha), of which approximately 50 acres (20.2 ha) are useable. The two cells are currently separated by a cross-dike and have existing perimeter dikes. The top elevations of the existing dikes are variable. In general, the eastern dike height is about 16 ft (4.9 m) on the Cox Creek portion and 20 ft (6.1 m) on the CSX portion. The existing land mass dikes along the western side of the Cox Creek cell are at about elevation 36 ft (11 m). The side slopes of the dikes were constructed at a 2:1 or 3:1 slope; however, the exterior slopes along the eastern side of the facility have eroded to conditions approaching a 1:1 slope. This appears to be most pronounced on the northernmost portion of the dikes. Soft foundation soils were found to be present in the CSX cell. The original use for this site was as a dredged material containment area. No SNS or Atlantic Sturgeon were captured near the facility in the Reward Program. This site was not sampled in the USFWS/USACE sturgeon study.

5.1.4 Pooles Island Open Water (G-East, G-West, and Site 92)

Pooles Island open water site (Site 92) is an open-water dredged material placement area located immediately south of Pooles Island in the northern portion of the upper Chesapeake Bay (Figure 21). The site is approximately 934 acres (378 ha) in area, and is estimated to provide approximately 7.0 mcy (5.4 mcm) of capacity when brought to -14 ft (4.3 m) MLLW. Site 92 surrounds a shallow elongated basin, oriented in a northeast to southwest direction. G-West is also part of the Pooles Island open water site. Placement began there in 1994 and continued through 1997. In 1996, expansion of the Pooles Island area to include G-East and/or Site 92 was under consideration due to a need for increased capacity. Both G-East and Site 92 were selected as potential sites because of the extensive data already available on the Pooles Island area. Prior studies included sediment transport studies; sediment quality studies; sediment oxygen and nutrient exchange studies; water quality studies; fish abundance, size, and species composition studies; fishing activity studies; and benthic studies. These studies did not reveal any regional water quality impacts from the placement of dredged material. Studies showed that a change in water depth as a result of placement is likely to eliminate habitat for some fish species during certain times of the year, whereas it improves habitat or is not a factor in determining habitat use for other fish species.

No SNS or Atlantic Sturgeon were captured near the area in the Reward Program. According to the USFWS (2000b) report, one Atlantic sturgeon was captured in area G-East during the

USFWS/USACE sturgeon study; however, the fish was actually captured in area G-West, based upon the capture coordinates.

5.2 MODIFICATIONS TO EXISTING SITES

The modifications of existing sites are currently being considered as alternatives. These include the Hart-Miller Island South Cell Restoration, Hart-Miller Island Footprint Expansion, some reconstructed Maryland C&D Canal Upland Sites, and Poplar Island Dike Raising and Expansion. Some of the proposed modifications to existing sites would take place within the existing footprint, but others may include lateral expansion into the water.

5.2.1 Poplar Island Modification

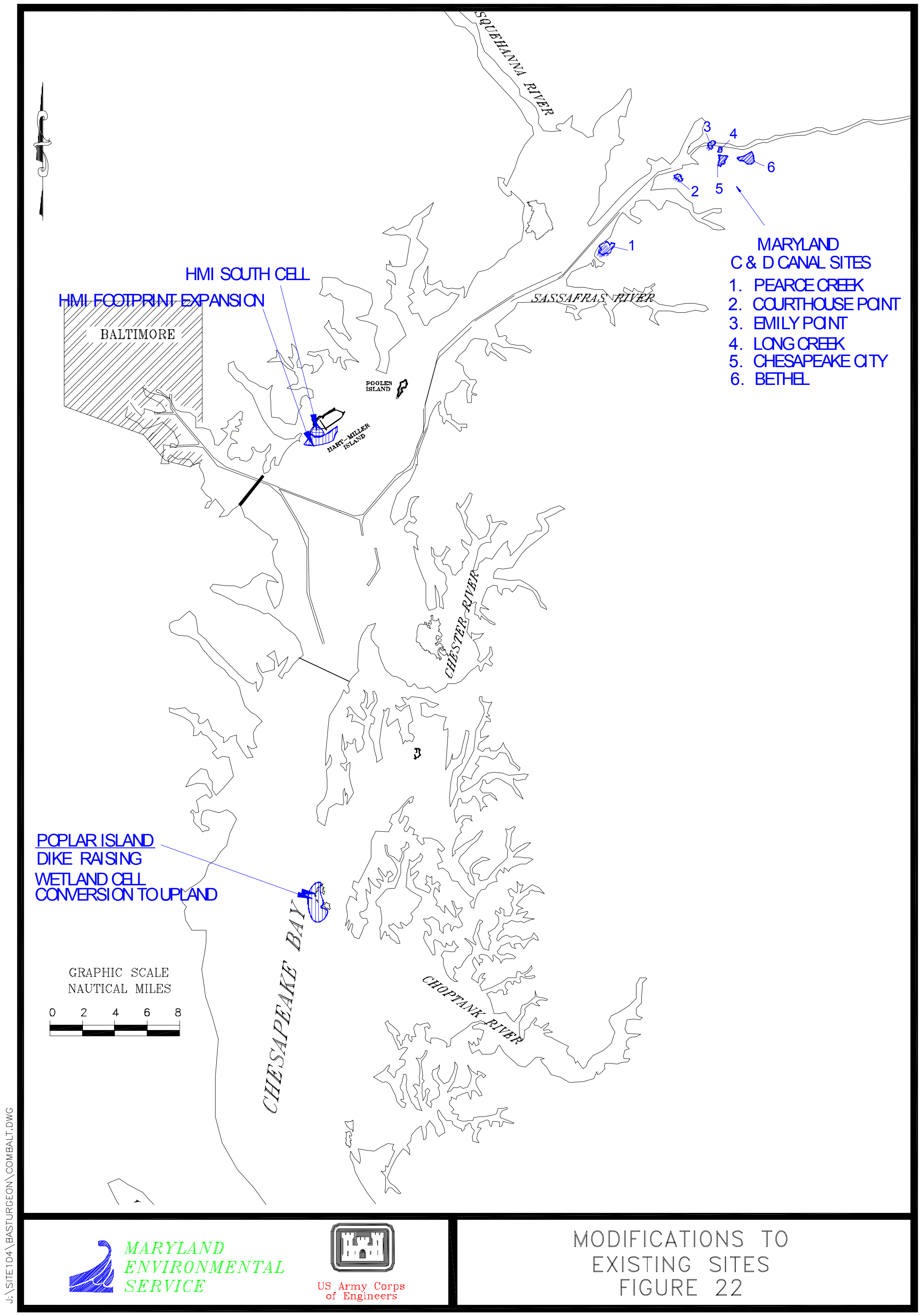
The PIERP is an existing placement site in the middle Chesapeake Bay. The Corps is considering several potential expansion options for this project. The proposed modification at PIERP would raise the upland dikes higher than the authorized 23-ft (7-m) dikes or expand the footprint to the north, south, or southwest of the current configuration. The alignments proposed under this modification range from 313 to 1,129 acres (126.7 to 457 ha).

See Section 5.1.2 for a description of the existing site, natural resources, and SNS utilization.

5.2.2 Maryland Chesapeake and Delaware Canal Placement Sites

The C&D Canal, located in northeast Maryland along the Elk River, connects the Chesapeake Bay and Delaware River (Figure 22). Six existing C&D Canal placement sites within Maryland are being looked at as potential upland placement sites for dredged material from the Port of Baltimore approach channels. The six sites are Pearce Creek, Courthouse Point, Emily Point, Long Creek, Chesapeake City, and Bethel. Several of these sites are precluded from immediate use due to environmental concerns and available capacity issues. The C&D Canal placement sites are designated for placement of material from the C&D Canal approach channels and the canal proper. Effects on water quality are site-dependent; however, no long-term effects are expected concerning dissolved oxygen, nutrient enrichment, turbidity, or salinity. Because these are upland sites, only minimal impacts are expected to water quality or benthic communities in the Chesapeake Bay. No SNS were captured within any of the sites, as they are upland facilities. However, SNS have been tracked through the C&D Canal passing between the Delaware River and Chesapeake Bay (Section 3.1.4.2).

Figure 22. Location of Modifications to Existing Sites



5.2.3 Hart-Miller Island South Cell Restoration

The Hart-Miller Island restoration site is located in the upper Chesapeake Bay approximately 14 mi (22.4 km) due east of Baltimore City, near the mouth of the Back River in Baltimore County (Figure 22). The South Cell of HMI is approximately 300 acres (121.4 ha) in size with an elevation of about ±18 ft (±5.5 m). The South Cell received Inner Harbor and Chesapeake Bay dredged material from 1984 to 1990.

The proposed South Cell Restoration of HMI will be comprised of approximately 200 acres (81 ha) of vegetated wetlands and mudflats, and 80 acres (32.4 ha) of uplands vegetated with grasses, shrubs, and a couple of ponds. Construction of the South Cell restoration project began in Fall 2002. Post-construction monitoring will include exterior sediment quality, SAV, water quality, fish community composition, and fish tissue (interior and exterior). The goals of the habitat restoration are to provide other wetland and upland habitats that will attract waterfowl, aquatic insects, and fish.

Because this is a site that will become wetland and upland, and is now upland, only minimal impacts are expected to water quality or benthic communities in the bay.

No SNS were captured within the site, as it is an upland site. However, two SNS were captured as a part of the Reward Program in the northern and eastern vicinity of the existing facility in January and February 1999, respectively. An Atlantic sturgeon was also captured in the northern vicinity of HMI off Millers Island. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.2.4 Hart-Miller Island Footprint Expansion

Hart-Miller Island is an existing State-owned and operated confined placement facility. It is part of the Pleasure Island Chain and is located in the upper Chesapeake Bay approximately 14 mi (22.4 km) due east of Baltimore City, near the mouth of the Back River in Baltimore County (Figure 22). Construction of the island started in 1981 and concluded in 1983. This alternative would involve the expansion of the site laterally to the south. Average depths of the waters are between -8 and -20 ft (-2.4 m and –6.1 m) MLLW. It is approximately 110 to 500 acres (44.5 to 202.4 ha) in size. The bottom is composed of predominantly fine-grained fluvial material consisting of sands, silts, and clays. This site is located in the oligohaline portion of the bay (0.5-5 ppt). Benthic monitoring in the vicinity of the site has indicated that benthic invertebrate populations in this region are predominantly opportunistic species with short life spans, small body size, and often high numerical densities (MDE 1998). These opportunistic species are characteristic of disturbed or environmentally variable regions (Beukema 1988) such as the upper Chesapeake Bay. No SNS were captured in this site according to the results of the Reward Program as of September 30, 2003. However, two SNS were captured in the northern and eastern vicinity of the existing facility in January and February 1999, respectively, during the Reward Program. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.3 OPEN-WATER ALTERNATIVES

5.3.1 Site 104

Site 104 is a previously used, 1,800-acre (728.5-ha), open-water placement site located approximately 0.5 mi (0.8 km) north of the Chesapeake Bay Bridge, east of the navigation channel, and 1 mi (1.6 km) west of Kent Island (Figure 23). Site 104 was established in 1924 by the Corps and was used for the placement of dredged material until 1975.

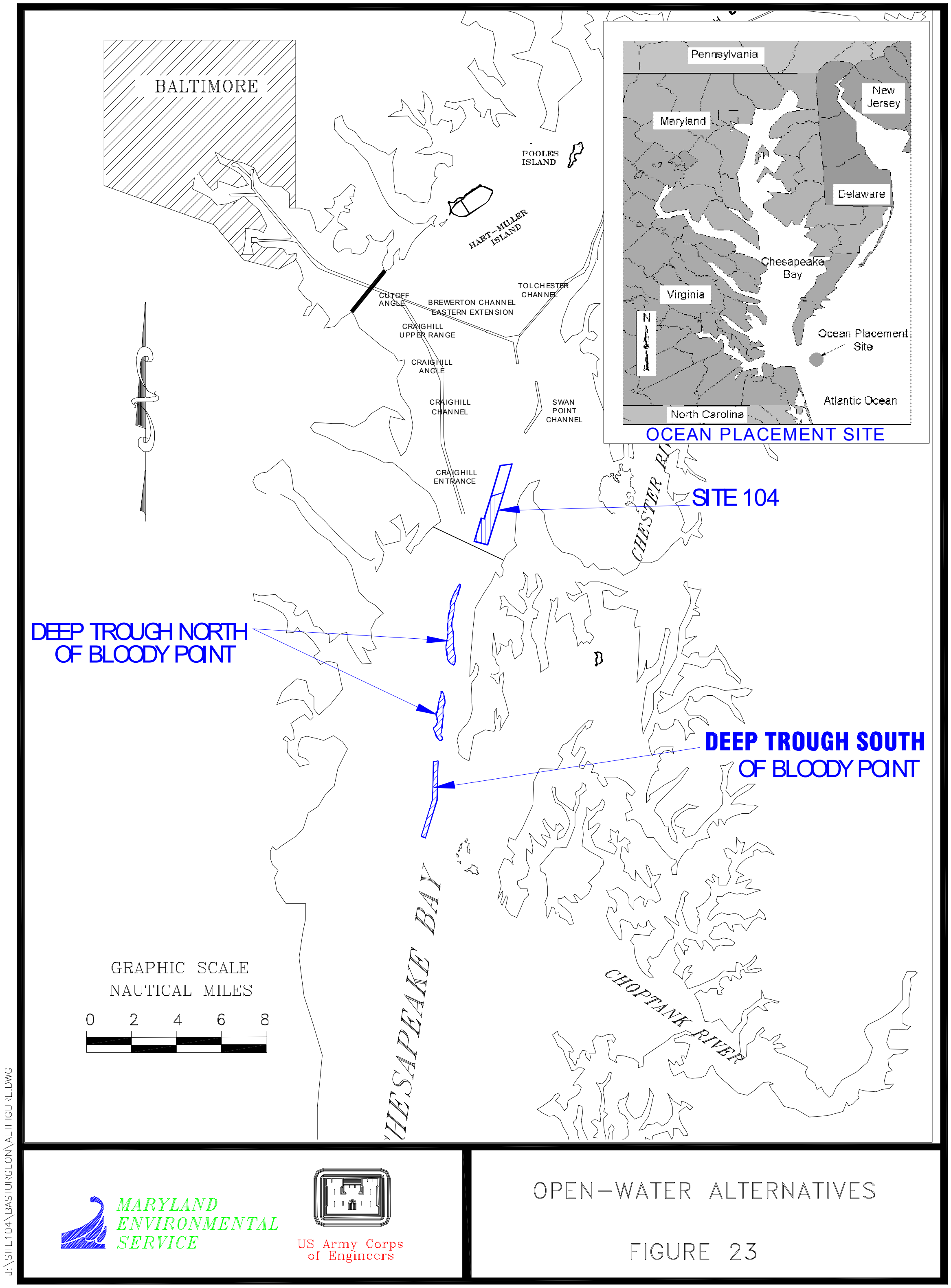
The site is approximately 4.2 mi (6.8 km) long and 0.65 mi (1.1 km) wide. The depth ranges from -42 to -78 ft (-12.8 to 23.8 m) MLLW. Placement is proposed to raise the elevation up to -45 ft (13.8 m) MLLW. This is approximately equivalent to the southern two-thirds of the site or 1,200 acres (486 ha; shaded area within Site 104, Figure 23). Site 104 is generally flat with a gentle southward slope. Because of depth and mainstem location, Site 104 is a depositional area for fine-grained and highly organic sediments originating from the northern Chesapeake Bay watershed. In 1997, surface waters at Site 104 had salinities ranging from 3.0 to 15.0 ppt and bottom waters had salinities ranging from 7.0 to 18.0 ppt (USACE 1999). The physical make-up of the site (substrate type, temperature, salinity, and dissolved oxygen) dictate that Site 104 be dominated by stress-tolerant, opportunistic species that are less sensitive to environmental fluctuations and can re-colonize rapidly. Benthic sampling in the area indicated that the benthic community had poor diversity and was considered stressed (MDE 1998). No SNS were captured in Site 104 during the USFWS/USACE sturgeon study during 1,190 hours of gillnetting in 90 deployments as of March 2000 or from the results of the Reward Program as of September 30, 2003. The USFWS/USACE study has, however, documented one WAS within the Site 104 boundaries (March 2000) (Appendix B, Figure 9 and Appendix B, Table 14).

5.3.2 Ocean Placement

The Norfolk ocean placement site lies on the continental shelf in an area that ranges in depth from -45 to -85 ft (-13.8 to -25.9 m). It is typical for the offshore ocean waters to have salinities of 36 ppt. This alternative is believed to be outside the SNS range, and no catches have been found in the literature review to indicate otherwise.

The ocean disposal site being considered for placement of dredged material from the Port of Baltimore approach channels is located approximately 17 nautical miles (19.6 statute miles) east of the mouth of the Chesapeake Bay. The site is circular in shape [radius = 24,000 ft (7,315 m)], covers approximately 65 mi^2, and has an average water depth of -70 ft (21.3m). The site is currently permitted and designated for placement of material from the Virginia channels, and would need to be authorized for placement of material from Maryland channels. MPA requested a study to evaluate the possibility of ocean placement. A report was completed in 2002 by Gahagan & Bryant Associates, Inc. to assess the U.S. dredging fleet's ocean placement capabilities in regard to fleet availability, material transport alternatives, and a dredging cost analysis. This site is an open-water placement option. Because the open-water placement site is in the ocean, most impacts associated with placement in the Chesapeake Bay do not apply.

Figure 23. Location of Open-Water Alternatives



5.3.3 Deep Trough (North of Bloody Point)

The Deep Trough (north of Bloody Point) is a deep trench located offshore of Kent Island, which is a remnant of the ancient Susquehanna River channel (Figure 23). It runs approximately 20 mi (32.2 km) from the Chesapeake Bay Bridge to Bloody Point. It is approximately 1,168 acres (473 ha) in size. The depth of the site ranges from -60 to -160 ft (-18.3 to -48.8 m) MLLW. One placement alternative at the site could raise elevations up to -90 ft (-27.4 m) MLLW. The bottom is predominantly fine-grained material. This site is located in the mesohaline portion of the Chesapeake Bay (5-18 ppt). It is common for deeper parts to be hypoxic to anoxic during the summer months. The physical make-up of the site (substrate type, temperature, salinity, and dissolved oxygen) dictate that the Deep Trough be dominated by stress-tolerant, opportunistic species that are less sensitive to environmental fluctuations and can re-colonize rapidly. No SNS were captured in this site as part of the Reward Program as of September 30, 2003. However, two SNS were caught in pound nets in the vicinity of the site below the Bay Bridge off of the shoreline of Kent Island in May 1996 (Figure 4). This site was not sampled as part of the USFWS/USACE sturgeon study. Approximately 15 WAS were captured in the vicinity of the site during the Reward Program (Figures 5 and 6).

5.3.4 Deep Trough (South of Bloody Point)

The Deep Trough (south of Bloody Point) is located on the eastern side of the upper Chesapeake Bay, which begins south of Bloody Point and extends as far south as the mouth of the Potomac River. Only the northern portion of the site from Bloody Point to Poplar Island was considered as a potential placement area (Figure 23). This site, like the Deep Trough north of Bloody Point site, is also part of the old Susquehanna River channel. This proposed placement site is approximately 2,600 acres (1,052 ha) in size and rectangular in shape. Depths at the site range from -60 to -174 ft (-18.3 to -53 m) MLLW. The bottom is composed of predominantly fine-grained material. This site is located in the mesohaline portion of the Chesapeake Bay (5-18 ppt). It is common for deeper parts to be hypoxic to anoxic during the summer months. The physical make-up of the site (substrate type, temperature, salinity, and dissolved oxygen) dictate that the Deep Trough be dominated by stress-tolerant, opportunistic species that are less sensitive to environmental fluctuations and stresses and can re-colonize rapidly. No SNS were captured in this site according to the results of the Reward Program as of September 30, 2003. Two WAS were captured in the vicinity of the site during the Reward Program (Figure 6). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4 CONFINED, UPLAND, AND OTHER ALTERNATIVES

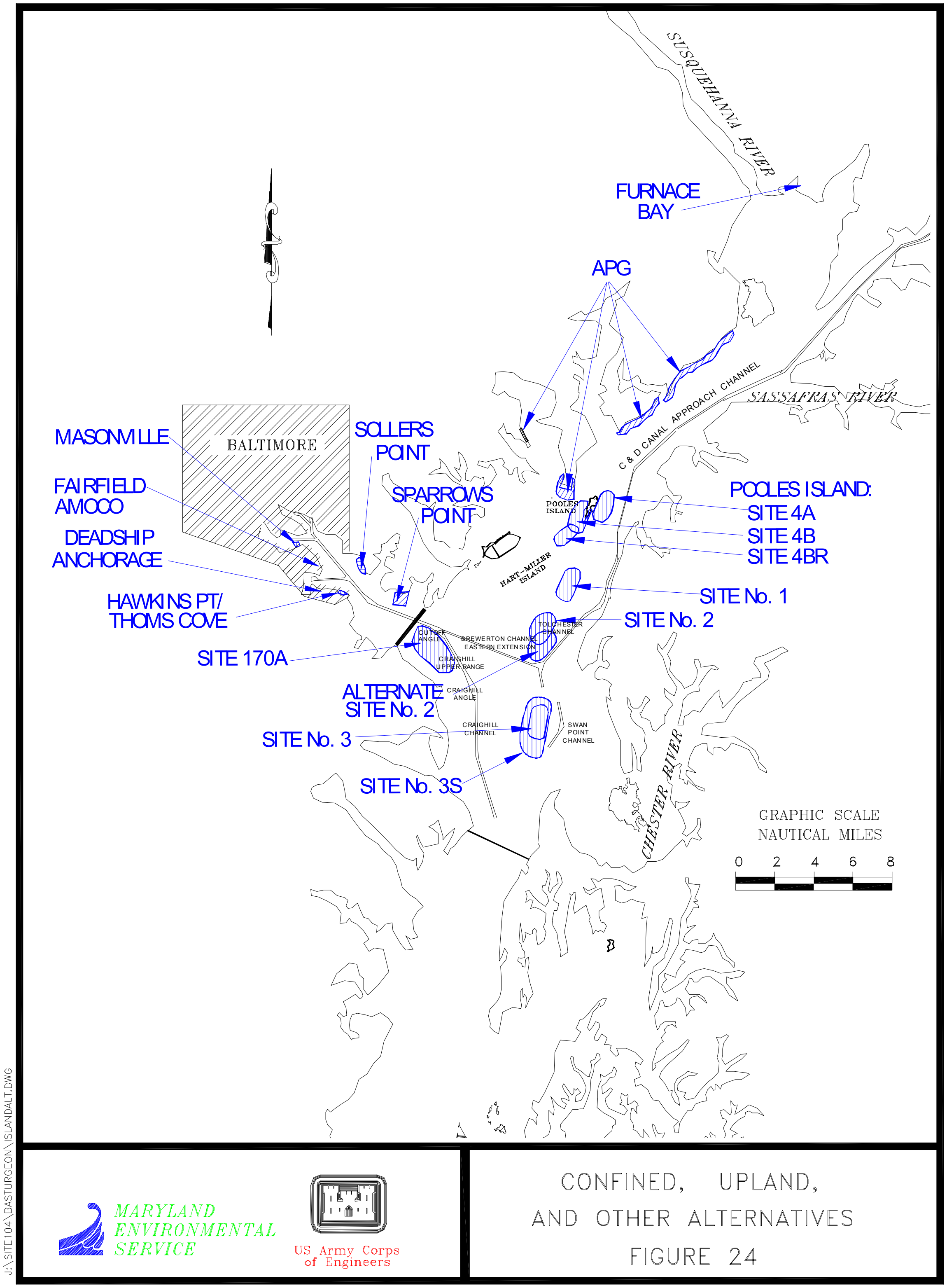
5.4.1 Tolchester West (Site 1)

The proposed containment site known as Tolchester West is located within the upper Chesapeake Bay to the west of the Tolchester Channel, in the vicinity of Gales Lump Reef (Figure 24). The island configuration described here is also known as Site 1 from the 1998 Upper Bay Island Placement Site Prefeasibility Study. The site is being looked at as a potential island creation site. The site varies in depth from -10 to -16 ft (-3.0 to -4.9 m) MLLW, with an average depth of approximately -12 ft (-3.6 m). The bottom is composed predominantly of sand, although some clayey silt and sandy oyster shell bottom are also present. It is approximately 790 to 1,060 acres (320 to 429 ha) in size. This site is located in the low mesohaline portion of the bay. The deeper waters nearby experience salinity stratification. The surface salinity is generally 0-13 ppt, while bottom salinity ranges from 0 to 17 ppt. Dissolved oxygen levels at monitoring stations in deeper water near the area of the site indicate some degree of anoxia in the summer months in bottom waters; however, no negative impacts are expected from the seasonal anoxia. The benthic community habitat is categorized as low mesohaline. The benthic community in adjacent areas studied shows the benthos is in good health, with a B-IBI of 3.4 (EA 1997). No SNS or Atlantic sturgeon were captured in Tolchester West during the sampling according to the preliminary results of the USFWS/USACE sturgeon study during 272 hours of gillnetting in 28 deployments or as part of the Reward Program as of September 30, 2003.

5.4.2 Site 168 (Site 2 and Alternative Site 2)

Site 168 is located at the intersection of the Brewerton Extension and Tolchester channels, approximately 3 mi (4.8 km) west of Swan Point (Figure 24). Site 168 lies partially within an old open water placement site (Man-o-War Shoals). An alternate configuration to this site was proposed during the pre-feasibility screening. The alternative configuration would shift the site north and west into shallower water away from the navigation channels. Overall, the bottom is relatively flat, varying in depth from -14 to -28 ft (-4.2 to -8.4 m) MLLW and sloping gently downward in a south-southeast direction. The site is approximately 1,075 to 1,195 acres (435 to 484 ha) in size. It is common for deeper parts to be hypoxic to anoxic during warmer months (EA 1997). This site is located in the mesohaline portion of the Chesapeake Bay (5-18 ppt). The physical make-up of the site (substrate type, temperature, salinity, and dissolved oxygen) dictate that Site 168 be dominated by stress-tolerant, opportunistic benthic species that are less sensitive to environmental fluctuations and stresses and that can re-colonize rapidly. Average B-IBI scores for this site were 2.3, indicating stress to the benthic community, which is expected due to naturally occurring hypoxia. No SNS or Atlantic sturgeon were captured in Site 168 according to the preliminary results of the USFWS/USACE sturgeon study during 186 hours of gillnetting in 26 deployments or as part of the Reward Program as of September 30, 2003.

Figure 24. Location of Confined, Upland, and Other Alternatives



5.4.3 Site 171 (Sites 3 and 3S)

Site 171 is located immediately west of the Swan Point Channel, approximately 9.6 km (6 mi) east/southeast of Bodkin Point (Figure 24). It is approximately 2,900 acres (1,174 ha) in size. Depths at the site range from -24 to -32 ft (-7.3 to -9.8 m). The bottom is predominately flat and composed of fine-grained silts and clays. Site 171 is heavily harvested for blue crabs in the shallower areas where the site does not go anoxic in the warmer months. This site is located in the mesohaline portion of the Chesapeake Bay (5-18 ppt). The benthic community habitat is categorized as high mesohaline clayey silt. The physical make-up of the site (substrate type, temperature, salinity, and dissolved oxygen) dictate that Site 171 be dominated by stress-tolerant, opportunistic species that are less sensitive to environmental fluctuations and can re-colonize rapidly. Benthic sampling in the area indicated that the benthic community had poor diversity and was considered stressed, as was indicated by the average B-IBI score of 1.7 for the site (EA 1997). No SNS were captured in Site 171 according to results of the USFWS/USACE sturgeon study during 420 hours of gillnetting in 38 deployments or as a result of the Reward Program as of September 30, 2003. No catches of WAS have been reported within the boundaries of this site by the USFWS/USACE sturgeon study. However, one Atlantic sturgeon was captured between the site and the Swan Point Channel (Figure 5).

5.4.4 Pooles Island Upper Bay Placement at Site 4 (Sites 4, 4A, 4B, and 4BR)

There are three potential configurations being investigated adjacent to Pooles Island, 3.2 km (2 mi) east of the mouth of the Gunpowder River (Figure 24). The configurations are (1) attached to the southern end of the island (4B); (2) immediately east of the island (4A); and (3) a smaller configuration south/southwest of the island (4BR). These locations lie on the edge of a flat, gently sloping shelf that runs along the western shore of the bay. Water depths in the area range from -4 to -34 ft (-1.2 to -10.4 m). Configurations range in size from 680 acres to 1,475 acres (275 to 597 ha).

The bottom at Site 4A is composed of clayey silt. The benthic community was categorized as low mesohaline (EA 1997). The B-IBI was 3.4 (reference) for this site, indicating a healthy benthic community (EA 1997). The bottom at Sites 4B and 4BR is sand, clayey silt, silty sand and sandy clay silt. The benthic community was characterized as low mesohaline, with a heterogeneous benthic community that varied at each sampling site. The B-IBI in the Site 4B area was 3.0 (reference), indicating a healthy benthic community (EA 1997). The shallower sites near Pooles Island had good benthic diversity as compared to deeper muddier areas sampled (EA 1998). No SNS were captured according to results of the USFWS/USACE sturgeon study in Pooles Island Site 4A during 493 hours of gillnetting in 52 deployments. In addition, no SNS were captured according to results of the USFWS/Corps sturgeon study in Station 4B during 350 hours of gillnetting in 31 deployments. USFWS did not sample Station 4BR as part of the study. The USFWS/USACE sturgeon study has, however, documented one WAS within the Upper Bay Island Site 4A boundaries (July 1998) (Figure 9 and Table B-2). The Reward Program as of September 30, 2003 captured no SNS in any of these sites.

5.4.5 Site 170

Site 170 is located at the mouth of the Patapsco River just south of the intersection of the Brewerton Channel and the Cutoff Angle (Figure 24). The site is currently an open-water site proposed for island creation with a beneficial use component. Average water depths are approximately -16 ft (4.9 m) MLLW. The salinity of the area is characterized as low mesohaline, with some salinity stratification expected.

Site 170 is approximately 1,000 acres (405 ha) in size. The site is relatively flat, varying in depth from -12 to -17 ft (-3.6 to -5.2 m) MLLW, sloping gently upward toward the Anne Arundel shoreline, and abruptly sloping downward toward the navigation channel to the northeast. The bottom is composed of predominantly fine-grained silty clays. The benthic community was sampled in Winter 1993, the majority of the species were polychaete worms and bivalve mollusks. The amphipod mollusk *Leptocheirus plumulosus* comprised 80.8% of the population, and *Macoma balthica* comprised 6.9%. Mean density of all macroinvertebrates was 6,629 ft2 (5,543/m^2) (Greeley-Polhemus 1994). All other species were not numerically important. Salinities in the area range from <1 ppt to >15 ppt. The water quality in this area is well mixed; therefore, dissolved oxygen concentrations remain within normal ranges to support aquatic life throughout the year.

No SNS were captured in this site as part of the Reward Program as of March 10, 2000. This site was not sampled as part of the USFWS/USACE sturgeon study. However, the Craighill Channel Upper Range was sampled and is located immediately adjacent to this site. No SNS were captured according to results of the USFWS/USACE sturgeon study in 240 hours of gillnetting in 28 deployments or as a result of the Reward Program as of September 30, 2003 in the Craighill Channel Upper Range. Three Atlantic sturgeon were captured within the Craighill Channel Upper Range during the USFWS/USACE sturgeon study. The Reward Program has documented one WAS within the Site 170A boundaries (July 1998) (Figure 5).

5.4.6 Sollers Point

Sollers Point is a 90-acre (36-ha) spit of land, which is owned by the State of Maryland. It is located in Baltimore Harbor just northeast of the Francis Scott Key Bridge (Figure 24). In 2002, six alignments were proposed for the site, some lying to the west-northwest and others to the east-northeast. The proposed areas of the alignments range from 99 to 457 acres (40 to 185 ha) with potential capacities of 4.11 to 23.91 mcy (3.14 to 18.3 mcm). The site includes shoreline, upland, and aquatic/open water areas. Two areas, the north-northwest and the east-northeast, have different aquatic habitat features. Sollers Point is stabilized along its entire length with riprap. The eastern expansion area shoreline is mainly sandy beach, and the bottom is predominately composed of a mixture of fine sands and muds. The site is situated in relatively shallow water. Water depths range between -2 and -6 ft (-0.6 and -1.8 m) MLLW over most of the site. Vegetation along the shoreline is sparse. The western expansion shoreline is a 30-40 ft (9.1-12.2 m) wide beach composed of sand, cobble, and bedrock. Substrates in the area are fine sands and clays, except where a pier is located, and the substrate is of a muddier composition. Water depths in this area are generally less than 10 ft (3 m) except for deep areas near the tip of Sollers Point. Vegetation along the western shore is also sparse; however, there is a 5-acre tidal marsh along the sand beach. In 2003, the plans for this area were revised to include smaller options that would have very little capacity and be constructed with clean dredged material from outside the harbor. These newer alignments would be in the same general vicinity as the original six alignments and would have the same fish habitat.

Water quality conditions in the Patapsco River vary due to many factors (proximity to urban areas, type and extent of industrial activity, stream flow characteristics, amount and type of upstream land, and water usage). Historically the water quality in the area was of poor quality due to a variety of anthropogenic stressors, and eutrophication is often a problem due to poor circulation and nutrient loading.

VIMS data from 1991 to 2000 show no SAV occurring near Sollers Point (EA 2003f). The State of Maryland's biannual benthic-monitoring program station #22 in the Patapsco River was used for benthic information at Sollers Point. Data from 1996-1999 shows that stress-tolerant annelid worms and other stress-tolerant species are most abundant in this area.

Sediments at a nearby station (WT5.1) were analyzed in August 1997. Results show elevated concentrations of cadmium and copper. Several polycyclic aromatic hydrocarbons (PAHs) and organophosphate pesticides were detected in concentrations that may have an impact on marine organisms (EA 2003f). Sediments were collected through a site-specific geotechnical investigation by E2CR and analyzed for total petroleum hydrocarbons (TPH). The surficial sediments within the borings at Sollers Point exceeded the Maryland residential soil criteria of 230 ppm (mg/kg) TPH. If this area is enclosed with dikes and not excavated, it is likely no special handling is need (EA 2003f).

No recent plankton or fish surveys have been conducted near Sollers Point. A study of the Baltimore Harbor's ichthyoplankton and juvenile/adult abundances in the early 1970s showed a number of resident and migratory fishes, although the abundance of species was reduced (EA 2003f). A study conducted in 1982 reported a high occurrence of diseased fish (mostly resident species) collected in bottom surveys. Although water quality has improved somewhat since these studies were conducted, poor diversity and low numbers of some fish species is expected as there are still prevailing water and sediment quality problems in the harbor (EA 2003f).

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4.7 Furnace Bay

Furnace Bay, located in Perryville, Maryland, is a sand and gravel quarry proposed for use as an upland placement site, resulting in mine relocation (Figure 24). The 130-acre (52.6-ha) property is located in western Cecil County on Principio Creek, a tributary of Furnace Bay. The quarry has an estimated 5 to 7 years of commercial operation remaining, and provisions of the quarry's surface mining permit require reclamation after commercial mining is exhausted. Mechanically placed dewatered dredged material from the Chesapeake Bay is proposed as suitable fill material for the mine reclamation. Because this is an upland site, there should be no impacts to water quality, benthic communities, or SNS/WAS in the bay.

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4.8 Dead Ship Anchorage

Dead Ship Anchorage is located within the Inner Harbor on the south shore of Curtis Bay about 1 mi (1.6 km) west of the Francis Scott Key Bridge in Baltimore (Figure 24). The area runs along the Grace-Davison property from Sledds Point at the mouth of Curtis Creek to the U.S. Gypsum property line along the southern bank of Curtis Bay. A single alignment has been proposed for this location, with an approximate footprint of 48 acres (19.4 ha) and providing 1.59 mcy (1.2 mcm) of placement capacity. The potential project will be connected to the existing shoreline. The property is an active industrial site composed of several landfills, and the predominant feature of the surrounding water is a series of sunken ships and barges that parallel the shoreline immediately west of the US Gypsum property. The waters between the shoreline and the sunken ships are shallow [<6 ft (<1.8 m)], and the substrates appear to be sandy. The water north of the sunken ships deepens quickly to >15 ft (>4.6 m) and is exposed to open water. At the eastern end of Dead Ship Anchorage, approximately 100 ft (30.5 m) of deciduous hard woods are along the shoreline (EA 2003f).

General water quality, sediment quality, and fisheries habitat in the harbor have been described in Section 5.4.6.

Sediments were collected through a site-specific geotechnical investigation and analyzed for TPH. One of three borings conducted at Dead Ship Anchorage exceeded the Maryland residential soil criteria of 230 ppm (mg/kg) TPH (EA 2003f). There are contaminants present in the lower Patapsco River at levels that could have an impact on aquatic life (CBP 2002a).

Dead Ship Anchorage lies in an area of the harbor that is characterized as lower mesohaline. Benthic studies near Dead Ship Anchorage have determined that the area of the Patapsco is classified as semi-polluted, and only pollution-tolerant or stress-tolerant species are present and abundant in the area. The benthic studies conducted at the station closest to Dead Ship Anchorage had the lowest scores of all the harbor sites (EA 2003f). VIMS data from 1991 to 2000 show no SAV occurring near Dead Ship Anchorage.

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4.9 Hawkins Point/Thoms Cove

The Hawkins Point/Thoms Cove site is located in Baltimore Harbor on the western shore of the Patapsco River between the mouth of Curtis Bay at Leading Point and the Key Bridge (Figure 24). The area considered for dredged material placement actually lies within Thoms Cove, which is bisected by the MPA-Eastalco terminal pier. Three potential alignments have been proposed for the site and the footprints range in size from 107 to 196 acres (43.3 to 79.3 ha) with a material capacity ranging from 3.59 to 7.60 mcy (2.74 to 5.81 mcm). Use of Hawkins Point/Thoms Cove would result in confined placement and creation of uplands in existing shallow water [<10 ft (<3 m)]. Leading Point, which would provide the western tie-in point for the proposed material placement site, projects into Curtis Bay at the eastern end and is protected from erosion by a masonry wall at the toe of a containment cell. The shoreline, as well as most of the cove, is composed of fine sand with some clay (EA 2003f).

General water quality, sediment quality, and fisheries habitat in the harbor have been described in Section 5.4.6.

Sediments were collected through a site-specific geotechnical investigation by E2CR and analyzed for TPH. One of three borings conducted at Hawkins Point/Thoms Cove exceeded the Maryland residential soil criteria of 230 ppm (mg/kg) TPH.

Hawkins Point/Thoms Cove lies in an area of the harbor that is characterized as lower mesohaline. Benthic studies near Hawkins Point/Thoms Cove have determined that the area of the Patapsco is classified as semi-polluted, and only pollution-tolerant or stress-tolerant species are present and abundant in the area. VIMS data from 1991 to 2000 show no SAV occurring near Hawkins Point/Thoms Cove (EA 2003f).

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4.10 Aberdeen Proving Ground

APG is a 72,000-acre (29,138-ha) military installation with multiple national defense missions (Figure 24). APG-controlled areas include large amounts of open water, wetlands, and uplands. This option would possibly provide shoreline stabilization and provide beneficial habitat. Effects on water quality from this project are site-dependent. There are no long-term negative impacts expected on the dissolved oxygen or salinity of the area, and turbidity may be improved in the long-term for the area. There is a potential for nutrient enrichment. The effect on the benthic community is also site-dependent; however, the current benthos in the area of a project would be lost.

Five SNS were captured in the Chesapeake Bay off the shoreline of APG during the Reward Program (Figure 3). They include two SNS captures off Taylor's Island and one each at Sandy Point, Cherry Tree Point, and west of Delph's Creek. The Cherry Tree Point and West of Delph's Creek SNS were considered "possible" juveniles by USFWS. No SNS were captured according to results of the USFWS/USACE sturgeon study in 574 hours of gillnetting in 53 deployments or as a result of the Reward Program as of September 30, 2003. The USFWS APG site is portrayed in Figure 17, Site 1. One Atlantic sturgeon were captured in commercial gear in USFWS at Site 1 (USFWS 2000).

5.4.11 Masonville

The Masonville site is located in Baltimore Harbor on the southern shore of the Patapsco River immediately east of where the freshwater (flowing) portion of the river reaches the harbor (estuary). Masonville was previously used as a containment site for dredged material and was partially redeveloped for terminal usage. The current project is considering a further terminal expansion using dredged material. There is also a potential for a habitat rehabilitation component in Masonville Cove on the west side of the site. The shoreline adjacent to the proposed Masonville site is owned by the Maryland Department of Transportation (MDOT) and managed by MPA. A single alignment with a footprint of 94 acres (38 ha) is being considered for the Masonville dredged material containment site that would include acquisition and incorporation of the property and channel that leads to Kurt Iron & Metal on the east side of the site.

Studies of this placement option are currently ongoing and much of the new data was not yet available at the time of this writing. However, previous investigations of the Kurt Iron & Metal site have indicated that some parts of the channel proposed for filling with dredged material contain elevated levels of metals, TPH, and asbestos due to previous shipbuilding and decommissioning activities. It is anticipated that any project developed at this site would cap and contain the contaminants.

General water quality, sediment quality, and fisheries habitat in the Harbor have been described in Section 5.4.6. Water depths range between -4 and -15 ft (-1.3 and -4.5 m) MLLW over most of the site. Water quality conditions in the Patapsco River vary due to many factors, and historically the water quality in the area was of poor quality due to a variety of anthropogenic stressors (industrial discharges, stormwater runoff, and sewage outfalls). Eutrophication is often a problem due to poor circulation and nutrient loading. There are contaminants present in the lower Patapsco River at levels that could have an impact on aquatic life (CBP 2002a). Masonville lies in an area of the harbor that is characterized as low mesohaline. Benthic and fisheries studies near the site are currently ongoing, but indicate that the area is used by a variety of freshwater and estuarine species.

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4.12 Fairfield-Amoco

Fairfield is located on the point of land that separates Curtis Bay from the Patapsco River in Baltimore City. The site is located at Fishing Point, which is bordered by Curtis Bay on the southwestern side, and the Patapsco River on the eastern and southeastern sides. The area considered for fastland creation is about 0.4 mi (0.6 km) south of the Patapsco Wastewater Treatment Plant. The existing 60-acre (24-ha) site [48 acres (20 ha) upland and 12 acres (4 ha) water], owned by the Amoco Oil Company, began as a storage and transfer terminal for gasoline, kerosene, and asphalt. The site was then converted to an oil refinery with an associated research facility, asphalt packaging facilities, various maintenance facilities, utility stations, and shipping/receiving operations. Current operations at the site consist of remedial efforts that have centered on gross removal of spilled and leaked petroleum products and petroleum wastes, removal of above ground storage tanks, collection of soil and groundwater samples, and site assessment to determine further remedial action.

Studies of this placement option are in very early stages and no new data was available at the time of this writing. However, the site was listed in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database due to previous petroleum-handling activities. It was removed from the list after a Screening Site Inspection was completed in 1993. However, contaminants are present in the sediments adjacent to the site, including elevated levels of metals (particularly lead), PAHs, and trace concentrations of aldrin, heptachlor epoxide, and dieldrin. DDT, DDD, and DDE were detected in Curtis Creek sediments above the threshold effects levels (TELs) and permissible exposure limits (PELs). It is anticipated that any project developed at this site would cap and contain the contaminants.

General water quality, sediment quality, and fisheries habitat in the harbor have been described in Section 5.4.6. Water depths range between -2 and -15 ft (-0.75 and -4.5 m) MLLW over most of the site. Because the site lies immediately east of Masonville, it is expected that aquatic conditions would be similar (Section 5.4.11). Water quality conditions in the Patapsco River vary due to many factors, and historically the water quality in the area was of poor quality due to a variety of anthropogenic stressors (industrial discharges, stormwater runoff, and sewage outfalls). Eutrophication is often a problem due to poor circulation and nutrient loading. There are contaminants present in the lower Patapsco River at levels that could have an impact on aquatic life (CBP 2002a). Fairfield-Amoco lies in an area of the harbor that is characterized as low mesohaline. Benthic and fisheries are expected to include a variety of freshwater and estuarine species similar to the Masonville area.

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.4.13 Sparrows Point Fastland Creation

Sparrows Point is located on the southern shore of the Sparrows Point Plant of the ISG Corporation (formerly Bethlehem Steel Corporation) along the northern shore of the Patapsco River in Baltimore County, Maryland. Sparrows Point is a heavily industrialized site that includes the ISG steel manufacturing facility, Baltimore Marine Industries, shipbuilding and repair berths, concrete production plants, storage areas for raw materials, and a rail yard and docking piers for delivery of raw materials and shipping of manufactured products. The Sparrows Point site includes shoreline, upland, and aquatic/open water areas. Along the western shoreline, Baltimore Marine Inc. has ship-repair slips, bulkheads, and shoreline armor extending nearly the entire shoreline to the mouth of Bear Creek. The proposed project area has three basic parts: Bear Creek to the west and northwest, Old Road Bay to the east-northeast, and the open waters of Brewerton Channel of the Patapsco River to the south.

The site is currently being considered for several different placement options. Initially, a 333-acre (135-ha) beneficial use (wetland creation) site was considered using only bay sediments. This option is detailed in Section 5.5.12. In addition, several alignments with footprints ranging from 216 to 597 acres (87 to 242 ha) are being considered for dredged material containment. Some are fastland containment options that could be redeveloped later for terminal expansion facilities. The previously considered wetland area is being redesigned to cover less area and potentially accept some harbor materials in the bottom of the cells and be finished (capped) with bay materials prior to wetland creation.

Studies of this placement option are currently ongoing and much of the new data was not yet available at the time of this writing. Previous site-specific investigations are detailed in Section 5.5.12. Previous studies in the area have indicated that sediments in the vicinity of the site contain elevated levels of metals, which are potentially associated with iron working activities. It is anticipated that any project developed at this site would cap and contain the contaminants.

General water quality, sediment quality, and fisheries habitat in the harbor have been described in Section 5.4.6. Water depths range between -2 and -15 ft (-0.75 and -4.5 m) MLLW over most of the site. Water quality conditions in the Patapsco River vary due to many factors, and historically the water quality in the area was of poor quality due to a variety of anthropogenic stressors (industrial discharges, stormwater runoff, and sewage outfalls). Eutrophication is often a problem due to poor circulation and nutrient loading. There are contaminants present in the lower Patapsco River at levels that could have an impact on aquatic life (CBP 2002a). Sparrows Point lies in an area of the harbor that is characterized as mesohaline. Benthic and fisheries studies near the site are currently ongoing, but indicate that the area is used by a variety of anadromous and estuarine species. Sparrows Point lies east of the Key Bridge, which is the only reach of the harbor that is commercially harvested for finfish. It is also the reach with the highest recreational fishing activity.

No WAS or SNS were captured in this site from the results of the Reward Program as of September 30, 2003. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5 BENEFICIAL USE

5.5.1 Barren Island

Barren Island is an uninhabited island owned by the USFWS that lies in the eastern portion of the middle Chesapeake Bay, 1 mi (1.6 km) off the eastern shore in Dorchester County, Maryland, and approximately 27 mi (43.4 km) northeast of the mouth of the Potomac River (Figure 25). The island is currently 180 acres (72.8 ha) and serves as a Federal wildlife refuge as well as a satellite refuge for the Blackwater National Wildlife Refuge in Dorchester County, Maryland. Two proposed alignments for a restoration project at Barren Island were investigated as part of the state reconnaissance studies that would lie to the west of the island and cover an approximate area of either 1,000 acres (405 ha) (Alignment #1) or 2,000 acres (810 ha) (Alignment #2). The proposed site design would provide a ratio of 50/50 upland to wetland areas for each alignment (Weston 2002). Recent USACE evaluations of Barren Island have utilized these initial alignments, but are considering smaller, more refined alignments. These newer alignments would be in the same general vicinity as the original two alignments and would have the same fish habitat.

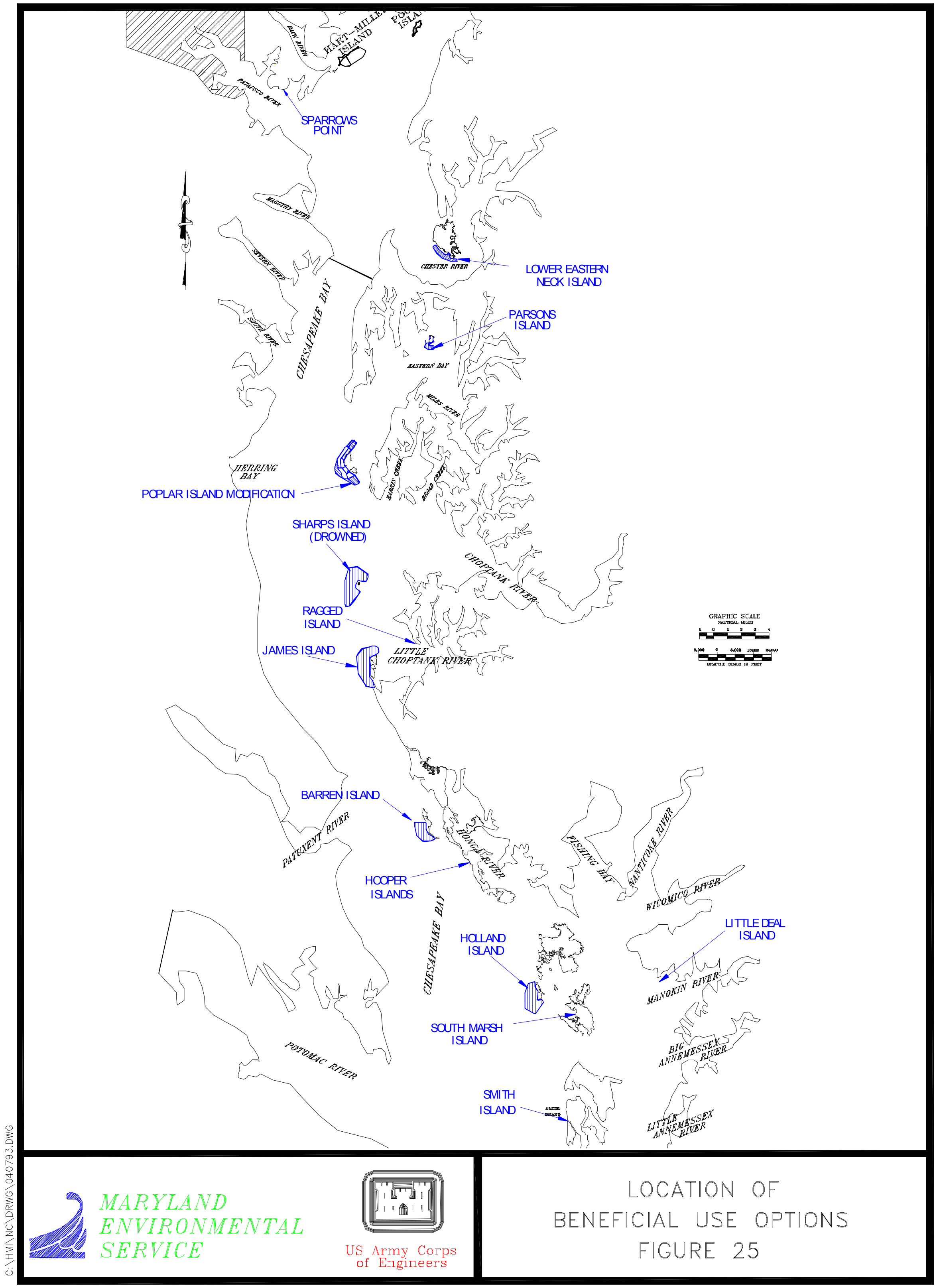
A survey of existing environmental conditions was conducted at Barren Island for the Summer 2002 season. Depths at 10 sampling stations around Barren Island range from 2 to 12 ft (0.6 to 3.6 m). Water temperature, salinity, dissolved oxygen, and pH were all recorded at the mid-depth of each station (Table 6).

Table 6. Barren Island Surrounding Water Conditions During Summer 2002

Range of Measurements at 10 Stations Around Barren Island	
Parameter	**Range of Measurements**
Temperature [°F (°C)]	74.6-78.4°F (22.0-25.8°C)
Salinity (ppt)	10.7-18.1
Dissolved Oxygen (mg/L)	6.9-8.5
pH	8.1-8.4

Source: EA 2003b.

Figure 25. Location of Beneficial Use Options



Turbidity was recorded at seven of the ten stations and ranged from 2.0 to 6.4 ntu. Nutrient sampling was conducted at each station during the Summer 2002 survey. Concentrations of nitrate ranged from 0.0028 to 0.0129 mg/L, concentrations of nitrite ranged from 0.0011 to 0.0029 mg/L, and concentrations of phosphate ranged from 0.0027 to 0.0054 mg/L. Concentrations of ammonium ranged from 0.006 to 0.02 mg/L. Concentrations of total dissolved organic carbon (DOC) ranged from 4.29 to 5.55 mg/L, concentrations of total dissolved nitrogen (TDN) ranged from 0.29 to 0.39 mg/L, and concentrations of total dissolved phosphorous (TDP) ranged from 0.013 to 0.017 mg/L. Particulate carbon (PC) concentrations ranged from 0.775 to 1.9 mg/L, particulate nitrogen (PN) concentrations ranged from 0.153 to 0.329 mg/L, and particulate phosphorous (PP) concentrations ranged from 0.0167 to 0.0314 mg/L (EA 2003a). The total suspended solids (TSS) concentration in water samples from Barren Island ranged from 13.4 to 67.7 mg/L with higher concentrations a result of shallow sampling depths. Chlorophyll-*a* concentrations ranged from 4.81 to 8.76 μg/L, and phaeophytin concentrations ranged from 1.34 to 2.81 μg/L (EA 2003a).

Beds of SAV have been documented by VIMS on the south and east sides of Barren Island, outside of the proposed project alignment. The same SAV beds were also observed in October 2001 during a site visit. Similar beds were observed during the Summer 2002 survey. Total B-IBI scores were high (3.0-5.0) for all stations sampled at Barren Island in Summer 2002 (EA 2003a). Sediments were not sampled for contaminants in waters near Barren Island in this survey.

No SNS were captured in this site in the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 8 nautical miles to the northwest of Barren Island; two SNS were captured by way of pound nets (Figure 4). Pound nets in the immediate vicinity and within the proposed alignment location at Barren Island yielded 77 WAS during the Reward Program as of September 30, 2003 (Figure 6).

No SNS or WAS were captured during the Summer 2002 fisheries sampling at Barren Island by EA.

5.5.2 Holland Island

Holland Island is located on the eastern side of the Chesapeake Bay approximately 16 mi (25.7 km) northeast of the mouth of the Potomac River (Figure 25). The island is approximately 56 mi (90 km) south of the Chesapeake Bay Bridge. Holland Island now consists of three distinct remnant islands totaling approximately 87 acres (35 ha). MDNR owns approximately 0.5 acre (0.2 ha) of land on the northeast edge of the southern remnant. The remaining acres are privately owned. The Holland Island Preservation Foundation is actively encouraging restoration of the island (Baker Consolidated 2003). Holland Island is being considered for an island restoration project using dredged material from the Baltimore Harbor Approach Channels. The two proposed alignments for the restoration project would lie to the west of the island and be approximately 939 acres (380 ha) (alignment #2) or 1,639 acres (663 ha) (alignment #1). The proposed site design would provide a ratio of 50/50 upland to wetland areas for each alignment.

Holland Island is surrounded by shallow water of 0.5 to 2.5 ft (0.2 to 0.8 m), which extends approximately 1 nautical mile on all sides of the island except for a narrow, deep channel to the east. Water quality in the vicinity of Holland Island is characterized as good. Water quality sampling was conducted at four stations for salinity, conductivity, and pH at Holland Island (Baker 2002). Salinity ranged from 16.8 to 17.4 ppt, indicative of high mesohaline waters. Conductivity ranged from 27.49 to 28.36 mS/cm, and pH from 7.34 to 8.12. In addition, the Chesapeake Bay Water Quality Monitoring Program stations CB5.2 (mainstem) and EE3.1 (tributary) were used to gather other water quality data for Holland Island from 1995 to 2000. Data was taken from these stations at a depth of 1.6 ft (0.5 m) to be comparable to depths surrounding Holland Island. Average temperatures at these stations have been 63°F (17°C) over the 5-year sampling period. The main Bay station gave dissolved oxygen levels of 9.5 mg/L while the tributary station reported levels of 8.5 mg/L. Average monthly concentrations of particulate carbon, nitrogen, and phosphorous ranged from 0.587 to 1.740 mg/L, 0.096 to 0.227 mg/L, and 0.007 to 0.017 mg/L, respectively. TDN concentrations ranged from 0.335 to 0.580 mg/L and TDP ranged from 0.007 to 0.017 mg/L. Monthly averages of chlorophyll-*a* ranged from 4.112 to 13.083 µg/L (Baker 2003). Since 1992, SAV beds around Holland Island have sharply declined and have not been observed at all on the western side of the island since 1996 (Baker 2002).

VIMS surveys from 2000 and 2001 show small beds of widgeon grass (*Ruppia maritima*) on the eastern side of Holland Island. No benthic studies have been recently performed in the vicinity of Holland Island.

No SNS were captured at this site during the Reward Program as of September 30, 2003 (Figure 4). The nearest SNS catch was approximately 9 nautical miles to the northeast of Holland Island in Hoopers Strait; two SNS were captured by way of pound net (Figure 4). Pound nets near Holland Island yielded nine WAS during the Reward Program as of September 30, 2003 (Figure 6). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.3 Hooper Islands

Hooper Islands is located in Dorchester County, in the vicinity of Barren Island. Lower Hooper Island is approximately 6 nautical miles south of Barren Island (Figure 25). General assessments about water quality near Hooper Islands can be made based on the information gathered for Barren Island (see above). VIMS data shows SAV east of Upper Hooper Island and north, northeast, and south of Middle Hooper Island for years 1994, 1995, 1999, 2000, and 2001. Little or no SAV was found in these areas from 1996 to 1998. SAV was found west of Lower Hooper Island in 1994, 1999, 2000, and 2001 (VIMS website maps #073 and #082).

No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 8 nautical miles to the southeast of Lower Hooper Island in Hooper's Strait; two SNS were captured by way of pound net (Figure 4). The nearest catches of WAS to Hooper Islands from the results of the Reward Program as of September 30, 2003, were several miles from the island in the main bay (Figure 6). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.4 James Island

James Island is located in Dorchester County (Maryland) at the mouth of the Little Choptank River in the Chesapeake Bay, approximately 1 mi (1.6 km) north-northwest of Taylors Island (Figure 25). The Dorchester County Resource Preservation and Development Corporation (DCRPDC), a non-profit organization, originally recommended and presently supports James Island as a possible habitat restoration project using dredged material from the Baltimore Harbor Approach Channels. The private landowners of James Island also support a restoration project (EA April 2003). James Island currently consists of three eroding island remnants totaling less than 100 acres. The five proposed alignments for a restoration project at James Island range from 979 to 2,202 acres and would lie to the west of the island. The proposed site design would provide a ratio of 50/50 upland to wetland areas for each alignment.

Surveys were conducted in Fall 2001 and Summer 2002 using 10 sampling station locations in the vicinity of James Island. For these stations, fall and summer temperatures ranged from 56.5 to 65.5°F (13.6 to 18.6°C) and from 75.4 to 80.4°F (24.1 to 26.9°C), respectively. The waters surrounding James Island are shallow ranging from 4 to 13 ft (1.2 to 4 m). Salinities over both sampling seasons were 10.8 to 16.8 ppt, classifying the area as being mesohaline. Dissolved oxygen readings for these surveys were erroneous due to a meter malfunction. In both seasons, pH ranged from 8.0 to 8.5. Turbidity was low in both seasons of sampling, but somewhat elevated near the shoreline (EA 2003a).

As of the Summer 2002 survey, no SAV has occurred within any of the proposed dike alignments. According to VIMS data, no SAV beds occurred around James Island from 1994 to 1998. Two small beds were present on the eastern side of James Island in 1999 but had vanished by data collection for 2000. Data for 2001 indicates that two SAV beds occur on the eastern side of the island and are of moderate density; no SAV beds are present on the western side of the island (VIMS website #051). No SAV beds have been documented within the proposed project area.

In the Fall 2001 survey, the mean total B-IBI score for the combined stations sampled at James Island was 1.8. Mean total B-IBI score for Summer 2002 was 1.6. These low scores may be related to below normal precipitation for both seasons of sampling. Of the 155 chemical constituents tested in the sediment of five benthic sampling stations, 57 were detected. The majority were detected at background concentrations.

No SNS or WAS were captured during the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 8 nautical miles to the south of James Island; two SNS were captured by way of pound net (Figure 4). Captures of Atlantic sturgeon, from the results of the Reward Program as of September 30, 2003, occurred to the west and east of the island (Figure 6). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.5 Little Deal Island

Little Deal Island is located in Somerset County, approximately 6 nautical miles east of Holland Island (Figure 25). General assessments about water quality near Little Deal Island can be made based on the information gathered for Holland Island (see above). No SNS or WAS were captured during the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 8 nautical miles to the north of Little Deal Island in Hooper's Strait; two SNS were captured by way of pound net (Figure 4).

5.5.6 Lower Eastern Neck Island

Eastern Neck Island (ENI), a Federally managed National Wildlife Refuge, is located in Kent County, Maryland (Figure 25). The island, just north of Kent Island, lies in the mouth of the Chester River. The southwestern portion of the island, referred to as Lower Eastern Neck Island (LENI), is being considered for an island restoration project using dredged material from the Baltimore Harbor Approach Channels. The four proposed alignments for the restoration project would all consist entirely of wetland restoration and lie to the southwest of the island. The proposed alignments are approximately 505 acres (204 ha) (alignment 1 and 1A), 865 acres (350 ha) (alignment 2), or 438 acres (177 ha) (alignment 3). Alignments 2 and 3 would connect to the existing island.

Depths within 0.5 to 1.5 mi (0.8 to 2.4 km) of LENI in all directions are less than approximately 6 ft (1.8 m). Approximately 0.75 mi (1.2 km) from the eastern side, the water deepens to a navigation channel. EA used water quality data from Chesapeake Bay Water Quality Monitoring Program station ET4.2 for LENI. Monthly average data from April 1999 to April 2000 at a depth of 1.6 ft (0.5 m) was used. In this period, average monthly temperatures ranged from -32.2 to 81.3°F (-0.1 to 27.4°C). Salinity ranged from 9.27 to 13.19 ppt, dissolved oxygen ranged from 5.4 to 12.9 mg/L, and pH ranged from 7.5 to 8.6. Concentrations of particulate carbon, nitrogen, and phosphorous ranged from 0.722 to 3.55 mg/L, 0.153 to 0.468 mg/L, and 0.0101 to 0.0512 mg/L, respectively. TDN concentrations ranged from 0.34 to 1.48 mg/L and TDP ranged from 0.0083 to 0.0.0366 mg/L. Dissolved organic carbon ranged from 3.28 to 4.72 mg/L. Chlorophyll-*a* ranged from 2.691 to 25.717 μg/L (EA 2003f).

According to VIMS data from 1994-2000, no SAV exists along the western shore of LENI except an ephemeral bed in a cove along the southwestern shoreline. SAV beds that occurred in coves on the eastern side of the island in 1999 were no longer evident in 2000 (EA 2003f). USFWS collected 17 invertebrate species from the created wetland area north of the proposed restorations area in 1993 and 1994. Annelids and crustaceans dominated this survey (EA 2003f). No recent studies of sediment quality have been conducted in the vicinity of LENI. No recent plankton or fish surveys have been conducted at LENI.

No SNS or WAS were captured during the Reward Program as of September 30, 2003. One WAS was captured in a pound net off of LENI's southern tip, outside of the proposed project area (Figure 5).

5.5.7 Parsons Island

Parsons Island is a privately owned island located in the Eastern Bay on the southwest side of the entrance to Prospect Bay, just south of the Kent Narrows in Queen Anne's County (Figure 25). The island is approximately 100 acres (40.5 ha). The landowner continues to show interest in participating in an island restoration project. The two alignments being considered for a restoration project would consist of an approximate ratio of 65/35 upland to wetland in either 108 acres (43.7 ha) (Alignment 1) or 308 acres (124.6 ha) (Alignment 2).

Depths within 0.5 mi (0.8 km) of Parsons Island in all directions are approximately 6 ft (1.8 m). EA used water quality data from Chesapeake Bay Water Quality Monitoring Program station EE1.1 for Parsons Island. Monthly average data from April 1999 to April 2000 at a depth of 1.6 ft (0.5 m) was used. In this period, average monthly temperatures ranged from -32.2 to 81.3°F (-0.1 to 27.4°C). Salinity ranged from 12.40 to 15.47 ppt, dissolved oxygen ranged from 6.1 to 12.5 mg/L, and pH ranged from 7.6 to 8.3. Concentrations of particulate carbon, nitrogen, and phosphorous ranged from 0.532 to 2.33 mg/L, 0.0929 to 0.343 mg/L, and 0.0061 to 0.0215 mg/L, respectively. TDN concentrations ranged from 0.26 to 0.67 mg/L and TDP ranged from 0.0068 to 0.0209 mg/L. Dissolved organic carbon ranged from 3.65 to 4.74 mg/L. Chlorophyll-*a* ranged from 2.691 to 15.849 μg/L (EA 2001).

Over the years, Parsons Island has had fluctuating levels of SAV around its perimeter. VIMS data for 2001 shows a low density of SAV on the eastern side of Parsons Island and a larger and much more dense bed to the west of the island (VIMS website, quads 32 and 33). Formal field surveys have not been conducted. Benthic sampling was not conducted at Parsons Island during this survey. Data from the State of Maryland's benthic-monitoring program from nearby stations [approximately 1-2 mi (1.6-3.2 km) from Parsons Island] show a variety of species, with the gem clam (*Gemma gemma*) dominating. No recent plankton or fish surveys have been conducted at Parsons Island. No sediment sampling has been conducted in the area.

No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003. Collections of SNS nearest to Parsons Island occurred in pound nets off of the western shore of Kent island, over 12 nautical miles from Parsons Island. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.8 Ragged Island

Ragged Island is located in Dorchester County, approximately 4 nautical miles west of James Island (Figure 25). General assessments about water quality near Ragged Island can be made based on the information gathered for James Island (see above). VIMS data shows no SAV in the vicinity of Ragged Island from 1994 to 1998. Areas of SAV occur on the east and northeast side of Ragged Island in 1999, 2000 and 2001 (VIMS map #051). No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003 (Figures 4 and 6). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.9 Sharps Island

Sharps Island is a drowned island in the middle part of the Chesapeake Bay near the mouth of the Choptank River in Talbot County (Figure 25). It is approximately 4 mi (6.4 km) southwest of Blackwalnut Point, and approximately 4 mi (6.4 km) west of Dorchester County (Figure 1). Sharps Island is being considered for an island restoration project using dredged material from the Baltimore Harbor Approach Channels. Five alignments are proposed ranging in size from 1,070 to 2,260 acres (433 to 915 ha). The proposed site design would provide a ratio of 50/50 upland to wetland areas for each alignment [Andrews, Miller and Associates, Inc. (AMA) 2002].

Depths along the shoreline of the island footprint range from 5 to 11 ft (1.5 to 3.4 m). Chesapeake Bay Water Quality Monitoring Program stations CB4.2C and EE2.1 were used to gather water quality data for Sharps Island from January 2001 to mid-2002. Surface water temperature in the vicinity of Sharps Island ranges from 33.8-50°F (1-10°C) in the winter months to 68-80.6°F (20-27°C) in the summer months. Surface salinity ranges from 2 to 12 ppt during spring and from 9 to 18 ppt in the fall and winter. Dissolved oxygen measurements taken from 1998 to 1999 range from 4.5-6.2 mg/L in the summer and 8.8 to 9.2 mg/L in the spring [Blasland, Bouck & Lee, Inc. (BBL) 2002]. No nutrient or pH data is currently available. No SAV has been observed in the vicinity of Sharps Island, and SAV growth is not likely without the construction of protected shallow water habitat (BBL 2002). No benthic or sediments studies have been conducted at Sharps Island. Plankton and fisheries studies have not been conducted. This site was not sampled as part of the USFWS/USACE sturgeon study.

No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 10 nautical miles to the northwest of Sharps Island near Herring Bay; one SNS was captured by way of gillnet (Figure 4). One WAS was captured by gillnetting just northeast of the proposed project area (Figure 6).

5.5.10 Smith Island

Smith Island is located predominately in Somerset County, Maryland, with its southern portion lying in Virginia. Smith Island is approximately 6 nautical miles south of Holland Island and 12 mi (19.3 km) west of Crisfield, Maryland (Figure 25). Water temperatures range from 82.2°F (27.9°C) in July to 39.2°F (4.0°C) in February. Salinity ranges from 11 to 19 ppt. For the Corps study, water quality data was collected from two stations located in proximity to Smith Island, one in Tangier Sound and one in the main bay. Readings indicated that average yearly dissolved oxygen concentrations range from 6.3 mg/L in August to 12.1 mg/L in February. The average water clarity depth in 1998 ranged from 2.3 ft (0.7 m) in August to 4.6 ft (1.4 m) in December (USACE-CENAB 2001).

No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 12 nautical miles to the west of Smith Island at the mouth of the Potomac River; two SNS were captured by way of pound net (Figure 4). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.11 South Marsh Island

South Marsh Island is located in Dorchester County approximately 3 nautical miles southeast of Holland Island (Figure 25). General assessments about water quality near South Marsh Island can be made based on the information gathered for Holland Island (see above). No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 6 nautical miles to the northeast of South Marsh Island in Hooper Strait; two SNS were captured by way of pound net (Figure 4). An Atlantic sturgeon was captured by pound net on the eastern side of Holland Island in the Reward Program. This site was not sampled as part of the USFWS/USACE sturgeon study.

5.5.12 Sparrows Point

A 333-acre (135-ha) habitat development project [300 acres (122 ha) of tidal wetlands, 33 acres (13 ha) of upland habitat] was proposed for the southern end of the Sparrows Point Plant of the Bethlehem Steel Corporation along the Patapsco River in Baltimore County (Figure 25). The site is located in a relatively shallow open-water area immediately south of and contiguous to the Sparrows Point shoreline. Water depths range between -10 and -15 ft (-3 and -4.6 m) MLLW over most of the site (E2Si 1992). The bottom is predominantly fine-grained material.

Water quality studies were performed by the University of Maryland, Center for Environmental Science (UMCES) during the June to October 1994 fisheries cruise. Water temperatures ranged from 60.8 to 85.6°F (16 to 29.8ºC) during the study and followed seasonal trends: warmest water during July and coldest water in October. Salinity during this period ranged from 2.7 to 14.2 ppt and followed seasonal trends: lowest salinity during summer and highest salinity during September and October. Bottom water dissolved oxygen conditions at the Sparrows Point site were consistently below 5 mg/L during the study period (UMCES 1995). Abundance for mesozooplankton and microzooplankton was found to be typical for this area of the bay, although microzooplankton densities were consistently lower at the Sparrows Point project site in comparison with reference areas [Versar 1994b; Academy of Natural Sciences Estuarine Research Center (ANSERC) 1994]. The Sparrows Point site met the restoration goal index in an August 1994 study performed by Versar, indicating that it had a healthy functioning benthic community (Versar 1994a). Versar 1994a indicated that the condition of the benthic community at Sparrows Point was not unique in Baltimore Harbor.

No SNS or WAS were captured in this site from the results of the Reward Program as of September 30, 2003. The nearest SNS catch was approximately 6 nautical miles east of Sparrows Point, off the shore of North Point State Park (Black Marsh area); one SNS was captured by way of fyke net (Figure 3). This site was not sampled as part of the USFWS/USACE sturgeon study.

5.6 INNOVATIVE USE

5.6.1 Agricultural

Innovative use of dredged material at agricultural sites is being considered. The MPA is currently in the process of identifying, evaluating, and performing field trials for the innovative use (e.g., beneficial use) of estuarine sediments on agricultural land. This concept would improve marginal, sandy agricultural soils through the addition of fine-grained dredged materials, increasing the ability of agricultural soils to hold water and nutrients and resulting in greater crop production. Because this is a terrestrial option, water quality factors such as dissolved oxygen and salinity will not be affected in the bay. It is possible that there will be a positive impact on the water quality of the bay with respect to nutrient enrichment, because removing the sediment will remove some nutrients from the bay's ecosystem, fixing them in crop vegetation. The agricultural option also will not have an effect on fish habitat because it is a terrestrial option.

5.6.2 Mines and Quarries

Innovative use of dredged material at mines and quarries is being considered. The MPA received a not-for-attribution inquiry from representatives of an out-of-state mine regarding the mine's potential suitability as a commercial placement site for dredged material. A preliminary visit to the mine by MPA and the study team found that the mine had potential for use as a placement site, so the possibility of expanding the study is being considered by MPA.

Water quality should not be greatly impacted by placing dredged material in mines and quarries. The effect on dissolved oxygen within the bay would be site-specific and there is no expected change to regional salinity. Placing the material in mines and quarries is not expected to cause nutrient enrichment in the bay over a long period of time, and the project will actually remove nutrients from the bay's ecosystem. Turbidity may also be positively affected, because placement in an upland location would protect or enhance existing water quality in the bay, and possibly in drainage areas of mines, because it would remove sediments and associated turbidity impacts from the aquatic environment. The benthic community and fish habitat should not be affected because these sites are existing upland mines and quarries.

5.6.3 Wetland Thin-Layering

Innovative use of dredged material with wetland thin-layering is being considered. The wetland thin-layer concept involves the spraying of a few inches of dredged material over an eroding wetland area. In the Chesapeake, where wetlands are being lost to subsidence and sea level rise, this option may offer opportunities both to protect "at risk" wetlands and to restore "unhealthy" wetlands. Experience, in the Chesapeake Bay area, to date with this option involves primarily small-scale applications where material dredged from small channels is sprayed on adjacent wetlands. Systems for transporting dredged material from commercial shipping channels to offsite locations for spraying wetland areas are still experimental. Ongoing studies are focusing not only on existing technologies, but technical innovations in pumping, spraying, and dredged material handling that may allow more effective and more extensive use of this option.

Using dredged material for wetland thin-layering has the potential to enhance water quality conditions with respect to dissolved oxygen, nutrient enrichment, turbidity, and salinity. The benthic community will briefly be covered, but then restored as material settles and benthic organisms burrow up to the surface. Ultimately, protection or enhancement of benthic conditions is expected as wetlands are restored. Enhancement of fish habitat is also expected as wetlands are restored.

5.6.4 Innovative Use at Cox Creek

Innovative use of dredged material at Cox Creek is being considered. MPA hopes to create renewable capacity at Cox Creek Dredged Material Containment Facility (DMCF) by using large quantities of dredged material to manufacture environmentally safe commercial products that may be marketed, used, or otherwise used of offsite by the service provider. Cox Creek DMCF is an existing facility. The MPA is renovating the existing dikes for operations at the facility. As there is no planned expansion of the existing facility footprint or additional discharges into the facility from innovative use systems, there are no foreseen adverse environmental effects associated with using the facility as a transfer and interim storage site for dredged material in conjunction with planned facility operations, consistent with applicable regulatory criteria.

Using dredged material for innovative use at Cox Creek should have no effect on water quality; specifically dissolved oxygen, turbidity, and salinity, because the option utilizes an existing upland facility. Using the material for innovative use at Cox Creek is not expected to cause nutrient enrichment in the bay over a long period of time, and the project will actually remove nutrients from the bay's ecosystem. There should be no effect on fish habitat because this option uses an existing upland facility.

6.0 ENVIRONMENTAL SETTING OF THE UPPER BAY

The following is a discussion of the environmental setting of the Maryland portion of the Chesapeake Bay. This section is more general than the specific conditions to each site that were described in Chapter 5.

6.1 HYDROLOGY

The movement of water in the Chesapeake Bay estuary is influenced by the action of wind and waves, as well as freshwater flow and tides. Wind forcing produces surface waves. Together the wind forcing and the surface waves create oscillatory currents in the water column that can help reduce stratification. Homer and Mihursky (1992) describe most of the Chesapeake Bay as microtidal, indicating a relatively small range of tide. Tidal force enters the bay through the mouth and travels northward up the bay, dissipating with distance as it is damped by bottom friction. A second tidal component enters the bay through the C&D Canal (Browne and Fisher 1988). However, due to the small cross-sectional area of the C&D Canal, this constituent has little effect on the tidal range in the upper Chesapeake Bay relative to the oceanic tide entering at the mouth of the bay. The C&D Canal connects the Chesapeake Bay and the Delaware River. The canal is located about 45 mi (72.4 km) north of Baltimore, and 15 mi (24.1 km) south of Wilmington, Delaware. The C&D Canal is approximately 19 mi (30.6 km) long with a net flow from the Delaware River to the Chesapeake Bay (MES 1997b).

There are fundamental differences in hydraulic regime and water quality between the Chesapeake and Delaware Canal and the approach channels in the Chesapeake Bay. The C&D Canal is included in this study because of its potential use in the movement of the SNS between the Delaware River and the Chesapeake Bay. Mean maximum current speeds in the approach channels are significantly lower than in the C&D Canal, whose currents are driven by a bi-directional flow, which at times can exceed 3 ft (0.9 m) per second. In the C&D Canal, the navigation channel occupies a significant fraction of the bank-to-bank cross section. Flow in the canal is predominantly tidal, driven by the water level differences between Reedy Point on the east and Welch Point on the west. The mean tidal range is 5.5 ft (1.7 m) at Reedy Point, which is located a distance of about 50 nautical miles above the ocean entrance to the Delaware Bay. The mean tidal range is approximately 2.2 ft (0.67 m) at Welch Point, which is located a distance of about 175 nautical miles above the ocean entrance to the Chesapeake Bay.

The primary component modifying the movement of tides in the upper Chesapeake Bay is freshwater discharges from the rivers that flow into the bay. The Susquehanna River supplied more than 50%, on average, of the freshwater input to the entire estuary and more than 64% to the Maryland portion of the bay over the period of 1980 to 1991 (Magnien et al. 1993). In the study area, the Susquehanna River supplies in excess of 90% of the fresh water. The addition of fresh water modifies tidal action and the associated currents. Tidal currents in the upper Chesapeake Bay are moderate to weak with an average maximum velocity of about 2 ft (0.6 m) per second [National Ocean Service (NOS) 1996].

Average flow from the Susquehanna varies within and from year to year in response to seasonal rainfall, evapotranspiration, and temperature. The highest flows are generally recorded in the winter and early spring and the lowest in the summer and early fall. A moderate increase in flow can serve to decrease the salinity of the surface water in the Chesapeake Bay and in some cases, if the fresh water flow is substantial enough, the upper Chesapeake Bay may take on the flow characteristics of a river. This is a common occurrence during the spring freshet.

The eastern portion of the C&D Canal area receives spring flows in a net eastward direction, but has been known to flow in the opposite direction depending upon meteorological conditions. Because the flow is dependent on the salinity concentrations and water levels in the Delaware River and the upper Chesapeake Bay, storm events and rainfall can impact these conditions. When the salinity in the upper part of the Chesapeake Bay becomes lower than the salinity in the Delaware, the net flow generally moves eastward (MES 1997b).

6.2 SALINITY

Salinity concentrations in the upper Chesapeake Bay and the C&D Canal vary with depth, season, geographical location, and freshwater influences. Generally speaking, salinity declines in the spring when rainfall, groundwater, and melting snow cause large increases in freshwater input. Vertically, salinity levels are lower at the surface and increase with depth. This stratification, for example, is most prominent in the deeper waters below Pooles Island, where the difference between the surface and bottom often exceeds 5 ppt (Biggs 1970).

The changing flow of the Susquehanna has a direct influence on the salinity. High flow years such as 1991, 1993, 1994, and 1996 result in low salinities, while low flow years such as 1992 and 1995 result in increased salinities in the upper Chesapeake Bay area (Boynton et al. 1996). Generally deeper waters in the bay are stratified, with higher salinity on the bottom and lower salinity near the top. In the C&D Canal, salinity levels were found in 1994 to range from 1 to 8 ppt for high and low-flow periods, respectively, with a mean value of about 5 ppt (MES 1994). The Feasibility Study for deepening the C&D Canal found an average salinity in the canal of 1 to 2 ppt (USACE 1996).

6.3 WATER QUALITY

Water quality conditions in the Chesapeake Bay as of 1996 were considered by the Chesapeake Bay Monitoring Program (CBMP) to be generally good. No widespread occurrences of metal concentrations exceeding U.S. Environmental Protection Agency (EPA) water quality criteria or state water quality standards existed in the mainstem as of 1987 (CPB 1994).

In the upper Chesapeake Bay north of Pooles Island, the relatively shallow depths and the well-mixed water column, due to tidal and wave action during the winter and spring months, prevents the development of hypoxic or anoxic conditions (USACE 1996). During the summer, hypoxia and anoxia potentially pose a greater threat to aquatic life. However, studies have shown that in the Pooles Island area, dissolved oxygen concentrations of bottom waters for the period 1994-1996 were greater than 80% of saturation, indicating no oxygen stress of bottom waters (Boynton et al. 1996).

Hypoxia is generally found in the June-September time frame in bottom waters in the deeper, more saline areas of the bay. This can include the bottom waters of Site 104, the Deep Trough (north of Bloody Point), Deep Trough (south of Bloody Point), Site 168, Site 171, and the navigation channels, including those in the upper Chesapeake Bay.

6.4 TEMPERATURE

In the upper Chesapeake Bay, water temperatures can range from close to freezing [32°F (0°C)] to almost 86°F (30°C). Temperatures in the water column can also reflect the stratified nature of the bay. In deeper water, surface water temperatures are warmer than bottom water temperatures in the summer. This trend reverses in the winter when bottom water is warmer.

6.5 SEDIMENTOLOGY

Mean annual average river discharge from the Susquehanna River between 1928 and 1975 was about 36,000 cubic feet (ft^3) [1,019 cubic meters (cm^3)] per second. In 1996, the Susquehanna River flow was an average of 84,240 ft^3 (2,385 m^3) per second. This flow rate and water volume was much higher than in 1995, which was a notably low flow year, and more constant than in 1993 and 1994, which were characterized by spiked flows (Boynton et al. 1996).

The upper Chesapeake Bay is a region where a relatively large quantity of fine-grained sediment is deposited (USACE 1999). The two primary sources of these fine-grained sediments are discharge from the Susquehanna River and adjacent shoreline erosion from within the upper Chesapeake Bay. Studies have shown that the average sediment input from the Susquehanna equals 2,806,500 cubic yards (yd^3) [2,145,723 cubic meters (m^3)], while sedimentation originating from coastal sources equals 399,500 yd^3 (305,440 m^3), for a total of 3,206,000 yd^3 (2,451,163 m^3) annually (Kerhin et al. 1988).

The zone of maximum turbidity is located between Tolchester Beach and Turkey Point (Schubel 1968). Because of the turbidity maximum and the particle size of the sediments, the levels of suspended sediments in the upper Chesapeake Bay are relatively high compared to areas outside the turbidity maximum. The upper Chesapeake Bay is a zone of net deposition of these sediments. Grain size of the sediment in the upper Chesapeake Bay, from the Sassafras River to the C&D Canal, are predominantly clayey silt with some locations where sand-silt-clay occurs (MES 1994). There exists a constant state of sediment deposition and erosion in this area.

Sediment proposed for placement will be dredged from the approach channels to the Port of Baltimore that are located in the mainstem of the upper Chesapeake Bay (north of the Bay Bridge and east of the North Point/Rock Point Line, Figure 2). Sediments proposed for placement include materials from both maintenance and new work dredging projects. Channels/areas proposed for dredging include: Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel Eastern Extension, Swan Point Channel, Tolchester Channel, and the C&D Canal southern approaches. Physical and chemical evaluations of sediments from each of the proposed dredging areas were conducted in 1999-2000 (EA 2000). Physical analyses indicated that the channel sediments were primarily comprised of silt and clay particles (approximately 90% fine-grained material) and contained an average organic content (total organic carbon) ranging from 3.2 to 13.4 percent.

6.6 BIOLOGICAL RESOURCES

Marine, freshwater, estuarine, anadromous, and catadromous species all utilize the Chesapeake Bay, the C&D Canal, and the Delaware Estuary. Murdy et al. (1997) cataloged 267 species of fish that inhabited the Chesapeake Bay during a portion of their life history. A total of 93 species of fish have been collected in the C&D Canal alone (USACE 1996). The composition of the fish community in the upper Chesapeake Bay varies markedly with temperature and salinity conditions. Abundance and species diversity are greatest from summer to early autumn and lowest in the winter (MES 1997b). The upper Chesapeake Bay between Pooles Island and Turkey Point is considered an important fish nursery and commercial and recreational fishing area.

Fish species that occur in the upper Chesapeake Bay mainstem can be divided into two dominant groups based upon utilization of the area: permanent residents and migratory species. The permanent residents consist of species that spend their entire life cycle in the upper bay (CBP 1995). The bay anchovy (*Anchoa mitchilli*) is an example of a resident species. This species has a life expectancy of 1 year and is an important link in the bay's food web (Miller 1998). Migratory fish are categorized based upon their utilization of the bay. Migratory fish include both species that regularly (seasonally) utilize the area for some period of their life cycles as well as many that are only occasional transients of the fish community (Setzler-Hamilton 1987). Migratory fish can be further divided on the basis of spawning behavior: anadromous fish, which migrate from the ocean to spawn in the bay or its tributaries, and catadromous fish, which migrate from bay waters to spawn in the ocean (CBP 1995). True anadromous fish include alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), striped bass (*Morone saxatilis*), shortnose sturgeon (*Acipenser brevistrum*), and Atlantic sturgeon (*Acipenser oxyrinchus*). Semi-anadromous fish, which migrate from the lower estuary to upper estuary fresh waters to spawn, include white perch (*Morone americanus*), gizzard shad (*Dorosoma cepedianum*), yellow perch (*Perca flavescens*), and estuarine populations of threadfin shad (*Dorosoma petenense*). Eels (*Anguilla rostrata*) are the only true catadromous species in the Chesapeake Bay (CBP 1995). Although eels live in the Chesapeake for long periods, they eventually migrate to open waters in the Sargasso Sea to spawn.

Other fish, mostly marine species, utilize the bay not for spawning purposes, but for successful completion of a portion of their life cycle (e.g., as larvae or juvenile life stages) (Setzler-Hamilton 1987). Examples of marine fish that spend some portion of their life cycle in the Chesapeake Bay include Atlantic menhaden (*Brevoortia tyrannus*), weakfish (C*ynoscion regalis*), and bluefish *(Pomotomus saltatrix)*. Some marine fishes that utilize the bay, if given the opportunity, may survive equally as well in coastal or oceanic waters during these life stages (e.g., Tautog and harvestfish) (Setzler-Hamilton 1987).

An inventory of fishes commonly known to occur in the upper Chesapeake Bay from the Bay Bridge to the Pooles Island area was derived from a variety of literature sources and is included in Table 7.

USFWS recorded bycatch data during their Sturgeon Study gillnetting efforts at 19 sites located above the Chesapeake Bay Bridge (Appendix B, Figure 1). The 19 sample locations were determined by the NMFS based on proposed dredged material placement sites and shipping channels. Gillnetting catches grouped by season are given in Appendix B, Table14. Seasons are represented as fall (October, November, and December), winter (January, February, and March), spring (April, May, and June), and summer (July, August, and September). Overall, gillnetting yielded a total of 34 species representing 18 families. Dominant catches varied among seasons and sites sampled. However, all sites combined, striped bass dominated catches in the winter, gizzard shad dominated in the fall, and menhaden dominated in the spring and summer. The specific results of this study are included in Appendix B.

Table 7. Finfish Species found in the Upper Bay (Chesapeake Bay Bridge to Pooles Island Area)

Scientific Name	Common Name
Engraulidae	Anchovies
Anchoa mitchilli	bay anchovy
Percichthyidae	Bass, Temperate
Morone americana	white perch
Morone saxatilis	striped bass
Pomatomidae	Bluefish
Pomatomus saltatrix	bluefish
Ictaluridae	Catfish, Freshwater
Ictalurus punctatus	channel catfish
Ictalurus catus	white catfish
Ictalurus nebulosus	brown bullhead
Ictalurus natalis	yellow bullhead
Sciaenidae	Drums
Cynoscion regalis	weakfish
Leiostomus xanthuras	spot
Micropogon undulatus	Atlantic croaker
Pogonias cromis	black drum
Anguillidae	Eels, Freshwater
Anguilla rostrata	American Eel
Pleuronectidae	Flounder, Righteye
Pleuronectes americanus	winter flounder
Gobiidae	Gobies
Gobiosoma bosci	naked goby
Clupeidae	Herrings
Alosa aestivalis	blueback herring
Alosa pseudoharengus	alewife
Alosa sapidissima	American shad *****
Alosa mediocris	hickory shad
Brevoortia tyrannus	Atlantic menhaden
Dorosoma cepedianum	gizzard shad
Dorosoma petenense	threadfin shad
Cyprinodontidae	Killifishes
Fundulus heteroclitus	mummichog
Fundulus majalis	striped killifish
Fundulus diaphanus	banded killifish
Cyprinidae	Minnows and carp
Cyprinus carpio	carp
Hybognathus nuchalis	silvery minnow
Notemigonus crysoleucas	golden shiner
Notropis hudsonius	spotted shiner
Percidae	Perch
Perca flavescens	yellow perch
Etheostoma olmstedi	tessellated darter
Atherinidae	Silversides
Menidia menidia	Atlantic silverside
Menidia beryllina	inland silverside
Membras martinica	rough silverside
Soleidae	Sole
Trinectes maculatus	hogchoker
Batrachoididae	Toadfish
Opsanus tau	oyster toadfish
	*** Indicates Rare or Uncommon**

(Miller 1998)

7.0 IMPACTS OF DREDGING ON SHORTNOSE STURGEON

Few studies have been conducted on dredging impacts to SNS. However, potential impacts that could occur from dredging and placement include: (1) physical injury or death to sturgeon due to entrainment by a cutterhead with hydraulic pipeline, bucket dredge, or hopper dredge; (2) burial from dredged material placement; (3) injury to larvae or juveniles from dredging operations; (4) the disruption of migrations due to physical disturbance and noise; (5) the settling of suspended material on the spawning ground or foraging locations; (6) if the material is contaminated, toxin uptake by sturgeon; and (7) permanent conversion of habitat could impact winter thermal refuge, spawning and juvenile habitat and foraging areas. Dredging could also have a beneficial impact on sturgeon by creating or maintaining deeper channel regions, which both juveniles and adults seem to prefer for overwintering (Hastings 1983).

During other projects it has been postulated that maintenance dredging of Federal navigation channels can adversely affect or jeopardize SNS populations. Potential impacts from dredging operations may be avoided by imposing work restrictions during sensitive time periods (i.e., spawning, migration, feeding) when sturgeon are most vulnerable to mortalities from dredging activity. In 1991, the NMFS concluded that an Army Corps of Engineers' maintenance dredging operation in the lower Connecticut River was likely to jeopardize the continued existence of the Connecticut River SNS population. This conclusion was based on the season during which the project was scheduled (early summer) and the proposed use of a hydraulic hopper dredge and in-river placement within high use feeding areas. To avoid jeopardy, the NMFS recommended that the Corps use alternative dredge types (i.e., clamshell or hydraulic pipeline) and/or reschedule the project after sturgeon were likely to have moved away from the project area.

On January 26, 1999 a Biological Opinion (BO) was issued to CENAP by the NMFS concerning impacts to endangered SNS from maintenance dredging (hopper dredge) of the C&D Canal and the Northern Approach Channel to the C&D Canal in Maryland and Delaware (see Section 3.0).

The NMFS determined anticipated take levels based on several factors, including: (1) SNS occurrence in the action area; (2) time of year in which dredging will occur; (3) duration of the project; (4) potential use of a hopper dredge; and (5) history of sturgeon/dredge interactions during previous maintenance dredging of river channels near SNS overwintering areas. The NMFS determined that the level of anticipated take would not be likely to result in jeopardy to SNS.

On August 29 and October 29, 2002, and in response to CENAB plans to dredge some of the approach channels to the Port of Baltimore, NOAA responded that due to recent captures and a death of an Atlantic sturgeon in bucket operations, they would have to reconsider their prior findings regarding dredging impacts to SNS. They indicated that if a mechanical/clamshell dredge was used in CENAB maintenance dredging, there might be takes of SNS. Their position was based on an Atlantic sturgeon that was killed in the Cape Fear River in a bucket and dredge operation and another Atlantic sturgeon that was captured in a clamshell bucket, deposited in a dredge scow, and released unharmed during dredging operations in the Kennebec River (see Section 3.0). State and federal resource agency recommendations have restricted dredging activities in the Kennebec River to the time period of November 1 – April 1, the time of year when the least number of anadromous fish species would be present, with special emphasis on

SNS (NOAA 1998). The Delaware Basin Fish and Wildlife Management Cooperative has imposed "no work" windows to reduce impacts from dredging on anadromous fish populations.

NOAA recommended that measures be taken to minimize impacts to SNS during the dredging (see Section 3.0). Specifically, they recommended that dredging take place from September to November and if this was not possible that biological observers be present for all hydraulic dredging activities. Sturgeon observers were utilized during recent dredging operations to comply with NOAA restrictions for hopper dredging activities conducted from January to March at Courthouse Point. There were no observed takes of sturgeon during that operation or during five respective seasons of CENAP dredging activities in the upper Chesapeake Bay utilizing a bucket dredge. CENAB used observers during the 2002/2003-placement season (December 1 – January 29) while conducting maintenance dredging in the Baltimore Harbor Approach Channels by bucket dredge. There were no observed takes of sturgeon during these activities.

7.1 DREDGING EQUIPMENT AND METHODS

Typically, the Corps does not specify the type of equipment that a contractor must use to dredge a channel. Each type of dredging equipment has different strengths and weaknesses. Any type of dredge can accomplish some jobs; other projects require specialized equipment. Often times, one type of equipment will be more efficient than another. In these cases, the bidding process usually results in the more efficient plant and equipment being used to accomplish the required dredging. Given sufficient cause, the Corps can restrict contract work to specific equipment types. Discussion of the different types of dredging equipment that might be suitable for dredging is provided below.

7.1.1 Self-Propelled Hopper Dredges

Hopper dredges are typically self-propelled seagoing vessels. They are equipped with propulsion machinery, sediment containers (i.e., hoppers), dredge pumps, and other specialized equipment required to perform their function of excavating sediments from the channel bottom. Hopper dredges have propulsion power adequate for required free-running speed and dredging against strong currents; they also have excellent maneuverability. This allows hopper dredges to provide a safe working environment for crew and equipment dredging bar channels or other areas subject to rough seas. This maneuverability also allows for safely dredging channels where interference with vessel traffic must be minimized.

A hopper dredge removes material from the bottom of the channel in thin layers, usually 2-12 in. (5.1-30.5 cm), depending on the density and cohesiveness of the dredged material (Taylor 1990). Pumps within the hull, but sometimes mounted on the dragarm, create a region of low pressure around the dragheads. This forces water and sediment up the dragarm and into the hopper. The more closely the draghead is maintained in contact with the sediment, the more efficient the dredging (i.e., the greater the concentration of sediment pumped into the hopper). Hopper dredges are most efficient for noncohesive sands and silts and low density clay. Hopper dredges are not as efficient with medium to high-density clays, or with dense sediments containing a significant clay fraction.

Dredging is usually done parallel to the centerline or axis of the channel. Sometimes, a waffle or crisscross pattern may be utilized to minimize trenching and produce a more level channel bottom (Taylor 1990). This movement up and down the channel while dredging is called *trailing* and may be accomplished at speeds of 1-6 knots, depending on sediment type, sea conditions, and numerous other factors.

In the hopper, the slurry mixture of sediment and water is managed to settle out the dredged material solids and overflow the supernatant water when permitted. When an efficient load is achieved, the vessel suspends dredging, the dragarms are heaved aboard, and the dredge travels to the placement site. Because dredging stops during the trip to the placement site, the overall efficiency of hopper dredges is dependent on the distance between the dredging and placement sites—and whether the material can be released from the bottom of the hopper or must be pumped out. The hopper dredge loses efficiency as the distance to placement site and the time to place material increase, and if overflow is not permitted.

7.1.2 Clamshell Bucket Dredges

The bucket-type dredge is a mechanical device that utilizes a bucket to excavate the material to be dredged. The dredged material is placed in scows or hopper barges that are towed or pushed to the placement site. Bucket dredges include the clamshell, orange-peel, and dragline types and can sometimes be interchanged to suit requirements. The crane that operates the bucket can be mounted on a flat-bottomed barge, on fixed-shore installations, or on a crawler mount. In most cases, spuds, or anchors and spuds, are used to position the plant.

Clamshell bucket dredges are effective working near bridges, docks, wharves, pipelines, piers, and/or breakwater structures because they do not require much area to maneuver (McLellan et al. 1989). However, because they are not quickly or easily maneuvered, they are not well suited for dredging high traffic areas. Clamshell dredges are very efficient in dredging silts and clays, and are better than any other dredge types for excavating areas where debris may be present. However, clamshell dredges can have difficulty excavating hard clays and compact sands.

Because the clamshell bucket dredge loads scows or hopper barges, work is only suspended when a fully loaded barge is moved away and replaced with another empty scow or barge. As distance increases between the dredging site and the site for placement of the dredged material, more tugs and scows/barges can be added to the rotation. Because dredging can continue while the dredged material is being transported to the site, clamshell bucket dredge efficiency is not affected by haul distance, provided that a sufficient number of tugs and scows can be employed on the project. The typical floating plant for clamshells dredges would be unsafe for workers and equipment in rough seas when the barge is pitching and/or rolling, or with decks awash.

7.1.3 Hydraulic Cutterhead Pipeline Dredging

A cutterhead pipeline dredge is the most commonly used dredging plant in the United States. The cutterhead dredge is suitable for maintaining harbors, canals, and outlet channels where wave heights are not excessive and suitable placement areas are nearby. It is essentially a barge hull equipped with a movable rotating cutter apparatus surrounding the intake of a suction pipe (Taylor 1990 and Hrabovsky 1990). By combining the mechanical cutting action with the hydraulic suction, the hydraulic cutterhead has the capability of efficiently dredging a wide range of materials, including clay, silt, sand, and gravel.

The largest hydraulic cutterhead dredges have 30- to 42-in. (76.2- to 106.7-cm) diameter pumps with 15,000 to 20,000 horsepower. These dredges are capable of pumping certain types of material through as much as 5 to 6 mi (8 to 10 km) of pipeline, though up to 3 mi (5 km) is more typical. The dredge can pump material further distances if booster pumps are inserted into the discharge pipeline. The attached pipeline also limits the maneuverability of the dredge. In addition, the cutterhead pipeline plant employs spud and anchors in a manner similar to floating clamshell dredges. Accordingly, as with floating clamshell dredge plants, the hydraulic cutterhead should not be used in high traffic areas. Only the larger dredges can be safely employed in rough seas. cutterhead dredges are normally limited to operating in protected waterways where wave heights do not exceed 3 ft (0.9 m).

7.2 DREDGING-RELATED INJURIES TO SNS

Hastings (1983) was unable to correlate dredging impacts to SNS in the upper tidal reach of the Delaware River. Moser and Ross (1993), in the Cape Fear River in North Carolina, found no evidence that dredges affected SNS. Moser's studies found that Atlantic and SNS occupied both relatively undisturbed and regularly dredged areas and were tracked through the Wilmington Harbor during dredging activities, with no negative impacts. Fewer sturgeon were found in the dredged areas than in undisturbed areas, perhaps due to avoidance or lack of availability of food. While the fish appeared to seek out deep areas and stay in midchannel, certain behaviors could put them in the proximity of the dredges. Moser & Ross (1993) and McCleave *et* al. (1977) have found evidence that at least some SNS remain within 2 m of the surface while moving, which would limit the potential for entrainment of migrating fish in dredges.

A direct impact to SNS would be entrainment in the dredge equipment. Two dead SNS were reported to have been found in a placement area during dredging near Philadelphia in the Delaware River in February 1996 (USACE 1997b). Subsequent personal communication with representatives of the Philadelphia District provided additional information (USACE 1998). The dredging job was accomplished using more than one type of dredging. The sturgeon parts were found in the placement area utilizing both a hopper dredge and a cutterhead dredge with hydraulic pipeline placement. There is some discussion as to the actual cause of the sturgeon death and the attribution to dredging causes. As the taking of sturgeon was not directly observed and no Corps personnel observed the sturgeon in the placement area, it is not known how it occurred. Three more SNS were discovered in January 1998 in an upland placement area after dredging the Kinkora range of the Delaware River. Atlantic sturgeon have been entrained in both hydraulic pipeline and in a bucket and barge operation in the Cape Fear River, North Carolina (NMFS 1998) and in a hopper dredge in Kings Bay, Georgia (NMFS 1998). In 2001, an Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and released unharmed during dredging operations in the Kennebec River, Maine (Normandeau Associates, Inc. 2001).

Adult, juvenile, larval, and young-of-the-year sturgeon feed primarily on zoobenthos and appear to remain close to the substrate. Some studies in the Chesapeake Bay support the finding that sturgeon come in to relatively shallow waters to feed and return to deeper waters after feeding (Brundage, personal communication 1997). Some evidence of this assertion can be verified from the location and water depths of the SNS captured in the USFWS Reward Program. If this is the case, there is less likelihood that sturgeon that are feeding in the shallows would be subject to entrainment in a deep channel dredging operation when in close contact with the benthos for feeding. However, during larval development, sturgeon larvae tend to be concentrated near the bottom of the water column. Hydraulic dredging during this time period has been documented in Russia to have disastrous effects on sturgeon fry (Sbikin et al. 1988).

It would be expected that the short and temporary nature of the dredging operation would not have any impacts to larval, young-of-the-year, or juvenile sturgeon due to the location of the channels with respect to NMFS speculation of habitat location. Time-of-year restrictions for dredging in the C&D Canal Northern Approach Channels (Figure 2) and placement activities in the Pooles Island open water placement sites are currently limited to October 1 to March 31. This window is set to limit potential impacts to larval, young-of-the-year, or juvenile SNS as well as other fish species. The window is also set to limit potential conflicts with recreational fisheries.

The only designated "possible" SNS juveniles were captured in the upper Chesapeake Bay from the Worton Point area to Veasey's Cove in the Bohemia River, APG west of Delphs Creek, and APG Sandy Point during the period of February to April 1998. Depths for the captures ranged from 4 ft (1.2 m) (fyke net) to 8 ft (2.4 m) (gillnet) for the Bohemia River SNS. The Bohemia River captures occurred on February 26 and March 24, 1998. Capture depths were not recorded for the remaining juveniles. However, two of the "possible" juveniles were captured along the shoreline of APG in fyke nets, typically used in shallow water. These occurred in the APG vicinity, west of Delph's Creek and at Sandy Point. The remaining two juveniles were captured in a gillnet and eel trap at Worton Point. Four adult SNS were captured in the vicinity of the southern approach channels to the C&D Canal, but only one was located directly in the channel itself, near the mouth of the Sassafras River. These fish were captured during the months of December (two fish) and April (two fish) (Figure 18).

Time-of-year restrictions have recently been requested by NMFS for the dredging of the approach channels to Baltimore Harbor including the Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel Eastern Extension, Swan Point Channel, and Tolchester Channel (Figure 2). The restrictions requested by NMFS are to limit dredging to August 1 through November 30 each year, and if not possible, to use observers for the December – March time period. It is presumed that this restriction is targeting potential takes of adults. These channels are a distance from habitat that NMFS assumes is utilized by larval, young-of-the-year, or juvenile sturgeon; therefore, no impact is anticipated. In addition, no juvenile SNS were captured this far south in the Chesapeake Bay. One SNS was captured near the Tolchester Channel during the month of December in the USFWS Reward Program.

Results of the USFWS Reward Program (USFWS 2000, Appendix B) indicate that three Atlantic sturgeon were captured in the vicinity or in one of the bay channels. Specifically, one fish was captured in the southern approach channel to the C&D Canal by gillnet (near Grove Point), one fish in the connecting channel between the Tolchester and Brewerton Eastern Extension channels, and one fish in the vicinity of the Tolchester Channel.

7.3 IMPACTS ON BENTHIC HABITAT AND PREY

Adult SNS are reported to feed on benthic organisms, aquatic vegetation and small fish. Their feeding pattern has been observed by Hastings (1983) to occur far upstream in the shallows, and outside of the channels. Feeding in deeper areas has been documented in estuaries (Hall et al. 1991 and Rogers and Weber 1995a). SNS feeding has also been reported in gravelly and sandy mud bottoms in Canada and South Carolina River systems (Dadswell et al. 1984). The substrate types found in the Federal navigation channels proposed for dredging are fine grained, with silt and clay as the primary particle sizes, and are consistent with maintenance dredged material in this area. Sediment particle size may suggest a less suitable feeding habitat for SNS.

Gilbert (1989) has described the movement of sturgeon to deeper water, possibly to feed in the winter. If this is the case within the Chesapeake Bay, the sturgeon could be moving to lower portions of the bay to feed where average depths are greater. The times of placement and dredging should avoid the post-spawning movement to the deeper water typically occurring in April. Since no SNS have been found in the placement sites, it is unlikely that placement activities in these sites would significantly impact their movement during the winter migration in October-January.

Due to the relatively small area dredged compared to the entire area of benthos available for SNS feeding, as well as the silty clay nature of the sediments, dredging of the navigational channels discussed in this BA is not likely to cause harm to the SNS benthic habitat and prey.

Use of an already constructed island or upland placement site would have no impact on SNS because all of the placement activities would take place out of water.

Placement of material at an open-water placement area would potentially prevent yearly benthic recolonization, in a portion of the sites, for 18 to 20 months after placement activities have ceased. However, annual recolonization at the deep-water alternative sites (Site 104, Site 171, Deep Trough North, and Deep Trough South) is already restricted due to annual summer anoxia. These sediments are primarily fine-grained silts and clays. The area impacted annually would be small compared to the upper Chesapeake Bay area available for feeding.

Selection of a footprint expansion (HMI Footprint Expansion, Poplar Island Modification), new island facility (Tolchester West, Site 168, Site 171, Pooles Island sites, Site 170A), or island restoration site (James Island, Barren Island, Holland Island, Hooper Islands, Little Deal Island, Lower Eastern Neck Island, Parsons Island, Ragged Island, Sharps Island, Smith Island, South Marsh Island, or Sparrows Point) would permanently eliminate shallow water habitat. However, the majority of the island restoration sites are located in the mid-bay where capture of SNS were reduced relative to upper bay captures. Construction of dikes at these sites would result in some habitat loss for the specific areas being used for dike construction borrow materials and for the actual footprint of the constructed site as it proceeds.

It has been reported that SNS use deeper areas, when these areas are not anoxic or hypoxic, as overwintering sites. Suitable overwintering habitat is probably dependent upon salinity, temperature, and oxygen content, as opposed to available food organisms in these deep areas because of reduced benthic populations and reduced metabolism during colder months. The full extent of utilization of overwintering habitat in the Chesapeake Bay by SNS is unknown. Most

SNS have been captured in the winter and spring in the far northern bay by the USFWS Reward Program. These fish were captured in shallow water gear types by commercial fishermen [except for SNS captured in the Susquehanna River at depths of 60 ft (18.3 m)]. No SNS were captured as a result of the deep water gillnetting sampling performed by the USFWS/USACE sturgeon study. From available literature, it is still projected that deeper waters in the far upper bay could be used by overwintering SNS.

7.4 DIRECT IMPACT TO SNS DURING CONSTRUCTION

A hydraulic dredge would most likely be used to construct the sand dikes of the island containment, footprint expansion/modification, or beneficial use options. There is potential for entrainment of SNS that might be in the construction area during use of hydraulic dredges for dike creation. Entrainment risk during construction is the same type of risk that exists during hydraulic dredging (Section 7.2). However, construction of the sand dikes for the 1,100-acre (445-ha) PIERP did not encounter or impact any SNS or WAS.

7.5 BURIAL DURING DREDGED MATERIAL PLACEMENT

SNS eggs and larvae would potentially be subject to burial during bottom release or hydraulic placement action. However, since no sturgeon eggs or larvae have been found in the Chesapeake Bay in at least 20 years, impacts to sturgeon eggs and larvae from placement is unlikely. In addition, none of the dredged areas or placement alternatives are located within the rivers that are suspected by NMFS as spawning reaches for SNS, and the proposed time period for dredging and placement (October 1 to March 31) does not correlate with parameters required for sturgeon spawning and larval development.

Spawning habitat should not be impacted by burial during the settling of dredged material placement actions since none of the proposed placement alternatives are located in suspected spawning habitat and the proposed time period for dredging and placement, October 1 to March 31 [October 15 to March 31 is proposed for Site 104, Deep Trough (North of Bloody Point), and Deep Trough (South of Bloody Point)], does not correlate with reported water temperatures [48-59°F (9-15°C)] and other water quality parameters required for sturgeon spawning and larval development. Additionally, the fine-grained sediment expected to be placed from the Federal channels and what is currently found at the open water placement areas are not the type of sediments typically found to be used for sturgeon egg laying or by larvae historically.

Another potential impact is burial of SNS under deposited material or displacement from overwintering habitats. However, according to the NMFS (1999) review of the most current information on SNS, overwintering habitat of SNS is likely to be between Howell and Grove Points. Therefore, no impact to SNS eggs, larvae, or suspected overwintering habitat is projected due to direct burial. Based on Delaware River population observations, impacts of siltation on spawning areas are unlikely because SNS spawning areas would be found much further upstream.

To date no SNS have been found within the placement alternatives under consideration. The USFWS Reward program has documented one WAS within the placement boundaries of Site 170a (February). There have been several WAS captures in close vicinity to the Deep Trough North (January, November, March, and May) and Deep Trough South (May); however, these were not within the site boundaries. There were several captures (77 fish) of Atlantic sturgeon in pound nets in the vicinity of Barren Island, some within the footprint. There were also 9 captures of Atlantic sturgeon near Holland Island, but not in the footprint for the proposed restoration site. Many of these captures can be attributed to the location of the commercial gear, rather than an affinity of Atlantic sturgeon to some sites over others.

7.6 WATER QUALITY RELATED IMPACTS

Short-term nutrient and turbidity water quality impacts are expected during dredging, placement, and construction activities. Modeling and studies of sediment/water nutrient interactions have not predicted significant negative water quality impacts (Cerco 2000). Water quality modeling of the upper bay does not indicate large increases in phytoplankton activity and does not find increased hypoxia (Cerco 2000). To minimize short-term impacts, dredging, construction, and placement activities are scheduled for the fall and winter quarters. Dredging, construction, and placement activities during this time frame would avoid peak fish prevalence and reproductive periods. Finfish species in the bay are generally used to and tolerant of turbid water quality. Turbidity levels at the open-water placement sites are expected to be elevated for approximately 20 to 30 minutes during and after each placement event. It is expected that SNS would avoid these areas during placement events. The turbidity and nutrient short-term impacts would apply to dredging and open water placement activities. There would be minimal turbidity impacts associated with placement on a constructed island or upland placement site because placement activities would take place outside of the water and the discharge from the sites would be regulated to meet State water quality standards.

7.7 DISRUPTION OF MIGRATORY MOVEMENTS

Migratory movements of shortnose sturgeon in nearby estuaries have been found to have the following pattern:

- Spawning migrations occur in January to March with water temperatures between 45 and 48°F (7 and 9°C) ;

- Spawning of adult ripe SNS occurs in April or May near this latitude and is dependent on water temperature and bottom type;

- Migration to feeding areas occurs in June near this latitude, with fish staying within these areas for the summer and early fall; juvenile migration usually occurs in the region above the freshwater/saltwater interface;

- After spawning and summer feeding, the adults move to deep overwintering sites that are sometimes adjacent to the spawning grounds (Dadswell et al. 1979). Overwintering adults occupy a variety of salinity regimes depending on longitudinal location. Salinity ranges were generally noted by Kynard (1997) to vary from 0 to 21 ppt depending on geographic location; and

- There is conflicting information reported about SNS migration. However, NMFS (1998) has reported that younger adult SNS have been known to travel long distances in the pre-spawning years. Migration of these sturgeon can be unpredictable in terms of location and the length of time spent at different location.

Because of the lack of documentation of SNS occurrence in the Federal navigation channels proposed for dredging and areas proposed for placement, the minimal number of SNS caught in the channels proposed for dredging (one fish), the lack of captures in proposed placement areas by the USFWS/USACE sturgeon study, the lack of SNS taken during dredging operations, and the small number of sturgeon from the USFWS Sturgeon Reward Program, it is unlikely except for the approach channel to the C&D Canal that any sturgeon would be within the project area during dredging and placement**.** Dredging is expected to occur from October 1 to March 31 on an annual basis. Some studies have found little migration of sturgeon in the winter; other studies in the southern part of their range have shown wide movement of sturgeon in the winter. If there is no resident population of SNS in the bay, sturgeon impacted during this action would likely be transients from the Delaware River population or migratory adults from another East Coast population. According to the NMFS (1999) review of the most current information on SNS, overwintering habitat of SNS in the Chesapeake Bay is likely to be between Howell and Grove Points (although no SNS were captured in this reach by the USFWS/USACE sturgeon study). All of the placement sites and channel dredging proposed by CENAB are south of this location, so there is no projected impact due to impedance of migratory movements. If SNS spawning is still occurring in the Potomac River as is presumed in the recent BO for the Washington Aqueduct (NMFS 2003), it would not be affected by dredging or placement activities in the mainstem of the Chesapeake Bay.

If there is a resident population, then it is possible that dredging occurring in February to March, when water temperatures exceed 46°F (8°C) could coincide with migration. Given the relatively small cross-sectional area of the bay affected by the project, migratory movements are not projected to be impacted, if a resident population exists.

As a result of the Section 7 Consultation and data collection efforts associated with this project, further elucidation of the migratory patterns of transient or resident populations of SNS in the Chesapeake Bay is expected. The potential winter movements of sturgeon should not be affected by the proposed dredging or placement actions because the majority of fish found have been in the upper Chesapeake Bay, north of Pooles Island.

7.8 CUMULATIVE IMPACTS

Cumulative impacts from other projects that may affect SNS include:

- The Susquehanna River Channel Project;
- Aberdeen Proving Grounds Project;
- Northeast River Project;
- Rock Hall Harbor Project;
- MDNR Fossil Oyster Shell Mining;
- C&D Canal Northern Approach Channel Maintenance;
- State Regulated Fisheries; and
- Local and Private Projects.

All of the above projects were evaluated by NMFS in the 1999 BO concerning similar proposed impacts to endangered SNS from maintenance dredging of the C&D Canal and southern approach channels, and were found not to be a factor**.**

The following list of projects have their own National Environmental Policy Act (NEPA) and RTE requirements to comply with. To date none of these projects have been reported as affecting SNS or its habitat.

- Maintenance of Baltimore Harbor and Baltimore Approach Channels within Maryland;
- C&D Canal Deepening;
- Delaware Bay Channel Deepening;
- Tolchester S-Turn Straightening;
- Brewerton Channel Eastern Extension Widening;
- Poplar Island Environmental Restoration Construction;
- Hart-Miller Island South Cell Restoration Construction;
- Dredged Material Placement at Poplar Island;
- Dredged Material Placement at Pooles Island Site G-West;
- Dredged Material Placement at Site 92;
- Dredged Material Placement at Hart Miller Island;
- Dredged Material Placement at Courthouse Point;
- Susquehanna River below Havre de Grace;
- Northeast River; and
- Rock Hall Harbor.

8.0 CONCLUSIONS

The status of SNS in the Chesapeake Bay and potential impacts relative to dredging and dredged material placement activities have been detailed throughout this document. Historical life history information, contemporary and ongoing studies of SNS within Chesapeake Bay and its tributaries, dredging mechanics, and placement site details support the following conclusions:

- Although the recent BO for the Washington Aqueduct (NMFS 2003) states that SNS may still be spawning in the Potomac River, field studies have not yet verified this assertion. Additionally, if spawning is still occurring in the Potomac River, it would not be affected by dredging or placement activities in the mainstem of the Chesapeake Bay.

- Although SNS have been captured below the Conowingo Dam, no SNS spawning activity has been document in the Susquehanna River, and it is very likely that SNS are no longer spawning in the Chesapeake Bay. This is supported by genetic analyses.

- Any spawning activity that may still be occurring in the upper Chesapeake Bay is miles from maintenance dredging activities in the Federal Navigation Channels and any currently proposed placement sites. Therefore, dredging activities within the bay are not expected to affect spawning or early life stages of SNS.

- Genetic analysis indicates that the SNS that were caught in the Chesapeake Bay are not a distinct population segment separate from the Delaware River population. This has also been supported by USFWS telemetry studies of SNS using the C&D Canal (USFWS 2000b) indicating that the SNS captured in the Chesapeake Bay were similar to the Delaware River population.

- The Delaware River population is known to be relatively stable and self-sustaining, if not increasing (Hastings 1987). Latest estimates indicate population numbers in the thousands, with ongoing study of the feeding grounds and some study of spawning grounds. Wirgin et al. 2002 indicated that abundances of some populations, including the Delaware River population, may have rebounded to levels that could permit population-level endangered species delisting.

- Gillnetting studies have not collected any SNS. Reward Program captures have been recorded from a variety of depths, but very few collections have been made at depths similar to those in the Federal navigation channels [50 ft (15.2 m).

- Although SNS have been collected in the general vicinity of the southern approach channels to the C&D Canal and one was captured near the Tolchester Channel, none have been documented using the navigation channels (other than the C&D Canal) with either passive capture techniques or telemetry. Based upon this data, it appears that SNS are transients within the Baltimore Harbor Approach channels, and any utilization is probably incidental.

- Although SNS and WAS have been collected near some of the existing or proposed placement sites, no sturgeons have been collected within the proposed footprints of any site except one WAS caught in the G-East area of the existing Pooles Island site. Based upon these observations, it appears that SNS are transients to the existing and proposed dredged material placement sites within the Chesapeake Bay.

- Except for one deep area within the Susquehanna River Channel, SNS were generally found in shallower waters during the warmer months. Time of year dredging restrictions (October 1 to March 31) used within Maryland waters to be protective of aquatic resources would restrict dredging activities during the period when SNS are likely to be at the greatest depths and would be protective of the species.

- Most dredging of the Federal Navigation Channels in the upper reaches of the Chesapeake Bay are conducted with mechanical dredges (clamshell dredge) which has been documented to be the least likely to impact sturgeon based upon activities in other areas. Sturgeon have been captured within clamshell buckets and released alive and unharmed.

- Sturgeon observers were utilized during recent dredging operations to comply with NOAA restrictions for hopper dredging activities conducted from January to March at Courthouse Point. There were no observed takes of sturgeon during that operation or during five respective seasons of CENAP dredging activities in the upper Chesapeake Bay utilizing a bucket dredge.

- CENAB used observers during the 2002/2003-placement season (December 1 – January 29) while conducting maintenance dredging in the Baltimore Harbor Approach Channels by bucket dredge. There were no observed takes of sturgeon during these activities.

- Negligible impacts to SNS are expected due to the small number of SNS found by the USFWS Reward Program, the lack of SNS utilization of the Federal channels or proposed placement areas, and the absence of SNS taken during dredging operations in the upper Chesapeake Bay based upon observer data).

- Based upon activities in other areas, incidental takes of sturgeon may be possible and an Incidental Take Permit (ITP) would likely be required for future dredging activities in the Chesapeake Bay. An ITP of three fish per year set for the dredging of the C&D Canal Northern Approach Channel, which was a number that NMFS indicated would not likely have a negative impact on the status of the SNS in the area. Therefore, incidental takes of this magnitude, if set for the current dredging operations, are not expected to have a negative impact on SNS in the Chesapeake Bay or the Delaware River.

9.0 LIST OF PREPARERS

Maryland Environmental Service

Suzanne M. Kelly	Environmental Specialist
Cece Donovan	Senior Environmental Specialist
Tammy Rose Banta	Senior Environmental Specialist
Elizabeth Habic	Environmental Specialist
Lauren Franke	Environmental Specialist
Erika Kehne	Environmental Specialist
Brian D. Wolf	Environmental Specialist

U.S. Army Corps of Engineers, Baltimore District

Mark Mendelsohn	Biologist
Jeff McKee	Ecologist
Michele Gomez	Biologist

EA Engineering, Science & Technology

Peggy Derrick	Scientist
Jane Boraczek	Scientist
Janet Earickson	Technical Writer

10.0 REFERENCES

Academy of Natural Sciences Estuarine Research Center (ANSERC). 1994. Microzooplankton Community Composition in the Vicinity of Sparrow's Point, Patapsco River, MD. November 30, 1994.

Andrews, Miller and Associates, Inc. (AMA). 2002. Final Consolidated Reconnaissance Report for Sharps Island, Maryland for Potential Beneficial Sue and Habitat Restoration. December 2002.

Bain, M. B. 1997. Atlantic and Shortnose sturgeons of the Hudson River: common and divergent life history attributes. Env. Bio. Fish. Vol. 48., pp. 347-358.

Bain, M. B., Nancy Haley, Douglas L. Peterson, Kristin K. Arend, Kathy E. Mills, and Patrick J. Sullivan. 2000. Shortnose Sturgeon of the Hudson River: an Endangered Species Recovery Success. EPRI-AFS Symposium: Biology, Management and Protection of Sturgeon. 2000 Annual Meeting of the American Fisheries Society, St. Louis, MO. 23-24 August 2000.

Beukema, J.J. 1988. An evaluation of the ABC-method (abundance/biomass comparison) as applied to macrozoobenthic communities living on tidal flats in the Dutch Wadden Sea. Marine Biology 99: 425-433.

Biggs, R.B. 1970. Sources and Distribution of Suspended Sediment in Northern Chesapeake Bay. Marine Geology 9:187-201.

Blasland, Bouck & Lee, Inc. (BBL). 2002. Reconnaissance Study of Environmental Conditions at Sharps Island. September 2002.

Boynton, W.R., J.M. Barnes, F.M. Rohland, L.L. Matteson, J. Frank, and M.M. Weir. 1996. G-East and Site 92 Subaqueous Placement Baseline Study: Sediment Oxygen and Nutrient Exchanges. November; Chesapeake Biological Laboratories Ref. No. 96-149; Final Report (June-August 1996).

Browne, D.R. and C.W. Fisher. 1988. Tide and Tidal Currents in the Chesapeake Bay. Rockville; August 1981-December 1983.

Brundage, Hal. 1997. Personal Communication with Hal Brundage, December 2, 1997.

Buckley, J. and Boyd Kynard. 1981. Spawning and Rearing of SNS from the Connecticut River. Prog. Fish-Cult. 43: 74-76.

Buckley, J. and Boyd Kynard. 1985. Yearly Movements of SNS in the Connecticut River. Transactions of the American Fisheries Society. 114: 813-820.

Cerco, Carl F. 2000. Additional Water Quality Model Examinations at Site 104. USACE Waterways Experiment Station. Prepared for the Maryland Port Administration and Maryland Environmental Service. Final Report. February 2000.

Chesapeake Bay Program (CBP). 1994. Chesapeake Bay Basinwide Toxins Reduction Strategy Reevaluation Report. U.S. Environmental Protection Agency

Chesapeake Bay Program (CBP). 1995. Living Resources and Biological Communities pp. 16-22. In: Chesapeake Bay, Introduction to an Ecosystem (K. Reschetiloff, ed.). U.S. Environmental Protection Agency.

Chesapeake Bay Program (CBP). 2002a. The State of the Chesapeake Bay: A report to the Citizen's of the Bay. U.S. EPA CBP Office, Annapolis, MD. CBP/TRS 260/02. June 2002.

Chesapeake Bay Program (CBP). 2002b. Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for Chesapeake Bay and its Tidal Tributaries. April 2003.

Collins, M.R., and T.I.J. Smith. 1993. Characteristics of the adult segment of the Savannah River population of SNS. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies. 47:485-491.

Collins, M.R., and T.I.J. Smith. 1997. Distribution of shortnose (*Acipenser brevirostrum*) and Atlantic (*A. oxyrinchus oxyrinchus*) sturgeons in South Carolina. North American Journal of Fisheries Management.

Collins, Mark R., William C. Post, and Daniel C. Russ. 2001. Distribution of Shortnose Sturgeon in the Lower Savannah River. Results of Research Conducted 1999-2000. Final Report to Georgia Ports Authority. August 2001.

Collins, Mark R., William C. Post, Daniel C. Russ, and Theodore I. J. Smith. 2002. Habitat Use and Movements of Juvenile Shortnose Sturgeon in the Savannah River, Georgia-South Carolina. Transactions of the American Fisheries Society: Vol. 131, No. 5, pp. 975-979. February 11, 2002.

Cronin, L.E., R.B. Biggs, D.A. Flemer, H.T. Pfitzenmeyer, F. Goodwyn, W.L. Dovel and D.E. Ritchie. 1970. Gross Physical and Biological Effects of Overboard Spoil in Upper Chesapeake Bay. Solomons: Natural Resources Institute, University of Maryland. 1965-1968.

Cronin, E.L. 1971. A biological study of Baltimore Harbor. Natural Resources Institute, The University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland. NRI. Ref. No. 71-76, September 1971.

Dadswell, M. J. 1979. Biology and population characteristics of the SNS, *Acipenser brevirostrum* LeSueur 1818 (Osteichthyes: Acipenseridae), in the Saint John River estuary, New Brunswick, Canada. Canadian Journal of Zoology 57:2186-2210.

Dadswell, M.J., B. D. Taubert, T.S. Squires, D. Marchette, J. Buckley. 1984. Synopsis of biological data on SNS, *Acipenser brevirostrum* LeSueur 1818. NOAA/NMFS Tech. Rep. 14. Washington, D.C.

Dalal, V.P. 1996a. Benthic Community Assessment of Courthouse Point Upland Dredged Material Placement Site, Cecil County, Maryland. June 1996; Pre-Placement Analysis-Phase I Study. Maryland Department of the Environment.

Dalal, V.P. 1996b. Benthic Community Assessment of G-West Open-Water Dredged Material Placement Site, Maryland. June 1996; 2 year monitoring.

Dames and Moore. 1976. A Study of Aquatic Biota in the Curtis Bay Region of Baltimore Harbor for Crown Central Petroleum Corporation, Baltimore, Maryland. March 10, 1976.

Dovel, W.L. 1979. The Biology and Management of Shortnose and Atlantic Sturgeon of the Hudson River. NYS Department of Environmental Conservation. Final Report Project AFS-9-R.

Dovel, W.L. and J.R. Edmunds. 1971. Recent Changes in Striped Bass (Morone saxatilis) Spawning Sites and Commercial Fishing Areas in Upper Chesapeake Bay; Possible Influencing Factors. Chesapeake Science 12:33-39.

Earth Engineering and Sciences, Inc. (E2Si). 1992. Preliminary Subsurface Investigation Bethlehem Shoreline Enhancement Baltimore County.

EA Engineering, Science, and Technology, Inc. 1997. Environmental Investigation: Prefeasibility Study for Upper Bay Island Placement Sites. Final. Prepared for Maryland Port Administration. December 1997.

EA Engineering, Science, and Technology, Inc. 2000. Evaluation of Dredged Material from Chesapeake Bay Approach Channels to Baltimore Harbor and Placement Site 104: Sampling, Physical and Chemical Analyses, and Ecotoxicological Studies.

EA Engineering, Science & Technology, Inc. 2001. Final Reconnaissance Study of Parsons Island for Beneficial Use and Habitat Restoration Environmental Conditions Report. August 2001.

EA Engineering, Science & Technology, Inc. 2002. Final Reconnaissance Study of Poplar Island Sites for Beneficial Use and Habitat Restoration: Environmental Conditions. November 2002.

EA Engineering, Science and Technology, Inc. 2003a. Final Barren Island Habitat Restoration Existing Environmental Conditions: Summer 2002 Survey. May 2003.

EA Engineering, Science and Technology, Inc. 2003b. Final James Island Habitat Restoration Existing Environmental Conditions: Fall 2001 and Summer 2002 Surveys. February 2003.

EA Engineering, Science & Technology, Inc. 2003c. Final Reconnaissance Study of Lower Eastern Neck Island for Beneficial Use and Habitat Restoration: Environmental Conditions. January 2003.

EA Engineering, Science and Technology, Inc. 2003e. Final James Island Habitat Restoration Existing Environmental Conditions: Fall 2002 Surveys. May 2003.

EA Engineering Science and Technology, Inc. 2003f. Final Reconnaissance Study of Baltimore Harbor Sites for Upland, Confined Placement of Harbor Dredged Material: Environmental Conditions. January 2003.

Flournoy, P.H., S.G. Rogers, and P.S. Crawford. 1992. Restoration of SNS in the Altamaha River, Georgia. Final Report to the U.S. Fish and Wildlife Service, Atlanta, Georgia.

Gahagan & Bryant Associates, Inc. (GBA) 2002. Analysis of Placement of Dredged Material at the Cape Henry Ocean Placement Site. November 2002.

Gilbert, R.J. and A.R. Heidt. 1979. Movements of the SNS, *Acipenser brevirostrum*, in the Altamaha River. Assoc. Southeastern Biol. Bull. 26:35.

Gilbert, C.R. 1989. Species profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic Bight) Atlantic and SNSs. U.S. Fish and Wildlife Service Biological Report 82 (11.122) U.S. Army Corps of Engineers TR EL-82-4.

Greeley-Polhemus Group, Inc. 1994. An Aquatic Study for the Chesapeake and Delaware Canal Deepening Feasibility Study Phase II. Final Report. September 1994.

Hall, W.J., T.I.J. Smith, and S.D. Lamprecht. 1991. Movements and Habitats of SNS *Acipenser brevirostrum* in the Savannah River. Copeia (3): 695-702.

Hastings, R. W. 1983. A study of the SNS (*Acipenser brevirostrum*) population in the upper tidal Delaware River: assessment of impacts of maintenance dredging. Final Report to the USACE, Philadelphia, Pennsylvania. 129 pages.

Hastings, R. W., J.C. O'Herron, K. Schick, and M.A. Lazzari. 1987. Occurrence and Distribution of SNS*, Acipenser brevirostrum*, in the Upper Tidal Delaware River. Estuaries Vol. 10, No. 4, 337-341.

Henwood, T.A. 1990. An overview of the Endangered Species Act of 1973, as amended, and its application to endangered species/dredging conflicts in Port Canaveral, Florida. In: Dickerson, D. D. and D.A. Nelson (Comps.); Proceedings of the National Workshop on Methods to Minimize Dredging Impacts on Sea Turtles, 11-12 May 1988, Jacksonville, Florida. Miscellaneous Paper EL-90-5. Department of the Army, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. February 1990. Pp. 17-25.

Hirschfield, M.F., and J.H. Hixson. 1981. Fish and Blue Crab Studies. Presented in Benthic and Fish Studies to Assess Thermal Impacts of the H.A. Wagner Steam Electric Station Patapsco River, Maryland, 1980-1981. Report No. 81-24F. Prepared for Benedict Estuarine Research Laboratory and the Academy of Natural Sciences of Philadelphia. November 13, 1981.

Homer, M.L. and J.A. Mihursky. 1992. Spot Leiostomus xanthurus. In Habitat Requirements for Chesapeake Bay Living Resources. Second Edition; eds. S.L. Funderburk, J.A. Mihursky, S.J. Jordan and D. Riley. Solomons, Maryland. Chesapeake Research Consortium, Inc.

Hrabovsky, L. 1990. Hydraulic cutterhead pipeline dredging. In: Dickerson, D.D. and D.A. Nelson (Comps.); Proceedings of the National Workshop on Methods to Minimize Dredging Impacts on Sea Turtles, 11-12 May 1988, Jacksonville, Florida. Miscellaneous Paper EL-90-5. Department of the Army, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. February 1990. Pp. 56-58.

Jarvis, Peter L., James S. Ballantyne, and William E. Hogans. 2001. The Influence of Salinity on the Growth of Juvenile Shortnose Sturgeon. North American Journal of Aquaculture: Vol. 63, No. 4, pp.272-276. April 11, 2001.

Kerhin, R.T., Halka, J.P., Wells, D.V, Hennessee, E.L. Blakeslee, P.J., Zoltan, N., and Cuthbertson, R.H. 1988. The surficial sediments of the Chesapeake Bay, Maryland: physical characteristics and sediment budget: Maryland Geological Survey Report of Investigations No. 48, 82 p.

Kieffer, M.C. and Boyd Kynard. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society. 122: 1088-1103.

Kieffer, M.C. and Boyd Kynard. 1996. Spawning of SNS in the Merrimack River. Transactions of the American Fisheries Society. 125: 179-186.

Kynard, Boyd. 1997. Life history, latitudinal patterns, and status of the SNS, *Acipenser brevirostrum*. Env. Bio. Of Fishes. Vol. 48., pp. 319-334.

LeSueur, C.A. 1818. Description of several species of Chondropterigious fishes, of North America, with their varieties. Trans. Am. Philos. Soc. 1: 383 - 394.

Magnien, R.E., D.K. Austin and B.D. Michael. 1993. Chesapeake Bay Water Quality Monitoring Program. Chemical/Physical Properties Component, Level I Data Report (1984-1991). Maryland Department of the Environment; Baltimore, Maryland.

Maryland Department of the Environment (MDE). 1998. Assessment of the Environmental Impacts of the Hart-Miller Island Containment Facility, Maryland, Year 13 Exterior Monitoring Technical Report (September 1993 - August 1994). Prepared for the Maryland Port Administration. September 1998.

Maryland Department of the Environment (MDE). 2000. Assessment of Impacts from the Hart-Miller Dredged Material Containment Facility, Maryland. Year 17 Technical Report (July 1998-April 2000).

Maryland Department of the Environment (MDE) Dredging and Coordination Assessment Division. March 2000. Assessment of the Environmental Impacts of the Hart-Miller Island Confined Disposal Facility, Maryland Year 15 Exterior Monitoring Technical Report.

Maryland Department of Natural Resources (MDNR), Fisheries Service. 2003. Pound Net Locations Map. May 2, 2003.

Maryland Environmental Service (MES). 1994. Sediment and Water Quality Investigation Delaware for the C&D Canal Feasibility Study. Prepared for: the Maryland Port Administration. February, 1994.

Maryland Environmental Service (MES). 1997a Pooles Island G-West Comprehensive Monitoring Final Report. Prepared for the U.S. Army Corps of Engineers, Philadelphia District, and Maryland Port Administration. February, 1997.

Maryland Environmental Service (MES). 1997b. Final Environmental Assessment. Designation of Aquatic Dredged Material placement Areas G-East and Site 92 for Maintenance Dredging, Prepared for the U.S. Army Corps of Engineers, Philadelphia District, and Maryland Port Administration. August 1997.

Maryland Environmental Service (MES). 1998. Break Out Biological Assessment for Hopper Dredging of A Portion of the C&D Canal and Northern Approach Channels Maryland. Prepared for: the Maryland Port Administration. February 1998.

Maryland Environmental Service (MES). 2000. Thermal Refuge Investigation of Dredged Material Placement Alternatives in the Chesapeake Bay Draft Report. June 2000.

Maryland Environmental Service. 2002a. Poplar Island Environmental Restoration Project 2000/2001 Discharge and Exterior Monitoring Annual Draft Report. January 2002.

Maryland Environmental Service. 2002b. Dredged Material Management Program (DMMP) Proposed Options Preliminary Technical Results Interim Report to the Bay Enhancement Working Group. September 2002.

Maryland Environmental Service. 2002c. Hart-Miller Island South Cell Environmental Restoration Project (HMI SCERP) Monitoring Plan. September 2002.

Maryland Environmental Service. 2003a. Monitoring of 1999/2000 Dredged Material Placement at Pooles Island Open-Water Placement Site 92 Final Comprehensive Monitoring Report. February 2003.

Maryland Environmental Service. 2003b. Monitoring of 2001/2002 Dredged Material Placement at Pooles Island Open-Water Placement Site 92 Site Management Report. March 2003.

McCleave, J.D., S.M. Fried, and A.K. Towt. 1977. Daily movements of SNS, *Acipenser brevirostrum,* in a Maine estuary. Copeia: 149-157.

McLellan, T.C., R.N. Havis, D.F. Hayes, and G.L. Raymond. 1989. Field studies of sediment resuspension characteristics of selected dredges. Improvement of Operations and Maintenance Techniques Research Program, Technical Report HL-89-9, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Meyer, Dave. 2001. Annual Report on the Post-Phase I Nekton Surveys of the Poplar Island Beneficial Use Project. Prepared for the U.S. Army Corps of Engineers, Baltimore and the Poplar Island Work Group.

Michael Baker, Jr., Inc (Baker). 2001. Hart-Miller Island South Cell Environmental Restoration Revised Concept Plan DRAFT. February 15, 2001.

Michael Baker, Jr., Inc (Baker). 2002. Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration Final Environmental Conditions Report. August 21, 2002.

Michael Baker Jr., Inc (Baker). 2003. Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration Final Consolidated Report. January 31, 2003.

Miller, T. 1998. Assessment of Fish Community Structure Within and Near Site 104 Final Report. Report to Maryland Environmental Service. Chesapeake Biological Laboratory Ref. [UMCEES] CBL 97-123.

Millsaps, HS and CF Tsai. 1984. Fish Near Hart and Miller Islands. Presented in Assessment of the Environmental Impacts of Construction and Operation of the Hart and Miller Island Containment Facility. Second Interpretive Report, August 1982-August 1983. CRC Publication No. 114. January 1984.

Mitigated Environmental Assessment for the Renovation of the Proposed CSX/Cox Creek Dredged Material Containment Facility by the Maryland Port Administration and Use of the Facility by the US Army Corps of Engineers. May 2000. Glen Burnie, North Anne Arundel County, MD.

Moffatt & Nichol et. al. June 1996. Site Operational Assessment Study for Cox Creek.

Moser, M. L. and S. W. Ross. 1993. Distribution and movements of SNS *, (Acipenser brevirostrum)* and other anadromous fishes of the lower Cape Fear River, North Carolina. Final Report to the U.S. Army Corps of Engineers, Wilmington, NC.

Murdy, E.O., R.S. Birdsong, and J.A. Musick. 1997. Fishes of Chesapeake Bay. Smithsonian Institution Press. Washington D.C. 324 p.

National Marine Fisheries Service (NMFS). 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Final. Prepared by the Shortnose Sturgeon Recovery Team for the NMFS, Silver Spring, Maryland. 104 pages

National Marine Fisheries Service (NMFS). 1999. Section 7 consultation Biological Opinion for the Dredging Activities within the Philadelphia District. Conducted by: National Marine Fisheries Service. Prepared for U.S. Department of the Army, Philadelphia District. May 1999

National Marine Fisheries Service (NMFS). 2003. Endangered Species Act Biological Opinion: National Pollutant Discharge Elimination System Permit for the Washington Aqueduct F/NER/2003/00600, conducted by National Marine Fisheries Service Northeast Region. July 14, 2003.

National Ocean Service (NOS). 1996. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Tidal Currents 1996. Rockville, MD.

National Oceanic and Atmospheric Administration (NOAA). 1998. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). September 1998.

National Oceanic and Atmospheric Administration (NOAA). Personal communication with Kimberly Damon-Randall, October 29, 2002.

National Oceanic and Atmospheric Administration (NOAA). Personal communication with Carrie McDaniel, August 29,2002.

Niklitschek, E.J. 2001. Bioenergenetic modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons in Chesapeake Bay. Ph.D. thesis. University of Maryland, College Park, Maryland.

Normandeau Associates, Inc. 2001. Bath Iron Works Dredged Monitoring Results. October 2001.

O'Herron, J. C., K. W. Able, and R. W. Hastings. 1993. Movements of SNS (*Acipenser brevirostrum*) in the Delaware River. Estuaries 16:235-240.

Orth, R.J., J.F. Nowak, D.J. Wilcox, J.R. Whiting, and L.S. Nagey. 1998. Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Tributaries and the Coastal Bays-1997. VIMS #138.

Pottle & Dadswell. 1979. Studies on larval and juvenile shortnose sturgeon (*Acipenser brevirostrum*). Report to Northeast Utilities Service Company, Hartford, Connecticut.

Richmond, A. M., and B. Kynard. 1995. Ontogenetic behavior of shortnose sturgeon. Copeia 1995: 172-182.

Rogers, S. G., and W. Weber. 1994. Occurrence of shortnose sturgeon (*Acipenser brevirostrum*) in the Ogeechee-Canoochee river system, Georgia during the summer of 1993. Final Report of the United States Army to the Nature Conservancy of Georgia.

Rogers, S.G., and W. Weber. 1995a. Movements of SNS in the Altamaha River system, Georgia. Contributions Series #57. Coastal Resources Division, Georgia Department of Natural Resources, Brunswick, Georgia.

Rogers, S.G., and W. Weber. 1995b. Status and restoration of Atlantic and SNSs in Georgia. Final Report to NMFS 9A46FA102-01, Georgia Department of Natural Resources, Brunswick, Georgia.

Savoy, T. and D. Shake. 2000. Atlantic sturgeon, *Acipenser oxyrinchus*, movements and important habitats in Connecticut waters. Biology, Management, and Protection of Sturgeon Symposium Pre-Print. EPRI. Palo Alto, CA.

Savoy, T. and D. Shake. 1992. Sturgeon status in Connecticut Waters. Final Report to the NMFS, Gloucester, Massachusetts.

Sbikin, Yu. N., N.I. Bibikov. 1988. The Reaction of Juvenile Sturgeons to Elements of Bottom Topography. Voprosy Ikhtiologii, No. 3, pp. 473-477.

Schubel, J.R. 1968. Suspended Sediment of the Northern Chesapeake Bay. Baltimore, Maryland: Chesapeake Bay Institute, the Johns Hopkins University.

Schubel, J.R and D.W. Pritchard. 1986. Responses of the Upper Chesapeake Bay to Variations in Discharge of the Susquehanna River. Estuaries 9 (4A, December); 236-249.

Secor, D.H., and E.J. Niklitschek. 2001. Hypoxia and Sturgeons. Report to the Chesapeake Bay Program Dissolved Oxygen Criteria Team. Technical Report Series No. TS-314-01-CBL. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science. March 29, 2001.

Secor, D.H., E. Niklitschek, J.T. Stevenson, T.E. Gunderson, S. Minkkinen, B. Florence, M. Mangold, J. Skjeveland and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic sturgeon *Acipensar oxyrinchus* release into the Chesapeake Bay. *Fisheries Bulletin* 98 (4): 800-810.

Setzler-Hamilton, E.M. 1987. Utilization of Chesapeake Bay by early life history stages of fishes. pp. 64-93. In: Contamination Problems and Management of Living Chesapeake Bay Resources (S.K. Majumdar, L.W. Hall and H.M. Austin, eds.). American Association for the Advancement of Science.

Smith, T. I. J., M. R. Collins, and E. Kennedy. 1992. Identification of critical habitat requirements of SNS in South Carolina. Final Report to the U.S. Fish and Wildlife Service, Project No. AFS-17.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. An Atlantic Coastal Fisheries Cooperative Management Act Report for National Marine Fisheries Service by the USFWS. Fiscal Year 1998.

Squiers, T.S. and M. Smith. 1979. Distribution and abundance of shortnose sturgeon in the Kennebec River Estuary. Final Report to the National Marine Fisheries Service, Gloucester, Massachusetts.

Squiers, T.S.. 1982. Evaluation of the 1982 spawning run of SNS (*Acipenser brevirostrum*) in the Androscoggin River, Maine. Final Report to Central Maine Power Company, Augusta, Maine.

Taubert, B. D. 1980. Reproduction of SNS, *Acipenser brevirostrum*, in the Holyoke Pool, Connecticut River, Massachusetts. Copeia 1980:114-117.

Taylor, A.C. 1990. The hopper dredge. In: Dickerson, D.D. and D.A. Nelson (Comps.); Proceedings of the National Workshop on Methods to Minimize Dredging Impacts on Sea Turtles, 11-12 May 1988, Jacksonville, Florida. Miscellaneous Paper EL-90-5. Department of the Army, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. February 1990. Pp. 59-63.

Uhler, P.R. and Otto Lugger. 1876. List of Fishes of Maryland. Report of the Commissioners of Fisheries of Maryland. John F. Wiley, Printer. Annapolis, MD.

University of Maryland Center for Environmental Science (UMCES). 1995. Sparrows Point Shoreline Reclamation Project Fish and Crab Survey. Prepared for the Maryland Environmental Service by the University of Maryland Center for Environmental and Estuarine Studies. June 1995.

U.S. Army Corps of Engineers, Philadelphia District (USACE -CENAP). Personal Communication with Walter DePrefontaine.

U.S. Army Corps of Engineers, Philadelphia District (USACE -CENAP). 1996. Chesapeake and Delaware Canal-Baltimore Harbor Connecting-Channels (Deepening) Delaware and Maryland. Final Feasibility Study and Environmental Impact Statement. August 1996.

U.S. Army Corps of Engineers, New England District. (USACE-CENAE). 1997a. Biological Assessment for SNS in the Kennebec River, in Bath, Maine. Submitted to: National Marine Fisheries Service.

U.S. Army Corps of Engineers, Philadelphia District (USACE -CENAP). 1997b. Personal Communication with Walter DePrefontaine, December 11, 1997.

U.S. Army Corps of Engineers, Philadelphia District (USACE-CENAP). 1998. Personal Communication with Walter DePrefontaine, May 22, 1998.

U.S. Army Corps of Engineers, Baltimore District (USACE-CENAB). 1999. Draft Environmental Impact Statement for Proposed Open-water Placement of Dredged Material at Site 104. Draft Environmental Impact Statement. February 1999.

U.S. Army Corps of Engineers, Philadelphia District (USACE-CENAB). 2003. Personal Communication with Jeff McKee. 2003.

U.S. Army Corps of Engineers, Baltimore District (USACE–CENAB). 2003. Personal Communication with Kevin Mainquist, April 28, 2003.

U.S. Army Corps of Engineers (US.ACE) and Maryland Port Administration (MPA). 1996. Poplar Island, Maryland Environmental Restoration Project Integrated Feasibility Report and Environmental Impact Statement. February 1996.

U.S. Department of Transportation (USDOT/FHWA). 1979. Environmental Assessment of Dredging and Spoil Disposal Technical Report 1. Fort McHenry Interstate Route 95. Prepared by EA Engineering for the Maryland Port Administration.

U.S. Department of Interior (USDOI). 1973. Threatened Wildlife of the US Resource Publication 114, March 1973.

U.S. Fish and Wildlife Service (USFWS). 1997. Personal Communication with Mike Mangold. January 6, 1997.

U.S. Fish and Wildlife Service (USFWS). 1999. Personal Communication with Mike Mangold. November 26, 1999.

U.S. Fish and Wildlife Service (USFWS). 2000a. Personal Communication with Mike Mangold. April 4, 2000.

U.S. Fish and Wildlife Service (USFWS). 2000b. A Report of Investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay. Maryland Fisheries Resource Office. October 2000.

U.S. Fish and Wildlife Service (USFWS). 2003. Personal Communication with Mike Mangold. January 10, 2003.

Versar, Inc. 1990. Impact Assessment of Craighill Channel Dredged Material Placement in the Deep Trough. Prepared for Maryland Department of Natural Resources, Power Plant & Environmental Review Division. March 1990.

Versar, Inc. 1994a. Assessment of Benthic Community Conditions at a proposed Wetland Creation Area in the Vicinity of Sparrows Point, Baltimore Harbor. December 1994. Prepared for the Maryland Environmental Service and the Chesapeake Bay and Watershed Management Administration of the Maryland Department of the Environment.

Versar, Inc. 1994b. Zooplankton Survey Sparrows Point Shoreline Reclamation Project. December 1994. Prepared for the Maryland Department of the Environment.

Washburn and Gillis Associates LTD. 1981. Studies of the Early Life History of the SNS (*Acipenser brevirostrum*). Final Report to the Northeast Utilities Service Company. 120 pp.

Weston Solutions, Inc. 2002a. Final Report: Preliminary Assessment of Environmental Conditions on Barren Island Dorchester County, Maryland. April 16, 2002.

Weston Solutions, Inc. 2002b. Final Consolidated Report Reconnaissance of the Proposed Environmental Restoration Project Near Barren Island Dorchester County, Maryland. August 2002.

Weisberg, S.B., J.A. Ranasinghe, D.M. Dauer, L.C. Schaffner, R.J. Diaz, and J.B. Frithsen. 1997. An estuarine benthic index of biotic integrity (B-IBI) for the Chesapeake Bay. 1998. Estuaries 20 (1): 149-158.

Welsh, S.A., J.E. Skjeveland, M.F. Mangold and S.M. Eyler. 2000. Distributions of wild and hatchery-reared Atlantic sturgeon in the Chesapeake Bay, Maryland. *Biology, Management, and Protection of Sturgeon Symposium*. Preprint. EPRI. Palo Alto, California.

Wirgin, I., C. Grunwald, E. Carlson, J. Stabile, J. Waldman. 2002. Range-Wide Population Structure of Shortnose Sturgeon (*Acipenser brevirostrum*) Using Mitochondrial DNA Control Region Sequence Analysis. Submitted to Fishery Bulletin December 31, 2002. 37 pages.

Appendix A

A-1: Shortnose Sturgeon and
A-2: Wild Atlantic Sturgeon Captures

From the USFWS Reward Program
(Last updated September 30, 2003)

Table A-1 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Depth (feet)	Capture Site	Gear	Latitude	Longitude	Length-mm	Tag
1996	April 4	Susquehanna Flats	-	Elk Neck	Pound Net	39.30.150	75.59.400	692	-
	April 4	Susquehanna Flats	-	Elk Neck	Pound Net	39.30.150	75.59.400	815	-
	April 4	Chesapeake Bay	-	APG	Pound Net	39.26.900	75.59.400	726	-
	May 7	Chesapeake Bay	-	Kent Island	Pound Net	38.53.640	76.22.512	940	-
	May 14	Chesapeake Bay	-	Kent Island	Pound Net	38.56.900	76.21.900	785	-
	May 17	Potomac River	-	Mouth Potomac Creek	Pound Net	38.21.000	77.17.000	800	*
	June 12	Chesapeake Bay	-	Turkey Point	Catfish Trap	39.25.000	76.01.000	890	*
1997	January 7	Chesapeake Bay	-	N. Millers Island	Gill Net	39.16.150	76.21.500	850	*
	April 10	Chesapeake Bay	-	Rocky Point	Pound Net	39.29.300	76.00.000	860	-
	April 20	Chesapeake Bay	-	Rocky Point	Pound Net	39.29.300	76.00.000	790	-
	April 24	Susquehanna River	-	I-95 Bridge	Hoop Net	39.34.600	76.06.300	930	*
	December 5	Chesapeake Bay	-	Mouth Sassafras River	Gill Net	39.23.400	76.03.900	840	*
	December 5	Chesapeake Bay	-	APG	Gill Net	39.25.000	76.05.500	730	*
	December 9	Chesapeake Bay	12-14'	Howell Pt	Gill Net	39.22.500	76.08.400	1030	*
	December 9	Chesapeake Bay	12-14'	Howell Pt.	Gill Net	39.22.500	76.08.400	850	*
	December 9	Chesapeake Bay	12-14'	Howell Pt.	Gill Net	39.22.500	76.08.400	990	*
	December 30	Elk River	25'	Grove Pt.	Gill Net	39.24.800	76.02.000	950	*
1998	January 19	Chesapeake Bay	10'	Howell Pt.	Gill Net	39.23.000	76.07.500	955	*
	January 22	Chesapeake Bay	12-14'	Howell Pt.	Gill Net	39.22.500	76.08.400	980	*
	February 26	Bohemia River	8'	Veazey's Cove	Gill Net	39.28.600	75.55.000	478	J*
	March 24	Bohemia River	4'	Veazey's Cove	Fyke Net	39.28.600	75.54.400	445	J*
	April 3	Chesapeake Bay	-	APG-W. of Delphs Creek	Fyke Net	39.24.100	76.09.800	395	J*
	April 18	Chesapeake Bay	-	APG-Sandy Pt.	Fyke Net	39.26.800	76.03.800	384	J*
	April 21	Potomac River	-	Mouth of St. Mary's	Pound Net	38.05.465	76.25.203	875	*
	April 22	Chesapeake Bay	-	Worton Point	Gill Net	39.19.400	76.11.200	410	J*
	April 23	Chesapeake Bay	-	Worton Point	Eel trap	39.19.500	76.11.900	432	J*
	April 23	Chesapeake Bay	-	APG-Taylors Island	Fyke net	39.23.000	76.10.200	527	*
	April 28	Susquehanna River	-	Port Deposit and I-95 Bridge	Catfish Trap	39.35.300	76.06.300	680	*
	April 30	Chesapeake Bay	-	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	712	*
1999	February 5	Chesapeake Bay	12'	APG-Cherry Tree Point	Gill Net	39.24.500	76.06.500	643	*
	February 11	Sassafrass River	18	Knights Island	Gill Net	39.22.500	75.57.000	643	-, recap
	February 19	Susquehanna River	-	Port Deposit	Gill Net	39.36.150	76.07.000	743	*

Table A-1 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Depth (feet)	Capture Site	Gear	Latitude	Longitude	Length-mm	Tag
	June 8	Fishing Bay	-	Stradding Point	Pound Net	38.13.900	76.02.000	895	*
2000	January 2	Chesapeake Bay	32	Holland Point	Gill Net	38.43.400	76.30.000	757	*
	February 24	Chesapeake Bay	13’	Btwn Grove Pt. & APG	Gill Net	39.23.800	76.06.500	820	*
	February 28	Chesapeake Bay	17’	Btwn Hart-Miller & Pooles Island	Gill Net	39.14.800	76.19.500	643	*
	April 7	Chesapeake Bay	4’	Mouth of Romney Creek	Fyke Net	39.22.200	76.10.700	991	
	April 11	Chesapeake Bay	6’	Black Marsh, Mouth of Patapsco	Fyke Net	39.13.300	76.24.600	610	
	May 3	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	37.54.800	76.15.100	1219	
	May 19	Chesapeake Bay		North of Barren Island	Pound Net	38.25.000	76.19.500	2438	**
	June 5	Hoopers Straits		Crocheron	Pound Net	38.12.400	76.00.300	2134	**, recap
	December 19	Chesapeake Bay		South of Tolchester	Gillnet	39.11.600	76.15.800	1067	
2001	February 6	Susquehanna River	60’	Railroad Bridge near Perryville	Catfish Trap	39.33.250	76.04.900	991	
	February 17	Susquehanna River	60’	Railroad Bridge near Perryville	Catfish Trap	39.33.250	76.04.900	1448	
	March 11	Chesapeake Bay	25’	Turkey Point	Catfish Trap	39.27.500	76.01.000	838	
	March 26	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	37.55.400	76.16.500	1829	
	December 21	Chesapeake Bay		Howell Pt.	Gillnet	39.22.800	76.07.000	793	
2002	March 8	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	38.20.900	77.16.800	872	
	March 8	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	38.21.000	77.17.000	860	
	June 5	Susquehanna R.	60’	Railroad Bridge near Perryville	Catfish Trap	39.33.250	76.04.900	-	
2003	March 4	Susquehanna R.		Above 95 Bridge 25' str.	Catfish Trap	39.35.150	76.06.100	-	
	March 17	Susquehanna R.		Above 95 Bridge 18’ wtr.	Catfish Trap	39.35.200	76.06.500	-	
	April 21	Chesapeake Bay		Aberdeen	Fyke Net	39.24.100	76.09.800	-	
	May 22	Chesapeake Bay		Cedar Point Hollow	Pound Net	38.14.200	76.23.100	-	

Key: (-) not recorded; (*) tagged, (J) possible juvenile, (**) lost sonic tag

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1996	February 15	Potomac River	Colonial Beach	Gillnet	38.17.500	76.59.100	1139
	February 20	Severn River	N. of Severn R. Bridge	Gillnet	39.00.600	76.30.900	1160
	March 25	Whitehall Bay	Hacketts Point	Gillnet	38.58.500	76.26.900	884
	April 13	Chesapeake Bay	Smith Island	Crab pot	37.59.400	76.04.400	1030
	April 18	Susquehanna Flats	Elk Neck	Pound Net	39.28.600	76.00.100	915
	May 14	Chesapeake Bay	Kent Island	Pound Net	38.56.900	76.21.900	870
	May 14	Chesapeake Bay	Kent Island	Pound Net	38.53.900	76.23.150	915
	May 31	Chesapeake Bay	Elk Neck	Pound Net	39.30.150	75.59.600	510
	May 31	Chesapeake Bay	Kent Island	Pound Net	38.52.150	76.22.900	600
	June 13	Chesapeake Bay	N. of Point no Point	Pound Net	38.10.900	76.20.900	874
	June 22	Chesapeake Bay	Kent Island	Pound Net	38.53.900	76.23.150	685
	November 1	Chesapeake Bay	Love Point	Pound Net	38.02.150	76.17.900	895
	December 10	Potomac River	Ophelia (VA)	Pound Net	37.55.150	76.16.900	953
	December 18	Chesapeake Bay	N. of Tip of Millers Island	Gillnet	39.16.150	76.21.500	700
1997	February 14	Chesapeake Bay	Kent Island	Gillnet	38.54.000	76.26.000	960
	April 21	Potomac River	Sandy Point	Pound Net	38.04.500	76.31.700	1500
	April 28	Fishing Bay	Stradding Point	Pound Net	38.13.600	76.02.000	815
	May 9	Chesapeake Bay	Kent Island	Pound Net	38.53.900	76.23.150	815
	May 19	Chesapeake Bay	N. of Bay Bridge	Pound Net	39.00.000	76.20.200	851
	May 20	Potomac River	4 miles off of Grays Point	Pound Net	38.05.350	76.24.750	1068
	May 22	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	1740
	May 31	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.22.200	76.18.500	995
	June 4	Fishing Bay	Bishops Head	Pound Net	38.15.700	76.02.000	1020
	June 5	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.11.000	1030
	June 15	Chesapeake Bay	N. of Bay Bridge	Pound Net	39.00.000	76.20.200	820
	June 24	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	910
	September 16	Pocomoke River	Pocomoke River	Trawl	37.59.972	75.37.222	950
	November 3	Chesapeake Bay	Hacketts Point	Gillnet	39.59.300	76.24.500	900
	October 28	Fishing Bay	Clay Island	Pound Net	38.14.000	76.59.000	930
	November 10	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	1526
	December 9	Chesapeake Bay	Cove Point	Gillnet	38.27.000	76.22.500	850

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1997	December 15	Chesapeake Bay	Cove Point	Gillnet	38.23.400	76.22.500	860
	December 15	Chesapeake Bay	Point no Point	Gillnet	38.07.200	76.13.200	860
	December 24	Chesapeake Bay	S. of Hooper Island Lt.	Gillnet	38.14.000	76.15.500	905
	December 24	Chesapeake Bay	S. of Hooper Island Lt.	Gillnet	38.14.000	76.15.500	830
	December 24	Chesapeake Bay	S. of Hooper Island Lt.	Gillnet	38.14.000	76.15.500	880
	December 24	Chesapeake Bay	S. of Hooper Island Lt.	Gillnet	38.14.000	76.15.500	1215
	December 29	Chesapeake Bay	Cove Point	Gillnet	38.23.400	76.22.500	856
1998	January 2	Chesapeake Bay	N. of Hooper Island Lt.	Gillnet	38.16.000	76.17.000	884
	January 5	Chesapeake Bay	Cove Point	Gillnet	38.26.000	76.22.200	804
	January 5	Chesapeake Bay	S. of Hooper Island Lt.	Gillnet	38.14.000	76.15.500	841
	January 5	Chesapeake Bay	Cove Point	Gillnet	38.25.000	76.21.300	1040
	January 7	Chesapeake Bay	Cove Point	Gillnet	38.25.000	76.25.300	839
	January 7	Chesapeake Bay	Cove Point	Gillnet	38.25.000	76.21.000	976
	January 13	Chesapeake Bay	Cove Point	Gillnet	38.26.000	76.22.000	900
	January 29	Chesapeake Bay	Kent Island	Gillnet	38.55.000	76.24.500	824
	January 29	Chesapeake Bay	Barren Island	Gillnet	38.16.000	76.18.200	1121
	February 16	Chesapeake Bay	Tolchester Marina	Gillnet	39.12.300	76.16.000	931
	February 26	Chesapeake Bay	Tolchester Marina	Gillnet	39.13.000	76.15.000	670
	April 15	Fishing Bay	Bishops Head	Pound Net	38.15.700	76.02.000	710
	April 21	Potomac River	Mouth of St. Mary's River	Pound Net	38.05.606	76.25.095	659
	April 21	Potomac River	Mouth of St. Mary's River	Pound Net	38.05.465	76.25.203	620
	April 21	Potomac River	Virginia Shore	Pound Net	37.59.586	76.25.196	550
	April 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	573
	April 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	590
	April 22	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.20.640	76.17.708	635
	April 22	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.20.640	76.17.708	972
	April 22	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	700
	April 22	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	645
	April 22	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	2413
	April 22	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	663
	April 22	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	935

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	April 23	Chesapeake Bay	Off of Barren Island	Pound Net	38.19.700	76.16.700	885
	April 23	Hooper Straits	Hooper Straits	Pound Net	38.12.800	76.04.200	572
	April 23	Hooper Straits	Hooper Straits	Pound Net	38.12.800	76.04.200	680
	April 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	612
	April 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	635
	April 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	705
	April 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	562
	April 30	Chesapeake Bay	Off of Barren Island	Pound Net	38.19.700	76.16.700	529
	May 4	Fishing Bay	Stradding Point	Pound Net	38.13.900	76.02.000	611
	May 7	Chesapeake Bay	Deale/Parker Cr.	Pound Net	38.46.600	76.31.900	590
	May 10	Severn River	Severn River Channel	Gillnet	38.58.000	76.27.500	1090
	May 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	639
	May 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	662
	May 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.20.640	76.17.708	881
	May 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	881
	May 12	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	703
	May 12	Chesapeake Bay	Off of Barren Island	Pound Net	38.19.700	76.16.700	523
	May 13	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	608
	May 13	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	562
	May 14	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	635
	May 14	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	655
	May 14	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	445
	May 14	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	606
	May 20	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	935
	May 20	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	900
	May 20	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	641
	May 20	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	645
	May 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	972
	May 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	665
	May 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	590
	May 25	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	610

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	May 25	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	668
	May 25	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	1306
	May 25	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	627
	May 25	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	629
	May 27	Chesapeake Bay	Kent Island	Pound Net	38.54.000	76.23.000	582
	May 27	Chesapeake Bay	Kent Island	Pound Net	38.54.000	76.23.000	700
	June 2	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	629
	June 2	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	649
	June 2	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	703
	June 2	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	675
	June 2	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	776
	June 2	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	631
	June 2	Chesapeake Bay	Off of Barren Island	Pound Net	38.19.700	76.16.700	540
	June 5	Chesapeake Bay	Tilghman Island	Pound Net	38.41.000	76.22.000	662
	June 8	Fishing Bay	Clay Island	Pound Net	38.13.000	76.01.600	702
	June 8	Fishing Bay	Clay Island	Pound Net	38.13.000	76.01.600	690
	June 8	Fishing Bay	Clay Island	Pound Net	38.13.000	76.01.600	730
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.21.492	76.17.352	700
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.21.492	76.17.352	628
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.21.492	76.17.352	700
	June 8	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	665
	June 8	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	680
	June 8	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	585
	June 8	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	655
	June 8	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	649
	June 8	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	663
	June 8	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	645
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	602
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	805
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	616
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	663

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	738
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	780
	June 8	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	613
	June 9	Hooper Strait	Hooper Strait	Pound Net	38.12.800	76.04.200	582
	June 9	Hooper Strait	Hooper Strait	Pound Net	38.12.800	76.04.200	635
	June 9	Hooper Strait	Hooper Strait	Pound Net	38.13.000	76.06.000	770
	June 10	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	923
	June 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	7800
	June 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	670
	June 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	715
	June 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	690
	June 11	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	625
	June 11	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	690
	June 11	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	740
	June 11	Chesapeake Bay	N. of Barren Island	Pound Net	38.21.492	76.17.352	609
	June 12	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	720
	June 12	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	745
	June 12	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	715
	June 12	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	700
	June 12	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	650
	June 12	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	562
	June 12	Chesapeake Bay	Off Taylors Island	Pound Net	38.31.000	76.18.000	700
	June 12	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	670
	June 12	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	625
	June 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.22.239	76.17.602	663
	June 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.22.239	76.17.602	740
	June 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.20.659	76.17.731	930
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	766
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	646
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	668
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	661

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	990
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	770
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	679
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	636
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	730
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	688
	June 15	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	682
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	634
	June 15	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	620
	June 15	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	660
	June 15	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	645
	June 15	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	768
	June 16	Chesapeake Bay	Kent Island	Pound Net	38.54.000	76.23.000	640
	June 18	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	633
	June 18	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	646
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	713
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	963
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	729
	June 22	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	831
	June 22	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500.	657
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	696
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	731
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	746
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	651
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	804
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	694
	June 22	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	695
	June 22	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	930
	June 22	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	732
	June 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	749
	June 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	713

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	June 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	633
	June 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	635
	June 22	Hooper Strait	Hooper Strait	Pound Net	38.12.400	76.00.300	730
	June 22	Hooper Strait	Hooper Strait	Pound Net	38.12.800	76.04.200	705
	June 22	Hooper Strait	Hooper Strait	Pound Net	38.12.800	76.04.200	742
	June 26	Chesapeake Bay	Deale/Parker Cr.	Pound Net	38.46.708	76.31.424	640
	June 26	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	712
	June 29	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	690
	June 29	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	654
	June 29	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	620
	June 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	565
	June 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	580
	June 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	640
	June 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	645
	June 30	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	625
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	700
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	753
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	735
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	675
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	696
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	656
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	667
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	680
	June 30	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	674
	June 30	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	715
	June 30	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	734
	July 15	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	613
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	690
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	846
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	670
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	600

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	702
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	715
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	735
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	594
	July 15	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	660
	July 28	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	629
	July 28	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	750
	July 28	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	620
	July 28	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	650
	August 3	Little Choptank R.	3/4 mile E. of James Island	Pound Net	38.30.300	76.19.500	842
	August 7	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	670
	August 7	Fishing Bay	Bishops Head	Pound Net	38.14.000	76.01.000	640
	October 21	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	839
	October 28	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	842
	November 2	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	840
	November 2	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	825
	November 7	Potomac River	Sandy Point	Gillnet	38.29.000	77.17.000	841
	November 10	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	677
	November 10	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	675
	November 10	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	738
	November 10	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	710
	November 10	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	655
	November 10	Potomac River	Ophelia (VA)	Pound Net	37.54.200	76.14.200	775
	November 13	Chester River	S. of Eastern Neck Island	Pound Net	39.00.000	76.13.100	720
	November 16	Chesapeake Bay	Belvedere Shoals	Gillnet	39.07.000	76.22.000	860
	November 16	Potomac River	Split Rock	Pound Net	38.22.200	77.17.200	850
	November 25	Chesapeake Bay	S. of Ches. Bay Bridge	Gillnet	38.58.000	76.23.000	747
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	710
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	791
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	716
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	732

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1998	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	760
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	785
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	722
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	702
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	793
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	770
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	807
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	777
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	716
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	827
	December 1	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	766
	December 1	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	880
	December 1	Chesapeake Bay	Off of Barren Island	Pound Net	38.18.302	76.16.500	714
	December 1	Chesapeake Bay	Off of Barren Island	Pound Net	38.19.700	76.16.700	782
	December 2	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	658
	December 2	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	820
	December 2	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	790
	December 9	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	860
	December 9	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	760
	December 17	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	780
	December 15	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	942
1999	January 1	Chesapeake Bay	Cove Point	Gillnet	38.23.400	76.22.500	834
	January 1	Chesapeake Bay	Cove Point	Gillnet	38.23.400	76.22.500	747
	January 1	Chesapeake Bay	Cove Point	Gillnet	38.23.400	76.22.500	766
	January 8	Chesapeake Bay	Cove Point	Gillnet	38.25.000	76.21.000	757
	January 8	Chesapeake Bay	Cove Point	Gillnet	38.25.000	76.21.000	777
	January 11	Chesapeake Bay	Gas Buoy	Gillnet	38.44.800	76.26.800	944
	January 15	Chesapeake Bay	S. of Bay Bridge	Gillnet	38.58.500	76.23.300	1337
	January 25	Chesapeake Bay	Near APG	Gillnet	39.23.000	76.07.200	1475
	January 28	Chesapeake Bay	Gas Buoy	Gillnet	38.44.500	76.26.500	775
	February 9	Pocomoke Sound	Btwn Saxes & Marumsco	Gillnet	37.56.700	75.43.800	968

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1999	February 11	Chesapeake Bay	Chesapeake Beach	Gillnet	38.41.300	76.29.800	736
	February 11	Patapsco River	Bodkin Point	Gillnet	39.10.000	76.26.000	1380
	February 22	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	825
	February 23	Chesapeake Bay	N. of Power Plant	Gillnet	38.28.000	76.23.000	805
	February 17	Chesapeake Bay	Btwn H.I.L. & Patuxent R.	Gillnet	38.17.000	76.17.600	834
	February 25	Chesapeake Bay	Btwn H.I.L. & Patuxent R.	Gillnet	38.17.000	76.17.600	785
	February 25	Chesapeake Bay	Btwn H.I.L. & Patuxent. R.	Gillnet	38.17.000	76.17.600	815
	March 1	Chesapeake Bay	N. of Power Plant	Gillnet	38.28.000	76.23.000	760
	March 2	Chesapeake Bay	Btwn Barren Isld & Cove Pt.	Gillnet	38.17.000	76.17.600	805
	March 3	Chesapeake Bay	S. of Hooper Island Lt.	Gillnet	38.14.000	76.15.500	845
	March 5	Chesapeake Bay	N. of Power Plant	Gillnet	38.28.000	76.23.000	852
	March 8	Chesapeake Bay	Cove Point	Gillnet	38.25.800	76.21.400	630
	March 10	Chesapeake Bay	Gas Docks	Gillnet	38.28.000	76.22.900	730
	March 12	Chesapeake Bay	N. of Cove Point Buoy	Gillnet	38.28.500	76.23.900	670
	March 12	Chesapeake Bay	Mattapeake	Gillnet	38.57.900	76.22.900	960
	March 12	Chesapeake Bay	Off James Island	Gillnet	38.33.200	76.21.700	803
	March 15	Potomac River	Lower Cedar Point	Gillnet	38.20.400	76.59.200	950
	April 5	Chesapeake Bay	Btwn Gas Buoy & Holland Pt	Gillnet	38.44.000	76.28.700	760
	April 12	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	940
	April 12	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	866
	April 12	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	735
	April 20	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	605
	April 20	Hooper Straits	Hooper Straits	Pound Net	38.12.400	76.00.300	724
	April 23	Nanticoke River	Middleground	Pound Net	38.15.400	75.55.700	847
	April 26	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	905
	April 26	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	1695
	April 26	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	935
	April 26	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	700
	April 29	Fishing Bay	1/2 mile S. of Clay Island	Pound Net	38.13.300	75.58.500	673
	April 27	Hooper Straits	Hooper Straits	Pound Net	38.13.100	76.04.100	840
	April 27	Hooper Straits	Hooper Straits	Pound Net	38.13.100	76.04.100	730

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1999	May 4	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	900
	May 4	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	676
	May 4	Chesapeake Bay	N. of Barren Island	Pound Net	38.24.100	76.19.500	820
	May 6	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	801
	May 6	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	763
	May 6	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	736
	May 6	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	797
	May 6	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	905
	May 10	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	820
	May 10	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	1200
	May 10	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	900
	May 10	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	2420
	May 15	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	950
	May 15	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	943
	May 17	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	885
	May 18	Fishing Bay	Stradding Pt.	Pound Net	38.13.900	76.02.000	880
	May 18	Fishing Bay	Stradding Pt.	Pound Net	38.13.900	76.02.000	756
	May 18	Fishing Bay	Stradding Pt.	Pound Net	38.13.900	76.02.000	880
	May 19	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	771
	May 19	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	731
	May 21	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	762
	May 22	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	780
	May 26	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	765
	May 26	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	862
	May 26	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	938
	May 26	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	815
	May 26	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	797
	May 26	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	867
	May 23	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	890
	May 21	Hooper Straits	Hooper Straits	Pound Net	38.12.700	76.02.800	885
	May 21	Hooper Straits	Hooper Straits	Pound Net	38.12.700	76.02.800	831

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1999	May 28	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	889
	May 28	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	925
	May 29	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	590
	May 28	Hooper Straits	Hooper Straits	Pound Net	38.12.700	76.02.800	798
	May 28	Holland Straits	Hooper Straits	Pound Net	38.06.700	76.04.700	804
	May 29	Holland Straits	Hooper Straits	Pound Net	38.06.700	76.04.700	855
	May 29	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	891
	May 29	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	918
	May 29	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	797
	June 1	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	865
	June 1	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	797
	June 1	Chesapeake Bay	Adams Island	Pound Net	38.08.800	76.06.600	781
	May 28	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	885
	May 28	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	720
	May 28	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	985
	May 28	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	881
	May 31	Chesapeake Bay	Off Bloodsworth Island	Pound Net	38.11.800	76.06.400	950
	May 31	Chesapeake Bay	Off Bloodsworth Island	Pound Net	38.11.800	76.06.400	820
	June 1	Chesapeake Bay	Off Barren Island	Pound Net	38.22.110	76.22.56	1830
	June 2	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	775
	June 4	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	833
	June 4	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	907
	June 4	Hooper Straits	Hooper Straits	Pound Net	38.12.700	76.02.800	890
	June 5	Hooper Straits	Hooper Straits	Pound Net	38.12.700	76.02.800	930
	June 5	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	935
	June 5	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	666
	June 5	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	753
	June 7	Nanticoke River	Middleground	Pound Net	38.15.400	75.55.700	791
	June 8	Fishing Bay	Thorofare Trape	Pound Net	38.18.500	76.01.800	828
	June 14	Chesapeake Bay	Adams Island	Pound Net	38.08.800	76.06.600	855
	June 15	Chesapeake Bay	Off Barren Island	Pound Net	38.22.110	76.22.56	803

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
1999	June 15	Fishing Bay	Stradding Pt.	Pound Net	38.13.900	76.02.000	890
	June 15	Fishing Bay	Bishops Head	Pound Net	38.13.000	76.01.600	885
	June 15	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	786
	June 15	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	810
	June 15	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	832
	June 18	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	950
	June 18	Chesapeake Bay	N.W. of Barren Island	Pound Net	38.21.492	76.17.352	851
	June 18	Chesapeake Bay	Richland Point	Pound Net	38.16.000	76.15.500	731
	June 18	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	900
	June 18	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	872
	June 21	Chesapeake Bay	Off Bloodsworth Island	Pound Net	38.11.800	76.06.400	900
	June 21	Hoopers Straits	Hoopers Straits	Pound Net	38.13.100	76.04.100	809
	June 21	Fishing Bay	Stradding Point	Pound Net	38.13.900	76.02.000	773
	June 24	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	851
	June 25	Fishing Bay	Stradding Point	Pound Net	38.13.900	76.02.000	768
	June 26	Chesapeake Bay	Swan Point	Pound Net	39.09.000	76.17.500	830
	July 7	Pocomoke Sound	Pocomoke Sound	Pound Net	37.57.800	75.41.500	899
	July 8	Hoopers Strait	Hoopers Straits	Pound Net	38.13.100	76.04.100	770
	July 19	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.12.000	842
	July 22	Chesapeake Bay	N. of Barren Island	Pound Net	38.25.000	76.19.500	760
	August 31	Chesapeake Bay	North Pt. Fort Howard	Pound Net	39.11.600	76.26.000	845
	September 22	Chesapeake Bay	Swan Point	Pound Net	39.09.000	76.17.500	839
	October 1	Chesapeake Bay	Swan Point	Pound Net	39.09.000	76.17.500	970
	October 7	Pocomoke Sound	Pocomoke Sound	Pound Net	37.57.800	75.41.500	920
	December 8	Chesapeake Bay	Grove Point	Drift Gill Net	39.24.800	76.02.000	630
	December 27	Chesapeake Bay	N. of Gas Buoy	Gillnet	38.47.200	76.26.500	630
2000	February 8	Chesapeake Bay	Calvert Cliffs	Drift Gill Net	38.26.000	76.24.000	980
	February 8	Chesapeake Bay	Calvert Cliffs	Drift Gill Net	38.26.000	76.24.000	1075
	February 8	Chesapeake Bay	Cove Pt.	Drift Gill Net	38.23.300	76.21.500	882
	February 8	Chesapeake Bay	Cove Pt.	Drift Gill Net	38.23.300	76.21.500	1011
	February 10	Chesapeake Bay	Cove Pt.	Drift Gill Net	38.25.000	76.21.000	1102

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
2000	February 14	Chesapeake Bay	Btwn. Grove Pt. & APG	Drift Gill Net	39.23.800	76.06.500	558
	February 16	Chesapeake Bay	Cove Pt.	Drift Gill Net	38.23.300	76.21.500	1358
	February 21	Chesapeake Bay	Poplar Island	Drift Gill Net	38.44.500	76.25.500	792
	February 22	Chesapeake Bay	Chesapeake Beach	Drift Gill Net	38.42.300	76.29.000	1021
	February 26	Chesapeake Bay	Chesapeake Beach	Drift Gill Net	38.41.000	76.30.000	895
	February 26	Chesapeake Bay	Cove Pt.	Drift Gill Net	38.23.300	76.21.500	971
	February 28	Chesapeake Bay	Cove Pt.	Drift Gill Net	38.23.300	76.21.500	815
	March 3	Chesapeake Bay	Chesapeake Beach	Drift Gill Net	38.41.000	76.30.000	825
	March 3	Chesapeake Bay	Breezy Point	Drift Gill Net	38.37.200	76.27.500	790
	March 13	Potomac River	Cedar Pt.	Gillnet	38.19.700	76.58.500	860
	March 15	Potomac River	Mth Piccowaxen Crk.	Gillnet	38.19.200	76.57.000	928
	March 15	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	890
	March 15	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	840
	March 15	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	910
	March 18	Potomac River	Cobb Bar	Gillnet	38.13.800	76.50.500	1014
	March 20	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	720
	March 20	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	768
	March 22	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	941
	April 2	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	825
	April 2	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	806
	April 11	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	784
	April 11	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	799
	April 11	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	717
	April 11	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	772
	April 13	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	905
	April 13	Chesapeake Bay	N.W. of Barren Isl.	Pound Net	38.21.492	76.17.352	910
	April 13	Chesapeake Bay	N.W. of Barren Isl.	Pound Net	38.21.492	76.17.352	939
	April 18	Hoopers Straits		Pound Net	38.12.700	76.02.800	715
	April 18	Hoopers Straits		Pound Net	38.12.700	76.02.800	772
	April24	Chesapeake Bay	Off Baren Island	Pound Net	38.22.110	76.22.560	868
	April 24	Chesapeake Bay	Off Baren Island	Pound Net	38.22.110	76.22.560	1005
	May 1	Chesapeake Bay	Off Bloodsworth Isl.	Pound Net	38.11.800	76.06.400	773
	May 1	Chesapeake Bay	Off Baren Island	Pound Net	38.18.302	76.16.500	1076
	May 2	Hoopers Straits		Pound Net	38.13.100	76.04.100	989

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
2000	May 2	Chesapeake Bay	Off Baren Island	Pound Net	38.18.302	76.16.500	767
	May 8	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	875
	May 8	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	772
	May 15	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	745
	May 26	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	910
	May 26	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	1050
	May 29	Hoopers Straits		Pound Net	38.12.400	76.00.300	557
	May 30	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	970
	June 9	Chesapeake Bay	Off Bloodsworth Isl.	Pound Net	38.11.800	76.06.400	1100
	June 10	Fishing Bay	Adams Island	Pound Net	38.08.800	76.06.600	950
	October 13	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	1122
	November 6	Chesapeake Bay	Poplar Isl.	Pound Net	38.45.500	76.21.000	1372
	November 8	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	1036
	November 13	Hoopers Straits		Pound Net	38.12.700	76.02.800	1036
	December 15	Chesapeake Bay	Buoy 14	Gillnet	39.06.400	76.23.000	647
2001	January 11	Chesapeake Bay	Bloody Point	Gillnet	38.50.000	76.25.000	1052
	January 12	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	896
	January 25	Chesapeake Bay	Swan Pt.	Gillnet	39.07.700	76.20.000	1210
	February 1	Chesapeake Bay	Cove Pt.	Gillnet	38.24.000	76.21.000	925
	February 1	Chesapeake Bay	Mth Chester River	Gillnet	39.05.000	76.19.000	1210
	February 5	Potomac River	Buoy 29	Gillnet	38.18.700	76.59.500	855
	February 8	Choptank River	Cook Point	Gillnet	38.38.600	76.17.800	925
	February 16	Choptank River	Chlora Point	Gillnet	38.37.800	76.09.000	925
	February 17	Potomac River	Just North of St. Patricks Crk.	Gillnet	35.12.000	76.45.200	920
	February 19	Potomac River	2 miles off Bonum Crk.	Gillnet	38.07.000	76.34.000	1230
	February 21	Potomac River	Mth Nomini Bay	Gillnet	38.11.000	76.43.700	1050
	February 21	Potomac River	Mth Yeocomico River	Gillnet	38.03.300	76.30.000	1060
	February 23	Potomac River	Mth Popes Creek	Gillnet	38.23.800	77.00.000	875
	February 23	Chesapeake Bay	Calvert Cliffs	Gillnet	38.26.500	76.24.800	921
	February 26	Chesapeake Bay	Off James Isl.	Gillnet	38.30.800	76.23.100	1020
	February 26	Potomac River	Btwn Swan Pt.&Cobb Isl.	Gillnet	38.16.000	76.54.500	853
	March 7	Potomac River	Off Ragged Point	Gillnet	38.09.800	76.36.400	755
	March 8	Potomac River	Mth Nomini Bay	Gillnet	38.11.000	76.43.700	835

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
2001	March 11	Potomac River	Buoy 29	Gillnet	38.18.500	76.59.500	962
	March 12	Potomac River	Mth Nomini Bay	Gillnet	38.10.500	76.44.500	897
	March 12	Potomac River	Cedar Pt.	Gillnet	38.20.500	76.59.200	874
	March 18	Potomac River	Mth Nomini Bay	Gillnet	38.10.500	76.43.500	1020
	March 19	Potomac River	Mth Piccowaxen Crk.	Gillnet	38.19.100	76.56.000	1130
	March 19	Potomac River	Mth Nomini Bay	Gillnet	38.11.000	76.43.700	905
	March 19	Potomac River	Mth Nomini Bay	Gillnet	38.11.000	76.43.700	897
	March 23	Potomac River	Off Ragged Point	Gillnet	38.09.800	76.36.400	885
	March 25	Potomac River	Lower Cedar Pt.	Gillnet	38.20.500	76.58.900	955
	March 26	Potomac River	Ophelia (VA)	Pound Net	37.55.400	76.16.500	1778
	March 28	Potomac River	Mth Yeocomico River	Gillnet	38.02.500	76.29.500	651
	March 28	Potomac River	Mth Yeocomico River	Gillnet	38.02.500	76.29.500	974
	March 31	Pocomoke Sound	Virginia Shore	Gillnet	37.53.200	75.48.200	872
	April 6	Chesapeake Bay	Kent Island	Pound Net	38.54.800	76.22.500	936
	April 7	Chesapeake Bay	Cove Pt.	Pound Net	38.22.500	76.22.500	1102
	April 14	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	662
	April 17	Chesapeake Bay	Richland Point	Pound Net	38.13.900	76.11.300	878
	April 19	Chesapeake Bay	Adams Island	Pound Net	38.08.800	76.06.600	875
	April 19	Chesapeake Bay	Adams Island	Pound Net	38.08.800	76.06.600	750
	April 23	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	1245
	April 23	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	916
	April 23	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	673
	April 23	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	953
	April 23	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	885
	April 19	Chesapeake Bay	Black Walnut Pt.	Pound Net	38.40.200	76.22.200	642
	April 25	Chesapeake Bay	Richland Point	Pound Net	38.14.600	76.12.900	806
	April 26	Chesapeake Bay	Richland Point	Pound Net	38.13.900	76.11.300	990
	April 26	Tangier Sound		Pound Net	38.09.500	76.59.800	880
	May 1	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	876
	May 2	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	880
	May 2	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	845
	May 2	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	800
	May 8	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	825
	May 8	Chesapeake Bay	Cove Pt.	Pound Net	38.22.200	76.22.800	830

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
2001	May 8	Chesapeake Bay	Cove Pt.	Pound Net	38.22.200	76.22.800	885
	May 13	Chesapeake Bay	Off Holland Island	Pound Net	38.07.500	76.07.000	991
	May 14	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	781
	May 16	Honga River	Muddy Hook	Pound Net	38.14.300	76.05.100	752
	May 18	Chesapeake Bay	Kent Island	Pound Net	38.53.800	76.22.700	752
	May 18	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	700
	May 19	Chesapeake Bay	Cove Pt.	Pound Net	38.22.200	76.22.800	620
	May 22	Chesapeake Bay	Richland Point	Pound Net	38.14.600	76.12.900	705
	May 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	615
	May 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	800
	May 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	900
	May 22	Chesapeake Bay	Off Barren Island	Pound Net	38.25.000	76.19.500	850
	May 22	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	725
	May 24	Honga River	Muddy Hook	Pound Net	38.14.300	76.05.100	710
	May 24	Honga River	Muddy Hook	Pound Net	38.14.300	76.05.100	880
	May 24	Chesapeake Bay	Off Barren Island	Pound Net	38.18.302	76.16.500	640
	May 29	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	712
	May 29	Chesapeake Bay	Off Barren Island	Pound Net	38.19.700	76.16.700	670
	May 29	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	858
	May 29	Chesapeake Bay	N. of Barren Isl.	Pound Net	38.25.000	76.19.500	660
	May 31	Chesapeake Bay	Cove Pt.	Pound Net	38.22.200	76.22.800	776
	June 2	Chesapeake Bay	Cove Pt.	Pound Net	38.22.200	76.22.800	632
	June 2	Broadwater Creek		Pound Net	38.47.500	76.31.850	942
	June 4	Chesapeake Bay	Hoopers Isl. Light	Pound Net	38.15.700	76.13.800	715
	June 5	Chesapeake Bay	Richland Point	Pound Net	38.14.600	76.12.900	655
	June 11	Chesapeake Bay	Richland Point	Pound Net	38.13.900	76.11.300	712
	June 15	Chesapeake Bay	Richland Point	Pound Net	38.14.600	76.12.900	653
	June 21	Chesapeake Bay	Richland Point	Pound Net	38.13.900	76.11.300	707
	June 25	Chesapeake Bay	Kent Island	Pound Net	38.53.800	76.22.700	686
	June 26	Chesapeake Bay	Off Baren Island	Pound Net	38.19.700	76.16.700	Not given
	July 16	Chesapeake Bay	Richland Point	Pound Net	38.14.600	76.12.900	758
	August 10	South River	Saunders Point	Gillnet	38.53.700	76.28.900	687
	October 6	Pocomoke Sound	Shelltown	Pound Net	37.57.800	75.41.500	1020
	November 2	Potomac River	Piney Point	Pound Net	38.07.900	76.31.800	1310

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

Year	Date	Water Body	Capture Site	Gear	Latitude	Longitude	Length-mm
2001	November 8	Choptank River	Chlora Point	Gillnet	38.38.100	76.09.200	810
	November 19	Chesapeake Bay	Barren Island	Pound Net	38.19.500	76.17.700	784
	December 12	Chesapeake Bay	Buoy 82	Gillnet	38.43.200	76.27.000	810
	December 12	Chesapeake Bay	Swan Point	Gillnet	39.08.500	76.19.500	933
	December 28	Chesapeake Bay	Cove Point	Gillnet	38.24.000	76.21.000	850
2002	January 1	Chesapeake Bay	Mattapeake	Gillnet	38.58.200	76.22.000	985
	January 1	Chesapeake Bay	Mattapeake	Gillnet	38.58.000	76.22.500	815
	January 22	Chesapeake Bay	Off James Island	Gillnet	38.31.300	76.24.000	1056
	March 23	Potomac River	Off Popes Creek (VA)	Gillnet	38.12.000	76.54.000	952
	April 8	Trippe Bay	Mouth of Choptank River	Pound Net	38.36.500	76.17.200	1010
	April 24	Chesapeake Bay	Off Lower Hoopers Isl.	Pound Net	38.14.800	76.13.500	2273
	May 1	Stradding Pt.	Fishing Bay	Pound Net	38.13.900	76.02.000	921
	May 4	Richland Point	Chesapeake Bay	Pound Net	38.13.700	76.11.200	742
	May 4	Richland Point	Chesapeake Bay	Pound Net	38.13.700	76.11.200	982
	May 9	Off Kent Island	Chesapeake Bay	Pound Net	38.52.400	76.22.700	1663
	May 21	N. of Barren Isl.	Chesapeake Bay	Pound Net	38.25.000	76.19.500	1765
	May 25	Shelltown	Pocomoke Sound	Pound Net	37.57.800	75.41.500	770
	May 28	Off Barren Island	Chesapeake Bay	Pound Net	38.18.302	76.16.500	880
	June 11	Off Barren Island	Chesapeake Bay	Pound Net	38.18.302	76.16.500	1510
	June 17	Richland Point	Chesapeake Bay	Pound Net	38.13.700	76.11.200	650
	June 26	Ophelia (VA)	Potomac River	Pound Net	37.54.800	76.16.100	880
	July 23	Saunders Point	South River	Gillnet	38.54.000	76.29.200	650
	July 29	Bloodsworth Island	Chesapeake Bay	Pound Net	38.12.800	76.03.000	753
	September 18	Muddy Hook	Honga River	Pound Net	38.14.300	76.05.100	1335
	October 22	Off Barren Island	Chesapeake Bay	Pound Net	38.18.302	76.16.500	1200
	October 25	Off Lower Hoopers Isl.	Chesapeake Bay	Pound Net	38.14.800	76.13.500	1550
2003	January 15	Chesapeake Bay	Cove Pt.	Gillnet	38.24.000	76.21.000	1512
	January 16	Chesapeake Bay	Cove Pt.	Gillnet	38.24.000	76.21.000	1505
	February 5	Chesapeake Bay	Black Walnut Pt.	Gillnet	38.38.000	76.20.200	1300
	February 7	Potomac River	Kettle Bottom Shoals	Gillnet	38.13.000	76.53.000	1430
	March 2	Potomac River	Buoy 17	Gillnet	38.14.000	76.51.100	822
	March 4	Pocomoke Sound	Old Rocks	Gillnet	37.57.300	75.41.000	820
	March 5	Potomac River	Below 301 Bridge	Gillnet	38.21.400	76.59.600	1020
	March 7	Potomac River	Cobb Bar	Gillnet	38.15.500	76.51.600	1015
	March 13	Potomac River	Ragged Pt.	Gillnet	38.08.500	76.35.000	-
	March 15	Potomac River	Off Bonum Creek	Gillnet	38.06.500	76.33.000	2020

Table A-2 - Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated September 30, 2003). Data provided by USFWS Reward Program

2003	March 18	Potomac River	Buoy 29	Gillnet	38.18.700	76.59.300	812
	April 15	Chesapeake Bay	Off Lower Hoopers Isl.	Pound Net	38.14.800	76.13.500	997
	April 17	Potomac River	Ophelia (VA)	Pound Net	37.54.800	76.16.100	1760
	April 23	Potomac River	Deep Point	Pound Net	38.05.700	76.28.000	1260
	May 2	Chesapeake Bay	Richland Point	Pound Net	38.13.700	76.11.200	1390
	May 2	Chesapeake Bay	Richland Point	Pound Net	38.13.700	76.11.200	1025
	May 8	Chesapeake Bay	Off Lower Hoopers Isl.	Pound Net	38.14.800	76.13.500	740
	May 14	Chesapeake Bay	Richland Point	Pound Net	38.14.000	76.11.100	689
	June 24	Chesapeake Bay	Off Kent Island	Pound Net	38.53.000	76.23.000	1035

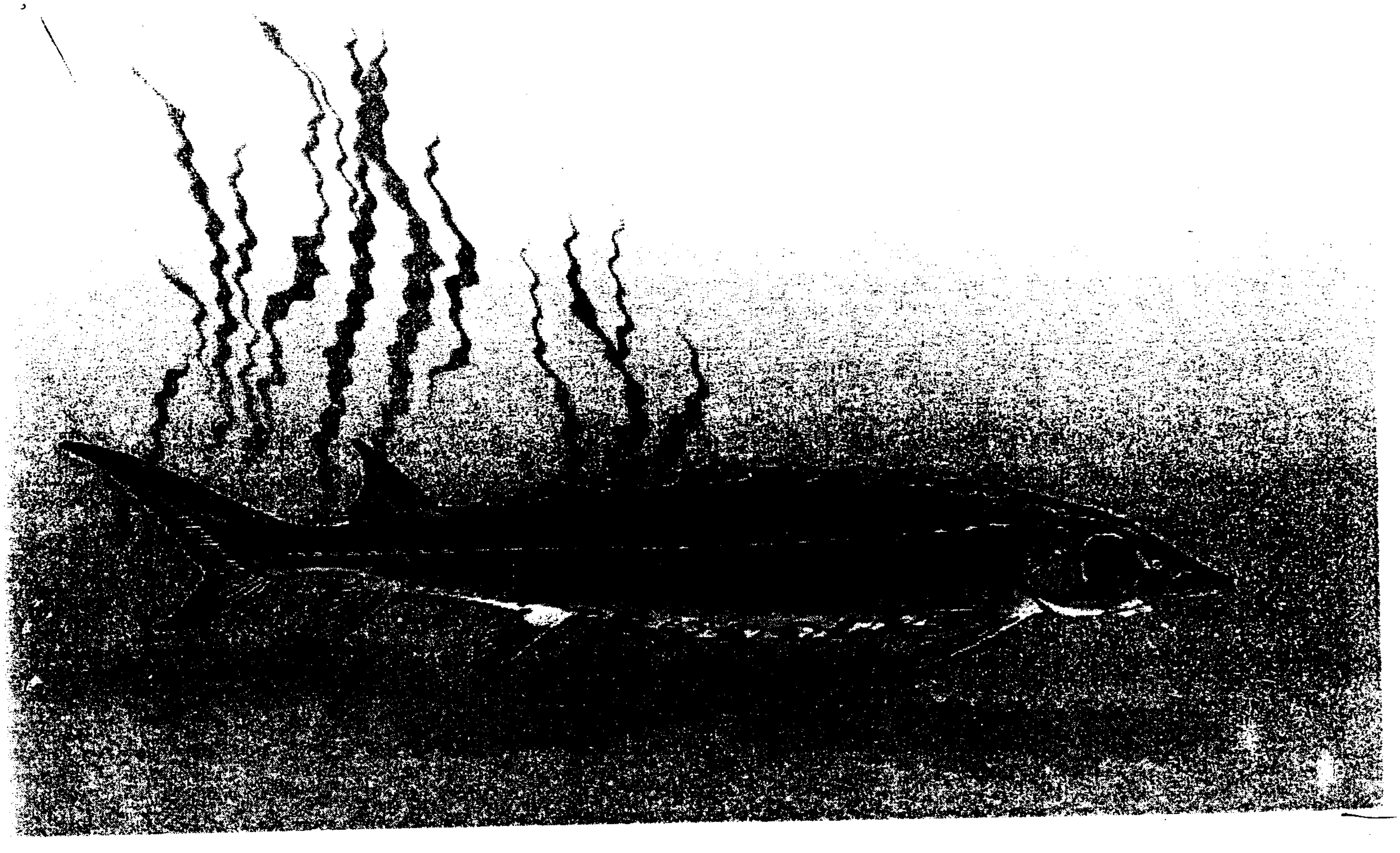
Appendix B

A Report of Investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay by USFWS October 2000

U.S. Fish & Wildlife Service

A Report of Investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay

Maryland Fisheries Resources Office
October 2000



A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay (1996-2000)

By

Jorgen E. Skjeveland
Stuart A. Welsh[1]
Michael F. Mangold
Sheila M. Eyler
Seaberry Nachbar[2]

U.S. Fish and Wildlife Service
Maryland Fisheries Resource Office
Annapolis, MD 21401

10 OCTOBER 2000

Partially funded by

U.S. Army Corps of Engineers (Baltimore and Philadelphia Districts)
Maryland Port Administration
Maryland Department of Natural Resources
U.S. Fish and Wildlife Service

ACKNOWLEDGMENTS

We thank F.D. Allen, A. Buchanon, M. Craig, J. Gill, S. Hammond, P. Hanchin, J. Herema, M. Lawrence, K. Lechert, B. van der Leeuw, R. Li, T. McCrobie, P. McGowan, D. Murphy, R. Peaslee, and R. Wise for data collected.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

A two-year gillnet study was conducted in Maryland waters of the upper Chesapeake Bay to determine the occurrence of the endangered shortnose sturgeon occurrence within areas of proposed dredge-fill operations. The U.S. Fish and Wildlife Service (USFWS), Maryland Fisheries Resource Office (MFRO) conducted the study in 19 sites determined by the National Marine Fisheries Service (NMFS). During the study, MFRO captured 14 Atlantic sturgeon within the proposed sites, but no shortnose sturgeon. In July 1996, USFWS in cooperation with Maryland Department of Natural Resources (MDNR) released 3,275 hatchery-reared Atlantic sturgeon into the Nanticoke River, a tributary of the Chesapeake Bay. A sturgeon reward program designed to pay commercial fishermen for holding live sturgeon to be processed by MFRO was another method used to determine distributions and movement of sturgeon within Maryland waters of the Chesapeake Bay. Through the reward program, 39 shortnose sturgeon, 451 wild Atlantic sturgeon, and 461 hatchery-reared Atlantic sturgeon were tagged and released by MFRO. Total length, fork length, weight, capture site and genetic samples were taken from each sturgeon before being tagged and released. Sonic tags were attached to 15 shortnose sturgeon to track movement in the Chesapeake Bay. We confirmed 3 shortnose sturgeon used the C&D canal, from the Chesapeake Bay to the Delaware River. We tagged wild Atlantic sturgeon and hatchery-reared Atlantic sturgeon with external tags, and recapture information suggests similar movements between hatchery-reared and wild sturgeon within the Chesapeake Bay and along the Atlantic Coast.

INTRODUCTION

Atlantic sturgeon (Acipenser oxyrinchus) and shortnose sturgeon (Acipenser brevirostrum) are anadromous fishes that occur along the Atlantic coast from Canada to Florida (Gruchy and Parker 1980a, 1980b). Historically, native Americans harvested sturgeon for meat and caviar (Hildebrand and Schroeder 1928). During colonial times (17th century) sturgeon were preserved by salting and smoking, and large numbers were exported to European Markets (Hildebrand and Schroeder 1928). A second period of heavy exploitation began just after the Civil War, with a harvest on the Atlantic coast reaching a high of 7 million pounds in 1890 (Atlantic and shortnose were not differentiated in these historical fishing records), but by the early part of the 20th Century the stocks had collapsed indicated by the low 1920 harvest of 22,000 pounds (Smith 1985). In addition to over exploitation, habitat losses, dams, decreased water quality, and siltation, have likely contributed to sturgeon declines in the Chesapeake Bay (Musick et al. 1993).

Few shortnose and Atlantic sturgeon were reported as bycatch in Chesapeake Bay fisheries during the mid to late 1900's. During the early 1990's, anecdotal information from commercial fishermen (watermen), however, indicated that sturgeon were not as rare in the Chesapeake Bay as indicated from bycatch. In 1992, at the request of the Atlantic States Marine Fisheries Commission (ASMFC), the Maryland Fisheries Resources Office (MFRO) of the U.S. Fish and Wildlife Service started a coast wide cooperative tagging program for Atlantic and shortnose sturgeon, patterned after the striped bass tagging program. The sturgeon program received financial assistance by the Hudson River Foundation and the National Fish and Wildlife Foundation, and now has federal, state, and university cooperators.

In addition to the cooperative tagging program, the MFRO has conducted or cooperated with other agencies on several studies of Atlantic and shortnose sturgeon in the Chesapeake Bay, many of which are ongoing. This report provides background information, methodologies, results, and conclusions for these studies. Study objectives are provided below.

1. To determine movement patterns of sturgeon using data from a cooperative tagging program in the Chesapeake Bay.

2. To determine if a resident shortnose sturgeon population exists within the Chesapeake Bay.

3. To determine if shortnose sturgeon move from the Delaware River to the Upper Chesapeake Bay via the Chesapeake and Delaware Canal (C&D Canal).

4. To assess genetic composition of shortnose sturgeon from the Chesapeake Bay and Delaware River.

5. To assess genetic composition of Atlantic sturgeon in the Chesapeake Bay.

6. To determine if sturgeon use areas of proposed dredge and fill operations in the Chesapeake Bay.

7. To evaluate the success of hatchery-reared Atlantic sturgeon released into the Nanticoke River in 1996.

8. To determine growth rates in Atlantic and shortnose sturgeon based on tagging data.

9. To estimate ages of Atlantic sturgeon from analysis of pectoral spines.

MATERIALS AND METHODS

Study area

The Chesapeake Bay is the nation's largest estuary, and one of its most valuable resources. The Bay is located in the mid-Atlantic region and is 314 km long, and between 5.5 and 56 km wide. The Chesapeake Bay watershed encompasses six states and drains an area of 165,760 km^2. The bay averages 30 ft in depth, and the tidal influence ranges from about 2.5 ft at the mouth to less than one foot at the head. The Bay's watershed is highly populated (about 13 million people) and both point and nonpoint pollution caused a decline of water quality and living resources in past years. However, programs initiated by participants of the 1987 Chesapeake Bay Agreement (including the Federal Government, states within the Chesapeake Bay watershed, and Washington D.C.) have improved water quality.

Sturgeon tagging program in the Chesapeake Bay

Sturgeon (both Atlantic and shortnose) are a bycatch of commercial fisheries in the Chesapeake Bay. Because commercial watermen fish throughout the Chesapeake Bay, information on bycatch is useful in understanding sturgeon distributions. Beginning in 1994, we cooperated with commercial watermen in a tagging program to determine the distribution and movement patterns of sturgeon within the Chesapeake Bay. Initially, we asked watermen to retain the sturgeon until a MFRO biologist could tag the fish, but apparently the time and effort involved with keeping fish alive resulted in a low reporting rate (only two fish in two years). As an incentive, we offered a $100 reward for live sturgeon from Maryland Chesapeake Bay waters beginning January 1996 (cooperators were the Maryland Department of Natural Resources (MDNR) and the Chesapeake Bay Foundation (CBF)). In 1997, the reward program was modified to include a $25 reward for hatchery-reared sturgeon, and a $100 reward for wild sturgeon, and announced by postcard to all licensed watermen. The sturgeon reward program was expanded in February 1997 to include the James, York, and Rappahannock rivers in Virginia (Spells 1998, unpublished report, Appendix 1).

When a waterman reported a captured sturgeon, we recorded the location of capture, type of gear, and holding site. Watermen typically held fish at dockside in pens, cages, crab pots, or tied fish to the dock by string around the caudal peduncle. Fish captured in pound nets were sometimes held at the capture site, and staff would accompany the waterman to the net to tag the fish. Tagging procedures for the hatchery reared Atlantic sturgeon and shortnose sturgeon are described later. The wild Atlantic sturgeon were tagged with yellow T-Bar tags manufactured by Hallprint LTD[3], Holden Circle, South Australia. Typically, two T-Bar tags were placed on each fish, one at the base of the dorsal fin, and the other through the left pectoral fin. Later, in addition, a Floy FIM 96[3] double barb tag was placed in the musculature of the anterodorsolateral region (below the 3rd, 4th, or 5th scute) of large fish over 700 mm. An applicator supplied by Floy was used to insert the double barb tag into the musculature through a small incision in the skin. Sturgeon were weighed on an O'haus[3] model CT6000 electronic scale to the nearest gram, or a DETECTO[3] model T50 mechanical scale to the nearest 1/4 pound. Fish over 50 lbs exceeded scale capacity, and therefore were generally not weighed. Lengths (total and fork) were recorded to the nearest millimeter.

Sturgeon use of areas of proposed dredge and fill operations in the Chesapeake Bay.

In addition to the sturgeon reward program, the MFRO initiated a gill net study (funded by the U.S. Army Corps of Engineers) to determine if sturgeon use areas of proposed dredge and fill operations in the Chesapeake Bay. Experimental monofilament gillnets (400 ft X 8 ft or 300 ft X 8 ft comprised of 100 ft panels of 4, 5, or 6 inch stretched mesh) were fished by MFRO biological technicians. The nets were set during daytime (3-4 hours) and overnight (24 hours). Overnight sets were not used in water temperatures above 18° C, because mortality of sturgeon and bycatch will likely increase as temperature exceeds 18° C. The nets were set on a rotating schedule at 19 stations (see Table 1, Figure 1), and in other areas where watermen had captured sturgeon. The 19 sample locations were determined by the National Marine Fisheries Service (NMFS) based on areas for proposed dredge and fill operations. Location of all net sets were recorded using a Geographic Positioning System (GPS), and both set and pull time were recorded. Depth and water quality parameters such as temperature, conductivity, salinity, and dissolved oxygen were recorded. Bycatch species were enumerated and recorded.

Success of hatchery-reared Atlantic sturgeon released into the Nanticoke River in 1996.

Of 3,275 hatchery-reared Atlantic sturgeon released into the Nanticoke River on 8 July 1996, 1,657 were released at Sharptown and 1,618 were released at Vienna. Because of heater malfunction, some hatchery sturgeon were kept in cold water over the winter and ranged from 80 - 210 mm total length at the time of release. Others were held in heated water and ranged from 190 - 420 mm total length at release. Before initial release, all hatchery-reared Atlantic sturgeon were tagged under the third dorsal scute with a binary coded wire tag (CWT) manufactured by Northwest Marine Technologies[3], Seattle, WA. The CWT were used to differentiate hatchery-reared sturgeon from wild sturgeon. Atlantic sturgeon examined after the release of hatchery fish were scanned for the presence of a CWT using a Northwest Marine Technology detector wand to determine their origin. In addition to the CWT, 910 hatchery-reared Atlantic sturgeon in the 190 - 420 mm group were tagged (T-Bar) at the base of the dorsal fin before release following procedures described above for wild Atlantic sturgeon. In addition, recaptured hatchery-reared Atlantic sturgeon were tagged, weighed, and measured using procedures described above for wild fish; however, tags on recaptured fish were left in place.

To determine if a resident shortnose sturgeon population exists within the Chesapeake Bay.

Movement and genetic analyses (see below) were done to determine if shortnose sturgeon captured in the Chesapeake Bay were migrants from the Delaware River. To assess movement between the Chesapeake Bay and Delaware River, shortnose sturgeon were tagged in the upper Chesapeake Bay and in the Delaware River. Shortnose sturgeon from the upper Chesapeake Bay were obtained during the sturgeon reward program and those from the Delaware River (below Scutter's Falls) were captured using 30 m X 2 m and 60 m X 2 m monofilament gill nets (5-6 inch stretched mesh) set by the MFRO and Environmental Research and Consulting, Inc.

(ERC). Shortnose sturgeon from the Chesapeake Bay and Delaware River were tagged with Hallprint T-Bar tags, Carlin tags manufactured by Floy Inc.[3], passive integrated transponder (PIT) tags, 400 KHz, manufactured by Destron[3], and sonic tags (CT82-2E manufactured by Sonotronics[3], Tucson, AZ). T-Bar tags were placed through the pectoral fin using the same method as described above for Atlantic sturgeon. To attach a Carlin tag, two hypodermic needles were punched through the base of the dorsal fin (Smith et al. 1990), wire (attached to the Carlin tag) was then threaded through the needles from the left side and tied off on the right side after removal of the hypodermic needles. The PIT tags (2.1 X 11 mm glass coated tags that emit a signal corresponding to a unique number when scanned) were injected 1 cm into the musculature of the upper anterodorsolateral region between the 3rd and 4th dorsal scutes using a syringe (12 gauge needle). A sonic tag was mounted on two scutes using 60 lb test nylon-coated stranded stainless steel trolling/leader wire. The wire was first threaded through holes in the sonic tag, then through holes drilled through the point of the scutes, and then through holes of a backing plate. The wire was then fashioned into a harness using leader sleeves (size 4) and crimped with a crimping tool.

A permit from the National Marine Fisheries Service was issued to the Maryland Fisheries Resource Office (MFRO) in March 2000 allowing sonic tags to be internally implanted in shortnose sturgeon. The sonic tags were placed in the ventral portion of the body cavity. Using a sterile scalpel, a MFRO biological technician made a one to two inch incision in the ventral body wall approximately three to four inches anterior to the anal opening. The tag was inserted into the body cavity of the sturgeon and pushed forward as far as possible to prevent it from irritating the surgical area. The incision was sewn together using Ethicon©[3] 3-0 chromic gut surgical sutures placed approximately 1/4" apart along the length of the incision. The wound was then treated with Betadine[3] solution to prevent infection. Following surgery, the fish was contained until it showed signs of recovery and then released into the water. Fish under 700 mm were generally not fitted with sonic tags due to the size of the tag.

Fish with sonic tags were tracked by boat with a Directional Hydrophone DH-2 and a Sonotronics Digital Receiver USR-5W. Researchers deployed the hydrophone every ½ to 3/4 mile, and would travel toward a sonic signal until it was equal strength in every direction. The fish was then assumed to be directly under the boat, and depth and geographic coordinates (determined with a GPS) were recorded. To monitor possible movement through the C& D Canal a Data logger DL-95, Scan Receiver USR-90, and a Directional Hydrophone were placed at the U.S. Army Corps of Engineers Compound at Chesapeake City, MD. The hydrophone was mounted on the seawall pointing diagonally across the canal. The system was powered by a 12 volt marine battery hooked to a battery charger that was powered by night security lights. Data from the palmtop logger were downloaded to a laptop computer every 4 to 6 weeks. A second logger was later placed at the National Oceanic and Atmospheric Administration (NOAA) monitoring station on the Canal's south shore near Delaware City, Delaware.

Genetics

Tissue samples for genetic analyses were taken from Atlantic and shortnose sturgeon provided by watermen or from those captured by researchers. A ½ square inch tissue sample was cut from the ray section of the caudal fin using sterilized scissors. Tissue samples were placed into a labeled vial containing 95% Ethyl alcohol, and refrigerated for 24 hours to allow time for tissue fixation. Tissue samples from Atlantic sturgeon were sent to Dr. Tim King at USGS-BRD Kerneysville, WV, for genetic analysis. Tissue samples from shortnose sturgeon were collected from 73 individuals from the Delaware River and 28 individuals from the upper Chesapeake Bay. These tissue samples and existing tissue samples from the Hudson and Savannah River fish were analyzed using mitochondrial and genomic DNA analysis. The mitochondrial DNA analysis (PCR and direct sequencing) was conducted by Dr. Isaac Wirgin, NYU Medical Center, Tuxedo, NY. The cellular DNA analysis (microsatellites) is currently being done by Dr. Tim King, but at this time is not complete.

Ageing of Atlantic sturgeon.

A 5 -10 mm section of the right pectoral spine of wild Atlantic sturgeon was removed with a mini hacksaw (Sandvik[3] 268 Junior Hacksaw) and placed into a labeled plastic bag. After removal of the spine section, we applied an antiseptic (Betadine solution) to the pectoral fin. Atlantic sturgeon were aged by Dr. David Secor and students at the Chesapeake Biological Laboratory, Solomons, MD, using the following methods summarized from Stevenson and Secor (2000). Sections of pectoral spines were embedded in a block of Spurr epoxy and sectioned using an Isomet saw, or not embedded and sectioned using a jeweler's saw. Next, thermoplastic glue was used to mount all sections onto glass slides. Sections were then polished using an automatic polishing wheel with fine grit carborundum paper and a 0.3 um alumina slurry on a polishing cloth. Due to a good representation of spines taken from all size classes of wild Atlantic sturgeon, samples were not collected during the last year of the project.

RESULTS AND DISCUSSION

Atlantic sturgeon distribution

From 1996 through 2000, 451 wild and 461 hatchery-reared Atlantic sturgeon (these numbers do not include multiple captures) were tagged and released in the Chesapeake Bay, MD (Figures 2 and 3). Distributions determined from captures reported to the reward program are biased because of fishery dependence. Bycatch of sturgeon during the summer was primarily from a poundnet fishery near the shoreline, whereas most sturgeon captured in the winter were bycatch from a gill net fishery (Figures 4 and 5). Nevertheless, distributions based on fishery dependent samples can provide useful information, particularly when little distribution information is available. Our fishery dependent data suggest that distributions of wild and hatchery-reared sturgeon are similar.

Three hatchery-reared Atlantic sturgeon (76 - 127mm TL) stocked in the Hudson River in October 1994 were recaptured several years later in the Chesapeake Bay (30 Oct. 1997, 965 TL; 9 Nov 1997, 965 TL; and 5 Jan. 1998, 912 TL) and the individual captured on 9 Nov 1997 was caught two months earlier (9 Sept 1997) in the lower Delaware River.

Growth, age, and genetics of Atlantic sturgeon

Length-weight relationships for sturgeon between 445 and 1100 mm were similar between wild and hatchery-reared fish (Figure 6); however, all sturgeon longer than 1100mm were wild fish (Figure 7). Genetic and age studies of Atlantic sturgeon are still in progress, and will be reported at a later date.

Sturgeon use of areas of proposed dredge and fill operations in the Chesapeake Bay

From 1998 to 2000, 14 Atlantic sturgeon were captured in MFRO gillnets in the 19 proposed dredge sites and fill areas in the Chesapeake Bay (Table 2, Figure 8). The gillnets were sampled seasonally, a total of 10,661 hours (Table 3). During the study, there were no shortnose sturgeon caught in MFRO gillnets. Although the data shows that few sturgeon were captured in these sites, Atlantic and shortnose sturgeon were captured in commercial gear within the proposed dredged dumping sites during the time of the study (Table 4). Therefore, our results may be a function of sampling and can only suggest that Atlantic and shortnose sturgeon were not frequenting these sites while MFRO gillnets were fishing.

The bycatch recorded during each gillnet set consisted of species common to the Chesapeake Bay (Murdy et al., 1997) and varied seasonally in species composition and number (Table 5-8). Average temperature, salinity, dissolved oxygen, percent dissolved oxygen, and conductivity varied seasonally (Table 9-13).

Shortnose distribution, growth, and genetics

Since the beginning of the Atlantic sturgeon reward program in 1996, 39 shortnose sturgeon have been captured in the Chesapeake Bay, MD (Figure 9). Three shortnose sturgeon were captured in the lower Susquehanna River, two were caught in the Bohemia River, two south of the Bay Bridge near Kent Island, three in the Potomac River, and one just north of Hoopers Island. In addition, one was captured in the Elk River and two in Fishing Bay. The remaining sturgeon were caught in the upper Chesapeake Bay north of Hart-Miller Island. The length-weight relationship for shortnose sturgeon from the upper Chesapeake Bay was Log W = 3.17(Log FL) - 5.60 or Log W = 3.25 (Log TL) - 6.00 (Figure 10) and was similar to those reported and summarized by Dadswell et al. (1984).

Before the reward program, there were only 15 published historic records of shortnose sturgeon in the Chesapeake Bay (Dadswell et al. 1984). Most of these are based on personal observations from the upper Chesapeake Bay during the 1970's and 1980's (Dadswell et al. 1984), but one verified record from the Potomac River dates back to 1876 (Musick et al. 1993). An additional record is from the Rappahannock River in Virginia (Spells 1998, unpublished report). Shortnose sturgeon are rarely caught as bycatch in commercial fisheries, even in the Hudson and Delaware Rivers where large populations exist (pers. comm. O'Herron 1997, pers. comm. Brundage 1997). This suggests that these fish may be widely distributed in Maryland waters of the Chesapeake Bay and possibly constitute a resident population.

The 1876 record indicates that shortnose sturgeon were present in the Chesapeake Bay before the Chesapeake and Delaware Canal (C&D canal) was a sea-level canal which allowed fish to move freely between the Chesapeake Bay and Delaware River in 1927. Before the C&D canal, shortnose sturgeon in the Chesapeake Bay were geographically separated and potentially genetically isolated from those in the Delaware River. From 1996 through 2000, tissue samples from 28 shortnose sturgeon were collected through the reward program in the Chesapeake Bay. PCR and direct sequencing showed no significant differences between shortnose sturgeon from the Delaware River and Chesapeake Bay(Dr. I. Wirgin, Nelson Institute of Environmental Medicine, pers. comm., 2000).

Movement of shortnose sturgeon

Sonic tags were attached to 35 shortnose sturgeon (26 external and 9 internal) from the Delaware River and 15 snortnose sturgeon (14 external and 1 internal) from the Chesapeake Bay. These were used to monitor the movement of shortnose sturgeon through the Chesapeake and Delaware (C&D) Canal. Monitoring equipment located in the canal at the NOAA station, Delaware City, gave a false signal and performance did not improve after a low pass filter (LPF-94) was added to reduce noise. Due to excessive noise, the monitoring equipment was removed. A shortnose sturgeon tagged in the Chesapeake Bay on 5 April 1998 (Figure 11) was recorded in the canal by monitoring equipment located at Chesapeake City, and later relocated in the Delaware River by C. Shirey (DE Division of Fish and Wildlife). It is likely that this shortnose sturgeon swam through the canal, because it was tagged in the Chesapeake Bay, later relocated in the canal, and later relocated in the Delaware River. Another shortnose sturgeon tagged in the middle Chesapeake Bay (Figure 12) and relocated 101 days later in the Delaware River was not detected in the canal; however, the monitoring equipment at Chesapeake City had malfunctioned for approximately three weeks after this sturgeon had been sonic tagged. From May to August 2000 the monitoring equipment at the Chesapeake City location did not record information due to a malfunction in the computer. The monitoring equipment was removed from the Chesapeake City location in September 2000, due to seawall reconstruction and will be placed elsewhere.

Telemetry from boats yielded 22 of the 50 sonic tagged sturgeon, and several tags were relocated more than once (Table 13). Delaware River fish were tagged and released on or near the spawning grounds (near Scutter's Falls or Bordentown); consequently, most of these fish were later relocated downstream of their release site.

Movements of shortnose sturgeon in the Chesapeake Bay did not appear to follow a specific pattern (Figures 14 - 17).

Locations provided by telemetry can be used to estimate distances of sturgeon movements. A straight path between two locations is "hypothetical" because a sturgeon likely does not follow a straight line between two points determined by telemetry. However, the hypothetical path provides an estimate of the minimum distance traveled during a given period of time. Distances moved by shortnose sturgeon in this study ranged from 0 to 5.7 km per day (Table 10). Sturgeon captured by watermen in the Chesapeake Bay were typically tagged and released at dockside (Figures 15-17), and estimates of movement include distances fish swam from the tag and release location. Our findings of movement by shortnose sturgeon are similar to those reported and summarized by Dadswell et al. (1984).

LITERATURE CITED

Dadswell , M.J., B.D. Taubert, T.S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of biological data on shortnose sturgeon Acipenser brevirostrum Leseuer 1818. NOAA (National Oceanic and Atmospheric Administration) Technical Report NMFS (National Marine Fisheries Service) 14.

Gruchy, C.G. and B. Parker. 1980a. Acipenser brevirostrum Lesueur Shortnose sturgeon. Page 38 in D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr., eds. Atlas of North American Freshwater Fishes, North Carolina State Museum of Natural History.

Gruchy, C.G. and B. Parker. 1980b. Acipenser oxyrhynchus Mitchell Atlantic sturgeon. Page 41 in D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr., eds. Atlas of North American Freshwater Fishes, North Carolina State Museum of Natural History.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. U.S. Bureau of Fisheries Bulletin 43.

Murdy, E.O., R.S. Birdsong, J.A. Musick. 1997. Fishes of the Chesapeake Bay. Smithsonian Institution Press, Washington and London.

Musick, J.A., R.E. Jenkins, and N.M. Burkhead. 1993. Sturgeons; Family Acipenseridae. Pages 183-190 in R.E. Jenkins and N.M. Burkhead. The Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

National Marine Fisheries Service. 1998. Recovery plan for the shortnose sturgeon (Acipenser brevirostrum). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages.

Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic Sturgeon, Acipenser oxyrhynchus, in North America. Environmental Biology of Fishes 14:61-72.

Spells, A. 1998. Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay. U.S. Fish and Wildlife Service, Charles City, VA.

Stevenson, J. and D. H. Secor. 2000. Age determination and growth of Hudson River Atlantic sturgeon (Acipenser oxyrinchus). Fish. Bull., vol. 98(1), pp.153-166.

FOOTNOTES

[1]Current Address: West Virginia Cooperative Fish and Wildlife Research Unit, U.S.G.S., POB 6125, Morgantown, WV 26506, phone 304-293-2941, fax 304-293-2441, swelsh@wvu.edu

[2]Current Address: NOAA, 1305 East West Highway, Silver Spring, MD 20910, phone 301-713-3060 x145, fax 301-713-4270, seaberry.nachbar@NOAA.gov

[3]The USFWS MFRO does not promote or endorse the equipment used

Table 1. Sites where gill nets were deployed in the upper Chesapeake Bay, Maryland (see Figure 1).

---

1. Aberdeen around Poole's Island
2. G-east
3. Site 92
4. Site 1
5. Site 2
6. Site 3
7. Site 104
8. Mouth of Susquehanna River
9. Worton Point
10. Worton Deep
12. Swan Point Channel
13. Craighill Channnel Upper Range
14. Craighill Channel
15. Brewerton Channel Extension
16. Tolchester Channel South
17. Tolchester Channel North
20. C&D Approach of Still Pond Creek
21. C&D Approach of Bohemia River
22. Shad Battery Shoal

Table 2. Sturgeon captured in Maryland Fisheries Resource Office gillnet sites during 1998-2000.

Species	Capture Date	Site #	Total Length (mm)	Fork Length (mm)	Weight (g)
Atlantic Sturgeon	10/25/99	2	970	871	4763
Atlantic Sturgeon	7/6/99	2	890	790	3856
Atlantic Sturgeon	8/19/99	2	980	860	4536
Atlantic Sturgeon	8/19/99	2	915	790	4536
Atlantic Sturgeon	6/18/98	4	885	796	3515
Atlantic Sturgeon	8/4/98	4	700	630	1588
Atlantic Sturgeon	8/4/98	4	770	675	2268
Atlantic Sturgeon	6/10/98	6	880	760	1814
Atlantic Sturgeon	3/7/00	7	864	760	3289
Atlantic Sturgeon	7/21/99	12	840	735	2835
Atlantic Sturgeon	7/27/98	13	700	590	1588
Atlantic Sturgeon	7/27/98	13	700	620	1588
Atlantic Sturgeon	7/27/98	13	720	640	2041
Atlantic Sturgeon	6/10/98	22	1285	1110	9526

Table 3. Total hours of sampling conducted in Maryland Fisheries Resource Office gillnet sites during each season. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6),summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site #	Season				Total Hours
	Winter*	Spring	Summer	Fall	
1	68	158	70	277	574
2	88	226	71	109	493
3	175	120	55	0	350
4	99	112	61	0	272
5	101	15	70	0	186
6	191	167	47	15	420
7	689	201	149	151	1190
8	234	144	200	411	990
9	206	57	42	188	494
10	792	43	43	7	886
12	84	125	50	101	360
13	148	48	45	0	240
14	92	72	109	133	406
15	93	34	52	0	178
16	99	148	72	0	318
17	91	108	66	194	459
20	288	171	182	760	1400
21	586	174	153	139	1052
22	0	332	60	0	392
Total	4124	2454	1598	2485	10661

**Total hours during winter months are greater due to overnight sets.

Table 4. Atlantic and shortnose sturgeon caught in commercial gear during Maryland Fisheries Resource Office study.

Species	Capture Date	Site #	Capture Gear	Origin	Total Length (mm)	Fork Length (mm)	Weight (g)
Atlantic Sturgeon	02/16/98	1	Drift Gillnet	Hatchery	762	-	2381
Atlantic Sturgeon	02/28/00	3	Drift Gillnet	Wild	643	582	1361
Atlantic Sturgeon	12/18/96	6	Drift Gillnet	Hatchery	530	440	680
Atlantic Sturgeon	11/16/98	6	Drift Gillnet	Wild	860	740	2721
Atlantic Sturgeon	01/30/97	7	Drift Gillnet	Hatchery	-	-	-
Atlantic Sturgeon	05/19/97	7	Pound Net	Wild	851	740	2535
Atlantic Sturgeon	06/15/97	7	Pound Net	Wild	820	720	2280
Atlantic Sturgeon	06/15/97	7	Pound Net	Hatchery	690	600	1437
Atlantic Sturgeon	04/22/98	10	Gillnet	Wild	950	820	3175
Shortnose Sturgeon	04/22/98	10	Drift Gillnet	Wild	410	355	340
Shortnose Sturgeon	04/23/98	10	Eel Pot	Wild	432	390	453
Atlantic Sturgeon	02/11/99	13	Drift Gillnet	Wild	1380	1210	14742
Atlantic Sturgeon	02/23/99	16	Drift Gillnet	Hatchery	985	850	3855
Atlantic Sturgeon	02/19/98	20	Drift Gillnet	Hatchery	857	750	3175
Atlantic Sturgeon	02/19/98	20	Drift Gillnet	Hatchery	927	780	3515
Atlantic Sturgeon	01/25/99	20	Drift Gillnet	Wild	1475	1290	16897
Shortnose Sturgeon	12/05/97	20	Drift Gillnet	Wild	840	740	2496

Table 5. Bycatch caught in Maryland Fisheries Resource Office gillnets during winter months (January, February, and March).

	Site #																	
Species	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	20	21
American Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
American Shad	0	0	0	2	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Atlantic Menhaden	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0
Blue Crab	0	1	0	0	0	0	0	0	1	1	0	0	1	0	4	0	6	8
Catfish Species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2
Channel Catfish	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	1
Duck (Scaup)	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Duck species	0	0	0	0	1	0	2	0	0	0	0	0	0	0	2	0	0	0
Flounder species	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gizzard Shad	1	5	1	10	1	1	62	7	17	0	0	9	0	2	4	2	2	25
Hogchoker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Horseshoe Crab	0	0	0	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0
Red Throated Loon	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skilletfish	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Striped Bass	0	1	31	90	1	1	49	52	62	0	2	4	0	2	1	7	51	40
White Perch	0	4	3	0	0	0	3	0	1	0	2	0	1	0	3	0	1	3
Yellow Perch	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Total	1	11	35	106	3	2	166	66	90	1	5	13	2	4	14	9	68	81

Table 6. Bycatch caught in Maryland Fisheries Resource Office gillnets during spring months (April, May, and June).

	Site #																		
Species	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	20	21	22
American Shad	2	0	1	1	2	1	1	49	2	1	0	0	0	0	0	0	0	0	0
Atlantic Croaker	0	0	1	1	0	34	26	0	0	0	16	11	65	12	8	1	0	0	0
Atlantic Menhaden	2	12	76	73	0	702	357	41	5	3	396	234	1090	177	320	104	322	3	3
Blue Crab	12	7	20	23	0	5	18	0	3	4	9	10	11	12	0	3	3	21	20
Catfish species	40	1	1	1	2	1	0	2	0	1	0	0	0	0	1	0	12	35	11
Channel Catfish	7	8	14	8	0	0	5	50	5	0	0	5	16	10	8	4	10	39	7
Common Carp	0	0	0	0	0	0	0	23	2	0	0	0	0	0	0	0	3	5	0
Cownose Ray	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Crayfish species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Flounder species	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0
Gizzard Shad	62	4	14	2	31	46	10	204	64	9	10	5	14	14	19	2	186	221	41
Hickory Shad	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hogchoker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Horseshoe Crab	0	0	0	0	0	24	5	0	0	0	2	2	11	0	5	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Spot	0	0	0	2	0	1	9	0	0	0	1	0	0	0	0	0	0	0	3
Spotted Seatrout	0	0	0	0	0	0	4	0	0	0	0	0	1	1	1	0	0	0	0
Striped Bass	27	22	7	26	6	23	26	40	6	2	18	14	43	4	106	5	30	58	131
White Perch	0	0	2	0	2	5	10	6	0	0	1	1	10	0	5	3	8	6	0
Total	152	54	136	139	44	843	474	417	87	20	453	283	1261	230	473	122	574	389	216

Table 7. Bycatch caught in Maryland Fisheries Resource Office gillnets during summer months (July, August, and September).

Species	Site # 1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	20	21	22
Alewife	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Atlantic Croaker	0	1	15	2	33	28	145	0	6	3	1	27	22	12	53	14	14	0	2
Atlantic Menhaden	7	60	25	0	232	19	123	288	15	7	138	66	314	13	209	73	50	45	15
Blue Crab	23	47	40	29	40	0	47	3	26	12	19	11	29	12	30	48	110	190	52
Bluefish	0	0	1	0	5	0	2	0	1	0	2	3	5	2	5	0	3	1	0
Catfish species	0	0	0	0	1	0	0	23	2	0	0	0	0	0	0	0	22	8	0
Channel Catfish	22	4	5	43	2	6	0	52	1	2	0	20	2	3	2	5	72	39	2
Common Carp	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	1	1	0
Cownose Ray	1	0	1	0	4	2	0	0	1	0	0	3	1	1	0	0	0	0	0
Flounder species	0	5	1	2	2	0	9	0	0	0	0	1	1	0	0	0	0	0	0
Gizzard Shad	37	14	6	3	22	49	11	170	33	22	25	49	34	11	26	8	30	15	14
Harvestfish	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hogchoker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Horseshoe Crab	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Smallmouth Bass	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Spanish Mackerel	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Spot	0	1	5	4	15	46	74	0	0	1	5	4	34	10	34	2	6	1	0
Spotted Seatrout	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Striped Bass	4	5	2	1	10	79	6	6	0	0	16	36	44	7	10	13	2	0	3
Weakfish	0	1	0	0	0	0	3	0	0	0	1	1	2	0	6	0	3	0	0
White Catfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
White Perch	1	0	0	1	2	9	1	2	1	0	1	1	5	2	8	0	7	0	0
Total	95	138	101	85	370	241	423	592	86	48	209	223	494	74	383	163	320	300	88

Table 8. Bycatch caught in Maryland Fisheries Resource Office gillnets during fall months (October, November, and December).

	Site #											
Species	1	2	6	7	8	9	10	12	14	17	20	21
Atlantic Croaker	0	0	0	20	0	0	0	41	2	0	0	0
Atlantic Menhaden	5	3	14	133	0	81	0	1	13	20	84	0
Black Drum	0	0	0	2	0	0	0	0	0	0	0	0
Blue Crab	2	4	7	30	0	5	1	0	7	7	62	2
Bluefish	0	0	3	0	0	0	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0	0	0	0	1	0	0
Catfish species	0	0	0	0	0	0	0	0	0	0	7	0
Channel Catfish	3	3	0	0	135	4	1	0	0	7	33	23
Common Carp	0	0	0	0	39	0	0	0	0	0	0	0
Flounder species	0	0	0	2	0	1	0	0	1	2	2	0
Gizzard Shad	220	1	10	209	71	136	0	72	14	2	30	8
Harvestfish	0	0	9	0	0	0	0	0	2	0	0	0
Hogchoker	0	0	0	0	65	0	0	0	0	0	0	0
Horseshoe Crab	0	0	0	21	0	0	0	0	0	0	0	0
Largemouth Bass	0	0	0	0	4	0	0	0	0	0	0	0
Lizardfish	0	0	0	1	0	0	0	0	1	0	0	0
Northern Hogsucker	0	0	0	0	1	0	0	0	0	0	0	0
Quillback	0	0	0	0	1	0	0	0	0	0	0	0
Smallmouth Bass	0	0	0	0	1	0	0	0	0	0	0	0
Spot	0	0	1	2	0	0	0	0	1	7	0	0
Spotted Seatrout	0	0	0	0	0	0	0	0	1	0	1	0
Striped Bass	19	3	4	11	15	2	0	6	5	14	45	20
Walleye	0	0	0	0	2	0	0	0	0	0	0	0
Weakfish	0	1	0	2	0	0	0	1	4	6	5	0
White Catfish	0	0	0	0	0	0	0	0	0	0	1	0
White Perch	0	0	0	0	0	0	0	0	0	0	2	0
White Sucker	0	0	0	0	3	0	0	0	0	0	0	0
Total	249	15	48	433	337	229	2	121	51	66	272	53

Table 9. Seasonal average temperature (°C) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	6.0	19.2	24.9	11.0
2	4.0	15.9	27.2	20.0
3	5.0	24.5	-	-
4	6.5	20.0	26.0	-
5	3.2	15.0	24.1	-
6	4.0	15.8	25.6	18.0
7	7.2	17.7	26.2	14.1
8	7.2	22.5	24.1	10.6
9	7.1	18.8	27.3	19.0
10	3.1	22.6	26.7	19.0
12	4.3	16.4	26.0	11.0
13	1.0	20.0	25.0	-
14	7.2	17.9	24.9	14.3
15	1.0	17.0	27.0	-
16	7.0	23.0	25.9	-
17	2.5	22.0	24.0	17.0
20	6.3	21.3	26.2	13.6
21	6.7	22.2	27.5	20.0
22	-	15.6	26.8	-

Table 10. Seasonal average salinity (ppt.) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site #	Season: Winter	Spring	Summer	Fall
1	3.0	1.7	7.0	8.0
2	3.5	1.2	7.3	3.0
3	4.0	1.8	-	-
4	4.0	1.0	6.3	-
5	7.0	1.0	7.7	-
6	5.0	4.5	8.8	8.0
7	6.2	5.5	8.5	11.2
8	1.0	0.0	0.2	0.5
9	2.1	0.5	8.7	3.5
10	0.2	2.1	7.8	3.5
12	8.8	4.0	9.1	10.0
13	11.0	4.5	11.0	-
14	4.0	3.4	8.0	9.4
15	10.5	2.3	6.2	-
16	6.5	3.5	8.3	-
17	3.0	1.5	5.2	4.5
20	0.0	2.3	3.4	4.3
21	1.5	0.8	2.8	2.0
22	-	0.5	4.0	-

Table 11. Seasonal average dissolved oxygen (ppm.) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	16.40	11.02	8.30	-
2	-	7.96	7.32	-
3	14.61	8.01	-	-
4	-	-	6.84	-
5	14.92	-	7.66	-
6	7.68	10.34	10.73	7.06
7	10.94	7.23	6.28	9.76
8	14.43	8.30	7.60	10.42
9	12.94	7.85	6.70	-
10	14.50	7.61	6.23	-
12	11.16	-	7.06	9.97
13	-	8.78	8.46	-
14	12.19	11.52	8.04	10.40
15	12.28	-	5.09	-
16	14.74	-	7.12	-
17	11.80	-	8.86	-
20	15.20	7.80	8.47	9.54
21	13.80	7.01	6.39	-
22	-	8.21	5.72	-

Table 12. Seasonal average percent dissolved oxygen at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	-	85.0	105.7	-
2	-	88.3	94.9	-
3	114.8	95.5	-	-
4	-	-	90.2	-
5	115.0	-	98.7	-
6	60.0	110.4	148.5	79.2
7	99.7	89.9	82.2	98.2
8	60.5	88.2	90.4	94.7
9	-	94.9	90.1	-
10	-	93.2	82.4	-
12	91.2	-	87.8	97.1
13	-	108.7	108.3	-
14	103.8	124.6	95.8	100.0
15	93.3	-	67.6	-
16	124.3	-	94.1	-
17	93.1	-	105.3	-
20	98.8	94.3	112.4	90.4
21	94.8	83.5	79.2	-
22	-	76.2	75.2	-

Table 13. Seasonal average conductivity ($\mu mhos$) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	3100	2600	12100	5280
2	3700	1560	13200	6000
3	3950	3280	-	-
4	4200	1000	11900	-
5	6200	1200	14100	-
6	4300	6030	16400	7500
7	6550	8070	13600	11900
8	430	202	323	250
9	2810	615	13000	4000
10	309	3340	9480	4000
12	9200	4320	13600	12500
13	10000	8900	18000	-
14	4200	5830	13200	11500
15	10000	2800	11900	-
16	518	4600	14400	-
17	3200	2150	6830	3240
20	147	2550	5190	5260
21	819	1290	4560	3950
22	-	1250	8040	-

Table 14. Movement data (minimum distances) from sonic tagged shortnose sturgeon.

Sonic Tag Number	Release/ Located*	Date	Distance (km)	Days	Estimated distance (km)/day	Location: C = Chesapeake Bay D = Delaware River
2-2-9	release	1/23/98				C
2-2-9	located	4/3/98	11.23	70	0.160	C
2-2-9	located	4/6/98	0.85	3	0.283	C
2-2-9	located	4/7/98	0.67	1	0.670	C
2-2-9	located	4/8/98	0.62	1	0.620	C
2-2-9	located	4/21/98	0.81	13	0.062	C
2-2-9	located	5/6/98	0.64	15	0.043	C
2-2-9	located	6/2/98	0.41	27	0.015	C
2-3-2-7	release	12/8/97				C
2-3-2-7	located	2/10/98	10.25	69	0.149	C
2-3-3-6	release	1/6/98				C
2-3-3-6	located	3/6/98	30.8	59	0.522	C
2-3-3-6	located	4/7/98	14.9	32	0.466	C
2-3-3-6	located	4/8/98	5.74	1	5.740	C
2-3-3-6	located	4/13/98	12.86	5	2.572	C
2-3-3-6	located	5/6/98	10.38	23	0.451	C
2-3-3-6	located	5/28/98	12.2	22	0.555	C
2-3-4-5	release	12/10/97				C
2-3-4-5	located	2/10/98	16.84	62	0.272	C
2-3-4-5	located	4/2/98	18.82	51	0.369	C
2-3-4-5	located	4/3/98	5.28	1	5.280	C
2-3-9	release	4/4/00				D
2-3-9	located	7/25/00				D
2-4-2-6	release	12/10/97				C
2-4-2-6	located	3/20/98	22.83	100	0.228	C
2-4-3-5	release	12/10/97				C
2-4-3-5	located	4/21/98	13.74	132	0.104	C
2-4-3-5	located	5/6/98	4.82	15	0.321	C
2-4-3-5	located	5/28/98	11.24	22	0.511	C
2-4-3-5	located	11/19/98	6.66	175	0.038	C

Table 14. Continued.

Sonic Tag Number	Release/ Located*	Date	Distance (km)	Days	Estimated distance (km)/day	Location: C = Chesapeake Bay D = Delaware River
2-4-7	release	1/24/98				C
2-4-7	located	6/16/98	54.3	142	0.382	
2-4-7**	located	7/15/98	24.6	30	0.820	D
2-4-8	release					
2-4-8**	located	5/4/98				C
2-6-6	release	4/4/00	203.9	101	2.019	D
2-6-6	located	7/25/00				D
3-7-5	release	3/19/98				D
3-7-5	located	8/31/98	0.42	165	0.003	D
3-8-4	release	3/19/98				D
3-8-4	located	8/31/98	2.57	165	0.016	D
3-9-5	release	4/2/98				D
3-9-5	located	9/3/98	106.55	154	0.692	D
3-9-5	located	9/24/98	0.6	21	0.029	D
4-4-6	release	3/26/98				D
4-4-6	located	7/30/98	88.68	126	0.704	D
4-4-6	located	8/5/98	0.34	6	0.057	D
4-4-6	located	8/13/98	0.25	8	0.031	D
4-4-6	located	9/3/98	0.13	21	0.006	D
4-4-6	located	9/11/98	1.28	8	0.160	D
4-4-7	release	3/6/98				D
4-4-7	located	8/31/98	17.9	178	0.101	D
4-5-5	release	4/2/98				D
4-5-5	located	8/31/98	53.2	151	0.352	D
4-5-8	release	4/1/98				D
4-5-8	located	8/31/98	51.8	152	0.341	D

Table 14. Continued.

Sonic Tag Number	Release/ Located*	Date	Distance (km)	Days	Estimated distance (km)/day	Location: C = Chesapeake Bay D = Delaware River
4-6-5	release	3/6/98				D
4-6-5	located	7/15/98	112.4	131	0.858	D
4-6-5	located	7/30/98	0	15	0.000	D
4-6-7	release	4/1/98				D
4-6-7	located	8/31/98	31.87	152	0.210	D
5-8-9	release	6/9/00				D
5-8-9	located	7/25/00				D
8-8	release	6/30/00				D
8-8	located	7/25/00				D
9-10	release	4/1/98				D
9-10	located	8/31/98	31.27	152	0.206	D

*located by telemetry
**movements of 2-4-7 and 2-4-8 were assumed to be through the C & D canal

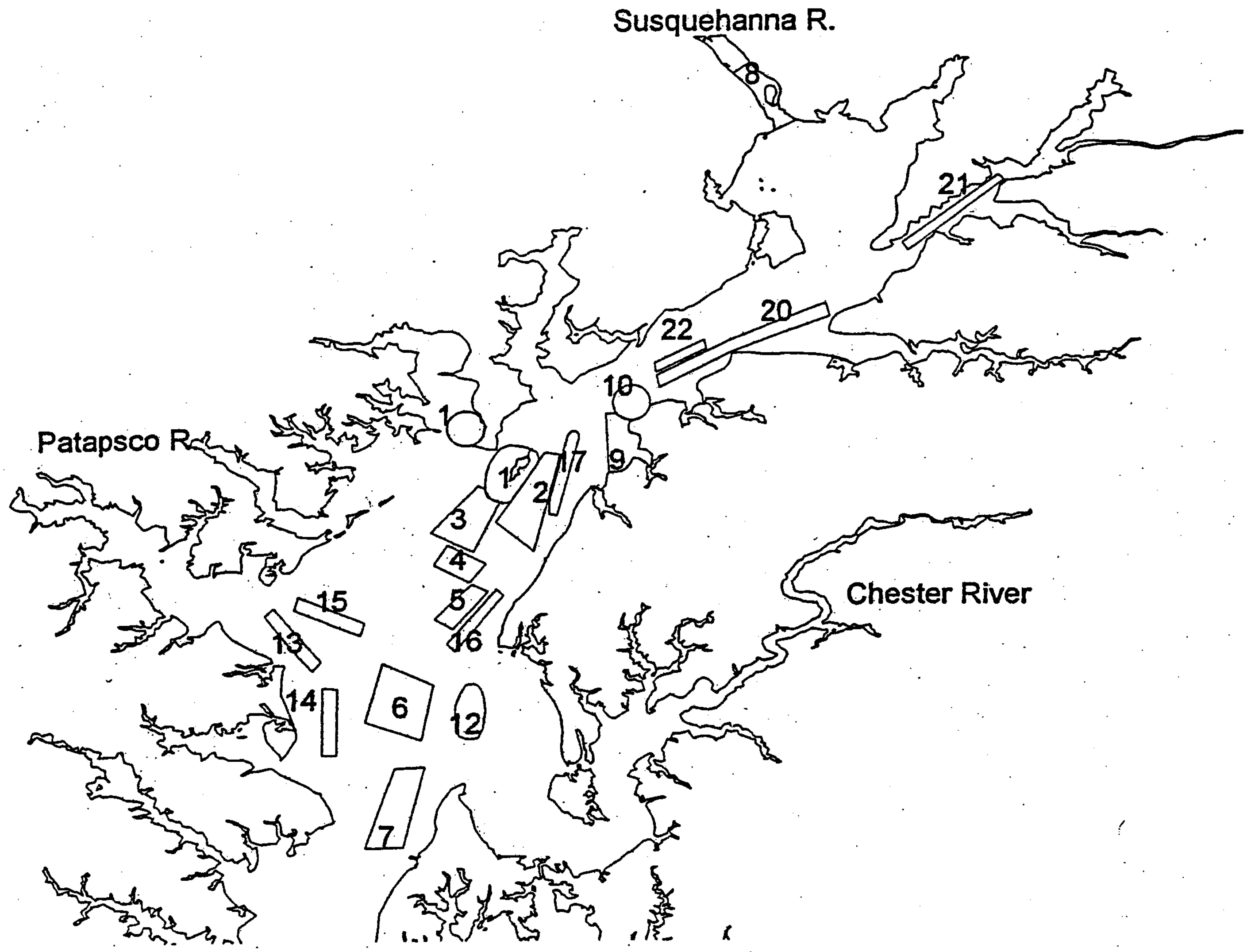


Figure 1. Site locations where gillnets were deployed in the Upper Chesapeake Bay, Maryland (see Table 1).

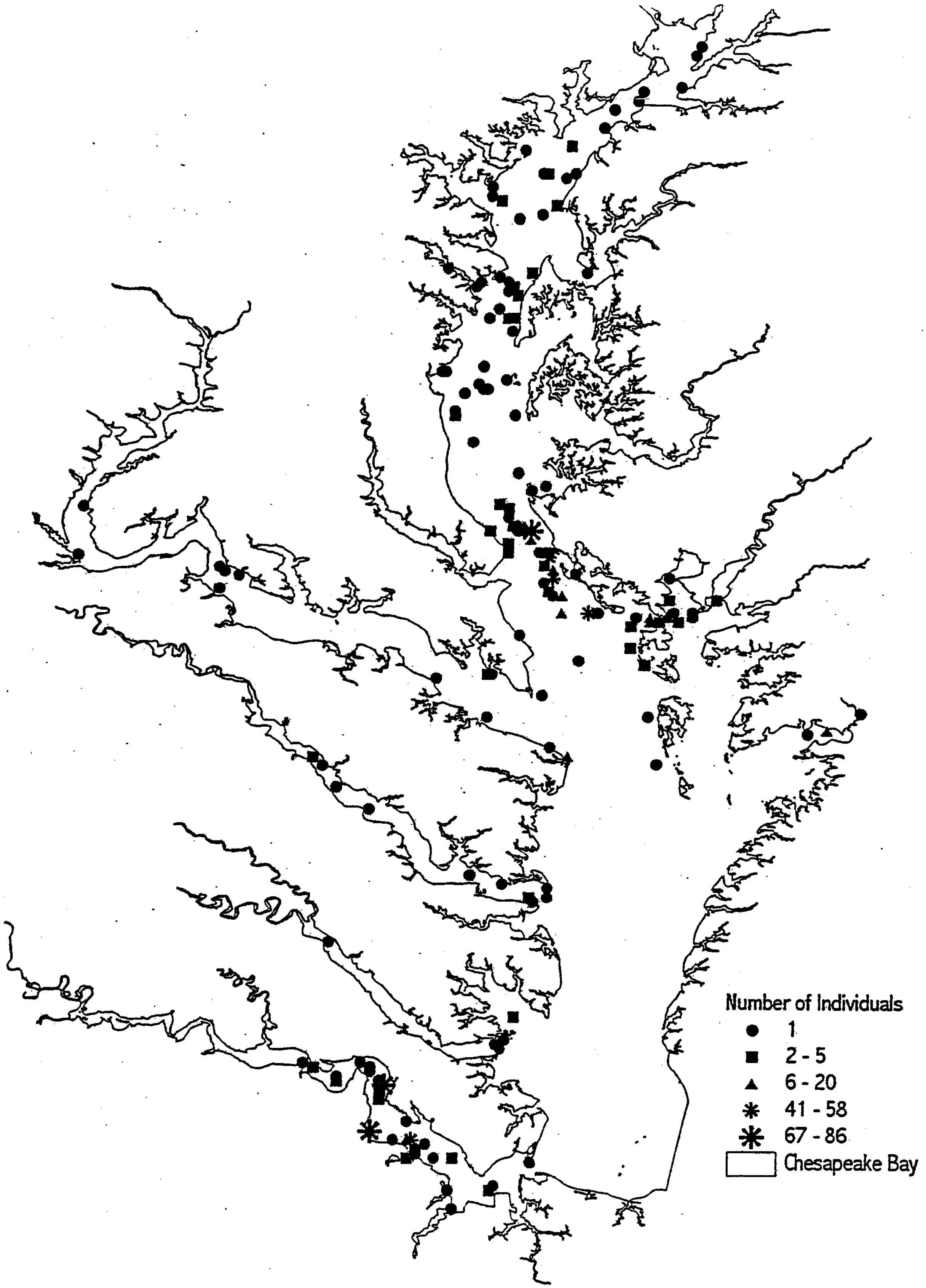


Figure 2. Capture locations of wild Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Virginia data provided by A. Spells (USFWS).

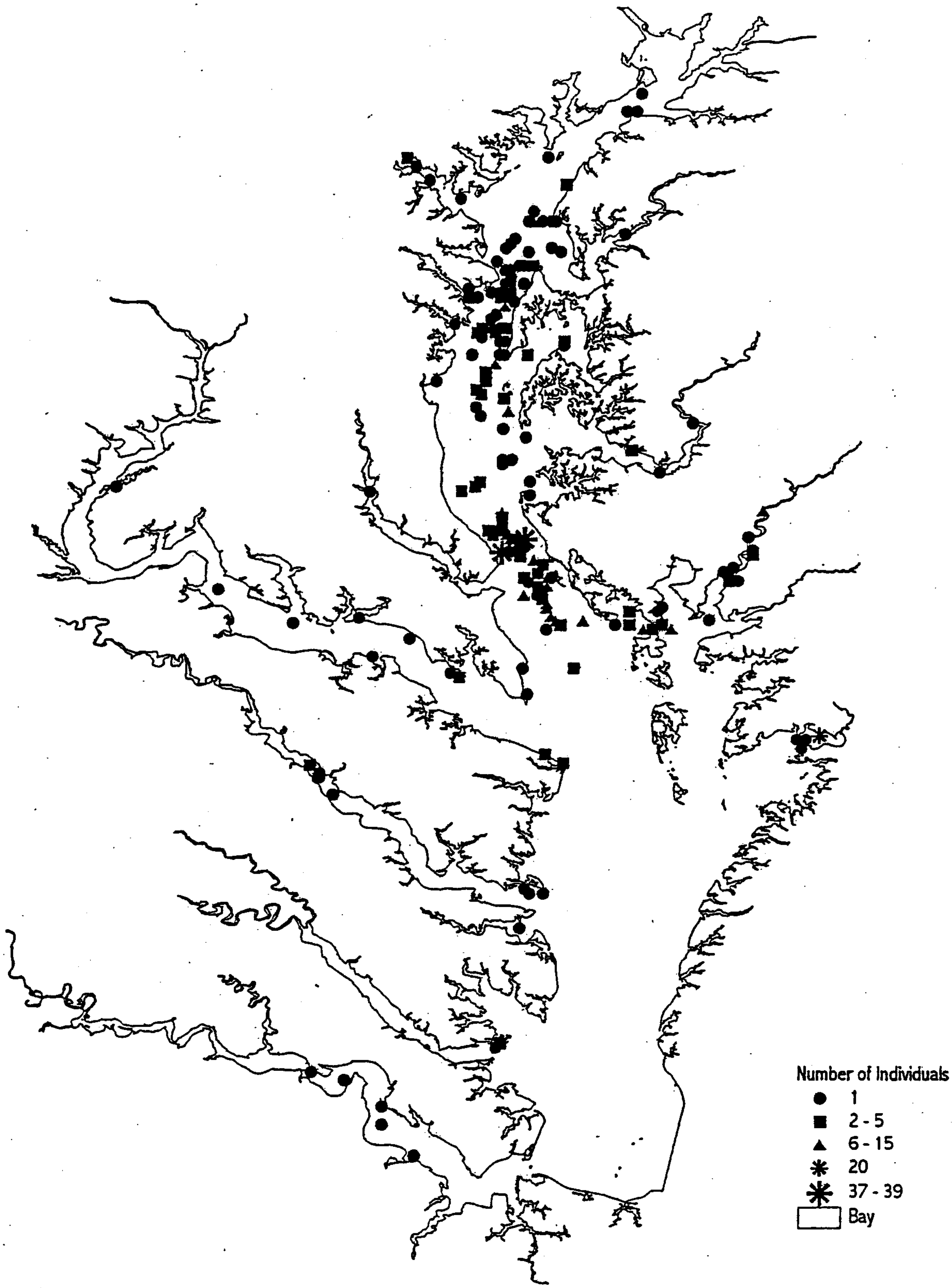


Figure 3. Capture locations of hatchery-reared Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Virginia data provided by A. Spells (USFWS).

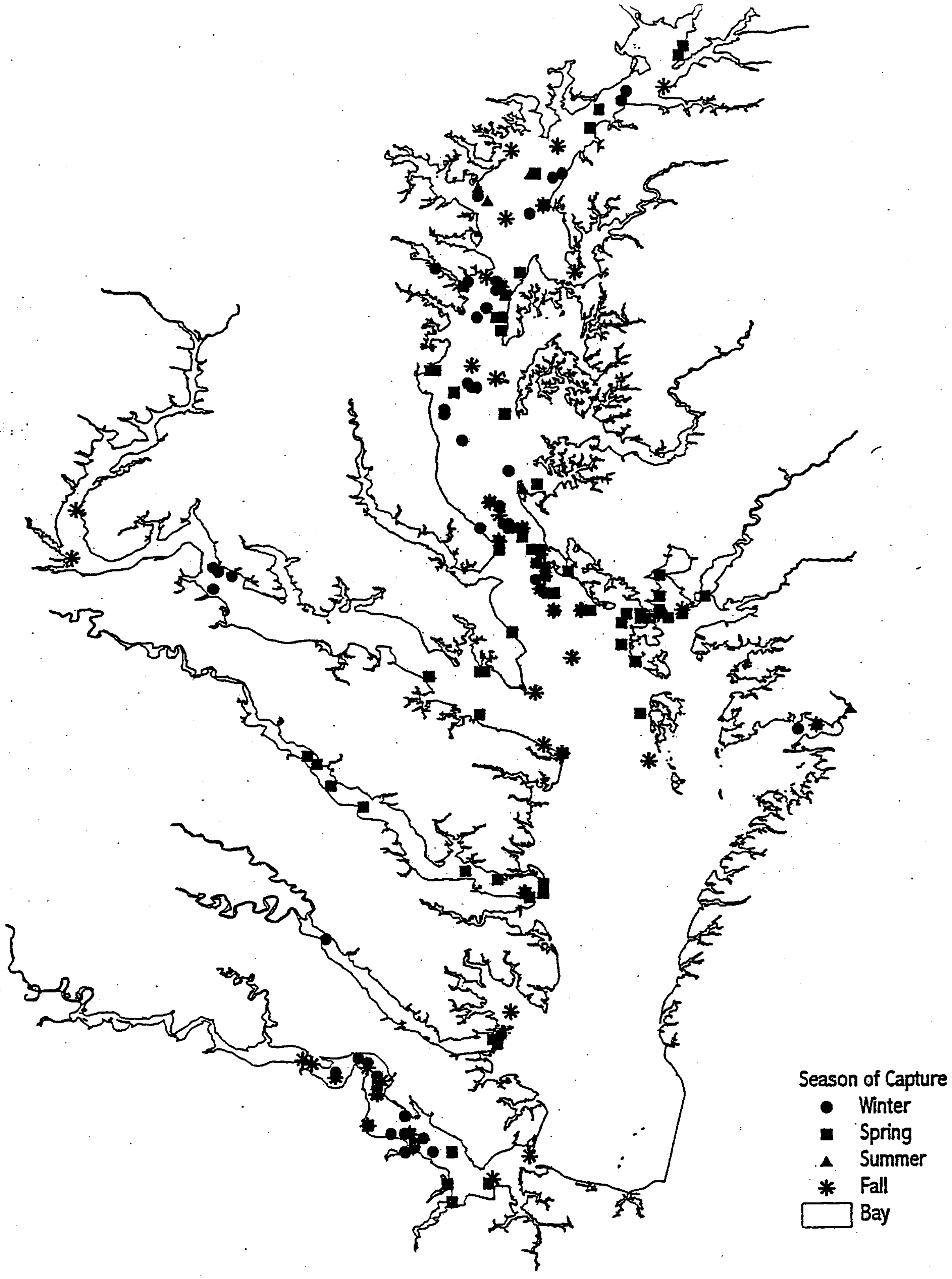


Figure 4. Capture locations of wild Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Locations are categorized by winter (months 1,2 and 3), spring (months 4,5 and 6), summer (months 7,8 and 9), and fall (months 10, 11 and 12).

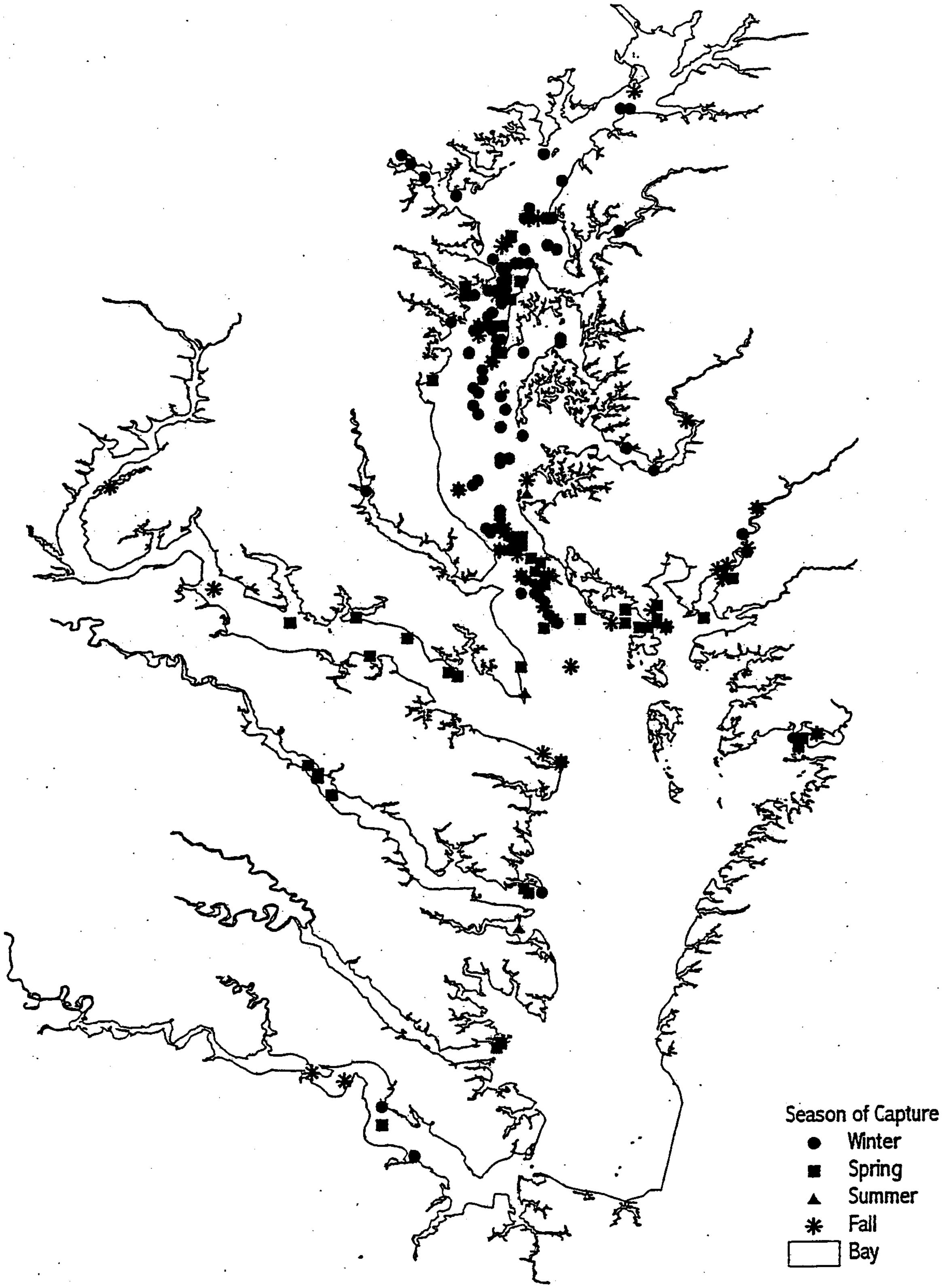


Figure 5. Capture locations of hatchery-reared Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Locations are categorized by winter (months 1,2 and 3), spring (months 4,5 and 6), summer (months 7,8 and 9), and fall (months 10, 11 and 12).

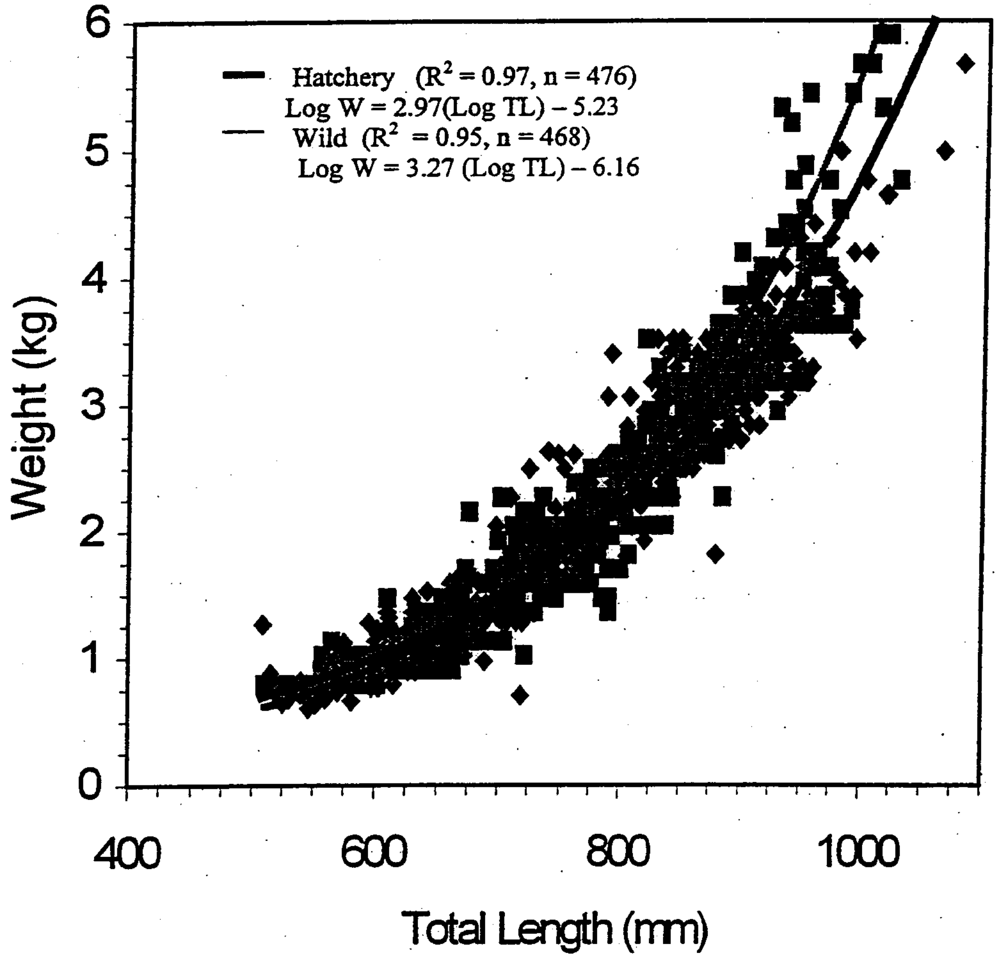


Figure 6. Weight-length relationship from wild (range 445-1100 mm TL) and hatchery-reared (range 465-1100mm TL) Atlantic sturgeon from Chesapeake Bay.

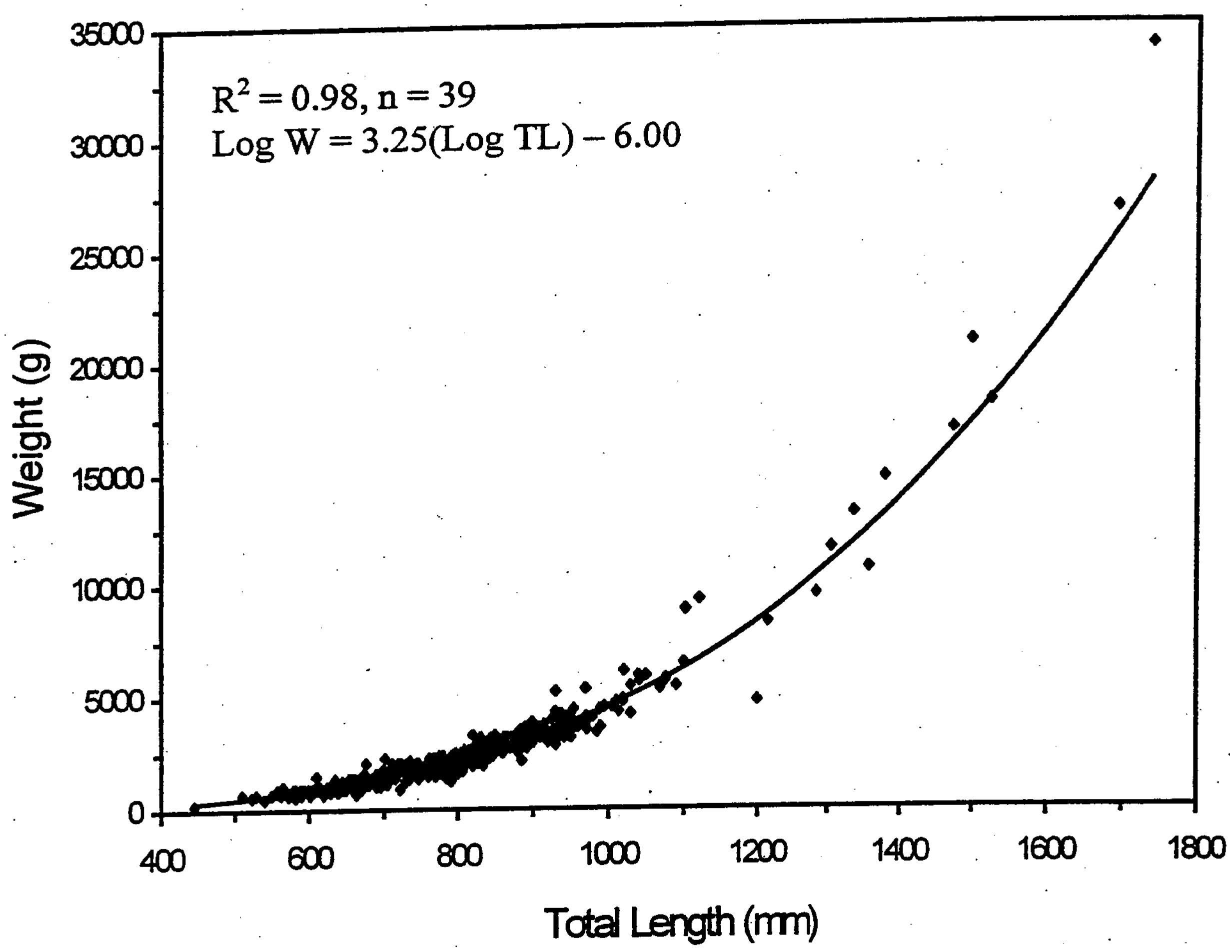


Figure 7. Weight-length relationship for wild Atlantic sturgeon (range 445-1740 mm TL) from Chesapeake Bay.

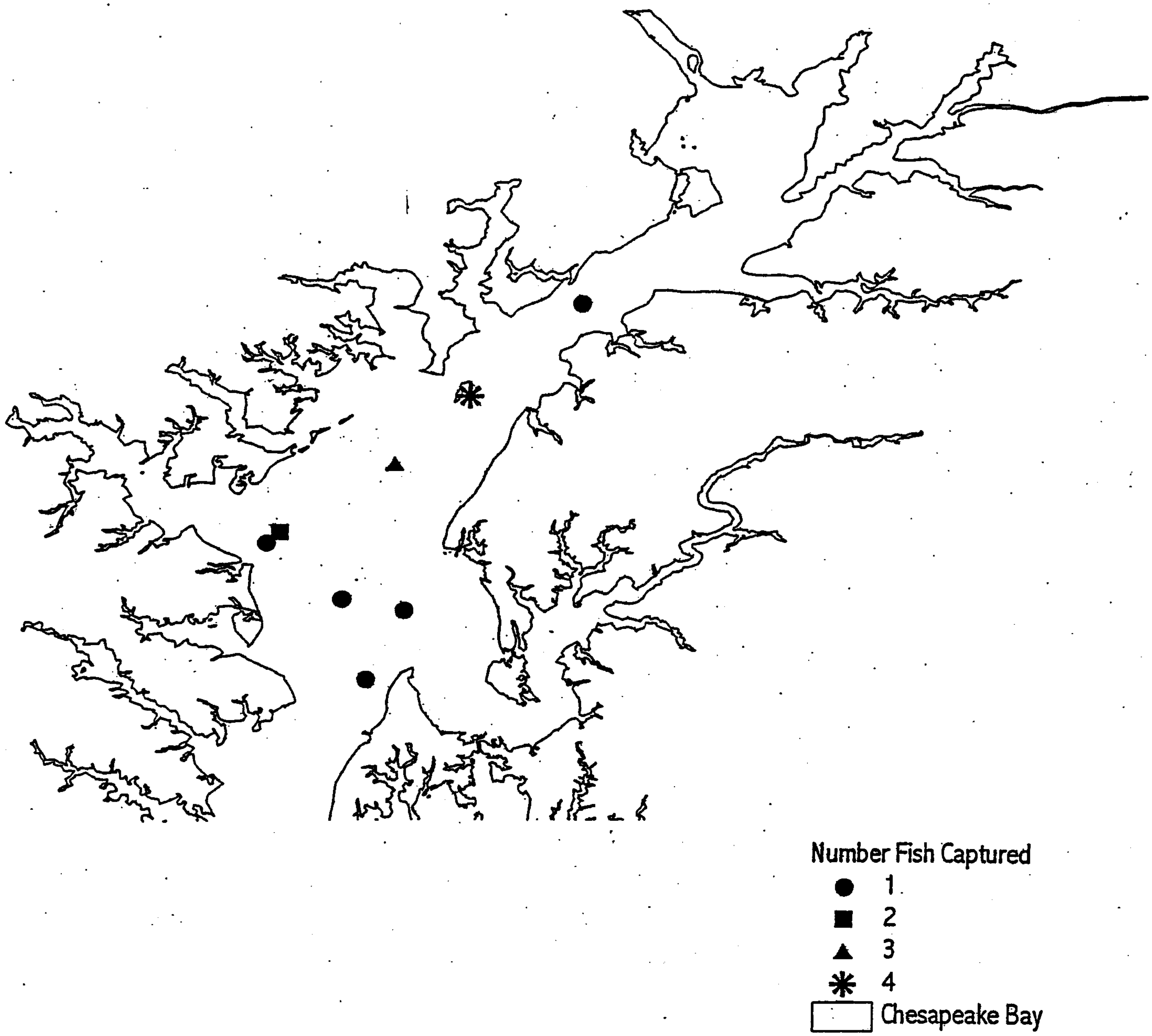


Figure 8. Locations of Atlantic sturgeon captured in Maryland Fisheries Resource Office gillnets in the Upper Chesapeake Bay, Maryland during (1998-2000)

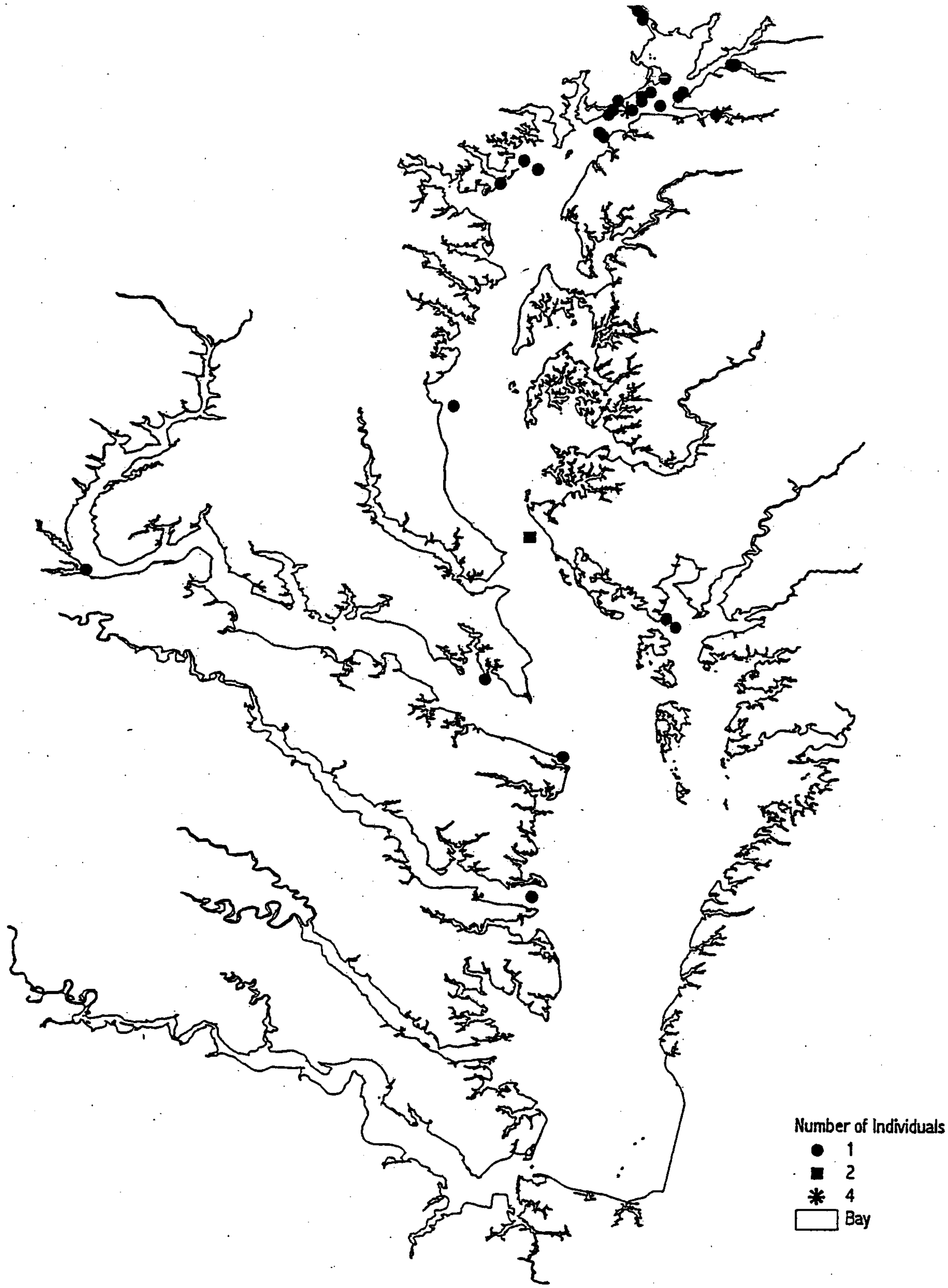


Figure 9. Capture locations of shortnose sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Virginia data provided by A. Spells (USFWS).

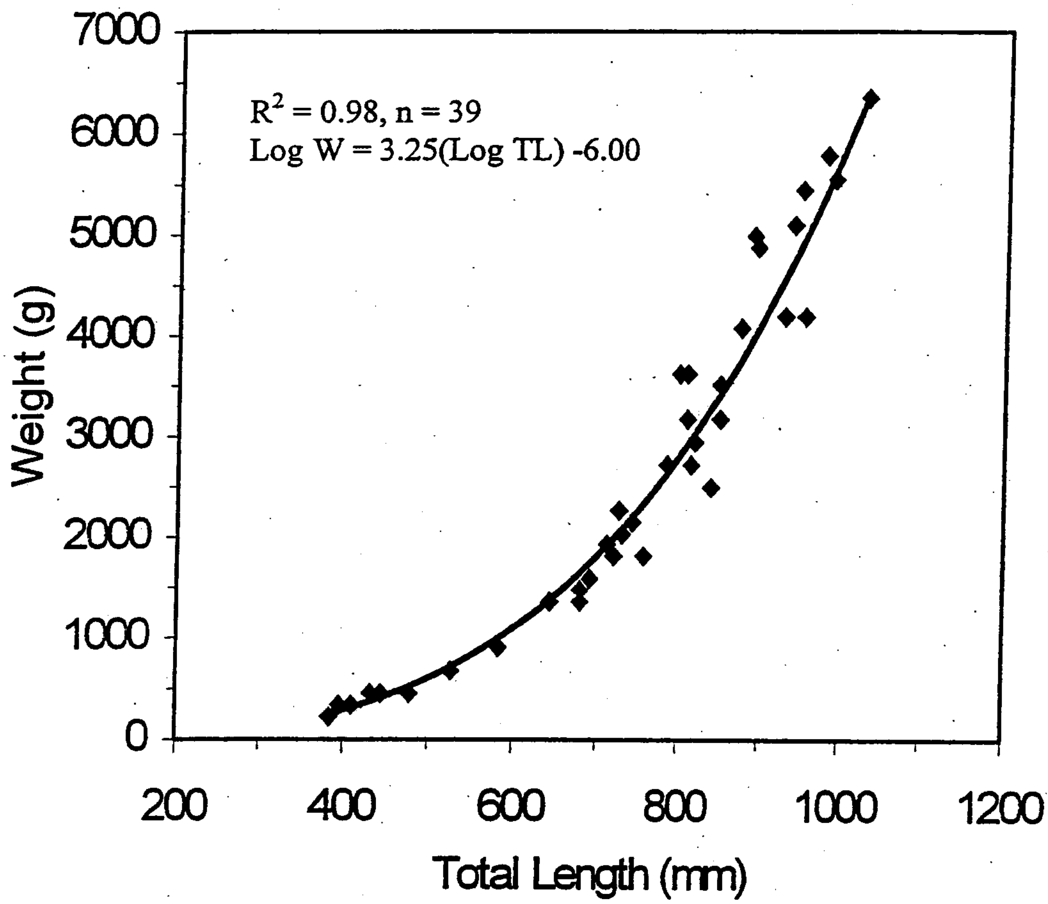


Figure 10. Weight-length relationship for shortnose sturgeon (range 384 - 1030 mm TL) from Chesapeake Bay.

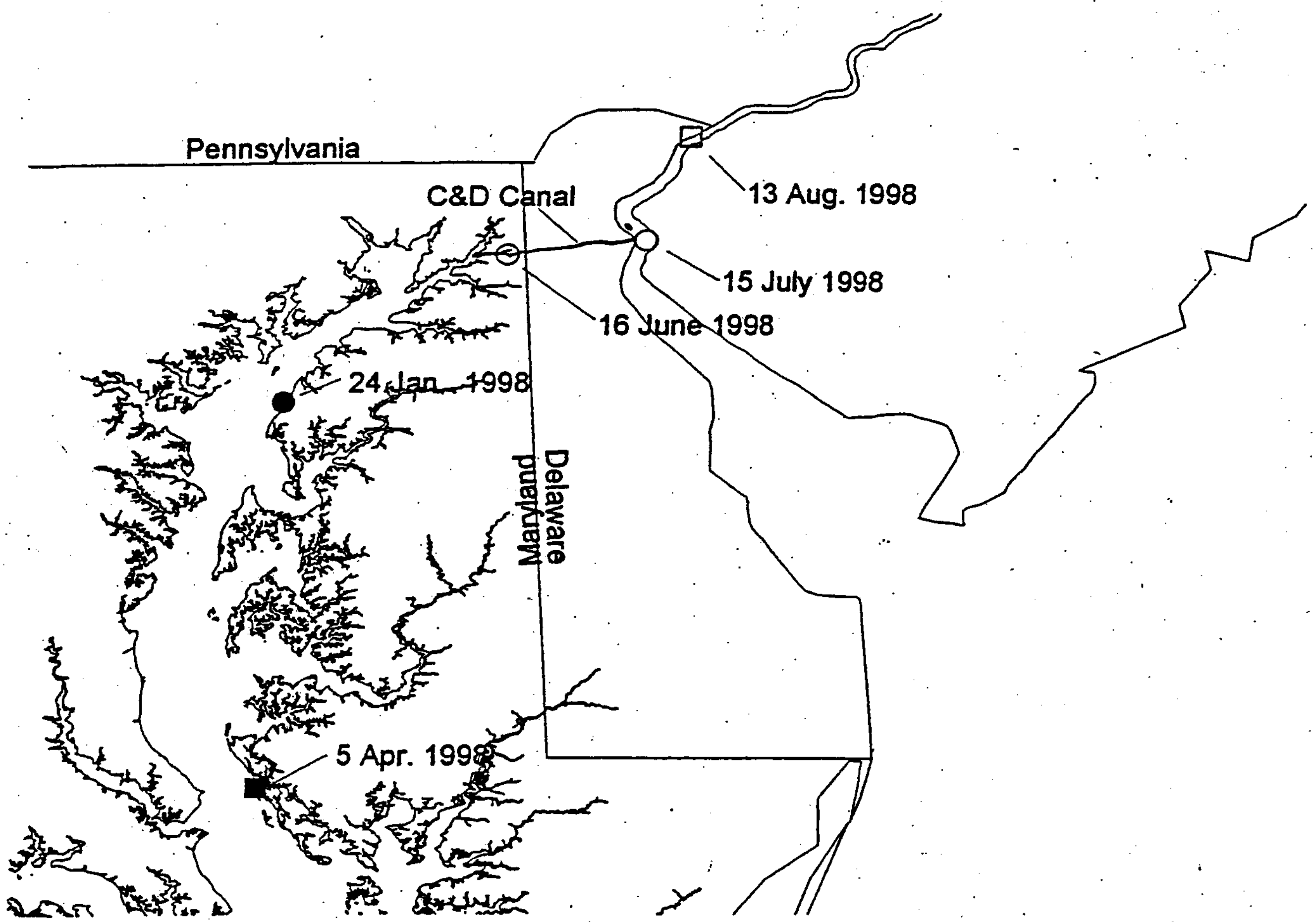


Figure 11. Tag and release locations (closed symbols) of two shortnose sturgeon in the Chesapeake Bay that were located by telemetry (open symbols) in the Delaware River.

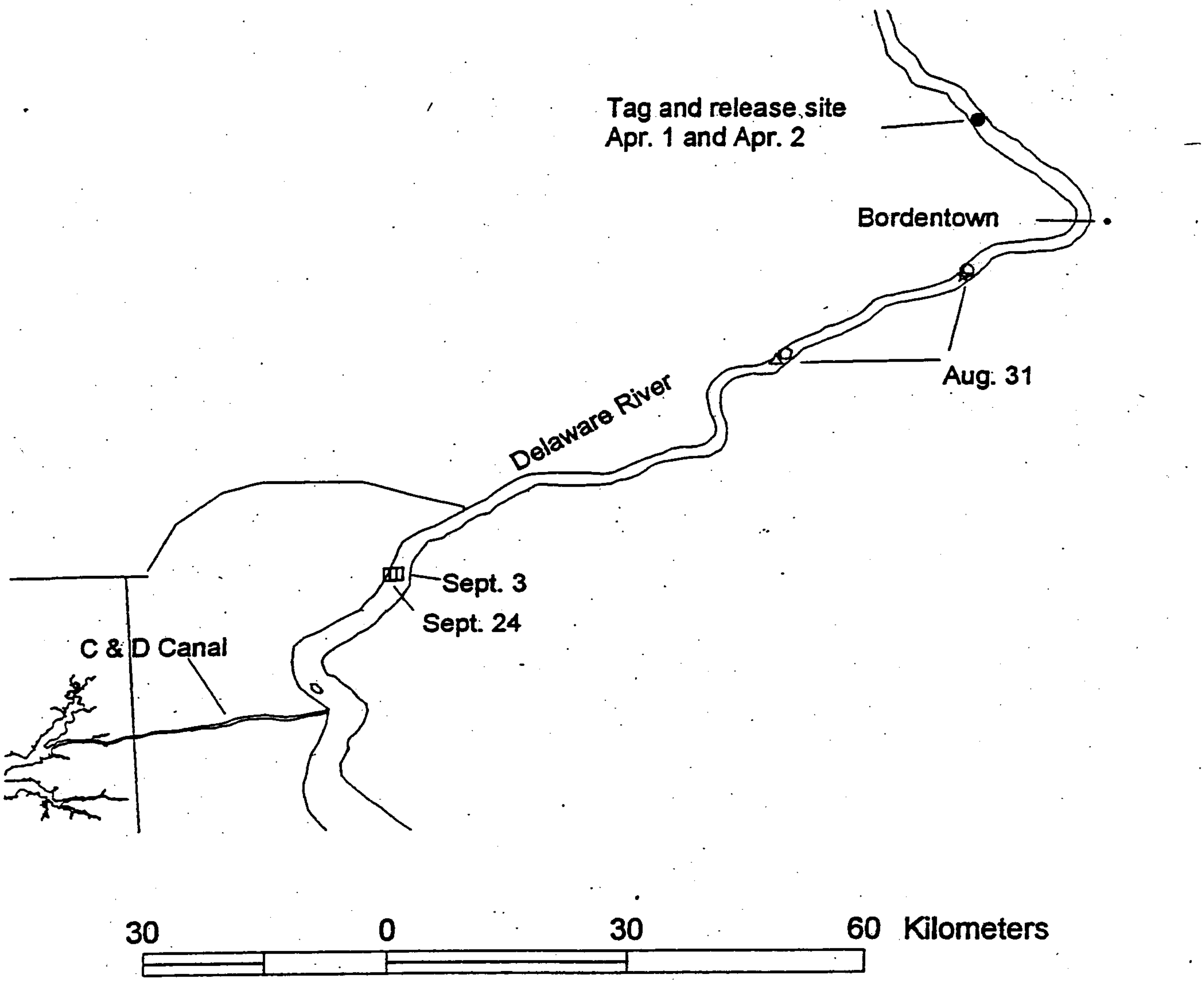


Figure 12. Movements of five shortnose sturgeon in 1998 released on 1 April or 2 April. Fish locations (open symbols) were determined by telemetry.

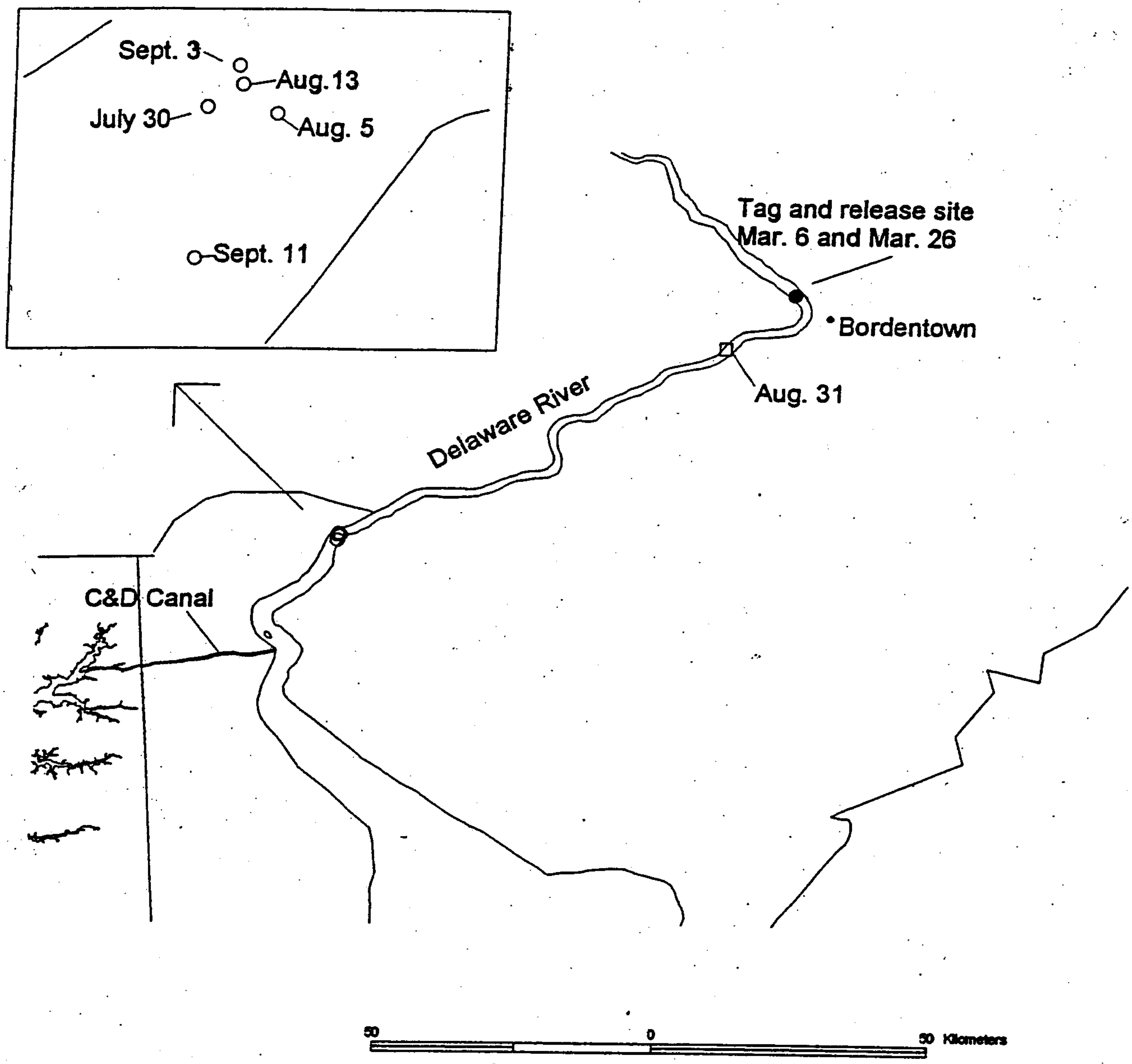


Figure 13. Movements of two shortnose sturgeon released at the same location in March 1998. Fish locations (open symbols) were determined by telemetry for individuals released on 6 March (square) and 26 March (circle).

APPENDIX A

Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay

Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay

An Atlantic Coastal Fisheries Cooperative Management Act Report

For
National Marine Fisheries Service

By
Albert J. Spells
U.S. Fish And Wildlife Service
Virginia Fisheries Coordinator
Charles City, Virginia

Fiscal Year 1998

Atlantic sturgeon population evaluation... a fishery dependent reward program in Virginia: FY98

The National Marine Fisheries Service provided Atlantic Coastal Fisheries Cooperative Management Act funds to the U.S. Fish and Wildlife Service to assess the absence or presence of Atlantic sturgeon in the major western shore tributaries (James, York and Rappahannock River Systems) of the Chesapeake Bay in Virginia in FY98. Funds were used to pay rewards for sturgeon captured by watermen and held alive for FWS during commercial fishing operations. Other funding agencies for this program included FWS, the Fish and Wildlife Service's Chesapeake Bay/Susquehanna River Ecosystem Team, Virginia Marine Resources Commission, Chesapeake Bay Foundation, and Maryland Department of Natural Resources. Other cooperators included the United States Geological Survey- Biological Resources Division, Leetown Laboratory; the University of Maryland-Chesapeake Bay Laboratory; and the Virginia Institute of Marine Science.

The purpose of the program was to obtain data on the presence of sturgeon in Virginia's major tributaries to the Chesapeake Bay. Objectives included ascertaining age and growth of captured fish, determining genetic diversity among fish captured from the Bay and fish from other Atlantic coast systems. The program consisted of working closely with commercial watermen fishing on the James, York, and Rappahannock Rivers. The partnership offered a $100 reward for each live sturgeon that watermen would retain for the program through November 1997. In February 1998 the reward was reduced to $50 per live sturgeon. Rewards were pad only if captured fish were alive and could be released. Watermen were given several telephone numbers through which they could reach the Fish and Wildlife Service. These numbers were to office phones, cellular phones, and a pager. A Service staff member from the Virginia Fisheries Coordinator Office was on call seven days a week from February through November 1997, and in February 1998.

When we received a call, a staffer was dispatched to the location where the fisherman was holding the fish. Information obtained from fishermen included the location of the capture site, the type of gear, size of gear, depth of water, and quantity of gear. Total and fork lengths were measured, and the fish was weighed. Because Maryland Department of Natural Resources released approximately 3,000 Atlantic sturgeon into the upper Chesapeake Bay during the summer of 1996, a wand type coded wire tag (cwt) detector was used to scan each fish for the presence of a cwt.. Small portions of the caudal fin, and a barbel were collected from each specimen and preserved in pure ethyl alcohol for genetic analysis. A small section of the pectoral spine was taken to ascertain age and growth of a sturgeon captured during the program. Anchor tags were inserted into the right pectoral fin (looking from the rear), and into the left base of the dorsal fin. Sample for genetic analysis were immediately put on ice until the sample could be refrigerated later on.

A total of 303 sturgeon were reported during the program. One sturgeon captured from the Rappahannock River in May has been confirmed as a shortnose sturgeon. This may be the first confirmed living shortnose ever recorded in Virginia. Most fish were captured in anchor gill nets with mesh ranging from three-inch stretch mesh, up to 7-inch stretch mesh. Ninety percent (90%) of all sturgeon captured came from the James River, and 95.7% of all sturgeon captured appear to be wild fish, i.e., no external tag or cwt were observed (Table 1). Hatchery released fish accounted for 1.1%, 33.3 % (of nine fish captured) and 33.3% (21 fish sample), of sturgeon from the James, York and Rappahannock Rivers, respectively. A month-by-month summary of sturgeon captured during the program is attached (Table 2). The month-by-month data do not include several specimen captured by the Virginia Institute of Marine Science juvenile trawl survey program.

Preliminary results of this program suggest that a successful spawn of Atlantic sturgeons in the lower Bay in the very recent past may have occurred. Many small (<500 mm TL) fish were collected during October and November. VIMS captured a 260 mm TL individual in April. A reliable source also reported the capture and release of two sturgeon in the 250-mm size class in the upper James River during the winter of 1997. These specimens were captured with cast nets that were being used to catch bait fish. Preliminary age results from spines indicated that 34% of 85 spines examined from sturgeon examined during this study were age 1. Thirty-nine percent (39%) were age 2 (Dr. David Secor, Chesapeake Bay Laboratory, personal communications).

Sizes of fish captured appear to have been dictated by the target species that watermen were after. During the period that watermen targeted striped bass (February through May), sturgeon averaged 945 mm TL. 805 mm. 811 mm. and 817 mm, In February, March, April and May, respectively. The typical mesh size during the period was 5 inches or more. During October, November and February 1998 when fishermen targeted croaker, weakfish, and perch using three to 3.25 inch mesh, the average size of fish dropped to 510 mm, 504 mm and 543 mm. Due to the nature of the commercial fisheries in Virginia, few watermen fish upriver, and we therefore do not have any fish captured above Jamestown Island in the James River, for example. The U.S. Geological Survey's Biological Resources Division (Leetown Laboratory, WV) has conducted preliminary genetic analysis on tissue samples for DNA markers. Those results are reported in King and Lubinski (1998).

The reward program was suspended in Virginia beginning on November 6 due to a lack of funds. Additional funding was receive to re-start the program in February 1998, but they were expended in four (4) days after the reward was reduced to $50 per live fish. Watermen continued to cooperate regarding keeping incidentally caught fish alive, and waiting with the fish until someone could process the data. A reward amount lower than $50 per live fish may not encourage participation by many watermen. This project should be established as a multi year program to determine any trends in the numbers and sizes of fish in Virginia tributaries.

Table 1. Atlantic sturgeon* reported during the sturgeon reward program in Virginia's tributaries of the Chesapeake Bay, February-November 5, 1997, and February 10 - 13, 1998 (USFWS).

River	Total Fish Captured	Wild Fish Captured	% of Total	Hatchery Fish Captured	% of Total
TOTAL	303	290	95.7	13	4.2
James	273	270	98.9	3	1.1
York	9	6	66.7	3	33.3
Rappahannock	21	14	66.7	7	33.3

*One sturgeon from the Rappahannock River was confirmed as a shortnose sturgeon.

Table 2. Month by month summary of sturgeon data collected during the reward program in Virginia's tributaries to the Chesapeake Bay, February - November 3, 1997, and February 10-13, 1998 (USFWS)

River		MONTH				
		Feb	Mar	Apr	May	Jun
James	# Cap/# Hat.	2/0	10/2	14/1	18/0	2/0
	Avg. TL/Hat.	945/-	805/575	811/815	817/-	648
	Size Range/(Hat.)	835-1055(-)	440-1030(510-640)	260-1390(815)	510-1700(-)	420-931
York	# Cap/# Hat.	1/0	2/1	3/2	1/1	0/0
	Avg. TL/Hat.	625/-	1150(630)	675/683	759/-	-
	Size Range/Hat	-	-	675(680-687)	-	-
Rapp	# Cap/# Hat.	0/0	1/1	14/5	4/0	1/1
	Avg. TL/Hat.	-	-/595	716/647	630/-	-/630
	Size Range/Hat	-	-	506-993(508-744)	506-708(-)	-

River		MONTH					
		Jul	Aug	Sep	Oct	Nov	Feb
James	# Cap/# Hat.	1/0	2/0	4/0	90/0	30/0	69/0
	Avg. TL/Hat.	875/-	-	470/-	510/-	504/-	543/-
	Size Range/Hat.	-	-	445-495(-)	402-2600(-)	442-940(-)	438-953
York	# Cap/# Hat.	0/0	0/0	1/0	0/0	0/0	0/0
	Avg. TL/Hat.	-	-	615/-	-	-	-
	Size Range/Hat	-	-	-	-	-	-
Rapp	# Cap/# Hat.	0/0	0/0	0/0	1/0	0/0	0/0
	Avg. TL/Hat.	-	-	-	1004/-	-	-
	Size Range/Hat	-	-	-	-	-	-

Cap./# Hat = Number of fish captured/# hatchery fish recaptured
Avg. TL/Hat. = Average Total Length (mm) of all wild fish captured*/Average Total Length(mm) of hatchery fish recaptured
Size Range/Hat. = Size range (Total Length, mm)of wild fish/size range (Total Length, mm) of recaptured hatchery fish

*All fish not possessing an external tag or cwt indicating that they were hatchery fish are considered wild until proven otherwise, e.g. DNA analysis

References

King, T.L., and Lubinski, B.A. 1998. Conservation genetics of Atlantic sturgeon (*Acipenser oxyrinchus*): marker development and identification of genetic diversity (Status Report). USGS-BRD, Aquatic Ecol. Lab., Leetown, WV.

Appendix C

Transmittal Letter to USFWS for Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon November 2000

November 13, 2000

Operations Division

Mr. John Wolflin
Field Supervisor
U.S. Fish & Wildlife Service
177 Admiral Cochrane Drive
Annapolis, Maryland 21401

Dear Mr. Wolflin:

I am enclosing a copy of the *Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon, June 2000,* for your information, review, and comment.

The Interim Biological Assessment (BA) reflects most of the results of the two and one-half-year sturgeon study conducted by your office. Copies of the Interim BA and *A Report of Investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay, October 2000* were sent to the National Marine Fisheries Service (NMFS) for review and comment. Upon receipt of comments from the NMFS and your office, and receipt of the genetic analyses reports, we will incorporate this information together with the findings of your report in the final BA and forward a copy to your office for information.

I received Mr. Skjeveland's October 17, 2000 proposal to continue tagging and tracking sturgeon for an additional year. We will continue to cooperate with the NMFS and the FWS in this endeavor. Details of the study will be worked out upon Mr. Skjeveland's return to the office.

Please provide any comments on the Interim BA before December 15, 2000. Please call me at 410-962-5657 if you have any questions regarding this matter.

Sincerely,

Jeffrey A. McKee
Operations Manager
Operations Division

Enclosure

McKEE/CENAB-OP/nls/25657

FILE: WORD\BALTIMORE\FWS-STUR-BA

Appendix D

Transmittal Letter to NMFS for Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon November 2000

November 13, 2000

Operations Division

Dr. Chris Mantzaris
United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
One Blackburn Drive
Gloucester, Massachusetts 01930-2298

Dear Dr. Mantzaris:

I am enclosing a copy of the draft *Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon, June 2000,* and the U.S. Fish & Wildlife Service's (FWS) *A report of investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay, October 2000*, for your information, review, and comment.

The Interim Biological Assessment (BA) and FWS report were prepared in response to the National Marine Fisheries Service's (NMFS) October 20, 1997, and December 18, 1999, letters requesting that the Baltimore District initiate consultation with the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act, conduct a two-year sampling and tracking program to collect information on the distribution and habitat requirements of the shortnose and Atlantic sturgeon in the upper Chesapeake Bay, study the ecology and genetics of the shortnose sturgeon in order to evaluate the potential impacts of dredging and dredged material placement on the shortnose sturgeon in the upper Chesapeake Bay, and prepare a biological assessment. The Interim BA and FWS report reflect the results of the two and one-half-year conducted by the FWS under contract to the Corps of Engineers. The final results of the genetic testing are expected within the next several weeks. Upon receipt of the genetics report and any comments on the Interim BA, we will finalize the BA and forward it to your office for use in preparing a biological opinion.

The FWS recently approached us about continuing to tag and track sturgeon for an additional year. The scope of work for this additional work has been coordinated with your staff. We will cooperate with the NMFS and the FWS in this endeavor.

Please provide any comments on the reports before December 15, 2000. Please call me at 410-962-5657 if you have any questions regarding this matter.

Sincerely,

Jeffrey A. McKee
Operations Manager
Operations Division

Enclosures

Copy Furnished:

Mr. Timothy E. Goodger
Habitat Protection Branch
Environmental Assessment Division
National Marine Fisheries Service
Oxford Laboratory
Oxford, Maryland 21654

McKEE/CENAB-OP/nls/25657

S:\General Correspondence\O P\Baltimore Harbor\NMFSSTURBA.rtf

Appendix E

Carrie McDaniel
NOAA email
dated August 29, 2002

-----Original Message-----
From: Carrie Mcdaniel [mailto:Carrie.Mcdaniel@noaa.gov]
Sent: Thursday, August 29, 2002 5:16 PM
To: Jeff McKee
Cc: Kim Damon-Randall; Pasquale Scida
Subject: Upper Bay dredging

Hi Jeff-
This is in regards to our earlier conversation on your upcoming dredging in the Upper Chesapeake Bay. I understand the ACOE Baltimore District plans to dredge 4 channels beginning in October of this year. I believe these 4 channels include the Craighill Entrance, Craighill Channel, Craighill Upper Range, and Cutoff Angle; please let me know if this isn't the case.

NOAA Fisheries previously has had limited information on the potential for sturgeon to be taken in mechanical dredges. As such, previous letters to you (dated October 1997; January 1998; December 2000) indicated that if a mechanical/clamshell dredge was used in ACOE Baltimore maintenance dredging, shortnose sturgeon were not likely to be adversely affected. As I mentioned on our call, new information has come up that indicates sturgeon may be taken in these types of dredges. For example, an Atlantic sturgeon was killed in the Cape Fear River in a bucket and barge operation, and within the last year, an Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and release apparently unharmed during dredging operations in the Kennebec River. While these documented takes have been Atlantic sturgeon, the similarity of the species, distribution, and behavior, indicates that shortnose sturgeon could be taken as well. Endangered species takes of these kind are not authorized without an Incidental Take Statement. While the impacts to shortnose sturgeon from mechanical bucket dredging are expected to be less than those from other types of dredges (e.g., hopper and hydraulic pipeline), the potential for taking shortnose sturgeon with this type of dredge exists. Furthermore, dredging in the Delaware River and Kennebec River have incorporated mechanical dredging time of year restrictions due to the presence of shortnose sturgeon.

This represents new information that was not available to NOAA Fisheries during the last consultation, and this information changes the basis for the previous conclusion. We recommend that measures be taken to minimize impacts to shortnose sturgeon during the upcoming dredging projects. Specifically, NOAA Fisheries recommends dredging take place this year from September to November. If this is not possible and mechanical dredging must occur from December to March this year (or a hydraulic dredge is used), we recommend the ACOE initiate formal consultation with NOAA Fisheries so that the impacts of dredging on shortnose sturgeon during this time frame can be assessed. Regardless, if the ACOE plans to use mechanical dredges in the Chesapeake Bay in the future and NOAA Fisheries determines that shortnose sturgeon may be taken during these operations, it will be necessary to engage in formal consultation for all of the Baltimore Harbor Channels to assess the impacts to shortnose sturgeon and provide an Incidental Take Statement.

Please let us know if you have any questions, or if you would rather address these comments in an official letter. Either Kim Damon-Randall or I can discuss these comments with you if you would like. [Kim 978-281-9112; Carrie 978-281-9388]. Thank you.
carrie

Appendix F

Kimberly Damon-Randall
NOAA email
dated October 29, 2002

-----Original Message-----
From: Kimberly.Damon-Randall [mailto:Kimberly.Damon-Randall@noaa.gov]
Sent: Tuesday, October 29, 2002 7:25 AM
To: Mckee, Jeffrey A
Cc: Carrie Mcdaniel; Pasquale Scida; Mary A Colligan
Subject: dredging and dredge placement in the upper Chesapeake Bay

Hi Jeff. I have been working with Carrie McDaniel regarding the proposed dredging in the upper Chesapeake Bay. We have reviewed the biological assessment (BA) that was prepared in 2000, and we believe the ACOE has done a thorough job with the BA. However, several sections need to be updated with new information collected since June 2000. Those sections include: the information related to dredging and shortnose sturgeon, all details related to the proposed project (i.e., what has happened with the ACOE's schedule for dredging, channels to be dredged, placement areas, etc. since 2000), and the dredging impacts to the species (e.g., include details on mechanical takes and any others in hoppers, how species may be impacted given NOAA Fisheries preferred time of year restriction that prohibits dredging from December through the month of July). Also, after having carefully reviewed the information contained in the BA, we recommend the following revisions:

> Page 8: in the fourth paragraph, a reference is made to an interim BO being prepared. NOAA Fisheries does not issue interim BOs.
>
> Page 9: information pertaining to the FWS Reward Program should be updated to reflect the shortnose sturgeon captures since June 2000. As of July 2002, 50 shortnose sturgeon have been documented in the Chesapeake Bay and its tributaries as a result of the Reward Program.
>
> Page 27: last partial paragraph, states that post-spawning adults move to deep overwintering sites. This should be changed to pre-spawning adults as post-spawning adults migrate downstream after spawning to forage, typically in estuarine areas.
>
> Page 29: first full sentence on the page states that after spawning, adults move to deep overwintering sites. After spawning, adults move downstream to forage. This, therefore, should be changed to prior to spawning, adults move to deep overwintering sites.
>
> Page 31: update Reward Program information

The BA states that a bucket, hydraulic, or hopper dredge might be used for this project. As such, NOAA Fisheries must assess the effects of each type of dredge on shortnose sturgeon. As Carrie mentioned in her August 29, 2002 email, we have new information on the potential effects of bucket dredging on shortnose sturgeon. An Atlantic sturgeon was killed in the Cape Fear River in a bucket and barge operation (NMFS 1998) and in 2001, an Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and release apparently unharmed during dredging operations at Bath Iron Works in the Kennebec River (Maine DMR 2002). While these documented takes were Atlantic sturgeon, the similarity of the species, distribution, and behavior indicates that shortnose sturgeon could be taken as well. While the impacts to shortnose sturgeon from mechanical bucket dredging are expected to be less than those from other types of dredges (e.g., hopper and hydraulic pipeline), the potential for taking shortnose sturgeon with this type of dredge exists. As such, if the dredging in the upper Chesapeake Bay cannot be accomplished during the preferred time period, formal consultation will be necessary.

I will be the contact person for the consultation. If you have any questions or require further clarification on any of the issues addressed in this email, please feel free to call me at the number provided below or respond to this email. Thanks.

Kim