Chapter 7.3
Status of Molluscan Shellfish Populations in Maryland's Coastal Bays

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Abstract
In 1993 the Maryland Department of Natural Resources (DNR) initiated a comprehensive study to inventory the molluscan fauna of the Coastal Bays. Intended to establish baseline values for future management needs, both commercially important shellfish and ecologically valuable species have been targeted. A total of 63 molluscan species, and an additional 10 species represented only by dead specimens, were collected as part of the most recent DNR molluscan survey. Among the findings characterizing the molluscs of the Coastal Bays were the high species diversity and pronounced geographic heterogeneity, the substantial seasonal and annual variability within these assemblages, and the elucidation of their ecological functions and habitats. The intertidal zone was numerically dominated by the ribbed mussel (*Geukensia demissa*) where it is ecologically important in processing nutrients and binding substrate, especially in salt marshes. As for commercial species, none of the 28 documented shell bars in the Coastal Bays have living oysters (*Crassostrea virginica*) and many of the bars are buried under sediment; presently there is only one small oyster population inhabiting a subtidal relic bar in southern Chincoteague Bay. The 2008 ban on mechanical harvesting in the Coastal Bays has had mixed results for the hard clam (*Mercenaria mercenaria*) populations. While hard clam densities have climbed in Isle of Wight Bay and are approaching historical high levels, the Chincoteague population remains at about 25% of estimates made 45 to 60 years ago. Bay scallops (*Argopecten irradians*), which had occurred in most of the Coastal Bays during the early 2000s, have not been observed in Chincoteague since 2005. Some scallops still inhabit the northern bays, albeit in very low numbers. The high degree of spatial and temporal variability due to physical and biological factors within the Coastal Bays creates difficulty in drawing strong conclusions about trends in molluscan population and community dynamics. Consequently, DNR continues to track the population status of select species.

A. Molluscan Community

Mollusc Introduction
The significance of molluscs to the estuarine ecosystem has long been recognized. Over 120 years ago the concept of an ecological community was developed through observations of the faunal assemblages of oyster reefs. Functionally, molluscs serve as a key trophic link between primary producers and higher consumers. Bivalves in particular are important as biogeochemical agents in benthic-pelagic coupling, cycling organic matter from the water column to the bottom. Predatory gastropods contribute to structuring prey assemblages and parasitic snails may serve as disease vectors within host populations. In addition, molluscs can have a pronounced impact on the physical structure of an ecosystem, whether by reworking the sediment, grazing, binding or securing existing substrate, or building new substrate such as oyster reefs. Aside from their ecological roles, many molluscs are commercially valuable, both directly as a harvestable

resource and indirectly as a food source for commercially and recreationally important species including crabs, fish and waterfowl. Some of the potential threats to molluscs in the Coastal Bays include diseases, loss of habitat, invasive species such as green crabs (*Carcinus maenas*) and harmful algal blooms like brown tide (*Aureococcus anophagefferens*).

Molluscan Community Data Sets

Assateague Ecological Studies, 1969-71. Data are as number per m^2 and in tables, sample sites are given on maps.

Maryland Department of Natural Resources surveys, 1980-81. Most samples were from Isle of Wight. Data are in tables (number per unit area) with map of sampling sites.

Coastal Bays Joint Assessment, U.S. Environmental Protection Agency E-MAP Surveys, 1993. Data presented in tables. Sites are depicted on maps. Latitude/longitude sample site information is available from U.S. Environmental Protection Agency.

Mid-Atlantic Integrated Assessment, MAIA, Iteration of E-MAP. Twenty-one sites were sampled between 1997 and 1998. Focus was on Sinepuxent and lower Chincoteague Bays.

National Coastal Assessment, Iteration of E-MAP Surveys, 2000-03.

National Park Service, 1994-96. Box core and trawl samples in Chincoteague and Sinepuxent Bays. Includes seasonal data. Data available from NPS.

Maryland Department of Natural Resources Molluscan Inventory, 1993-96. Population data were collected on individual species (density, distribution, size-frequencies, animal-sediment relationships) and community analyses from Ponar grab, hydraulic dredge, and shoreline quadrat samples. Data are available with geographic and habitat information. This three-year study represents the most comprehensive inventory of molluscan fauna in the coastal bays conducted to date.

Management Objective

Maintain optimum sustainable shellfish abundances.

Molluscan Community Indicators

A. Primary (all species)

1. Species (Genus species)
2. Density (# live/unit area)
3. Geographic Distribution (lat/long; bay or tributary; sub-bay or region)

B. Secondary (species of particular interest)

1. Size-Frequency Distribution (% frequency)

C. Tertiary (species of particular interest)

1. Mortality

a) Natural (boxes/unit area)
b) Harvest (commercial landing records)

2. Disease

Data Collection
Between October 1993 and September 1996, the DNR Shellfish Program carried out a comprehensive effort to inventory the molluscan fauna of Maryland's coastal bays and major tributaries including the St. Martin River and Greys, Turville, and Herring creeks. Intended to establish baseline values for future management needs, both commercially important molluscs and ecologically valuable species were targeted. During the 3-year period approximately 1,800 stations were sampled using five different collection methods including hydraulic escalator dredge, oyster handscrape, Ponar sampler, clam rake and intertidal quadrat. For an account of molluscan sampling, see Tarnowski 1997b.

Molluscan Community Results
Over 50,000 live individuals comprising 63 mollusc species were collected; an additional 10 species were represented by dead specimens only (for a species list, see Appendix A of this volume). Sixteen of these species had not been reported in previously published accounts of the Coastal Bays, including three northward range extensions.

A total of 1,020 Ponar bottom grab samples generated information on population and community parameters such as species composition and hierarchy, distribution, richness, abundance, size structure, and habitat characterization. Among the findings was the highly diverse nature of the coastal bays molluscan communities; the significantly lower molluscan abundances and species richness in the coastal tributaries when compared with the bays; the strong relationships of the species with habitat types including sediment, vegetation, shell cover and other biogenic structures; the elucidation of ecological communities and functions of the coastal bays molluscs; the pronounced geographic heterogeneity of the assemblages; and the distinctive and substantial variability in the molluscan community over time, both on a seasonal and annual basis. Because the Maryland coastal bays are situated at the overlap of two faunal provinces, shifts in community composition may serve as an indicator of climatic change. However, the spatial and temporal variability due to physical and biological factors can confound short-term attempts at detecting disturbances, whether natural or anthropogenic.

In addition to the bottom grab survey, 67 intertidal shoreline quadrat stations and nine intertidal structure stations were sampled. The intertidal zone was numerically dominated by the ribbed mussel (*Geukensia demissa*) where it is ecologically important in processing nutrients and binding substrate, especially in salt marshes. Man-made intertidal structures can provide additional scarce, hard substrate as a supplement, but not substitute, for existing natural intertidal shoreline.

B. Hard Clams

Introduction
The hard clam (*Mercenaria mercenaria*) has long been an important species both in terms of

sustenance and commerce. In addition to being items of food for the indigenous people of the Coastal Bays, the clams were highly valued as a source of purple shell for making wampum beads, the common currency of exchange among tribes all along the Atlantic coast. During recent times, the hard clam was one of the species that flourished in the coastal bays after the Ocean City Inlet opened in 1933. Prior to that time, the population was confined to the higher salinities in southern Chincoteague Bay. Significantly, the improvement of commercial shellfish resources was one of the primary rationales for allocating funds to construct and stabilize a new inlet. Just before construction was to begin, a hurricane serendipitously breached the island at the southern edge of Ocean City, which the Army Corps of Engineers quickly stabilized. New clam populations and an associated fishery consequently developed throughout the bays. Since the 1960s, the hard clam has supplanted the oyster in commercial landings and value in the Coastal Bays, and is the basis of a recreational fishery, especially for tourists that visit the region during the warmer months. However, with the 2008 prohibition of mechanical harvesting for shellfish in the Coastal Bays, the commercial fishery has been practically eliminated.

Hard Clam Data Sets

Maryland Department of Research and Education. 1952-53. System-wide hard clam study includes density, distribution, size structure, and habitat.

University of Maryland Assateague Ecological Studies. 1969-70. Same data classes as above, with emphasis on eastern Chincoteague Bay. No samples above the Ocean City Inlet.

Maryland Department of Chesapeake Bay Affairs; Maryland Department of Natural Resources. 1968-71. Surveys of commercial hard clam areas.

Maryland Conservation Department; Bureau of Natural Resources; Dept. Chesapeake Bay Affairs. 1928-1969. Annual Reports. Annual landings and licensing data as well as occasional anecdotal information.

Maryland Department of Natural Resources Shellfish Program. 1993-present. System-wide hard clam surveys includes density, distribution, size structure, habitat and other organisms. Bay scallops and other select species are included in this survey, in addition to limited surveys dedicated to scallops.

Management Objectives

Maintain optimum sustainable clam abundances.

Hard Clam Indicators

1. Density (# live/unit area)
2. Geographic Distribution (lat/long; bay or tributary; sub-bay or region)
3. Length-Frequency Distribution (% frequency)
    a) Recruitment (% sublegal clams 31-50 mm shell length)
    b) Average length
4. Mortality
    a) Natural (% dead)

b) Fishing (commercial landings records)
5. Disease

Data Collection
Since 1993, the Maryland Department of Natural Resources Shellfish Program has conducted annual surveys of the hard clam population in Chincoteague Bay. These surveys were expanded in 1994 to include the remainder of the Coastal Bays. A commercial hydraulic escalator dredge is towed along a 76.2 m transect at each site, effectively sampling 58.1 m^2 of bottom. The number of stations has increased over the years; since 2012 a minimum of 260 randomly-selected samples have been taken. Sampling is stratified by embayment, with Chincoteague Bay being further quartered. In addition, since 2012 Sinepuxent Bay has been stratified into two (upper and lower) sections. A size bias is associated with this gear; it does not adequately sample clams smaller than 31 mm shell length. For more details about hard clam data collection and analysis, see Homer (1997).

Hard Clam Results: Status and Trends

Table 7.3.1 Summary of Maryland Department of Natural Resources Hard Clam Surveys (2007-2013) and 1953 clam densities.

	Seven-Year Averages (2007-2013)					1953
	Total n	Length (mm)	%< 51 mm	% Dead	Live/m^2	Live/m^2
Chincoteague Bay	957	79.1	7.8	3.4	0.18	1.30
Newport Bay	70	80.1	4.6	4.8	0.10	0.40
Sinepuxent Bay	203	79.1	14.0	2.6	0.33	1.04
Isle of Wight Bay	206	70.6	22.5	1.2	0.73	1.19
Assawoman Bay	159	67.9	24.1	1.8	0.28	1.00
St. Martin River[1]	20	76.9	17.0	1.4	0.06	0.14

[1] Surveys in 2008 and 2011.

1. Chincoteague Bay
a) 2013 Status

A total of 140 samples were taken employing a commercial clamming vessel equipped with a hydraulic escalator dredge (Fig. 7.3.1). Average density was 0.24 clams/m^2, ranking Chincoteague Bay fourth among the five bays. Clams were more abundant on the east side of the bay, with highest concentrations in the southeast quadrant (0.32 clams/m^2). The lowest density was in the northwestern quadrant (0.18 clams/m^2). Observed mortality was low - the proportion of boxes in the population was only 2.7%. The average length of the clams was 78.6 mm, with only 6.6% in the 31 - 50 mm size class, indicating relatively low recruitment.

b) 7-Year Trend

Between 2007 and 2013, a total of 957 stations were sampled in Chincoteague Bay, averaging 0.18 clams/m^2 (Table 7.3.1). Despite the 2008 ban on mechanical harvesting, hard clam population densities continued to decline, reaching their lowest point on record in 2010 when densities averaged only 0.12 clams/m^2, or less than 10% of the historical benchmark (Fig. 7.3.2). Thereafter densities climbed back to about the 20-year average of 0.23 clams/m^2. Clam densities were higher on the east side of the bay during this period. Boxes comprised only 3.4% of the population. Recruitment was poor, as reflected by the 2007-13 average clam length of 80.1 mm, with only 7.0% in the 31 - 50 mm size class. In comparison, the 20-year average proportion of these small clams was 10.2%; during the 7-year trend period only 2010 (13.8%) exceeded this (Fig. 7.3.3).

c) 60-Year Benchmark

Four surveys were conducted intermittently over a 17-year interval prior to the most recent DNR effort, but only the 1953 survey included the entire coastal system. Three of the studies were during the 1950s, when the most of the population had been established for only about 20 years. These initial densities were low relative to other regions along the Atlantic coast and steadily declined during this period, from 1.34 clams/m^2 in 1952 to 1.09 clams/m^2 in 1969. Nevertheless, in 1953 Chincoteague Bay had the highest clam densities of the Maryland coastal bays and was ten times higher than the present 7-year average (Table 7.31, Fig. 7.3.2). Mortality data is not available for these surveys. The average length was little different from the present, ranging between 82.5 mm (1952) and 71.9 mm (1969). Recruitment seems to have always been low, with the proportion of clams between 31 mm and 50 mm in length varying from 2.2% in 1952, to 7.6% in 1958, to 14.4% in 1969.

2. Newport Bay

a) 2013 Status

Hard clam densities averaged 0.15 clams/m^2 over 10 stations, the lowest density of the coastal bays (Fig. 7.3.1and 7.3.2). Boxes comprised 1.1% of the Newport Bay population. The average length of these clams was 82.1 mm, with a mere 1.4% of the clams between 31 mm and 50 mm (Fig 7.3.3).

b) 7-Year Trend

Since 2007, a total of 70 samples have been taken in Newport Bay (Table 7.3.1). Clam densities consistently have been the lowest of the five primary coastal bays, averaging 0.10 clams/m^2 (Fig. 7.3.2). Observed mortalities dropped substantially over this period - box counts averaged 4.8% of the population, compared with the 19-yr average of 13.6%. Recruitment was consistently poor, averaging 4.6% of the sampled population between 31 mm and 50 mm in length; two of the years had no sublegal-size clams (Fig. 7.3.3). This is further indicated by the high proportion of larger, older clams, with a 7-year average length of 80.1 mm.

c) 60-Year Benchmark

Newport Bay has always ranked lowest in clam densities among the Maryland Coastal Bays. Between 1952 and 1969, densities dropped from 0.51 clams/m^2 to 0.08 clams/m^2, which is lower than the present population (Fig. 7.3.2). Historic recruitment data are not available.

3. Sinepuxent Bay

a) 2013 Status

The average live clam density of 0.48 clams/m^2 was the highest recorded in Sinepuxent Bay over the 19-year time series, and was the second highest among the Maryland coastal bays this year (Fig. 7.3.2). This was still slightly less than half of the 1953 baseline data. A total of 40 samples were collected, evenly divided between the upper and lower bay (using the Verrazzano Bridge as the demarcation line) (Fig. 7.3.1). Boxes accounted for 1.1% of the population. The average length was 78.2 mm, with 12.4% of the sampled population between 31 mm and 50 mm (Fig. 7.3.3).

b) 7-Year Trend

Sinepuxent Bay live clam densities have been relatively stable since 2007, averaging 0.33 clams/m^2 with 203 samples taken in total (Table 7.3.1). This is almost identical to the 19-year average of 0.32 clams/m^2. More recently, however, the trend has been upward; the peak density of 0.48 clams/m^2 in 2013 was the highest recorded for this bay during the 1994-2013 period (Fig. 7.3.2). The 7-year average observed natural mortality was 2.6%. This is one of the more consistent areas of recruitment; averaged over the past seven years, 14.0% of the clams were less than 51 mm, which is slightly under the 19-year average of 15.9%. Peak recruitment was 34.7% in 2009, after when the proportion of small clams fell below the time series average (Fig. 7.3.3). Despite this influx of small clams into the population, in the absence of harvesting, the average size of individual clams continued to grow, averaging 79.1 mm in length for the last 7-year period. The 19-year average was 75.2 mm shell length.

c) 60-Year Benchmark

Surveys in 1953 and 1969 yielded similar densities of about 1 clam/m^2 (Fig. 7.3.2). Recruitment data from the 1950s comparable to the present surveys are not available, although this bay was considered to have the most consistent recruitment. Recruitment in 1969 was lower than the present trend, with 11.1% of the population between 31 mm and 50 mm in length.

4. Isle of Wight Bay

a) 2013 Status

This bay had the highest clam density of the Maryland coastal ecosystem, averaging 0.95 clams/m^2 from 40 samples (Figs. 7.3.1 and 7.3.2). This density is 80% of the historical baseline, the highest percentage in the Coastal Bays. The observed natural mortality was 1.0%. The average length was 80.7 mm, with 7.5% of the population between 31 mm and 50 mm (Fig. 3).

b) 7-Year Trend

Isle of Wight Bay appears to have benefitted the greatest from the 2008 dredging ban in conjunction with favorable recruitment from 2005 through 2009. This bay ranked first among the Coastal Bays in clam densities during the past seven years, averaging 0.73 clams/m^2 from 206 samples (Table 7.3.1). Since 2011, the density has been even higher, averaging 0.99 clams/m^2 - more than double the 19-year average of 0.47 clams/m^2 and approaching the historical benchmark - but it also appears that densities have leveled off during this period (Fig. 7.3.2). Observed natural mortality was the lowest of the coastal bays, with boxes accounting for 1.2% of the population. This bay has enjoyed good recruitment over the past few years, with the proportion of clams smaller than 51 mm averaging 22.5% over the 7-year period (identical to the 19-year average) and peaking at

48.5% in 2009 (Fig. 7.3.3). However, over the past three years recruitment has dropped off considerably, averaging only 8.8%. The high recruitment rate is reflected in the lower average length of the sampled population, 70.6 mm.

c) 60-Year Benchmark

Prior to 1994, the only hard clam survey in this bay was conducted in 1953. The average clam density was 1.19 clams/m^2, which ranked it second among the Coastal Bays (Fig. 7.3.2). Historical recruitment data comparable to the present surveys are not available.

5. Assawoman Bay

a) 2013 Status

A total of 30 stations yielded an average density of 0.37 live clams/m^2 (Figs. 7.3.1 and 7.3.2) and an observed natural mortality of 1.5%. The average length of the sampled population was 74.7 mm, with 13.1% of the clams between 31 mm and 50 mm (Fig. 7.3.3).

b) 7-Year Trend

Clam densities, which had been low relative to most of the other coastal bays, have increased since the 2008 prohibition on mechanical harvesting. The 7-year average of 0.28 clams/m^2, based on 159 samples (Table 7.3.1), was almost double the average of 0.15 clams/m^2 for the preceding 11 years, placing it slightly higher than Chincoteague Bay. This upward trend seems to be continuing, with the last two years averaging 0.35 clams/m^2 (Fig. 7.3.2). The observed mortality has also been consistently low, averaging 1.8%. Recruitment was poor during the mid-2000s but jumped in 2007, with an average of 24.1% between 2007 and 2013 (Fig.4). Like Isle of Wight Bay, the peak year was 2009, when 43.1 % of the clams were under 51 mm, the highest in the 19-year time series (Fig. 7.3.3). This trend is reflected in a lowering of the average lengths, bottoming out at 62.0 mm in 2009 and resulting in a 7-year average of 67.9 mm. Since then recruitment has dropped off with the last three years averaging 15.8%.

c) 60-Year Benchmark

Prior to 1994, the only hard clam survey in this bay was conducted in 1953. The average clam density was 1.0 clam/m^2 (Fig. 7.3.2). Historical recruitment data comparable to the present surveys are not available.

6. St. Martin River

a) Recent Status

Over the recent 7-year period, this coastal tributary was surveyed in 2008 and 2011, when a total of 20 samples were taken (Table 7.3.1). For the two survey years, clams were observed at only 55% of the stations, whereas in the bays they are found at almost 100% of the stations. Clam densities were the lowest of any coastal bay region, averaging 0.06 clams/m^2 (Fig. 7.3.2). Observed mortalities were low, averaging 1.4% for the two years. In 2008, one uncharacteristically sandy station provided all but one of the sublegal–size clams found in this river, resulting in an inflated recruitment of 28.6% (Fig.7.3. 3). If this station is ignored, recruitment was 7.7% (one sublegal of 13 clams total). A more typical scenario was in 2011, when clam lengths were the largest of the Coastal Bays, averaging 82.8 mm, with 5.4% of the clams between 31 mm and 50 mm. Aside from the one sandy station, the bottom at the remainder of the locations in the 2008 survey was often soupy mud, with clams absent in 50% of the stations. The high proportion of small clams at the station with sand substrate and their absence elsewhere suggests that the recruitment potential in the St. Martin River is constrained by generally unsuitable habitat. Due to pollution, this river has been closed to shellfish harvesting for many years, yet the clam population remains sparse.

b) 60-Year Benchmark

This tributary seems to be inhospitable to hard clams. The 1953 survey averaged 0.14 clams/m^2, well below the contemporaneous densities observed in the bays, although this figure was based on only three stations (Fig.7.3. 2). Historical recruitment data comparable to the present surveys are not available.

Hard Clam Summary

Despite a ban on mechanical harvesting for shellfish in the Coastal Bays that went into effect in 2008, current hard clam densities in all of the bays remain lower than historical levels. However, density trends in the northern bays have been improving, with the Isle of Wight Bay clam population approaching the 60-year benchmark. Although closed to shellfish harvesting for decades, the St. Martin River continues to have the lowest clam densities in the Coastal Bays. Observed mortalities have been negligible throughout the bays. The Coastal Bays populations are dominated by older, larger clams, with recruitment generally low and sporadic in the lower bays. Parts of Sinepuxent, Isle of Wight and Assawoman bays experienced a strong recruitment period during the late 2000s which accounted for the boost in clam densities, but has tailed off since then.

C. Oysters

The variety of the eastern oyster (*Crassostrea virginica*) known as Chincoteagues has long been prized for its salty flavor, providing profitable livelihoods to generations of watermen in the remote villages along the shores of the bay for which they were named. Immediately following the Civil War, the unique conditions of the region led to the culturing of oysters, an advanced practice at the time that no doubt sustained the industry much longer than it otherwise would have lasted. In addition to their commercial value, oysters are ecologically important as reef builders, contributing structure and hard substrate to a rich community of organisms associated with them in an otherwise soft-bottom environment. The shell provides protection from predation in areas that are otherwise devoid of shelter, benefitting the newly settled juveniles and small adults of numerous species, including hard clams. As filter-feeders, oysters are important in processing organic matter and nutrients from the water column. However, episodic natural events, in particular the opening and stabilization of the Ocean City Inlet, fundamentally changed the coastal bays ecosystem, creating a situation where oyster populations and the industry they supported, could no longer exist. Equally important, the demise of the Coastal Bays oyster has resulted in the loss of a critical functional component of the ecosystem and the gradual disappearance of a significant structural element as well.

Oyster Data Sets

Yates oyster bars survey of 1907.

Maryland Conservation Bureau; Maryland Conservation Department; Md. Bureau of Natural Resources; Maryland Department of Chesapeake Bay Affairs. 1916-1969. Annual Reports. Annual landings and licensing data as well as occasional anecdotal information.

Maryland Department of Natural Resources oyster bars survey of 1994. Revisits the old Yates bars. Data include surface shell per 1.5 minute dredge tow and associated species. No oysters were found.

Maryland Department of Natural Resources. 1994-95. Intertidal survey of Chincoteague Bay. Data include molluscan species, abundance (live and dead), and sizes per 0.25 m^2 quadrat.

Maryland Department of Natural Resources. 1994-95. Oyster survivorship study in Chincoteague Bay. Data include survivorship, growth, disease, and predation from arrays of suspended bags containing hatchery reared oysters.

Maryland Department of Natural Resources. 1999-2007. Dynamics of an intertidal oyster population in West Ocean City. Annual data include density of live and dead, recent or old boxes, height-frequency distributions, spat settlement, presence of drill holes, number of drills, presence of other species, and disease analyses.

Maryland Department of Natural Resources. 2005-present. Subtidal oyster population in Chincoteague Bay. Annual data include recruitment, height-frequency distributions, mortality estimates, and disease analyses.

Management Objectives

None

Oyster Indicators

1. Density (# live/unit area when feasible)
2. Geographic Distribution (lat/long; bay or tributary; sub-bay or region)
3. Height-Frequency Distribution (% frequency)
4. Mortality (% dead)
5. Disease

Data Collection

In 1994, all 28 formerly charted oyster bars were sampled by handscrape along a total of 150 transects throughout Chincoteague Bay. For details, see Tarnowski 1997c. A 0.25 m^2 quadrat was used to annually sample an intertidal population at West Ocean City from 1999-2007. Since 2005, a subtidal oyster population in southern Chincoteague Bay has been sampled annually using a commercial clamming vessel equipped with a hydraulic escalator dredge.

Oyster Results: Status and Trends

1. Recent Status

None of the 28 documented shell bars in the Coastal Bays have living oysters.
In addition to the 150 handscrape tows taken in 1994 on the former oyster bars of

Chincoteague Bay, almost 4,000 clam dredge stations throughout the coastal system have been sampled over the past twenty years and never has a live oyster been found on the old oyster grounds. To a large extent the bars themselves have been buried by sediment, greatly reducing this ecologically important habitat.

First observed in 2005, presently there is only one small oyster population inhabiting an uncharted subtidal bar in southern Chincoteague Bay. The 2013 survey found the population dominated by larger, older oysters, with an average shell height of 98.4 mm (Fig. 7.3.4a). Over the 10-year time series there were recruitment peaks in 2008 and 2010, but since then spatfall has dropped off (Fig. 7.3.4b). Only two spat (3.2% of the total) and one additional sublegal oyster were observed during the latest survey. Recent disease levels have been low, both for *Perkinsus marinus* and *Haplosporidium* spp. infections (Fig. 7.3.4c). Despite these low disease levels, mortalities have increased in recent years, averaging 10.2% from 2005 to 2008 and 23.9% from 2009-2012 (Fig. 7.3.4d). The shells of the individuals were heavily riddled with boring sponge (*Cliona* sp.), and the average meat condition was a relatively poor 3.8 on a scale where 1 = watery and 9 = fat. Given the large percentage of older oysters in poor condition, the low recruitment exacerbated by heavy biofouling competing for settlement space, and the increasing mortalities, it appears this population might be dying out.

Small, relic oyster populations still exist intertidally at a few locations throughout the coastal bays, with occasional spatfall on man-made structures such as riprap, pilings, and bridge supports. From 1999 to 2007, DNR Shellfish Program monitored one such population in West Ocean City, a single year class that set in 1998(Fig. 6). Over the course of the study period, the population density declined to less than 1% of the initial survey findings, from 480 oysters/m^2 to 4 oysters/m^2. Despite the long-term absence of significant oyster populations in the Coastal Bays, at least two major oyster diseases, dermo (*Perkinsus marinus*) and SSO (*Haplosporidium costalis*), were still detected. While earlier mortalities could be attributed in large part to predation, as evidenced by drill holes in the shells of dead oysters, subsequent mortalities were more likely due to an increase in dermo disease levels.

2. Historical Trends

The Yates Survey of 1907 identified 1,665 acres of oyster bars in the coastal bays, all confined to Chincoteague Bay. No bars existed in the upper bays as the water was not salty enough to support oysters. Even in the northern portion of Chincoteague Bay, oysters were subjected to occasional killing freshets, and poor growth and sporadic spatfalls were the norm. With the opening of the Ocean City Inlet in 1933 and its subsequent stabilization came the expectation that oysters would flourish with the increased salinities, creating a scramble to obtain leases for oyster growing bottom. This optimism was short lived, however, as a host of problems associated with increased salinities ultimately proved ruinous to the oyster industry. The elevated salinities allowed predators, particularly oyster drills, to thrive. Fouling organisms that compete for food and hard substrate also found conditions more suitable. Although the natural oyster populations rapidly declined, the culture based industry still managed to exist for some time longer. The death knell of the oyster industry sounded when disease came to the coastal bays in the late 1950s. The last recorded landings were in 1983.

Oyster Summary

The demise of the Coastal Bays oyster has resulted in the loss of a critical functional component of the ecosystem and the gradual disappearance of a significant structural element as well.

D. Bay Scallops

Among the more exotic of the Coastal Bays bivalves is the bay scallop (*Argopecten irradians*). Unlike other species, which are bound to some substrate either by burrowing or attachment, adult bay scallops are free-living and extremely motile, even though they lack a characteristic foot that most active bivalves possess. They are capable swimmers for short distances, which they accomplish by jetting water through their valves, generally in response to predators. Other unusual scallop attributes are their 18 pairs of blue eyes and hermaphroditic reproductive strategy, concurrently possessing both male and female sex organs. Bay scallops have relatively short life spans of only about 12 to 24 months, compared to the 40 year maximum life span of the hard clam. Their preferred habitat is eelgrass beds (providing the beds are not too thick), although they can also be found on other firm substrates such as shell and hard sand. Traditionally, scallops have been appreciated both for the succulent flavor of their adductor muscle and the aesthetic value of their shells.

Bay Scallop Data Sets

Maryland Department of Natural Resources. 1995-2001. Re-establishment of the bay scallop in Chincoteague Bay. Data from predator exclosures include abundance, survivorship, size distribution, growth, predation rates, and gametogenesis.

Data sets for scallops in the wild are identical to those used for hard clams.

Management Objective

Re-establish bay scallop populations in the bay.

Bay Scallop Indicators

1. Density (# live/unit area)
2. Geographic Distribution (lat/long; bay or tributary; sub-bay or region)
3. Size-Frequency Distribution (% frequency)

Bay Scallop Results: Status and Trends

1. Current Status

This species' status remains tenuous in the Coastal Bays. During the 2013 survey, only two bay scallops were caught out of 260 stations, both in eelgrass beds in Sinepuxent Bay. Eelgrass beds, the preferred habitat of bay scallops, appear to have diminished throughout the bays. A transect run in Assawoman Bay just north of the Rt. 90 bridge found that a formerly lush grass bed was reduced to a few sprigs of eelgrass, and was largely supplanted by macroalgae. No scallops have been observed in Chincoteague Bay since 2005.

2. Historical Trends

Evidence of former bay scallop populations in the coastal bays includes ancient shells dredged up during the hard clam surveys or scattered on the beaches of Assateague Island. During the 1920s bay scallops were the object of a modest but lucrative fishery based in Chincoteague, Virginia. Generally, however, salinities in the Maryland coastal bays during this period were too low to support scallops. Although the opening of the Ocean City Inlet in 1933 raised salinities to suitable levels, bay scallops were unable to exploit the new areas available to them because the eelgrass beds had been largely eliminated by "wasting disease" during the early 1930s. Scallops made a brief return to the Coastal Bays during the late 1960s but soon disappeared.

In an attempt to re-establish a population in Chincoteague Bay, DNR Shellfish Program planted 1.2 million bay scallops and raised them to reproductive age during 1997 and 1998. At the same time, wild scallops of unknown origin appeared in the vicinity of the Virginia state line. Mimicking the pattern of seagrass expansion a decade earlier, the geographic spread of the scallop population occurred relatively rapidly in a northerly direction. By 2002, for the first time, live scallops were recorded north of the Ocean City Inlet, both in Isle of Wight and Assawoman bays. Considering the inadequate habitat conditions for this species that had existed in the upper bays until recently (low salinity prior to 1933, absence of eelgrass beds afterwards), these scallops were possibly the first to occur in this area in well over a century. Their widest distribution was in 2002, when bay scallops were caught at 8% of the Shellfish Survey stations throughout the Coastal Bays (except Newport Bay, which lacked suitable habitat) from the Virginia to the Delaware state lines, albeit in very low numbers. This represents the greatest geographic extent of the species in Maryland. Thereafter, their range began to contract, to the point that since 2005 no scallops have been found in Chincoteague Bay, which ironically has the greatest amount of eelgrass habitat and the least development of the Coastal Bays, and was the first bay with an established scallop population. After a brief resurgence in the northern bays in 2008-09 (Fig. 5), the scallop population density receded just as quickly, coincident with a loss of eelgrass in Assawoman and Isle of Wight bays. From 2010 to the present, scallops were caught in less than 1% of the survey stations, with none found in 2011.

Bay Scallop Summary

Extremely low densities over the past four years, diminishing habitat, and declining water quality suggest that the long-term viability of the bay scallop population is in question.

V. References

A. Hard Clams

Boynton, W. 1970. The commercial fisheries of Chincoteague Bay - past, present, and future. *In*: Assateague Ecological Studies, Part I: Environmental Information. Nat. Res. Inst. Univ. Md. Contrib. no. 446.

Drobeck, K., H. Hidu, J.M. Odell and W. Boynton. 1970. Chincoteague and Sinepuxent Bay Benthos. *In*: Assateague Ecological Studies. Nat. Res. Inst., U. Md. NRI Contrib. No. 446, p. 173-241.

Homer, M.L. 1997. Hard Clam Survey. *In:* M.L. Homer, M.L. Tarnowski, R. Bussell & C. Rice. Coastal Bays Shellfish Inventory. Final Rept. to Coastal Zone Mangement Div., MARYLAND DEPARTMENT OF NATURAL RESOURCES, Contract No. 14-96-134-CZM010, Grant No. NA570Z0301. Annapolis, Md. 206 pp.

Tarnowski, M.L. and R. Bussell. 2002. Report on the MARYLAND DEPARTMENT OF NATURAL RESOURCES 2002 coastal bays hard clam survey and other related subjects. Annapolis, Md. 7 pp.

Wells, H.W. 1957. Abundance of the hard clam, *Mercenaria mercenaria*, in relation to environmental factors. Ecology 38: 123-128.

B. Oysters

Boynton, W. 1970. The commercial fisheries of Chincoteague Bay - past, present, and future. *In*: Assateague Ecological Studies, Part I: Environmental Information. Nat. Res. Inst. Univ. Md. Contrib. no. 446.

Bussell, R. 1997. Oyster Growth and Survivorship. *In:* Homer, M.L., M.L. Tarnowski, R. Bussell & C. Rice. 1997. Coastal Bays Shellfish Inventory. Final Rept. to Coastal Zone Mangement Div., MARYLAND DEPARTMENT OF NATURAL RESOURCES, Contract No. 14-96-134-CZM010, Grant No. NA570Z0301. Annapolis, Md. 206 pp.

Grave, C. 1912. Fourth Report of the Shell Fish Commission of Maryland, pp. 242 - 246.

Ingersoll, E. 1881. The oyster industry. *In*: G.B. Goode (ed.), The History and Present Condition of the Fishery Industries. Gov. Print. Off., Wash., 251 pp.

Tarnowski, M.L. 1997. Oyster Populations in Chincoteague Bay.. *In:* Homer, M.L., M.L. Tarnowski, R. Bussell & C. Rice. 1997. Coastal Bays Shellfish Inventory. Final Rept. to Coastal Zone Mangement Div., MARYLAND DEPARTMENT OF NATURAL RESOURCES, Contract No. 14-96-134-CZM010, Grant No. NA570Z0301. Annapolis, Md. 206 pp.

C. Bay Scallops

Tarnowski, M., M. Homer, and R. Bussell. 1999. The Re-Establishment of the Bay Scallop in

Chincoteague Bay. Maryland Department of Natural Resources Final Report to National Marine Fisheries Service, Northeast Regional Office, Project No. 95-FIG-078, Grant No. NA66FK0086. Annapolis, Md. 69 pp.

Tarnowski, M.L. and R. Bussell. 2002. Report on the Maryland Department of Natural Resources 2002 coastal bays hard clam survey and other related subjects. Annapolis, Md. 7 pp.

D. Non-Commercial Molluscs

Drobeck, K., H. Hidu, J.M. Odell and W. Boynton. 1970. Chincoteague and Sinepuxent Bay Benthos. *In*: Assateague Ecological Studies, Part I: Environmental Information. 1970. Natural Resources Institute, Univ. Md. Contrib. no. 446, p. 173-241..

Chaillou, J.C., S.B. Weisberg, F.W. Kutz, T.E. DeMoss, L. Mangiaracina, R. Magnien, R. Eskin, J. Maxted, K. Price, and J.K. Summers. 1996. Assessment of the Ecological Condition of the Delaware and Maryland Coastal Bays. EPA/620/R-96/004. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Counts, C.L. and R.S. Prezant. 2001. Assateague National Seashore Benthic Invertebrate Diversity Study Final Taxonomic Report. Cooperative Agreement No. 4000-4-3007, Indiana University of Pennsylvania and U.S. National Park Service.

Llanso, R.J. and L.C. Scott. 2001. Coastal 2000: Benthic Community Condition in Maryland's Coastal Bays. Final Report to Maryland Department of Natural Resources, Tidewater Ecosystem Assessment Division.

Llanso, R.J., L.C. Scott and F.S. Kelley. 2002. National Coastal Assessment 2001 Benthic Community Condition in Maryland's Coastal Bays. Final Report to Maryland Department of Natural Resources Tidewater Ecosystem Assessment Division.

Tarnowski, M.L. 1997. Intertidal Molluscs. *In:* Homer, M.L., M.L. Tarnowski, R. Bussell & C. Rice. 1997. Coastal Bays Shellfish Inventory. Final Rept. to Coastal Zone Mangement Div., MARYLAND DEPARTMENT OF NATURAL RESOURCES, Contract No. 14-96-134-CZM010, Grant No. NA570Z0301. Annapolis, Md. 206 pp.

Tarnowski, M.L. 1997. Molluscan Inventory. *In:* Homer, M.L., M.L. Tarnowski, R. Bussell & C. Rice. 1997. Coastal Bays Shellfish Inventory. Final Rept. to Coastal Zone Mangement Div., MARYLAND DEPARTMENT OF NATURAL RESOURCES, Contract No. 14-96-134-CZM010, Grant No. NA570Z0301. Annapolis, Md. 206 pp.

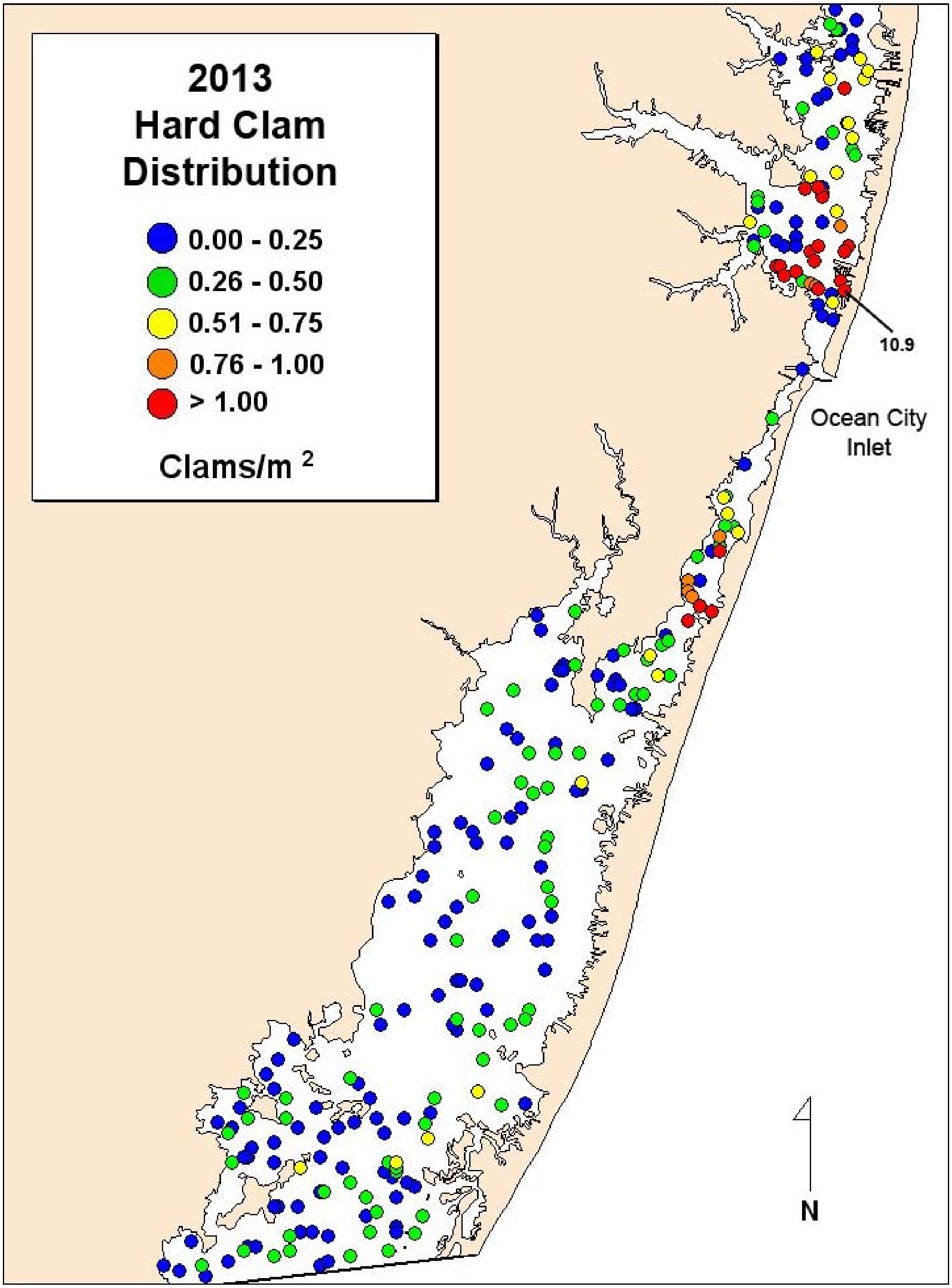

Figure 7.3.1 Hard clam station locations and densities from the 2013 survey. Clam density is measured in number of live clams/m^2.

Hard Clam Densities

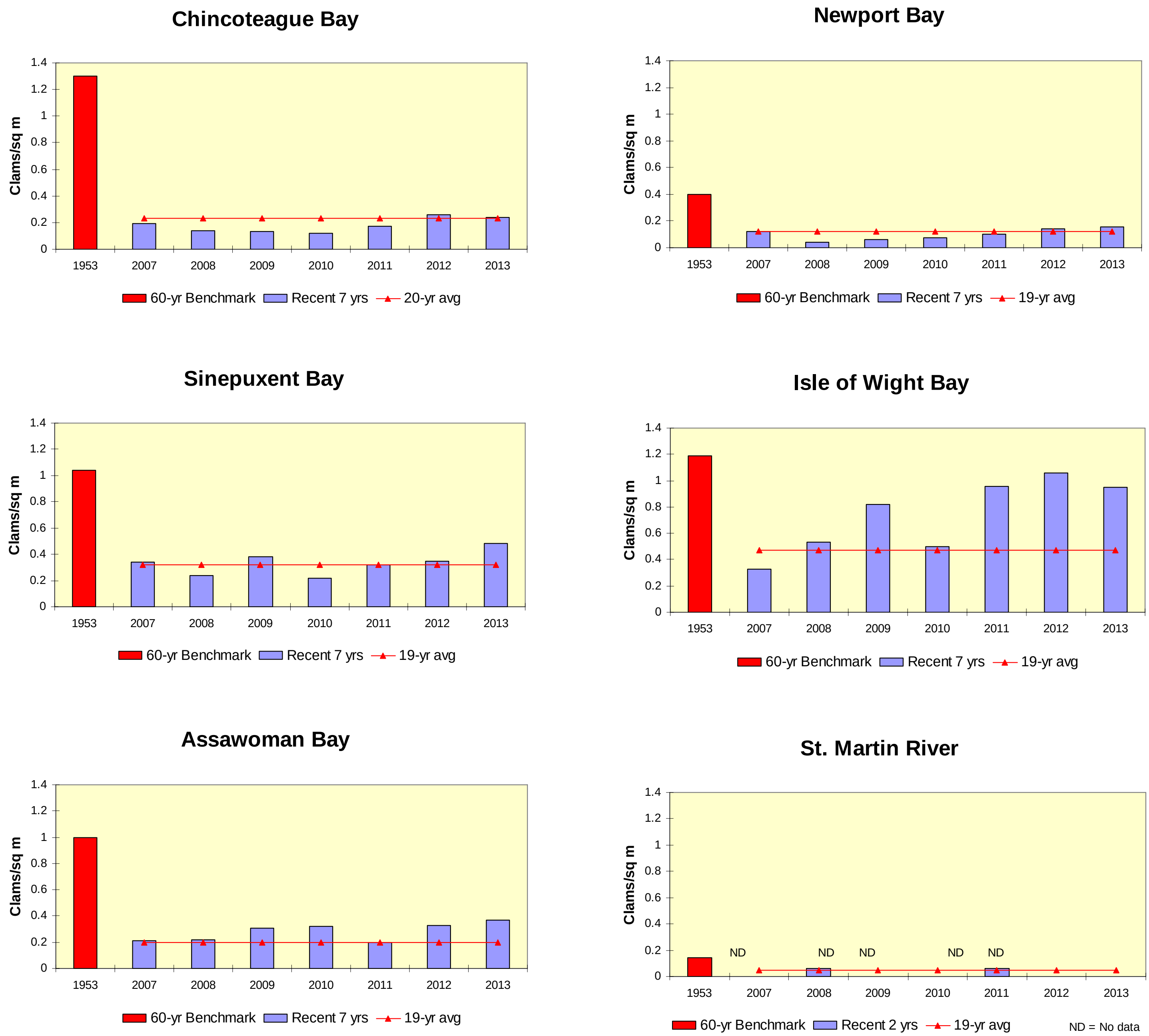

Figure 7.3.2 Hard clam densities per Coastal Bays segment, 2007-2013 and 1953 benchmark. Only Chincoteague Bay was surveyed in 1993.

Hard Clam Recruitment

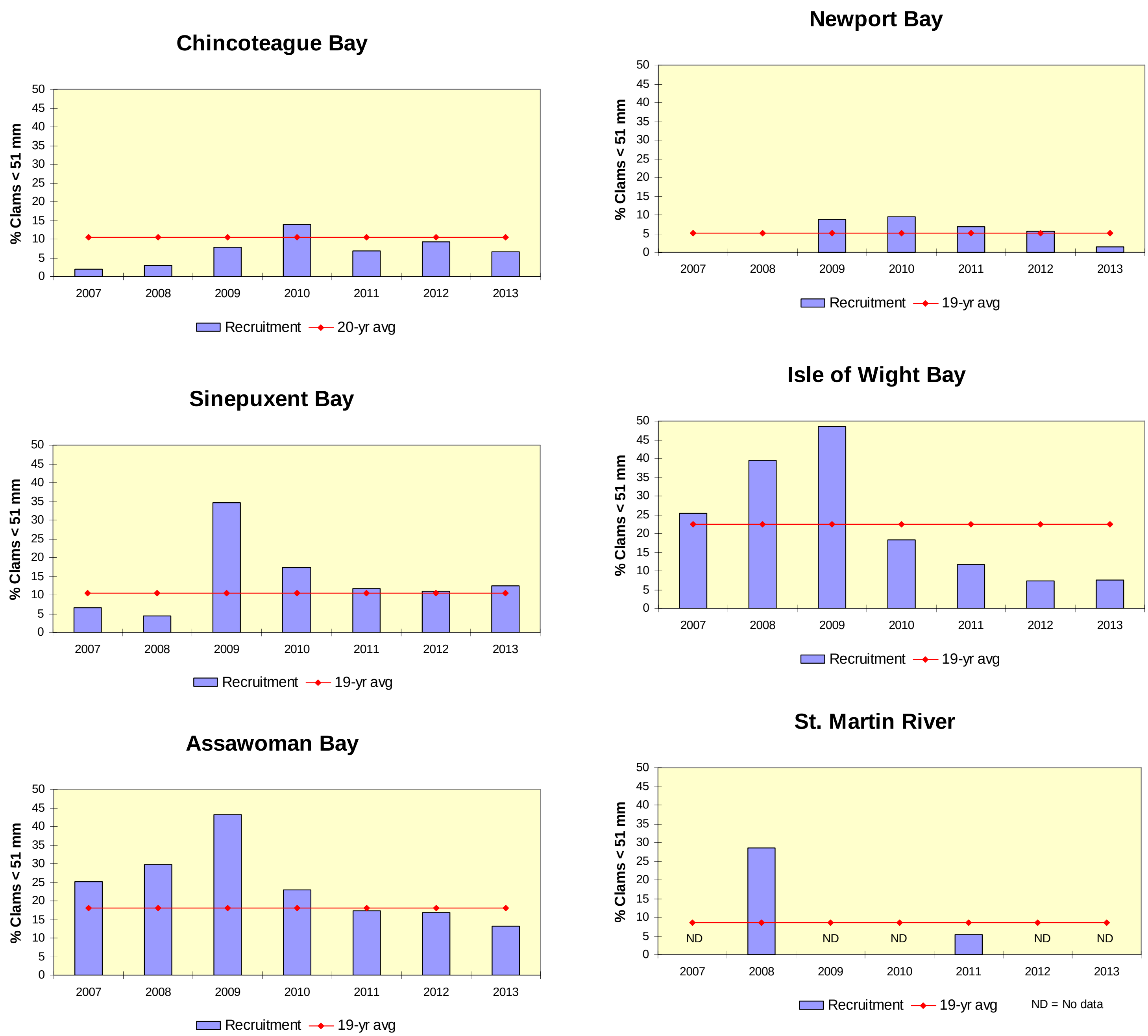

Figure 7.3.3 Hard clam recruitment per Coastal Bays segment, 2007-2013. Only Chincoteague Bay was surveyed in 1993.

Chincoteague Bay Subtidal Oyster Population

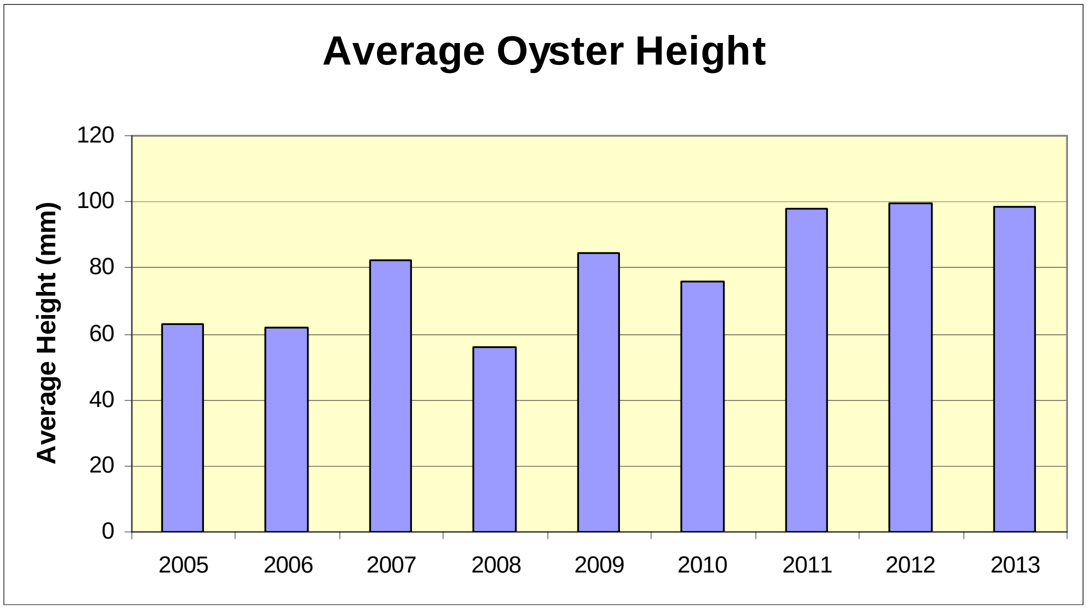

Figure 7.3.4a. Average size of oysters in the Chincoteague Bay subtidal population, 2005-2013.

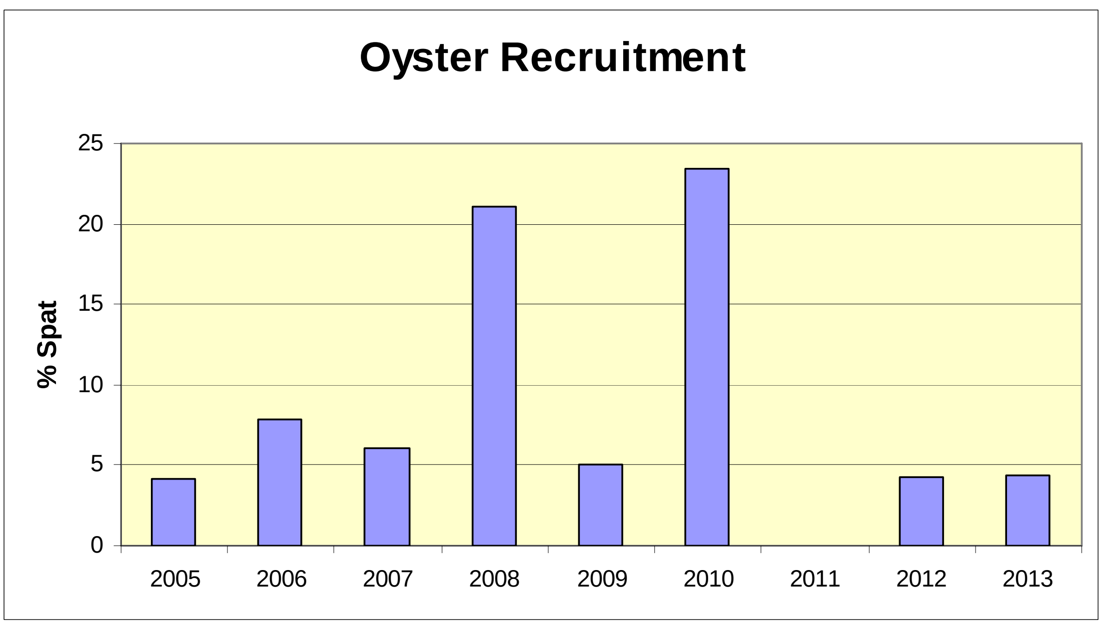

Figure 7.3.4b. Oyster recruitment as percent of spat observed in the subtidal oyster population in Chincoteague Bay, 2005-2013. No spatfall was observed in 2011.

Subtidal Oysters (cont'd)

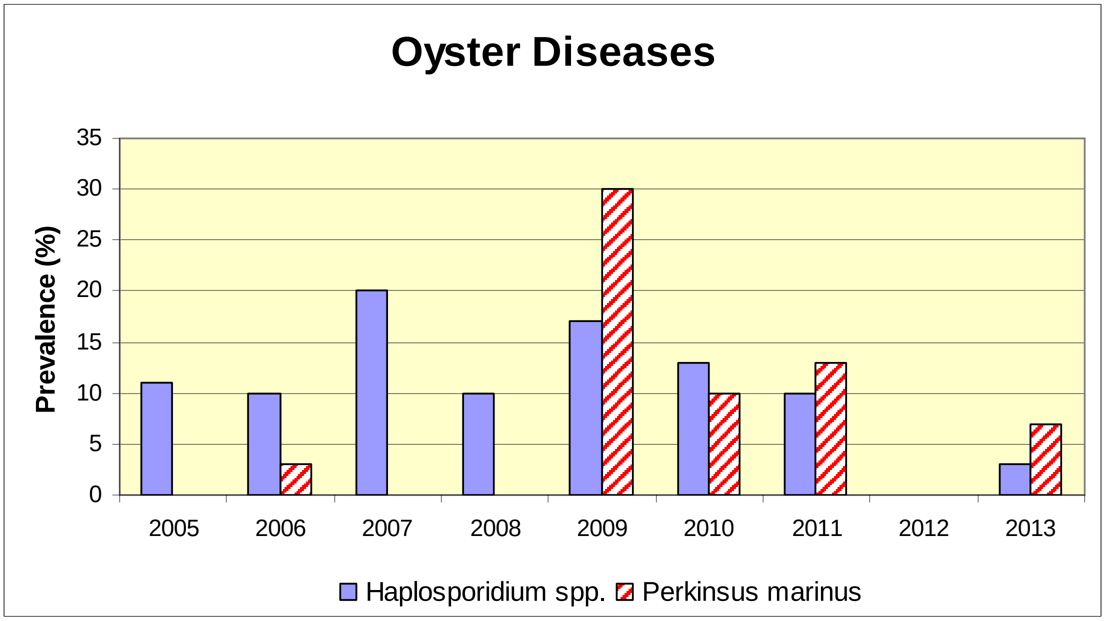

Figure 7.3.4c. Disease prevalence in the subtidal oyster population in Chincoteague Bay, 2005-2013. No disease was detected in 2012.

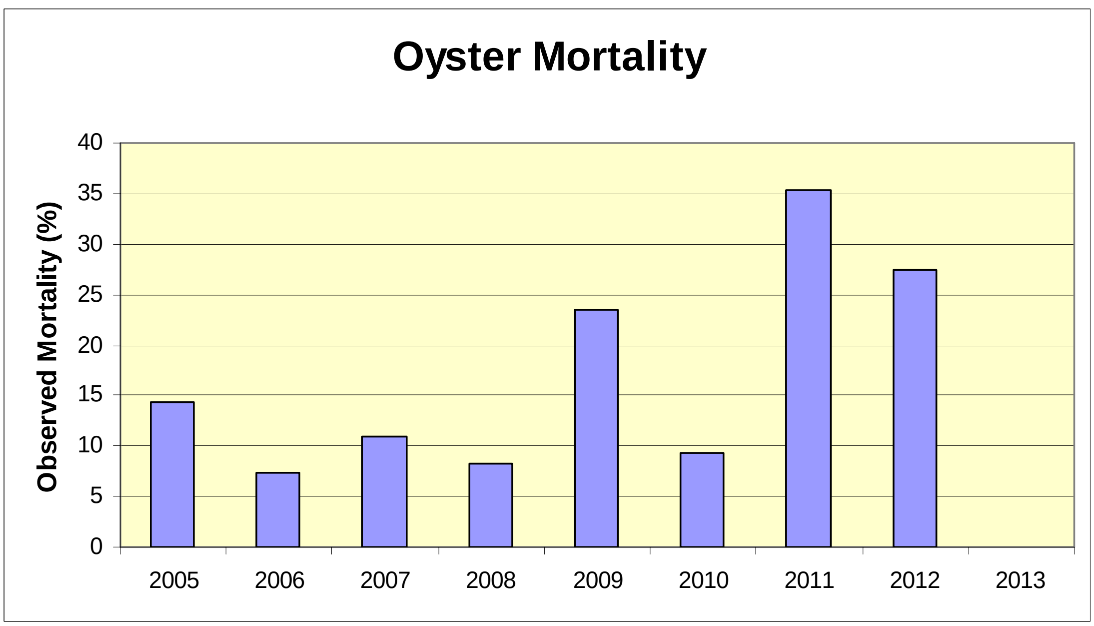

Figure 7.3.4d - Observed oyster mortalities in the Chincoteague Bay subtidal population, 2005-2012. Mortality data were not collected in 2013.

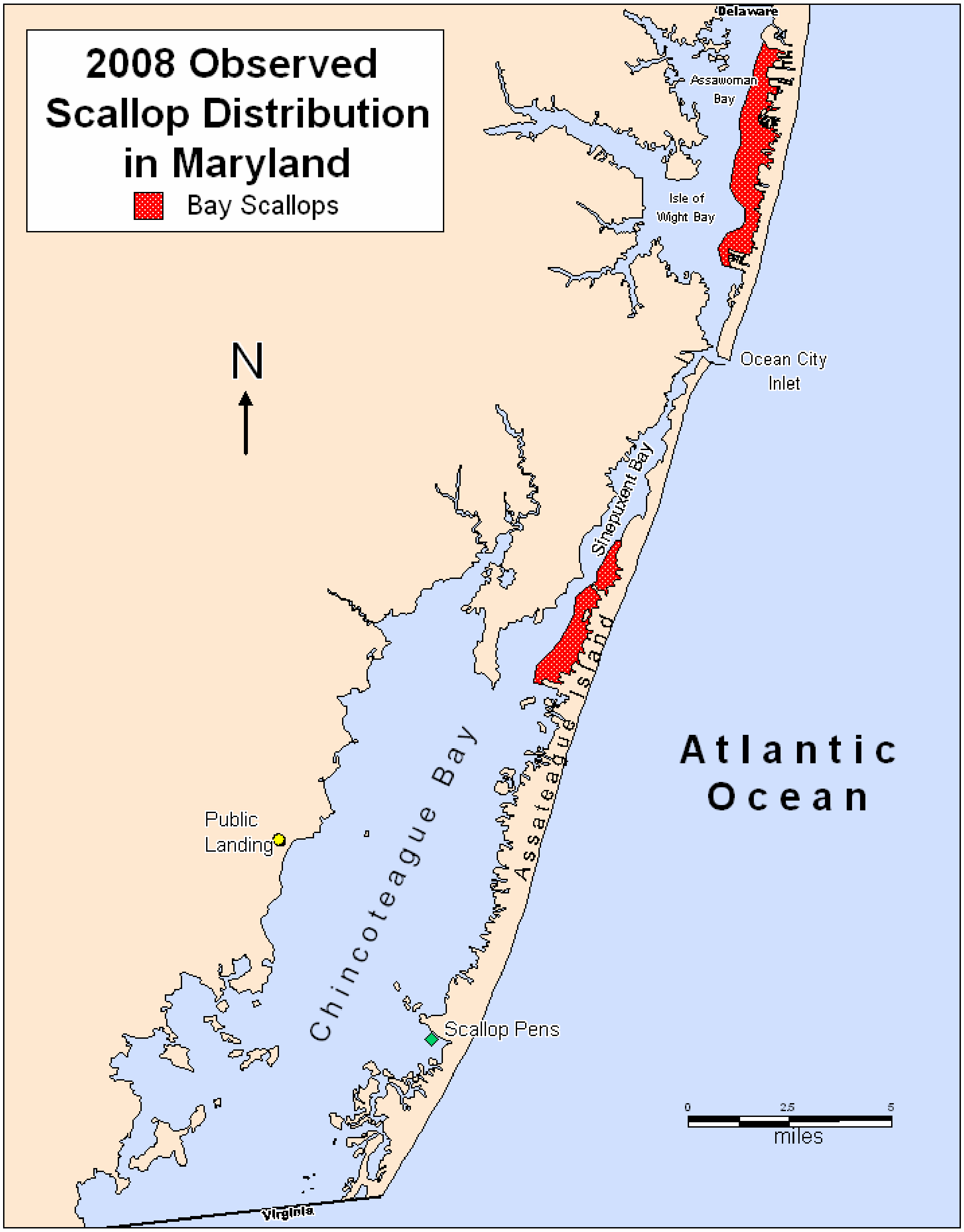

Figure 7.3.5 2008 observed scallop distribution area in the Maryland Coastal Bays.