# Maryland Oyster Population Status Report

## 2006 Fall Survey

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Prepared by the Staff of the
Maryland Department of Natural Resources
Shellfish Program and Cooperative Oxford Laboratory
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# EXECUTIVE SUMMARY

The 2006 Annual Fall Oyster Survey was conducted by Shellfish Program staff from the Maryland Department of Natural Resources (MDNR) Fisheries Service from 10 October to 14 November. Oyster parasite diagnostic tests were performed by staff of the Cooperative Oxford Laboratory (COL). A total of 451 samples were collected during surveys on 282 natural oyster bars, including Key Bar and Disease Bar sites and sanctuaries, as well as contemporary seed oyster planting sites, shell planting locations, and seed production areas.

Annual streamflow during 2006 was close to normal, in contrast to the wide fluctuations between wet and dry years over the past decade and a half. However, monthly streamflows showed much greater deviation from the mean over the course of the year. Flows from March through May were abnormally low, running from about 50% to 65% below average. This dry spell broke in June and July, when flows were between 70% and 116% above normal. High streamflows persisted from September through November, when they peaked at 143% above the average for the latter month. The timing of this freshet, occurring when dermo disease starts to intensify and oysters begin to spawn, spared the population from widespread severe disease-related mortalities but inhibited recruitment over much of the bay.

The 2006 Maryland oyster spatfall index was the highest since 2002, representing a five-fold increase over the previous two years, and was ranked in the second highest statistical grouping for the past 22 years. However, the spatfall was unevenly distributed, with the highest concentrations found in the waters of the lower eastern shore, especially in Tangier Sound, and a pocket of spatfall in the St. Mary's River. Spatfall was extremely poor elsewhere. Aside from a very light set in the Eastern Bay region and the lower western shore, recruitment north of the Choptank River and in most of the Potomac River was negligible.

Oyster diseases for the most part remained suppressed for a fourth consecutive year, following record high levels in 2002. Although widely distributed, oyster parasite populations in general have been slow to rebound despite moderating streamflows and consequent salinity increases over the past two years. Dermo disease, caused by the parasite *Perkinsus marinus*, persisted on almost every oyster bar tested for the disease, but mostly at below average prevalences and intensities. The annual mean prevalence and intensity was similar to the previous year, and was well below the 17-year average. Nevertheless, the sustained widespread distribution of *P. marinus*, even at low to moderate intensity levels, indicates that dermo disease remains enzootic throughout most of the tidal waters of the state. In contrast, *Haplosporidium nelsoni*, which causes MSX disease, was confined to two localized areas – lower Tangier Sound and the St. Mary's County bayshore north of Point Lookout. Prevalences of MSX disease, which plummeted during the high-flow years of 2003 and 2004, continued to be very low. No *Bonamia* sp. pathogens were detected in any of the 1,610 oysters examined; it is believed this parasite's salinity requirement is higher than typically occurs in Maryland Chesapeake Bay waters.

Survivorship continued to improve for the fourth successive year. The 2006 observed mortality was the lowest since 1989, approaching the background mortality levels found prior to the mid-1980's disease epizootics and well below the 22-year average. Areas that received notable spatfalls in 2001 and 2002, such as the lower bay oyster sanctuaries, have benefited from good survivorship over the past four years and now have flourishing oyster populations.

As a consequence of good recruitment in 2002 and subsequent sustained low mortalities, commercial oyster landings increased for the second year in a row. The 2006 oyster harvest (2005-06 season) was 154,436 bushels, over twice the previous year's total and nearly six times greater than the record low harvest in 2004. However, this promising increase does not yet approach the landings prior to the mid-1980's. Harvest by gear type shifted dramatically in 2006, with patent tongs, diving and hand tongs accounting for 75% of the harvest. Only 20% of the harvest was attributable to power dredging, down from about 50% for the previous two seasons.

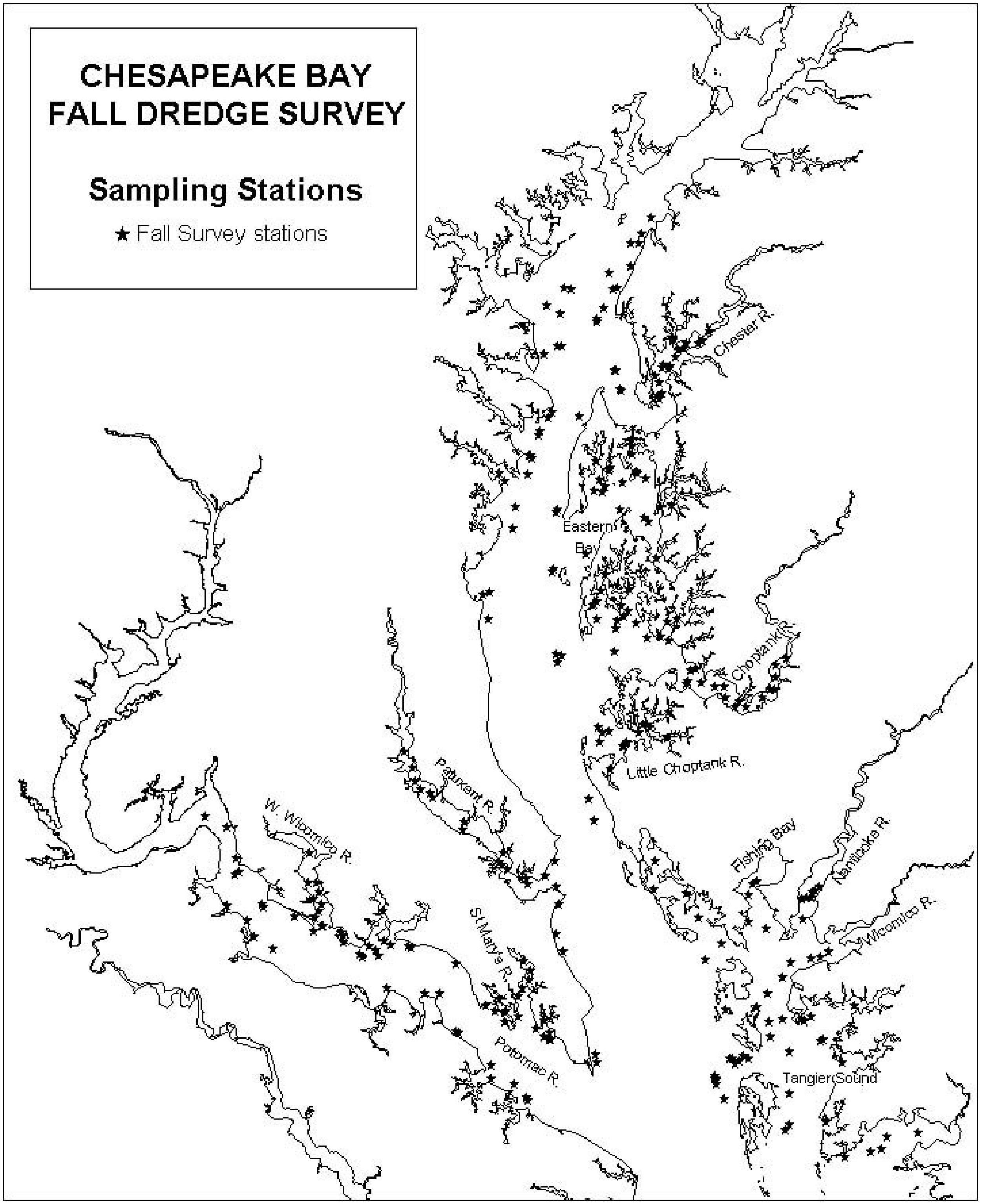



**Figure 1a. Annual Maryland Fall Survey station locations, all bar types (standard, Key, Disease) included.**

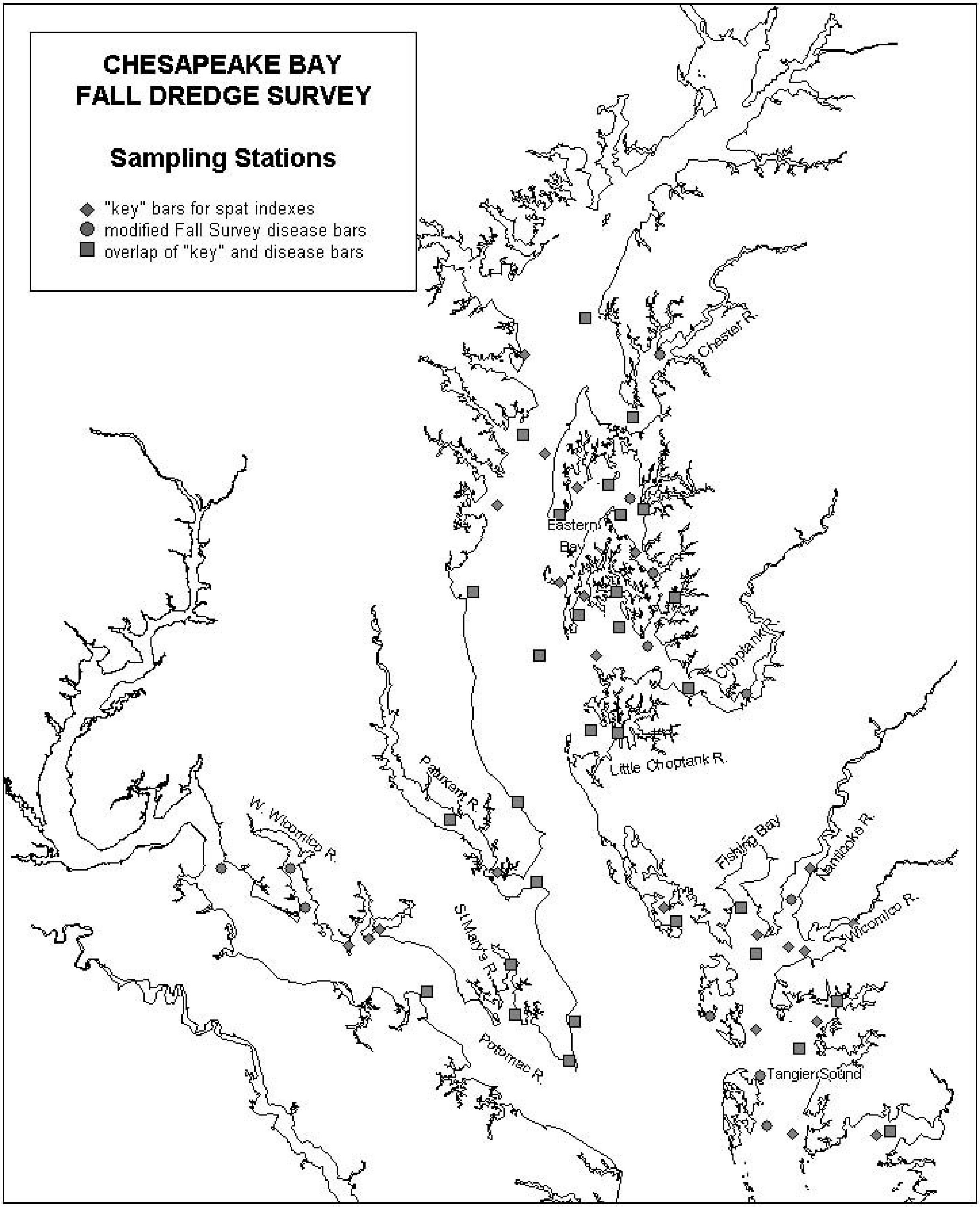



**Figure 1b. Annual Maryland Fall Survey station locations for Key and Disease bars.**

## INTRODUCTION

Since 1939, a succession of Maryland state agencies have conducted annual dredge-based surveys of oyster bars. These assessments have provided biologists and managers with information on oyster spatfall intensity, observed mortality, and more recently on parasitic infection status in Maryland's Chesapeake Bay. The long-term nature of the data set is a unique and valuable aspect of the survey that gives a historical perspective and allows the discernment of trends in the oyster population. Monitored sites have included natural oyster bars, seed production and planting areas, dredged and fresh shell plantings, and sanctuaries. Since this survey began, several changes and additions have been made to allow the development of structured indices and statistical frameworks while preserving the continuity of the long-term data set. In 1975, 53 sites and their alternates, referred to as the historical "Key Bar" set, were fixed to form the basis of an annual spatfall intensity index (arithmetic mean) (Krantz and Webster 1980). These sites were selected to provide both adequate geographic coverage and continuity with data going back to 1939. An oyster parasite diagnosis component was added in 1958, and in 1990 a 43-bar subset (Disease Bar set) was established for obtaining standardized parasite prevalence and intensity data. Thirty-one of the Disease Bars are among the 53 spatfall index oyster bars (Key Bars).

## METHODS

The 2006 Annual Fall Oyster Survey was conducted by Shellfish Program staff from the Maryland Department of Natural Resources (MDNR) Fisheries Service from 10 October to 14 November. Oyster parasite diagnostic tests were performed by staff of the Cooperative Oxford Laboratory (COL). A total of 451 samples were collected during surveys on 282 natural oyster bars, including Key Bar and Disease Bar sites and sanctuaries, as well as contemporary seed oyster planting sites, shell planting locations, and seed production areas (Figures 1a and 1b). Data on seed and shell plantings are provided in Hess (2006).

A 32-inch-wide standard oyster dredge was used to obtain the samples. The number of samples collected varied with the type of site. At each of the 53 Key Bar sites and the 43 Disease Bars, two 0.5-bushel subsamples were collected from replicate dredge tows. On seed production areas, five 0.2-bushel subsamples were taken from replicate dredge tows. At all other sites, one 0.5-bushel subsample was collected. A list of data categories recorded from each sample appears in Table 1. Beginning in 2005, tow distances have been recorded for all samples (providing the dredge was not full) using the odometer function of a global positioning system unit, as well as the total volume of material in the dredge from which the subsample is taken.

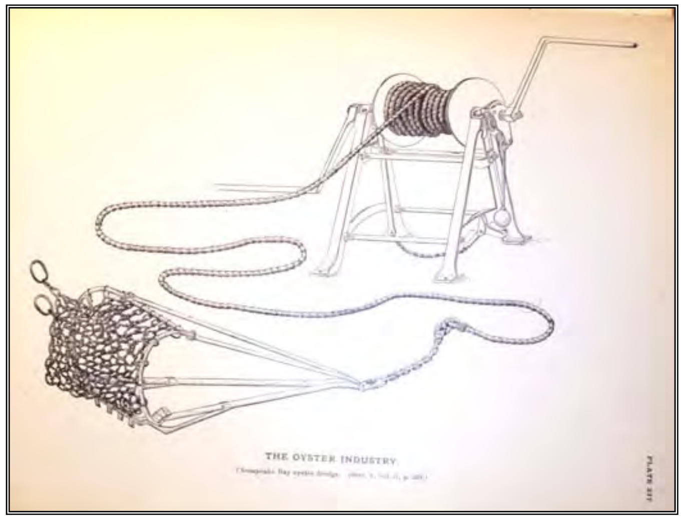
Total observed mortality (small and market oysters combined) was calculated as the number of dead oysters (boxes and gapers) divided by the sum of live and dead oysters (Appendix 2).

Representative samples of 30 oysters older than one year were taken at each of the 43 Disease Bar sites. Additional samples for disease diagnostics were collected from seed production areas, seed planting areas, and areas of special interest. Due to scarcities of oysters at three sampling sites, smaller subsamples ($n$ = 7 - 29) were secured for some disease assays. All oysters were transported to COL for disease assays. Data reported for *Perkinsus marinus* (dermo disease) are from rectal Ray's fluid thioglycollate medium (RFTM) assays. Prior to 1999, the less sensitive hemolymph assays were performed. Data reported for *Haplosporidium nelsoni* (MSX disease) have been generated from tissue histology since 1999. Before 1999, hemolymph cytology was performed, while histology samples were examined for *H. nelsoni* only from selected locations.

In this report, prevalence refers to the percentage of oysters in a sample that were infected, regardless of infection intensity (Appendix 2). Infection intensity refers to the mean infection stage, or relative pathogen abundance, in analyzed oyster tissues. A categorical infection intensity range from zero to seven, based on pathogen concentration in hemolymph or solid tissues, was used to classify dermo disease intensities (See Gieseker 2001 for a complete description of parasite diagnostic techniques and calculations).

To provide a statistical framework for some of the Annual Fall Survey data sets, a non-parametric treatment, Friedman's Two-Way Rank Sum Test, was used (Hollander and Wolfe 1973). This procedure, along with an associated multiple-range test, allowed among-year comparisons for several parameters. Additionally, mean rank data can be viewed as annual indices, thereby allowing temporal patterns to emerge. Friedman's Two-Way Rank Sum Test, an analog of the normal scores general Q statistic (Hájek and Šidák 1967), is an expansion of paired replicate tests (e.g. Wicoxon's Signed Rank Test or Fisher's Sign Test). Friedman's Test differs substantively from a Two-Way ANOVA in that interactions between blocks and treatments are not allowed by the computational model (See Lehman 1963 for a more general model that allows such interactions). The lack of block-treatment interaction terms is crucial in the application of Friedman's Test to the various sets of Fall Survey oyster data, since it eliminates nuisance effects associated with intrinsic, site-specific characteristics. That is, since rankings are assigned across treatments (in this report - years), but rank summations are made along blocks (oyster bars), intrinsic differences among oyster bars are not an element in the test result. All Friedman's Test results in this report were evaluated at $\alpha=0.05$.

To quantify annual relationships, a distribution-free multiple comparison procedure, based on Friedman's Rank Sum Test, was used to produce the "tiers" discussed in this report. Each tier consists of a set of annual mean ranks that are statistically similar to one another. This procedure (McDonald and Thompson 1967) is relatively robust, very efficient, and, unlike many multiple comparison tests, allows the results to be interpreted as hypothesis tests. Multiple comparisons were evaluated using "yardsticks" developed from experimental error rates of $\alpha=0.15$.




**19th century illustration of Chesapeake Bay oyster dredge and hand winder.**

## RESULTS

### Freshwater Discharge Conditions

Freshwater flow into Chesapeake Bay affects the salinity of the bay, which is a key factor influencing oyster spatfall, disease, and mortality. Annual streamflow during 2006 was close to normal, only about 10 % above the 70-year average (Sec. "C" in Bue 1968; USGS 2007), in contrast to the wide fluctuations between wet and dry years[1] over the past decade and a half (Figure 2a).

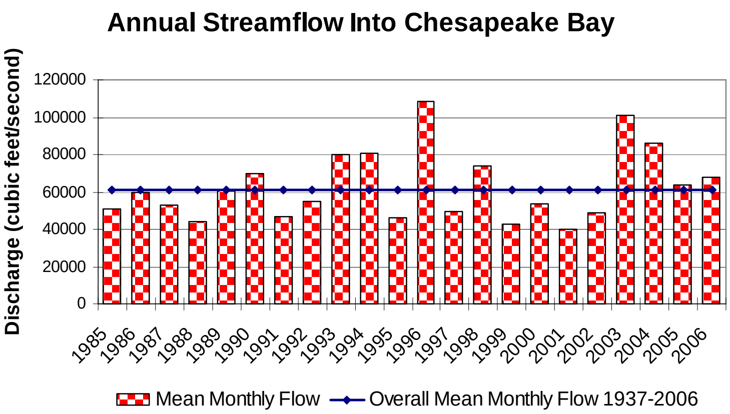



**Figure 2a. Mean monthly freshwater flow into Chesapeake Bay. USGS Section C: all Maryland tributaries and the Potomac River.**

However, monthly streamflows showed much greater deviation from the mean over the course of the year (Figure 2b). Flows from March through May were unusually low, running from about 50% to 65% below average. This dry spell broke in June and July, when flows were between 70% and 116% above normal. High streamflows persisted from September through November, when they peaked at 143% above the average for the latter month.

The 2006 annual mean marked the second successive year of normal annual streamflows, after six years of particularly extreme conditions, when a severe drought during 1999-2002 was followed in 2003-2004 by the second and third highest freshwater discharges over the

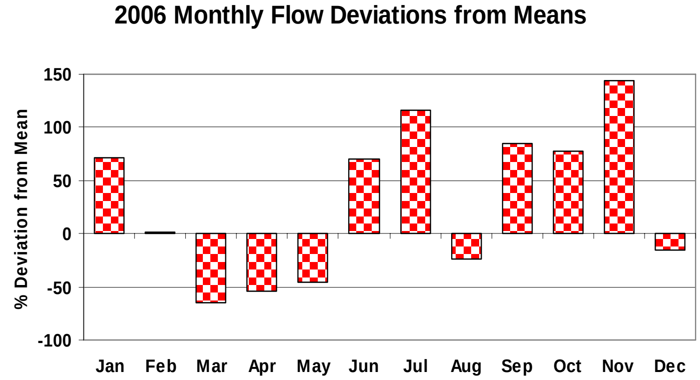



**Figure 2b. Percent deviations from mean monthly total freshwater flow into Chesapeake Bay during 2006.**

past two decades. Prior to the drought, low flow years had alternated with high flow years on an annual, or at most biennial, basis.

Since 1985, significant freshets occurred in 1993, 1994, 1996, and 1998. These often resulted in substantial oyster mortalities, such as the 1993 event in the Potomac River drainage (MDNR 2001). The freshets of 1994, 1996, and 1998 had a more geographically widespread impact on oyster mortality. The freshets of 1993, 1994, and 1998 were winter/spring events, unlike the 1996 high freshwater flows that persisted over the entire year (USGS 2000). Despite the high flows during 2003 and 2004, no significant oyster mortalities were observed as a consequence (Tarnowski 2005).

In recent years, moderately to severely low freshwater flows into Chesapeake Bay resulted in elevated salinities during 1997 and 1999-2002. Since 1985, low flows were particularly severe (≤80% of the 50-year average) in 1988, 1991, 1995, 1997, 1999, and 2001.

### Spatfall Intensity

Maryland oyster spatfall in 2006 was the highest since 2002, although it was unevenly distributed. The highest concentrations of spat were found in the waters of the lower eastern shore, especially in Tangier Sound, with a pocket of spatfall in the St. Mary's River (Figure 3). Spatfall was extremely poor elsewhere. Aside from a very light set in the Eastern Bay region and along the lower western shore, spatfall north of the

[1] Categorized by the U.S. Geological Survey as freshwater flow above the 75th percentile or below the 25th percentile of mean monthly flows for the 1937-2003 period, respectively.

Choptank River and in most of the Potomac River was negligible.

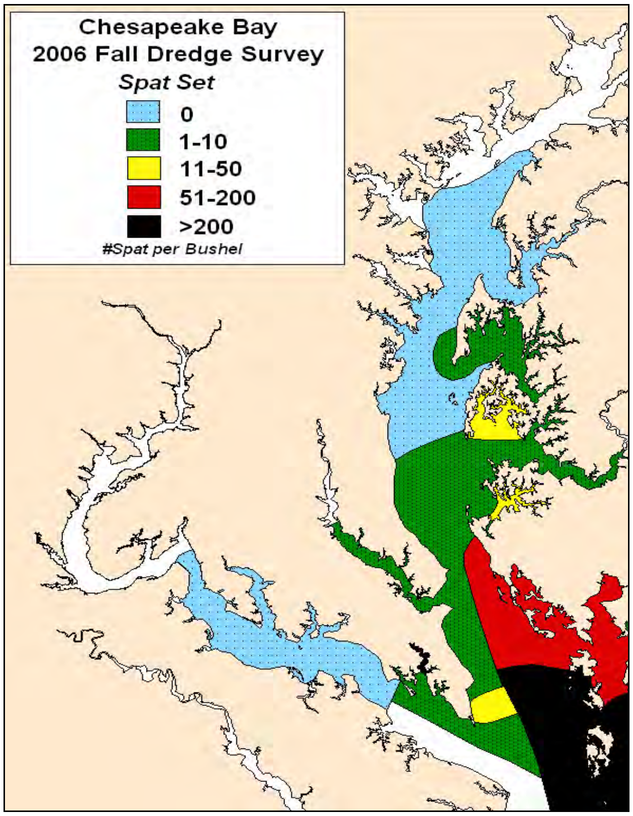



**Figure 3. Spatfall intensity ranges and distribution, 2006.**

The 2006 spatfall intensity index represented a five-fold increase over the previous two years (Table 2). Although the index was below the 22-year average, it was ranked in the second highest statistical grouping for that period (Figure 4).

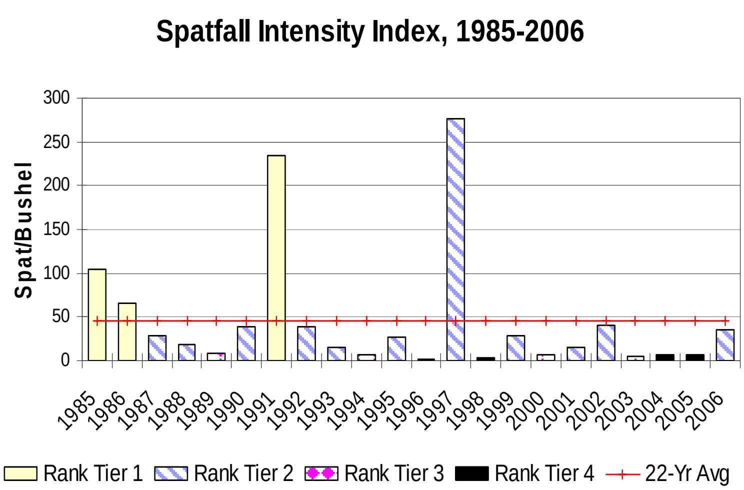



**Figure 4. Spatfall intensity (spat per bushel of cultch) on Maryland "Key Bars" for spat monitoring.**

Oyster spatfall during the period from 1985 to 2006 (Figure 4; Table 2) has been extremely variable. These years included some of the lowest spatfall intensity indices (1994, 1996, 1998, 2003-05) and two of the highest (1991, 1997) over the 67-year history of the annual Fall Survey (Krantz 1996). Spatfall intensity indices in recent years included the lowest on record (1996) followed by the second highest (1997).

The spatfall intensity index is an arithmetic mean that does not take into account geographic distribution. For example, the high spatfall intensity in 1997 was actually limited in extent, being concentrated in the eastern portion of Eastern Bay, the northeast portion of the lower Choptank River, and to a lesser extent, in parts of the Little Choptank and St. Mary's Rivers (MDNR 2001). Over 75% of the 1997 index was accounted for by only five of the 53 Key Bars, while ten contributed nearly 95%. In contrast, the 1991 spatfall was far more widespread, with 15 Key Bars totaling 75% of the index (the 3rd highest on record), and 28 sites were needed to attain 95% of the spatfall intensity index. As mentioned, spatfall in 2006 was geographically confined, with nine bars or 17% of the Key Bars accounting for 75% of the index. Eighteen sites or fully one-third of the Key Bars had no detected spat.

### *Historic Spat Index*

The historic spat index, dating back to 1939, is being reviewed and revised. To date, most of the adjustments have produced only minor changes in the annual indices. This effort has been completed for the years 1985 to 2006 and the revisions are highlighted in **bold** in Table 2. A detailed synopsis of methods, data standards, and revisions to the historic spat index will be included in the next Fall Survey report.

## Oyster Diseases

Oyster diseases for the most part remained suppressed for a fourth consecutive year, following record high levels in 2002. Although widely distributed, oyster parasite populations in general have been slow to rebound despite moderating streamflows and consequent salinity increases over the past two years.

**Dermo disease**, caused by the parasite *Perkinsus marinus*, persisted on 42 of 43 Disease Bars, with 60% of the sampled oysters infected (Table 3). Nonetheless, this annual mean infection prevalence was well below the 17-year average, ranking 2006 in the lowest statistical grouping for prevalence (Figure 5).

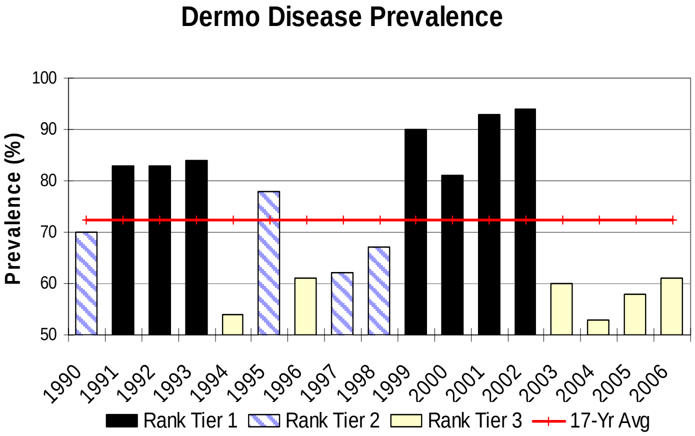



**Figure 5. Statistical ranking and 17-year mean of *P. marinus* prevalence.**

The geographic distribution of prevalences over 60% expanded during 2006 into the mid-Bay and Patuxent and Potomac Rivers, while prevalences declined in the upper Bay, Honga River, and Fishing Bay (Figure 6).

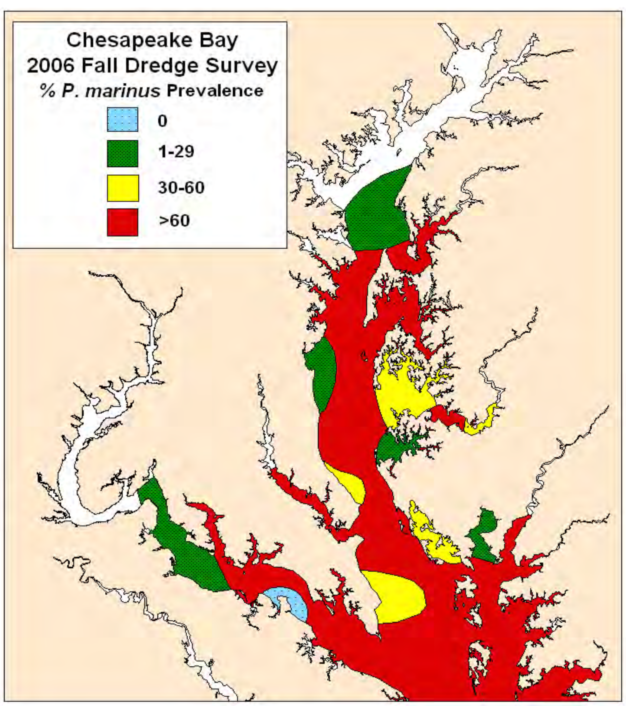



**Figure 6. Geographic extent and prevalence of dermo disease.**

Higher prevalences were also present in many of the eastern shore tributaries as far up-bay as the Chester River. High sample prevalences did not necessarily indicate high sample infection intensities, however, nor were they reflected in high mortality rates.

The 2006 annual mean infection intensity, still depressed relative to the drought period of 1999-2002, was comparable to the previous three years, which all fell within the second lowest statistical grouping for Disease Bar infection intensity (Figure 7).

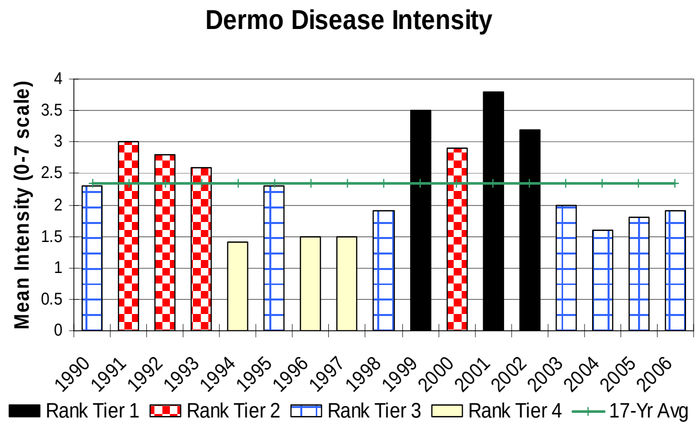



**Figure 7. Annual mean P. marinus infection intensity on a scale of 0-7 in oysters from Maryland disease monitoring bars. Overall mean is for the years 1990-2006.**

The frequency distributions of sample infection intensities were also similar over the past four years (Figure 8). Infection intensities in individual oysters that are ≥5 on a 0-7 scale are considered terminal. Terminal infection intensities were detected in only 14% of sampled oysters, only slightly higher than in 2004-05. Younger oysters, below market size, sampled from natural seed production areas exhibited fewer terminal infection intensities (4%). Among samples from sanctuaries and reserves, 24% of individual oysters exhibited terminal infection intensities. In 2006, only 21% of the Disease Bar samples had mean infection intensities of 3.0 or greater and 2% had mean intensities of 4.0 or greater, in contrast to 67% and 24%, respectively, in the peak disease year of 2002.

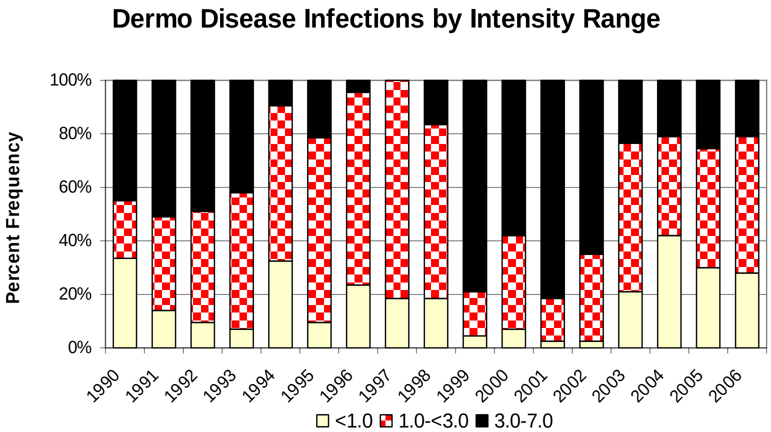



**Figure 8. Perkinsus marinus infection intensity ranges, percent frequency by year and range.**

One disturbing trend was the elevated level of dermo disease on two of the southernmost oyster sanctuaries for the second year in a row. *Perkinsus marinus* prevalences were 97% at Pt. Lookout and 100% at Piney Island East Addition. Mean sample infection intensities, already relatively high during 2005, increased to 4.1 and 4.2, respectively. Pt. Lookout Sanctuary in particular had a thriving oyster population as a result of good recruitment and survivorship in recent years. However, during 2006 mortalities reached 28% there, and 34% at Piney Island East Addition.

**MSX disease**, resulting from the parasite *Haplosporidium nelsoni*, is another potentially devastating oyster disease. This parasite can cause rapid mortality in oysters and generally kills a wide range of year classes, including younger oysters, over a long seasonal period. Specifically, MSX disease kills young oysters and does so during both spring and fall.

During 2006, *H. nelsoni* was detected in two localized areas – lower Tangier Sound and the St. Mary's County bayshore north of Point Lookout (Figure 9). Infected oysters were found on only 9% of the Disease Bars and prevalences, which plummeted during the high-flow years of 2003 and 2004, continued to be very low, even in the affected areas, with an overall mean of only 0.7% (Table 4). The highest infection prevalence was 17% at the Kedges Straits seed area.

The abatement of MSX disease in 2003-04 signified the end of the most severe *H. nelsoni* epizootic on record in Maryland waters. The 2002 epizootic set record high levels for both the frequency of occurrence (88%) and mean annual prevalence (28%), leaving in its wake observed oyster mortalities approaching 60% (see following section). Since 1990, there have been three *H. nelsoni* epizootics: 1991-92, 1995, and 1999-2002. These epizootics were followed closely by periods of unusually high freshwater input into parts of Chesapeake Bay, which resulted in the purging of *H. nelsoni* infections from most Maryland oyster populations.

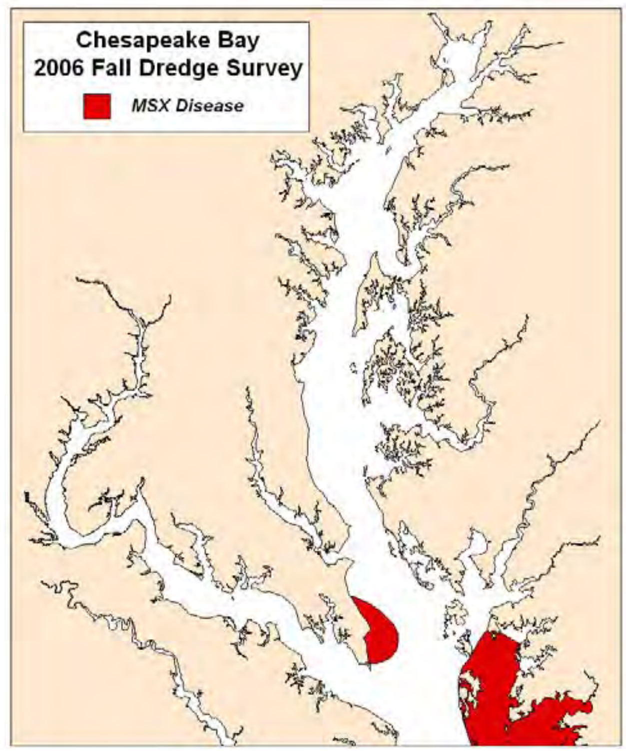



**Figure 9. Geographic extent of MSX disease in Maryland waters, 2006.**

***Bonamia*** sp. infections were not detected among the 1,610 oysters examined histologically during the 2006 Fall Survey. Current understanding of the salinity requirements of *Bonamia* sp. parasites detected from the mid-Atlantic region suggest that their minimum needs are at or above 20‰ (Carnegie et al. 2006). The salinity regime of Maryland's Chesapeake Bay is generally below this threshold and is thus unfavorable to this group of exotic pathogens.

## Observed Mortality

Observed mortalities continued to decline for the fourth successive year. The 2006 observed mortality of 16% was the lowest since 1989 (Table 5), approaching the background mortality levels of 10% or less found prior to the mid-1980's disease epizootics (MDNR, unpubl. data) and well below the 22-year average of 28%. As a result, 2006 was ranked in the second lowest statistical grouping, along with the preceding two years (Figure 10).

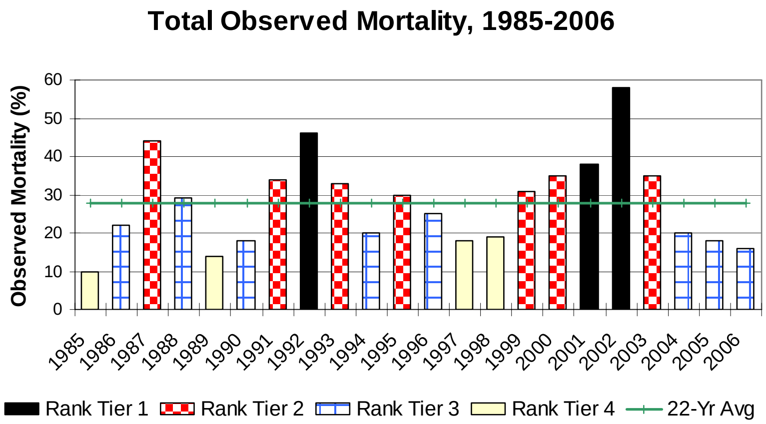



**Figure 10. Mean annual total observed mortality, small and market oysters combined. Overall mean is for the period 1985 to 2006.**

Regions with the highest observed mortalities were Eastern Bay, upper Tangier Sound, and the lower Potomac and Patuxent Rivers (Figure 11). No region exceeded an average total observed mortality of 50%, and only two individual Disease Bars did, including Turtle Back in the Miles River (51%) and Georges in the Manokin River (76%, but with a very small sample size).

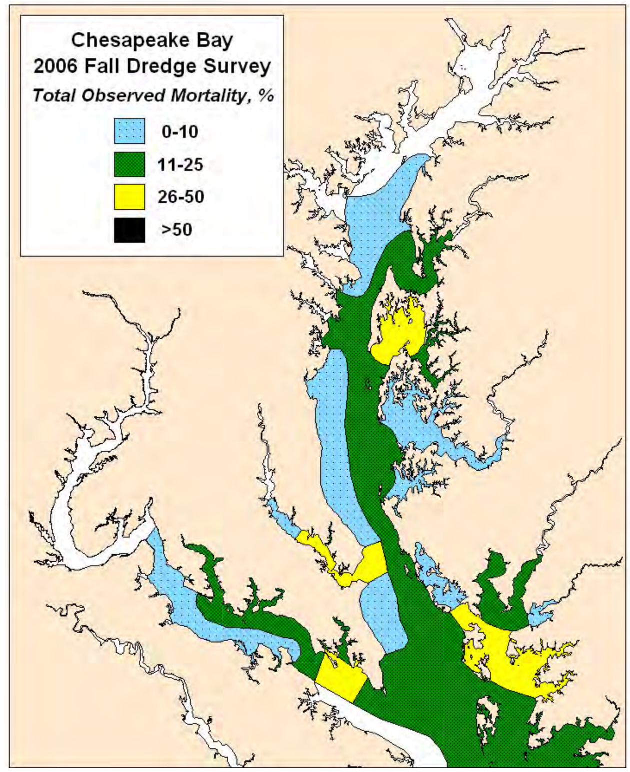



**Figure 11. Total observed oyster mortality.**

The steep decline in total observed mortalities from record high levels in recent years was correlated with the abatement of MSX disease (Figure 12). Furthermore, as salinities remained unfavorable to MSX disease and less than optimal for dermo disease, the continued general reduction of dermo disease infection intensities to sub-lethal levels became the dominant factor influencing declines in observed mortality to well below the 22-year average.

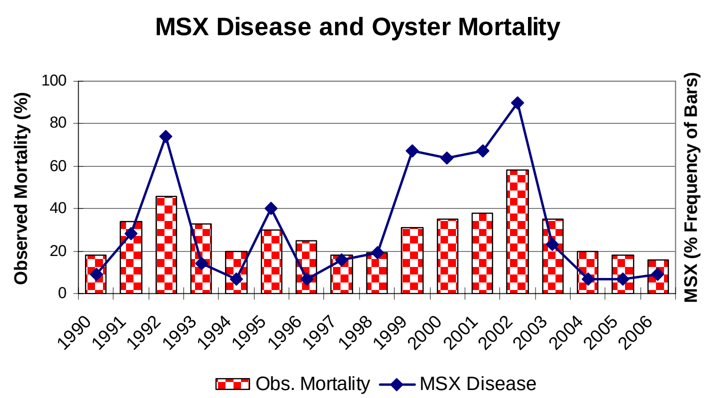



**Figure 12. Changes in total observed oyster mortalities and *H. nelsoni* prevalence.**

## Commercial Harvest

As a consequence of good recruitment in 2002 and sustained low observed mortalities, commercial oyster landings continued to climb. The 2006 oyster harvest (2005-06 season) was 154,436 bushels, nearly six times greater than the record low harvest in 2004 of 26,471 bushels and was over twice last year's total of 72,218 bushels (Figure 12). The 2006 dockside value was $4.7M, compared to only $0.7M for 2004 and $1.1M for 2005. The number of oystermen reporting a harvest for 2006 was 708, in contrast to only 273 for 2004.

The dominant harvest areas for 2006 were, in descending order, Eastern Bay, the upper and mid Bay, Patuxent River, and Broad Creek (Table 6). With over 25 harvest areas tracked, 75% of the harvest came from just these four areas. The bushel increases for 2006 compared to 2005 for these areas were:

Eastern Bay – increased 32,000 bushels
Upper Bay/Mid Bay – increased 32,000 bushels
Patuxent River– increased 17,000 bushels
Broad Creek – increased 12,000 bushels

Tangier Sound, a strong area in prior years and a key power dredging area, decreased by 20,600 bushels compared to 2005. Chester River harvest increased from a low of 557 bushels in 2004 to over 4,000 bushels in 2006, but harvests in the late 1990's were much stronger - between 20,000 and 70,000 bushels.

Harvest by gear type shifted dramatically in 2006 (Table 7). Power dredging no longer was the driving factor, with 20% of the harvest due to this gear, down from about 50% for the previous two seasons. Although this gear shift is largely attributable to an increase in landings from non-power dredging areas, the actual number of bushels harvested by power dredging also declined by 18%, reflecting the decrease in landings from Tangier Sound, a primary power dredging area. Harvest increases were reported for hand tonging, diving, and patent tonging, with skipjacks holding steady. Patent tongs were the dominant gear, followed by diving.

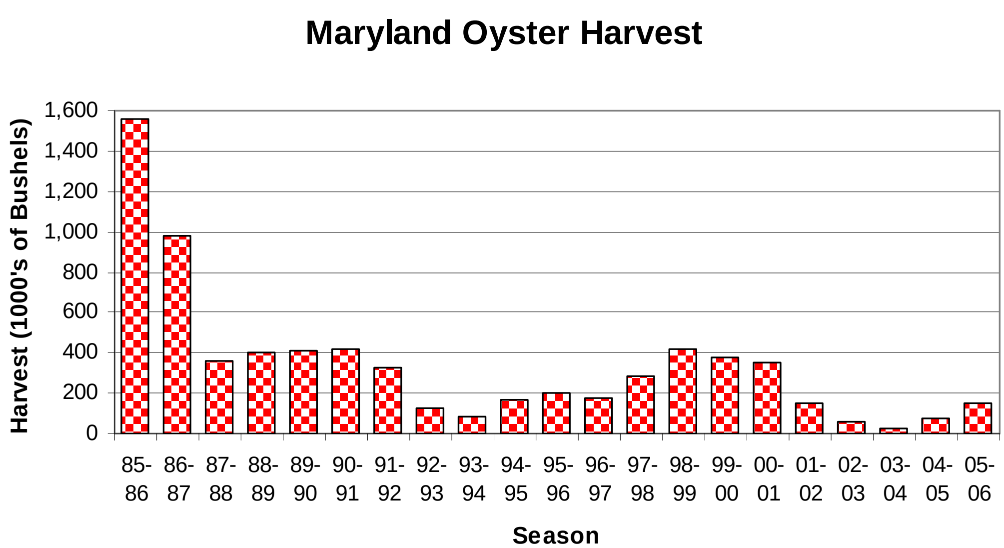



Figure 13. Maryland seasonal oyster landings, 1985-86 to 2005-06.

## DISCUSSION

**Failure of Disease to Intensify**

In June, 2006 Virginia Sea Grant released an advisory bulletin warning oyster growers of anticipated high dermo disease levels. Virginia Institute of Marine Sciences scientists based this projection on the mild temperatures of the previous winter and the drought gripping the Chesapeake region that spring, conditions that are conducive to an epizootic outbreak of dermo disease. Biologists in Maryland had similar expectations for dermo disease in their portion of the bay. Compounding the impending problem was that streamflows had returned to normal in 2005 after two wetter than average years, allowing salinities to rise. Consequently, dermo disease levels in the southern Maryland portion of the bay were also anticipated to have increased to the point where large-scale disease-related oyster mortalities could be expected. The stage was set for an oyster disaster. It didn't happen.

As the VSG advisory was being prepared and released, the drought had broken and the Chesapeake watershed was buffeted by rains. Freshwater input to the Bay jumped from a sluggish 44,000 cfs in May to a brisk 91,000 cfs in June. Above average streamflows persisted for much of the remainder of the year. The timing of this freshwater inundation, just as increasing water temperatures were approaching the point where *P. marinus* begins proliferating in earnest, likely spared the oyster populations in the southern part of Maryland from much higher disease-related mortalities.

As a consequence of the early summer freshwater surge, observed mortalities in 2006 were the lowest since 1989. However, there were disturbing mortality trends, particularly in the southern portion of Maryland. Observed mortalities in Tangier Sound, which had been the premier oyster producing region in the state, were well above the state-wide average. Also, oysters at the Pt. Lookout power-dredge sanctuary, which has a thriving population based largely on the 2001 year class, were heavily infected by *P. marinus.* This sanctuary, which already suffers from an above-average observed mortality of 28%, has been on the verge of even higher die-offs for the past two years. The well-timed decrease in salinity during 2006 was just sufficient to stave off a catastrophe. Nevertheless, the stage is set yet again for heavy mortalities if summer salinities and water temperatures become favorable for *P. marinus*.

**Factors Influencing Natural Mortality**

Non-fishing mortality in oysters may be attributed to any of a suite of causes, including, but not limited to, predation, starvation, smothering by sediment, low dissolved oxygen, and freshets. However, the overwhelming factor in natural mortalities of oysters over the past 20 years has been disease. Prior to the introduction of *H. nelsoni* and impacts from *P. marinus* outbreaks, sporadic mass natural mortality of oysters in Maryland's Chesapeake Bay was generally associated with freshets and occurred in the lower salinity areas. Outside of these infrequent events, however, annual mortality averages ranged between 5% and 10%. Since the onset of parasitic infections, mass mortalities have become more common, severe, and increasingly widespread. Following the widespread establishment of *P. marinus* in the mid-1980's, bay-wide annual mortalities have averaged about 30%, with some areas suffering over 80% total observed mortality. Higher salinities favor both MSX and dermo disease, while lower salinities purge MSX disease from Maryland waters and may reduce, but not entirely eliminate, the prevalence and/or intensity of dermo disease.

The highest total observed mortalities during the past two decades are associated with elevated frequencies of MSX disease associated with higher than average salinities. An increasing trend in observed mortality and MSX disease frequency occurred during the drought years of 1999-2002. Beginning in 2003, the continued decline in observed mortalities can be correlated with a reduction in the geographic range and depression of MSX disease prevalence and intensity over the past four years, resulting from unfavorable salinity regimes.

In the absence of MSX disease, and under current conditions of average to below average salinity, the activity of dermo disease becomes the dominant measurable influence on observed mortality. Even though the annual mean prevalence has decreased from record highs during 1999-2002, this disease still affects approximately 60% of the oyster population, and is present throughout the range of oyster habitat in Maryland. However, infection intensities have dropped to below lethal levels over a wide geographic range, and observed mortalities have continued a 4-year decline. The exception where mortalities, primarily of market oysters, have not declined to as great an extent is in the higher salinity waters of the Tangier Sound region.

**Spatfall Patterns**

The elevated June/July streamflows also affected the distribution of spatfall. The freshet occurred during the peak spawning period for Maryland oysters. This produced a pronounced geographic division in settlement, with little or no spatfall above the mouth of the Little Choptank River, where freshwater input from the Susquehanna River had the greatest influence. Similarly, the Potomac River, which acts as a freshwater conduit, experienced little spatfall. The exceptions were some sheltered backwaters, such as Broad Creek in the Choptank River, which have small watersheds and were not as affected by runoff. Areas that were most impacted by freshwater inputs lost an entire year class of oysters. Where the influence of freshwater flow was moderated, such as in Tangier Sound, oyster recruitment was moderately successful. Salinities in this region seem to have been finely balanced between enabling good recruitment and suppressing disease-related mortality.

**Harvest Trends**

During 2006, the industry experienced many gains: in harvest, dockside value, number of working watermen, and in rebounds for hand tongers, divers, and patent tongers, which had been in a serious downturn the two prior seasons. The dismal record-low harvest of 2004 is the backdrop for discussing 2006 as a stronger, better year, for when compared to other recent years, 2006 doesn’t stand out as anything other than a poor to average year. The improvement seen in 2006 doesn’t signal an actual recovery of oysters to historic levels or support an expectation for longstanding gains for the fishery. Yet, the 2006 season shows real economic gains over 2004, a benefit to the industry and working watermen.

The increase in harvest for 2005-06 was due to reduced disease levels and improved survivorship over the three preceding growing seasons. The significantly higher than average freshwater inputs during 2003 and 2004 lowered salinity, and consequently disease pressure, allowing more oysters to survive to market size into this season. Coupled with the widespread spatfall in 2002, this resulted in notable population increases in areas worked by hand tongers, divers, and patent tongers, who collectively produced 75% of the harvest in 2006. In contrast, there was a reduction in harvest by power dredgers, both in terms of the percentage of the total catch and of bushels landed. Power dredge harvest dominated the fishery during the 2004 and 2005 seasons, producing about 50% of the harvest. This trend was reversed in 2006 The decline in power dredge landings was due to persistent disease and relatively higher mortalities in Tangier Sound, a major portion of the area open to power dredging. The observed mortality rates of market oysters in Tangier Sound were 34% in 2004 and 41% in 2005, well above the Maryland-wide averages of 20% and 17%, respectively.

Good recruitment in 2002 increased the supply of seed oysters for the MDNR repletion program, which in turn supplemented the natural spatfall. Much of the harvest gain for 2006 came from areas planted by MDNR with shells and seed oysters, indicating a return on these efforts compared to if no action had been taken. The top three harvest areas of Eastern Bay, upper and mid Bay and Patuxent River have been heavily planted with shells and/or seed oysters. These Repletion Program activities, coupled with improvement in disease and survival in these areas, enabled harvests to increase.

The Chester River harvest data show how the fishery is dependent on consistent and constant seeding when natural recruitment is too low to support a fishery. Harvests from 1998 to 2002 ranged from 20K bushels to 70K bushels but plummeted after 2002, a period when no transplanting occurred in the river. With the end of the Seed Program in the Chester River, harvests collapsed and have not recovered in spite of some modest amounts of hatchery seed that have been planted on a few select Harvest Reserves (areas established for the production of harvest using hatchery seed). Since the Reserve Program has dominated the river's production, harvests have been a few thousand bushels.

## LITERATURE CITED


Bue, C.D. 1968. Monthly surface-water inflow to Chesapeake Bay: U.S. Geological Survey Open-File Report, Arlington, Va., October 1968, 45 pp.

Carnegie, R.B., N.A. Stokes, C. Audemard, E.M. Burreson, M.J. Bishop, C.H. Peterson, A.E. Wilbur, T.D. Alphin, M.H. Posey. 2006. Potential impacts of *Bonamia* sp. on *Crassostrea ariakensis* in Chesapeake Bay and North Carolina. J. Shellfish Res. **25**: 717.

Dungan, C.F. and R.M. Hamilton. 1995. Use of a tetrazolium-based cell proliferation assay to measure effects of *in vitro* conditions on *Perkinsus marinus* (Apicomplexa) proliferation. J. Eukaryot. Microbiol. **42**: 379-388.

Ford, S. and M.R. Tripp. 1996. Chapter 17. Diseases and defense mechanisms. *In:* V.S. Kennedy, R.I.E. Newell, and A.F. Eble (eds.). The Eastern Oyster, *Crassostrea virginica*, p. 581-660. Md. Sea Grant Publ. UM-SG-TS-96-01. College Park, Md.

Gieseker, C.M. 2001. Year 2000 Maryland Oyster Disease Status Report. MDNR, Fish. Serv., Sarbanes Cooperative Oxford Lab. FS-SCOL-01-1. Oxford, Md.

Hájek, J. and Z. Šidák. 1967. Theory of Rank Tests. Academic Press, New York.

Hess, J. 2006. Seed oyster and shell activity reports. MDNR, Shellfish Program, Annapolis, Md.

Hollander, M. and D.A. Wolfe. 1973. Nonparametric Statistical Methods. John Wiley and Sons, New York.

Krantz, G.E. 1990. Maryland Oyster Population Status Report, 1989 Fall Survey. MDNR, Ches. Bay Res. Monitoring Div., CBRM-OX-90-1. Oxford, Md.

Krantz, G.E. 1996. Oyster Recruitment in the Chesapeake Bay, 1939 to 1993. MDNR, Fish. Serv. Spec. Publ. Oxford, Maryland.

Krantz, G.E. and D.W. Webster. 1980. Maryland Oyster Spat Survey Fall 1979. Md. Sea Grant Prog. Tech Rept. No. UM-SG-TS-80-01. College Park, Md.

Lehman, E.L. 1963. Asymptotically nonparametric inference in some linear models with one observation per cell. Ann. Math. Statist. **34**: 1494-1506.

McDonald, B.J. and W.A. Thompson, Jr. 1967. Rank sum multiple comparisons in one- and two-way classifications. Biometrika **54**: 487-497.

MDNR. 1975- 1984. Unpublished data, Bay-wide Bottom Survey and Annual Fall Dredge Surveys.

MDNR. 1988. Status and Trends, Maryland's Oyster Resources. Tidewater Admin., Fish. Div. 61 pp.

MDNR. 2001. Maryland Oyster Population Status Report: 1996-2000 Fall Surveys. Sarbanes Coop. Oxford Lab. and Shellfish Prog.

Smith, G. and S. Jordan. 1993. Monitoring Maryland's Chesapeake Bay Oysters. MDNR, Ches. Bay Res. Monitoring Div., CBRM-OX-93-3. Oxford, Md.

Tarnowski, M. (ed.). 2005. Maryland Oyster Population Status Report: 2003 and 2004 Fall surveys. MDNR, Shellfish Prog. and Coop. Oxford Lab., MDNR Publ. No. 17-1072005-62. Annapolis, Md.

USGS. 2007. Estimated streamflow entering Chesapeake Bay above selected cross sections. United States Geological Survey Inflow Database. http://md.water.usgs.gov/monthly/bay.html

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# TABLES

Table 1. Listing of data recorded during the Annual Fall Dredge Survey.

***Physical Parameters***

-Latitude and longitude

-Bottom type

-Depth

-Temperature

-Salinity

-Tow distance (2005-present)

***Biological Parameters***

-Total volume of material (2005-present)

-Counts of live and dead oysters by age/size classes (spat, smalls, markets)

-Stage of oyster boxes (recent, old)

-Average and range of shell heights of live and dead oysters by age/size classes

-Shell heights of oysters grouped into 5 mm intervals (Disease Bar sites, 1990-present)

-Condition index and meat quality of live oysters

-Type and relative extent of fouling

-Type of sample and year of action (e.g. 1997 seed, natural, 1990 fresh shell planting, etc.)

(Return to text)

Table 2. Spatfall intensity (spat per bushel of cultch) from the 53 "Key" spat monitoring bars, 1985-2006.
Numbers in **bold** have been revised from previous years.

| Oyster Bar | Spatfall Intensity, Number Per Bushel | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
| Mountain Point | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Swan Point | 4 | 0 | 2 | 2 | 0 | 0 | **1** | 0 |
| Brickhouse | 78 | 0 | 4 | 8 | 0 | 3 | 0 | 0 |
| Hackett Point | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tolly Point | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Three Sisters | 10 | 2 | 8 | 0 | 0 | 0 | 0 | 0 |
| Holland Point | 6 | **5** | 0 | 0 | 0 | 0 | 0 | **0** |
| Stone Rock | 136 | **20** | **0** | **50** | **22** | 37 | 355 | **9** |
| Flag Pond | **52** | **144** | 128 | **0** | 0 | 4 | 330 | **0** |
| Hog Island | 116 | 32 | 58 | **29** | **4** | 7 | 169 | **0** |
| Butler | **nd** | **197** | **142** | 16 | 2 | 24 | 617 | 3 |
| Buoy Rock | 16 | 0 | 6 | 0 | 0 | 1 | 0 | 0 |
| Parsons Island | 78 | **4** | 4 | 2 | 0 | 7 | 127 | 18 |
| Wild Ground | 46 | 8 | 4 | 8 | 0 | 18 | 205 | 8 |
| Hollicutt Noose | 24 | 8 | 12 | 6 | 0 | **2** | 11 | 1 |
| Bruffs Island | 82 | 0 | 0 | 2 | 0 | **2** | 12 | 8 |
| Ash Craft | 10 | 2 | 0 | 10 | 0 | 2 | 12 | 0 |
| Turtleback | 382 | 40 | 12 | **52** | 6 | 11 | 168 | 15 |
| Shell Hill | 50 | **6** | 0 | 6 | 0 | **48** | 79 | 0 |
| Sandy Hill | 74 | 16 | 2 | 0 | 0 | 28 | 179 | 2 |
| Royston | 440 | 8 | 8 | 0 | 0 | 57 | 595 | 20 |
| Cook Point | **66** | 82 | 4 | 28 | 0 | 17 | 171 | 1 |
| Eagle Pt./Mill Pt. | **258** | **92** | 2 | 6 | 6 | 18 | 387 | 4 |
| Tilghman Wharf | 156 | **28** | 38 | 4 | **4** | 109 | 719 | 10 |
| Deep Neck | 566 | 114 | 6 | 22 | 4 | 48 | 468 | 22 |
| Double Mills | 332 | 24 | 2 | 0 | 0 | 1 | 129 | 0 |
| Ragged Point | 134 | **82** | 34 | 112 | 0 | 65 | 1036 | 53 |
| Cason | **102** | 24 | 46 | 50 | 0 | 143 | 1839 | 43 |
| Windmill | 34 | 112 | **28** | 22 | 16 | 155 | 740 | 46 |
| Norman Addition | 56 | 214 | 38 | 17 | 34 | 82 | 1159 | 53 |
| Goose Creek | 34 | **97** | 16 | 18 | 4 | 4 | 153 | 41 |
| Clay Island | 4 | 78 | 14 | 48 | 18 | **19** | 256 | 46 |
| Wetipquin | 34 | 10 | 0 | 0 | 0 | 3 | 3 | 6 |
| Middleground | **8** | 12 | 26 | 9 | **16** | 40 | 107 | 63 |
| Evans | **18** | 10 | 12 | **17** | **2** | **13** | 20 | 27 |
| Mt. Vernon Wharf | **nd** | 0 | 0 | 0 | 0 | 0 | 15 | 0 |
| Georges | 26 | **98** | 14 | 4 | 16 | 4 | 52 | 42 |
| Drum Point | 48 | 186 | 48 | 90 | **78** | 16 | 140 | 185 |
| Sharkfin Shoal | 18 | 44 | 22 | 24 | 2 | 16 | 43 | 97 |
| Turtle Egg | **154** | 90 | 12 | 26 | 26 | 204 | 289 | 591 |
| Piney Island East | 182 | **192** | **194** | 160 | **82** | 64 | 429 | 329 |
| Great Rock | 2 | 6 | 4 | 6 | 10 | **66** | 208 | 44 |
| Gunby | 124 | **24** | 50 | **4** | 8 | 21 | 302 | **149** |
| Marumsco | **26** | 50 | 18 | **5** | 12 | 6 | 142 | 34 |
| Broome Island | **15** | 0 | 0 | 0 | 0 | 3 | **8** | 0 |
| Back of Island | 42 | 0 | 8 | 4 | 4 | 15 | 49 | 5 |
| Chicken Cock | 620 | 298 | 96 | 62 | 18 | 29 | 182 | 5 |
| Pagan | 140 | 34 | 52 | 36 | 6 | 613 | 190 | 62 |
| Black Walnut | 16 | **12** | 0 | 0 | 0 | 1 | 6 | 0 |
| Blue Sow | **55** | **40** | 0 | 0 | 0 | 1 | 22 | 0 |
| Dukehart | **20** | **7** | **0** | 0 | 0 | **1** | 19 | 0 |
| Ragged Point | 69 | **35** | 4 | 0 | 0 | 2 | **26** | 0 |
| Cornfield Harbor | 383 | 908 | 362 | 28 | 14 | **36** | 212 | 2 |
| **Spat Index** | **103.8** | **66.1** | **29.1** | **18.7** | **7.8** | **39.0** | **233.6** | **38.6** |

Table 2 (Continued).

| Oyster Bar | Spatfall Intensity, Number Per Bushel | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Mountain Point | **3** | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Swan Point | 3 | 0 | **0** | 0 | 0 | 0 | 0 | 0 |
| Brickhouse | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 1 |
| Hackett Point | **0** | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Tolly Point | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| Three Sisters | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 |
| Holland Point | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 |
| Stone Rock | 4 | 4 | **16** | 0 | 18 | 0 | 3 | 34 |
| Flag Pond | **8** | 0 | 10 | 0 | 7 | 0 | 1 | 5 |
| Hog Island | **0** | 0 | **17** | 0 | 5 | 2 | 6 | 1 |
| Butler | 2 | 1 | 7 | 1 | 8 | 0 | 6 | 1 |
| Buoy Rock | 0 | 0 | 6 | 0 | 8 | 0 | 0 | 0 |
| Parsons Island | 2 | 0 | **44** | 0 | 3,375 | 3 | 6 | 6 |
| Wild Ground | **2** | 0 | **54** | 0 | 990 | 0 | 2 | 5 |
| Hollicutt Noose | 0 | 0 | 7 | 0 | 56 | 0 | 6 | 2 |
| Bruffs Island | 0 | **0** | 15 | 0 | 741 | 4 | 5 | 9 |
| Ash Craft | 0 | 0 | 60 | 1 | 2,248 | 0 | 14 | 2 |
| Turtleback | 0 | 0 | 194 | 0 | 3,368 | 5 | 13 | 4 |
| Shell Hill | 0 | 0 | 15 | 0 | 19 | 1 | 4 | 4 |
| Sandy Hill | 0 | 0 | 4 | 0 | 55 | 0 | 4 | 0 |
| Royston | **10** | 0 | **10** | 0 | 289 | 0 | 39 | 0 |
| Cook Point | 0 | 2 | **14** | 0 | 20 | 0 | 1 | 5 |
| Eagle Pt./Mill Pt. | 15 | 0 | **62** | 0 | 168 | 2 | 16 | 0 |
| Tilghman Wharf | 59 | 4 | 64 | 0 | 472 | 0 | 49 | 1 |
| Deep Neck | 94 | 12 | 294 | 3 | 788 | 1 | 211 | 3 |
| Double Mills | 13 | 0 | 15 | 0 | 40 | 0 | 1 | 0 |
| Ragged Point | **9** | **1** | **25** | 0 | 106 | 0 | 43 | 3 |
| Cason | 37 | 28 | 48 | 5 | 228 | 4 | 53 | 5 |
| Windmill | **22** | 19 | 13 | 2 | 5 | 1 | 37 | 0 |
| Norman Addition | 33 | 17 | 25 | 0 | 8 | 0 | 31 | 1 |
| Goose Creek | 43 | 27 | 3 | 0 | 5 | 0 | 0 | 0 |
| Clay Island | 58 | 31 | 11 | 1 | 20 | 2 | 5 | 4 |
| Wetipquin | 1 | 4 | 1 | 0 | 0 | 10 | 0 | 0 |
| Middleground | 14 | 28 | 2 | 6 | 27 | 0 | 9 | 1 |
| Evans | **6** | 30 | **3** | 1 | 5 | 0 | 1 | 0 |
| Mt. Vernon Wharf | 18 | 0 | 3 | 0 | 0 | 1 | 0 | 0 |
| Georges | 19 | 9 | **5** | 0 | 8 | 6 | 50 | 6 |
| Drum Point | 45 | 13 | 14 | 10 | 16 | 11 | 157 | 27 |
| Sharkfin Shoal | 18 | 11 | 6 | 0 | 7 | 0 | 9 | 5 |
| Turtle Egg | 37 | 31 | **6** | 35 | 70 | 3 | 180 | 33 |
| Piney Island East | 22 | 25 | 23 | 25 | 45 | 16 | 118 | 28 |
| Great Rock | 27 | 11 | 3 | 7 | 0 | 1 | 82 | 6 |
| Gunby | **68** | 7 | **5** | 9 | 0 | 24 | 54 | 32 |
| Marumsco | **60** | 5 | 6 | 0 | 0 | 57 | 27 | 27 |
| Broome Island | 0 | 0 | 58 | 0 | 0 | 1 | 7 | 0 |
| Back of Island | 0 | 1 | 17 | 0 | 3 | 0 | 22 | 9 |
| Chicken Cock | 45 | 4 | 78 | 2 | 36 | 10 | 132 | 16 |
| Pagan | 15 | 7 | 54 | 0 | 1,390 | 6 | 95 | 42 |
| Black Walnut | 1 | 0 | 1 | 0 | 2 | 0 | 3 | 0 |
| Blue Sow | 1 | 0 | **7** | 0 | 0 | 0 | 11 | 0 |
| Dukehart | **3** | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Ragged Point | **2** | 0 | **19** | 0 | 2 | 0 | 1 | 1 |
| Cornfield Harbor | 29 | 0 | 49 | 0 | 4 | 11 | 25 | 5 |
| **Spat Index** | **16.0** | 6.3 | **26.8** | 2.0 | 276.7 | 3.5 | 29.1 | 6.4 |

Table 2 (Continued).

| Oyster Bar | Spatfall Intensity, Number Per Bushel | | | | | |
|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
| Mountain Point | 0 | 1 | 0 | 0 | 0 | 0 |
| Swan Point | 0 | 0 | 0 | 0 | 0 | 0 |
| Brickhouse | 3 | 97 | 0 | 0 | 0 | 0 |
| Hackett Point | 0 | 13 | 0 | 0 | 0 | 0 |
| Tolly Point | 1 | **10** | 0 | 0 | 0 | 0 |
| Three Sisters | 1 | 0 | 0 | 0 | 0 | 0 |
| Holland Point | 1 | 4 | 0 | 0 | 0 | 0 |
| Stone Rock | 2 | 17 | 1 | 0 | 0 | 3 |
| Flag Pond | 5 | 7 | 0 | 0 | 0 | 4 |
| Hog Island | 28 | 10 | 5 | 1 | 6 | 1 |
| Butler | 27 | 33 | 3 | 0 | 3 | 7 |
| Buoy Rock | 2 | 1 | 1 | 1 | 0 | 0 |
| Parsons Island | 6 | 5 | 2 | 0 | 3 | 0 |
| Wild Ground | 5 | 6 | 4 | 0 | 1 | 0 |
| Hollicutt Noose | 1 | 15 | 3 | 0 | 0 | 0 |
| Bruffs Island | 6 | 0 | 4 | 0 | 0 | 0 |
| Ash Craft | 10 | 0 | 8 | 0 | 0 | 0 |
| Turtleback | 45 | 9 | 72 | 1 | 5 | 0 |
| Shell Hill | 0 | 0 | 0 | 0 | 0 | 0 |
| Sandy Hill | 1 | 1 | 0 | 2 | 0 | 5 |
| Royston | 3 | 10 | 0 | 14 | 0 | 44 |
| Cook Point | 5 | 3 | 1 | 4 | 0 | 9 |
| Eagle Pt./Mill Pt. | 5 | 4 | 1 | 12 | 0 | 19 |
| Tilghman Wharf | 1 | 4 | 0 | 15 | 0 | 22 |
| Deep Neck | 11 | 31 | 1 | 167 | 0 | 30 |
| Double Mills | 0 | 0 | 0 | 3 | 0 | 3 |
| Ragged Point | 5 | 0 | 1 | 2 | 0 | 6 |
| Cason | 2 | 9 | 1 | 5 | 1 | 93 |
| Windmill | 21 | 9 | 0 | 0 | 0 | 21 |
| Norman Addition | 30 | 33 | 2 | 0 | 6 | 80 |
| Goose Creek | 0 | 1 | 0 | 0 | 0 | 73 |
| Clay Island | 8 | 16 | 0 | 0 | 0 | 139 |
| Wetipquin | 0 | 3 | 1 | 0 | 0 | 6 |
| Middleground | 0 | **14** | 0 | 0 | 1 | 54 |
| Evans | 0 | 12 | 0 | 1 | 0 | 13 |
| Mt. Vernon Wharf | 0 | 0 | 0 | 0 | 0 | 0 |
| Georges | 1 | 280 | 15 | 4 | 5 | 75 |
| Drum Point | 44 | 124 | 13 | 8 | 40 | 202 |
| Sharkfin Shoal | 0 | 57 | 0 | 2 | 4 | 63 |
| Turtle Egg | 33 | 207 | 25 | 7 | 90 | 181 |
| Piney Island East | 167 | 127 | 1 | 27 | 116 | 420 |
| Great Rock | 140 | 1 | 3 | 19 | 28 | 92 |
| Gunby | 6 | 108 | 0 | 29 | 24 | 36 |
| Marumsco | 4 | 89 | 0 | 14 | 11 | 22 |
| Broome Island | 1 | 15 | 1 | 0 | 3 | 4 |
| Back of Island | 44 | 27 | 11 | 0 | 0 | 1 |
| Chicken Cock | 12 | 151 | 56 | 2 | 2 | 6 |
| Pagan | 117 | 535 | 9 | 6 | 10 | 125 |
| Black Walnut | 1 | 2 | 0 | 0 | 0 | 0 |
| Blue Sow | 2 | 4 | 1 | 0 | 0 | 0 |
| Dukehart | 0 | 1 | 0 | 0 | 0 | 1 |
| Ragged Point | 0 | 1 | 0 | 0 | 0 | 1 |
| Cornfield Harbor | 35 | 31 | 9 | 0 | 8 | 6 |
| **Spat Index** | 15.9 | **40.3** | 4.8 | 6.5 | 6.9 | 35.2 |

(Return to text)

Table 3. *Perkinsus marinus* prevalence and intensity (scale of 0-7) in oysters from the 43 disease monitoring bars, 1990-2006. NA=insufficient quantity of oysters for analytical sample.

| Oyster Bar | *Perkinsus marinus* Prevalence (%) and Intensity (I) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | |
| | % | I | % | I | % | I | % | I | % | I |
| Swan Point | 7 | 0.1 | 27 | 0.7 | 23 | 0.4 | 37 | 0.8 | 3 | 0.1 |
| Hacketts Point | 0 | 0.0 | 27 | 0.8 | 57 | 1.2 | 97 | 3.2 | 23 | 0.5 |
| Holland Point | 20 | 0.5 | 47 | 1.1 | 80 | 2.4 | 93 | 3.0 | 36 | 1.1 |
| Stone Rock | 47 | 0.5 | 27 | 0.9 | 100 | 4.4 | 100 | 3.5 | 90 | 2.5 |
| Flag Pond | 30 | 0.8 | 97 | 2.6 | 97 | 5.7 | 88 | 2.7 | 30 | 0.8 |
| Hog Island | 90 | 3.0 | 97 | 4.5 | 100 | 4.2 | 93 | 2.4 | 37 | 1.0 |
| Butlers | 100 | 4.0 | 100 | 4.0 | 81 | 2.4 | 97 | 3.3 | 80 | 2.1 |
| Buoy Rock | 23 | 0.5 | 80 | 2.5 | 97 | 2.8 | 93 | 3.3 | 10 | 0.3 |
| Oldfield | 17 | 0.2 | 20 | 0.5 | 37 | 0.9 | 83 | 2.4 | 20 | 0.6 |
| Bugby | 100 | 3.4 | 100 | 4.0 | 73 | 1.8 | 100 | 3.0 | 43 | 0.8 |
| Parsons Island | 20 | 0.5 | 97 | 3.6 | 80 | 2.1 | 100 | 3.3 | 93 | 3.1 |
| Hollicutts Noose | 30 | 0.3 | 73 | 2.0 | 82 | 2.1 | 97 | 2.7 | 70 | 1.7 |
| Bruffs Island | 83 | 2.8 | 83 | 2.8 | 93 | 3.0 | 83 | 2.6 | 63 | 1.3 |
| Turtleback | 100 | 3.8 | 100 | 3.3 | 77 | 1.6 | 100 | 3.3 | 60 | 1.2 |
| Long Point | 73 | 2.3 | 94 | 4.3 | 86 | 3.0 | 77 | 2.6 | 60 | 2.0 |
| Cook Point | 17 | 0.2 | 23 | 0.3 | 87 | 3.7 | 97 | 4.2 | 90 | 3.0 |
| Royston | -- | --- | 100 | 4.5 | 97 | 4.8 | 100 | 3.3 | 80 | 2.0 |
| Lighthouse | 90 | 2.3 | 100 | 4.0 | 100 | 4.6 | 93 | 3.2 | 47 | 1.2 |
| Sandy Hill | 100 | 5.0 | 100 | 5.7 | 100 | 4.2 | 100 | 3.8 | 83 | 2.3 |
| Oyster Shell Point | 3 | 0.1 | 60 | 1.7 | 100 | 3.9 | 93 | 2.8 | 10 | 0.3 |
| Tilghman Wharf | 100 | 3.2 | 97 | 3.0 | 100 | 3.4 | 100 | 3.2 | 63 | 1.9 |
| Deep Neck | 100 | 4.9 | 100 | 5.6 | 100 | 3.7 | 100 | 3.8 | 67 | 2.3 |
| Double Mills | 97 | 3.6 | 100 | 4.9 | 100 | 4.1 | 100 | 3.8 | 90 | 2.0 |
| Cason | 100 | 3.4 | 100 | 4.4 | 90 | 2.6 | 93 | 2.8 | 83 | 2.2 |
| Ragged Point | 100 | 4.8 | 100 | 4.6 | 100 | 5.0 | 100 | 3.9 | 87 | 2.3 |
| Normans Addition | 100 | 4.2 | 100 | 3.4 | 83 | 2.0 | 96 | 3.6 | 93 | 3.3 |
| Goose Creek | 60 | 1.8 | 100 | 3.1 | 100 | 3.6 | 87 | 2.1 | 53 | 1.1 |
| Wilson Shoals | 93 | 2.9 | 100 | 2.8 | 90 | 2.5 | 83 | 1.6 | 40 | 0.9 |
| Georges | 83 | 1.9 | 93 | 2.9 | 58 | 1.4 | 30 | 0.7 | 50 | 1.2 |
| Holland Straits | 100 | 4.2 | 100 | 4.0 | 100 | 3.4 | 76 | 2.3 | 57 | 1.6 |
| Sharkfin Shoal | 23 | 0.3 | 60 | 1.2 | 97 | 2.8 | 93 | 2.2 | 63 | 1.4 |
| Back Cove | 100 | 2.7 | 100 | 4.2 | 97 | 3.3 | 36 | 1.0 | 80 | 2.2 |
| Piney Island East | 93 | 2.7 | 97 | 3.1 | 87 | 2.7 | 83 | 2.2 | 87 | 3.1 |
| Old Woman's Leg | 57 | 1.1 | 100 | 4.5 | 100 | 4.0 | 82 | 2.0 | 73 | 2.1 |
| Marumsco | 97 | 3.5 | 93 | 3.3 | 60 | 1.3 | 87 | 2.5 | 72 | 1.6 |
| Broomes Island | 97 | 3.4 | 100 | 2.8 | 63 | 1.5 | 87 | 3.0 | 40 | 0.6 |
| Chicken Cock | 100 | 4.2 | 97 | 3.1 | 93 | 3.2 | 96 | 2.6 | 40 | 1.0 |
| Pagan | 93 | 3.3 | 97 | 2.3 | 100 | 3.0 | 93 | 2.1 | 10 | 0.3 |
| Lancaster | 97 | 3.6 | 97 | 2.8 | 67 | 1.4 | 67 | 1.6 | 20 | 0.2 |
| Mills West | 13 | 0.2 | 80 | 2.0 | 90 | 2.9 | 63 | 1.8 | 20 | 0.2 |
| Cornfield Harbor | 97 | 3.4 | 83 | 2.3 | 100 | 3.8 | 93 | 2.9 | 77 | 1.9 |
| Ragged Point | 97 | 3.8 | 90 | 2.8 | 40 | 0.9 | 50 | 1.4 | 10 | 0.2 |
| Lower Cedar Point | 40 | 0.7 | 10 | 0.3 | 23 | 0.6 | 7 | 0.1 | 7 | 0.1 |
| **Annual Means** | **70** | **2.3** | **83** | **3.0** | **83** | **2.8** | **84** | **2.6** | **54** | **1.4** |

Table 3 (Continued).

| Oyster Bar | *Perkinsus marinus* Prevalence (%) and Intensity (I) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | | 1996 | | 1997 | | 1998 | | 1999 | |
| | % | I | % | I | % | I | % | I | % | I |
| Swan Point | 20 | 0.2 | 0 | 0.0 | 3 | 0.1 | 43 | 1.2 | 97 | 3.4 |
| Hacketts Point | 90 | 2.5 | 30 | 0.7 | 43 | 1.3 | 43 | 1.1 | 97 | 3.3 |
| Holland Point | 87 | 2.9 | 47 | 1.4 | 37 | 1.1 | 37 | 0.9 | 93 | 2.8 |
| Stone Rock | 87 | 2.2 | 93 | 2.7 | 90 | 2.3 | 100 | 3.5 | 100 | 4.0 |
| Flag Pond | 87 | 3.3 | 63 | 2.0 | 53 | 1.2 | 73 | 2.3 | NA | NA |
| Hog Island | 93 | 2.7 | 43 | 1.2 | 47 | 1.3 | 97 | 3.2 | 93 | 5.5 |
| Butlers | 87 | 2.5 | 60 | 1.6 | 57 | 1.0 | 97 | 3.3 | 93 | 3.2 |
| Buoy Rock | 67 | 1.7 | 13 | 0.4 | 7 | 0.7 | 33 | 0.9 | 93 | 3.0 |
| Oldfield | 83 | 2.3 | 0 | 0.0 | 10 | 0.2 | 33 | 0.8 | 97 | 3.0 |
| Bugby | 83 | 2.6 | 80 | 2.0 | 70 | 1.8 | 60 | 1.4 | 100 | 3.9 |
| Parsons Island | 70 | 2.1 | 73 | 2.8 | 63 | 1.4 | 80 | 2.5 | 100 | 4.7 |
| Hollicutts Noose | 90 | 2.8 | 60 | 1.4 | 50 | 1.0 | 83 | 2.5 | 90 | 3.0 |
| Bruffs Island | 73 | 2.1 | 67 | 1.4 | 17 | 0.2 | 57 | 1.6 | 100 | 3.7 |
| Turtleback | 100 | 2.8 | 83 | 2.1 | 83 | 1.8 | 50 | 1.6 | 100 | 4.3 |
| Long Point | 67 | 2.2 | 20 | 0.4 | 23 | 0.6 | 100 | 2.7 | 100 | 3.6 |
| Cook Point | NA | --- | 60 | 1.5 | 70 | 2.4 | 87 | 2.8 | 93 | 3.4 |
| Royston | 63 | 2.0 | 50 | 1.1 | 67 | 1.5 | 90 | 2.5 | 97 | 3.5 |
| Lighthouse | 90 | 3.3 | 77 | 1.8 | 57 | 1.5 | 43 | 1.5 | 87 | 2.3 |
| Sandy Hill | 89 | 3.4 | 30 | 0.7 | 60 | 1.3 | 40 | 1.0 | 97 | 3.4 |
| Oyster Shell Pt | 68 | 1.8 | 13 | 0.2 | 50 | 0.9 | 20 | 0.3 | 83 | 2.3 |
| Tilghman Wharf | 93 | 2.5 | 67 | 1.3 | 60 | 1.0 | 67 | 2.0 | 87 | 2.5 |
| Deep Neck | 97 | 3.0 | 83 | 2.1 | 100 | 2.6 | 97 | 2.9 | 97 | 4.5 |
| Double Mills | 75 | 2.5 | 70 | 1.2 | 83 | 2.0 | 100 | 3.0 | 100 | 4.8 |
| Cason | 93 | 2.3 | 87 | 1.9 | 93 | 2.4 | 50 | 1.4 | 97 | 3.8 |
| Ragged Point | 93 | 2.5 | 97 | 2.6 | 97 | 2.1 | 87 | 1.4 | 100 | 4.0 |
| Normans Add. | 87 | 2.8 | 93 | 2.4 | 73 | 1.6 | 73 | 2.3 | 93 | 3.5 |
| Goose Creek | 87 | 2.5 | 97 | 4.0 | 83 | 2.0 | 100 | 3.0 | 100 | 5.4 |
| Wilson Shoals | 63 | 1.1 | 83 | 1.8 | 80 | 1.9 | 70 | 1.6 | 100 | 4.3 |
| Georges | 87 | 2.8 | 93 | 2.0 | 93 | 2.2 | 83 | 2.4 | 93 | 3.5 |
| Holland Straits | 93 | 3.1 | 83 | 2.0 | 67 | 1.8 | 57 | 1.2 | 80 | 2.5 |
| Sharkfin Shoal | 90 | 3.0 | 97 | 2.1 | 93 | 2.6 | 80 | 2.7 | 100 | 4.3 |
| Back Cove | 83 | 3.0 | 97 | 3.2 | 93 | 2.9 | 90 | 2.3 | 100 | 5.5 |
| Piney Isl East | 93 | 2.5 | 63 | 1.7 | 73 | 2.2 | 83 | 1.9 | 63 | 2.4 |
| Old Woman’s Leg | 100 | 4.2 | 80 | 2.3 | 57 | 1.3 | 90 | 3.2 | 87 | 3.9 |
| Marumsco | 100 | 4.2 | 90 | 2.4 | 61 | 2.1 | 80 | 2.8 | 90 | 3.4 |
| Broomes Island | 43 | 1.0 | 17 | 0.4 | 83 | 2.1 | 83 | 3.0 | 100 | 4.6 |
| Chicken Cock | 83 | 1.9 | 77 | 1.4 | 73 | 1.7 | 80 | 1.7 | 100 | 5.0 |
| Pagan | 93 | 2.2 | 82 | 1.4 | 86 | 1.7 | 73 | 1.7 | 97 | 3.4 |
| Lancaster | 27 | 0.6 | 56 | 1.2 | 80 | 1.6 | 37 | 0.7 | 83 | 2.5 |
| Mills West | 57 | 1.4 | 60 | 1.2 | 60 | 1.2 | 20 | 0.4 | 90 | 3.2 |
| Cornfield Harbor | 93 | 2.5 | 87 | 2.0 | 83 | 1.8 | 83 | 2.0 | 97 | 3.9 |
| Ragged Point | 33 | 0.8 | 7 | 0.2 | 0 | 0.0 | 0 | 0.0 | 17 | 0.5 |
| Lower Cedar Pt. | 13 | 0.2 | 3 | 0.3 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| **Annual Means** | **78** | **2.3** | **61** | **1.5** | **62** | **1.5** | **67** | **1.9** | **90** | **3.5** |

Table 3 (Continued).

| Oyster Bar | *Perkinsus marinus* Prevalence (%) and Intensity (I) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | |
| | % | I | % | I | % | I | % | I | % | I |
| Swan Point | 80 | 1.2 | 93 | 3.3 | 97 | 2.7 | 33 | 1.0 | 33 | 0.7 |
| Hacketts Point | 97 | 3.7 | 97 | 3.4 | 100 | 3.3 | 33 | 1.1 | 30 | 0.8 |
| Holland Point | 87 | 3.4 | 93 | 3.2 | 100 | 3.6 | 33 | 1.1 | 30 | 0.6 |
| Stone Rock | 93 | 3.6 | 83 | 2.8 | 100 | 2.3 | 77 | 2.4 | 10 | 0.2 |
| Flag Pond | NA | NA | NA | NA | 37 | 0.5 | 0 | 0.0 | 3 | 0.03 |
| Hog Island | 83 | 3.9 | 93 | 3.4 | 87 | 2.9 | 53 | 2.3 | 53 | 1.4 |
| Butlers | 83 | 2.7 | 80 | 2.4 | 80 | 1.4 | 10 | 0.3 | 7 | 0.1 |
| Buoy Rock | 97 | 3.5 | 93 | 3.5 | 100 | 2.6 | 97 | 3.7 | 50 | 1.5 |
| Oldfield | 93 | 3.0 | 100 | 3.3 | 97 | 2.5 | 80 | 2.5 | 33 | 0.7 |
| Bugby | 100 | 4.0 | 100 | 4.6 | 97 | 3.1 | 97 | 3.4 | 63 | 1.7 |
| Parsons Island | 100 | 3.5 | 100 | 4.5 | 100 | 4.4 | 90 | 3.3 | 93 | 2.8 |
| Hollicutts Noose | 100 | 4.1 | 100 | 4.8 | 100 | 3.6 | 80 | 2.7 | 40 | 1.5 |
| Bruffs Island | 97 | 3.2 | 100 | 3.8 | 100 | 3.6 | 73 | 1.8 | 80 | 2.5 |
| Turtleback | 97 | 3.1 | 100 | 4.2 | 100 | 4.7 | 100 | 3.6 | 80 | 2.8 |
| Long Point | 97 | 3.3 | 100 | 4.2 | 100 | 3.1 | 97 | 2.8 | 97 | 3.2 |
| Cook Point | 40 | 1.2 | 77 | 2.2 | NA | NA | 66 | 2.1 | 0 | 0.0 |
| Royston | 97 | 4.7 | 100 | 5.2 | 100 | 4.2 | 48 | 1.8 | 13 | 0.3 |
| Lighthouse | 100 | 3.4 | 100 | 3.3 | 100 | 4.6 | 20 | 0.6 | 43 | 1.2 |
| Sandy Hill | 87 | 3.6 | 100 | 4.5 | 100 | 5.0 | 93 | 3.5 | 87 | 3.3 |
| Oyster Shell Pt | 73 | 2.2 | 100 | 3.6 | 100 | 3.0 | 43 | 1.0 | 43 | 0.8 |
| Tilghman Wharf | 93 | 3.4 | 100 | 3.5 | 90 | 3.2 | 87 | 2.4 | 43 | 0.8 |
| Deep Neck | 100 | 4.0 | 97 | 4.8 | 100 | 3.2 | 97 | 3.7 | 27 | 0.5 |
| Double Mills | 100 | 4.7 | 100 | 5.5 | 97 | 2.9 | 53 | 1.7 | 53 | 2.1 |
| Cason | 100 | 3.6 | 100 | 4.3 | 94 | 4.4 | 17 | 0.4 | 3 | 0.03 |
| Ragged Point | 97 | 3.7 | 100 | 4.3 | 100 | 3.5 | 43 | 1.0 | 13 | 0.2 |
| Normans Add. | 80 | 3.4 | 90 | 3.0 | 67 | 1.9 | 37 | 1.3 | 93 | 3.3 |
| Goose Creek | 97 | 3.1 | 100 | 4.1 | 93 | 4.0 | 57 | 2.0 | 77 | 2.0 |
| Wilson Shoals | 70 | 2.1 | 100 | 4.0 | 100 | 3.6 | 83 | 2.3 | 97 | 2.3 |
| Georges | 80 | 2.3 | 100 | 5.2 | 100 | 4.0 | 83 | 2.6 | 100 | 4.2 |
| Holland Straits | 30 | 0.9 | 43 | 1.4 | 50 | 1.1 | 40 | 0.7 | 70 | 1.7 |
| Sharkfin Shoal | 80 | 2.3 | 90 | 3.7 | 97 | 3.6 | 47 | 3.4 | 100 | 4.4 |
| Back Cove | 40 | 1.2 | 100 | 5.0 | 97 | 3.8 | 100 | 4.6 | 97 | 3.7 |
| Piney Isl East | 86 | 2.3 | 60 | 1.5 | 100 | 3.1 | 100 | 3.9 | 100 | 3.9 |
| Old Woman's Leg | 70 | 1.7 | 100 | 5.0 | 100 | 3.7 | 100 | 4.4 | 93 | 3.7 |
| Marumsco | 93 | 2.7 | 100 | 5.0 | 97 | 4.1 | 90 | 2.3 | 87 | 2.8 |
| Broomes Island | 93 | 4.0 | 100 | 4.8 | 97 | 3.8 | 47 | 1.3 | 47 | 1.4 |
| Chicken Cock | 63 | 1.8 | 93 | 3.6 | 100 | 2.9 | 23 | 0.7 | 40 | 0.9 |
| Pagan | 68 | 1.6 | 100 | 4.6 | 93 | 4.0 | 60 | 1.3 | 83 | 2.3 |
| Lancaster | 90 | 2.7 | 100 | 4.5 | 97 | 2.7 | 50 | 1.5 | 37 | 0.9 |
| Mills West | 97 | 3.6 | 100 | 4.8 | 93 | 3.1 | 60 | 1.6 | 57 | 1.5 |
| Cornfield Harbor | 80 | 2.1 | 80 | 2.9 | 97 | 1.7 | 27 | 0.7 | 30 | 0.5 |
| Ragged Point | 13 | 0.7 | 33 | 0.5 | 93 | 2.6 | 24 | 0.7 | 9 | 0.1 |
| Lower Cedar Pt. | 17 | 0.5 | 90 | 2.3 | 97 | 2.5 | 13 | 0.5 | 17 | 0.4 |
| **Annual Means** | **81** | **2.9** | **93** | **3.8** | **94** | **3.2** | **60** | **2.0** | **53** | **1.6** |

Table 3 (Continued).

| Oyster Bar | *Perkinsus marinus* Prevalence (%) and Intensity (I) | | | |
|---|---|---|---|---|
| | 2005 | | 2006 | |
| | % | I | % | I |
| Swan Point | 47 | 1.2 | 20 | 0.6 |
| Hacketts Point | 13 | 0.4 | 70 | 1.3 |
| Holland Point | 53 | 1.6 | 10 | 0.4 |
| Stone Rock | 50 | 1.3 | 77 | 1.9 |
| Flag Pond | 13 | 0.3 | 43 | 0.9 |
| Hog Island | 93 | 3.4 | 93 | 4.4 |
| Butlers | 30 | 1.1 | 40 | 1.2 |
| Buoy Rock | 77 | 2.4 | 63 | 1.8 |
| Oldfield | 57 | 1.1 | 63 | 1.4 |
| Bugby | 53 | 1.8 | 87 | 2.7 |
| Parsons Island | 87 | 2.6 | 87 | 2.1 |
| Hollicutts Noose | 40 | 1.0 | 83 | 2.9 |
| Bruffs Island | 73 | 1.8 | 53 | 1.6 |
| Turtleback | 100 | 3.3 | 97 | 3.8 |
| Long Point | 90 | 2.7 | 80 | 2.1 |
| Cook Point | 13 | 0.3 | 40 | 0.5 |
| Royston | 3 | 0.2 | 47 | 0.9 |
| Lighthouse | 27 | 0.6 | 30 | 0.4 |
| Sandy Hill | 80 | 2.5 | 70 | 2.3 |
| Oyster Shell Pt | 17 | 0.3 | 30 | 1.1 |
| Tilghman Wharf | 0 | 0.0 | 50 | 0.7 |
| Deep Neck | 20 | 0.4 | 50 | 1.1 |
| Double Mills | 53 | 1.6 | 40 | 1.1 |
| Cason | 33 | 0.5 | 23 | 0.4 |
| Ragged Point | 10 | 0.3 | 23 | 0.4 |
| Normans Add. | 90 | 3.8 | 57 | 2.0 |
| Goose Creek | 63 | 2.2 | 8 | 0.3 |
| Wilson Shoals | 90 | 3.0 | 93 | 3.7 |
| Georges | 90 | 3.3 | 97 | 3.8 |
| Holland Straits | 83 | 3.0 | 83 | 2.1 |
| Sharkfin Shoal | 87 | 3.2 | 83 | 3.4 |
| Back Cove | 100 | 3.1 | 77 | 2.5 |
| Piney Isl East | 100 | 3.7 | 80 | 3.4 |
| Old Woman's Leg | 80 | 2.4 | 57 | 1.8 |
| Marumsco | 93 | 3.3 | 67 | 2.8 |
| Broomes Island | 37 | 0.9 | 77 | 2.5 |
| Chicken Cock | 87 | 3.5 | 90 | 3.4 |
| Pagan | 83 | 2.9 | 80 | 3.1 |
| Lancaster | 57 | 1.5 | 73 | 2.2 |
| Mills West | 50 | 1.3 | 87 | 2.6 |
| Cornfield Harbor | 80 | 2.6 | 100 | 3.3 |
| Ragged Point | 37 | 0.9 | 0 | 0.0 |
| Lower Cedar Pt. | 13 | 0.2 | 10 | 0.1 |
| **Annual Means** | **57** | **1.8** | **60** | **1.9** |

(Return to text)

Table 4. Prevalence of *Haplosporidium nelsoni* in oysters from the 43 disease monitoring bars, 1990-2006. NA=insufficient quantity of oysters for analytical sample. ND=no diagnostic sample collected; prevalence assumed to be 0.

| Oyster Bar | *Haplosporidium nelsoni* Prevalence (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
| Swan Point | 0 | 0 | 0 | 0 | ND | 0 | 0 | 0 |
| Hacketts Point | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Holland Point | 0 | 3 | 13 | 0 | 0 | 0 | 0 | 0 |
| Stone Rock | 0 | 0 | 43 | 0 | 0 | 3 | 0 | 0 |
| Flag Pond | 0 | 0 | 53 | 0 | 0 | 27 | 0 | 0 |
| Hog Island | 0 | 0 | 43 | 0 | 0 | 14 | 0 | 0 |
| Butlers | 0 | 0 | 50 | 0 | 0 | 23 | 0 | 7 |
| Buoy Rock | ND | 0 | 0 | 0 | ND | 0 | 0 | 0 |
| Oldfield | ND | 0 | 0 | 0 | ND | 0 | 0 | 0 |
| Bugby | 0 | 7 | 3 | 0 | 0 | 0 | 0 | 0 |
| Parsons Island | ND | 0 | 7 | 0 | 0 | 0 | 0 | 0 |
| Hollicutts Noose | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 |
| Bruffs Island | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Turtleback | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 |
| Long Point | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cook Point | 0 | 7 | 73 | 0 | 0 | ND | 0 | 3 |
| Royston | ND | 0 | 33 | 0 | 0 | 0 | 0 | 0 |
| Lighthouse | 0 | 0 | 53 | 0 | 0 | 0 | 0 | 0 |
| Sandy Hill | 0 | 0 | 13 | 0 | ND | 0 | 0 | 0 |
| Oyster Shell Pt | 0 | 0 | 30 | 0 | ND | 0 | 0 | 0 |
| Tilghman Wharf | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| Deep Neck | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 |
| Double Mills | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 |
| Cason | 0 | 0 | 43 | 0 | 0 | 0 | 0 | 0 |
| Ragged Point | 0 | 20 | 57 | 0 | 0 | 0 | 0 | 0 |
| Normans Add | 3 | 0 | 53 | 0 | 0 | 33 | 0 | 0 |
| Goose Creek | 0 | 10 | 27 | 7 | 0 | 20 | 0 | 0 |
| Wilson Shoals | 0 | 0 | 57 | 0 | ND | 7 | 0 | 0 |
| Georges | 10 | 7 | 23 | 0 | 0 | 33 | 0 | 0 |
| Holland Straits | 0 | 20 | 13 | 13 | 0 | 52 | 0 | 10 |
| Sharkfin Shoal | 20 | 43 | 40 | 17 | 0 | 33 | 0 | 0 |
| Back Cove | 0 | 17 | 27 | 33 | 7 | 20 | 3 | 3 |
| Piney Isl East | 7 | 23 | 17 | 20 | 13 | 10 | 7 | 13 |
| Old Woman's Leg | 0 | 33 | 23 | 30 | 10 | 43 | 20 | 4 |
| Marumsco | 0 | 20 | 20 | 0 | 0 | 20 | 0 | 11 |
| Broomes Island | 0 | ND | 20 | 0 | 0 | 0 | 0 | 0 |
| Chicken Cock | 0 | 0 | 57 | 0 | ND | 0 | 0 | 0 |
| Pagan | 0 | 0 | 0 | 0 | ND | 0 | 0 | 0 |
| Lancaster | 0 | 0 | 0 | 0 | ND | 0 | 0 | 0 |
| Mills West | 0 | 0 | 0 | 0 | ND | 0 | 0 | 0 |
| Cornfield Harbor | 0 | 0 | 57 | 0 | 0 | 37 | 0 | 0 |
| Ragged Pt. (Potomac) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lower Cedar Pt. | ND | ND | 0 | 0 | ND | 0 | 0 | 0 |
| **Percent** | **9** | **28** | **74** | **14** | **7** | **40** | **7** | **16** |

Table 4 (Continued).

| Oyster Bar | *Haplosporidium nelsoni* Prevalence (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
| Swan Point | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hacketts Point | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 |
| Holland Point | 0 | 0 | 3 | 7 | 40 | 0 | 0 | 0 |
| Stone Rock | 0 | 30 | 47 | 40 | 30 | 3 | 0 | 0 |
| Flag Pond | 0 | NA | NA | NA | 20 | 0 | 0 | 0 |
| Hog Island | 0 | 60 | 27 | 27 | 20 | 0 | 0 | 0 |
| Butlers | 3 | 47 | 17 | 27 | 20 | 3 | 3 | 0 |
| Buoy Rock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oldfield | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bugby | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 |
| Parsons Island | 0 | 0 | 0 | 3 | 17 | 0 | 0 | 0 |
| Hollicutts Noose | 0 | 7 | 10 | 17 | 37 | 0 | 0 | 0 |
| Bruffs Island | 0 | 0 | 0 | 3 | 17 | 0 | 0 | 0 |
| Turtleback | 0 | 0 | 0 | 7 | 33 | 0 | 0 | 0 |
| Long Point | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Cook Point | 0 | 13 | 33 | 37 | NA | 0 | 0 | 3 |
| Royston | 0 | 3 | 7 | 0 | 60 | 0 | 0 | 0 |
| Lighthouse | 0 | 13 | 7 | 3 | 67 | 0 | 0 | 0 |
| Sandy Hill | 0 | 0 | 0 | 10 | 53 | 0 | 0 | 0 |
| Oyster Shell Pt | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| Tilghman Wharf | 0 | 3 | 27 | 7 | 60 | 0 | 0 | 0 |
| Deep Neck | 0 | 3 | 7 | 0 | 63 | 0 | 0 | 0 |
| Double Mills | 0 | 3 | 0 | 0 | 33 | 0 | 0 | 0 |
| Cason | 0 | 7 | 27 | 33 | 59 | 0 | 0 | 0 |
| Ragged Point | 0 | 20 | 47 | 40 | 30 | 0 | 0 | 0 |
| Normans Add | 3 | 63 | 37 | 37 | 20 | 7 | 0 | 0 |
| Goose Creek | 0 | 47 | 17 | 13 | 33 | 0 | 0 | 0 |
| Wilson Shoals | 0 | 4 | 10 | 10 | 27 | 0 | 0 | 0 |
| Georges | 0 | 40 | 20 | 13 | 30 | 0 | 0 | 0 |
| Holland Straits | 3 | 73 | 40 | 47 | 57 | 7 | 0 | 0 |
| Sharkfin Shoal | 20 | 53 | 37 | 20 | 27 | 7 | 0 | 0 |
| Back Cove | 10 | 33 | 37 | 10 | 7 | 7 | 0 | 7 |
| Piney Isl East | 17 | 43 | 53 | 40 | 17 | 10 | 3 | 0 |
| Old Woman's Leg | 23 | 53 | 30 | 13 | 13 | 3 | 3 | 13 |
| Marumsco | 7 | 37 | 30 | 17 | 30 | 0 | 0 | 0 |
| Broomes Island | 0 | 3 | 10 | 0 | 13 | 0 | 0 | 0 |
| Chicken Cock | 0 | 77 | 7 | 17 | 30 | 3 | 0 | 0 |
| Pagan | 0 | 3 | 13 | 10 | 40 | 0 | 0 | 0 |
| Lancaster | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| Mills West | 0 | 3 | 0 | 0 | 43 | 0 | 0 | 0 |
| Cornfield Harbor | 3 | 53 | 17 | 33 | 50 | 10 | 0 | 0 |
| Ragged Pt. (Potomac) | 0 | 13 | 10 | 7 | 60 | 0 | 0 | 0 |
| Lower Cedar Pt. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Percent Frequency** | **19** | **67** | **64** | **67** | **90** | **23** | **7** | **7** |

Table 4 (Continued).

| Oyster Bar | *Haplosporidium nelsoni* Prevalence (%) |
|---|---|
| | 2006 |
| Swan Point | 0 |
| Hacketts Point | 0 |
| Holland Point | 0 |
| Stone Rock | 0 |
| Flag Pond | 0 |
| Hog Island | 0 |
| Butlers | 3 |
| Buoy Rock | 0 |
| Oldfield | 0 |
| Bugby | 0 |
| Parsons Island | 0 |
| Hollicutts Noose | 0 |
| Bruffs Island | 0 |
| Turtleback | 0 |
| Long Point | 0 |
| Cook Point | 0 |
| Royston | 0 |
| Lighthouse | 0 |
| Sandy Hill | 0 |
| Oyster Shell Pt | 0 |
| Tilghman Wharf | 0 |
| Deep Neck | 0 |
| Double Mills | 0 |
| Cason | 0 |
| Ragged Point | 0 |
| Normans Add | 0 |
| Goose Creek | 0 |
| Wilson Shoals | 0 |
| Georges | 0 |
| Holland Straits | 0 |
| Sharkfin Shoal | 0 |
| Back Cove | 13 |
| Piney Isl East | 3 |
| Old Woman's Leg | 13 |
| Marumsco | 0 |
| Broomes Island | 0 |
| Chicken Cock | 0 |
| Pagan | 0 |
| Lancaster | 0 |
| Mills West | 0 |
| Cornfield Harbor | 0 |
| Ragged Pt. (Potomac) | 0 |
| Lower Cedar Pt. | 0 |
| **Percent Frequency** | **9** |

(Return to text)

Table 5. Oyster population mortality estimates from the 43 disease monitoring bars, 1985-2005. NA=unable to obtain a sufficient sample size.

| Oyster Bar | Total Observed Mortality (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
| Swan Point | 14 | 1 | 2 | 1 | 9 | 4 | 4 | 3 | 5 |
| Hacketts Point | 7 | 0 | 10 | 9 | 5 | 2 | 2 | 12 | 18 |
| Holland Point | 4 | 21 | 19 | 3 | 19 | 3 | 14 | 45 | 43 |
| Stone Rock | 6 | NA | NA | NA | NA | 2 | 9 | 45 | 30 |
| Flag Pond | NA | 48 | 30 | 39 | 37 | 10 | 35 | 77 | 43 |
| Hog Island | NA | 26 | 47 | 25 | 6 | 19 | 73 | 85 | 76 |
| Butlers | NA | 23 | 84 | 15 | 7 | 30 | 58 | 84 | 66 |
| Buoy Rock | 10 | 0 | 0 | 1 | 10 | 5 | 11 | 16 | 51 |
| Oldfield | 8 | 3 | 3 | 4 | 2 | 7 | 3 | 9 | 8 |
| Bugby | 8 | 25 | 46 | 33 | 25 | 39 | 53 | 18 | 29 |
| Parsons Island | 19 | 1 | 26 | 13 | 2 | 7 | 43 | 27 | 29 |
| Hollicutts Noose | 2 | 32 | 42 | 25 | 14 | 1 | 7 | 9 | 29 |
| Bruffs Island | 2 | 1 | 45 | 12 | 9 | 12 | 50 | 77 | 47 |
| Turtleback | NA | 1 | 19 | 27 | 15 | 27 | 51 | 23 | 24 |
| Long Point | 17 | 8 | 23 | 8 | 12 | 11 | 53 | 73 | 44 |
| Cook Point | 40 | 20 | 45 | 63 | 6 | 11 | 2 | 88 | 63 |
| Royston | 4 | 21 | 19 | 11 | 14 | 14 | 33 | 43 | 37 |
| Lighthouse | 3 | 14 | 59 | 14 | 8 | 8 | 45 | 52 | 57 |
| Sandy Hill | 12 | 6 | 29 | 34 | 7 | 11 | 75 | 48 | 45 |
| Oyster Shell Point | 9 | 0 | 1 | 2 | 2 | 3 | 2 | 19 | 20 |
| Tilghman Wharf | 2 | 36 | 57 | NA | 20 | 30 | 34 | 26 | 36 |
| Deep Neck | 2 | 25 | 37 | 32 | 47 | 66 | 48 | 40 | 32 |
| Double Mills | 4 | 7 | 13 | 9 | 6 | 28 | 82 | 50 | 24 |
| Cason | 4 | 22 | 60 | 37 | 40 | 63 | 25 | 48 | 53 |
| Ragged Point | 5 | 31 | 84 | 38 | 7 | 23 | 53 | 49 | 71 |
| Normans Addition | 15 | 53 | 82 | NA | 11 | 11 | 48 | 49 | 51 |
| Goose Creek | 6 | 26 | 84 | 59 | 19 | 7 | 23 | 63 | 38 |
| Wilson Shoals | 23 | 65 | 51 | 41 | 38 | 10 | 29 | 60 | 23 |
| Georges | 5 | 24 | 84 | 55 | 23 | 31 | 50 | 55 | 16 |
| Holland Straits | 19 | 51 | 85 | 90 | 15 | 27 | 35 | 71 | 18 |
| Sharkfin Shoal | 25 | 61 | 94 | 80 | 8 | 0 | 10 | 63 | 16 |
| Back Cove | NA | NA | NA | NA | NA | 11 | 49 | 88 | 4 |
| Piney Island East | 21 | 16 | 88 | 11 | 5 | 23 | 57 | 55 | 13 |
| Old Woman's Leg | 4 | 17 | 79 | 21 | 8 | 5 | 50 | 80 | 15 |
| Marumsco | 3 | 27 | 77 | ND | 20 | 8 | 31 | 44 | 21 |
| Broomes Island | 10 | 29 | 31 | 6 | 4 | 24 | 53 | 70 | 53 |
| Chicken Cock | 18 | 43 | 63 | 43 | 24 | 27 | 31 | 51 | 33 |
| Pagan | 9 | 30 | 27 | 13 | 20 | 39 | 24 | 19 | 17 |
| Lancaster | 13 | 6 | 4 | 4 | 6 | 28 | 20 | 8 | 7 |
| Mills West | 18 | 0 | 2 | 1 | 1 | 2 | 11 | 9 | 2 |
| Cornfield Harbor | 17 | 59 | 92 | 51 | 11 | 16 | 29 | 77 | 47 |
| Ragged Point | 10 | 14 | 29 | 79 | 54 | 63 | 34 | 63 | 28 |
| Lower Cedar Point | 6 | 9 | 2 | 1 | 6 | 6 | 7 | 5 | 47 |
| **Annual Means** | **10** | **22** | **44** | **29** | **14** | **18** | **34** | **46** | **33** |

Table 5 (Continued).

| Oyster Bar | Total Observed Mortality (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Swan Point | 35 | 18 | 43 | 20 | 3 | 7 | 13 | 12 | 14 |
| Hacketts Point | 30 | 30 | 16 | 10 | 26 | 22 | 13 | 30 | 60 |
| Holland Point | 42 | 35 | 49 | 36 | 36 | 8 | 33 | 42 | 67 |
| Stone Rock | 29 | 40 | 25 | 15 | 33 | 46 | 66 | 30 | 86 |
| Flag Pond | 28 | 24 | 16 | 13 | 33 | 50 | NA | NA | 23 |
| Hog Island | 16 | 45 | 20 | 16 | 33 | 67 | 67 | 14 | 31 |
| Butlers | 37 | 63 | 17 | 20 | 20 | 48 | 67 | 32 | 11 |
| Buoy Rock | 33 | 22 | 17 | 7 | 7 | 6 | 25 | 43 | 61 |
| Oldfield | 12 | 8 | 17 | 8 | 5 | 8 | 21 | 36 | 47 |
| Bugby | 18 | 18 | 27 | 15 | 8 | 5 | 29 | 48 | 63 |
| Parsons Island | 18 | 36 | 22 | 25 | 8 | 16 | 29 | 60 | 59 |
| Hollicutts Noose | 32 | 30 | 13 | 15 | 14 | 13 | 38 | 55 | 85 |
| Bruffs Island | 47 | 33 | 6 | 6 | 11 | 16 | 33 | 44 | 50 |
| Turtleback | 40 | 51 | 21 | 9 | 9 | 26 | 38 | 48 | 54 |
| Long Point | 8 | 28 | 8 | 3 | 9 | 14 | 33 | 34 | 66 |
| Cook Point | 40 | 22 | 16 | 11 | 20 | 35 | 63 | 28 | 100 |
| Royston | 10 | 17 | 9 | 9 | 6 | 32 | 31 | 51 | 91 |
| Lighthouse | 27 | 18 | 15 | 5 | 6 | 20 | 33 | 44 | 92 |
| Sandy Hill | 36 | 29 | 23 | 22 | 4 | 15 | 27 | 50 | 77 |
| Oyster Shell Point | 14 | 18 | 25 | 6 | 2 | 1 | 15 | 28 | 55 |
| Tilghman Wharf | 6 | 10 | 9 | 15 | 6 | 12 | 19 | 34 | 85 |
| Deep Neck | 1 | 23 | 14 | 8 | 13 | 37 | 23 | 37 | 85 |
| Double Mills | 10 | 20 | 9 | 8 | 10 | 38 | 40 | 50 | 85 |
| Cason | 6 | 7 | 12 | 11 | 18 | 28 | 32 | 62 | 98 |
| Ragged Point | 17 | 16 | 12 | 13 | 19 | 34 | 37 | 70 | 94 |
| Normans Addition | 28 | 39 | 55 | 31 | 54 | 35 | 38 | 29 | 29 |
| Goose Creek | 7 | 38 | 69 | 64 | 20 | 64 | 63 | 81 | 85 |
| Wilson Shoals | 10 | 17 | 11 | 11 | 9 | 29 | 25 | 26 | 52 |
| Georges | 0 | 55 | 33 | 36 | 12 | 32 | 60 | 50 | 44 |
| Holland Straits | 16 | 45 | 43 | 20 | 18 | 35 | 35 | 17 | 12 |
| Sharkfin Shoal | 7 | 66 | 59 | 47 | 28 | 62 | 61 | 39 | 61 |
| Back Cove | 6 | 46 | 33 | 29 | 50 | 59 | 20 | 46 | 38 |
| Piney Island East | 20 | 65 | 56 | 49 | 67 | 38 | 27 | 12 | 20 |
| Old Woman's Leg | 25 | 63 | 46 | 33 | 38 | 42 | 15 | 53 | 27 |
| Marumsco | 8 | 78 | 53 | 49 | 26 | 40 | 22 | 35 | 45 |
| Broomes Island | 27 | 8 | 0 | 13 | 11 | 44 | 25 | 59 | 72 |
| Chicken Cock | 28 | 15 | 10 | 7 | 24 | 82 | 63 | 28 | 63 |
| Pagan | 11 | 9 | 27 | 15 | 3 | 14 | 35 | 51 | 84 |
| Lancaster | 4 | 19 | 25 | 8 | 8 | 18 | 48 | 58 | 52 |
| Mills West | 4 | 21 | 18 | 17 | 16 | 24 | 36 | 40 | 75 |
| Cornfield Harbor | 25 | 56 | 24 | 7 | 27 | 78 | 62 | 44 | 33 |
| Ragged Point | 35 | 8 | 11 | 4 | 25 | 10 | 8 | 33 | NA |
| Lower Cedar Point | 28 | 5 | 23 | 3 | 26 | 8 | 0 | 3 | 44 |
| **Annual Means** | **20** | **30** | **25** | **18** | **19** | **31** | **35** | **38** | **58** |

Table 5 (Continued).

| Oyster Bar | Total Observed Mortality (%) | | | |
|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2006 |
| Swan Point | 13 | 10 | 11 | 8 |
| Hacketts Point | 17 | 10 | 2 | 5 |
| Holland Point | 50 | 29 | 5 | 0 |
| Stone Rock | 13 | 5 | 5 | 20 |
| Flag Pond | 0 | 0 | 2 | 4 |
| Hog Island | 11 | 6 | 12 | 25 |
| Butlers | 9 | 2 | 3 | 23 |
| Buoy Rock | 41 | 28 | 6 | 21 |
| Oldfield | 34 | 10 | 38 | 12 |
| Bugby | 50 | 14 | 2 | 20 |
| Parsons Island | 37 | 11 | 8 | 35 |
| Hollicutts Noose | 25 | 3 | 6 | 48 |
| Bruffs Island | 50 | 12 | 5 | 4 |
| Turtleback | 43 | 11 | 12 | 51 |
| Long Point | 54 | 10 | 10 | 14 |
| Cook Point | 21 | 0 | 0 | 0 |
| Royston | 69 | 14 | 0 | 0 |
| Lighthouse | 89 | 47 | 0 | 0 |
| Sandy Hill | 88 | 59 | 44 | 24 |
| Oyster Shell Point | 48 | 20 | 0 | 4 |
| Tilghman Wharf | 62 | 17 | 0 | 1 |
| Deep Neck | 54 | 14 | 1 | 3 |
| Double Mills | 59 | 23 | 8 | 0 |
| Cason | 57 | 4 | 0 | 2 |
| Ragged Point | 52 | 5 | 4 | 13 |
| Normans Addition | 9 | 14 | 40 | 5 |
| Goose Creek | 53 | 59 | 50 | 50 |
| Wilson Shoals | 19 | 27 | 7 | 21 |
| Georges | 4 | 24 | 44 | 76 |
| Holland Straits | 11 | 18 | 43 | 48 |
| Sharkfin Shoal | 23 | 32 | 54 | 22 |
| Back Cove | 22 | 23 | 32 | 12 |
| Piney Island East | 28 | 48 | 50 | 23 |
| Old Woman's Leg | 35 | 56 | 26 | 0 |
| Marumsco | 4 | 11 | 29 | 20 |
| Broomes Island | 14 | 19 | 6 | 6 |
| Chicken Cock | 2 | 38 | 50 | 20 |
| Pagan | 7 | 29 | 66 | 9 |
| Lancaster | 35 | 27 | 14 | 7 |
| Mills West | 48 | 11 | 0 | 7 |
| Cornfield Harbor | 1 | 7 | 20 | 2 |
| Ragged Point | 76 | NA | NA | NA |
| Lower Cedar Point | 55 | 22 | 17 | 3 |
| **Annual Means** | **35** | **20** | **17** | **16** |

(Return to text)

Table 6. Regional summary of oyster harvests (bu.) in Maryland, 1985-86 through 2004-05 seasons.

| Region/Tributary | 1985-86 | 1986-87 | 1987-88 | 1988-89 | 1989-90 |
|---|---|---|---|---|---|
| Upper Bay | 5,600 | 30,800 | 19,100 | 17,700 | 15,700 |
| Middle Bay | 73,400 | 37,900 | 42,500 | 10,500 | 15,900 |
| Lower Bay | 32,500 | 5,900 | 70 | 0 | 3,600 |
| Total Bay Mainstem | 111,500 | 74,600 | 61,700 | 28,200 | 35,200 |
| Chester River | 21,300 | 20,600 | 30,900 | 49,900 | 54,000 |
| Eastern Bay | 216,100 | 149,100 | 28,700 | 15,700 | 20,400 |
| Miles R. | 40,400 | 20,600 | 17,100 | 13,600 | 1,400 |
| Wye R. | 20,100 | 2,200 | 700 | 3,800 | 8,000 |
| Total Eastern Bay Region | 276,600 | 171,900 | 46,500 | 33,100 | 29,800 |
| Upper Choptank River | 29,000 | 42,400 | 36,500 | 51,900 | 27,700 |
| Middle Choptank R. | 144,500 | 89,700 | 66,400 | 66,400 | 71,000 |
| Lower Choptank R. | 225,100 | 52,500 | 26,200 | 9,100 | 32,100 |
| Tred Avon R. | 67,700 | 60,900 | 13,700 | 42,400 | 92,100 |
| Broad Creek | 12,900 | 58,700 | 8,500 | 13,500 | 8,100 |
| Harris Cr. | 3,500 | 16,700 | 6,900 | 7,800 | 8,800 |
| Total Choptank R. Region | 482,700 | 320,900 | 158,200 | 191,100 | 239,800 |
| Little Choptank River | 27,100 | 10,500 | 21,500 | 15,000 | 19,000 |
| Upper Tangier Sound | 84,000 | 30,400 | 40 | 0 | 0 |
| Lower Tangier S. | 64,400 | 22,200 | 90 | 0 | 0 |
| Honga River | 29,400 | 49,300 | 7,700 | 300 | 1,100 |
| Fishing Bay | 107,600 | 87,300 | 90 | 20 | 20 |
| Nanticoke R. | 21,300 | 5,100 | 1,500 | 900 | 2,600 |
| Wicomico R. | 3,600 | 200 | 100 | 40 | 20 |
| Manokin R. | 40,800 | 47,400 | 500 | 70 | 10 |
| Annemesex R. | 90 | 10 | 10 | 0 | 40 |
| Pocomoke S. | 32,700 | 22,300 | 0 | 0 | 0 |
| Total Tangier Sound Region | 383,900 | 264,200 | 10,000 | 1,300 | 3,800 |
| Patuxent River | 96,300 | 16,800 | 1,400 | 3,700 | 8,900 |
| Wicomico R., St. Clement's and Breton Bays | 16,000 | 23,400 | 23,000 | 47,600 | 22,200 |
| St. Mary's River and Smith Cr. | 80,700 | 30,700 | 2,300 | 500 | 1,100 |
| Total Potomac Md Tributaries | 96,700 | 54,100 | 25,300 | 48,100 | 23,300 |
| **Total Maryland (bu.)[1]** | **1,500,000** | **1,000,000** | **360,000** | **390,000** | **413,000** |

[1] Including regions not listed.

Table 6 (continued).

| Region/Tributary | 1990-91 | 1991-92 | 1992-93 | 1993-94 | 1994-95 |
|---|---|---|---|---|---|
| Upper Bay | 19,800 | 35,200 | 18,200 | 8,900 | 7,800 |
| Middle Bay | 17,700 | 39,200 | 9,000 | 4,400 | 4,900 |
| Lower Bay | 37,900 | 9,300 | 90 | 0 | 1,100 |
| *Total Bay Mainstem* | *75,400* | *83,800* | *27,300* | *13,300* | *13,800* |
| Chester River | 60,400 | 55,100 | 53,800 | 51,300 | 29,100 |
| Eastern Bay | 33,200 | 20,600 | 3,600 | 2,400 | 3,700 |
| Miles R. | 1,700 | 100 | 300 | 0 | 200 |
| Wye R. | 2,300 | 300 | 20 | 30 | 50 |
| *Total Eastern Bay Region* | *37,200* | *21,000* | *3,900* | *2,700* | *4,000* |
| Upper Choptank River | 42,200 | 29,200 | 9,500 | 2,600 | 2,500 |
| Middle Choptank R. | 49,700 | 25,000 | 3,100 | 1,600 | 4,900 |
| Lower Choptank R. | 9,000 | 14,200 | 1,700 | 900 | 600 |
| Tred Avon R. | 22,000 | 800 | 0 | 0 | 5,900 |
| Broad Creek | 4,300 | 40 | 50 | 10 | 400 |
| Harris Cr. | 3,300 | 100 | 20 | 0 | 14,200 |
| *Total Choptank R. Region* | *130,500* | *69,300* | *14,400* | *5,100* | *28,500* |
| Little Choptank River | 8,800 | 3,800 | 50 | 300 | 19,300 |
| Upper Tangier Sound | 1,000 | 11,300 | 70 | 0 | 17,600 |
| Lower Tangier S. | 1,600 | 1,700 | 40 | 0 | 5,400 |
| Honga River | 5,600 | 600 | 20 | 100 | 1,700 |
| Fishing Bay | 900 | 6,400 | 500 | 30 | 11,900 |
| Nanticoke R. | 3,000 | 12,500 | 7,700 | 2,500 | 10,500 |
| Wicomico R. | 60 | 600 | 500 | 500 | 80 |
| Manokin R. | 60 | 200 | 40 | 10 | 100 |
| Annemesex R. | 0 | 10 | 0 | 0 | 0 |
| Pocomoke S. | 300 | 500 | 0 | 0 | 100 |
| *Total Tangier Sound Region* | *12,500* | *33,800* | *8,900* | *3,100* | *47,400* |
| Patuxent River | 48,400 | 24,500 | 0 | 0 | 30 |
| Wicomico R., St. Clement's and Breton Bays | 36,000 | 29,600 | 14,900 | 4,000 | 18,200 |
| St. Mary's River and Smith Cr. | 1,700 | 100 | 60 | 30 | 3,900 |
| *Total Potomac Md Tributaries* | *37,700* | *29,000* | *15,000* | *4,000* | *22,100* |
| **Total Maryland (bu.)[1]** | **411,000** | **323,000** | **123,000** | **80,000** | **164,000** |

[1] Including regions not listed.

Table 6 (continued).

| Region/Tributary | 1995-96 | 1996-97 | 1997-98 | 1998-99 | 1999-00 |
|---|---|---|---|---|---|
| Upper Bay | 26,600 | 2,600 | 18,800 | 13,100 | 28,100 |
| Middle Bay | 12,600 | 20,000 | 15,300 | 55,800 | 31,500 |
| Lower Bay | 800 | 300 | 4,800 | 8,300 | 3,800 |
| *Total Bay Mainstem* | *40,000* | *22,800* | *38,900* | *77,200* | *63,400* |
| Chester River | 42,600 | 5,400 | 43,000 | 21,000 | 70,100 |
| Eastern Bay | 1,500 | 1,100 | 3,800 | 30,900 | 75,800 |
| Miles R. | 200 | 500 | 30 | 800 | 35,700 |
| Wye R. | 0 | 0 | 400 | 900 | 9,400 |
| *Total Eastern Bay Region* | *1,700* | *1,600* | *4,200* | *32,600* | *120,900* |
| Upper Choptank River | 11,600 | 3,200 | 4,800 | 3,100 | 7,100 |
| Middle Choptank R. | 15,000 | 4,700 | 5,600 | 2,800 | 1,900 |
| Lower Choptank R. | 900 | 300 | 200 | 2,400 | 8,300 |
| Tred Avon R. | 1,300 | 3,800 | 6,900 | 11,700 | 3,700 |
| Broad Creek | 1,000 | 4,000 | 27,600 | 46,200 | 18,200 |
| Harris Cr. | 5,000 | 13,600 | 21,400 | 67,000 | 18,200 |
| *Total Choptank R. Region* | *34,800* | *29,600* | *66,500* | *133,200* | *57,400* |
| Little Choptank River | 1,900 | 40,800 | 36,100 | 84,100 | 33,600 |
| Upper Tangier Sound | 12,100 | 8,100 | 6,000 | 3,500 | 1,500 |
| Lower Tangier S. | 500 | 10,100 | 4,200 | 8,500 | 2,800 |
| Honga River | 400 | 200 | 1,300 | 300 | 50 |
| Fishing Bay | 20,900 | 8,800 | 3,800 | 700 | 90 |
| Nanticoke R. | 15,200 | 23,000 | 30,300 | 21,700 | 8,800 |
| Wicomico R. | 100 | 1,400 | 2,200 | 1,400 | 500 |
| Manokin R. | 0 | 900 | 600 | 300 | 90 |
| Annemesex R. | 0 | 0 | 0 | 0 | 200 |
| Pocomoke S. | 0 | 300 | 400 | 80 | 100 |
| *Total Tangier Sound Region* | *49,200* | *52,800* | *48,800* | *36,500* | *14,100* |
| Patuxent River | 100 | 20 | 60 | 5,600 | 2,000 |
| Wicomico R., St. Clement's and Breton Bays | 27,500 | 7,300 | 10,200 | 13,700 | 8,800 |
| St. Mary's River and | 900 | 16,200 | 36,700 | 16,400 | 4,500 |
| Total Potomac Md | 28,400 | 23,500 | 46,900 | 30,100 | 13,300 |
| **Total Maryland (bu.)[1]** | **199,000** | **178,000** | **285,000** | **423,000** | **380,700** |

[1] Including regions not listed.

Table 6 (continued).

| Region/Tributary | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 |
|---|---|---|---|---|---|
| Upper Bay | 31,150 | 16,100 | 18,930 | 2,210 | 1,632 |
| Middle Bay | 16,400 | 4,550 | 2,410 | 750 | 295 |
| Lower Bay | 2,050 | 600 | 50 | 187 | 1,801 |
| *Total Bay Mainstem* | *49,600* | *21,250* | *21,390* | *3,147* | *3,728* |
| Chester River | 20,800 | 29,450 | 11,830 | 557 | 3,239 |
| Eastern Bay | 120,500 | 33,400 | 4,650 | 5,446 | 16,767 |
| Miles R. | 20,150 | 6,600 | 50 | 56 | 353 |
| Wye R. | 11,300 | 1,800 | 60 | 0 | 173 |
| *Total Eastern Bay Region* | *151,950* | *41,800* | *4,760* | *5,502* | *17,293* |
| Upper Choptank River | 1,100 | 7,450 | 10 | 0 | 78 |
| Middle Choptank R. | 8,150 | 5,600 | 520 | 30 | 67 |
| Lower Choptank R. | 350 | 1,500 | 40 | 0 | 267 |
| Tred Avon R. | 8,950 | 1,000 | 40 | 0 | 139 |
| Broad Creek | 36,850 | 4,900 | 700 | 954 | 1,342 |
| Harris Cr. | 26,200 | 3,300 | 30 | 12 | 71 |
| *Total Choptank R. Region* | *81,600* | *23,750* | *1,340* | *996* | *1,964* |
| Little Choptank River | 27,850 | 2,400 | 190 | 1,150 | 144 |
| Upper Tangier Sound | 100 | 5,050 | 3,570 | 7,630 | 13,658 |
| Lower Tangier S. | 1,450 | 13,200 | 5,960 | 5,162 | 15,648 |
| Honga River | 0 | 50 | 590 | 378 | 2,744 |
| Fishing Bay | 0 | 0 | 390 | 24 | 106 |
| Nanticoke R. | 600 | 2,700 | 540 | 57 | 965 |
| Wicomico R. | 50 | 50 | 10 | 0 | 0 |
| Manokin R. | 200 | 1,850 | 970 | 1,638 | 2,816 |
| Annemesex R. | 0 | 0 | 0 | 0 | 5 |
| Pocomoke S. | 10 | 20 | 0 | 0 | 2,676 |
| *Total Tangier Sound Region* | *2,400* | *22,920* | *12,030* | *14,889* | *38,618* |
| Patuxent River | 10 | 0 | 0 | 0 | 466 |
| Wicomico R., St. Clement's and Breton Bays | 2,600 | 1,400 | 220 | 13 | 18 |
| St. Mary's River and Smith Cr. | 6,150 | 1,650 | 0 | 0 | 91 |
| *Total Potomac Md Tributaries* | *8,750* | *3,050* | *220* | *13* | *109* |
| **Total Maryland (bu.)[1]** | **348,000** | **148,200** | **55,840** | **26,471** | **72,218** |

[1] Including regions not listed.

Table 6 (continued).

| Region/Tributary | 2005-06 | |
|---|---|---|
| Upper Bay | 17,420 | |
| Middle Bay | 17,346 | |
| Lower Bay | 269 | |
| *Total Bay Mainstem* | *35,035* | |
| Chester River | 4,385 | |
| Eastern Bay | 49,120 | |
| Miles R. | 3,660 | |
| Wye R. | 122 | |
| *Total Eastern Bay Region* | *52,902* | |
| Upper Choptank River | 591 | |
| Middle Choptank R. | 967 | |
| Lower Choptank R. | 1,250 | |
| Tred Avon R. | 149 | |
| Broad Creek | 14,006 | |
| Harris Cr. | 4,429 | |
| *Total Choptank R. Region* | *21,392* | |
| Little Choptank River | 3,534 | |
| Upper Tangier Sound | 2,874 | |
| Lower Tangier S. | 5,828 | |
| Honga River | 270 | |
| Fishing Bay | 6 | |
| Nanticoke R. | 387 | |
| Wicomico R. | 0 | |
| Manokin R. | 737 | |
| Annemesex R. | 108 | |
| Pocomoke S. | 1,071 | |
| *Total Tangier Sound Region* | *11,281* | |
| Patuxent River | 17,808 | |
| Wicomico R., St. Clement's and Breton Bays | 1,414 | |
| St. Mary's River and Smith Cr. | 1,863 | |
| *Total Potomac Md Tributaries* | *3,277* | |
| **Total Maryland (bu.)[1]** | **154,436** | |

[1] Including regions not listed. (Return to text)

Table 7. Distribution of oyster harvest by gear type.

**% of Harvest by Gear Type**

| SEASON | HT | DI | PT | PD | SJ |
|---|---|---|---|---|---|
| 1989-90 | 75 | 12 | 8 | 3 | 3 |
| 1990-91 | 52 | 18 | 25 | 1 | 3 |
| 1991-92 | 38 | 16 | 33 | 2 | 10 |
| 1992-93 | 57 | 20 | 14 | 2 | 7 |
| 1993-94 | 60 | 25 | 15 | <1 | <1 |
| 1994-95 | 61 | 18 | 19 | 1 | 1 |
| 1995-96 | 57 | 13 | 23 | 3 | 4 |
| 1996-97 | 74 | 9 | 9 | 5 | 3 |
| 1997-98 | 67 | 13 | 11 | 5 | 4 |
| 1998-99 | 69 | 14 | 9 | 6 | 2 |
| 1999-00 | 62 | 16 | 12 | 5 | 3 |
| 2000-01 | 56 | 22 | 12 | 5 | 3 |
| 2001-02 | 41 | 20 | 18 | 12 | 6 |
| 2002-03 | 21 | 17 | 33 | 22 | 4 |
| 2003-04 | 6 | 20 | 15 | 51 | 7 |
| 2004-05 | 8 | 20 | 9 | 52 | 6 |
| 2005-06 | 18 | 25 | 32 | 20 | 2 |

HT = Hand Tongs
DI = Diver
PT = Patent Tongs
PD = Power Dredge
SJ = Skipjack

**Bushels of Harvest by Gear Type**

| SEASON | HT | DI | PT | PD | SJ |
|---|---|---|---|---|---|
| 1989-90 | 309,723 | 47,861 | 31,307 | 11,424 | 14,007 |
| 1990-91 | 219,510 | 74,333 | 105,825 | 4,080 | 14,555 |
| 1991-92 | 124,038 | 53,232 | 108,123 | 6,344 | 31,165 |
| 1992-93 | 71,929 | 24,968 | 18,074 | 1,997 | 8,821 |
| 1993-94 | 47,309 | 19,589 | 11,644 | 787 | 133 |
| 1994-95 | 99,853 | 29,073 | 31,388 | 1,816 | 2,410 |
| 1995-96 | 115,677 | 25,657 | 46,040 | 6,347 | 7,630 |
| 1996-97 | 130,861 | 16,780 | 15,716 | 8,448 | 6,088 |
| 1997-98 | 191,079 | 37,477 | 30,340 | 14,937 | 10,543 |
| 1998-99 | 294,342 | 58,837 | 36,151 | 25,541 | 8,773 |
| 1999-00 | 237,892 | 60,547 | 44,524 | 18,131 | 12,194 |
| 2000-01 | 193,259 | 75,535 | 43,233 | 18,336 | 8,820 |
| 2001-02 | 62,358 | 30,284 | 26,848 | 17,574 | 8,322 |
| 2002-03 | 11,508 | 9,745 | 18,627 | 12,386 | 2,432 |
| 2003-04 | 1,561 | 5,422 | 3,867 | 13,436 | 1,728 |
| 2004-05 | 5,438 | 14,258 | 6,548 | 37,641 | 4,000 |
| 2005-06 | 28,098 | 38,460 | 49,227 | 30,824 | 3,576 |

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# APPENDIX 1
## OYSTER HOST and OYSTER PARASITES
*C. Dungan*

### Oysters

The eastern oyster, *Crassostrea virginica*, tolerates water temperatures of -2° to 36°C and salinities of 3 to 40 ppt, where ocean water has 35 ppt salinity. Oysters reproduce when sexes simultaneously spawn their gametes into Chesapeake Bay waters, which can occur from May through September and peaks during June and July. Externally fertilized eggs develop into planktonic larvae, which are transported by water currents for two to three weeks while feeding on phytoplankton as they grow and develop. Mature larvae seek solid benthic substrates, preferably oyster shells (valves), to which they attach as they metamorphose to become sessile juvenile oysters. Unlike fishes and other vertebrates, oysters do not strictly regulate the salt content of their tissues. Instead, the salt content of functioning oyster tissues conforms to the broad and variable range of salinities in oyster habitats. Thus, oyster parasites with high or narrow salinity requirements may be exposed to low environmental salinities when shed into the environment, and while infecting oysters whose habitat salinity is diluted by precipitation. Upon its death, an oyster's valves spring open passively, exposing its tissues to consumption by predators and scavengers. However, the resilient hinge ligament holds the articulated valves together for months. Vacant, articulated oyster shells (boxes) in our samples are interpreted to represent oysters that died during the previous year, and their relative numbers, along with dead and moribund oysters with tissue still present (gapers) are used to estimate annual natural mortality (observed mortality).

### Dermo disease

Although the protozoan parasite that causes dermo disease is now known as *Perkinsus marinus*, it was first described as *Dermocystidium marinum* in Gulf of Mexico oysters (Mackin, Owen, and Collier 1950), and its name was colloquially abbreviated accordingly. Almost immediately, dermo disease was also reported in Chesapeake Bay oysters (Mackin 1951). *Perkinsus marinus* is transmitted through the water to uninfected oysters in as few as three days, and such infections may prove fatal by 18 days. Heavily infected oysters are emaciated, showing reduced growth and reproduction (Ray and Chandler 1955). Although *P. marinus* survives both low temperatures and low salinities, its proliferation is high in the broad range of temperatures (15° to 35°C) and salinities (10 to 30 ppt) that are typical of Chesapeake Bay waters during oyster dermo disease mortality peaks (Dungan and Hamilton 1995). Over several years of drought during the 1980's, *P. marinus* expanded its Chesapeake Bay distribution into upstream areas where it had been rare or absent, and became prevalent in newly infected oyster populations (Burreson and Ragone Calvo 1996). Since 1990, some oysters in most Maryland populations have been infected.

### MSX disease

The high-salinity, protozoan oyster pathogen *Haplosporidium nelsoni* was first detected and described as a *multinucleated sphere X* (MSX) from diseased and dying Delaware Bay oysters during 1957 (Haskin et al. 1966) and was found infecting oysters from lower Chesapeake Bay during 1959 (Andrews 1968). Although the location of early *H. nelsoni* infections in oyster gill tissues suggests waterborne transmission, the complete life cycle and infection mechanism of this parasite remain unknown. Despite many attempts, MSX has rarely been experimentally transmitted in the laboratory, although experimental oysters deployed in endemic waters above 14 ppt salinity may acquire infections and die within three to five weeks. In Chesapeake Bay, MSX disease is most active at water temperatures of 5° to 20°C (Ewart and Ford 1993), H. nelsoni infection rates typically peak during May, and deaths from *H. nelsoni* infections peak during August. Since MSX disease is rare in oysters from waters below 9 ppt salinity, the distribution of *H. nelsoni* in Chesapeake Bay varies as salinities change with freshwater inflows. During 1999 through 2002, consistently low freshwater inflows to Chesapeake Bay fostered upstream range extensions by *H. nelsoni* and MSX disease during each successive drought years (Tarnowski 2003). During the subsequent years of 2003 and 2004, consistent above-average freshwater inflows have reduced salinities of upstream Chesapeake Bay waters and dramatically reduced the geographic range and effects of MSX disease to Tangier Sound waters (Tarnowski 2005).

**Appendix 1 References**


Andrews, J.D. 1968. Oyster mortalitiy studies in Virginia VII. Review of epizootiology and origin of *Minchinia nelsoni*. Proc. Natl. Shellfish. Assn. **58:** 23-36.

Burreson, E.M. and L.M. Ragone Calvo. 1996. Epizootiology of *Perkinsus marinus* disease in Chesapeake Bay, with emphasis on data since 1985. J. Shellfish Res. **15:** 17-34.

Dungan, C.F. and R.M. Hamilton. 1995. Use of a tetrazolium-based cell proliferation assay to measure effects of in vitro conditions on *Perkinsus marinus* (Apicomplexa) proliferation. J. Eukaryot. Microbiol. **42**: 379-388.

Ewart, J.W. and S.E. Ford. 1993. History and impact of MSX and dermo diseases on oyster stocks in the Northeast region. NRAC Fact Sheet No. 200, 8 pp. Univ. of Massachusetts, North Dartmouth, Ma.

Haskin, H.H., L.A. Stauber, and J.G. Mackin. 1966. *Minchinia nelsoni* n. sp. (Haplosporida, Haplosporidiidae): causative agent of the Delaware Bay oyster epizootic. Science **153:** 1414-1416.

Ray, S.M. and A.C. Chandler. 1955. Parasitological reviews: *Dermocystidium marinum*, a parasite of oysters. Exp. Parasitol. **4:** 172-200.

Mackin, J.G., H.M. Owen, and A. Collier. 1950. Preliminary note on the occurrence of a new protistan parasite, *Dermocystidium marinum* n. sp. in *Crassostrea virginica* (Gmelin). Science **111:** 328-329.

Mackin, J.G. 1951. Histopathology of infection of *Crassostrea virginica* (Gmelin) by *Dermocystidium marinum* Mackin, Owen, and Collier. Bull Mar. Sci. Gulf and Caribbean **1:** 72-87.

Tarnowski, M. 2003. Maryland Oyster Population Status Report: 2002 Fall Survey. Maryland Department of Natural Resources, Annapolis, Md. 32 pp.

Tarnowski, M. 2005. Maryland Oyster Population Status Report: 2003 and 2004 Fall surveys. Maryland Department of Natural Resources Publ. No. 17-1072005-62. Annapolis, Md. 33 pp.

# APPENDIX 2
## GLOSSARY

| | |
|---|---|
| box oyster | Pairs of empty shells joined together by their hinge ligaments. These remain articulated for months after the death of an oyster, providing a durable estimator of recent oyster mortality (see gaper). |
| bushel | Unit of volume used to measure oyster catches. The official Maryland bushel is equal to 2,800.9 cu. in., or 1.0194 times the U.S. standard bushel (heaped) and 1.3025 times the U.S. standard bushel (level). |
| cultch | Hard substrate, such as oyster shells, spread on oyster grounds for the attachment of spat. |
| dermo disease | The oyster disease caused by the protozoan pathogen, *Perkinsus marinus.* |
| dredged shell | Oyster shell dredged from buried ancient (3000+ years old) shell deposits. Since 1960 this shell has been the backbone of the Maryland shell planting effort to produce seed oysters and restore oyster bars. |
| fresh shell | Oyster shells from shucked oysters. It is used to supplement the dredged shell plantings. |
| gaper | Dead or moribund oyster with gaping valves and tissue still present (see box oyster). |
| *Haplosporidium nelsoni* | The protozoan oyster parasite that causes MSX disease. |
| infection intensity, individual | *Perkinsus* sp. parasite burdens of individual oysters, estimated by RFTM assays and categorized on an eight-point scale. Uninfected oysters are ranked 0, heaviest infections are ranked 7, and intermediate-intensity infections are ranked 1-6. Oysters with infection intensities of 5 or greater are predicted to die imminently. |
| infection intensity, mean sample | Averaged categorical infection intensity for all oysters in a sample:<br>*sum of all categorical infection intensities (0-7) ÷ number of sample oysters*<br>Oyster populations whose samples show mean infection intensities of 3.0 or greater are predicted to experience significant near-term mortalities. |
| infection intensity, mean annual | Averaged categorical infection intensities for all annual survey oysters:<br>*sum of all sample mean intensities ÷ number of annual samples* |
| intensity index, sample | Categorical infection intensities averaged only for infected oysters:<br>*sum of individual infection intensities(1-7) ÷ number of infected oysters* |

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| intensity index, annual | Categorical infection intensities averaged for all infected survey oysters:<br>*sum of all sample intensity indices ÷ number of annual samples* |
| market oyster | An oyster measuring 3 inches or more from hinge to mouth (ventral margin). |
| mortality (observed), sample | Percent proportion of annual, non-fishing oyster population mortality estimated by dividing the number of dead oysters (boxes and gapers) by the sum of live and dead oysters in a sample:<br>*100 x [number of boxes and gapers ÷*<br>*(number of boxes and gapers + number of live)]* |
| mortality (observed), annual | Percent proportion of annual, bay-wide, non-fishing oyster mortality estimated by averaging population mortality estimates from all samples collected during an annual survey:<br>*sum of sample mortality estimates ÷ number of survey samples* |
| MSX disease | The oyster disease caused by the protozoan pathogen *Haplosporidium nelsoni.* |
| MSX frequency, annual | Percent proportion of sampled populations infected by *H. nelsoni* (MSX):<br>*100 x (number of sample with MSX infections ÷ total sample number)* |
| *Perkinsus marinus* | The protozoan oyster parasite that causes dermo disease. |
| prevalence, sample infection | Percent proportion of infected oysters in a sample:<br>*100 x (number infected ÷ number examined)* |
| prevalence, mean annual | Percent proportion of infected oysters in an annual survey:<br>*sum of sample percent prevalences ÷ number of samples* |
| RFTM assay | Ray’s fluid thioglycollate medium assay. Method for enlargement, detection, and enumeration of *Perkinsus marinus* cells in oyster tissue samples. This diagnostic assay for dermo disease has been widely used and refined for over fifty years to date. |
| seed oysters | Young oysters produced by planting shell as a substrate for oyster larvae to settle on in historically productive areas. If the spatfall is adequate, the seed oysters are subsequently transplanted to growout (seed planting) areas, generally during the following spring. |
| small oyster | An oyster over one year old but less than 3 inches (see market oyster, spat). |
| spat | Oysters less than one year old. |
| spatfall, spatset, set | The process by which swimming oyster larvae attach to a hard substrate such as oyster shell. During this process the larvae undergo metamorphosis, adopting the adult form and habit. |

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| spatfall intensity | The number of spat per bushel of cultch. This is a relative measure of density used to calculate the spat index. |
| spatfall intensity index | The arithmetic mean of spatfall intensities from 53 fixed reference sites or Key Bars: *sum of Key Bar spatfall intensities ÷ number of Key Bars* |


Photo: M. Homer