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ANALYSIS OF MARINE POLICE CITATIONS AND JUDICIAL DECISIONS FOR ILLEGAL HARVESTING OF EASTERN OYSTERS (*CRASSOSTREA VIRGINICA*, GMELIN 1791) IN THE MARYLAND PORTION OF THE CHESAPEAKE BAY, UNITED STATES, FROM 1959 TO 2010

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ABSTRACT Illegal harvesting of oysters is a concern for a broad range of stakeholders in the Chesapeake Bay region, including natural resource managers, oyster growers, fishermen, environmentalists, and public health advocates. This study analyzed oyster harvest citations issued by marine police in Maryland ($n = 5{,}282$ citations) from 1959 to 2010 as well as judicial decisions and fines resulting from these citations. Nearly three quarters of citations (73.9%) were issued for harvesting undersized or unculled oysters, or exceeding the daily catch limit. The citation rate per year was inversely proportional to the number of person-days worked. Of those individuals with a citation, 45% received citations on multiple days; ca. 10% of individuals had 5 days or more with at least 1 citation. Citations and harvests after 1994 were mapped using GIS. Eighty-two percent of court cases for oyster citations resulted in guilty verdicts. The distribution of court cases by county and verdict are presented. During the past decade (2000 to 2009), Maryland courts issued fines totaling $150,237 (mean fine, $179). Implications of our findings for oyster ecology and natural resource management in the Maryland portion of the Chesapeake Bay are discussed.

KEY WORDS: *Crassostrea virginica*, oyster, restoration, sanctuary, poaching, shellfish

INTRODUCTION

Eastern oysters (*Crassostrea virginica*) have been important ecologically and economically to the Chesapeake Bay and its residents, although current estimates of oyster biomass are 0.3–1% of levels in the early 1800s (Newell 1988, Wilberg et al. 2011). Seasonal oyster harvests in Maryland have declined to less than 200,000 bushels, which has decreased the total harvest value of oysters even though oyster price per pound has remained fairly stable (Fig. 1).

Commercial oyster harvesting is regulated in Maryland by the Department of Natural Resources (DNR). Laws and regulations include specifications for a commercial fishing season, as well as time of day, gear type and location restrictions, harvest documentation, tax and oyster surcharge, and protection of state-managed oyster reserves and sanctuaries as described in Code of Maryland Regulations, Title 8, Section 2 and Annotated Code of Maryland; Natural Resources, Title 4. Enforcement of state laws and regulations related to oyster harvesting is conducted by the Natural Resource Police Division within the Maryland DNR. The Potomac River Fisheries Commission also has jurisdiction and enforcement capabilities over the Potomac River tributary (Potomac River Fisheries Commission 2003).

Illegal harvest is a serious and ongoing concern for managers of oyster sanctuaries and oyster growers. In its 2008 report to the Governor and General Assembly, the Maryland Oyster Advisory Commission recommended addressing illegal oyster harvesting, stating "currently, there is no single factor more important to the future of ecologic restoration and aquaculture than to address and dramatically reduce the ongoing illegal oyster harvesting activities" (Maryland Oyster Advisory Commission 2009, p. 20).

The objective of this study was to examine illegal oyster harvesting citations issued in Maryland for historical trends. Specifically, we characterized the seasonality in citations, the indicated reasons for the citations, spatiotemporal differences among Chesapeake Bay tributaries, and distribution of citations received by repeat offenders. In addition, citations with court case decisions (e.g., verdicts and fine amounts) were analyzed to understand more completely the outcomes from enforcement. This study can help inform the focus of current and future natural resource monitoring and enforcement programs in the Maryland portion of the Chesapeake Bay.

METHODS

Data Collection and Cleaning

A data set of citations issued for oyster regulation violations was provided by DNR on request. The cleaned data set contained 5,282 unique citations from 1959 to 2010, with information about the citation date, county, reason for the citation, regulation being enforced, court date, court, judicial verdict, and fine amounts adjusted to 2010 U.S. dollars (USD) by the consumer price index (Bureau of Labor Statistics 2011). Citations issued on the water after 1994 contained latitude and longitude

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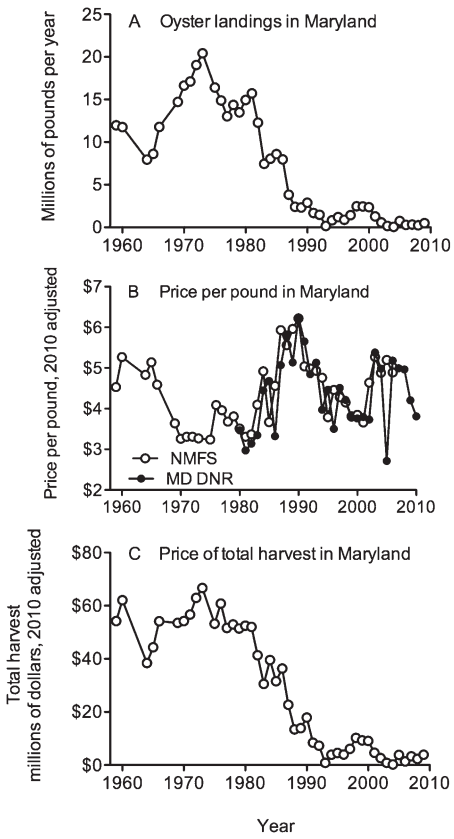


Figure 1. (A–C) Historical trends in Maryland for yearly oyster landings (National Marine Fisheries Service (NMFS) (A); price per pound of oyster meat in 2010 U.S. dollars, NMFS, and Maryland Department of Natural Resources (DNR) data (B); and total harvest in Maryland in 2010 U.S. dollars (NMFS) (C).

coordinates specific to subtributaries. Citations issued after 1994 on land were reported by county of citation.

The reasons for the citation were condensed into 6 general categories of citation: (1) administrative issues (e.g., license, taxes, paperwork), (2) use of illegal gear or dredging equipment, (3) harvesting at an illegal time or season, (4) harvesting in an illegal area, (5) collecting undersized (<3 in.) or unculled (i.e., unsorted) oysters, or (6) other reasons. Court verdicts were assigned to 4 groups: guilty or probation before judgment (PBJ), not guilty, not prosecuted or dismissed, and other.

For citations with missing data, the following sources were used: the Maryland Case Search online database available for 1994 and later (Maryland Judiciary 2011), local districts courts for case information, and the Maryland State Archives. In a few instances, missing data could not be retrieved and the citation was removed from the data set.

Annual oyster landings and harvest value were acquired from the National Marine Fisheries Service (NMFS) and DNR. DNR landings were expressed as bushels. For comparison with NMFS data, bushel amounts were multiplied by 6.4 lb/bushel to derive the number of pounds of oyster meat. Annual harvest value was adjusted to 2010 USD in the same manner as the citation fine amounts. DNR provided the annual number of person-days worked harvesting oysters. The citation rate for each year was determined by dividing the number of citations given by the number of total person-days worked for that year.

Data Mapping

Citations were mapped using ArcGIS v.10.0 (ESRI, Redlands, CA). Only citations from 1994 through 2009 were included in spatial analyses because of earlier data missing spatial reference, and data after 2009 being incomplete. The number of citations at each location was totaled over the time period (1994 to 2009) and these totals were projected on a color scale, with darker colors indicating more citations per location. The number of bushels harvested in Maryland (1994 to 2009) was mapped to Chesapeake Bay tributaries using National Oceanic and Atmospheric Administration harvest codes. Similar to the citations data, the total amount harvested in each harvest code area was totaled over the time period (1994 to 2009) and these totals were projected on a color scale, with darker colors indicating more citations per harvest code area. The shapefile of county lines was obtained from ESRI and was added to the map to indicate where each citation was issued. Tributary names were also added to the map.

Data Analyses

Excel (Microsoft, Redmond, WA) and STATA (StataCorp, College Station, TX) were used for data manipulation, coding, and statistical tests. The means of number of citations in season (April to September) versus out of season (October to March) were compared using a 2-tailed *t*-test and a level of significance of 0.05.

RESULTS

Historical Data on Citations

The number of citations began to increase steadily starting in the mid 1970s, and peaked in 1991 with 561 citations and in 1998 with 410 citations (Fig. 2A). Citations declined nearly 10-fold from the late 1990s to the mid 2000s, with only 43 citations in 2004. During the second half of the 2000s, citations had again increased to a maximum of 191 citations in 2009. Citations records for 2010 were incomplete at the time of this analysis. The citation rate per year was inversely proportional to the number of person-days worked (Fig. 2B). The citation rate has increased steadily since 2001, which corresponds with a decrease in the number of person-days worked.

Seasonality of Citations

Citations were more prevalent during the permitted harvesting season (October to March) than during the off-season (April to September) from 1959 to 2010 ($P < 0.0001$; data not shown). The mean number of citations per month ranged from 17 ± 2 (SE) to 35 ± 5 citations during harvesting season; in the off-season, the number of citations ranged from 1 ± 0.1–7 ± 2 citations/mo.

Reasons for Citations

Nearly three quarters (73.9%) of citations were issued for oyster-specific reasons, mainly for possessing unculled or undersized

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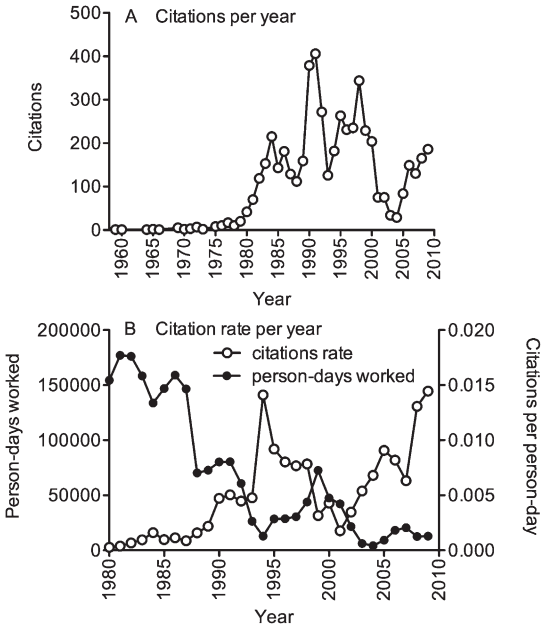


Figure 2. (A) Marine police oyster citations in the Chesapeake Bay from 1959 to 2010. (B) Citation rate and number of person-days worked per year from 1980 to 2009.

oysters (Fig. 3). The remaining citations were issued for administrative or paperwork issues (11.5%), harvesting in improper locations (8.7%), equipment violations (3.9%), or harvesting at improper times or seasons (1.6%). Citations related to paperwork included improper recordkeeping, nonpayment of surcharges and taxes, and failure to maintain a valid license. Citations related to location were associated more commonly with harvesting in a restricted area than harvesting in a polluted area.

Spatial Trends in Citations

Beginning in 1994, citations issued on the water were geocoded by DNR Marine Police. From 1994 to 2009, oyster citations were issued widely to individuals in all the major tributaries in the Maryland portion of the Chesapeake Bay, with the exception of the Patuxent River, Susquehanna River, Baltimore Harbor, and Northern Bay, where few citations were issued (Fig. 4). The highest density of citations was near Tilghman Island and Kent Narrows. Current hotspots for citations are in the Nanticoke River and Lower Eastern Shore of Maryland and the South, Severn, and Magothy Rivers near Annapolis, MD, on the western shore. The density of citations generally corresponded to areas of greater harvest.

Reasons for Citations Issued on the Water, by Tributary

Harvesting unculled or undersized oysters was the most common type of citation issued in each tributary compared with other reasons for citations (Fig. 5). In the South, Severn, and Magothy Rivers near Annapolis, MD, citations were also issued commonly for administrative reasons (e.g., failure to have a license, failure to pay surcharges and taxes, and so forth). Trends in types of citations issued within tributaries may indicate changes in enforcement policies and staffing by marine police, or they may indicate trends in number or types of poaching incidents.

Reasons for Citations Issued on Land, by County

Citations issued on land ($n = 557$), coded by county, constitute about 10% of all citations issued on land and water since 1994 (data not shown). Citations issued on land were either for possession of undersized or unculled oysters or for administrative reasons such as recordkeeping or nonpayment of surcharges or taxes. Equipment-, time-, or location-related citations

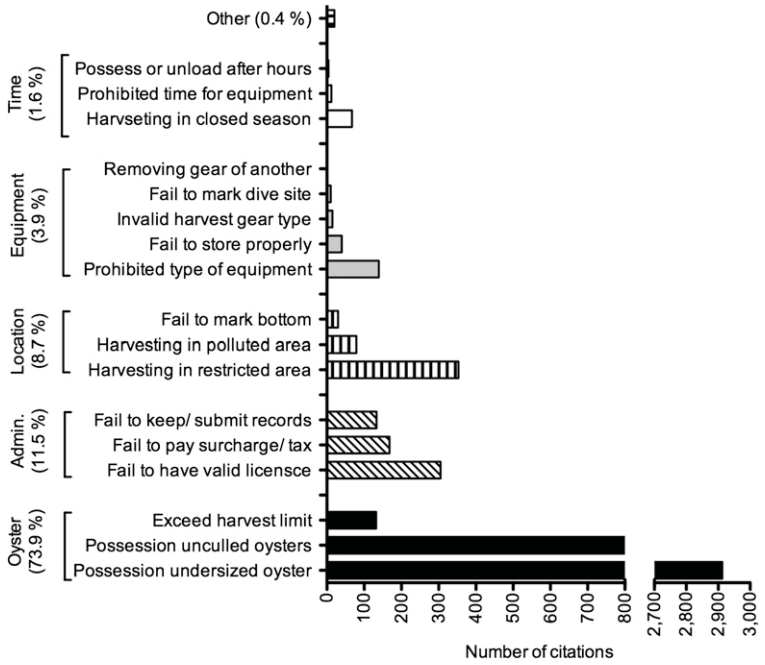


Figure 3. Reasons for oyster citations in Maryland from 1959 to 2010.

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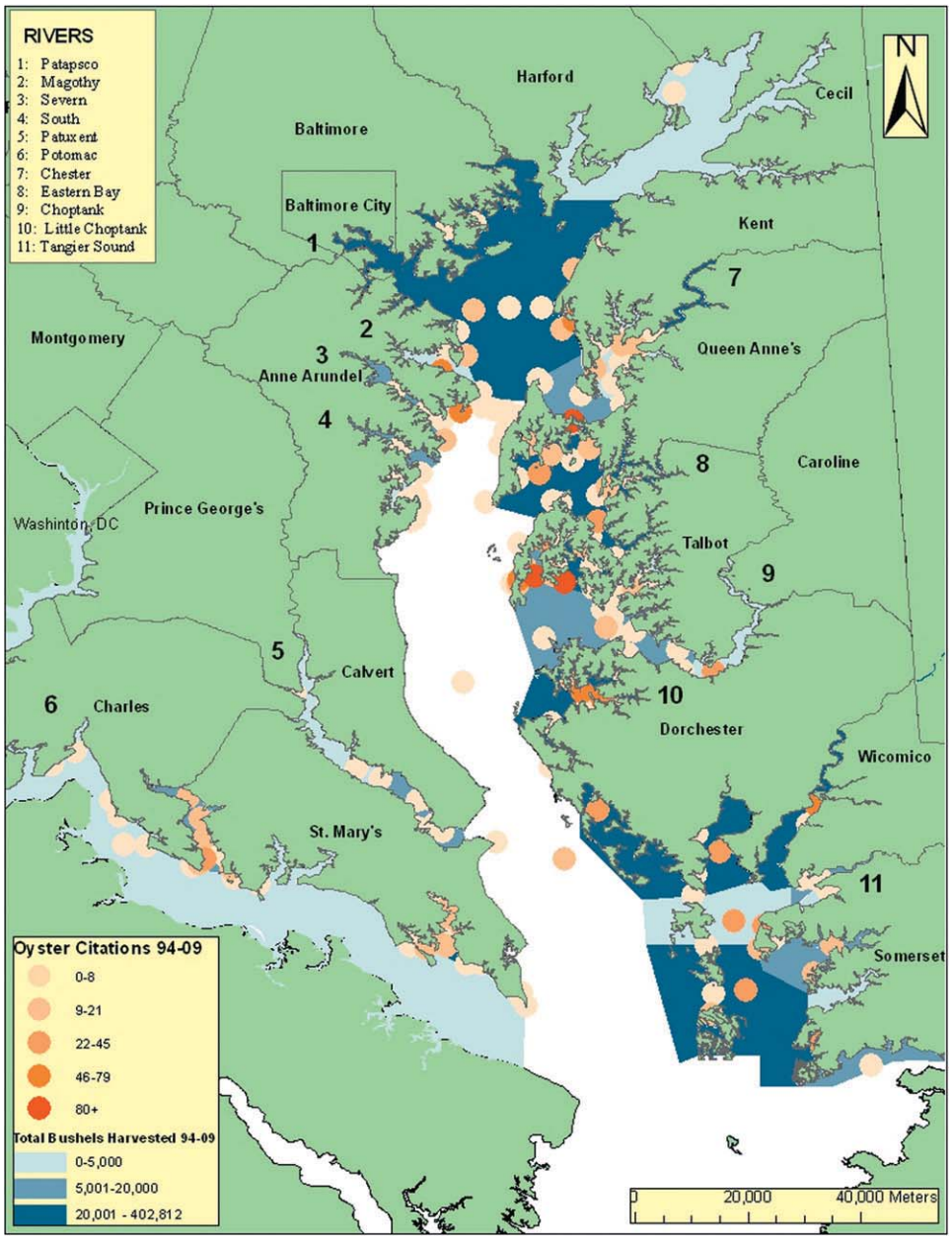


Figure 4. Gradient map of oyster citations and harvests in Maryland from 1994 to 2009. The mid-bay harvest data were not included on this map because of the low accuracy of the data in such large regions as well as the lack of most citations in the mid-bay.

were rarely issued on land, which is consistent with the nature of the violation. More citations were issued on land in Dorchester County than any other county.

Repeat Offenders

Of the 1,768 individuals with citations, the average person was cited on 3 separate days during the study period of 1959 to 2010 (Fig. 6). More than half (55%) the individuals in the data set had just 1 day with a citation. There did exist a fraction of repeat offenders; about 10% of individuals ($n = 177$) were cited on 5 days or more, and 1% of individuals ($n = 17$) were cited on 17 days or more. Days were used as the denominator instead of number of citations because multiple citations could be issued at the same time.

Court Case Decisions

The majority of Maryland court cases for oyster citations resulted in guilty or PBJ verdicts (82%), with the remaining cases dismissed or not prosecuted (13%), not guilty (4%), or other reasons (1%; Fig. 7). Maryland county courts varied in their rates of guilty verdicts, ranging from 74–94% among courts that heard more than 10 cases. Talbot County courts ruled on the greatest number of cases ($n = 1,209$) followed by Dorchester County ($n = 912$) and Queen Anne's County ($n = 593$). Eastern Shore, Maryland, counties accounted for 77% of all court cases. Courts that heard more cases also issued more fines.

Counties issuing the most fines were Talbot County ($187,000), Dorchester County ($134,000), and Queen Anne's County ($87,000), in 2010 USD (data not shown). The average

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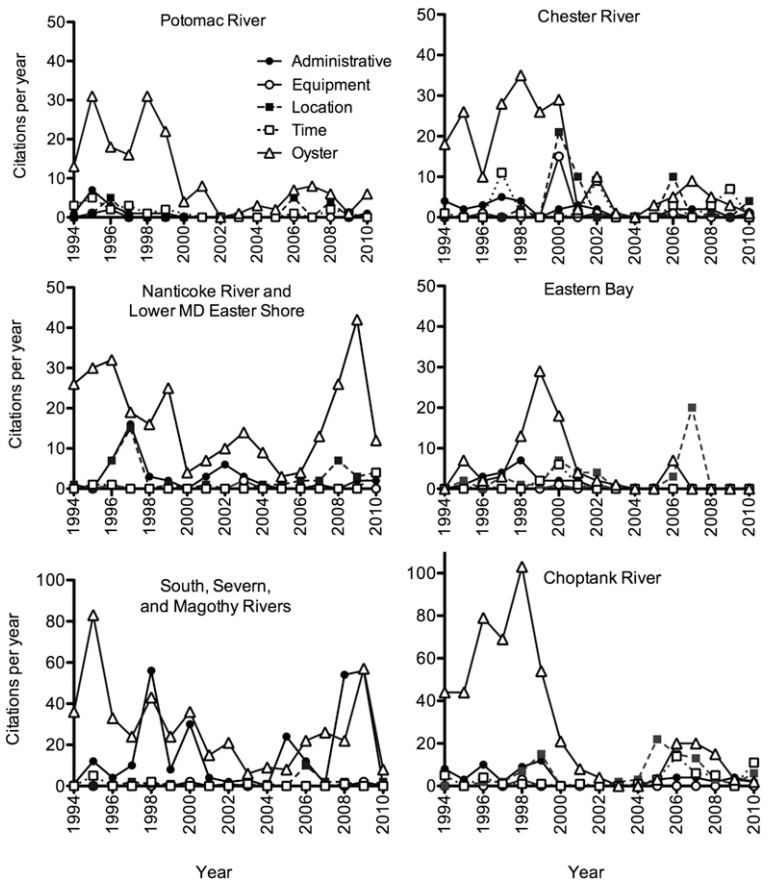


Figure 5. Oyster citations by tributary in Maryland from 1994 to 2010. Note the scale differs for some maps. Some tributaries or regions (e.g., Pautuxent River, Susquehanna River, Baltimore Harbor, Northern Bay) were omitted because of the low number of citations.

MD fine amount in 2010 USD for a guilty or PBJ verdict in the 2000s was $179, which was less than the average fine amount during 1990s ($204), 1980s ($192), 1970s ($336), and 1960s ($256). The total amount of fines issued in Maryland from 1959 to 2010 to individuals was $844,000 (2010 USD).

DISCUSSION

Illegal oyster harvesting is a longstanding challenge for stakeholders in the Chesapeake Bay region. More than 5,200 oyster-related citations have been issued during the past 50 y in the MD portion of the Chesapeake Bay to nearly 1,800 individuals. Illegal oyster harvesting impacts negatively the health of the Chesapeake Bay by removing more oysters than permitted by state natural resource managers, thus altering an already fragile ecosystem. Harvest of oysters from waters with health closures have resulted in human disease outbreaks (Desenclos et al. 1991). In addition, illegal harvest counteracts the millions of dollars invested to augment and protect oyster resources.

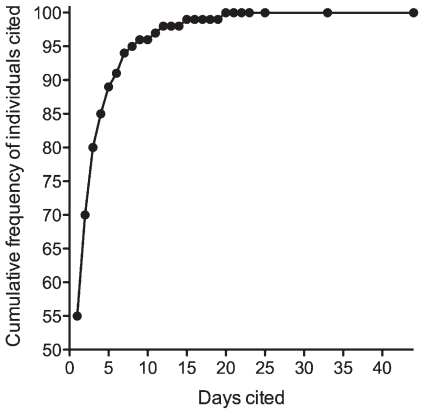


Figure 6. Repeat offenders in Maryland from 1959 to 2010, by number of days with a citation.

Harvesting Undersized Oysters

Market-size oysters in the Chesapeake Bay often succumb to disease, predation, or commercial harvest, leaving juvenile or undersized oysters as a prominent age class on many bars (Ford & Tripp 1996, Harding et al. 2008). Watermen culling through dozens or hundreds of 2.75-in. oysters for each 3-in. oyster face the obvious temptation to keep small oysters. In recognition of the fact that bill breakage can reduce oyster size, DNR officers do not issue tickets if measured bushels have fewer than 5% undersized oysters.

We found that 71% of all citations resulted from the possession of undersized oysters. Harvesting these oysters has potentially negative ecological consequences that may reduce the ability of oyster populations on harvestable bars to rebound. Harvesting in a restricted area was another common citation. Paynter et al.

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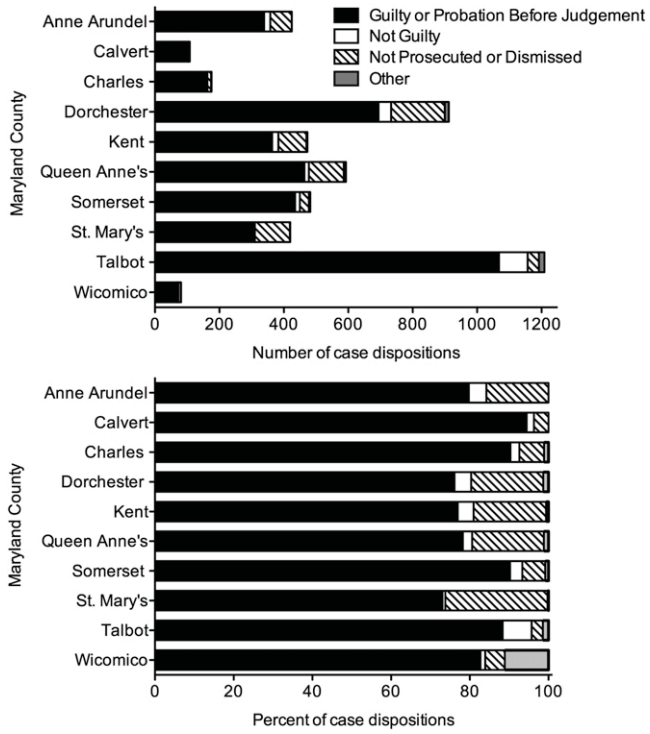


Figure 7. Verdict of oyster court cases by Maryland county courthouse from 1959 to 2010. Allegany, Baltimore, Caroline, Cecil, Howard, Price George, and Worchester County courts are not listed; these courts heard relatively few cases.

(2010) reported that illegal harvesting occurred on 10 of 16 sanctuary reefs studied, which reduced the apparent mean oyster size on bars. Illegal harvesting undermines the intent of sanctuary reefs as safe havens for oyster restoration. Reefs containing high densities of large oysters are the most ecologically valuable in that they harbor complex and abundant benthic communities (Rodney & Paynter 2006), filter copious amounts of seawater, and produce large amounts of biodeposits valuable for reef organisms. They also produce more gametes that are more readily fertilized because of their proximity to other oysters (Mann & Evans 1998). Harvesting with improper equipment (i.e., dredging), another leading category of citation, is problematic because this practice degrades the bay habitat (Lenihan & Peterson 2004, Smith et al. 2005).

Geographical and Temporal Patterns in Citations

Citations have been issued in most tributaries of the Chesapeake Bay, although we found that an order of magnitude more citations are issued in Maryland than Virginia, from reviewing Virginia Marine Resource Commission oyster citation records. Geographical differences in Maryland citations were likely primarily the result of where the bulk of the oyster fleet was fishing each year, which changes unpredictably from year to year. Enforcement officers maximize their effectiveness by focusing enforcement where fishing effort is the highest, such as targeted enforcement around historically good oyster bars (e.g., Honga River and Tangier Sound). Targeted enforcement appears warranted given the wide geographical area for which the Natural Resource Police is responsible for enforcing harvest laws. The number of citations issued is related directly to the size of the geographical area enforced, the size of the Natural Resource Police workforce, and the number of watermen fishing for oysters.

During the late 1970s, the annual rate of citations increased dramatically, which corresponds to both increased enforcement and a decreasing supply of oysters. We also observed that during the late 1990s and early 2000s, when the Natural Resource Police workforce decreased from about 250 people to about 150 people and the number of watermen fishing for oysters dropped from more than 1,000 to as low as 284, the annual rate of oyster citations decreased dramatically. These trends relate to specific tributaries as well; citations decreased during the early 2000s in the Choptank and Potomac Rivers and Eastern Bay at the same time as the number of oysters harvested from these areas declined and the number of Natural Resource Police personnel decreased in these areas. Increasing Natural Resource Police enforcement capacity would create a stronger deterrence against illegal harvest and would better protect sanctuary boundaries.

In years of low harvest landings, the number of person-days worked declines and the citation rate increases (Figs. 1A and 2B), suggesting that individuals may be under additional economic pressure to harvest illegally when oyster populations are reduced. These complex interactions between legal and illegal harvests and employment exist in other fisheries as well. In Baja California, Mexico, fishermen listed insufficient abalone harvest and other factors as leading to abalone poaching practices (Reyes et al. 2009). In the South African abalone fishery, cycles of overexploitation and reduced harvest quotas produced economic stress for individuals and ecological instability for abalone populations (Hauck & Sweijd 1999). In these situations, understanding the motivations for illegal harvesting, such as for "commercial gain, household consumption, poaching as rebellion, poaching as a traditional right, disagreement with specific regulations," are critical for effective resource management (Muth & Bowe 1998, p. 20).

Enforcement and Court Outcomes

Four out of 5 oyster citations led to guilty verdicts in Maryland courts, although the rate of guilty verdicts varied by county. St. Mary's County had the highest rate of cases not prosecuted. The average fine associated with a guilty verdict in the past decade was $179, which equates to the value of roughly 36 lb oyster meat, using $5/lb (2010 USD; Fig. 1B) as the average harvest value per pound of oyster meat. Modern oyster skiffs with dredges are permitted to harvest ca. 77 lb of oyster meat/day, based on a daily catch limit of 12 bushels (Code of Maryland Regulations, Title 8, Section 2) multiplied by 6.4 lb oyster meat per bushel, which could sell for $384, a little more than 2 days' harvest. Since 2010, penalties have been stiffened to correct the economic imbalance between the cost of getting caught for a violation and the potential economic benefit of harvesting a scarce natural resource.

When oystermen were found guilty, court fines from the previous 50 y generated only $844,000 (2010 USD) in revenue, and these fines were sent to the State General Fund instead of being earmarked for oyster restoration. In some instances, when poached seafood is recovered by the Natural Resource Police, such as poached rockfish, a process for recovering costs is

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permitted. The Natural Resource Police can sell poached rockfish on the open market, return the sales money to DNR, and the sale goes against market quotas for that species. State sale of poached oysters and earmarking of court fines could augment the economic burden poaching has on oyster replenishment and restoration.

Recent State of Maryland Laws and Regulations

A review of commercial fishing violations in 2008 by the Maryland Attorney General's Office found that 1,670 of the 3,940 commercial fishing license holders (43%) received citations for disregarding the law. In 2009, the Maryland General Assembly passed a law directing DNR to create a more effective penalty system for commercial fishermen who habitually violate fisheries laws and regulations.

Since that time, laws and regulations have been implemented to discourage illegal oyster harvesting. In April 2009, the MD General Assembly passed House Bill 1355 (2009) to remove requirements for 3 and 5 violations on separate days in certain year periods, and SB 164 (2009) to consolidate tidal and nontidal recreational license suspension and revocation authority into one authority. Also in 2009, HB 1355 (2009) created a tiered penalty system that altered the grounds for suspension or revocation of a tidal fish license so that DNR can suspend or even revoke a tidal fish license upon conviction for a single, egregious violation of fisheries law. The bill also required DNR to adopt regulations that included enhanced penalties for repeated violations of the Fisheries Title and for violations relating to species in need of special protection, including oysters.

In 2011, commercial penalties were enhanced further by passage of SB 159 (2011) and SB 665/HB 1225 (2011). SB 159 (2011) allows for the prompt revocation of a commercial oyster authorization through an administrative hearing when an individual is issued a citation for using illegal gear, oystering more than 200 ft within a closed or prohibited area, violating time restriction by more than 1 h, taking oysters during a closed season, and stealing oysters from a leased area. SB 665/HB 1225 (2011) increased the maximum penalty for engaging in commercial fishing with a suspended license, a revoked license, or without a license by establishing a fine of up to $25,000 and imprisonment for up to 1 y.

As a part of this penalty enhancement effort, DNR has also taken steps to improve the required reporting performance of watermen. Starting in the 2009/2010 season, for the first time in Maryland's history watermen reported their daily oyster harvests to the state on a monthly basis. Watermen who fail to submit a specific fishery report within 50 days of the due date 2 or more times in a 12-mo period risk having their authorization suspended.

A pilot program began in the Anne Arundel County, MD, courthouse in January 2010 to set 1 day each month for judges to try natural resource cases. This program has proved successful and has been expanded to 4 Maryland Eastern Shore counties: Dorchester, Somerset, Wicomico, and Worchester Counties (Maryland Department of Natural Resources 2011). A prospective analysis of court verdict and fine data would further confirm whether these natural resource days are achieving the desired outcomes.

CONCLUSIONS

This is the first published study that describes the geographical and temporal trends and other factors related to illegal oyster harvests during the past 50 y in Maryland. The significance of our findings is augmented by previous work showing the ecological impact of illegal oyster harvesting (Paynter et al. 2010). If the newly created oyster sanctuaries that span 24% of Maryland's Chesapeake Bay oyster habitat (Maryland Department of Natural Resources 2010) are to succeed, targeted state enforcement, self-policing by oystermen, and implementation of recent state policies for oyster poaching are needed to preserve the investments made in oyster restoration and to improve the resilience of Maryland oyster populations.

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