Operating Costs in the Chesapeake Bay Oyster Fishery

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1. Objectives of the Study

This study develops estimates for the average costs of harvesters in the public oyster fishery in Maryland's portion of the Chesapeake Bay. It examines cost differences across the various gear types with respect to daily harvest effort. Such estimates could be useful in understanding fishing behavior and helping to anticipate changes in effort, given changes in prices or oyster abundances.

There is a dearth of published information pertaining to harvesting costs in the Chesapeake Bay oyster fishery. Lipton and others 1994 describe some of the difficulties that have hindered such a study. Primary among these is finding watermen who are willing to participate in a detailed survey. Prochaska and Keithly 1986 describe oyster harvesting cost information for the Florida fishery, but this has limited application to the industry in the Chesapeake Bay.

2. Sample Frame and Methodology

In the fall of 2005, a cost questionnaire (annexed) was developed and field tested. This questionnaire sought information about four targeted oyster harvesting methods, with respect to both fixed and variable costs. The targeted harvest methods included: diving, power dredging, shaft tonging and patent tonging. A list of county oyster committee members[1] was obtained from Maryland's Department of Natural Resources (DNR). It was intended that this list would provide a basis for identifying respondents for the cost questionnaire.

The significant decline in oyster harvests in recent years was thought at the start of the study to be a potential obstacle to finding enough harvesters to generate a sufficient sample. In the event, oyster committee members from the western shore and the upper Eastern Shore were willing and able to identify respondents or responded themselves. As the survey moved south on the Eastern Shore, however, watermen named on the oyster committee lists tended to have dropped out of the fishery. Because of this, in Talbot, Dorchester and Somerset Counties the questionnaire was enumerated among harvesters returning to selected harbors after their day's work. It deserves mention that the vast majority of watermen approached in that context agreed to participate; even though it entailed answering a tedious set of questions at the end of a work day. It doubtless helped that the 2006 oyster season started strong in both harvests and prices.

[1] Tidewater counties have committees composed of representatives of oyster harvesters who coordinate management and restoration actions between county-resident watermen and MD DNR. These representatives have typically been active oyster harvesters but, currently, many committee members have not oystered for several seasons.

The resulting sample included 21 watermen, of whom: 5 patent-tonged, 6 power dredged, 6 shaft tonged and 4 had diving operations. Because the survey was enumerated at the start of the 2006 season, information was generally sought on harvesters' previous year's operations. However, 3 of the respondents had recently left the harvest industry[2] and their responses pertained to their most recent year's harvest. Another respondent had just returned to the fishery and his responses addressed his current year operations. All questionnaires were enumerated in face to face interviews, sometimes aboard respondents' vessels, sometimes at their home.

In general, the population from which this sample was drawn can be described as harvesters in Maryland's public oyster fishery. Under the most inclusive definition – all licenses – that population included 2,684 people in 2006. However, over 2,000 of those licenses are unlimited Tidal Fish Licenses, the vast majority of which are not used for the oyster fishery (although they could be, if desired by the holder). If one takes a more restrictive view of the population, considering just those license-holders reporting a harvest, the population was 1,133 in 2006. The population drops to 324 if we only consider those harvesters who reported catching more than 50 bushels of oysters in the year. By gear type, the population of those reporting any harvest breaks out as follows: Divers, 131; Patent Tongs, 348; Shaft Tongs 273; and Power Dredges, 253.

This relatively small population spread over a large area (and working a small fraction of the available time) restricted the candidate base for survey respondents. This problem not withstanding, the survey sample is thought to be representative of the wider fishery, both in its averages and in its wide variability. By spreading the sample across the tidewater counties, and by targeting any waterman who could be identified within this range, the survey sought to capture a variety of operations with respect to both gear type and levels of investments. However, the sample is small and extrapolations to the wider industry need to be mindful of this.

In addition to the survey of watermen, some cost information was gathered from marine equipment suppliers and mechanics. While the cost survey responses were anonymous, sources for this additional information are cited in the text as they are presented.

3. Background on Harvest Practices and Trends

3.1 A Description of Gear types in the Oyster Fishery

There are a number of ways to harvest oysters. The following discussion of commercial harvests focuses on the most important contemporary methods, namely: shaft or hand tonging, patent tonging, diving and power dredging. A brief description of each method is given below, followed by a discussion of the historical importance of each and trends over the past 17 years. Each different harvest gear has something to recommend it, as

[2] At least one of these respondents has since returned to the fishery.

shown by its continued use in the fishery. Other harvest methods, including sail dredging, rakes and scrapes are not discussed, because these methods have become increasingly rare over the period of interest.

Shaft tonging: Traditionally, shaft or hand tonging has been the most widespread method for harvesting oysters in the Chesapeake Bay. Until very recently, shaft tongers supplied the largest share of Maryland's oyster harvests. Shaft tongs – as the name implies – are long shafts of wood (14 to 24 feet) with rakes at the bottom and a pin about a third of the way up from the bottom which makes the handles scissor the rakes. They are operated by standing on the washboard of a workboat and feeling the bottom through the vibrations of the rakes up the shafts. When a likely spot is found, the rakes are worked back and forth to gather oysters into the enclosure that is formed when the handles come together. When they are full, the tongs are lifted in a hand-over-hand fashion[3] back out of the water and dumped onto a culling table where legal oysters are separated from smalls, boxes, shells and mud.

Many watermen will wax eloquent about the joys of hand tonging, but it is strenuous work and it takes a knack. It can be done singly or in pairs; each man working on opposite sides of the boat. Often, watermen will employee a culler to separate legal oysters from the rest of a haul. While hand-tonging is hard work, many watermen made a good living for many years this way. Regulations have, until recently, favored tonging by limiting more efficient harvest methods and by setting aside large portions of Bay bottom for their use alone. In the 2004 and 2005 seasons, shaft tongs proved too inefficient to cope with reduced oyster abundance and their share of total harvests dropped from 31 percent over the previous two seasons to 6.7 percent.

Patent tonging: Patent tongs are a mechanized method of oyster harvest that also involves a set of hinged rake heads but, instead of shafts, these hinged tongs are tethered by a cable. They are lowered through the water in an open position. When they strike the bottom, they spring shut and grasp whatever is between their two halves.   Patent tong boats can be identified by a bulky mast, set forward on the boat and having one or two booms affixed to it. A single boom indicates a single patent tong rig, and two booms indicate a double patent tong rig. The booms keep the tongs off the boat when they are being lowered and hauled. When the tongs are hauled out of the water, the waterman pulls them aboard and releases them over a culling table where the contents are separated into legal oysters and everything else.

While patent tongs have been around since the late 1800s, their use expanded in the late 1950s, when hydraulic systems were adapted to allow the operator to better control the action of the tongs on the bottom. With hydraulic patent tongs, watermen were able to make larger hauls and they could gather more oysters in a shorter time. Tarnowski

[3] In 1983, power assisted winders were allowed which basically pull the tongs up out of the water once the waterman has filled the rakes. While more efficient than manhandling the tongs out of the water, this method seems to have not been widely adopted in Maryland's oyster fishery.

(1999) estimates that hydraulic patent tongs are four times as efficient as hand tongs. Patent tonging areas tend to be in deeper and more open waters of the Bay.

Diving: Diving for oysters is a relatively recent innovation, legalized for commercial harvests in 1973. A diver in scuba gear goes down to the bottom with baskets which he fills with any legal oysters within his reach. He signals the boat when a basket is full and it is hauled back on board, emptied and sent back down to the diver. While diving in the Bay during the coldest months of the year may sound like an unattractive proposition to many, divers employ heating systems that they say keep them warmer than the man working up on the boat. It is a very efficient way of cleaning all the legal oysters off a worked portion of a bar, and for this reason diving is restricted to defined areas of the Bay[4].

Power dredging: An oyster dredge is a toothed metal frame with a mesh bag attached. It is dragged along oyster bottom and winched back on board when it is full. A mast and boom are required to keep the dredge off the boat when it is being lowered and retrieved. Modern rigs are controlled by hydraulics. In fact, boats rigged for patent tonging can be easily converted to dredging. Because much of the hydraulic gear is compatible, quick-release hoses allow dredge rigging to be converted to patent tong rigging in very short order.

In the mid-60s, power dredging meant using a motorized boat to push a wooden sailboat which in turn pulled a dredge. More reasonable uses of power were banned because dredging is extremely destructive to oyster reefs. However, as vertical reef structure became an increasing rarity in Maryland's portion of the Chesapeake Bay, areas in the lower Bay were opened to dredging by motorized work boats by temporary regulation. This regulation was in effect from 1983 to 1993 and its original range of was Somerset County. In 1993, the power dredging season was discontinued. But, it opened again in 1997 and has gradually expanded to include much of the lower Bay and significant parts of the middle Bay below the Chesapeake Bay Bridge.

3.2 Recent Trends in Harvest Effort by Gear Type

For much of the fishery's post-colonial history, shaft tonging has been the dominant harvest method both in terms of numbers of harvesters and quantities harvested. Historical data on harvest effort by gear type are spotty, but Christy (1964) presents a chart showing tongers as numbering from 3,800 to 5,000 between 1945 and 1960, and men working dredgeboats[5] numbering from 600 to 800 over that same period. In that

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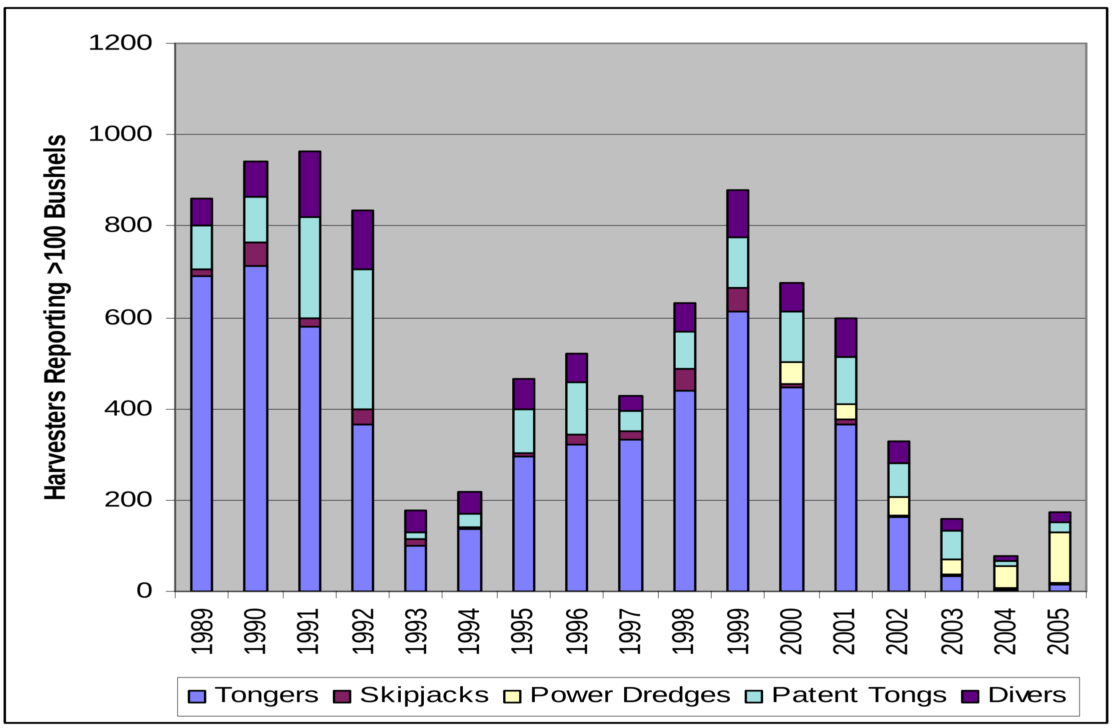
[4] Because divers can work an area much more completely than tongers, and, because the method came along at a time when catch per unit effort was declining, there has been considerable division within the industry about this harvest method. However, in a recent NOAA Fishery Bulletin, Lenihan and Peterson (2004) argue that diving is more efficient and less destructive to oyster bars than either tonging or dredging.
[5] Following convention, the term dredgeboats or skipjack is used when referring to sail-powered rigs. Power dredging implies that the vessel is driven by a motor.

same paper, he reports that, by value, tongers supplied two thirds of the average harvest between 1956 and 1960 and dredgeboats the other third.

Using more recent DNR data[6], **Figure 1**, below, shows the composition from 1989 to 2005 of harvest effort by number of harvesters in each gear category. Number of harvesters is limited to those reporting a catch in excess of 100 bushels in any given season. Using harvesters who report catches in excess of 100 bushels winnows out harvesters who either, start the season and drop out, or who only buy a license to keep their eligibility current[7]. Reporting years are by season, which include the last three months of the previous calendar year and the first three months of the year identifying the season – (e.g., the 2005 season started in the Fall of 2004 and ended in March of 2005). The figure shows the historical importance of shaft tonging and its decline in recent years. Diving and patent tonging, which are more efficient than shaft tonging, also declined in recent years but not as completely. Power dredging, which is widely thought to be the most efficient method of harvest, carried the industry in the 2004 and 2005 seasons although in 2006 (not shown) its share of total harvest decreased as stocks rebounded.

Figure 1: Composition of Harvesters (> 100 bu.)by Gear Type, 1989 - 2005



Data[8]: DNR Buy Ticket Dataset

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[6] DNR Commercial Shellfish Harvest Data. Tarnowski 1999 and Kennedy and Briesch were sources for regulatory background information.

[7] If harvesters let their license lapse there is a high (though, non-financial) cost to regaining it.

[8] Note: Due to confusion regarding power dredge harvests versus Skipjack harvests from 1997 to 2000, pre-2000 data do not attempt to distinguish between the two and harvests are credited to Skipjacks. Years 2000 to 2005 were corrected by DNR and a portion of the dredgeboat harvest was attributed to power dredgers.

While the "greater than 100 bushels" filter provides a more accurate picture of the number of harvesters working the commercial fishery, it is important to note that actual number of people licensed to work the fishery is much larger than the number who report catching over 100 bushels. According to DNR's figures, all four gear types have averaged excess capacity[9] between 69 percent (divers) to 79 percent (patent tongers) over the period, 1989 to 2005.

If this graph could be carried out to earlier years, the downward trend in effort to the present would be all the more impressive. Harvest effort has fallen by something in the range of 90 percent over the past twenty years. But, even with the existing data, the message of effort's recent history is clear. As oyster abundance has fallen, less efficient gear types (shaft tonging) have fallen in their importance. Harvesters have had to shift to more efficient gear in order to catch enough oysters to stay in the fishery. Below, we will try to establish the various cost factors that figure into watermen's calculations of whether to stay, quit, or move to more efficient gear.

4. Cost Survey Findings

4.1 Calculating Oyster Harvesting Capital Costs

In order to work in the oyster fishery, one needs to know something about harvest gear, boats and boat handling, motor and gear maintenance, navigation and position reckoning, complex regulations, weather and tides, and where to find oysters. Possessing these and a license, the next thing that one needs is a boat. Some descriptive statistics for the boats included in the survey sample are reported, below.

The typical workboat in the cost survey sample was 39 feet long, with responses ranging from 23 to 47 feet. Her average age was 25 years, with a range from new to 50 years old. The average purchase price was $20,500 and the average estimated market value was $30,200. Ten of these boats were made of wood, nine were fiberglass over wood and two of them were formed fiberglass hulls. All but one had inboard motors, ranging from a large Caterpillar diesel engine to a six cylinder gasoline engine. The one outboard-propelled boat had a 70 HP motor.

The boat length statistic is fairly robust, with a standard deviation (s.d.) of 5.16. However, the age statistic is more random (s.d. = 10.16) and the s.d. of the market price statistic (23,498) is 77% of its average value. The point to these statistics is that there is considerable variation in the sample, as there is also in the industry. At the small end, it is still possible for a few tongers with a small boat to work creeks and inshore areas. The

[9] Measured as total number of people licensed to work the fishery minus the number of people who harvested over 100 bushels and that difference divided by the number of people licensed.

boat costs for such an operation are low. At the other end, harvesters who patent tong and dredge and who work in open water want a larger, more dependable boat that will, in general, have higher fixed and operating costs. When one averages across these types of operations, much information is lost.

Our primary interest in the cost of a boat is to calculate both depreciation and capital costs of boat investments. Because the boat does not last forever, its value will depreciate over time, other market factors remaining equal. Capital costs address the cost of the capital tied up in the boat which, if borrowed, has an interest cost and, if not borrowed, has an opportunity cost equal to the return that could be earned if that capital were applied to some other investment. Both aspects of vessel costs represent an important element of harvesters' costs of operation. In order to develop a more useful estimate of these costs, sample responses are broken out by harvest method and, within each, boat costs are rank-ordered by reported market value. This provides a high-end and a low-end average for boats in each gear class from the survey sample.

Table 1, below, reports the average values of boats, grouped as described above, and capital and depreciation costs calculated as follows. Depreciation is calculated by the "straight line" method in which each year's loss is constant. This is appropriate since we do not know what period of depreciation any given boat in the sample is in. For the high-end boats, depreciation is calculated over thirty years with the boat retaining one quarter of its present value at the end of the period. For low-end boats, depreciation is calculated over 15 years, with the value reduced to zero at the end of the period[10]. Capital cost is calculated very simply as the boat's present value times 5%; a middle range between current loan interest and deposit interest rates.

Table 1: Capital Values and Costs for Survey Sample Work Boats

Boat	Boat Value*	Annual Depreciation	Annual Capital Cost @ 5%	Daily Capital & Depreciation**
Divers high (n=2)	$40,000	$1,000	$2,000	$11.54
Divers low (n=2)	$25,000	$1,667	$1,250	$11.22
Pwr Dredge high (n=2)	$80,000	$2,000	$4,000	$23.08
Pwr Dredge low (n=3)	$26,933	$1,796	$1,347	$12.09
Patent Tong high (n=2)	$36,000	$900	$1,800	$10.38
Patent Tong low (n=3)	$11,500	$767	$575	$5.16
Shaft Tong high (n=3)	$36,667	$917	$1,833	$10.58
Shaft Tong low (n=3)	$5,500	$367	$275	$2.47

*****Based on respondents estimates of their boat's current sale value
** Based on a 260 day work year

[10] These different depreciation schedules are predicated on the assumption that lower cost boats are either older or burdened with a problem that made them cheaper to buy. Newer, more expensive boats should last longer and retain more of their value. Older boats are on their way out.

The final column in the table reports the average daily cost of depreciation and interest based on 260 workdays per year. This measure provides a simple approximation of the daily carrying costs for a workboat if these were distributed equally across all the possible work days in a year. Every boat in the survey sample was used in other Chesapeake Bay fisheries, and the costs of owning it is reasonably spread across its different applications. For oyster-specific costs, it is assumed that there is a 260 day work year over which the harvester seeks to get a return on his boat and that the oyster harvest accounts for about 100 of those 260 work days.

4.2 Calculating Variable Costs in the Oyster Fishery

Some of the indirect costs facing a waterman who works several of the Chesapeake Bay's fisheries are independent of whether or not he works the oyster fishery. Others are incurred only if he harvests oysters. The discussion of variable costs, below, will start with the more general costs (those that accrue regardless of whether or not the waterman works the oyster fishery) and will proceed to those costs that apply specifically to oyster harvests and to specific harvest methods.

4.2.1 Annual Boat Maintenance Costs

Watermen's responses to survey questions about standard boat maintenance (haul-out, painting and repair costs) varied widely. They ranged from a low of $320 for painting costs, only, to estimates of $4,500 for the combined costs of haul-out, paint, repair and maintenance over an average year[11]. When the data were separated by whether the respondent provided summary annual maintenance values versus costs summed across the questionnaire's factor-specific questions, summary maintenance costs (n = 10) are $2,130; constructed costs[12] (n=8) are $1,037. It is likely, in retrospect, that estimates constructed from individual cost factors ignore many expenses that watermen incur in the course of maintaining their boat over the year. Although the simple average for the entire sample of responses is $1,664 (constructed and summary), the estimate that will be used for average maintenance costs is $2,000. Several respondents used this figure or, one very close to it, in their estimates of their average annual boat maintenance costs. More importantly, it discounts the potentially under-estimated value of the constructed costs.

4.2.2 Other Annual Costs

Boats need to be docked, and the annual cost of this can range from nothing to $1,500 and up. Within the survey sample, seven respondents (one third of the sample) had no explicit docking cost. Among the remainder, most docked at county facilities carrying

[11] See the appended survey questionnaire, questions 11 a. – f. While those questions identified specific anticipated costs, responses that summarized annual boat maintenance costs were also accepted.
[12] Three respondents did not provide complete estimates of maintenance costs. Costs include haul-out fees, materials and labor. Boat owners' time spent maintaining their boat, when reported, is valued at $17.30/hr.

charges of between $430 and $600 per year. One harbor in Somerset County carried an annual fee of $1,500 and rates in Rock Hall at private marinas are much higher than this. Due to increased competition for slips from pleasure boats, these costs are likely to rise. A simple average of the charges listed is $843 per year.

Most watermen, though by no means all, belong to one or more trade associations. The average annual membership and other costs of non-zero respondents (n = 16) was $182 per year. Five of the respondents did not belong to any associations and, including them in the calculation reduced the average to $137/year.

Prorating estimated docking costs for the oyster season (i.e., 100 days out of 260) and summing this with the inclusive measure of membership fees generates an average cost of $461 per year.

A license is required to harvest oysters. This licensing requirement can be met with either an Unlimited Tidal Fish License (TFL) or an oyster harvester license (OYH). The TFL carries a charge of $300 per year and covers a range – though not all – of the Bay's fishery resources. An OYH only costs $50 per year. In the sample, only 2 respondents used the OYH; the rest had TFLs. It should be noted that, although the TFL is about the same price as the purchase of individual licenses across the oyster, crab and fin fish fisheries, there is unsatisfied demand for these licenses. This demand is evidenced by the prices that entrants are willing to pay for already existing TFLs – reported as ranging from $10,000 to $17,000[13]. However, it is not likely that much of this market price for a TFL is driven by expectations regarding oyster harvests. Rather, these premiums are paid in anticipation of returns to other commercial fisheries and charter boat operations. Therefore, the $50 paid for an OYH will be used as a conservative estimate of licensing costs.

In addition to the license fee, since 1992 DNR has collected a surcharge from anyone wishing to sell oysters. The surcharge is currently $300. Some watermen can oyster without paying the surcharge if, for example, they work on a boat with someone who has paid it[14]. Within the survey sample, all the respondents but one paid the surcharge. License and surcharge costs for the oyster fishery are estimated at $350 per year.

The total "other annual costs" attributable to oyster harvesting works out to about $811 per season or, at our notional 100-day season, $8.11 per day.

4.2.3 Motor and Drive Train Maintenance Costs

Motors, transmissions, shafts and propellers are cost items that, relative to boat maintenance costs, are more dependent on how much the boat is used. While boat

[13] Technically, TFLs cannot be exchanged for money but, they can be reassigned by the owner and this sometimes requires a payment by the recipient. One way of reporting such a transaction is to include it in a sale of other gear. Value sources include watermen and DNR staff.
[14] The exception here is that power dredge applicants must have paid the surcharge.

maintenance costs are more nearly constant, independent of whether or not the boat is used to work the oyster fishery, motor maintenance costs are more likely to increase if the boat is used over the winter as opposed to sitting at the dock or on blocks.

In response to questions about engine maintenance and overhaul costs and frequencies, watermen cited a wide variety of estimates. Several suggested an annual cost of $1,200 for regular maintenance and repairs with a major overhaul cost of $6,000 every nine years. Others predicted shorter life spans and higher overhaul costs. The average engine maintenance and repair cost for the sample (n=15) was $2,112 per year. When checked against diesel engine life and cost estimates as a daily rate, the response average ($8.12/day[15]) is somewhat lower than the daily cost rate calculated as the engine replacement cost divided by the expected life of a smaller diesel engine ($9.80/day)[16]. Larger engines carry higher expected costs.

Transmission maintenance and replacement costs are captured in the engine costs, above. However, propeller shafts and propellers are not. While there is a wide range of types and sizes for both shafts and propellers, an average price of typically used shaft and propeller sizes is $2,681[17]. These will need to be replaced, on reported average, every 7 years. However, propellers are also reported to need repair every 2 years and this cost, given the range of commonly used propeller sizes, is about $230 per repair. Combining these numbers on an annual basis gives an average annual cost of just under $500 per year, or, $1.91 per day.

Combined motor and drive train maintenance costs are estimated to be $2,608 per year or, about $10 per day used.

4.2.4 Effort-Dependent Variable Costs

While motors and drive trains are somewhat effort-dependent, the set of costs discussed here are fully dependent on whether or not a waterman decides to work the oyster fishery. These include fuel, harvest gear maintenance and repair costs and the value of the harvester's time.

Fuel costs varied by region, with harvesters in the lower Bay using much more fuel daily than harvesters based in the mid-shore. The average cost over the entire sample, including both diesel and gasoline engines, was $45[18] per day. This ranged, however, from a high of $148 per day to a low of $13 per day.

The return that a waterman expects to earn for his time spent oystering is estimated here by averaging responses to the survey question: "In a typical year, do you make money from any other activities not associated with harvests from the Bay? (yes, no) Hourly

[15] At 260 work days per year.
[16] Information provided by Rodney Fluharty, a diesel engine installer in Talbot County, MD.
[17] Information provided by Barney Kastel of Kastel Brothers Marine, St. Michaels, MD.
[18] Diesel cost @ $2.60/gal. Gasoline cost @ $2.27/gal.

income?" Over the five responses to this question, wage rates averaged $17.30 per hour. Given a modal average reported work day of 7 hours, the average daily imputed wage cost for the sample is $121 per day.

Gear operating and maintenance costs are summarized in **Table 2**, below. These figures are generated by respondent estimates for replacement costs, annual maintenance costs and expected life of their harvest equipment. Replacement costs include associated mechanical and hydraulic equipment for dive, patent tong and power dredge gears as well as estimates for masts and rigging. The "annual combined" figure accounts an average of the number of sets of tongs or dredges across respondents using each given gear type and averages replacement costs at a constant rate over their expected useful life.

Table 2: Gear Replacement and Maintenance Costs

Gear Type	Replacement	Useful Life	Maintenance	Annual Combined
Dive Gear	$4,375	6 years	$ 807	$1,536
Patent Tongs	$5,775	10 years	$ 504	$1,236
Power Dredge	$4,875	9 years	$ 314	$ 939
Shaft Tongs	$266	9 years	$ 185	$ 410

Using the estimate of 100 days per oyster season, the daily costs by gear type can be got by moving the decimal place of the "Annual Combined" figure two digits to the left.

4.2.5 Cost Summary

Having described how the range of fixed and variable cost estimates were calculated, we now assemble them for a more summary view. **Table 3**, reports the (non-wage and excluding fuel) costs described in the preceding sections. The capital costs are pro-rated by the ratio of days in an oyster season (100) to total work days in a year (260).

Table 3: Pro-Rated Annual Cost Averages for the Oyster Fishery

Gear Type	Boat, Motor, Gear & Other Annual	Capital & Depr. Costs	Pro-rated Total
Divers High	4119	1154	5273
Divers Low		1122	5241
Power Dredge H	3819	2308	6127
Power Dredge L		1209	5028
Patent Tong H	3522	1038	4560
Patent Tong L		516	4038
Shaft Tong H	2993	1058	4051
Shaft Tong L		247	3240

If the assumption of a 100 day average working season is maintained for the oyster fishery, then the daily indirect cost for each gear type can be had by moving the decimal place two digits to the left in the "Pro-rated Total" column. **Table 4**, below, adds direct costs of labor and fuel to the mix. Labor cost is based on the previously discussed $121/day rate, applied in keeping with regulations (i.e., two registered harvesters are required on dive boats) and findings from the survey sample. Most dredge boats in the sample worked with more than one licensed harvester aboard, 60 percent of the patent tong respondents worked alone, and 57 percent of the shaft tonger respondents worked alone. Fuel costs are estimated from gear-specific responses and 2005 fuel costs.

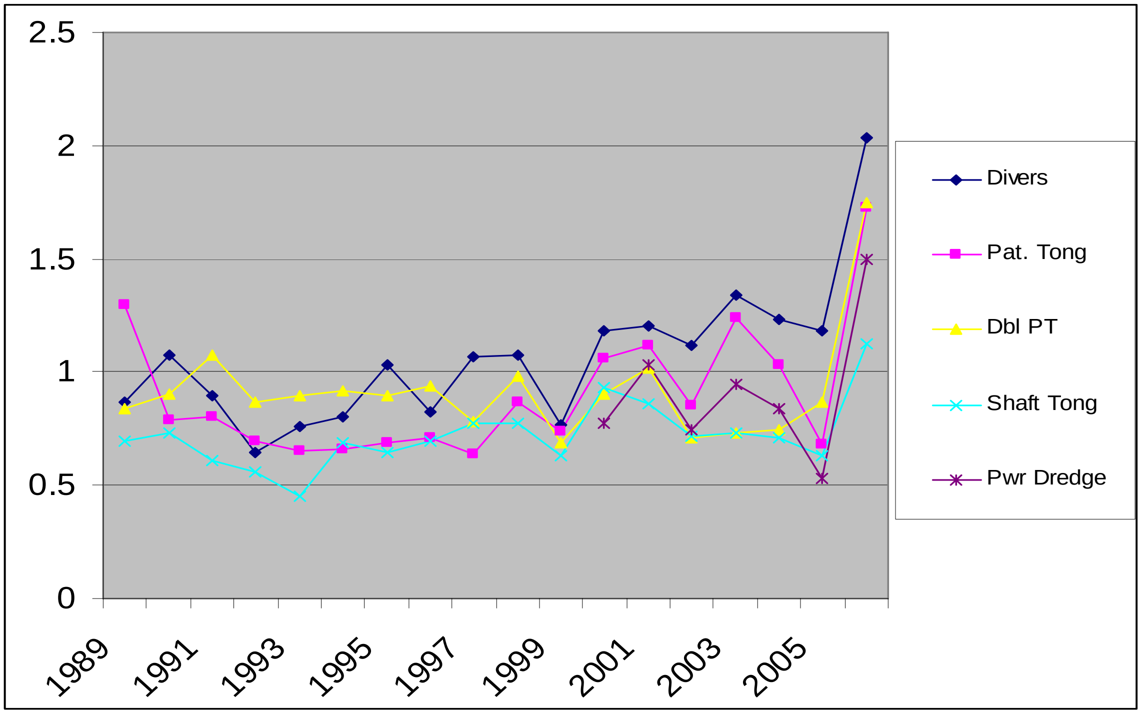
Table 4: Daily Direct and Indirect Harvest Costs for a 100 Day Season

Gear Type	Daily Indirect	Daily Fuel	Daily Labor	Total Daily
Divers High	$52.73	$27	$242	$322
Divers Low	52.41		242	$321
Power Dredge H	61.27	73	242	376
Power Dredge L	50.28		121	244
Patent Tong H	45.60	49	242	337
Patent Tong L	40.38		121	210
Shaft Tong H	40.51	24	242	307
Shaft Tong L	32.40		121	177

At the 2006 season price of about $30 per bushel, the harvests required to cover these costs range from 12.5 bushels per day (high-end dredges) to 5.9 bushels per day (low-end tongers). At 2005 average dockside oyster prices of about $20 per bushel, these cost-covering landings rise to 18.8 and 8.8 for high-end dredges and low-end shaft tongers, respectively. Examining catch per unit effort for the sample of harvesters who sold oysters through the buy-ticket program in 2006, power dredges averaged 13.6 bushels per boat day and shaft tongers averaged 10.6 bushels per boat day. In 2005, power dredges only averaged 12.6 bushels per boat day but shaft tongers brought in 8.65 bushels per boat day.

Figure 2 provides a record of the ratio of average seasonal harvest values (i.e., average catch per unit effort by gear type times price received, deflated by the CPI (2000 = 1)) to costs, estimated as above but using seasonal averages of crew per boat by gear type to set wage costs and, as with values, deflated by the CPI. This figure indicates that, in most seasons, for most gears, estimated costs are not being recovered. A ratio of less than one indicates that harvest costs are larger than average harvest returns.

Figure 2: **Ratio of Harvest Values to Costs by Gear Type, 1989 to 2006**



5. Conclusion

There is considerable variability in the cost of harvesting oysters from the Chesapeake Bay, depending on gear type, harvester choices and preferences, and the vagaries of nature. However, some costs are inevitable and costs not paid for maintenance will work through to higher costs in depreciation and replacement. This study has used empirical data from a survey of harvesters enumerated at the start of the 2006 harvest season to estimate a range of costs by gear type and has placed these in the context of recent seasonal harvests. While the costs described in the report are transparent and open to debate, the sample on which they are based is a small one and uncertainly representative of the larger population of oyster harvesters.

Independent of their representativeness, the estimates of costs from the sample are constructed in a manner that is transparent and replicable. If other estimates of any particular cost factor became available, it would be a simple matter to factor the calculations by the difference and thereby obtain a new total cost estimate. While imputed wages form the largest share of harvest costs, on average about a third of daily costs are accounted by fuel and other non-labor costs. The ratio of harvest receipts to costs tracks fairly closely with expectations for a fishery that has fished away natural resource rents, though the 2006 harvest shows that nature can still occasionally generate a bonus, even in the face of both harvest pressure and disease.

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Annex 1

Cost Survey Questionnaire

Oyster Harvest Cost Questionnaire

To the Respondent: This survey is part of a wider economic study of the Chesapeake Bay oyster fishery. It is being enumerated by Main Street Economics and is supported by NOAA FY 06 grant funding. In order to better understand the relationships between costs, prices, gear type and fishing behavior, we seek your cooperation and assistance in completing the survey questionnaire. You are under no obligation to do so, but the information provided by this survey will help to illuminate cost issues facing watermen that are relevant to policies under consideration for the fishery. Your response will be kept anonymous.

1. What kind of a boat do you have? _______________ (Length_____), (Motor ______)

2. How old is it? ________ years.

3. What did you pay for it? ______________ 3.b Current sale value? ________________

4. What method of oyster harvest do you use and how long have you been doing this:

Harvest Method ____________, Length of time ____________, Previous ____________

5. How many do you have, sets of: __________ oyster tongs/rakes, ___________ patent tongs (single or double), ___________ diving equipment, ____________ dredge gear?

6. Please estimate a (replacement) value for each set of: __________ oyster tongs/rakes, ___________ patent tongs (single or double), ___________ diving equipment, __________ dredge gear.

7. How much time do you spend during a season maintaining your: __________ oyster tongs/rakes, _________ patent tongs (single or double), _________ diving equipment, __________ dredge gear.

8. About how many years of use can you get out of your: ________ oyster tongs/rakes, ____________ patent tongs (single or double), ___________ diving equipment, ____________ dredge gear.

9. How much fuel do you use on a typical day of oystering? _________gal. (diesel/gas)

10. What electronic gear does your boat have and what did you pay for it?

Gear	Purchase $	Age
Communications		
Depth Finder		
GIS		
Other		

11. How often do you do each of the following and what are your costs:

Cost Item	Frequency (1/yrs)	Own time	Purchased time & mat.
a. Haul Out			
b. Topside paint			
c. Bottom paint			
d. Engine overhaul/ replacement			
e. Electronics repair			
f. Other			

12. What kind of commercial licenses/permits do you have?

_______________________________; ___________________________;

________________________________; ___________________________

13. How do you learn about rule changes and closures? _________________________

____

____

14. How much time does this take? ________________________________ per season.

15. Do you work alone or do you have a crew? ______alone, ______ crew, _______ #

16. If you have a crew, how much do you pay them per work day? ________________

17. Do you have a choice in buyers who you can sell to? _____ yes, ____no

18. How much do you contribute per season to any watermen's associations that you may belong to? $______________, or, Time ____________________

19. How many days did you oyster last season? ____________________

20. How many bushels did you get: on a good day? _________________ A slack day? _______________ On average? _____________________.

21. How far do you drive (on average) to get to your boat? _____________

22. How long do you usually stay out on the water when you are oystering?

________hr/day

23. How do you decide where to oyster? ____________________________________

23.b Time Spent? __________

24. How many years have you been oystering? ___________

25. Do you crab in the summer? _____ yes, _____no. __________ (gross) Income?

26. Do you clam? ____ yes, _____ no. ___________ (gross) Income?

27. Do you take fishing charters? ____ yes, _____ no. _________ (gross) Income?

28. Any other water-resource related work? __________________________________

____(gross income) ________

29. Do you have any bottom leases that you are currently using to produce oysters?

____yes, ____no. How big? _________

30. In a typical year, do you make money from any other activities not associated with harvests from the Bay? ____

_____________________________________Hourly income? ___________________

Hypothetical Questions:

If the economists found that a person could make a $1.00 profit on every dollar he invested in oyster aquaculture (including a $15/hr return on labor), would you be interested in doing it? ____ yes, ___no.

If no, why not? ____

____

____

What kind of return would it take before you would be interested in oyster aquaculture? _______ per dollar invested.