DISCARDED AND ABANDONED AQUACULTURE CLAM NETTING ON THE ATLANTIC BARRIER ISLANDS ON THE EASTERN SHORE OF VIRGINIA

2006 REPORT

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Cover photo: Virginia Eastern Shorekeeper retrieving clam net from Mockhorn Island Wildlife Management Area, 2005, D. Field, Virginia Department of Conservation and Recreation.

Photo enhancements: In no case was the content of any image or photo used as a figure changed or modified. Where noted some digital photos shown as figures were enhanced using Adobe Photoshop 6.0 to highlight a portion of the photo. Contrast and brightness level were adjusted to make images of the photos more recognizable. In some pictures all or some of the color was removed to highlight areas and to reduce overall image/pixel size. Except where cited all photo were by R. Ayers, 2004-2006

INTRODUCTION

The use of plastic mesh, generally referred to as "clam net", is used as a predator deterrent over the subaqueous tidal lands where clams are grown to market size. In 2004, the report, "*DISCARDED AND ABANDONED AQUACULTURE CLAM NETTING ON THE ATLANTIC BARRIER ISLANDS ON THE EASTERN SHORE OF VIRGINIA",* illustrated the wide distribution of clam net on barrier beaches of the Eastern Shore of Virginia. The 2004 assessment recommended additional studies of net abundance and continued monitoring of potential impacts to the coastal ecosystem. Because of the significance of the Virginia barrier islands to nesting and migratory birds, the study focused on the net found on the barrier beaches, dunes and adjacent areas.

Defined objective: Document human impacts to sensitive marine resources.
The objective was to locate, assess, and document the extent of discarded plastic netting used in the clam aquaculture industry on the barrier beaches of the Eastern Shore of Virginia. The assessment aimed to provide the basis for periodic public forums, involving aquaculturists, residents, county officials and representatives of regulatory agencies, to discuss and recommend remedial measures. The report included photo- documentation, mapped locations and observed effects of discarded clam net on the coastal system. In addition, the report included comments on the scope, impact and suggested remedies for addressing the discarded and abandoned plastic aquaculture netting on the seaside of the Eastern Shore.

To the extent possible this report attempts to qualify the 2004 findings and track and assess the recommendations made. In addition, the hard clam aquaculture industry was observed to determine if growth of the industry or changes in practices could measurably change the impact of netting on the barrier island beaches.

Background
The Virginia hard clam aquaculture industry continues to show modest expansion along the seaside waters of the Eastern Shore of Virginia. Based upon recent economic assessments, Virginia's clam farms lead the nation in the culture of hard clams. *(Virginia Shellfish Aquaculture Situation and Outlook Report Results of Virginia Shellfish Aquaculture Crop Reporting Survey 2005 – 2007).* In Northampton County clams are second only to tomatoes in their agricultural value (Northampton County Extension Service 2003). The clam aquaculture industry represents a significant fishery on the Eastern Shore. Because no permits are required to grow aquaculture clams in Virginia, it is difficult to assess the total number of clams being grown. Bottom leases are required, but do not necessarily reflect any particular use. The industry is eligible to apply for crop insurance through the USDA for planted clams. Changes in crop insurance policies over the past few years have caused some smaller independent growers to forgo insurance. Crop insurance figures suggest that there are 750 million clams planted around the Eastern Shore of Virginia annually. This includes both the seaside and Chesapeake Bay side, with no clear way to calculate the numbers. Clams are typically planted in tidal waters for 12 to 30 months.

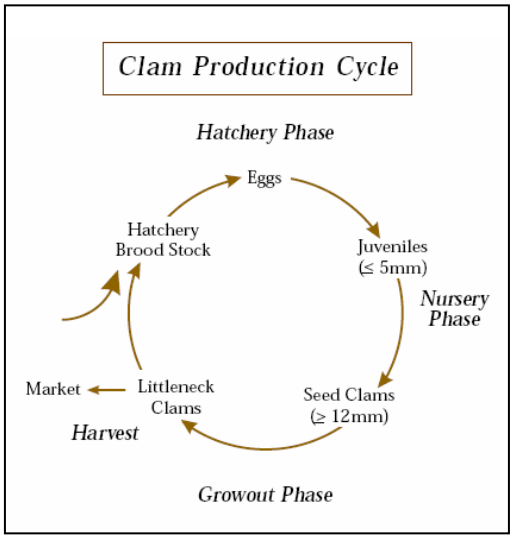

Figure 1. Clam Production Cycle (North Carolina Dept. of Agriculture 2001)

Shellfish aquaculture, specifically the term "clam aquaculture", includes shellfish spawned in a hatchery, raised in a nursery, stocked onto private leases for grow out, and then harvested. The hard clams grown on the Eastern Shore of Virginia are from the genus *Mercenaria* and grow in the near-shore waters from Maine to Florida. Locally, clams are known by a number of names, most often referring to a size and not a different species of clam. Names include clams, hard clams, cherrystones, littlenecks, topnecks, chowders and quahogs.

In clam aquaculture, three different systems are used during different phases of the clam's life (Figure 1). They are 1) The hatchery phase, which is designed to provide the ideal growing conditions for the brood stock. Select clams are spawned and grown to a specific size in hatcheries. The size of these young clams is controlled by screening out specific size clams. 2) The nursery phase, during which the juvenile clams are nurtured. Growers on the Eastern Shore have historically used land-based "raceways" during this phase. The raceway systems typically utilize long, shallow wooden or fiberglass trays that have been lined with plastic or covered with epoxy resin coatings. Large round tubes with various mesh filters lining the bottoms are lined up along each tray, over which the juvenile clams are distributed. Raw seawater is pumped into each tube at a prescribed rate. The second method used in the nursery phase is the field-based system, which involves placing seed clams from the hatchery or land-based nursery into submerged bottom trays. Traditional designs employ subtidal and intertidal trays made of plastic and have a protective cover of fine mesh netting to discourage predators. The third, becoming more prevalent on the seaside, is the bottom nursery. This method places nursery size clams on a sandy bottom. The small clams, around 5 mm, are then covered with a small mesh (1/6 inch) predator net. 3) The final phase, grow-out, is the time between planting seed clams and harvesting market size clams. The time will largely depend on water quality, food availability and temperature. Clams prefer water with a relatively high and stable salinity, and grow best in water that has two-thirds of the salinity of the ocean (~ 25 ppt.). Clams also prefer an area with active tidal flushing; tides mix oxygen throughout the water column, wash away waste and silt that can smother clams, and deliver supplies of microscopic algae, which the clams eat. Growth is influenced by water temperature, availability of food, planting densities, disease and predation. An18 to 36 month grow-out period is necessary for seed clams to reach a market size of 45 to 50 mm in shell length, or one inch thick.

Although land-based grow-out methods such as raceways and tanks have been developed, field-based grow-out methods are better suited for hard clam production on the Eastern Shore. Most field based grow-out operations utilize some form of pen, tray, soft bag or net. On the Eastern Shore of Virginia nets in subtidal and intertidal zones are the most common (Figure 2). The only notable exceptions are several growers in the Chincoteague Island area that use area enclosures or fences to keep predators out of large riparian areas. This practice is only possible in areas where the landowner has deeded rights to adjacent inner-tidal land, historically attached to upland property. While much of the Eastern Shore land includes such rights, most has a soft or muddy bottom not necessarily suitable for growing hard clams. Seed clams are planted in beds approximately 14 x 50 feet. Each bed may be planted with 40,000 to 50,000 seed clams. Nets are placed over the beds where seed clams are planted. The edges of the net are weighted down with steel rebar or weighted gravel bags as a means to keep the net in place and discourage predators. Prior to harvesting, the net is removing.

Figure 2. Clam beds. Dark rectangles are clam beds covered with clam net and covered by tide. Boat shown maneuvering into growing area.

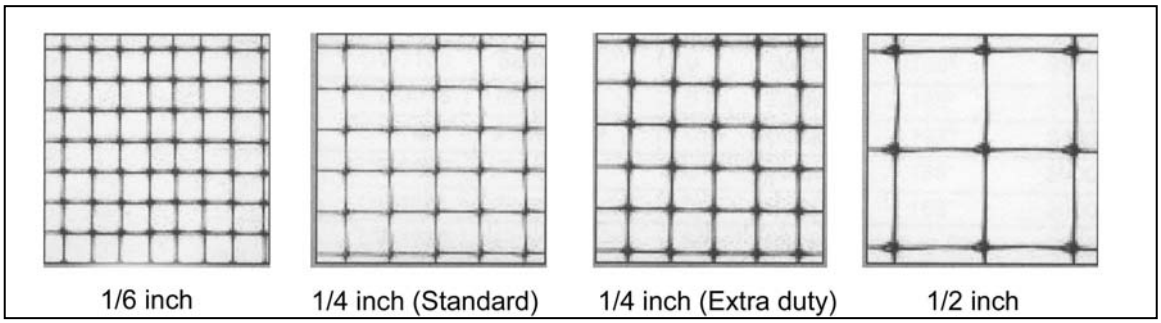

Figure 3. Common clam aquaculture net mesh sizes (InterNet® Inc., 2004).

For the purpose of this report the net with a mesh size of 1/6 to 1/8 inch will be referred to as ”nursery net.” All other netting used by the clam aquaculture industry will be referred to as “clam net” (Figure 3). This will be black or white net with a mesh size from ¼ to ½ inch in size. Other types of netting, not used by the clam aquaculture industry will be referred to by their common names; gill net, cast net, sand fence, etc.

Nets are used solely to protect clams from large predators. Skate, summer flounder, striped bass, black drum, starfish, whelk, blue crab and Atlantic Brant and most gulls are among the common larger predators on the seaside. Most of the netting reported in use on the seaside is an oriented polyethylene or polypropylene mesh imbedded with a UV additive to extend outdoor life. Most of the netting reported in use by the clam aquaculture industry on the seaside in produced by two suppliers, Tenax® and InterNet®. Tenax® supplies all the white ¼ inch net. InterNet® supplies all the black net, in various sizes. The most common net width is 14 feet (168 inches). However, with some manufacturers make net in 16’5” (197 inch) widths. Net is sold in a variety of roll lengths, up to 5000 ft.. Typically, most growers on the seaside use nets cut to a length of 50 to 60 feet, although some private growers use nets as short as 20 feet. Nursery nets have been observed in lengths from 20 to 100 feet.

METHODS

The primary survey method during 2005 and 2006 replicated the simple beach survey methods (Figure 4) used in 2004. The survey documented the presence of netting on Atlantic barrier beaches and evaluated potential impacts on beach nesting birds and sensitive beach grasses. Sampling was conducted in the spring and late summer to minimize potential disturbances to nesting birds.

Figure 4. Virginia Eastern Shorekeeper mapping the location of a large portion of abandoned clam net found during a beach survey.
Photo: (D. Field, DCR/DNH 2003)

The Virginia Eastern Shorekeeper and its volunteers conducted all the surveys. Landowners were notified, and where appropriate, research permits were obtained. Primary property owners included the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR/DNH), the Virginia Marine Resources Commission (VMRC), the U.S. Fish & Wildlife Service (USF&WS), Eastern Shore National Wildlife Refuge and Fisherman Island National Wildlife Refuge, The Nature Conservancy (TNC), Virginia Chapter and several private landowners.

The geographic area of the survey included Northampton County, VA, Atlantic coast and coastal bays; and Accomack County, VA, Atlantic coast and coastal bays south of Gargathy Inlet. In addition, random sampling was conducted while on the water throughout the Seaside Heritage Program area. The northern portion of Metompkin Island, owned by USF&WS, was surveyed by boat. Because of the low profile and low number of observed

nets on this island, a research permit was not deemed necessary. Fisherman Island NWR, part of Eastern Shore NWR was not surveyed in 2005 or 2006. Nets surveyed and tagged in the spring of 2004 were largely removed by volunteers conducting a beach clean up. Free floating nets and unobstructed nets located in the tidal seaside marshes were documented. Where access was possible, nets were collected, checked for tags and removed for proper disposal.

All beach surveys were conducted on foot. Surveys collected information on location, net description and habitat information. Nets were marked and numbered with biodegradable tagging. A handheld GPS unit was used to determine net location. In many cases, the net was almost completely buried in sand or debris. No attempt was made to dig out or overly disturb the net or the surrounding habitat. Generally, on barrier beaches the surveyor walked the high tide or "wrack line" looking for netting. On wider beaches and beaches without a substantial primary dune, the survey also explored recent over-wash areas to look for netting driven into interior or high marsh by storms. GPS waypoints were recorded and downloaded into the Garmin MapSource, version 6.3, software for mapping.

Marking the net:
Each accessible net found during the beach survey was tagged using an eight inch colored nylon wire tie; the spring survey used Blue (**BL**) ties on net when first tagged and smaller yellow (**YL**) ties during spring retagging. The fall surveys used Green (**GR**) ties north of New Inlet and Orange (**OR**) ties south of New Inlet (Table 1). For tagging: ¾" x 3" aluminum forestry tags were attached with the colored nylon wire tie (Figure 5). Tags were Forestry Suppliers "Al Tag" Double Faced Aluminum Tags, Item number 79500. These tags were used because they were field markable, and the manufacturer indicated that debossed markings would remain visible regardless of weather, grease, pitch or dirt. The tags would also biodegrade after a few years. Each tag was marked with a two-letter location identifier followed by a three-digit number (Table 1) (Figure 6).

Table 1. Field definitions used in net survey

Tag # AA000-XX999

MT	Metompkin Island		
CD	Cedar Island	**AM**	Atlantic Marsh
PM	Parramore Island NAP	**AS**	Atlantic Shoreline
RV	Revel's Island	**AX**	Atlantic Open Water
HG	Hog Island		
CB	Cobb's Island	**BM**	Bayside Marsh
LC	Little Cobb Island	**BS**	Bayside Shoreline
WK	Wreck Island NAP	**BS**	Bayside Open Water
SS	Ship Shoal Island		
MM	Mink/Myrtle Island	**SN**	Savage Neck NAP
SM	Smith Island	**TR**	Trower Bayshore NAP
FM	Fisherman Island NWR	**PK**	Parker's Marsh NAP

Flag Color	
BL	Blue
GR	Green
YL	Yellow
OR	Orange
Net Color	
B	Black
W	White (off white)
Mesh Size	
S	< ¼" (nursery)
M	= ¼" (normal)
L	> ¼" (unusual)

The tags were attached by the wire tie at a visible high point on the net (Figure 6). The soft aluminum tags held up well in the salt air but were highly susceptible to damage and even removal by large birds, primarily gulls. After having some tags damaged and destroyed by birds, subsequent tags were placed under or protected by the net, but still visible near the highest point.

An approximate size was given to all sampled netting. This was subjective because the actual length of clam net varies by grower and the netting was often buried in the sand or covered in wrack (Figure 7). However, a simple grouping of; Small (**S**)(net will easily fit into a clam basket), Medium (**M**)(net could be stuffed into a clam basket), Large (**L**)(net would not fit into a clam basket) and Whole Net (**W**) was used (Table 1). A standard plastic clam basket was used as the size reference. Whole net was most often determined by size, unbroken edging and lack of any significant damage, particularly on the ends. Nets less than one square meter are not surveyed or tagged.

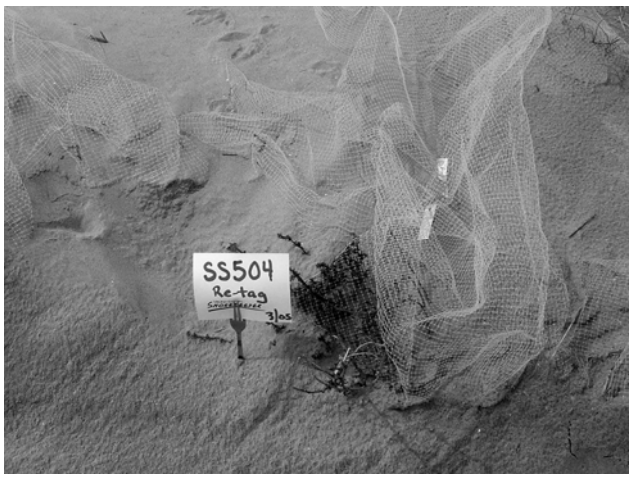

Figure 5. Net “SS504” retagged on Ship Shoal Island Figure 6. Tag “WK001” on Wreck Island NAP

The net color and size were also recorded. Only two colors, black (**B**) and white (**W**) were noted. White net often appeared tan when covered with growth. The definitions for net size were; ¼” Mesh (**M**), Smaller than ¼” (**S**), Larger than ¼” (**L**).

A general description of the habitat where the net was located was recorded. Table 2 provides details of field definitions. Net coverage was added to the fall survey. A 0-100 percent scale of net covered by sand or debris was used. In most cases this was an estimate and was generally recorded in increments of ten (*i.e.* 20, 50, 60 *etc*.). Unusual observations were also noted. Digital photographs were taken to document various effects of netting on coastal habitat. In most cases digital pictures were in a 2 mega pixel format for good picture quality. In some case a small (3” x 5”) card was used to show a large readable tag number to aid in later identification (Figure 6).

Table 2. Field definitions for habitat used during the 2004 net survey.

Habitat		**Additional definitions**
OW	Open Water	Includes surf zone.
LB	Lower Beach	Includes shoreline and intertidal zone.
WL	Wrack Line	Includes the clear debris line from recent high tides.
UB	Upper Beach	The beach strand above high tide line.
DUN	Dune	Includes primary dunes, secondary dunes and shell piles
SHR	Shrubs	All areas of shrubs and trees, including shrubs on dunes
CB	Clam Beds	Active clam beds and accessories, i.e. piles, poles, trays, etc.
TF	Tidal Flats	
LM	Low Marsh	Salt marsh, includes fringe marsh and cordgrass dominated marsh
MM	Marsh Wrack Line	The clear debris line from high tides
UM	Upper Marsh	Marsh above “normal” tide line
MAN	Man Made	Piers, bulkheads, pilings, bridges, docks or other manmade objects.

Figure 7. Large section of white clam net on upper beach. Net is beginning to sand in. Area of disturbed sand is the result of birds foraging in and around the net.

RESULTS

Overall, there was a 41% reduction in the amount of clam net found on the barrier island beaches of the Eastern Shore of Virginia over the period of time from spring 2004 to autumn 2006. The initial survey in spring 2004 yielded 323 nets. This compared to190 nets located during the autumn 2006 survey. While the lower autumn 2006 total suggests that the clam industry is being more responsible, there are a number of variables that impact the results. Over the three years (six sampling periods), 788 (+/-73) pieces of new netting were tagged (Figure 8). This includes the 323 pieces of net initially tagged and additional new netting added during each subsequent survey.

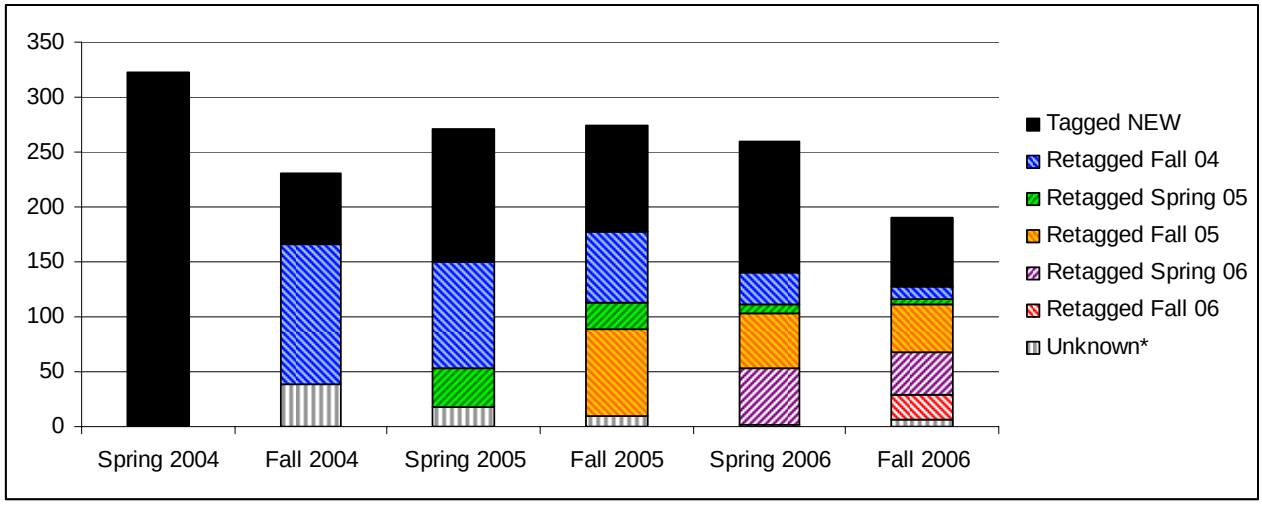

Figure 8: Clam Net located on the barrier island beaches from spring 2004 through fall 2006. (*) indicates nets without tags but believed to be relocated from previous survey. Additional information is provided in results.

Correction from 2004 Report: The data in the 2004 report results were correct. However, a map with graph (Figure 10 from the 2004 report) showing the distribution of clam net along the barrier island chain only depicts 317 nets. Six nets on Little Cobb Island were omitted in error. The total should have been 323.

The total number of new nets that were located on the barrier beaches increased on the two consecutive spring surveys and decreased on the three fall surveys (Figure 9). This is inconsistent with harvest data that indicates increases in harvest during the summer, when consumer demand for clams is higher. Spring surveys were generally conducted in March and April and fall surveys were generally conducted in September and October, with an average of 4 months between both surveys.

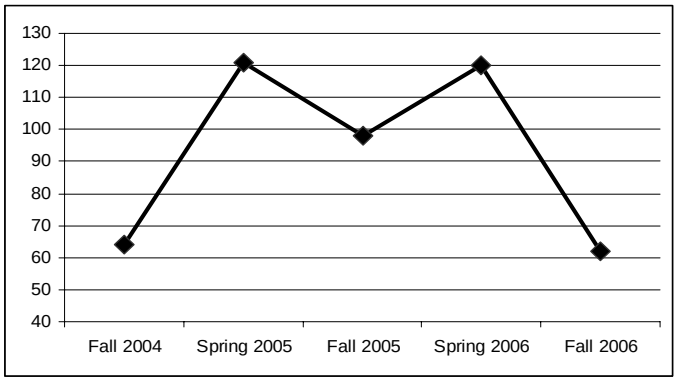

Figure 9: Number of new additional nets located following the initial spring 2004 survey.

Most surprising in the survey was the unlikelihood of relocating a net that was presumed moved by weather. While figure 8 indicates that all were retagged, all but three were retagged exactly in or near the general location of where they were first observed. Of the 788 (+/-73) only three nets were relocated away from the location of the original observation. Two of those nets CB502 and CB506 were located on the southern tip of Cobb's Island on the ocean side of the island in 16 April 2005 and relocated on the eastern end of Little Cobb Island on 5 October 2005, a travel distance of about 0.7 nautical miles. The anomaly was clearly WK060, which was first located and tagged on 17 April 2004 on the north end of Wreck Island, and area of the island that completely eroded away by the spring of 2006. WK060 was relocated in the high marsh on the northwest side of Parramore Island on 20 April 2005 18.3 nautical miles from its original location (Figure 10). This was the only net located a significant distance from its original location. It was also north and inland of the original location, which counters the general belief that items on the barrier beaches tend to stay seaward and move south towards the mouth of the Chesapeake Bay.

There was no evidence of clam net disrupting or disturbing any nesting birds. In five observed cases, two different bird species were observed nesting on the net (Figure 11). Due to research permit restrictions, only nesting birds on Wreck Island NAP were observed during nesting season.

There were also no observed impacts on any mammals, reptiles or amphibians. There has been an anecdotal report of diamond back terrapins trapped in net, but no evidence was produced to support this report. In a number of locations, ghost crabs had dug burrows in and around the net. In nets that were recently removed from clam beds, there was often heavy microalgal growth ther microorganism growth (M. Powers, C. Peterson1, H. Summerson, S. Powers, 2007). Most clam net found during the survey was remarkably clean. This was apparently due to the agitation of the net while floating in the sea and washing up on the beach. Nets removed from clam beds by growers are

Figure 10: Net "WK060" from Wreck Island relocated on the west side of Parramore Island one year later. Insert shows a close up of net and tags.

usually heavily encrusted with a variety of organic growth.

The wrack line, consisting primarily of smooth cordgrass (*Spartina alterniflora*) stalks that had senesced and broken free in the fall, represented a clear indicator on most beaches as to the recent tides. The wrack line forms a narrow band of debris that was easy to follow. Wrack lines generally form throughout the year, marking the higher tides down to the most recent tide. Extreme weather and tides, such as occurred during hurricane Isabel in September 2003, can literally erase many of these wrack lines. This was evident during the spring 2004 survey. Only six percent of the net was observed seaward of this line (Figure 12). During the fall 2004 survey, the largest percentage of the new net (47%) was located in the wrack line. In subsequent surveys, most new net was located on the upper beach. In most cases, the clam net observed in the tidal zone was carried or moved on and around the beach as part of the wrack line. New nets were observed in the surf-line or working free from the wrack in gusty winds. Once free, the movement of the net could best be described as “tumble-weed” like. The free net balled up and moved short distances by wind until it snagged on debris or shells.

Figure 11: Royal Tern nest on partially buried clam net on Wreck Island NAP

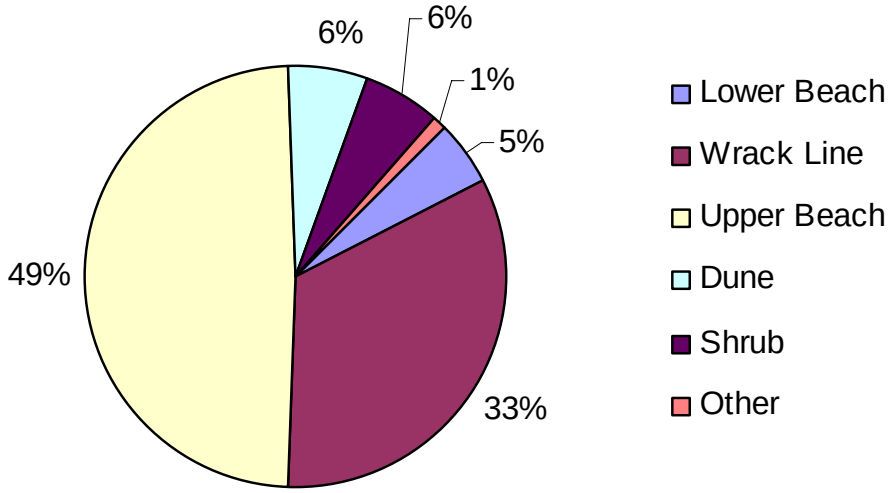

Figure 12: Percentage of clam net, by location, on the barrier beaches.

Generally, all clam net or any other debris on the upper beach held blowing sand. It appeared that clam net was easily covered by fine blowing sand. It was not possible to quantify the amount of clam net that was completely covered by sand, although it is likely a small amount. In just a few days, some net was 50 percent covered with sand. It is estimated that less than twenty nets found in the upper beach were buried by sand to the point where relocating them was impossible. No effort was made to dig in order to relocate any net. In most cases, partially buried nets observed during one survey were gone in the next, with evidence of high tide washing over the area and moving the net.

In many cases, clam net and wrack collected sand and began to support plants. Although clam net held sand, so did virtually everything else on the beach. Everything from tree stumps to abandoned crab pots acted as a mechanism for holding blowing sand. By far, the most efficient sand collector was the smooth cord grass wrack. Under the right conditions, the natural wrack lines could be 90 percent covered with sand in a few days. A variety of plants were observed growing in, among, and through the clam netting (Figure 13). Plant types were most often a result of where on the beach strand the net was located. The most common plant found growing in net collected soils was sea rocket (*Cakile edentula*) (Figure 14).

Figure 13. American beach grass (*Ammophila breviligulata*) growing among clam net and wrack.

Figure 14. Sea rocket (*Cakile edentula*) growing in sand trapped by clam net.

The amount of net on the island beaches varied slightly from the total number of nets, or portions of net observed. To determine the square footage of net, an average net dimension of 14 feet by 50 feet was used for a total of 700 square feet. Very small pieces of net, less than I meter square were not sampled. Of the nets sampled, the following values were assigned; Small (S) = 0.25, Medium (M) = 0.50, Large (L) = 0.75 and whole net = 1.00. The total average square footage was the total of all the values given, multiplied by 700 square feet. On nets sampled more than once and measured in different sizes, the larger value sampled was used. For example, a net observed in the spring as Large/0.75 and sampled again in the fall as a Medium/0.50 was valued as a 0.75, the larger of the two samples. Table 5 shows the total number of nets surveyed per sampling period and the estimated total square footage of net. The number of whole nets, net that appeared whole and intact was a fairly low number (16 to 21 whole nets.) Also the calculated average size of the net found declined over the survey period from 370 square foot to 345 square foot (roughly ½ of a whole clam net.

Table 3. Total number of nets surveyed by period and the total estimated square footage of net.

Survey period	Total net pieces	Whole nets	Square footage	Average net size
Spring 2004	323	21	119524.54	370.045
Fall 2004	230	16	80511.50	350.050
Spring 2005	271	18	97898.75	361.250
Fall 2005	275	16	97643.15	355.066
Spring 2006	260	21	90935.00	349.750
Fall 2006	190	18	65550.00	345.000

In 2004, the distribution of new net was mapped by island. During the 2004 to 2006 survey period greater than ninety percent of the new tagged net on the barrier beaches was located south of Quinby Inlet, south of Parramore Island. By comparison less than five percent of the tagged net was located on Parramore, Cedar or Metompkin Island. Compared to the southern portion of the lagoon system the area behind Parramore, Cedar and Metompkin Island has very few clam beds in the lagoons.

The actual locations of nets tagged were placed in a GIS data base and digitally mapped to show distribution. The effort was not believed to accurately show distribution on barrier beach for two primary reasons. 1) The

base map used was 2002 imagery and the island, particularly the beach profile, changed substantially by 2006. In some cases, large portions of the island had eroded away while other areas had substantially accreted. 2) The digital mapping indicateed that more new net was arriving on Hog, Cobb's and Smith Islands compared to the other southern islands. This is believed to be largely a result in changes to the beach profile. Myrtle, Ship Shoal, and part of Wreck Islands had expansive overwash areas following Hurricanes Hugo and Ernesto compared to normal island movement. As a result, the area where the beach transitioned into an upper beach and/or shrub zone tended to be where net was retained. Likewise, islands that experienced frequent overwash events retained little net. Therefore, without detailed seasonal island mapping any distribution based solely on the individual islands was considered misleading.

DISCUSSION

NET: The clam growers need the clam nets to protect their clams. Without net, cultured clams could not be planted in the wild and have survival rates that could sustain the industry. The nets provide adequate and cost effective protection from most predators encountered on the seaside of the Eastern Shore. To be effective, the nets must remain intact. Even a small tear of a few inches can allow some predators to devastate entire beds of clams. Growers have developed effective ways of securing their nets over the young clams to protect them. Despite the care given to ensure that nets are properly placed, nets are still damaged or destroyed by man-made and naturally occurring events.

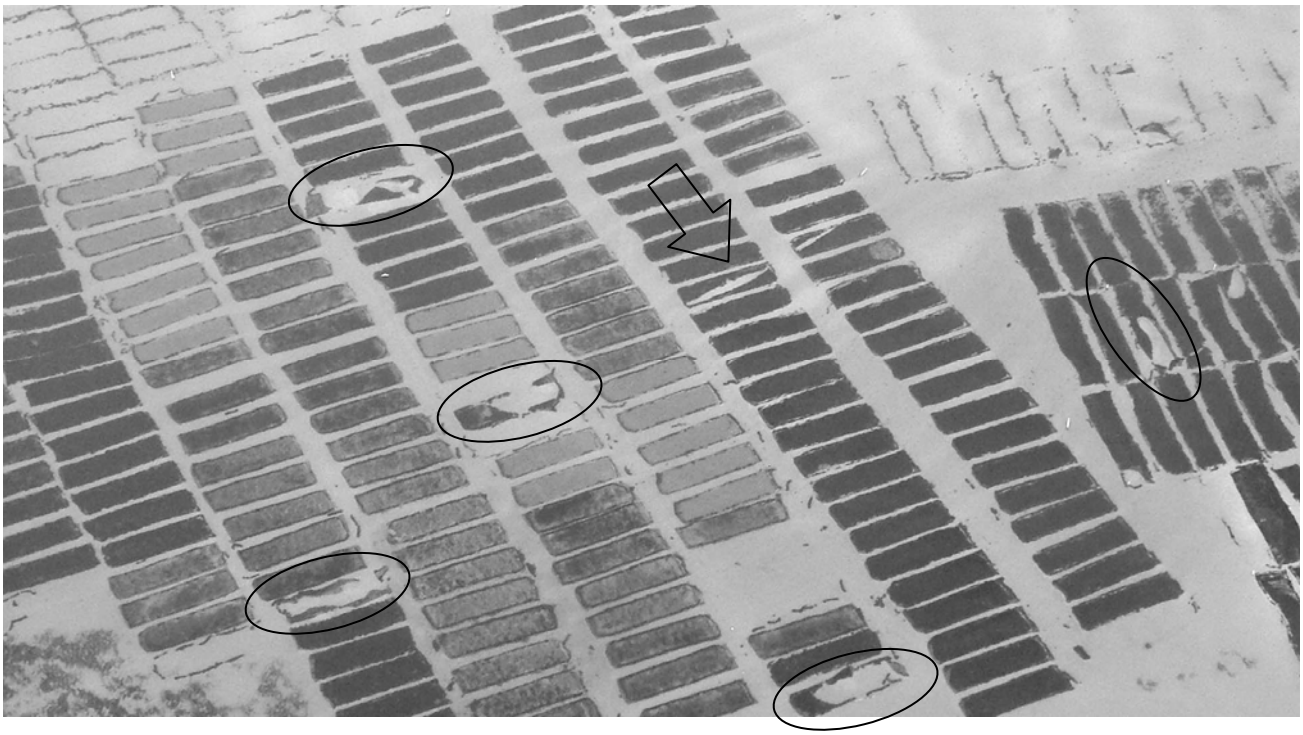

Figure 15: Clam beds covered by net on sandy bottom. The darker rectangles are generally the more mature clam beds. Upper right and top left are harvested beds or "ghost beds" whose shape can still be identified. The arrow points to two clam beds that have been struck by a passing boat. The large rip in the net is a propeller scar. Circled are other damaged nets. Each damaged net is the potential loss of 50,000 market size clams.

Man-made events, primarily nets struck by boats or boat propellers (Figure 15), are the most frustrating to growers who feel they are the most avoidable. Some shallow water beds are damaged by passing boats several times a season. Often it appears to be a recreational boat operating in unfamiliar waters. Although there are no specific guidelines for growers to mark their grounds, most have some type of marking. Small PVC pipe and locally cut bamboo are the two most popular markers. Some growers mark every bed, while others place a minimal amount of marks out. The amount of markings is largely up to the grower. Some feel

that more marks will keep boats away while other growers use minimal marks to not attract attention to the beds.

Natural events can have an even larger impact over large numbers of clam beds. Storms, strong currents and ice can have devastating impacts on clam beds. Storms can occur during any time of the year. The storms can produce relatively large waves in the shallow water bays. Wave action can both erode sand from and deposit sand on nets. Similarly, storms and normal astronomical tide cycles can produce above average tides & currents that can also erode and cover beds with sand. Eroded nets are essentially uncovered, allowing predators to freely feed on the young clams. This is primarily a concern in the warmer months when predator activity is highest. Sand deposition or burying is a year-round problem. Clams typically live in approximately three inches of sand. Although they can tolerate deeper sand cover for short periods and will often burrow deeper when stressed, clams will not survive if buried for long periods of time. In this case, the buried clam net prevents the clam from digging back to a more favorable depth near the surface. Buried nets need to be uncovered before the clams die. Digging out buried clam nets often necessitates use of hand labor or water pumps to wash and dig away the deposited sand. Because of the sheer weight of the sand on the net, some nets are torn during the process. Ice forming over clam beds can adhere to clam net during low tides and the rising tide can lift the net off the beds. This was reported in the Tom's Cove area near Chincoteague in 2003 (VMRC officers, personal comment).

Animals are reported to be adapting to the nets and the large concentration of food they cover. Anecdotal reports describe herring gulls grabbing net covering beds and "twisting" to tear a small hole in the net to access the clams. In nursery beds several varieties of young or small crabs work their way under the nets. Some growers even report that deer walking on the net can puncture the net and allow predators to enter.

PUBLIC PERCEPTION: As the clam industry has grown over the past ten years so have the complaints. Other than the generic complaints about watermen in general, aquaculture complaints seem to fall into three areas. 1) The clam bed obstructing the waterways. 2) The visual litter of the markers used to mark the clam beds, and 3) The nets as litter on the shores and beaches (Figure 16).

Figure 16: Clam net littering the tidal marsh near Chincoteague Island (26 nets counted in this photo).

The first two complaints are related and not a subject of this study. However, brief comments are given to help understand some of the public perception issues faced by the industry. Clam beds are best placed in permitted areas where the grower hopes the clams will grow to market size. For the most part, there is a very specific habitat requirement that represents a small percentage of total bottom land. Growers are constantly looking for additional land, but good growing land is limited. Virtually all growing land is in the shallow waters of the coastal bays and none is located in marked navigable channels. Many beds are located alongside of navigable waters and boaters who stray from these channels can find themselves striking clam beds. Large

areas of the seaside do not have marked waterways and many local boaters rely on personal knowledge to navigate safely. Where these locally known waterways include planted clams, a conflict will exist. Growers seem to respond to this by marking their beds with numerous markers. To the people with local knowledge of the waterway, the markers can clearly mark the way. To the novice boater, even the best marked beds are often confusing or misleading. The visual pollution of the markers seems to primarily be a problem on the bayside, where the waterfront property development is much denser. Complaints center around the aesthetics of the markers in an otherwise pristine viewshed. There are many areas on the seaside where clam beds are heavily marked, but few are visible from shore or from navigable channels and thus receive fewer complaints.

Discarded and abandoned clam net is a problem and is the primary reason this study was conducted. In the autumn of 2002 complaints of clam net washing up seemed to increase. It was the topic of conversation at most environmental gatherings. Field researchers on the barrier Islands were reporting the growing problem. Even the local newspapers were running occasional letters to the editor addressing or commenting on the netting. The non-profit organization, Citizens for a Better Eastern Shore (CBES), ran articles addressing the issue in the monthly newsletter to their membership. At the same time, CBES was in the process of helping to form the Virginia Eastern Shorekeeper (Figure 15) program and, in the initial organizational meeting notes, identified discarded clam net as a target for action. During the regular meeting of the Seaside Heritage Program partners in 2002, the issue of the clam net was addressed and led to the funding of this study by the Coastal Zone Management Program.

Figure 17: Virginia Eastern Shorekeeper retrieving discarded clam net.
Photo: D.Field 2005

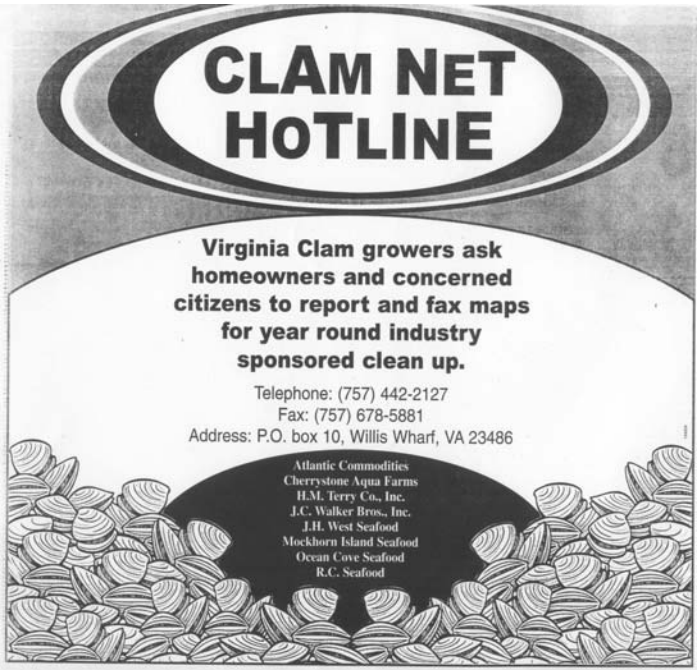

Figure 18: Image of "Clam Net Hotline" newspaper add from the Eastern Shore News.

INDUSTRY RESPONSE: The hard clam aquaculture industry on the Eastern Shore continues to mature. Clam aquaculture represented a 27 million dollar industry in 2006 on the Eastern Shore (T.Murray, M.Oesterling). The once fairly quiet companies are becoming more vocal as the tidal water quality may be degrading to the point it may affect their business. Northampton County's big three growers, Cherrystone Aqua Farms, H.M. Terry Company, Inc. and J.C. Walker Brothers, Inc., began to take a more public stand on water quality issues, particularly on Parting Creek in Willis Wharf, where all of the seaside clam hatcheries are located. They understood that the industry needed to address the discarded clam net to help improve their public image. Although these larger growers were already doing their part to keep their clam nets accounted for, they voluntarily began discussions with other growers, environmental organizations, particularly The

Nature Conservancy and the Virginia Eastern Shorekeeper, about cleaning up the netting. In October 2003, the Virginia Eastern Shorekeeper began to survey clam net. Immediately, calls were received from the clam growers reporting discarded net and who the net might belong to. Today it is common practice for the larger growers to send crews out to recover abandoned net, regardless of the origin. In response to public complaints, eight of the larger clam growers on the Eastern Shore of Virginia ran two half page ads in the "Eastern Shore News", a local newspaper (Figure 18) on June 9 & 16, 2004. The newspaper ad established a "Clam Net Hotline" and a phone and fax number to report net. The Virginia Eastern Shorekeeper provided the fax number for the growers to advertise. The Clam Net Hotline only received a few calls in 2004, and by the fall of 2006, was not receiving any calls. Since beginning the survey growers routinely contact the Virginia Eastern Shorekeeper to report where they see abandoned net and the efforts they have made to reclaim it. Growers have been reluctant to report the names of other growers, although they have indicated clearly who it was not.

The aquaculture industry reports some netting is lost during storm and unusual tide events. The quantity reported as lost appears significantly less than the actual netting deposited along the shoreline. Discounting weather, the vast majority of the growers believe the net is being abandoned by less the ten percent of the total growers (personal conversation, M.Peirson, P.Terry, T.Walker). Some have even reported hearing one of these growers say "he has never brought in a net." The larger growers, some of their co-op growers and several independent growers publicly condemn the practice of discarding net. They all indicated that a relatively small number of growers are creating a negative image for the rest of the industry. Some small growers have expressed concern about the actual disposal of the old netting. The bulk of even a small amount of net limits the use of local dumpsters for disposal, requiring the growers to travel to one of the areas three landfill adding additional time and cost to there day. To address these concerns the major growers rent large dumpsters primarily for their growers (Figure 19)

Figure 19: Dumpster overflowing with old clam net in Willis Wharf, VA

Figure 20. Gravel bag or "Sausage" used to hold netting down piled on clam grounds.

Figure 21: Clam net, removed from clam bed held down by rock bags.

It is illegal to discard any plastic from a boat. The Code of Federal Regulations, 33CFR151.67 Discharge of plastic prohibited, states; *"No person on board any ship may discharge into the sea, or into the navigable waters of the United States, plastic or garbage mixed with plastic, including, but not limited to, synthetic ropes, synthetic fishing nets, and plastic garbage bags. All garbage containing plastics requiring disposal must be discharged ashore or incinerated."*

It is widely believed that most of the discarded clam net is abandoned at or near the clam beds and not discarded from the boat. Growers who remove nets from the clam beds to harvest the clams or maintain the nets simply pile the nets up near the site and let the tide carry them away (Figure 20). Abandoned net would generally be an considered an enforcement problem. However there is no state or federal law that would prohibit a grower from "storing" the used net or gravel bags (Figure 21) near a bed until he had time to return to recover it. An enforcement agent would then have to prove intent to abandon the plastic net. This would be a very difficult case to prove in a court of law.

In 2004 the hard clam aquaculture industry believed it may be at, or near the market peak for hard shell clams. That concern is weaning and the belief is that there is room for modest growth of the industry. The limitation of desirable bottom land for planting and decreasing water quality along the Chesapeake bayside creeks are physical barriers to the industry. Market pressures and competition from other states also may also be limiting expansion. Despite market concerns there has been considerable investment by the major clam growers upgrade hatcheries, equipment and leasing new planting grounds (personal observation).

RECOMMENDATIONS

There is continued momentum within the clam aquaculture industry to clean up abandoned clam net. This industry effort should continue to be supported. The larger clam growers clearly understand that their positive actions in minimizing or curtailing discarded and abandoned clam net will help eliminate the need for any regulatory mandates that may add unwanted costs to the industry.

The presence of the Virginia Eastern Shorekeeper, or any other group monitoring the industry seems to be the most effective and cost effective deterrent. In addition, the Shorekeeper, out on the water educating the smaller growers using non-confrontational methods, as to the effects they are having on the industry also appears to have had a positive impact. After three years of patrolling and observing discarded clam net, the Shorekeeper was largely seen as a "watchdog" by the growers and the general public.

While the Shorekeeper monitoring effort supports the belief that the netting on the barrier beaches has minimal short term environmental impact on the island avian communities, much is still unknown (Figure 22). The environmental impacts of discarded clam net need further study. Additional study to assess the impactof nets across the entire habitat is needed. In addition, little is known about the longevity of the net when underwater or exposed to the weather.

Figure 22: Freshly washed up clam net on Wreck Island NAP. Photo color enhanced.

Clarification is needed to specifically address equipment used for aquaculture. Nearly all the current aquaculture regulations pertain to aquaculture fish farming conducted on closed ponds. Clams and the potential for large scale oyster farming in Virginia need clear guidance. To some extent, even the clam aquaculture industry wants regulatory help in protecting the area directly above their clam beds.

Specific recommendations fall into three groups; monitoring & education, enforcement and long range efforts.

1. Monitoring & Education:

- Educate citizens about the economic importance of clam aquaculture to the Eastern Shore of Virginia. This is particularly true for some of the state agencies. VIMS, VMRC and VCZMP do an outstanding job in promoting the value of clam aquaculture, particularly the economic and environmental values. Until recently, Virginia Department of Agriculture and Consumer Services (VDACS) the state agency to which aquaculture falls under largely ignored the clam industry. VDACS largely still supports agriculture but is slower beginning to acknowledge the economic value of aquaculture. The Virginia Cooperative Extension is inconsistent. The Northampton County Extension office fully supports aquaculture and the Accomack County Extension office largely supports land use initiatives that are harmful to the clam industry. DCR Soil & Water has recently begun to fund non-point pollution projects that were directly impacting shellfish water quality.
- Continue to educate the county Board of Supervisors. Northampton County has fully embraced clam aquaculture as an important industry. Accomack County, where clam aquaculture is smaller, tends to ignore the industry. The only exception was in 2006 when a proposed expansion of a waste treatment planned in the Captains Cove subdivision was projected to close shellfish grounds. The calm industry and local citizens rallied to oppose the project and Accomack County seemed to support the citizenry, adopting a resolution to protect shellfish waters.
- Continue to educate all growers on the negative impact the discarded clam netting is having on the industry. Though most violators know what they are doing is wrong, they may not understand the effect it is having on the industry.
- Consider expanded monitoring of the environmental impacts of discarded and abandoned clam netting. Expand monitoring to include impacts on the salt marsh.

2. Enforcement:

- Locate growers who knowingly discard or abandon plastic clam net into the water. Use a non-confrontational approach to contact growers who are observed discarding or abandoning net. Provide a background from the ongoing study and advise that their activities are being monitored.
- Identify potential sources of discarded and abandoned netting. Overtly and covertly observe the planting and harvesting process to assess when net is most likely discarded.

3. **Long range planning:**

- Support VCZMP in the development of the Seaside Management Plan. VCZMP through the Seaside Heritage Program has already networked the agencies, local government and citizens with the expertise to address a number of management issues, including hard calm aquaculture and the related gear.
- Support efforts to protect shellfish waters on the Eastern Shore. Key to the success of hard calm aquaculture is good water quality. The TMDL IP process for shellfish waters needs to have input from the clam industry. Aquacultures interest in keeping the waters clean and promoting responsible practices will benefit by the overall protection of the tidal waters.
- There has been discussion for years of developing additional laws and regulations that provide extra protection to the Eastern Shore's shellfish waters. As these efforts develop, ensure the hard calm aquaculture industry is engaged in the process.
- Continue to facilitate discussions with the aquaculture industry on the best ways to reduce the amount of net. Continue to support the aquaculture industry with its efforts to clean up discarded net.
- Track the industry's efforts to develop legislation to protect the area directly above the planted clam beds.

This report of findings will be provided to the Virginia Department of Environmental Quality, Virginia Coastal Program and to all partners and landowners who had surveys conducted. All data and photographs not included in the report of findings shall be retained by the Virginia Eastern Shorekeeper for 3 years and is available to all partners.

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