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Derelict Blue Crab Trap Impacts on Marine Fisheries in the Lower York River, Virginia

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Marine Debris Survey in Virginia

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Center for Coastal Resources Management
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Introduction

The blue crab, *Callinectes sapidus*, is an important component of the Chesapeake Bay, both ecologically and economically. Ecologically, *C. sapidus* is considered the foremost benthic scavenger/predator (Baird and Ulanowicz 1989). Economically, the Chesapeake Bay provided the bulk of the nation's blue crab catch in the 1950's but has seen a steady decrease over the last few decades (Miller 2001; Miller et al. 2005). Based on commercial landings the Chesapeake Bay is still the nation's largest provider of blue crabs (30% in 2003) but Virginia has dropped to fourth (Miller et al. 2005). Nonetheless, the blue crab fishery still accounts for over $200 million annually for the Chesapeake Bay region (Haddon 2005).

Lost or abandoned (derelict) commercial fishing gear, including nets and traps, can present safety, nuisance, and environmental impacts in estuarine waters. Derelict fishing gear damages sensitive habitat and continues to capture both target and non-target species, leading to reduced fitness and significant acute and delayed mortalities (High and Worlund 1979; Guillory 1993; Bullimore et al. 2001, Guillory 2001, Matsuoka et al. 2005). Animals captured in derelict traps die from starvation, cannibolism, infection, disease, or prolonged exposure to poor water quality (i.e. low dissolved oygen) (Van Engel 1982; Guillory 1993). The effect of derelict blue crab traps on additional species such as terrapins and commercially important finfish has been documented (Smolowitz 1978; Guillory 1993; Guillory and Prejean 1998;). Evidence that derelict traps contribute to significant mortalities in the Gulf of Mexico blue crab fishery prompted removal strategies to reduce the ecologic and economic impacts of derelict traps (Guillory 2001).

The number of derelict blue crab traps in the nation's estuaries is unknown. Estimates derived from trap loss calculations suggest a derelict trap number at 605,000 in 1993 in Florida, Alabama, Mississippi, and Louisiana: though Guillory and Perret (1998) state that this number probably is an underestimate. Guillory et al (2001) using an annual total number of traps fished commercially at 1 million and a 25% loss/abandonment rate suggests 250,000 derelict traps are added to the Gulf of Mexico annually.

In Virginia, an examination of existing derelict trap data retrieved from Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) trawl surveys shows the potential effect of derelict traps on fish communities in Virginia waters (Bonzek and Latour 2005). Since 2002, ChesMMAP has attempted to sample 90 stations in the mainstem Chesapeake Bay ranging from the southern edge of the Susquehanna Flats to the Bay mouth in all depths to a minimum of 10 feet during each cruise. There are approximately 4-5 cruises per year and a large mesh bottom trawl is used to capture adult fish of a variety of species. During this sampling time frame (2002-2005), when derelict traps were inadvertently dredged up with the trawl, observations on fish and shellfish species trapped within were made.

During ChesMMAP surveys from 2002-2005, 91 derelict traps were obtained during the biological active period (April – October). Catches within the traps were predominately blue crabs (*Callinectes sapidus*) at 32.1% with Atlantic croaker (*Micropogonias undulates*) 9.3% of the total catch (Table 1).

Common Name	Latin Name	Total Abundance	Average Length (cm)	Proportion of Catch
Oyster toadfish	*Opsanus tau*	44	26.4	27.2
Blue crab, male	*Callinectes sapidus*	30	14.3	18.5
Blue crab, adult female	*Callinectes sapidus*	21	14.4	13.0
Atlantic croaker	*Micropogonias undulatus*	15	31.6	9.3
Spot	*Leiostomus xanthurus*	15	20.9	9.3
Scup	*Stenotomus chrysops*	13	16.1	8.0
White perch	*Morone americana*	8	21.1	4.9
Black seabass	*Centropristis striata*	4	20.2	2.5
Pigfish	*Orthopristis chrysoptera*	3	18.1	1.9
Red hake	*Urophycis chuss*	2	24.7	1.2
Striped bass	*Morone saxatilis*	2	26.4	1.2
Atlantic spadefish	*Chaetodipterus faber*	1	10.0	0.6
Blue crab, juvenile female	*Callinectes sapidus*	1	5.3	0.6
Bluefish	*Pomatomus saltatrix*	1	25.1	0.6
Feather blenny	*Hypsoblennius hentzi*	1	6.0	0.6
Summer flounder	*Paralichthys dentatus*	1	21.2	0.6

Summary Numbers	
Average Length (cm) of fish in pots	**20.2**
Average Length (cm) of blue crabs in pots	**11.3**
Total number of animals in pots (2002-05)	**162**
Proportion of catch = blue crabs	**32.1**

Table 1. Abandoned derelict blue crab trap catches from ChesMMAP trawl survey data (2002-2005).

Evidence regarding the amount and effect of derelict traps in the Chesapeake Bay is limited. Casey (1990) suggests commercial trap losses in the Bay may be as high as 30% per fisherman. In 2005 Virginia issued 1,524 blue crab commercial trapping licenses (not including peeler trap licenses) for a total of potentially 368,900 traps (VMRC 2006). It is unlikely however that all the traps that could legally be deployed are actually deployed.

Typically, traps become lost when the buoy line is severed by vessel propellers, the line breaks due to age, the traps are abandoned, or storms roll the traps pulling the buoy below the surface.

In order to address the affect of derelict traps on marine organisms, we investigated the following questions in the lower York River, Virginia.

1. How many derelict traps are present and what is the annual trap loss rate?
2. How long do derelict traps continue to effectively capture organisms?
3. How does "self-baiting" affect catch rates?
4. What is the catch rate of derelict traps of various ages?

Methods

The bottom survey for derelict blue crab traps was accomplished with side-scan sonar technology using a Marine Sonics 600 KHz side scan transducer on a hard mount (Sea Scan Marine Sonics, 600 kHz). The Sea Scan side-scan sonar was towed to collect real-time, geo-referenced, crab trap data with overlapping edges matched to form a continuous profile of the bottom. Geo-referenced pots were converted to GIS coverage. This equipment provides high-resolution digital images of crab traps (Figure 1). Ground-truth activities included returning to a survey area and removing a subsample of targets identified as crab traps to test the accuracy of trap identification. The surveys were completed in 100 m swaths with 20% overlap of tracks.

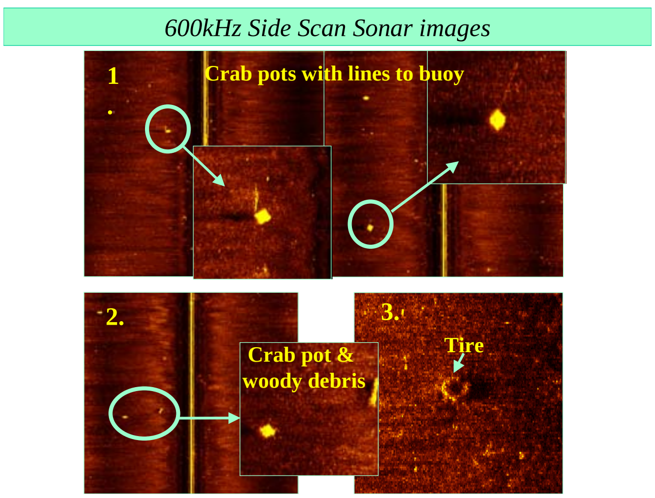


Figure 1. Side-scan image of derelict blue crab traps.

Approximately 34 km^2 were surveyed in the lower York River and approximately 0.2 km^2 Sarah Creek (Figure 2). The Sarah creek site was surveyed in the fall/winter of 2005. Derelict crab traps were removed and the area re-surveyed in the summer of 2006. Surveys to gage fishing pressure were conducted by boat in October 2006 by counting and logging GPS positions of buoyed traps in both the main stem lower York River and Sarah Creek.

Figure 2. Location of York River, Virginia survey area.

To test trap degradation rates and blue crab catch rates, twenty-eight unbaited vinyl coated fully outfitted (cull ring, rebar weight, zinc anode) traps were purchased from a commercial trap company and deployed in November 2005 to four areas of the York River, Virginia across a salinity gradient from 5.9 ‰ to 20.0 ‰ (Figure 3) and a depth range from constantly submerged to periodic exposure at low tide. Twenty-eight additional traps were deployed to the same sites on April 2006. The November and April deployment dates were selected to mimic conditions should a trap be lost at the end of the crabbing season (November) or at the beginning of the crabbing season (April). Trap entrance funnels were modified to allow the funnels to be closed. The funnel entrances were opened for 7 days of each month (November 2005 – November 2006 for first sample set; April 2006-November 2006 for second sample set). Traps were opened and weighed (wet weight kilograms) and trap condition noted on the first day then checked on the second, fourth and seventh day of fishing. On the seventh day the entrance funnels on all traps were closed and the traps were left undisturbed until the next sampling date. All organisms were identified, measured, and released. A subset of seventeen derelict traps was removed from the lower York River derelict trap population on August 22, 2006 and the catch rate and species composition compared with the experimental traps. In addition a second subset of 17 traps were removed to assess trapped organisms and trap condition. Both sets of traps had been derelict for at least one year.

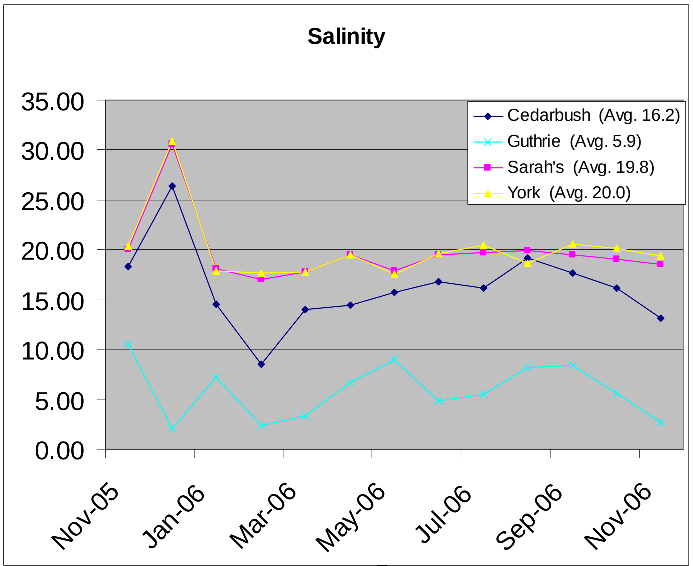


Figure 3. Annual salinity at experimental sites in parts per thousand.

To investigate trap loss rates, derelict traps were identified in Sarah Creek, a small tributary of the York River. All traps were removed during the off-season in 2005. Fishing pressure was determined by surveying the area for buoyed traps during the crabbing season in 2005 and 2006. The area was resurveyed for derelict traps in 2006.

To compare catch rates between unbaited and baited (self-baiting phenomenon), fourteen traps of two age classes (6 months and 11 months) were deployed to two sites for September and October: a low salinity site (5.9 ‰ average salinity) and a higher salinity site (19.8 ‰ average salinity). Seven traps at each site were baited by placing a dead croaker in the upper chamber to simulate the capture of a fish by a derelict trap while the other seven traps were left unbaited. After 5 days all traps were checked and the entrapped organisms identified, measured, and released.

Temperature and salinity measurements was taken monthly at each site using a hand-held YSI Sonde.

Results

Derelict Trap Density

In an identification accuracy test, 16 out of 17 (94%) side-scan targets were correctly identified as blue crab traps. A census of buoyed traps in Sarah Creek showed 40 in 2005 and 42 in 2006. Sixteen derelict traps were identified and removed from Sarah Creek in December 2005. The same area was resurveyed in July 2006 and 12 derelict traps were identified (75% annual accumulation rate). Sarah Creek trap loss rate is calculated at 40% and 28.6% for 2005 and 2006 respectively. A census of buoyed and derelict traps was conducted in a 9.7 km^2 section of the lower York River in October 2005 resulting in 302 buoyed traps and between 271 and 288 derelict traps. A subsequent complete census survey of the entire lower York River (33.5 km^2) identified a total of 676 derelict trap targets resulting in a derelict trap estimate of 635 to 676 with 905 buoyed traps (863 in the lower York and 42 in Sarah Creek) (Figure 4). Of the derelict trap estimate, 89 (approximately 14%) were abandoned traps with attached buoys. Twenty-eight of 34 (82%) derelict traps removed from the York River were deemed still functional.

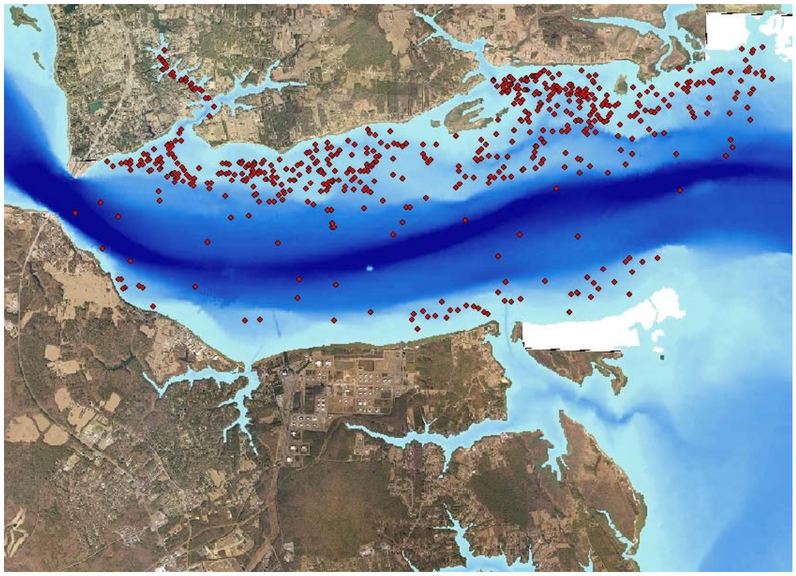


Figure 4. Location of 676 potential derelict blue crab traps identified through side-scan sonar in the lower York River, Virginia.

<u>Trap Degradation</u>

Traps continued to fish up to the end of the study period of one year and one month. Traps followed similar fouling trends of a gradual increase in weight over time. However, traps in the mainstem of the lower York River gained weight rapidly in the spring and then lost weight in the late summer due to the growth and dieback of tunicates (*Mogula spp.*) following an established pattern (McDougall, 1943) (Figure 5). Other trap fouling organisms include barnacles (*Balanus spp.*), tube weeds (*Polysiphonia spp.*), red beard sponge (*Microciona prolifera*) and hydroids (*Bougainvillia carolinensis*). The traps in the lower salinity site in Guthrie Creek were predominantly fouled with hydroids.

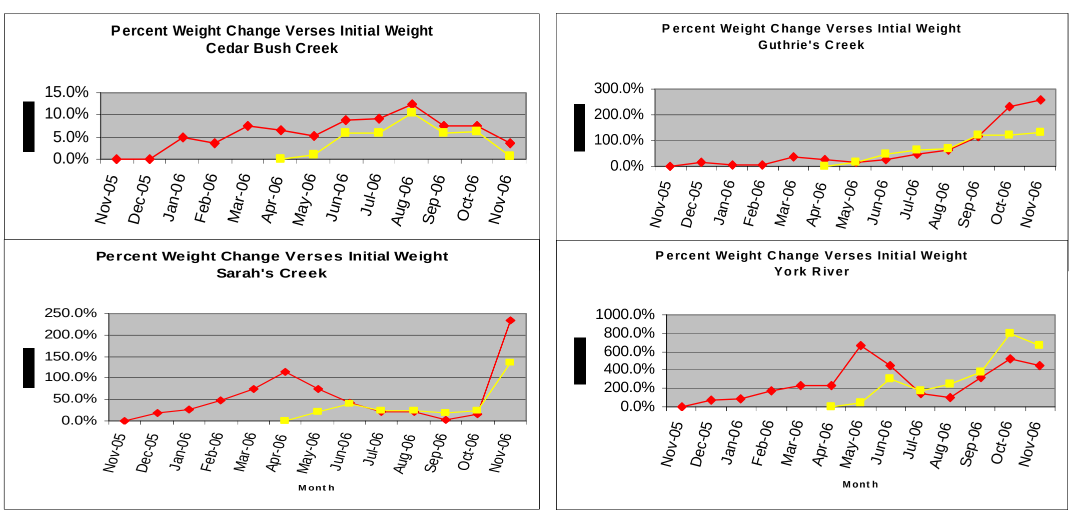


Figure 5. Percent change in trap wet weight per site.

Catch Rates

The overall blue crab catch rate for the experimental traps over the biologically active period (April – October) was 0.24 crabs/trap/day for an average of 50.6 crabs per trap over the 7-month period. The single day catch rate for the York River derelict traps removed in August was 0.65. A review of the ChesMap derelict trap data shows a catch rate averaged over 2002, 2003, and 2005 of 0.42 crabs/trap/day. There were no significant differences in overall catch rates between experimental sites (Table 2) or between 8-month and 2- month traps or 10-month and 4-month traps (p = 0.878, 0.429; respectively).

Site	Salinity ‰ (Average)	Trap days (April – October)	Catch rate (crabs/trap/day)
G	5.9	673	0.26 (SE = 0.08)
C	16.2	686	0.27 (SE = 0.08)
S	19.8	684	0.20 (SE = 0.06)
Y	20.0	625	0.21 (SE = 0.09)

Table 2. Trap catch rates per site.

There was a significant difference (p = 0.016) between baited and unbaited traps with the traps simulating 'self-baiting' capturing slightly more than double the unbaited traps (mean catch rate 0.785 and 0.385 crabs/trap/day, respectively).

Species Trapped

A total of 624 blue crabs were trapped from November 2005 to October 2006 (Figure 4). Fourteen other species were also trapped (Table 3). In the York River, 12% of the female crabs trapped were egg-bearing. A total of 172 fish were trapped with croaker consisting of 29.7 % of the catch. The average catch rate for croaker in the lower York River during May to August was 0.11 fish per trap per day.

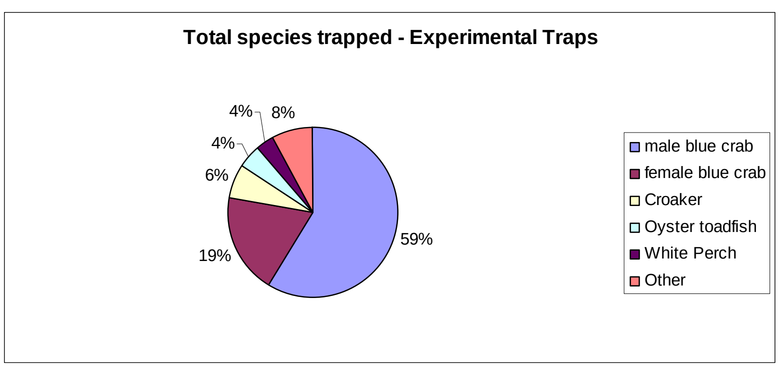
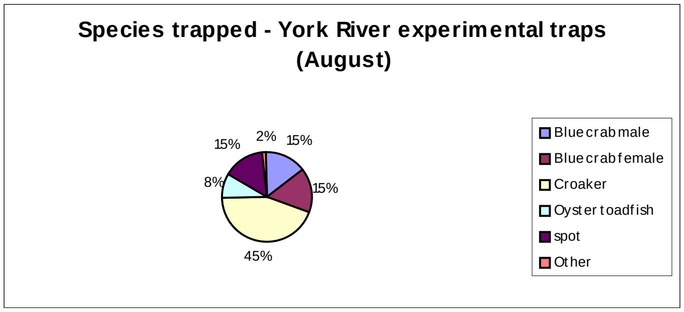


Figure 4. Total percent of species trapped at experimental sites.

Species trapped in the York River experimental site were similar to species noted from derelict traps recovered from the York River during August 2006 (Figure 5) with a total catch of blue crabs of 30% and 37%, respectively.



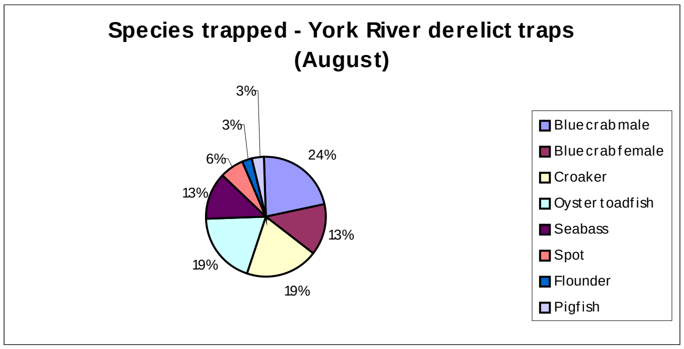


Figure 5. Comparison of species captured in experimental traps and derelict traps in August 2006.

Common name	Species	Number
Blue crab	*Callinectes sapidus*	624
Atlantic croaker	*Micropogonias undulates*	51
Oyster toadfish	*Opsanus tau*	34
White perch	*Morone americana*	29
White catfish	*Ameiurus catus*	16
Spot	*Leiostomus xanthurus*	15
Blue catfish	*Ictalurus furcatus*	9
Red drum	*Sciaenops ocellatus*	9
Muskrat	*Ondatra zibethicus*	6
Black seabass	*Centropristis striata*	3
Sheepshead	*Archosargus probatocephalus*	3
Flounder	*Paralichthys dentatus*	2
Pumpkinseed	*Lepomis gibbosus*	1
Eastern mud turtle	*Kinosternon subrubrum*	1
Diamondback terrapin	*Malaclemys terrapin*	1

Table 4. Species trapped at experimental sites.

Discussion

Side scan technology was effective at locating and identifying derelict traps and can be used to determine derelict trap density and attrition rates. It is evident for the lower York River a significant portion of the traps in the system are derelict (635 – 676 derelict vs. 905 buoyed) and traps are continually being added to the derelict trap population.

In addition, derelict traps have the potential to persist and continue to entrap blue crabs and fish. The traps located in the higher salinity zone were periodically encrusted with tunicates, barnacles, and hydroids to a higher degree than the traps located in the lower salinity zones suggesting that degradation will occur faster in higher salinity areas. However, encrustation of the traps was cyclic and traps were still effective at trapping organisms after one year. Shively (1997) reports that, depending on salinity, the life expectancy of vinyl-coated traps will average two years or more.

While derelict traps are effective at continuing to trap organisms, it is apparent that they also serve as habitat. A number of species (seahorse, *Hippocampus erectus*, pipefish, *Syngnathus fuscus*, blennies, *Hypsoblennius hentz*, juvenile crabs) were observed utilizing the encrusted traps. At some point in time the traps will degrade to such a condition that they no longer trap organisms but serve as habitat. The present study suggests the length time for degradation to reach a level of non-effectiveness in trapping is at least longer than one year in high salinity areas and probably significantly longer in lower salinity areas.

The affect of derelict traps on populations of marine organisms has been documented by a number of researchers (see Guillory et al. 2001). In a review of several derelict trap studies in the Chesapeake Bay, Casey and Daugherty (1989) report a trap mortality of 7.5 crabs/trap for August and September. This compares with our average catch rate of 8.7 and 12.6 crabs/trap for August and September 2006, respectively. Studies conducted in South Carolina concluded that the total annual mortality of derelict traps ranged from 20-60 blue crabs per trap with an average of 40 crabs per trap (Whitaker 1979). Data from this study suggests that 521 to 554 functional derelict traps are in the lower York River trapping an average of 50.6 blue crabs (26,363 – 28,032) and 13.6 croaker (7,086 – 7,534) per season. The self-baiting phenomenon could result in a doubling of the number of blue crabs trapped (52,726 – 56,064).

A few studies have attempted to calculate annual trap loss numbers. Casey (1990) suggests a figure of 30% for the Chesapeake Bay. Our study found an average trap loss figure of 34.3% for a tributary of the York River. In addition, if the fishing pressure of approximately 900 traps in the lower York River is consistent and the life of a derelict trap in this area is approximately two seasons then the trap loss rate in the lower York River averages approximately 30%. It should be noted that a number of events ranging from severe climatic activity (or lack thereof) to increased recreational use could modify this number.

Additional studies investigating blue crab mortality in derelict traps will be important to help quantify the affects of derelict traps on the overall blue crab population. In addition, it is necessary to investigate other regions of the Chesapeake Bay under varying fishing pressure to determine if the patterns observed in the lower York River are similar throughout the Bay.

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