1-1-2006

The Use of Bait Bags to Reduce the Need for Horseshoe Crab as Bait in the Virginia Whelk Fishery

Robert A. Fisher
Virginia Institute of Marine Science

Dylan Lee Fisher
Virginia Junior Academy of Science

Recommended Citation

Fisher, R. A., & Fisher, D. L. (2006) The Use of Bait Bags to Reduce the Need for Horseshoe Crab as Bait in the Virginia Whelk Fishery. Marine Resource Report No. 2006-10; VSG-06-12. Virginia Institute of Marine Science, College of William and Mary. http://dx.doi.org/doi:10.21220/m2-fjsz-jj36

The Use of Bait Bags to Reduce the Need for Horseshoe Crab as Bait in the Virginia Whelk Fishery

Robert A. Fisher
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Dylan 'Lee Fisher
Virginia Junior Academy of Science
Gloucester High School
Gloucester, Virginia 23061

Additional copies of this publication are available from Virginia Sea Grant, at:

Sea Grant Communications
Virginia Institute of Marine Science
P.O. Box 1346
Gloucester Point, VA 23062
804/684-7170
vsgpubs@vims.edu
www.vims.edu/adv/

VSG-06-12
VIMS Marine Resource Report No. 2006-10

This work is a result of research sponsored in part by NOAA Office of Sea Grant, U.S. Department of Commerce, under Grant No. NA96RG0025 to the Virginia Graduate Marine Science Consortium and Virginia Sea Grant College Program. The U.S. government is authorized to produce and distribute reprints for governmental purposes not-withstanding any copyright notation that may appear here.

Additional funding was provided by the Virginia Marine Resources Commission.

Abstract

The preferred and most effective bait in the Virginia whelk trap fishery is the horseshoe crab (Limulus polyphemis). Virginia fishermen alone used 1.4-1.5 million crabs in 2000 for bait in the whelk fishery. Leading producing states of horseshoe crabs for bait established harvesting quotas for crabs due to concerns of a declining population, which limited the number of crabs available for the whelk fishery. Measures were taken to reduce the fisheries' reliance on horseshoe crabs, which included the testing of bait holding devices which could potentially reduce the amount of horseshoe crab used per trap. A bait holding device (bait bag) constructed of rigid, plastic aquaculture mesh was tested in the Virginia commercial whelk pot fishery. The hypothesis was that if scavenger animals and trapped whelk could be kept from consuming bait placed in bait bags, then less bait would be needed. Horseshoe crabs were cut into halves, thirds and quarters (treatment groups), representing reduction of one-half, one-third and one-quarter of the traditional bait usage (control treatment). Three hundred and forty six treatment traps, and 341 control traps were tested. No significant differences (P>.05) were observed in the number of whelk caught per pot using half the amount of bait traditionally used. Bait reductions of thirds and quarters demonstrated an overall significant (P<.05) loss of catch, however, in areas of low whelk densities catch was more equal to whole crab(s). The results suggest that less horseshoe crab bait could be used in the Virginia whelk trap fishery without a significant loss in catch, but overall catch declines with bait reductions below one half.

Introduction

The whelk fishery in Virginia has become a key element in the Virginia seafood industry's effort to diversify its increasingly restricted traditional fisheries in order to stay competitive in the seafood market. Two species of whelk are harvested by Virginia fishermen, the knobbed whelk (*Busycon carica*), and the channeled or smooth whelk (*Busycon canaliculatum*). The channeled whelk commands a higher market price than the knobbed whelk due to the yellowish color of the marketable flesh. Whelk are harvested either by dredging within the Chesapeake Bay with modified crab dredges, or by trapping in baited traps (pots) along the Virginia coast, sometimes extending into federal waters. The majority of whelk is harvested in the pot fishery, which targets the more marketable channel whelk.

Whelk are processed locally and distributed fresh to canneries in New Jersey, or frozen raw to export markets. In 2000, approximately 50 boats and 150 fishermen actively participated in the Virginia conch pot fishery, with each boat fishing between 200-300 pots. An additional 120-150 individuals are associated with providing bait for the whelk fishermen, and processing and distributing the harvested whelk. The whelk pot fishery generates an estimated $4-5.5 million in revenues for Virginia processors (Manion et al., 2000), with a total estimated economic value to Virginia in excess of $42 million [Industry letter to the Virginia Marine Resource Commission (VMRC) dated February 16, 1999].

The preferred and most effective bait in the whelk pot fishery is the horseshoe crab (*Limulus polyphemis*). Other fisheries along the East Coast rely on the horseshoe crab as bait, including the eel and catfish fisheries. The major producers of horseshoe crabs for bait have been the states of Maryland, Delaware and New Jersey. The horseshoe crab has recently emerged as an important resource in the medical field. A blood clotting agent (Limulus amoebocyte lysate, LAL) found in horseshoe crab blood is used to detect certain human pathogens in patients, drugs and all intravenous equipment (Field 1997).

Horseshoe crabs also play an important ecological role in the food web of migrating shorebirds (Berkson and Shuster 1999) and the threatened Atlantic loggerhead turtle (Keinath et al. 1987). Horseshoe crabs inhabit coastal waters from the southern Gulf of Mexico to Maine, and are most abundant between Virginia and New Jersey with high concentrations found in Delaware Bay (Shuster and Botton 1985). Adult crabs spawn within the Chesapeake to Delaware Bay area in late spring (May), where they lay their eggs in the sandy beach habitat in clusters, or nest sites. These clusters are usually deposited between tide marks on the beach. The average number of eggs laid per cluster is 3,650, with each female able to lay approximately 88,000 eggs per year (Shuster and Bottom 1985). The eggs have historically served as a vital food source for migrating shore birds that arrive in the Delaware Bay area each year during the peak of crab spawning.

Historical records from the Delaware Bay indicate that commercial landings of horseshoe crabs have dropped from over 4 million at the turn of the 20th century to 1.8 million by the 1920s. More recent estimates of crab populations in Delaware indicate a drop from 1.2 million in 1990 and 1991 to less than 400,000 in 1992 and 1993 (Swan et al. 1991). According to aerial surveys conducted by Delaware and New Jersey, the number of migratory shorebirds on Delaware Bay has also declined from more than 400,000 in 1986, to 200,000 in 1997. Conservationist groups link the bird decline to the decline of horseshoe crabs, with over-harvesting of the crabs for bait being the primary factor in declining crab populations. In 2000 and 2001, the leading producers of horseshoe crabs for bait (Maryland, New Jersey, and Delaware) set limits and established harvesting quotas for horseshoe crabs, which resulted in a 59% decrease in crab landings.

In 1999, Virginia's whelk pot fishery required approximately 1.4-1.5 million horseshoe crabs annually (Industry letter to VMRC 1999), the majority of crabs harvested on the entire East Coast. Traditionally, one female crab or two male crabs are used as bait in a single whelk pot. Due to harvest restrictions on the horseshoe crab, Virginia whelk fishermen have a limited supply of bait while the cost per crab continually increases ($1.50/female and $0.65/male in 2000, 2001 compared to $0.75/female and $0.40/male in 1998). Alternative baits are being researched by this author to sustain commercial fisheries, but currently no bait has been developed that is as effective as the horseshoe crab. Until alternative bait is developed, whelk fishermen are limited to the number of crabs they can obtain. If fisherman can use less bait per pot without greatly reducing the number of whelk caught, then less demand for the crabs should result.

The objective of this experiment was to determine if reducing the amount of horseshoe crab bait placed in a mesh bait bag would affect the number of whelk caught per trap. The open design of commercial whelk traps allows scavengers access to the bait, which includes large finfish that can consume the bait within normal soak periods. It was hypothesized that if scavenger animals and trapped whelk were prevented from consuming the bait by the use of mesh bait bags, then less bait would be needed overall, as the bait used would continue to attract whelk during the total soak time. If the hypothesis is correct, fewer horseshoe crabs would be needed to sustain the whelk trap fishery thereby reducing pressure on the horseshoe crab resource.

Methods and Materials

Adult horseshoe crabs used in this research were randomly selected from four vats of crabs each containing approximately 400 crabs. Females averaged 29.9 cm in carapace length and 1.9 kg in weight (N=21). Males averaged 21.0 cm long and 1.2 kg in weight (N=21). One whole female crab, or two whole male crabs were used as the control groups for this study which mimicked traditional commercial usage of horseshoe crabs as whelk bait. Whole female and male horseshoe crabs were tested as whelk bait against halves, thirds, and quarters of crabs, cut and placed in mesh bait bags, representing reduction of one half, one third and one quarter, respectively, of the traditional bait usage.

Crabs for the various treatment groups were cut on a Hobart vertical food processing band saw (model 5215). With telsons (tail) removed, crabs were cut from anterior to posterior along the median ridge resulting in equally symmetrical halves for testing half bait usage. Female halves were cut in half transversely to obtain quarter crab treatments. To obtain female crab thirds, the abdomen section of a whole crab (opisthosoma) was first removed followed by an anterior to posterior cut through the thorax (prosoma) section along the median ridge, resulting in two symmetrical halves of the crab thorax and the crabs' abdomen section.

Bait bags were made from black, polyethylene plastic quarter inch square aquaculture mesh and measured 28 cm by 30.5 cm. Three sides of the bags were closed with stainless steel hog rings, leaving a long side (30.5 cm) open. Cut crabs were inserted into the mesh bait bags cut-side first, keeping the exposed flesh of the crab away from the open side of bag. Traps used were traditional wooden traps currently being used by commercial whelk fishermen. The traps were made of 1 inch wide wooden slats spaced 2.5 cm apart on all sides except the top, which are open. To prevent whelk from climbing back out of the trap once they enter it, tightly stretched rope, or one-inch square vinyl-coated wire mesh, is attached along the top edge extending inward. A roofing spike pointing upwards and a section of elastic cord are fixed to the bottom of the trap to hold the bait in place. Whole crabs (control traps by running the spike through bag mesh between the crab pieces and the open end of bag, and held in place with the elastic chord (Figure 1). This method of baiting closes off the open end of the bait bag and minimizes bait access to scavengers.

Figure 1. Commercial conch trap with bait bag containing horseshoe crab pieces secured in trap with traditional spike and elastic cord.

Research was conducted from December 1999 through June 2000 on a Virginia licensed commercial whelk potting vessel. Fishing occurred off-shore within both federal and Virginia State waters in areas between the Bay Bridge-Tunnel and the Virginia/North Carolina line in water 24-30 m deep (Figure 2).

Fishermen typically set traps in a "line", which is a row of traps extending in one direction. Each line fished between 20-55 traps spaced approximately 70 m apart. Testing consisted of alternating control (whole crab) traps and treatment traps within a line. This resulted in each line of traps having equal test and control groups. The density of whelk may vary greatly over the area covered by a given line, which could cause a bias as to where the traps are located along the line. By alternating the control with the treatment traps along the line this potential bias was minimized. Female treatment groups were tested against female controls, and male treatments against male controls. In testing male crab pieces against the traditional practice of 2 whole males per trap, one half and two halves represented reductions of quarters and halves, respectively. Soak periods for this study ranged from 3-6 days. Upon retrieval of the traps the number of whelk per trap was recorded, while the amount of bait remaining was noted. Statistical analyses were performed using the standard t-statistic of the means for significance.

Results

Eighteen lines totaling 346 treatment groups (traps) and 343 control groups were tested.

Eight lines (354 traps) tested bait reduction by half, four lines (155 traps) by thirds, and six lines (180) traps) by quarters. No significant differences in the number of whelk caught per pot (P>.05) were observed when comparing traps using half the amount of bait and the control (traditional) amount.

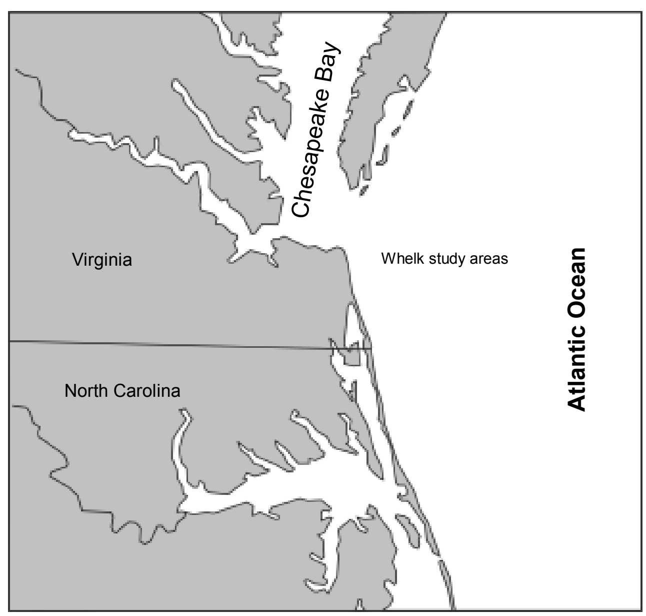


Figure 2. Off-shore commercial whelk fishing areas where bait bag testing occurred.

Both male (Figure 3) and female (Figure 4) half-crab test groups fished similarly, with an overall slight decrease in total catch (5.9% and 6.1% respectively) from the control groups, but were not statistically different (P>.05).

Figure 3. Whelk caught along a trap line with pots alternately baited with half male crabs placed in bait bags and whole male crabs.

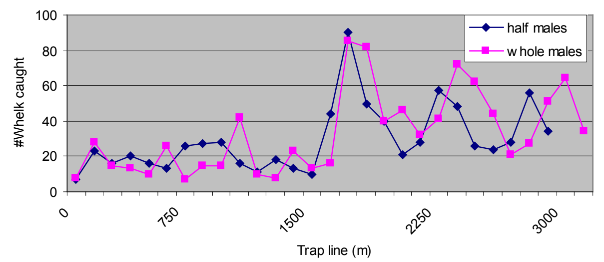
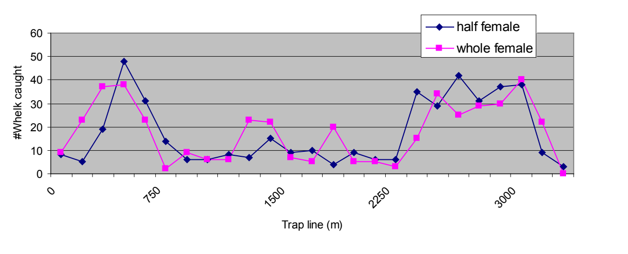


Figure 4. Whelk caught in trap line with pots alternately baited with half female crabs placed in bait bags and whole femal crabs.



Throughout testing of half crab usage, the amount of whelk caught per trap within a line was highly variable. However, variability was high for both test groups within lines. This indicated that both the treatment and the control groups fished equally in areas of high and low whelk densities. Soft tissue (body muscle, egg mass, viscera) of half crabs in bait bags was observed remaining within the majority of treatment groups even after the longest soak period (6 days). However, no significant difference (P>.05) in mean catch was observed in half crabs tested between 3-day and 6-day soak periods.

Average catch began to decline once the bait was reduced to thirds (6.6-42.5%), and sharply fell with the reduction to quarters (26.4-30.6%) providing for significant (P<.05) differences statistically. In areas of high whelk density, whole crabs consistently caught more whelk than third or quarter crab sections, but in areas of low whelk densities catch was more equal.

Comparing thorax third sections (Figure 5) against abdomen third sections (Figure 6), the thorax sections significantly (P<.05) caught more whelk than abdomen sections. There was no significant differences (P>.05) observed between whole female crabs and third female thorax sections tested. However, highly significant differences were observed between whole crabs and third abdomen sections tested, resulting in combined third sections statistical different (P<.05) from whole crabs.

Figure 5. Whelk caught along a trap line with pots alternately baited with third female (thorax) sections placed in bait bags and whole femal crabs.

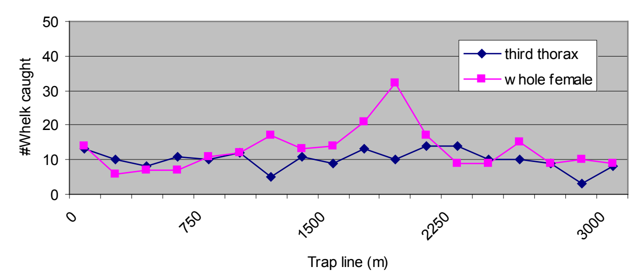
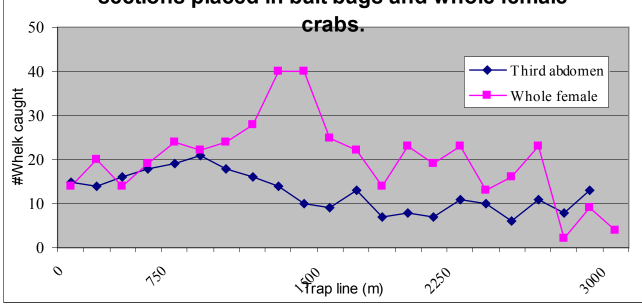


Figure 6. Whelk caught along trap line with pots alternately baited with third female crab (abdomen) sections placed in bait bags and whole female crabs.



Differences were also observed in catch between male (Figure 7) and female (Figure 8) quarter sections, with female quarters catching more whelk per line fished than male quarters.

Mean catch per trap was highly variable throughout all testing lines (Figure 9), but variability was similar for both test groups within respective lines. Relative catch efficiency (Figure 10) of tested horseshoe crab bait reductions (assuming controls equaling 100% of catch potential) demonstrated no difference in catch between male and female half sections, but once crabs were reduced to thirds and quarters, catch differences were observed depending upon section used (thirds) and sex (quarters).

Figure 7. Whelk caught along a trap line with pots alternately baited with quarter crab male sections placed in bait bags and whole male crabs.

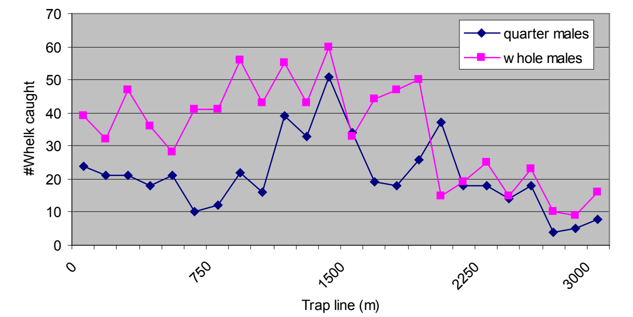
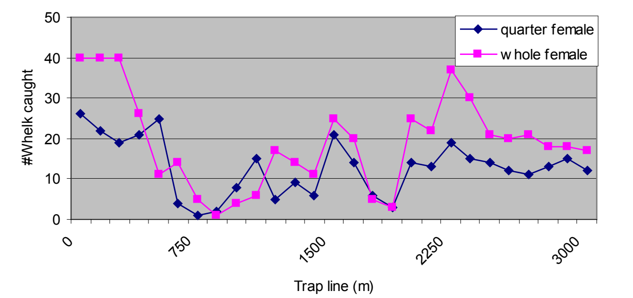


Figure 8. Whelk caught along a trap line with pots alternately baited with quarter female sections placed in bait bags and whole female crabs.



Discussion

Cutting whole horseshoe crabs to acquire smaller pieces for bait exposes body flesh, internal organs and egg masses (in females), which provides for both a stronger bait "scent" during soaking and a higher potential for more rapid loss of bait by water (current) movement and/or consumption by scavengers. Bait bags provide a physical barrier between the bait and large scavengers while also supplying support around the crab piece(s) to help contain exposed bait and reduce displacement via water movement. Small scavengers (small rock and spider crabs, starfish, periwinkles, juvenile fish), which are able to enter the bait bags, may be beneficial to the fishing effort. These small scavengers consume little bait, but through their feeding activity they release additional bait "scent" into the water column.

Mean catch per trap in the Virginia off-shore whelk fishery routinely experiences high variability (Figure 9 ±SD), regardless of bait type used. This variability can be explained, in part, by the fishing method commonly used in the off-shore resource area. Traps deployed in extended lines can stretch along various bottom substrates and/or profiles that are more, or less, preferred by whelk, creating variability in whelk densities along a given trap line. In this study, the variability in mean catch (±SD) per trap observed within individual trap lines varied little between testing groups, reflecting the high variability within the fishery. In halves treatment groups, catch was similar to whole crabs over varying whelk densities (Figures 3 and 4). However, differences in mean catch were observed in third and quarter treatment groups relative to whelk densities. Whole crabs consistently caught more whelks in areas of high whelk density, while third and quarter sections caught similar amount compared to whole crabs in low whelk density areas (Figures 5-8). Thus, reductions of horseshoe crab bait below one half in harvesting areas where whelk densities are low (relative to Virginia off-shore trap

Figure 9. Mean catch (±SD) from whelk traps baited with whole horseshoe crab(s) and pieces of crab placed in bait bags.

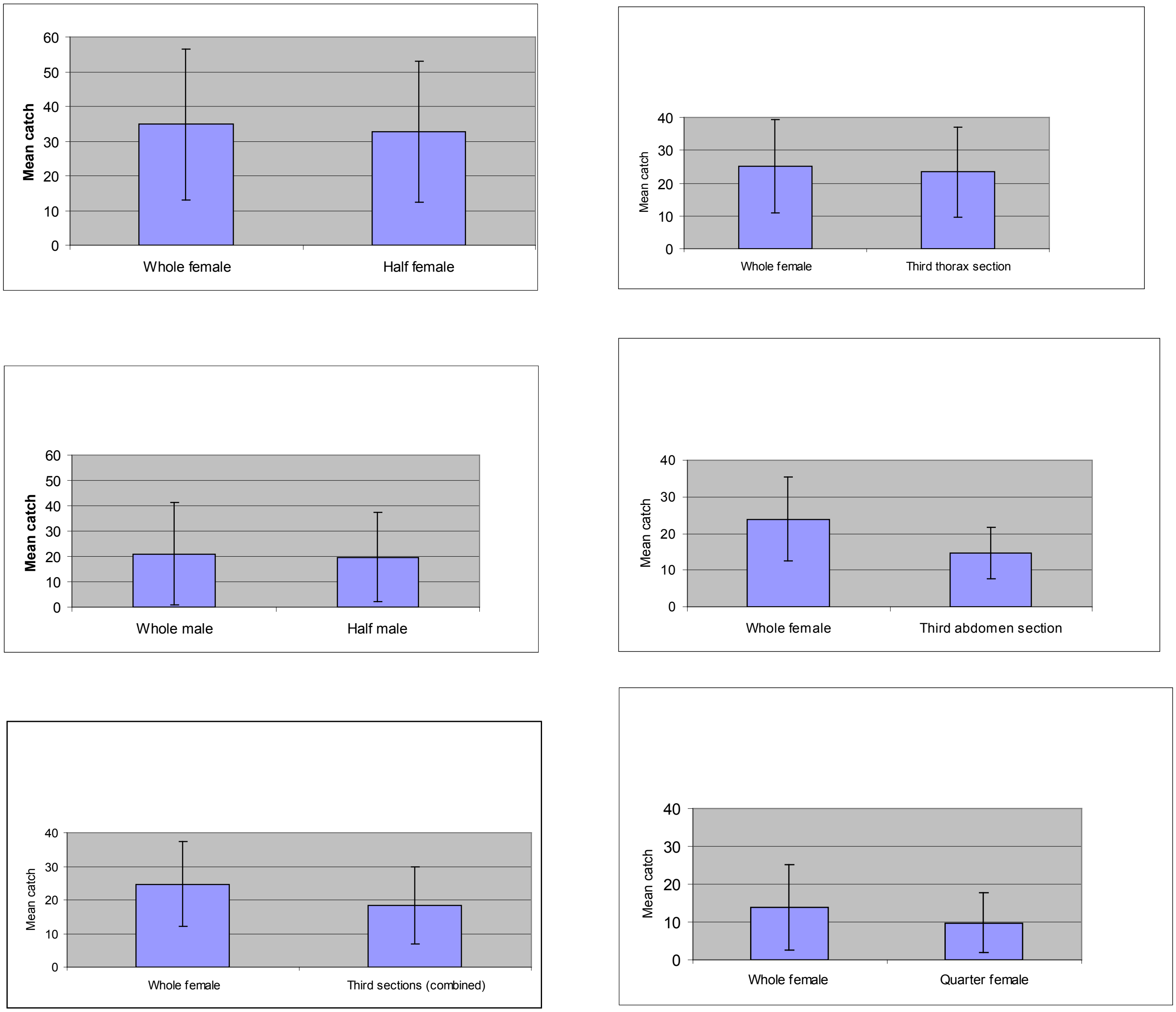
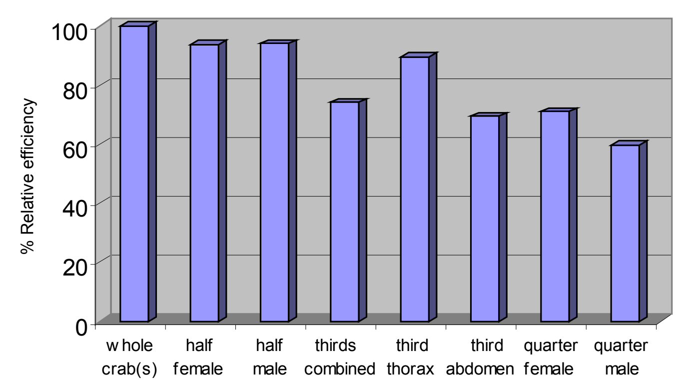


Figure 10. Relative efficiency (%) of whelk caught by reducing the amount of horseshoe crab used for bait in bait bags compared to the traditional usage of one whole female or two whole male crabs per trap.



fishery) may have success without significantly impacting whelk total catch.

Bait longevity was achieved with use of bait bags, however, bait functionality over time was not demonstrated in this study. Crab soft tissue was observed physically remaining through 6 day soak periods in half crab testing lines, but no significant difference (P>.05) in mean catch per trap between 3 and 6 day soak periods was observed. Assuming escapement of trapped whelk is negligible over soak time, several possible theories could be entertained which try to explain the observed leveling-off of catch over time, including: bait souring, exhaustion of attractant component of bait, and/or localized depletion of whelk within the affective zone of lines fished.

With respect to male verse female horseshoe crabs used as whelk bait, no significant difference in catch was observed when half reductions were tested. However, differences were observed between quarters tested, with female quarters significantly out-performing male quarters. These results suggest an association between female horseshoe crabs and a higher degree of whelk attraction, with crab egg masses suspected. Likewise, results from testing thirds demonstrated increased effectiveness of the crab thorax sections, which contain the egg masses, over the crab abdomen sections which are largely void of eggs. In light of current management directives designed to protect the horseshoe crab resource, further work is needed to identify attractive compounds from the horseshoe crab, especially from the eggs, for potential use in the development of alternative and/or synthetic baits.

The preferred bait currently used in the conch pot fishery is the horseshoe crab. Reports indicating the possible decline in the horseshoe crab and migratory shorebird populations have resulted in reductions of crabs harvested for bait. By placing less horseshoe crab into a bait bag, large scavengers and trapped whelk are prevented from consuming the bait during fishing, thus increasing bait longevity. Data collected showed no significant differences (P>.05) in the number of whelk caught per pot using half the amount of bait traditionally used when placed in bait bags. Reductions in overall catch were observed when bait was reduced to thirds and quarters. By using bait bags to conserve bait, whelk fishermen can reduce their bait cost without significantly impacting catch. Reducing the number of horseshoe crabs used for bait should relieve pressure on the horseshoe crab resource and help reduce the whelk trap fisheries' reliance on horseshoe crab as bait.

The bait bag used in this study represents a type of bait holding device designed to protect bait as discussed. Other devices, either fixed in the trap or detachable, can be employed to serve the same purpose.

Acknowledgements

I would like to thank Mr. Rick Robins of Chesapeake Bay Packing, Ldt. and captain Paul Herrick of the F/V *Sunrise* for their industry cooperation, Glenn Gauvry of the The Ecological Research & Development Group (ERDG) for providing the bait bags for this study, Dave Rudders at VIMS for statistical analysis assistance, and Erin Seiling, Virginia Sea Grant communicator, for editorial assistance.

Literature Cited

Berkson, J., and C. N. Shuster, Jr. 1999. The horseshoe crab: the battle for the true multiple-use resource. Fisheries, 24(11):6-10.

Field, J. 1997. Species Profile: Horseshoe Crabs. Atlantic States Marine Fisheries Commission (ASMFC) Fisheries Focus, Vol. 6, Issue 8, Washington, D.C.

Industry Report to the Virginia Marine Resource Commission (Commissioner Pruitt). February 16, 1999. Regarding proposed amendments to Virginia's horseshoe crab regulations. Authored by R. Robins, Chesapeake Bay Packing, LLC. Newport News, VA.

Keinath, J.A., J.A. Musick, and R.A. Byles. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. Virginia J. Sci. 38:329-336.

Lewis, A. 1983. The Horseshoe Crab-A Reminder of Delaware's Past. Marine Advisory Services Bulletin #6. Delaware Sea Grant College Program, Univ. of Delaware, Newark, DE.

Manion, M., West, A., and R. Unsworth. 2000. Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery. Prepared by Industrial Economics, Incorporated, Cambridge, MA for the Division of Economics, U.S. Fish and Wildlife Services, Arlington, VA, April 7, 2000.

Shuster, C.N., Jr. and M.L. Botton. 1985. A Contribution to the Population Biology of Horseshoe Crabs, Limulus polyphemus (L.), in Delaware Bay. Estuaries 8(4):363-372.

Swan, B.L., W.R. Hall, Jr. and C.N. Shuster, Jr. 1991. Limulus Spawning Activity on Delaware Bay Shores 25 May 1991. Univ. of Delaware, DE Sea Grant Program, Lewes, DE.