Atlantic States Marine Fisheries Commission

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Horseshoe Crab Technical Committee
Meeting Summary

Arlington, VA
September 25, 2013

Technical Committee Members: Penny Howell (chair, CT DEEP), Greg Breese (US FWS), Mike Millard (US FWS), Steve Doctor (MD DNR), Joanna Burger (Rutgers), Vin Malkoski (MA DMF), Jeff Brust (NJ DFW), Tiffany Black (FL FWC), Larry DeLancey (SC DNR), Adam Kenyon (VMRC), Tina Moore (phone, NC DMF), Jim Page (GA DNR), Derek Orner (phone, NOAA)

ASMFC Staff: Marin Hawk

Public: John Sweka (US FWS), Kim McKown (NY DEC)

The Horseshoe Crab Technical Committee (TC) met to review the 2013 stock assessment update for horseshoe crabs. The TC also reviewed the Adaptive Resource Management (ARM) harvest recommendations. States updated the TC on the status of Asian horseshoe crab importation in their state, and the TC also discussed promoting the use of artificial bait in the conch and whelk fisheries. Below is a summary of their discussions:

2013 Stock Assessment Update

John Sweka, chair of the Stock Assessment Subcommittee (SAS), presented the stock assessment update to the TC. The assessment update indicated little change in the status of the horseshoe crab population in the Delaware Bay and some increase in Southeast regions. There is continued concern with declines in the horseshoe crab populations in the New York and New England regions (Table 1). The TC discussed including analysis of biomedical harvest data by region in the upcoming stock assessment to more precisely show regional mortality sources. However, due to the limited number of biomedical companies and confidentiality rules, regional data cannot be published (in some cases there is only one company in a region). The TC is concerned that mortality due to the continuing growth of the biomedical harvest will eclipse management efforts focused on the bait fishery and would like to explore solutions to include biomedical data in future stock assessments. The TC noted that the coastwide biomedical harvest is now essentially equal to the bait harvest and that mortality attributed to the biomedical harvest has exceeded the annual maximum set the Board every year since 2007 (by 40% for 2011-2012).

The TC recommends that the Board accept the 2013 stock assessment update for management use while keeping the following in mind:

- Management regulations and population assessment should be implemented on a regional scale. Monitoring and research should reflect regional differences.
- Continued precautionary management is therefore recommended coastwide to anticipate effects of redirecting harvest from Delaware Bay to outlying populations.

Table 1. Number of surveys with terminal year having a greater than 0.50 probability of being less than the reference point (i.e. likely less than the reference point). Time series were only included in this summary if the terminal year was 2011 or 2012 and residuals from ARIMA model fits were normally distributed. Those that ended earlier are not included. Also, those surveys that did not begin until after 1998 were not included in the P(if<i1998)>0.50 summary. Similar data summaries from the 2009 ASMFC stock assessment are also provided for reference.

	Current Update		**2009 Assessment**	
Region	**$P(i_f<i_{1998})>0.50$**	**$P(i_f<Q_{25})>0.50$**	**$P(i_f<i_{1998})>0.50$**	**$P(i_f<Q_{25})>0.50$**
New England	5 out of 6	6 out of 7	2 out of 3	2 out of 5
New York	3 out of 5	1 out of 5	1 out of 5	1 out of 5
Delaware Bay	4 out of 11	2 out of 16	5 out of 11	1 out of 19
Southeast	0 out of 2	0 out of 5	0 out of 5	0 out of 3
Coastwide	**12 out of 24**	**9 out of 33**	**8 out of 24**	**4 out of 32**

ARM Harvest Output

The Delaware Bay Ecosystem Technical Committee (DBETC) is responsible for reviewing and approving the ARM harvest recommendations for 2014 (see DBETC Report from September 24, 2013) and informing the TC of those recommendations. The TC had no concerns with the harvest recommendations for 2014.

Importation of Asian Horseshoe Crabs

Since the Horseshoe Crab Management Board (Board) passed a resolution (Appendix A) encouraging states to ban the importation and use of Asian horseshoe crabs, several states have taken action (Table 2). The TC discussed various methods that states can employ to ban importation. Some states have not taken any action because they have very limited or no eel or conch fisheries and/or have taken the position that this issue is best dealt with on the federal level.

Artificial Bait

Early studies conducted at the University of Delaware isolated a chemical cue which attracts eel and conch to horseshoe crab, explaining the success of horseshoe crabs as bait in those fisheries. Recently UDel researchers have successfully manufactured a workable alternative bait product (see attached). This study showed that using as little as 1/16 of a female horsehose crab, when mixed with other crustaceans such as Asian shore crabs, is as successful in attracting eels as using the entire horseshoe crab. The TC discussed ways to promote the use of this alternative bait in order to further limit the horseshoe crab harvest while sustaining the fisheries relying on crab bait. The TC is investigating the cost effectiveness of the alternative bait since it is now commercially available.

Table 2: Status of state bans regarding importation or use of Asian horseshoe crabs as of September 25, 2013.

State	Status	Expected Implementation
NH	No action taken	
MA	Moving forward to ban	Unknown
CT	Sent out notice to fishermen; no legal action being taken until federal government takes action	
RI	Emergency Action filed April 12 2013; will go through public process this winter	Spring 2014?
NY	Committee decided not to list as invasive species; Makes difficult to ban imports	
NJ	Marine Fisheries does not have authority; endangered and non-game species committee may have authority	
DE	Start of Action notice released; published in register of regulations	In place
MD	Drafting regulations	Late Fall 2013
VA	No action taken	
NC	No action taken	
SC	Listed as a prohibited species; illegal to place any part of Asian HSC into salt waters of the state	In place
GA	No action taken	
FL	No action taken	
	*Importation has occurred in NY, but it may be happening in adjacent states; importer has approached fishermen in	
	adjacent states	

APPENDIX A

Resolution 13-01

Resolution to Ban the Import and Use of Asian Horseshoe Crabs as Bait

Whereas, the Atlantic States Marine Fisheries Commission (Commission) is comprised of representatives of the fifteen Atlantic coastal states and is charged with management of fisheries resources, marine, shell, and anadromous; and

Whereas, one of those fisheries resources is the Atlantic horseshoe crab (*Limulus polyphemus*) which is managed for its ecological services, use as bait, and in the biomedical industry; and

Whereas, horseshoe crabs are used as bait in fisheries for American eel and whelk fisheries; and

Whereas, bait shortages motivated seafood dealers in the State of New York to import 2,000 non-native Asian horseshoe crabs in 2011, and 7,400 kilograms of non-native Asian horseshoe crabs in 2012 for use as bait in state waters; and

Whereas, three species of Asian horseshoe crabs (*Tachypleus gigas, Carcinoscorpius rotundicauda*, and *Tachypleus tridentatus*) pose a potential threat to the marine resources and human health along the Atlantic coast of the United States; and

Whereas, recent evidence presented in 2011 suggests that the populations of these three species of Asian horseshoe crabs are in decline; and

Whereas, it will take the United States Fish and Wildlife Service up to a year to add the species to the Injurious Wildlife list of the Lacey Act so importation can be regulated on a federal level; and

Whereas, in the meantime measures should be put in place to address the issue; and

Whereas, one species of parasitic flatworm lays eggs in tough cocoons on the shell of the Asian horseshoe crab, which can easily survive and hatch even if the host crab is killed; and

Whereas, the introduction of such or similar parasites would have detrimental effects on the American horseshoe crab population, and

Whereas, detrimental impacts on American horseshoe crab populations will likely impact food availability for migratory shorebirds, including red knots; and

Whereas, one species of Asian horseshoe crab (*C. rotundicauda*) is known to contain the powerful, potentially painful, neurotoxin tetrodotoxin (TTX); and,

Whereas, the potential for TTX accumulation in commonly consumed seafood product (whelk and eel) and subsequent human illness is unknown; and

Now, therefore be it resolved that the Commission's Horseshoe Crab Management Board recommend to its member states that they take any and all action to ban the importation and use of Asian horseshoe crabs as bait as soon as possible.

Saving the Horseshoe Crab: Designing a More Sustainable Bait for Regional Eel and Conch Fisheries

by Kirstin Wakefield

Horseshoe crabs have been called by many names: ancient mariners, helmet crabs, and living fossils. Gracing our planet for more than 350 million years, they have been extremely resilient to changes in water conditions, climate, and human use. Once harvested en masse to be spread as fertilizer for Delaware's extensive corn and soybean crops, horseshoe crabs are now used in biomedical applications, and even more recently, as bait for regional eel and conch fisheries.

Horseshoe crabs were once so plentiful in Delaware Bay that they were considered a nuisance for fishermen and beachgoers alike, but their numbers dropped considerably by the early 1990s. While the exact reason for the population decline was unknown, concerns grew over their increasing use as bait for regional eel and conch fisheries. Between 1975 and 1983, bait-related fishing mortality was estimated to be 350,000 horseshoe crabs per year, or 8–15 percent of the total population (Botton and Ropes, 1987). In 1998, more than 2.7 million horseshoe crabs were harvested coast-wide to meet the bait needs for commercial fisheries (ASMFC, 2006). Compared to some traditional baits, horseshoe crabs were easy to harvest. Bait collectors walked along the beaches scooping up hundreds of nesting horseshoe crabs or dredged the bay as the horseshoe crabs came in to spawn, quickly filling their harvest quotas.

Horseshoe crabs collected for use as fertilizer and livestock feed at Bowers Beach, Del. (1928). Photo credit: Delaware Public Archives

If horseshoe crabs have always been found in Delaware Bay, what's the big deal about using them for bait?

- From an ecological perspective, Delaware Bay is the second-largest stopover on the East Coast for migratory shorebirds, for one key reason: Their arrival coincides with horseshoe crab nesting on the beaches. The small, greenish eggs are loaded with protein, providing an energy-rich fuel source for the birds' long flights north. Studies have shown that horseshoe crab eggs are a primary food source for the red knot; the weight of each bird nearly doubles during their two-week stopover in Delaware Bay (Niles et al., 2007). Downward trends in red knot population counts coinciding with increases in harvests of egg-laden female horseshoe crabs have prompted the U.S. Fish and Wildlife Service to consider listing the red knot under the Endangered Species Act.
- From a biomedical perspective, the chemistry of the horseshoe crab's blue blood has led to some amazing advances in medical technology. Many prosthetic devices, injectable drugs, and intravenous devices are tested for bacterial contaminants before they even leave the production facility. The basis for this test is LAL, or *limulus amoebocyte lysate*, a compound that is only found in horseshoe crab blood.
- From a physiological perspective, horseshoe crabs are slow to reach sexual maturity; it takes between nine and 12 years until a horseshoe crab's eggs are ready to be fertilized. Even though a female may lay as many as 90,000 eggs each year, only about 10 will survive to adulthood (ASMFC, 2010). So, the effects of such a heavy, sex-selective harvest would not be fully realized for a decade or more.

A clutch of horseshoe crab eggs collected from Port Mahon, Delaware. Photo credit: Kirstin Wakefield

As annual horseshoe crab harvests for the fishing industry soared and annual counts of juvenile and spawning horseshoe crabs began trending downward, conservationists urged New Jersey and Delaware state governments to protect the Delaware Bay horseshoe crab population. In addition to creating the first horseshoe crab reserve—a 30 square-mile no-take area at the mouth of Delaware Bay—scientists from the Delaware Department of Natural Resources and Environmental Control (DNREC) and the New Jersey Department of Environmental Protection (NJDEP) recommended bay-wide limits on horseshoe crab harvest for the bait fisheries. In 2001, annual harvests were capped at 25 percent of the reference period landings for each state along the Eastern seaboard. New Jersey and Delaware ultimately banned the harvest of female horseshoe crabs in 2006 and limited the harvest of male horseshoe crabs to 100,000 per year (Figure 1).

Can a Sustainable Alternative Bait Be Found?

At a fisheries workshop in the 1990s, University of Delaware researcher Nancy Targett listened to Delaware fishermen say that eel were overwhelmingly attracted to pots baited with female horseshoe crabs. This was especially surprising as horseshoe crabs are not a natural prey for eel. While fishermen had tried many other baits including herring, blue crabs, surf clams, and shrimp heads (Manion et al., 2000), none were as effective as the egg-laden female horseshoe crab.

A marine chemical ecologist, Targett studies the chemical cues that help plants and animals communicate underwater. While mulling over the conversations she had with the fishermen, she pondered whether a specific chemical cue that naturally occurs in horseshoe crabs could be responsible for attracting the eel. If that “scent” could be identified, could it then be bioengineered for use in an artificial bait? The mystery of the chemical message combined with intensifying restrictions on horseshoe crab harvests spurred Targett and her research team to investigate a more environmentally sustainable alternative to horseshoe crab bait.

Untangling the Chemical Cue

Partnering with scientists at DuPont and the Delaware Biotechnology Institute, Targett’s research lab embarked on a journey to identify the unique chemical cue in horseshoe crabs that attracted eel and conch. They used a combination of chemical separation techniques and laboratory-based animal assays to identify potential candidates for the scent. The most effective of these techniques was differential detection.

In this chemical separation technique, tissue samples from female horseshoe crabs were extracted in several solvents to tease apart the attractants from other components normally

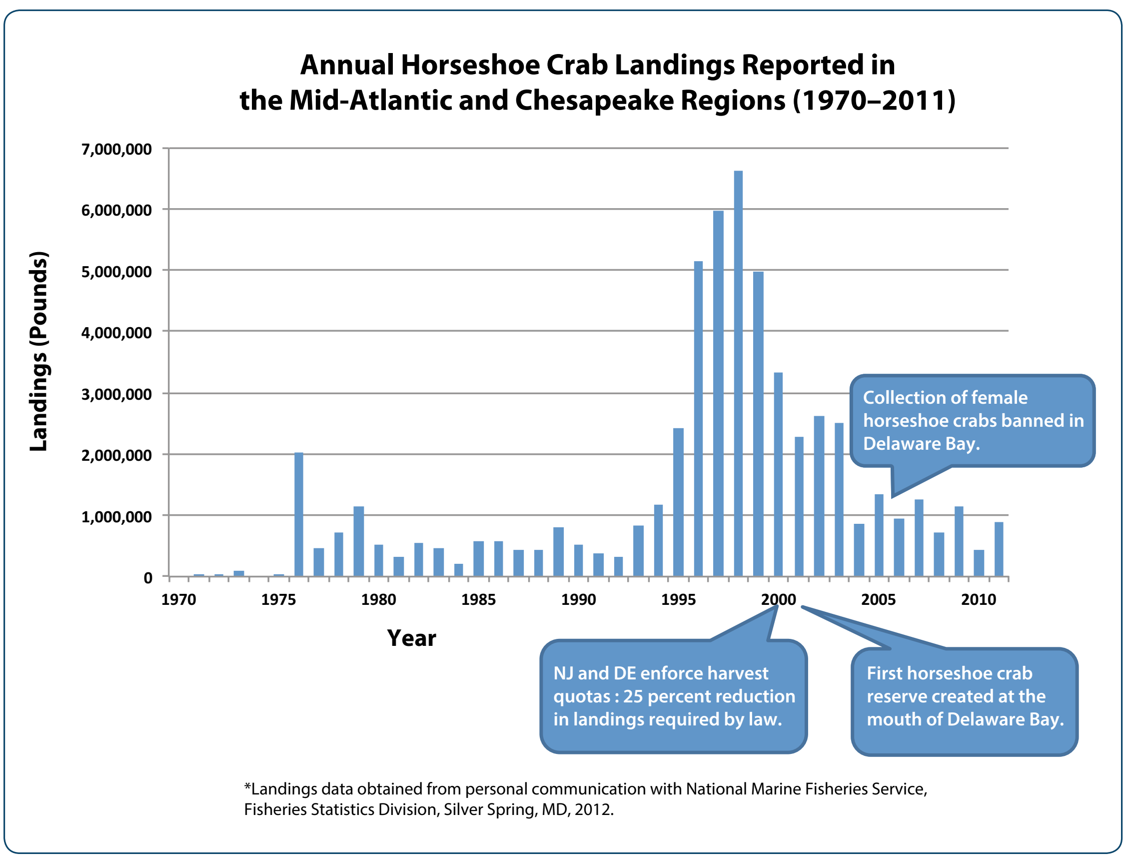

Figure 1. Horseshoe crab landings in the Mid-Atlantic and Chesapeake regions (1970–2011). Landings data are reported to NMFS in millions of pounds harvested per year. Mid-Atlantic States include NY, NJ, DE, MD, and VA.

found in the crabs' tissues. After each extraction step, tissue samples were mixed into a bait formulation and tested on eel and conch in the laboratory.

For each laboratory test, animals were offered a choice of two bait types: one prepared with the extracted tissues, called the "treatment bait," and one prepared from untreated tissues, called the "control bait." If the animals flocked to the control bait instead of the treatment bait, then the extraction technique had successfully knocked out the chemical cue. Figure 2 illustrates the difference in bait consumed between horseshoe crab tissue samples extracted in two solvents: benzyl alcohol and chloroform. In this test, nearly 93 percent of the control bait was consumed compared to only 30 percent of the treatment bait. The results showed that this suite of solvents successfully knocked out the scent in the horseshoe crab tissues.

Partners at DuPont compared the chemistry of the biologically active and inactive tissue samples using mass spectrometry and control/comparison software. More than 100 compounds were identified, the most common of which were peptides and amino acids. Two amino acids—betaine and homarine—were found in both the biologically active and inactive tissue samples. Their presence in both samples suggested that they were not likely to be a key component of the attractant. This finding supported previous laboratory bait tests with eel and conch. By themselves, neither amino acid mixed in the bait formulation attracted eel or conch.

DuPont scientists also identified an omega-3 fatty acid, eicosapentaenoic acid (EPA), that was notably present in the biologically active samples but not in the samples extracted with solvents. Since this compound is commonly found in fish oils and is readily available on a commercial scale, the research team decided to test its appeal in eel pots using the methods previously described. They mixed the EPA into the bait matrix along with a few other compounds that were also common among the active samples; however, field tests did not yield high catches at different St. Jones River sites. Further research is needed to evaluate whether baits impregnated with omega-3 fatty acids can attract eel and/or conch in the field.

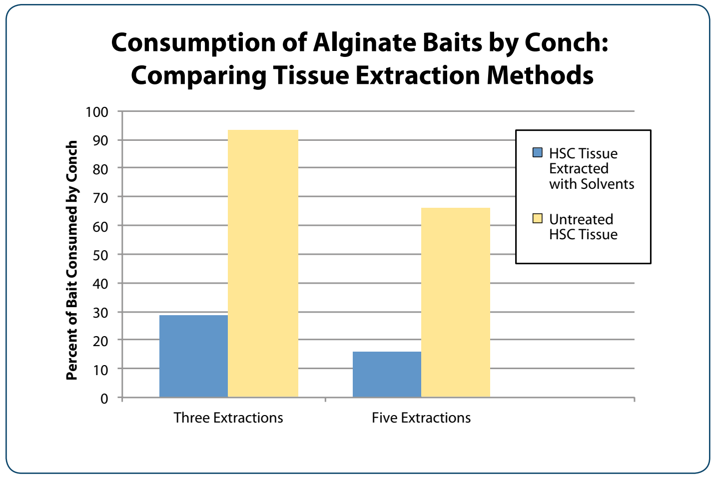

Figure 2. Laboratory assays comparing consumption of alginate baits by conch. Blue bars represent the treatment bait containing horseshoe crab (HSC) tissue that had been extracted with benzyl alcohol three or five times, consecutively. Yellow bars represent the control bait made from untreated HSC tissues.

Time-lapse photography documents a favorable eel response to alginate baits prepared from horseshoe crab tissues. The white (control) bait has been prepared without horseshoe crab tissues; the yellow (treatment) bait contains extracts from horseshoe crabs. Photo credit: Jason Rager

A Formula for the Bait: Brown Seaweed to the Rescue!

Paralleling their partners' quest for the chemical cue, Targett and her graduate students fine-tuned an artificial bait formulation. The first step was to learn more about what commercial fishermen desired in a bait alternative. After discussions with Delaware Bay eel and conch fishermen, a few important qualities were identified: The bait needed to be commercially available and reasonably priced (male horseshoe crabs cost fishermen $1.50–$2.50 each, while females cost up to $5.00), require minimal refrigeration, and hold up well for several tidal cycles.

Mixing an alginate made from brown seaweed with several food-grade chemicals, the scientists designed an inexpensive, edible, and biodegradable matrix. The gelatin hardens in minutes; no refrigeration is required as it sets. In field trials with conch, the baits kept their integrity for four days when enclosed in a polyvinyl mesh bait bag. Preservatives, such as ascorbic acid, can also be added to prevent bait spoilage during longer soak times.

The fronds of brown kelp create an underwater forest for many species of fish, crabs, and urchins. They also provide a rich source of alginate—a gelling agent used for preparing many foods. Photo credit: Kirstin Wakefield

Alginates are polysaccharides, or gums, found in many species of brown algae (kelp). When mixed with water, they form a thick gel that can be flavored or molded into a variety of shapes and textures. Widely used in food and medical industries, alginates are the base for dental impressions, burn dressings, and even the pimento stuffing in cocktail olives!

Horseshoe Crab-Based Bait Recipe

Not only does it use FDA-approved ingredients, but the bait is so easy to make, you can try it at home! All you need is a blender, a microwave, a few chemicals, several containers, and the special scent or fish product you want to add. Ingredients can be obtained from most major chemical suppliers.

Serves: 20 eel or conch pots
Prep time: 30 min.

Ingredients:

- 120 grams of alginic acid sodium salt
- 54 grams of citric acid
- 54 grams of sodium bicarbonate (baking soda)
- 27 grams of ascorbic acid
- 800 ml of a 7.11 percent calcium sulfate (gypsum) solution (0.568 grams dissolved in 800 ml of water)
- 6 liters of water (room temperature)
- 2 liters of coarsely ground horseshoe crab or other attractant*

Materials needed:

Food scale, drill blender, two large buckets, large microwavable container, microwave, 20 bait cups/containers (about 400 ml total volume)

Instructions:

First, prepare the aginate solution. Pour the citric acid, sodium bicarbonate, ascorbic acid,** and 3 liters of water into a large bucket. Mix well with a drill blender. In a separate microwavable container, heat 3 liters of water on high for 12 minutes. Add the heated water to the bucket and mix. Slowly add the alginic acid to the bucket. Mix well until everything is dissolved.

To make the baits, mix 6 liters of the alginate solution with 2 liters of horseshoe crab tissue or attractant scent in a large bucket. Next, add 800 ml of the calcium sulfate solution. Mix quickly and thoroughly, and immediately pour the mixture into your bait containers. Allow baits to harden for several minutes.

If you're not planning to use the bait right away, it can be stored in the refrigerator. Freezer storage is not recommended.

** Permits are required for the collection of horseshoe crabs. Please check with your state natural resource agency for more information.*

*** The ascorbic acid is not required when using ground horseshoe crabs as the attractant; you may want to add it if using a combination of ground fish or crabs to prevent the bait from changing color or degrading more quickly.*

A batch of horseshoe crab-based bait ready for field tests. Photo credit: Julie Anderson

Stretching the Crab: A Solution

Realizing that the search for a single cue was proving difficult, Targett and her team set out to find an alternative for local fishermen. Partnering with Dewayne Fox, a fisheries professor at Delaware State University, they tested several artificial baits made from the alginate matrix. Fox had already established baseline data for eel populations in the St. Jones River using mark and recapture studies. By comparing catch rates to baseline data for the river, the team could determine if the artificial bait fished better than traditional baits.

The artificial baits were fished in commercial eel pots at 40 sites stretching from Delaware Bay up the St. Jones River (Figure 3). Because the salinity varied so strongly between the mouth of the river (~20 ppt salinity) and the upper river (~1 ppt salinity), the river was divided into two sections for this study. Three baits (two treatment baits and a control bait) were randomly fished at the sites in both sections of the river. All baits were fished over a 24-hour period.

St. Jones River–Kent County, Delaware

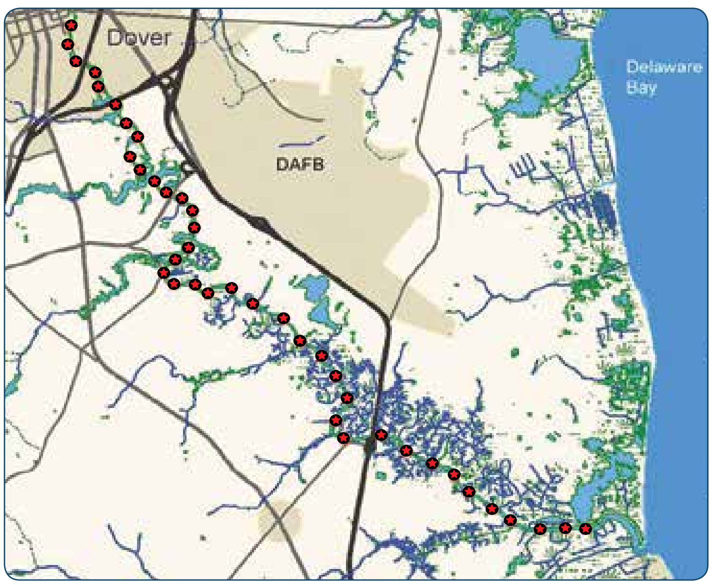

Figure 3. Map of St. Jones River eel trapping study area. The red stars represent the 40 sites where traps were set and collected after 24 hours.

The team first compared the artificial bait matrix impregnated with horseshoe crab tissues to a positive control ($^1/_2$ female horseshoe crab) to establish that the alginate-based bait formulation could indeed lure eel to the traps. When analyzing data from the 40 traps, the scientists found the differences in 24-hour catch rates were not statistically significant (Figure 4). *Not only did the artificial bait hold up well for the 24-hour duration of the trial, but also it was as effective as $^1/_2$ of a female horseshoe crab!*

As expected from previous research on eel capture rates in the St. Jones River, catch rates were significantly higher in the lower river sites vs. the upper river sites. In the lower river, traps baited with the artificial bait matrix averaged 50 eel per trap. In the upper river, the artificial bait matrix caught about 12 eel per trap. *The team found that location in the river affects catch rates for both the alginate bait and the traditional horseshoe crab bait.*

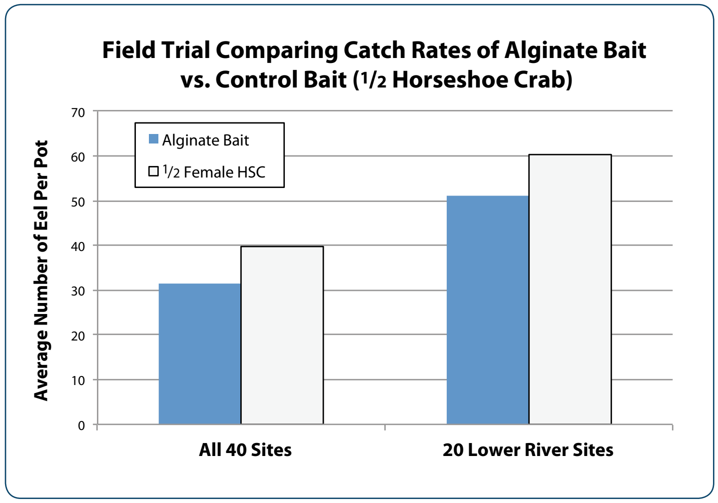

Figure 4. Field trials of alginate baits in the St. Jones River, Del. The trials compared the average number of American eels trapped using ½ of a female horseshoe crab as bait (white bars) vs. an alginate bait incorporating the equivalent of ½ of a female horseshoe crab (blue bars). Results are averaged across all 40 river sites, as well as the 20 sites on the lower river section.

Next, the team determined the minimum amount of artificial horseshoe crab bait that could be used to successfully trap eel in the St. Jones River study area. They compared catch rates when pots were baited with one block of artificial bait (equivalent to $^1/_2$ horseshoe crab), $^1/_2$ block of artificial bait (equivalent to $^1/_4$ horseshoe crab), and $^1/_4$ block of artificial bait (equivalent to $^1/_8$ horseshoe crab). *The field trials showed that $^1/_8$ of a female horseshoe crab is the maximum amount needed for each bait.*

Finally, the team compared baits prepared with equal amounts of female vs. male horseshoe crab tissue. They found that artificial baits made with the same concentration of male horseshoe crab tissues were just as effective at attracting eel into the traps. *From these results, the team concluded that female horseshoe crabs no longer need to be targeted as bait for eel in Delaware Bay's commercial fishery.*

The scientists also tested attractiveness of alginate-based baits to conch, using standard wooden conch pots. In each trial, 20 pots (10 control baits and 10 test baits) were fished in Delaware Bay, near the entrance to Roosevelt Inlet. Conch pots were fished for 24–48 hours. Alginate baits prepared with female horseshoe crab tissues repeatedly caught conch across three field trials, and catch rates were similar to pots baited with $^1/_4$ of a female horseshoe crab.

A bountiful harvest from the Delaware Bay field trials. Photo credit: Julie Anderson

This series of field trials showed that *less than $^{1}/_{8}$ of a female horseshoe crab could be used in each bait and achieve the same catch per unit effort as baiting with $^{1}/_{2}$ of a female horseshoe crab.* Moreover, because catch rates did not differ when traps were baited with equivalent concentrations of male or female horseshoe crab tissues, *the use of males only in the artificial bait matrix could be recommended.* Since Delaware state regulations limit horseshoe crab bait use to $^{1}/_{2}$ of a female, or one whole male per trap or pot, *the findings provide a solution that would significantly reduce the amount of horseshoe crab being used per trap, as well as reducing the long-term harvest pressure on female horseshoe crabs.*

And Yet, a Better Alternative, You Say?

While the search for the chemical cue continued, the team explored one more option for the artificial bait. They already knew that other species of fish and crab would catch eel and conch, just not as efficiently as horseshoe crabs. But what if they could combine a locally abundant nuisance with the alginate matrix to lower the percent of horseshoe crab needed to make each artificial bait?

Along the jetties and riprap near the mouth of Delaware Bay, *Hemigrapsus sanguineas,* the Asian shore crab, has become a fierce competitor for limited habitat. Not meaty enough for a gourmet meal, the prolific crab is being used locally as bait for tautog. Black drum, sea robins, and black sea bass are also known to prey on the nuisance crab.

Because Asian shore crabs are so numerous across the region and easy to collect by hand, the team decided to test them as a bait alternative. Two alginate baits were prepared for laboratory choice tests with conch: one a 50:50 mixture of Asian shore crab and horseshoe crab tissues, the other

Conch aggregate around and readily consume an alginate bait prepared with Asian shore crab. Photo credit: Julie Anderson

100 percent horseshoe crab tissue. To measure the amount of bait consumed overnight, baits were weighed before and after each choice test. The scientists found that conch readily consumed both baits in the laboratory assays. *Percent consumption did not differ between the baits, suggesting that Asian shore crab could readily be substituted for horseshoe crab tissues in the alginate matrix (Figure 5).*

Based on these promising laboratory results, the team tried the Asian shore crab baits in the field. Baits were tested in eel and conch pots in the same manner and at the same locations described above. In this suite of experiments, baits were prepared using a 50:50 mixture of Asian shore crab and horseshoe crab tissues. The Asian shore crab bait was fished

Asian shore crab, *Hemigrapsus sanguineas.* Photo credit: U.S. Geological Survey

Native to the western Pacific Ocean along the coasts of Russia, Korea, and Japan, the Asian shore crab was first reported in the U.S. in 1988. Initially found in New Jersey, they quickly spread from Maine to North Carolina along rocky coastlines. Able to tolerate a wide range of salinity and temperatures, their only known predators are rockfish and seagulls. However, Asian shore crabs prey on and compete with native mud crabs, blue crabs, rock lobster, and fish for food and space. Their long breeding season, combined with their monthlong floating larval stage, means that they can easily be transported by wind and currents up and down the Atlantic coast.

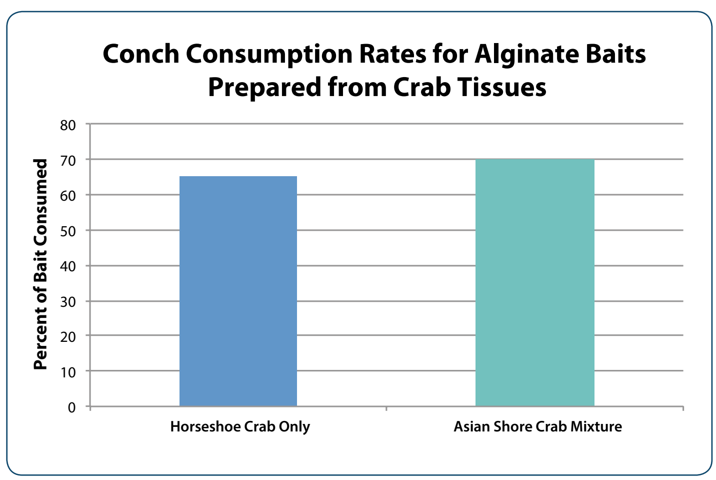

Figure 5. Laboratory choice tests with conch comparing two alginate-based baits. Horseshoe Crab Only (blue bar) consisted of 100 percent female horseshoe crab tissue in alginate formulation. Asian Shore Crab Mixture (teal bar) consisted of a 50:50 mixture of Asian shore crab and female horseshoe crab tissues. Both baits were readily consumed by conch. Differences in the percent of bait consumed were not statistically significant.

against an alginate bait made from 100 percent horseshoe crab tissue. Although catch rates for eel were low in the pilot tests, there was no difference in catch rates between the two baits. Conch trials gave similar results.

By replacing 50 percent of the horseshoe crab tissue with an equivalent amount of Asian shore crab, the team has designed a more environmentally sound, alginate-based bait that only uses $^{1}/_{12}$ *to* $^{1}/_{16}$ *of an adult horseshoe crab.*

A Commercially Available Bait

Now that you have the recipe at your fingertips, mix up a batch and test it in your traps! Or if you do not feel like tinkering, a ready-made bait is on the horizon. In the fall of 2012, LaMonica Fine Foods in Millville, N.J., scaled up production of the alginate-based bait, incorporating a proprietary fish attractant. In partnership with local conch fishermen, they have been field testing the baits in Delaware Bay. The field trials have been so successful that requests for more bait are pouring in. Plans for commercial production of an affordable bait that is easy to handle and easy to store are underway.

Inquiries about the commercial production and bait availability can be directed to Michael LaVecchia at LaMonica Fine Foods: 856-825-8111, ext. 102.

References

ASMFC 2006. Review of the Fishery Management Plan in 2005 for Horseshoe Crab *(Limulus polyphemus).*

ASMFC 2010. Species Profile: Horseshoe Crab. New Assessment Finds Trends in Horseshoe Crab Populations Vary by Region. Excerpted from: ASMFC Fisheries Focus, Vol. 19, Issue 2, 2010.

Botton, M. L., and J. W. Ropes. 1987. The Horseshoe Crab, *Limulus polyphemus,* Fishery and Resource in the United States. Marine Fisheries Review 49:57-61.

Manion, M. M., R. A. West, and R. E. Unsworth. 2000. Economic Assessment of the Atlantic Coast Horseshoe Crab Fishery. Industrial Economics, Inc., Cambridge, MA, 60 pp.

Niles, et al. 2007. Status of the Red Knot, *Calidris canutus rufa,* in the Western Hemisphere. NJDEP Publication. Available at: www.fws.gov/northeast/njfieldoffice/endangered/redknot.html.

Richerson, M. M. 2012. *Hemigrapsus sanguineus.* USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Available at http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=183. Revision Date: 4/6/2006

About the Author

Kirstin Wakefield earned a master's degree from the University of Delaware College of Earth, Ocean, and Environment. She was on the team of scientists working to find an alternative to horseshoe crabs as bait for eel and conch fisheries.

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