

**Massachusetts
Division of Marine Fisheries**



**Massachusetts 2012 Compliance Report to the
Atlantic States Marine Fisheries Commission –
Horseshoe Crab**

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I. Introduction

Summary of the year highlighting significant changes in monitoring, regulations or harvest.

Reported 2012 bait harvest to date is 106,821 crabs, a 37% increase over the reported 67,087 crabs landed in 2011. Dealer reported bait purchases were 124,439 horseshoe crabs. Market sampling of horseshoe crabs to obtain prosomal width measurements continued. We continued spawning surveys during the new and full moon periods in May and June using a modified Delaware Bay survey protocol. Over 146 volunteers and staff from government agencies, environmental organizations, and local service groups conducted surveys on 14 beaches in Massachusetts. Estimates of relative abundance on the spawning beaches remain low.

II. *de minimus* status – not applicable

III. Previous calendar year's fishery and management program

Activity and results of fishery dependent monitoring.

Massachusetts requires persons harvesting more than six crabs per day to have a regulated fishery permit and participate in trip-level reporting. Reports must include date of harvest, trip start time and duration, port, gear type, disposition, the gender of the crabs, harvest location, and harvest method. When crabs are sold, the harvester must identify the dealer or person purchasing the crabs. The single biomedical company located in Massachusetts, Associates of Cape Cod (ACC), must file monthly catch reports listing the harvester they purchased crabs from, harvest in-state or out-of-state, the number and gender of crabs purchased, and how the crabs were used. ACC must also report the number of crabs received dead or rejected and the number of dead crabs returned to fishermen with a biomedical harvest permit. These fishermen must report monthly the number of dead crabs from the time of harvest to the time the crabs are returned to the water. Bait dealers are required to file electronic reports weekly under the SAFIS (Standard Atlantic Fisheries Information System) system.

In 2012, Massachusetts issued 244 horseshoe crab bait permits and 16 horseshoe crab biomedical permits. Of these, 65 Massachusetts bait permit holders reported harvesting 106,821 horseshoe crabs (Figure 1).

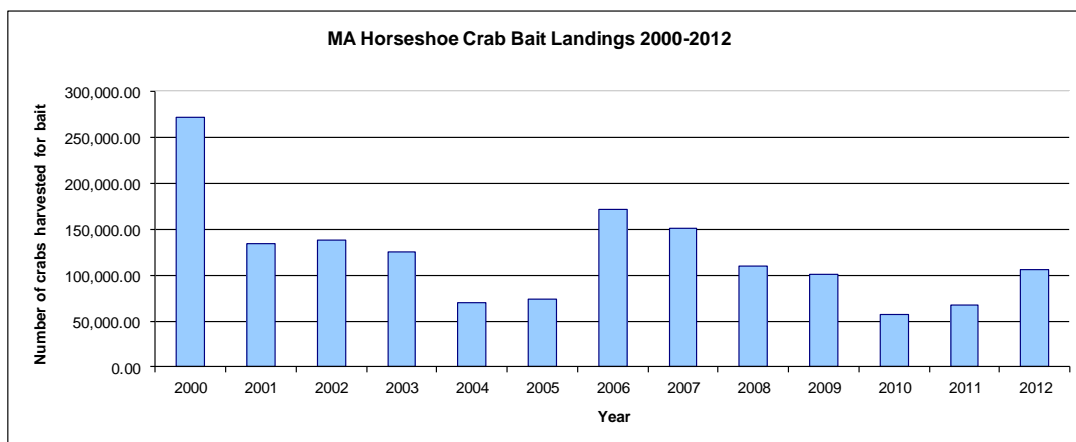


Figure 1. Massachusetts Horseshoe Crab Bait Harvester Landings 2000-2012.

Of the total, thirteen fishermen reported landing 3,676 crabs for personal use. The breakdown of harvested crabs by gender for both the bait and biomedical harvest is as follows:

Bait:	Biomedical: (confidentiality prohibits use of numbers)
Female: 39, 612 (37%)	Female: 72%
Male: 35,371 (33%)	Male: 27%
Unclassified: 31,838 (30%)	Unclassified: 1%

The number of crabs purchased by MA dealers from commercial harvesters in 2012 as recorded by SAFIS and the reported disposition was:

Total purchased for bait, personal use, food, and unspecified uses: 124,443 crabs

Harvest by fishing gear type as reported by SAFIS for 2012:

Hand & Rakes	29,277 crabs	Pots and Traps & Hook and Line & Dip net & Gill net	28,094 crabs
Otter Trawl	62,891 crabs		
Dredge	1,714 crabs	Not Coded	2,467 crabs

In an attempt to evaluate potential shifts in effort due to implementation of the lunar closures, we compared the bait landings by hand harvest and trawling over the last five years (Figure 2).

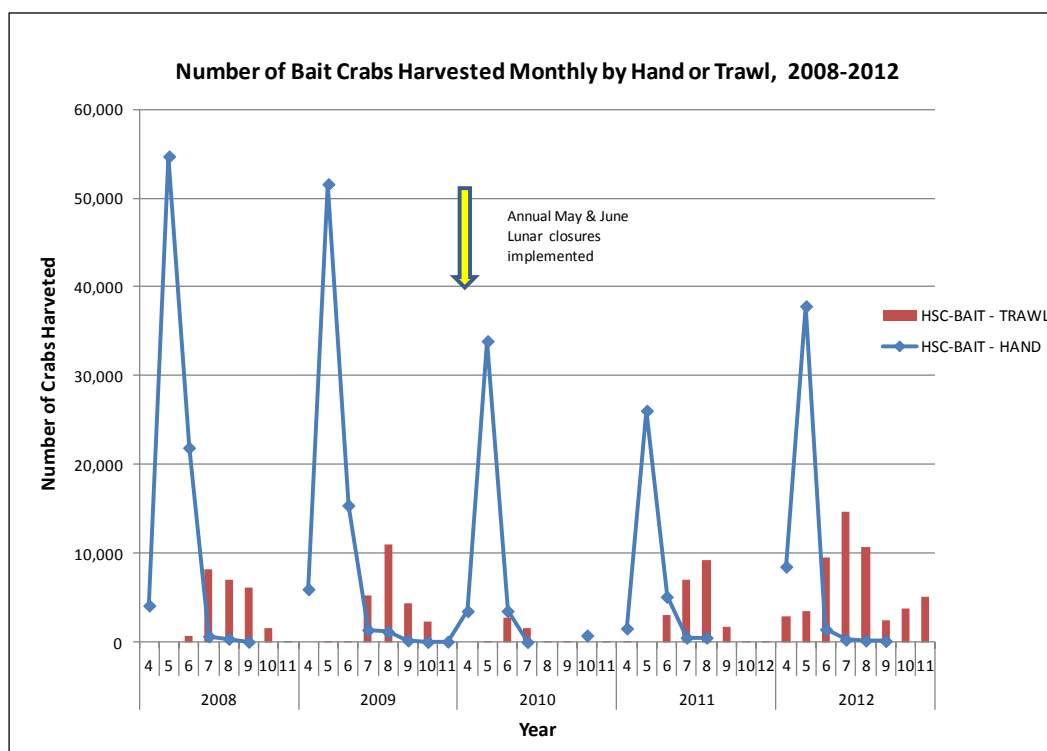


Figure 2. Massachusetts Horseshoe Crab Bait Landings by Gear Type, 2008-2012.

Overall landings declined in 2010 and 2011, although hand harvest on the beaches during the spring months remained proportionately high relative to trawling. Beach harvest during April and May of 2012 was also high but there was a marked increase in overall dragger landings, particularly in July after peak spawning. We will continue to evaluate if this apparent shift in effort distribution is a permanent effect of the lunar closures.

Scientific and research facilities reported collecting or purchasing fewer than 1,000 horseshoe crabs from fishermen. None of these crabs were returned to open water.

As the biomedical permit holders who collected crabs in 2012 sell to the Commonwealth's single biomedical dealer, their harvest numbers cannot be released. Massachusetts General Laws, Chapter 130, §21 protects the confidentiality of any person or business who submits such statistics.

All crab harvesters are required to identify harvest by Massachusetts Shellfish Growing Areas or Reporting Areas on the trip-level catch reports. The regional break-down by percent of total crabs landed and gear type was:

Ipswich	2%	Mobile gear
Cape Cod Bay	11%	Hand
Southern Cape Cod	46%	Hand
	2%	Mobile gear
Nantucket Sound	25%	Mobile gear
Martha's Vineyard	5%	Hand
	< 1%	Mobile gear
Vineyard Sound	< 1%	Mobile gear
Buzzards Bay	9%	Hand

Marine Fisheries continues to characterize the commercial harvest of the crabs. DMF staff biologists sampled horseshoe crabs at local dealers, the biomedical processor, and aboard commercial fishing vessels to collect information on sex composition and prosomal width. The results are presented in Section V.

Activity and results of fishery independent monitoring.

Resource Assessment Project

Marine Fisheries' Resource Assessment Project has conducted seasonal spring (May) and fall (September) bottom trawl surveys in state waters since 1978. Approximately 100 tows are made in five bio-geographic areas, following a stratified random sampling design, with 22 total strata. The net's design, (¾-sized two seam 39' x 51' otter trawl with 3 ½" cookies on a chain

sweep) is appropriate for sampling horseshoe crabs, however, the vessel size precludes towing inside most embayments or in water depths less than approximately 8 m. As a result, few horseshoe crabs are caught during these surveys. Nevertheless, due to the long time series these data are useful to illustrate trends over time (Figure 3).

Evaluation of GAM-fitted indices of stratified mean number crabs per tow for both spring and fall surveys indicate a trend of generally low abundance over time, with 2012 spring survey results continuing downward. The fall 2012 index was at the same approximate level as 2011.

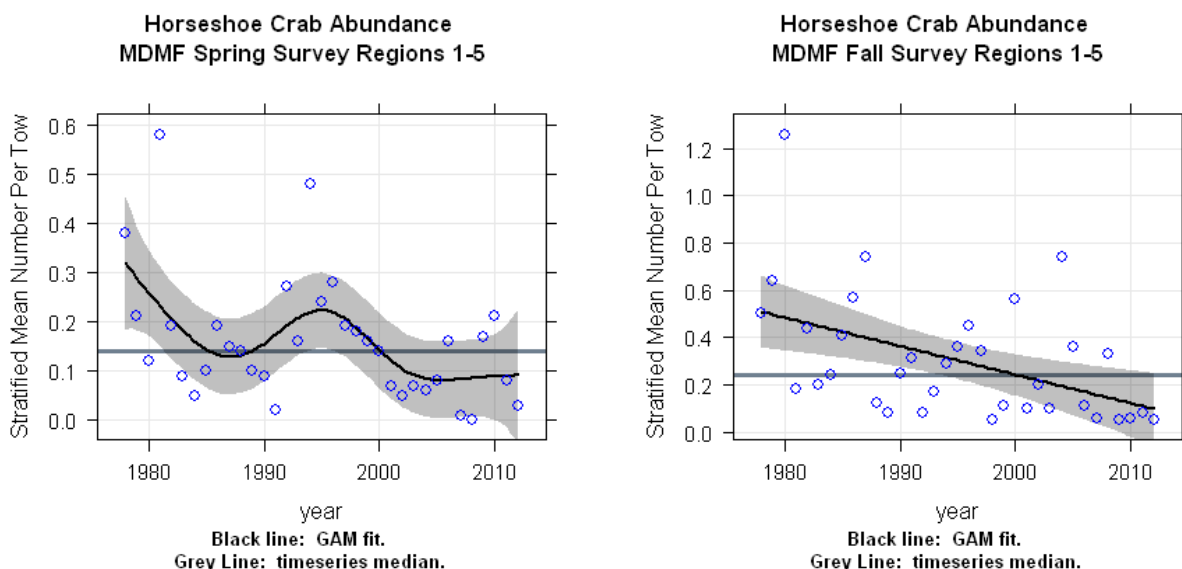


Figure 3. Results of the Massachusetts Resource Assessment spring and fall bottom trawl surveys 1978-2012

Spawning surveys

Over 146 volunteers and staff from federal and state agencies, organizations, and universities conducted spring spawning surveys in 2012. Regional spawning indices (SI = number of spawning females per 25 m²) are calculated and weighted by the number of quadrats sampled to reflect beach size. Since the inception of formalized spawning beach surveys in 2008, survey sites and effort have varied greatly depending on available resources. As such, we use data from a standardized set of beaches sampled every year in each region for comparisons between years.

Spawning indices calculated for each region sampled in 2012 remained low. Values ranged from 0.03 to 0.5 spawning females per 25 m² (Table 1), which is similar to 2011 indices. Comparison of the average SI (with standard error) for each standardized region across the four-year time series is presented in Figures 4 (day) and 5 (night). There are small fluctuations between years, but it is hard to separate potential trends from sampling variability. Average SI values for these beaches/regions have never exceeded 0.6 spawning females per 25 m², although SI values at other MA survey beaches have approached 1 spawning female per 25 m² in past years. There is still no evidence of greater numbers of spawning crabs on the beaches following enactment of the lunar spawning closure (five days around each new and full moon in May and June). In fact, we saw increased harvest activity of crabs in April 2012 due to the

warm winter temperatures. We plan to extend the lunar closures to the five days around the second lunar period in April and we will continue to investigate alternative methods for assessing spawning effort and success.

Table 1. Spawning indices (avg. number of spawning females per 25 m² quadrat) and standard error in MA regions for 2012. Data combined from select beaches in each region and averaged across both moon phases.

2012	Day		2012	Night	
Region	P	SE	Region	P	SE
Buzzards Bay	0.0773	0.0299	Buzzards Bay	0.2957	0.2651
Duxbury	0.3497	0.4450	Duxbury	0.4753	0.7596
Pleasant Bay	0.1171	0.2274	WBNERR	0.1787	0.1248
Wellfleet	0.0263	0.0178	Wellfleet	0.0529	0.0383

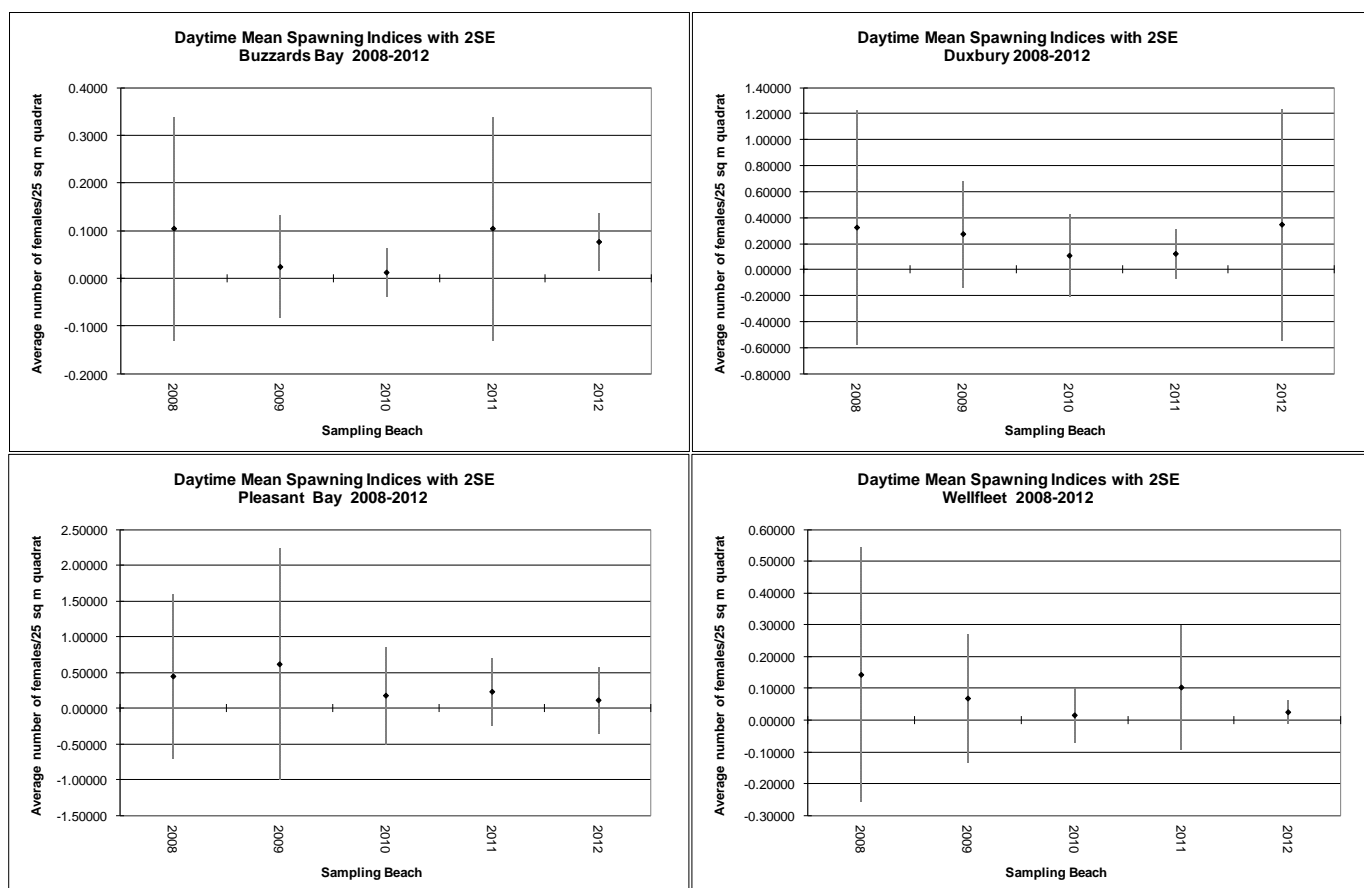


Figure 4. Day-time spawning indices (avg. number of spawning females per 25 m² quadrat) ± 2SE in standardized MA regions from 2008 through 2012. Data are averaged across both moon phases and combined from beaches sampled all five years in each region.

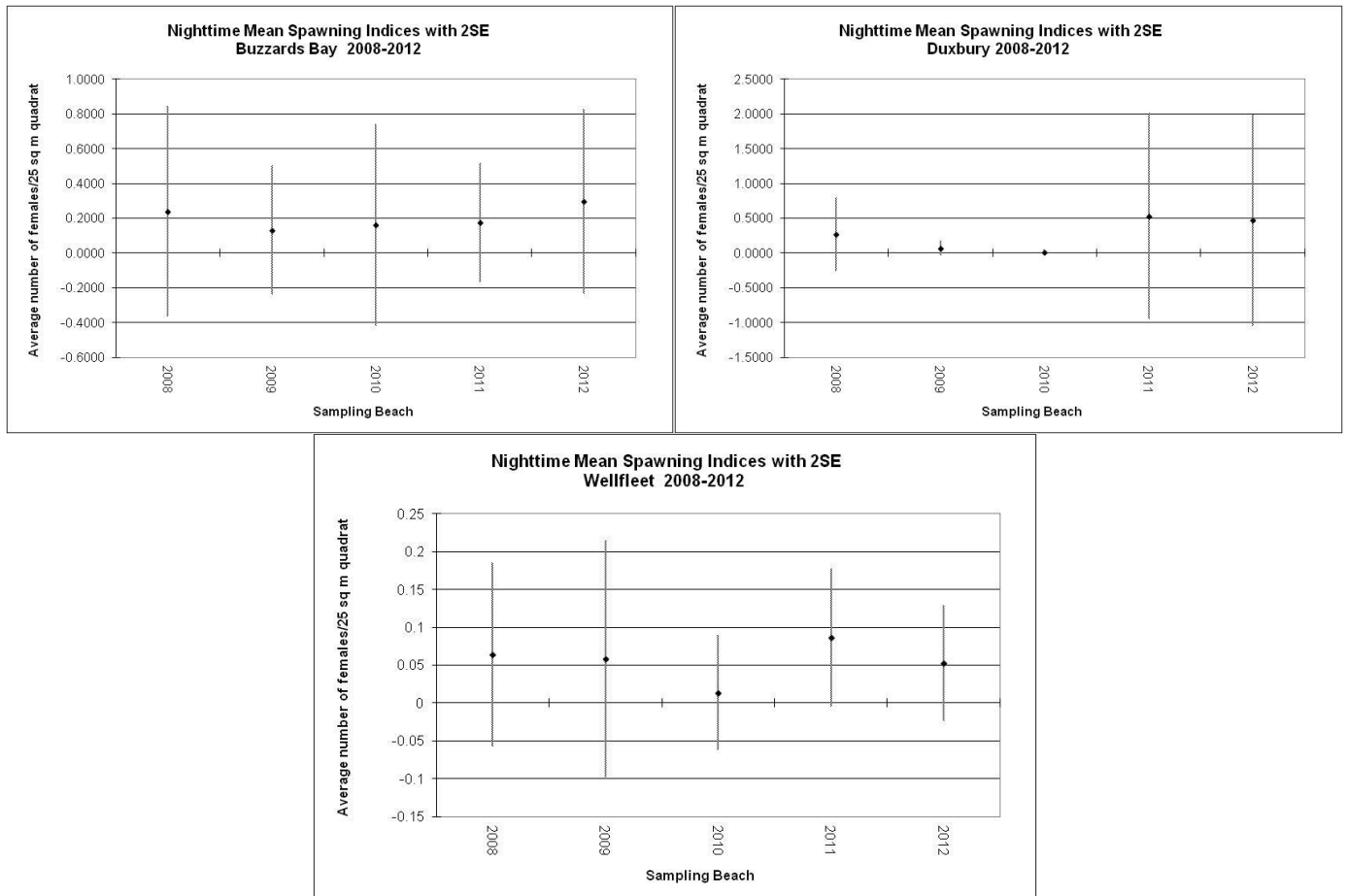


Figure 5. Night-time spawning indices (avg. number of spawning females per 25 m² quadrat) \pm 2SE in standardized MA regions from 2008 through 2012. Data are averaged across both moon phases and combined from beaches sampled all five years in each region

Most sampling regions exhibited a male-skewed sex ratio in the spawning survey data, the exception being Martha's Vineyard where the ratio is approximately 1:1 (Figure 6). Of particular concern are continued male-skewed sex ratios in Pleasant Bay on Cape Cod. As previously noted, these crabs are harvested only for biomedical purposes and a continuation of the highly male-skewed sex ratio may be an indication that bleeding is having a notable sub-lethal impact on the spawning behavior of females in this embayment. We will continue monitoring this situation in 2013.

Regulations in effect for 2012

The Code of Massachusetts Regulations 322(CMR):

6.34 Horseshoe Crab Management

- (1) Purpose. The purpose of 322 CMR 6.34 is to comply with the Interstate Management Plan for horseshoe crabs to manage horseshoe crab populations for continued use by current and future generations of the fishing and non-fishing public including the biomedical industry, scientific and educational research; migratory shorebirds; and, other dependent fish and wildlife. The plan requires the Commonwealth to monitor and control harvest levels by all sectors and conserve crabs through a commercial quota for crabs harvested as bait.

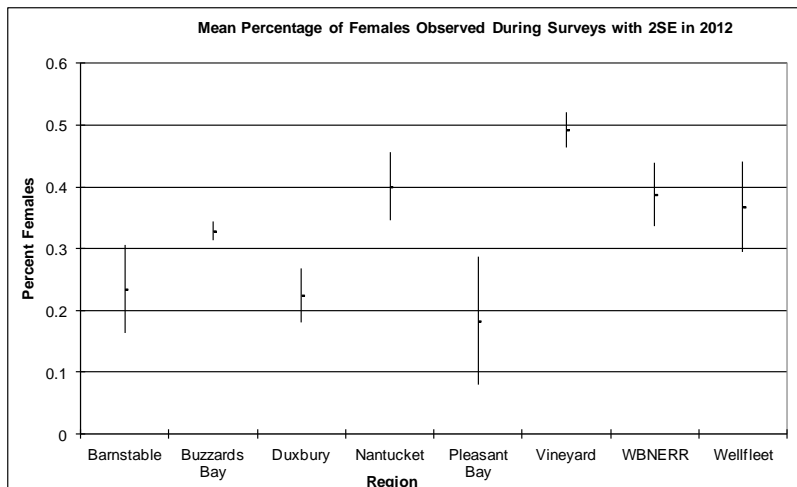
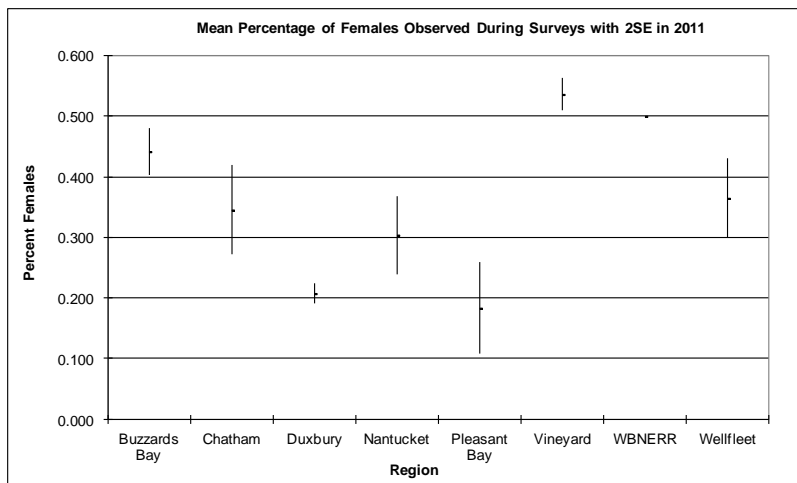
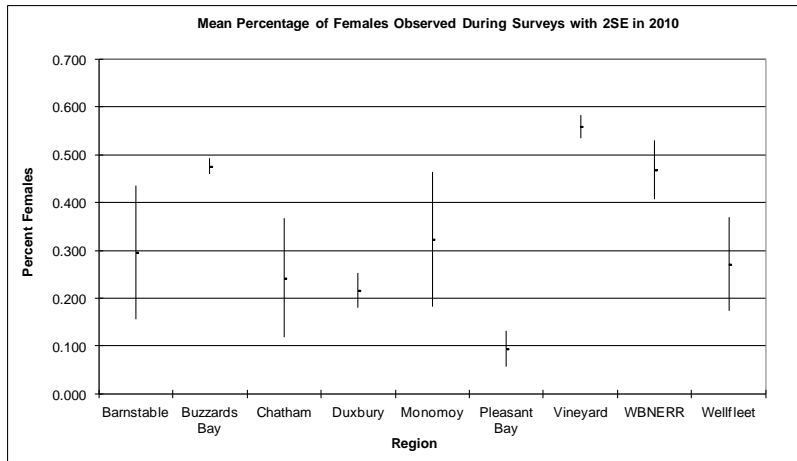
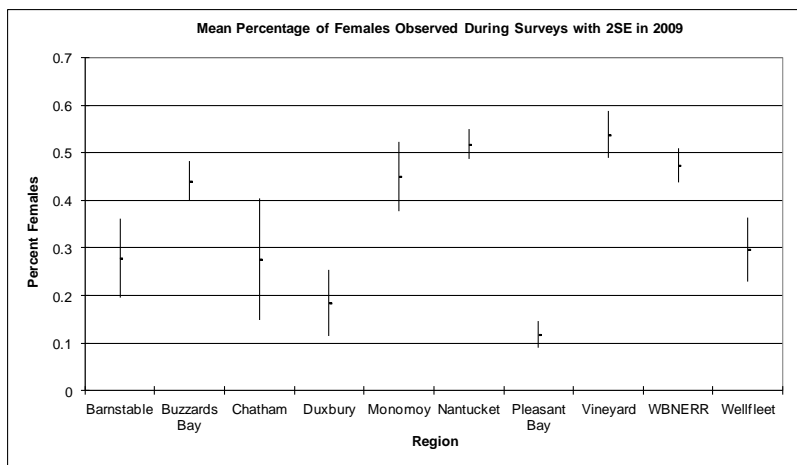


Figure 6. Mean percentage of females observed during surveys (avg. percentage of females per 25 m² quadrat) \pm 2SE in standardized MA regions from 2009 through 2012. Data are averaged across both moon phases and day/night surveys.

(2) Permit. It shall be unlawful for any person to take, land or possess more than six horseshoe crabs (*Limulus polyphemus*) per day for any purpose without a regulated fishery permit for horseshoe crabs issued by the Director. Licensed pot fishermen using horseshoe crabs as bait may possess more than six horseshoe crabs without a regulated permit, provided their documented source is a wholesale or bait dealer.

(a) Special Biomedical Harvest Permit. Harvesters collecting horseshoe crabs exclusively for use by the biomedical industry for the manufacture of limulus lysate or sale to a permitted scientific institution for research purposes must obtain a special permit limited to that purpose. The holder of the biomedical special permit shall not be allowed to obtain a Horseshoe Crab Permit.

(b) Permit Moratorium. As of March 28, 2008, the Director may not issue any new regulated fishery permit endorsements for horseshoe crabs. Failure to renew the horseshoe crab regulated fishery endorsement in any calendar year shall result in permit forfeiture to the Division.

(3) Bait Harvest Quota. The annual quota for horseshoe crabs harvested for bait purposes shall be 165,000 crabs. Horseshoe crabs harvested solely for biomedical or research purposes by harvesters licensed under 322 CMR 6.34(2)(a) which are bled and released alive in the area of capture or used for display or research shall not be counted against the annual quota established by the Atlantic States Marine Fisheries Commission. When 100% of the annual quota is reached, the Division shall file a notice of the horseshoe crab bait fishery closure with the Massachusetts Register, email a notice via the Marine Fisheries Listserv and post a notice on the Division's website.

(4) Quota Monitoring Closure. Beginning July 7th, the Director may prohibit commercial fisherman from landing and possessing horseshoe crabs taken for bait purposes to allow a comprehensive compilation of catch report information to assess the proportion of the annual quota taken. The Director may re-open the fishery if the quota has not been reached and may adjust the harvest rules if warranted to extend the season and to avoid overages.

(5) Possession Limits. Possession limits shall be vessel limits and shall apply regardless of the number of persons or permit holders aboard a vessel or working in conjunction with a vessel. It shall be unlawful for any person to harvest more than the possession limit in a day regardless of the number of permits held.

(a) Bait crab harvesters It shall be unlawful for any horseshoe crab harvester permitted to take crabs for bait purposes to take, land or possess:

1. more than 400 horseshoe crabs during any 24 hour period beginning at 12:00 P.M. (noon). Exception: After June 30, trawlers may lawfully possess up to 600 horseshoe crabs during any 24 hour period.
2. any horseshoe crabs once 100% of the horseshoe crab bait harvest quota has been taken.

(b) Biomedical crab harvesters. It shall be unlawful for any horseshoe crab harvester permitted to take crabs for biomedical purposes to take, land or possess more than 1,000 horseshoe crabs during any 24 hour period beginning at 12:00 P.M (noon).

(c) Exemption. Possession limits shall not apply to lawfully harvested horseshoe crabs held in storage by licensed conch pot or eel fishermen or dealers.

(6) Biomedical/Research Harvest.

(a) Authorization. Biomedical harvest permit holders must sell horseshoe crabs only to a dealer authorized by the Director to receive crabs harvested exclusively for biomedical purposes.

(b) Live Release.

1. Biomedical permit holders shall return all horseshoe crabs not used for display or research, other than bleeding, alive to the area of capture.
2. Dealers authorized by the Director to receive crabs harvested exclusively for biomedical purposes shall:
 - a. keep horseshoe crabs supplied by biomedical permit holders separate from horseshoe crabs supplied by bait permit holders; and
 - b. ensure horseshoe crabs supplied by biomedical permit holders are returned for live-release back into the same area of capture.

(c) Temporary Use of Horseshoe Crabs Harvested for Bait Purposes. If a biomedical company or permitted scientific institution chooses to purchase horseshoe crabs from bait dealers:

1. the company or institution shall keep records sufficient to show the number and source(s) of said horseshoe crabs;
2. horseshoe crabs purchased by a biomedical company from bait dealers may be returned to bait dealers to be sold as bait.

(d) Horseshoe Crabs Imported from Other States for Biomedical Purposes shall be counted against the quota of the producing state or returned to the producing state for release, according to established rules and regulations of the state of origin.

(7) Reporting.

- (a) Harvesters. Each holder of a regulated fishery permit for horseshoe crabs, or a scientific collecting permit shall file a monthly catch report on forms supplied by the Division. Failure to report shall be grounds for suspension or non-renewal of the permit.
- (b) Dealers. Wholesale Dealers and Bait Dealers who purchase horseshoe crabs from licensed fishermen shall register with the Division and record purchases on forms supplied by the Division. Failure to report purchases by the fifth day of each successive month shall be grounds for administrative action.

(8) Closed Days.

- (a) May and June Lunar Closures. It shall be unlawful to harvest horseshoe crabs within a series of five day periods coinciding with each new and full moon during May and June as published by the US Naval Observatory and adjusted for Eastern Daylight Savings Time. Lunar closures shall commence at 12:00 AM two days prior to, and end at 11:59 PM two days after the date of the full or new moon.
- (b) Mobile gear no-fishing days. In addition to closures described in 6.34.8(a), permit holders using mobile gear shall be prohibited from fishing for horseshoe crabs on Fridays and Saturdays during the summer flounder season beginning on June 10th and ending when the summer-time summer flounder quota is reached.

(9) Closed Areas. The Director may close any area to the taking of horseshoe crabs provided:

- (a) A majority of the members of the Massachusetts Marine Fisheries Commission approve, and;
- (b) A notice of closure has been filed with the Massachusetts Register stating the rationale for the closure, the duration of the closure and a description of the area to be closed, and;
- (c) All permit holders and dealers are notified.

(10) Minimum Size. It is unlawful to possess horseshoe crabs for commercial purposes with a prosomal width of less than 7 inches.

(11) Fishery Limit Adjustments.

(a) The Director may, by declaration, adjust the manner and times of taking horseshoe crabs, and the legal size limits, numbers and/or quantities of horseshoe crabs to be taken as prescribed by M.G.L. c. 130, § 17A and specified by the Atlantic States Marine Fisheries Commission (ASMFC).

(b) Declaration Process

1. a two-week comment period has been conducted by the Division;
2. it has been approved by a majority of the members of the Massachusetts Marine Fisheries Advisory Commission;
3. a notice has been filed with the Massachusetts Register;
4. a notice has been published by at least one local newspaper; and
5. a copy of the notice has been emailed via the Marine Fisheries Listserv and posted on the Division's website.

Closed areas

In addition to the above regulations, Monomoy National Wildlife Refuge (federal closure) and the National Season (NPS - federal) remain closed to all HSC harvest, and Pleasant Bay (state closure) remains closed to bait fishing only (Figure 7).

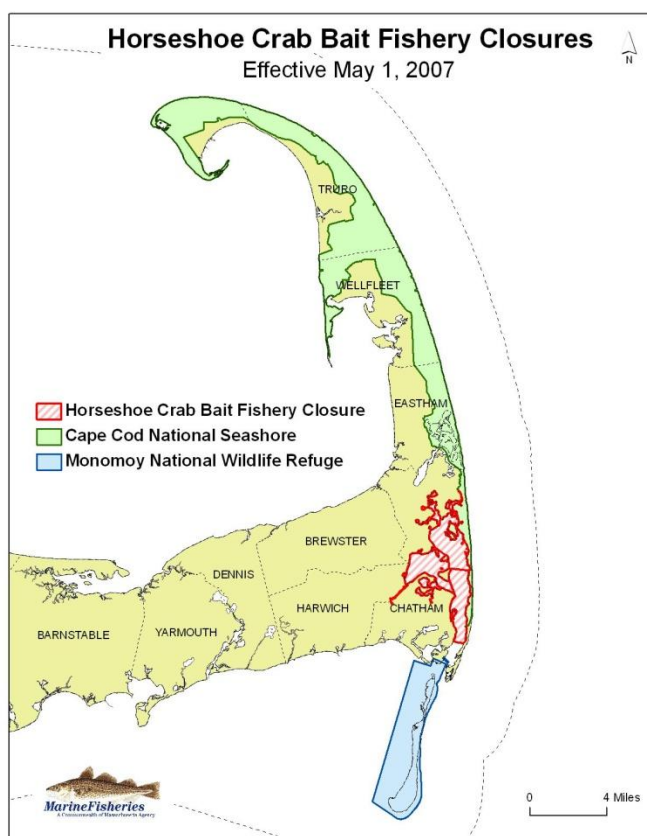


Figure 7. Areas closed to bait and/or biomedical harvest.

e. Review of progress in implementing habitat recommendations.

Marine Fisheries' Environmental Review Project makes recommendations on state and federal coastal alteration permits to protect horseshoe crab spawning and nursery areas. These typically take the form of recommendations to limit certain activities during the crab's May – July spawning season. Known spawning beaches have been entered into a GIS database to facilitate the environmental review process and a time-of-year guidance document authored by DMF is under review and will reiterate specific recommendations regarding dredging, beach fill, and construction projects vis à vis their potential impact on horseshoe crabs.

IV. Planned management programs for 2013

Summarize regulations that will be in effect (copy of current regulations if different from III c).

The lunar spawning closures will be extended to cover the second lunar period in April to afford greater protection to spawning horseshoe crabs.

Summarize monitoring program that will be performed.

- Spring spawning beach surveys will be continued.
- *Marine Fisheries* will continue collecting catch reports from all crab harvesters, dealers, and scientific permit holders. The biomedical company will submit monthly reports and an annual questionnaire. *Marine Fisheries* will also continue to identify horseshoe crab spawning and nursery habitat and to characterize the commercial fishery. The *Marine Fisheries* spring and fall trawl surveys will continue to monitor and record weight, number and prosomal width by sex of individuals collected.
- *Marine Fisheries* will continue to encourage ACC to bleed as many bait crabs as possible in order to reduce the demand for biomedical crabs, particularly in light of our bleeding mortality study results.

Highlight changes from previous year.

No regulatory changes were made by the Division of Marine Fisheries in 2012.

V. Monitoring Program Requirements – Including Addendums I-III

Component A₁: Addendum III requires monthly reporting of all harvest of horseshoe crabs (bait fisheries, biomedical, industry, by-catch, educational and scientific research) by number landed, by sex and harvest method. Continue characterization of the commercial catch based on prosomal width by sex. States will be required to characterize a portion of the commercial catch based on maturity once an appropriate technique is developed and approved by the Technical Committee.

Massachusetts' existing regulations comply with Addendum III of the FMP. The Code of Massachusetts Regulations 322(CMR) 6.34 requires any person harvesting, taking or landing more than six horseshoe crabs per day for any purpose to have a regulated fishery permit from the Director of the Division of Marine Fisheries. Permit holders are required to report at the trip-level the number of crabs harvested daily by gender, the beach or embayment of harvest, type of gear used and the intended use of the harvested crabs. If the crabs are sold, as a

directed fishery or as by-catch, the fisherman must identify the dealer or individual buying the crabs. Failure to report shall be ground for suspension of the permit and non-renewal.

Wholesale or bait dealers purchasing horseshoe crabs from licensed fishermen are now required to submit weekly electronic SAFIS reports. Biomedical facilities must report the name of the harvester, number of crabs and the use of horseshoe crabs monthly.

Commercially harvested horseshoe crabs were sampled during the beach harvest season by *Marine Fisheries* biologists at bait dealer and the biomedical facilities. A total of 1,174 horseshoe crabs (667 female and 507 male crabs) were identified by sex and measured to determine prosomal width (Figure 8). The mean prosomal width for female crabs was 23.9 cm and 19.9 cm for male crabs. The center of the distribution of prosomal widths for both males and females follows the recent trend and remains slightly shifted to smaller sizes. The male distribution remained stable in 2012. (See Attachment 1).

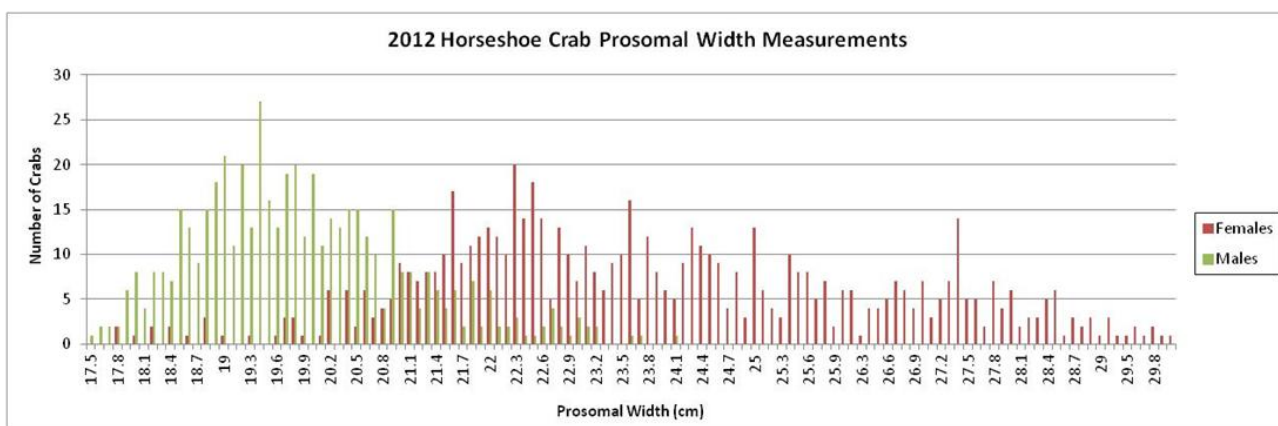


Figure 8. Prosomal widths (cm) for female and male horseshoe crabs sampled during market surveys.

Component A₂: To comply with Addendum III, states where horseshoe crabs are captured for biomedical use must monitor and report monthly and annual harvest of horseshoe crabs by biomedical facilities. All states must identify percent mortality from the point of harvest to release. States are required to use the HSC TC biomedical survey or some other means to obtain the required information.

The Massachusetts biomedical company, Associates of Cape Cod (ACC) obtained crabs from three licensed bait dealers, and four fishermen. Massachusetts regulations allow the biomedical company to purchase bait crabs for bleeding. Once bled, the crabs are returned to the bait dealers for sale as bait or to a biomedical dealer to be released at the site of capture. As nearly half of the crabs used by the biomedical company came from the bait dealers, the number of crabs harvested by biomedical permit holders is reduced, reducing the total number of crabs harvested in the Commonwealth.

In an effort to comply with Addendum III, the biomedical company is required to file monthly reports noting the number of crabs received from each dealer, the number of dead or rejected crabs and the number of dead crabs returned to the dealers. The biomedical company reported a rejection rate of approximately 5-6% for both the biomedical and bait dealers. Crabs from the biomedical dealer rejected by the biomedical company because of injury, size,

etc. were returned to the water near the harvest site. Rejected crabs obtained from bait dealers were sold as bait.

Component A₃: States must identify spawning and nursery habitat. States that have completed this work must report changes in spawning and nursery habitat over time. States must actively intervene to the extent of their authority to ensure that spawning and nursery habitat is conserved and the quality and productivity is maintained.

A comprehensive survey of horseshoe crab spawning and nursery habitat along the Commonwealth's 1,800 miles of coastline was completed in 2004 and partially updated in 2007 (Attachment 2). This assessment will be updated in the coming years as staffing allows. All crab harvesters are required to identify embayments on the catch reports. As in previous years, staff limitations allowed no updates to this map in 2012. Therefore the maps in Attachment 2 are from 2004 and the table is from 2007.

Marine Fisheries annually solicits public assistance by issuing postings on the website and in the *Marine Fisheries* newsletter. Anyone observing spawning horseshoe crabs is asked to contact *Marine Fisheries*.

Marine Fisheries' Environmental Review Project also recommends conditions to all coastal alteration projects to protect horseshoe crab habitat and requests time-of-year restriction on any activities on known horseshoe crab spawning beaches.

Monitoring Program Recommendations – Including Addendums I-III

Monitoring of Horseshoe Crab Populations and Habitat

Component B₁: Continue working towards expanding the annual coastwide benthic trawl survey following methods described in Hata and Berkson (2003).

Marine Fisheries continues working towards expanding the annual coastwide trawl survey. However, due to fiscal and manpower limits, the Commonwealth is unable to participate in a coastwide trawl survey at this time. *Marine Fisheries'* Coastal Resource Assessment Project currently records the number, and prosomal width by sex of all horseshoe crabs collected during the annual spring and fall bottom trawl surveys. Survey data is forwarded to the Stock Assessment Committee.

Component B₂: Continue existing benthic sampling programs.

As noted in Component B₁, *Marine Fisheries'* Resource Assessment Project currently records the number, and prosomal width by sex of all horseshoe crabs collected during the annual spring and fall bottom trawl surveys. Survey data is forwarded to the Stock Assessment Committee.

Component B₃: Continue monitoring spawning populations based upon standardized and statistically robust methodologies.

Massachusetts started annual spawning surveys in 2008 modeled after Delaware Bay's (with modification of quadrat size to 5 x 5 m² due to much lower populations in MA).

Component B₄: A coordinated tagging program should be implemented by the Tagging Subcommittee based upon the draft coast-wide framework developed in 2003.

Marine Fisheries worked with NPS and USFWS to develop a smaller tag more suited to our smaller crabs. These tags were successfully used in 2009, primarily in Pleasant Bay, Monomoy NWR, and to a limited extent in Waquoit Bay.

Joint Monitoring of Delaware Bay Horseshoe Crabs and Shorebirds

Component B₅ Continue existing state egg abundance surveys, particularly in the Delaware Bay region.

Marine Fisheries has explored funding and implementation options to implement crab egg abundance surveys. Because there is no strong HSC-shorebird connection in MA, it may make more sense for MA to survey juvenile horseshoe crabs. Work began on this in 2009, but it was a “learning year” without substantive results. We hope to pick it up again in 2013.

Component B₆ Continue existing state shorebird monitoring programs.

Shorebird monitoring in Massachusetts is conducted by other agencies and organizations.

Component E: Evaluate the post-release mortality of horseshoe crabs used by the biomedical industry by initiating a tagging program.

Marine Fisheries conducted a study in 2009 examining mortality in bled and unbled female crabs. The study results were published in 2010: Leschen, A. S. and Correia, S. J. (2010) 'Mortality in female horseshoe crabs (*Limulus polyphemus*) from biomedical bleeding and handling: implications for fisheries management', *Marine and Freshwater Behaviour and Physiology*, 43: 2, 135 — 147.

Component F: Identify potential horseshoe crab spawning and nursery habitats.

See Component A₃.

Changes to Research Needs Section.

Section 6.1 Develop an effective and efficient field protocol to identify critical life history stages. At a minimum, the protocol should identify horseshoe crabs that have spawned previously, those that are within one year of spawning for the first time and those that are more than one year from spawning for the first time.

Once developed, Massachusetts will incorporate the protocol into the sampling design.

Section 6.2 In addition to investigating, encouraging and funding alternative bait sources, the Committee suggested focusing on alternative trap design (i.e. traps with bait bags).

In 2004, *Marine Fisheries* in concert with several fishermen began trial use of bait cups and alternative baits. Preliminary results indicated that the use of the cups and bait bags reduced the amount of horseshoe crab required to bait a pot and extended the time between rebaiting. Over the course of the year quite a few conch fishermen began using modifications of the bait cups and bags. Almost all reported a significant reduction in the number of crabs needed per trip.

In 2005, fishermen continued modifying bait cups and bags and several new modifications were tested. All appeared to work well, allowing for smaller pieces of horseshoe crabs and other baits such as herring, skate or green crabs to be added to the containers. Based upon returns

of a questionnaire sent to conch pot fishermen, nearly all are using some form of bait bag or bait cup.

From meetings with conch fishermen, we learned there is a wide variety of techniques and number of pots/crab that people use. We hope to gather more information from the most efficient users of crabs, and share this information with other fishermen to potentially cut down on the need for crabs.

ATTACHMENT 1

HORSESHOE CRAB PROSOMAL WIDTHS

2000 – 2012

Prosomal width of horseshoe crabs by sex taken in market samples in 2000-2012

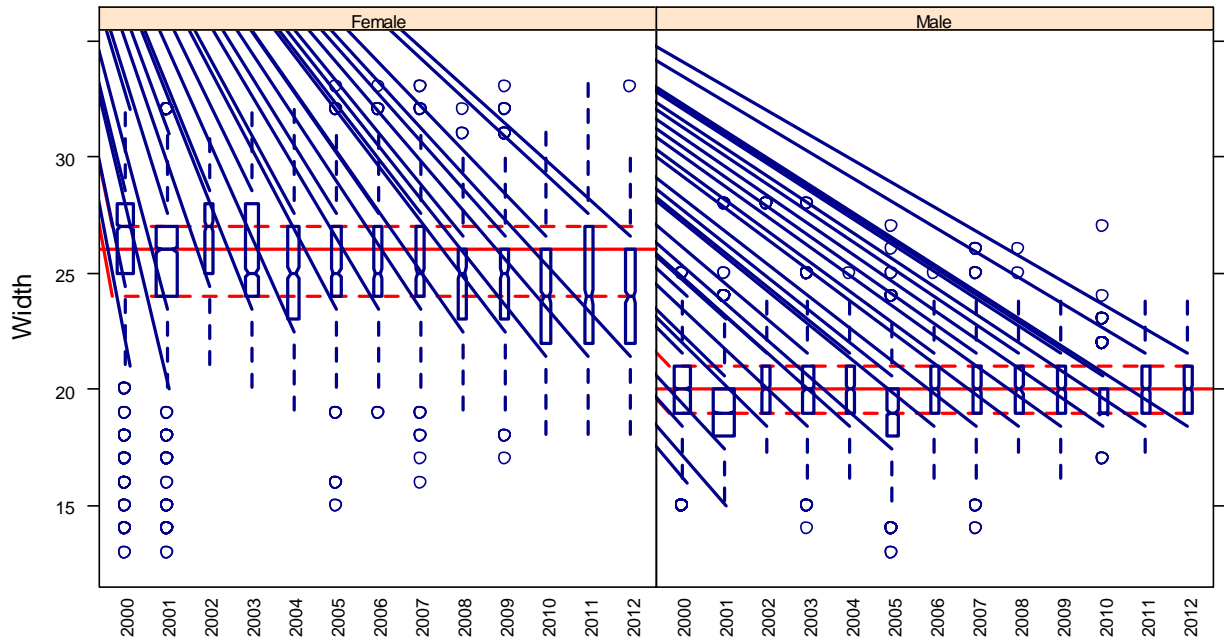


Figure 1. Box plots of prosomal widths taken in market sampling of horseshoe crabs for all areas combined (2000-2012). Solid red line is median, dashed lines are 25 and 75th quantiles (unweighted). Left panel: female horseshoe crabs. Right panel: male horseshoe crabs. Width of box is proportional to the square root of sample size.

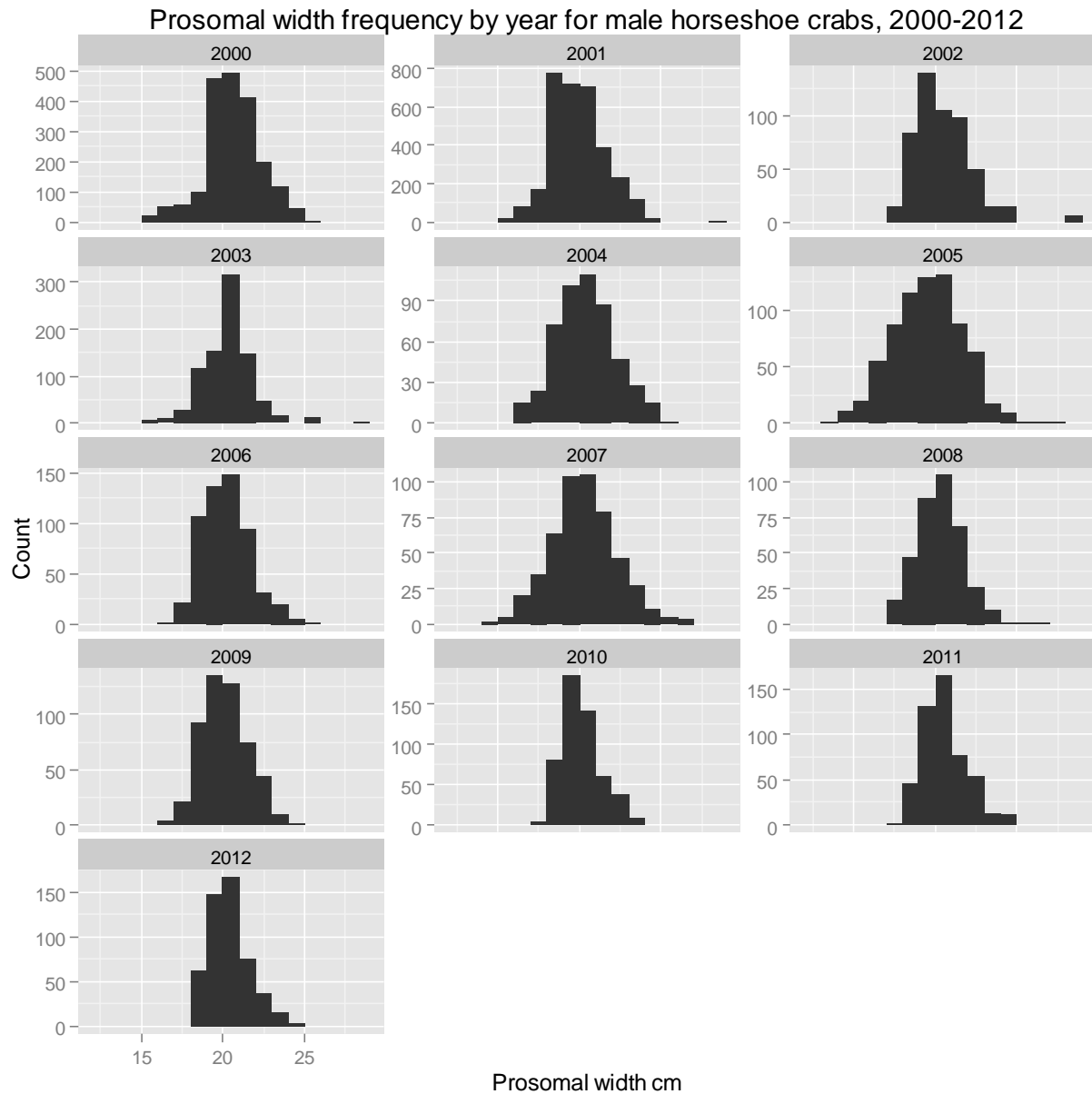


Figure 2. Prosomal width frequency from market sampling for male horseshoe crabs (2000-2012).

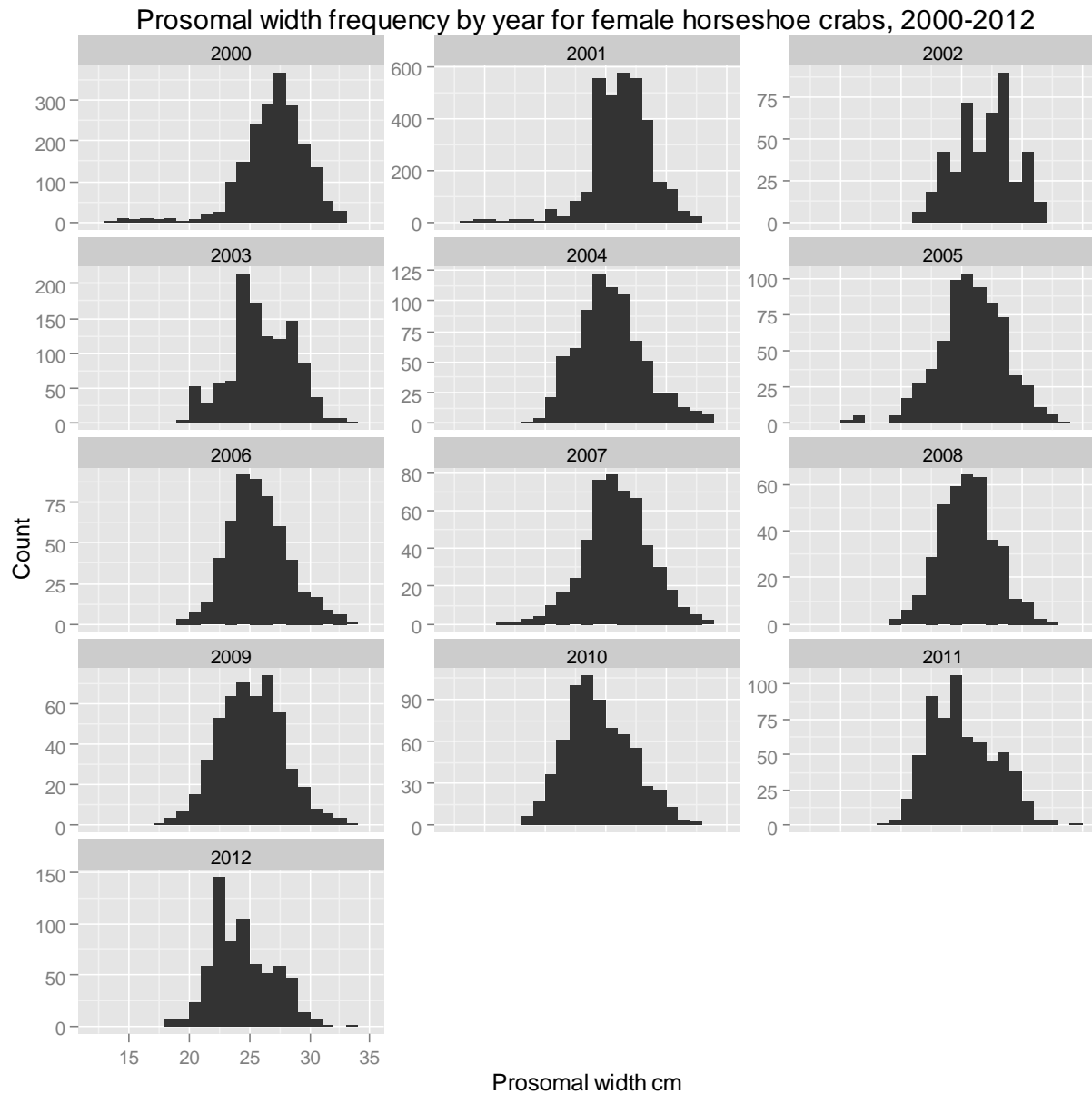
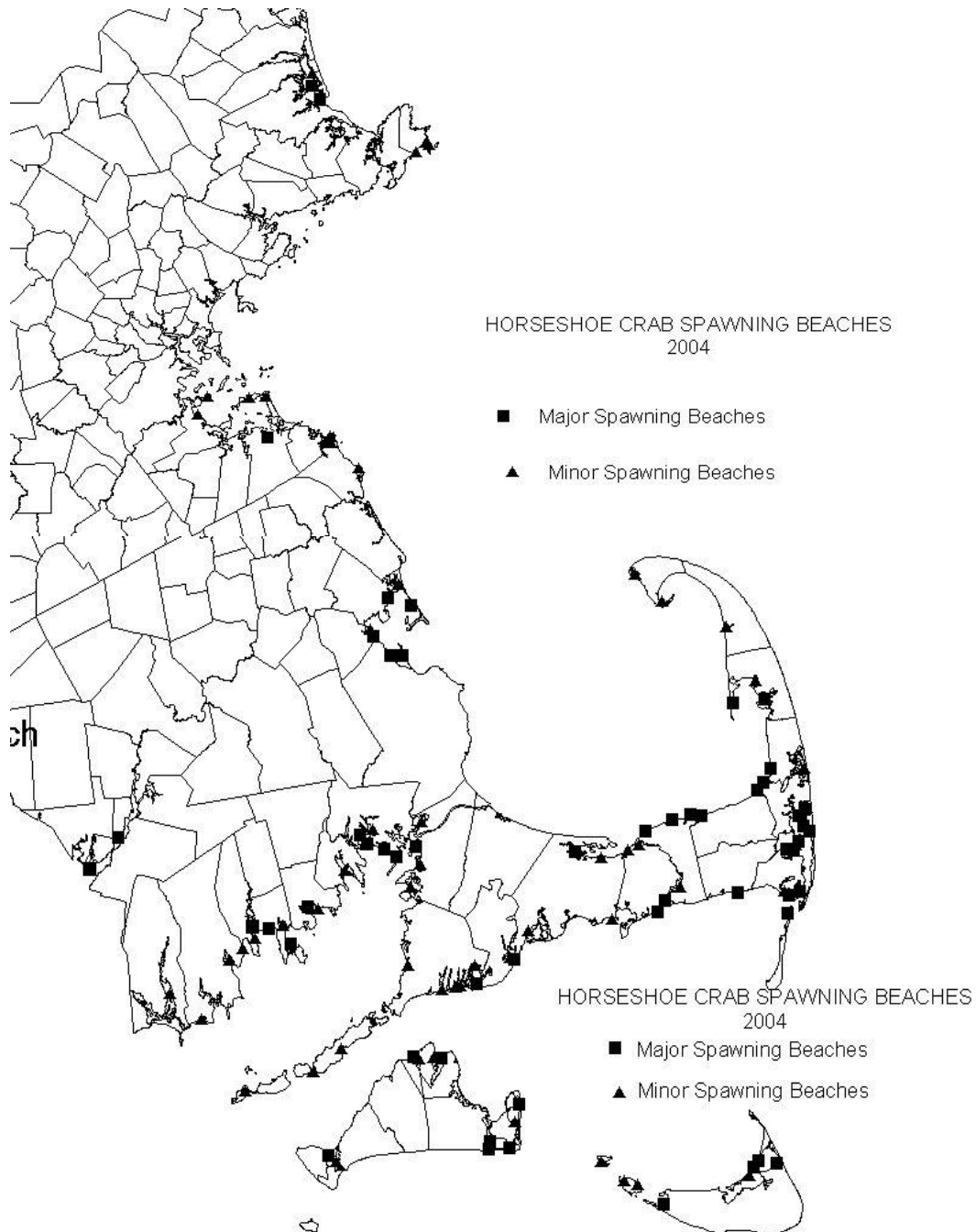


Figure 3. Prosomal width frequency from market sampling for female horseshoe crabs (2000-2012).

ATTACHMENT 2 HORSESHOE CRAB SPAWNING BEACHES AND NURSERY AREAS



HORSESHOE CRAB SPAWNING BEACHES 2007

MOUNT HOPE BAY			
Town	Embayment	Beach	Density
Somerset	Mount Hope Bay	Brayton Pt Beach	High
	Taunton River	Pierce Town Beach	High
Fall River	Taunton River	Ark Bait Cove	High
Swansea	Coles River	Bluffs Beach	High
	Coles River	Ocean Grove	High
	Coles River	Cedar Cove	Moderate
BUZZARDS BAY			
Bourne	Buttermilk Bay	Hideaway Village	Moderate
	Phinney's Harbor	Monument Beach	High
	Phinney's Harbor	Mashnee Dike	High
	Phinney's Harbor	Toby Island	Moderate
	Pocasset Harbor	North Cove	Moderate
	Pocasset Harbor	Tahanto Beach	Moderate
Dartmouth	Allen's Pond	South Beaches	Moderate
	Clarks Cove	Anthony Beach	Moderate
	Apponagansett Bay	Apponagansett Park Beach	Moderate
	Little River	Beach at mouth	Reported
	Slocum River	Demarest Lloyd State Beach	Reported
	Clarks Cove	Jones Beach	Moderate
	Apponagansett Bay	Little Bridge Beach	Reported
Fairhaven	Nasketucket Bay	Deacon's Cove	High
	Nasketucket Bay	Edgewater Ramp Beach	Moderate
	Acushnet River	Fairhaven Common's Beach	High
	NB Outer Harbor	Fort Phoenix Beach	Reported
	Nasketucket Bay	Knomere Beach	Reported
	NB Outer Harbor	Priest Cove, Red Rock Beach	High
	Nasketucket Bay	Raymond Street Beach	Reported
	NB Outer Harbor	Silver Shell Beach	Reported
	Acushnet River	Tin Can Island	High
	Nasketucket Bay	Association Beach	Moderate

Falmouth	Great Sippewisset	Black Beach	Reported
	Buzzards Bay	Old Silver Beach	Reported
Gosnold	Cuttyhunk Pond	Church Beach	Reported
	Pasque Pond	Beach	Reported
	Vineyard Sound*	Tarpaulin Cove	Moderate
Mattapoissett	Aucoot Cove	Hollywood Beach	Moderate
	Mattapoissett Harbor	Ned's Point	Reported
	Mattapoissett Harbor	Shining Tides Beach	Moderate
	Buzzards Bay	Point Connett Beach	Reported
Marion	Sippican Harbor	Meadow Island	Moderate
	Sippican Harbor	Ram Island	Reported
	Sippican Harbor	Planting Island	Moderate
	Aucoot Cove	Converse Pt Beach	Reported
New Bedford	Acushnet River	Palmer Cove	High
	NB Outer Harbor	East Beach	Moderate
	NB Outer Harbor	Ebb Tide Beach	Moderate
	NB Outer Harbor	Davy's Locker Beach	Reported
Wareham	Buttermilk Bay	Jefferson Shores	Moderate
	Wareham River	Long Beach	High
	Little Harbor	Little Harbor Beach	High
	Wareham River	Pine Hurst Beach	Reported
	Wareham River	Swifts Beach	High
	Buzzards Bay	Stony Point Dike	Moderate
Westport	Westport Harbor	Cherry & Webb Beach	Moderate
	East Branch West Branch	Upper Islands Sanford Flat Area	Reported Reported
	Westport Harbor	Boat Ramp Beach	Reported
SOUTH CAPE			
Barnstable	Centerville Harbor	Craigville Beach(5 th Ave)	Reported
	Cotuit Bay	Ropes Beach	Reported
	East Bay	Dawes Beach	Moderate
	Hall Creek	Backside Beach	Reported
	Hyannis Harbor	Kalmus Beach	Reported
	Cotuit Bay	Sampson Island	High
	Cotuit Bay	Pirate Cove	High

Chatham	Nantucket Sound	Cockle Cove Beach	High
	Nantucket Sound	Monomoy Island	High
	Stage Harbor	Harding Beach	High
	Stage Harbor	Morris Island	High
	Oyster Pond	Beaches at mouth	Reported
	Oyster River	Sear's Point Beach	High
Dennis	Bass River	Opposite High Bank	Moderate
	Bass River	Old Field Point	Reported
	Bass River	W. Dennis Beach	High
	Bass River	Georgetown Flats	Reported
Falmouth	Bourne's Pond	Old Mouth	Reported
	Great Pond	Entrance Beaches	Moderate
	Green Pond	Entrance Beaches	Moderate
	Eel River	Washburn Island	Reported
	Waquoit Bay	WBNERR Beach	Reported
Mashpee	Waquoit Bay	Sage Lot Pond	High
	Nantucket Sound	South Cape Beach	Reported
	Popponesset Bay	Popponesset Beach	Reported
	Popponesset Bay	Daniel Island Beach	Reported
	Popponesset Bay	Pirates Cove Landing	Moderate
Yarmouth	Bass River	Wind Mill Beach	Moderate
	Nantucket Sound	Sea Gull Beach	Moderate
	Nantucket Sound	Lighthouse Beach	Moderate
	Parker River/ Lewis Pond	Landing Beach	Reported
MARTHA'S VINEYARD			
Aquinnah	Menemsha Pond	Red Beach	High
Chilmark	Menemsha Pond	Landing	Moderate
Edgartown	Cape Poge Bay	Simon Point	Moderate
	Katama Bay	SE Corner	High
	Katama Bay	South Side	High
	Salt Pond	Fuller Street Beach	Reported
Oak Bluffs	Lagoon Pond	Worcester St.	Reported
	Vineyard Haven	Eastville Point	Moderate
Tisbury	Lake Tashmoo	Flats at mouth	High
	Lagoon Pond	Cedar Neck	Reported

NANTUCKET			
Nantucket	Madaket Harbor	Hither Creek	Moderate
	Muskeget Island	Coves	Reported
	Nantucket Harbor	Backside Outer Beach	Reported
	Nantucket Harbor	Pocomo Point Beach	High
	Tuckernut Island	Coves	Reported
	Barnstable Harbor	The Cove	Reported
	Barnstable Harbor	Calves Pasture Point	High
	Barnstable Harbor	Bone Hill	Reported
	Barnstable Harbor	Eastern end	High
	Barnstable Harbor	Salten Point	High
Brewster	Cape Cod Bay	Brewster Flats	High
	Cape Cod Bay	Ellis Landing	High
	Cape Cod Bay	Namskaket Creek	High
	Cape Cod Bay	Paine's Creek	Moderate
OUTER CAPE			
Chatham	Bassing Harbor	Fox Hill	Moderate
	Crows Pond	Nickerson Neck	Moderate
	Chatham Harbor	North Beach	Reported
	Chatham Harbor	Outermost Marine Cove	High
	Pleasant Bay	Muddy Creek Landing	Reported
	Chatham Harbor	South Beach	Reported
	Pleasant Bay	Strong Island, East Side & Creeks	High
	Pleasant Bay	Ryders Cove	Reported
Eastham	Nauset Harbor	Stony Island	Reported
	Nauset Harbor	Outer Beach	Reported
Harwich	Round Cove	Landing	Reported
Orleans	The River	Barley Neck	High
	Little Pleasant Bay	Hog Island	High
	Little Pleasant Bay	Jack Knife Cove	High
	Kesczyogansett Pond	Town Landing	Moderate
	Town Cove	YC Landing	Moderate
	Little Pleasant Bay	National Seashore	High
	Little Pleasant Bay	Pochet Island	High
	Little Pleasant Bay	Sampson Island	High

	Little Pleasant Bay	Old Field Point	Reported
	Pleasant Bay	Strong Island	High
Cape Cod Bay			
Barnstable	Barnstable Harbor	Scudder Lane	High
	Barnstable Harbor	Sand Island	High
	Barnstable Harbor	The Cove	Reported
	Barnstable Harbor	Calves Pasture Point	High
	Barnstable Harbor	Bone Hill	Reported
	Barnstable Harbor	Eastern end	High
	Barnstable Harbor	Salten Point	High
Brewster	Cape Cod Bay	Brewster Flats	High
	Cape Cod Bay	Ellis Landing	High
	Cape Cod Bay	Namskaket Creek	High
	Cape Cod Bay	Paine's Creek	Moderate
Dennis	Cape Cod Bay	Chapin Beach	High
	Cape Cod Bay	Corporation Beach	High
	Cape Cod Bay	Cold Storage Beach	Moderate
	Cape Cod Bay	Quivett Creek	Moderate
	Cape Cod Bay	Chase Garden Creek	Reported
Duxbury	Duxbury Bay	Back River	High
	Duxbury Bay	Duxbury Beach	High
	Duxbury Bay	Ship Yard Lane	High
	Duxbury Bay	Bradford Street	High
Eastham	Cape Cod Bay	First Encounter	High
	Cape Cod Bay	Sunken Meadow	High
	Cape Cod Bay	Boat Meadow Sand Spit	Reported
Kingston	Kingston Bay	Gray's Beach	Reported
	Kingston Bay	Rocky Nook Association Beach	Reported
Orleans	Cape Cod Bay	Rock Harbor Beach	Moderate
	Cape Cod Bay	Skaket Beach	Reported
Plymouth	Plymouth Harbor	Plymouth Beach	High
	Duxbury Bay	Saquish Cove	Reported
	Plymouth Harbor	Steven's Field	High
Provincetown	Hatches Harbor	Entrance Beach	Reported

	Inner Harbor	Wood's End	Moderate
Truro	Pamet Harbor	Harbor Bar	Reported
	Pamet Harbor	Landing Beach	Reported
	Cape Cod Bay	Corn Hill Beach	Reported
Wellfleet	Wellfleet Harbor	Chipman Cove	High
	Wellfleet Harbor	Great Island	Moderate
	Wellfleet Harbor	Mayo Beach	Reported
	Wellfleet Harbor	WBWS	High
	Wellfleet Harbor	Indian Neck	Moderate
Yarmouth	Cape Cod Bay	Bass Creek	Moderate
	Chase Garden Creek	Gray's Beach	Moderate
	Cape Cod Bay	Quivett Creek	Moderate
	Cape Cod Bay	Chase Garden Creek	Reported
Duxbury	Duxbury Bay	Back River	High
	Duxbury Bay	Duxbury Beach	High
	Duxbury Bay	Ship Yard Lane	High
	Duxbury Bay	Bradford Street	High
Eastham	Cape Cod Bay	First Encounter	High
	Cape Cod Bay	Sunken Meadow	High
	Cape Cod Bay	Boat Meadow Sand Spit	Reported
Kingston	Kingston Bay	Gray's Beach	Reported
	Kingston Bay	Rocky Nook Association Beach	Reported
Orleans	Cape Cod Bay	Rock Harbor Beach	Moderate
	Cape Cod Bay	Skaket Beach	Reported
Plymouth	Plymouth Harbor	Plymouth Beach	High
	Duxbury Bay	Saquish Cove	Reported
	Plymouth Harbor	Steven's Field	High
Provincetown	Hatches Harbor	Entrance Beach	Reported
	Inner Harbor	Wood's End	Moderate
Truro	Pamet Harbor	Harbor Bar	Reported
	Pamet Harbor	Landing Beach	Reported
	Cape Cod Bay	Corn Hill Beach	Reported
Wellfleet	Wellfleet Harbor	Chipman Cove	High
	Wellfleet Harbor	Great Island	Moderate
	Wellfleet Harbor	Mayo Beach	Reported

	Wellfleet Harbor	WBWS	High
	Wellfleet Harbor	Indian Neck	Moderate
Yarmouth	Cape Cod Bay	Bass Creek	Moderate
	Chase Garden Creek	Gray's Beach	Moderate
	Cape Cod Bay	Quivett Creek	Moderate
	Cape Cod Bay	Chase Garden Creek	Reported
Duxbury	Duxbury Bay	Back River	High
	Duxbury Bay	Duxbury Beach	High
	Duxbury Bay	Ship Yard Lane	High
	Duxbury Bay	Bradford Street	High
Eastham	Cape Cod Bay	First Encounter	High
	Cape Cod Bay	Sunken Meadow	High
	Cape Cod Bay	Boat Meadow Sand Spit	Reported
Kingston	Kingston Bay	Gray's Beach	Reported
	Kingston Bay	Rocky Nook Association Beach	Reported
Orleans	Cape Cod Bay	Rock Harbor Beach	Moderate
	Cape Cod Bay	Skaket Beach	Reported
Plymouth	Plymouth Harbor	Plymouth Beach	High
	Duxbury Bay	Saquish Cove	Reported
	Plymouth Harbor	Steven's Field	High
Provincetown	Hatches Harbor	Entrance Beach	Reported
	Inner Harbor	Wood's End	Moderate
Truro	Pamet Harbor	Harbor Bar	Reported
	Pamet Harbor	Landing Beach	Reported
	Cape Cod Bay	Corn Hill Beach	Reported
Wellfleet	Wellfleet Harbor	Chipman Cove	High
	Wellfleet Harbor	Great Island	Moderate
	Wellfleet Harbor	Mayo Beach	Reported
	Wellfleet Harbor	WBWS	High
	Wellfleet Harbor	Indian Neck	Moderate
Yarmouth	Cape Cod Bay	Bass Creek	Moderate
	Chase Garden Creek	Gray's Beach	Moderate
MASSACHUSETTS BAY			
Cohasset	Cohasset Harbor	Bassing Harbor Beach	Moderate
	Cohasset Harbor	Briggs Cove	Reported

Hingham	Hingham Harbor	Hingham Beach	Reported
Hull	Hull Bay	Pt Allerton Beach	Reported
	Hull Bay	Windmill Pt Beach	Reported
Scituate	Scituate Harbor	Jericho Landing Beach	Reported
NORTH SHORE			
Ipswich	Ipswich Bay	Cranes Beach	Reported
Newbury	Plum Island Sd.	Parker River Refuge	High
Quincy	Quincy Bay	Wollaston Beach	Reported
Rockport	Sandy Bay	Old Garden Beach	Moderate
		Back Beach	Reported
		Front Beach	Reported

HORSESHOE CRAB NURSERY AREAS 2007

MOUNT HOPE BAY		
TOWN	EMBAYMENT	DENSITY
Somerset	Mount Hope Bay	High
	Taunton River	High
Swansea	Mount Hope Bay	High
	Coles River	High
BUZZARDS BAY		
Bourne	Buttermilk Bay	High
	Phinney's Harbor	High
Fairhaven	Nasketucket Bay	High
	Outer Harbor	Moderate
Mattapoisett	Mattapoisett Harbor	Reported
New Bedford	Outer Harbor	Moderate
Wareham	Buttermilk Bay	Reported
	Outer Wareham River	Moderate
Westport	Westport Rivers	Reported
SOUTH CAPE		
Barnstable	Lewis Bay	Reported
	Cotuit Bay	Moderate
Chatham	Cockle Cove Beach	High
	Stage Harbor	High
	Monomoy Island	High

Dennis	Bass River	High
Falmouth	Waquoit Bay	Reported
Mashpee	Waquoit Bay (Sage Lot Pond)	High
	Popponesset Bay	Moderate
Yarmouth	Bass River	High
MARTHA'S VINEYARD		
Aquinnah	Menemsha Pond	Moderate
Chilmark	Menemsha Pond	Moderate
Edgartown	Cape Poge Bay	Moderate
	Katama Bay	High
Oak Bluffs	Lagoon Pond	Reported
	Vineyard Haven Harbor	Reported
Tisbury	Lake Tashmoo	Moderate
NANTUCKET		
Nantucket	Madaket Harbor	Reported
	Muskeget Island	Reported
	Nantucket Harbor	High
	Tuckernuck Island	Reported
OUTER CAPE		
Chatham	Bassing Harbor	Reported
	Chatham Harbor	High
	Crowes Pond	Reported
	Pleasant Bay	High
Eastham	Nauset Marshes	Moderate
Harwich	Pleasant Bay	High
Orleans	Little Pleasant Bay	High
	Pleasant Bay	High
CAPE COD BAY		
Barnstable	Barnstable Harbor	High
Brewster	Brewster Flats	High
Dennis	Dennis Flats	High
Duxbury	Duxbury Bay	High
	Back River Marsh	High
Eastham	Eastham Flats	High
Kingston	Kingston Bay	Moderate

Orleans	Orleans Flats	High
Plymouth	Plymouth Harbor	High
Provincetown	Hatches Harbor	Reported
Truro	Pamet Harbor	Reported
Wellfleet	Wellfleet Harbor	High
Yarmouth	Yarmouth Flats	High
	Chase Garden Creek	Reported
MASSACHUSETTS BAY		
Cohasset	Cohasset Harbor	Reported
Hull	Hull Bay	Reported
Scituate	Scituate Harbor	Reported
NORTH SHORE		
Ipswich	Plum Island Sound	High
Newbury	Plum Island Sound	High