**APPENDIX B4**: Cooperative survey report from F/V Endeavor.

# 2008 Cooperative Industry Surf Clam/Ocean Quahog Survey Cruise Report
# *F/V Endeavor*


## SUMMARY

The 2008 Cooperative Surf Clam/Ocean Quahog Survey took place from September 10-23, 2008 following the 2008 NEFSC clam survey during June. The *F/V Endeavor*, based in Atlantic City, NJ was the commercial vessel used in the cooperative survey while the NEFSC survey used the NOAA Fishing Vessel R/V Delaware II. Leg 1 of the cooperative survey took place during September 11-15, leg 2 during 15-19th; and leg 3 during September 20-23rd, 2009. The cooperative survey was a joint effort by the National Fisheries Institute Clam Committee, Rutgers University, Virginia Institute of Marine Science, and the Northeast Fisheries Science Center.

Principal objectives of the survey were to: (1) further evaluate the feasibility of a cooperative clam survey using commercial vessels; 2) augment the NEFSC clam survey by repeating stations already sampled by the R/V Delaware II using the NEFSC clam survey dredge; (3) estimate efficiency of the NEFSC survey and commercial dredges by conducting depletion experiments; and (4) collect data for use in estimating size-selectivity for surfclams in the commercial and NEFSC survey dredges.


## VESSEL, GEAR, and CREW INFORMATION

The *F/V Endeavor* is a 165-foot fishing vessel with a 42-foot beam, a 14,000-gallon fuel tank, and a 12,000-gallon fresh water tank. It has two 12.5-foot wide dredges, deployed by hydraulic power-out winches. The vessel was specifically outfitted with dredges that had bars with spacing reduced to 0.75 inches to retain small ocean quahogs and surfclams. The starboard dredge was lined with 1-inch hexagonal chicken wire for size selectivity studies. The dredge knives were set at 5.25 inches for surf clam sites and at 4.25 inches for quahog sites.

Two small belts ran the catch from the port and starboard hoppers onto a larger, centralized belt that transported the catch across a shaker table and onto a sorting belt. The large belt before the shaker table was about 4 feet wide and 10 feet long. Alongside the belt was a large, metal stand where workers could access the catch before it reached the shaker table, where the catch was mechanically sorted. The average spacing between the rolling bars on the shaker table was 0.73 (+/- 0.10) inches.

A NEFSC Survey Sensor Package (SSP) that records latitude, longitude, angle of the dredge (fore/aft and port/starboard), temperature, depth, and internal manifold pressure every second was carried inside the port dredge and was operational for parts of legs 1 and 2. Two Vemco mini-loggers (which record ambient temperature and pressure/depth) were fastened to each dredge on a metal rod welded to the top near the manifold. The mini-logger sensors were operational during all three survey legs.

The crew was split into two, 12-hour shifts so that operations could take place around the clock. Each shift was made up of seven people, including the captain or mate, four scientists, and two crew members. On-deck responsibilities, including sorting and measuring the catch, were shared by all four scientists on shift. In addition, one scientist was responsible for interacting with

the captain to execute the cruise plan and one scientist (from NEFSC) was responsible for operating the SSP software package. Having seven people on each shift worked well and allowed the catch to be processed in a timely fashion while steaming between sites.

## SITE DESCRIPTIONS AND METHODS

*A. Surf Clam Size Selectivity Sites*

Experiments were done at these sites to determine the size-selectivity of the commercial dredge and the NEFSC survey dredge by comparing catches from a lined commercial dredge, an unlined commercial dredge and a NEFSC survey dredge at the same site. Selectivity experiment sites were chosen based on location, and the size and species composition of the NEFSC survey dredge catches in 2008.

Experimental protocol was to first tow 5-minutes with the port (unlined) dredge. The catch was allowed to run over the shaker table and onto the sorting belt in the normal fashion in order to capture effects of both the dredge and shaker table on size selectivity. The shaker table had been pre-configured to increase selectivity of the commercial equipment as a whole for small quahogs. Thus, size selectivity for small ocean quahogs may be higher than during normal commercial operations. The total number of bushels in addition to the number of clams in any partial bushel was counted along with the number of clams in two full bushels to permit conversion of bushel counts to numbers of animals. Clams in two full bushels were also measured to the nearest mm.

The site was then towed for 30 seconds along an adjacent track using the starboard (lined) dredge. This time the catch was sorted before going over the shaker table so that the entire catch was sampled, until at least 6 full bushels of clams had been collected. All clams in the six full bushel samples were measured, regardless of size. The remainder of the catch was discarded. The volume of the catch was too large to sort the entire catch or accurately measure its volume. However, size composition data for surf clams in both tows at the site are directly comparable. Sorting the catches from the lined dredge generally took between one and three hours.

*C. Surf Clam and Ocean Quahog Depletion Experiment*

Depletion experiments were conducted to estimate capture efficiency of the commercial and NMFS survey dredge. The R/V Delaware II completed five "setup" tows at a predetermined site prior to the arrival of the commercial vessel. The setup tows were generally parallel and oriented either north-south or east-west.

After arriving at the site, the chief scientist aboard the F/V Endeavor selected a rectangular area near as many of the five setup tows as possible. The rectangle was oriented perpendicular to the setup tows to the extent possible with a target width of about 10 times the width of the dredge (125 feet). The length of the site was chosen so that initial catches were at least 10 bushels per tow (typically 1200 to 2400 feet) based on trial tows near the edge and parallel to depletion site.

After the size of the site was defined, depletion tows were carried out repeatedly (typically 17-22 tows per site) by the F/V Endeavor using the port dredge until the site showed substantial depletion and catch per tow declined significantly. Tow paths were adjusted based on GPS data to tow sufficiently over the entire rectangle to see a significant decline in catch per tow in all areas of the rectangle. In most cases, this took place after the entire area of the rectangle was covered at least twice with the dredge –usually between 17 and 22 tows. Each tow was approximately 5-minutes in duration. Ship positions were recorded during maximally every 5 seconds, after which the catch was allowed to run over the shaker table and onto the sorting belt. On every tow the number of clam

bushels was counted and the partial bushel estimated. On every fifth tow, starting with tow two, one full bushel was measured and a second counted. Depletion experiments took anywhere between 9 and 16 hours to complete depending on the conditions at the site and the number of animals in the selected rectangular grid.

*D. Surfclam and Ocean Quahog Repeat Stations*

About halfway through the 2008 NEFSC clam survey with the Delaware II, an electrical cable used to power the pump on the survey dredge was replaced with a longer cable. Similarly, the pump on the NEFSC survey dredge was replaced after the original pump failed after about a third of the survey. The *F/V Endeavor* reoccupied some stations originally towed by the Delaware II which was using various configurations of old and new equipment to help quantify potential changes in survey dredge efficiency due to changing equipment. In some cases, these repeat station experiments were combined with or carried out at the same location as surfclam size selectivity and depletion experiments.

These sites had already been occupied either once or twice by the Delaware II during 2008 using the NEFSC survey dredge and the old and/or new cable and pump. At these sites the *F/V Endeavor* towed the port dredge for 5-minutes. The catch was run over the shaker table and onto the sorting belt. The total number of bushels was counted. The number of clams in the partial bushel and in two full bushels was counted, and all clams in the two full bushels were measured to the nearest mm.

**Results**

See Table 1 and Figure 1, which list the location and type of all cooperative stations, along with station numbers from the NEFSC clam survey for repeat stations.

The length frequency of all ocean quahogs measured on the survey can be found in Figure 2. The length frequency of all surf clams measured from 5-minute, unlined tows (size-selectivity experiments and depletion experiments) can be found in Figure 3. The length frequency of all surf clams measured from 30-second, lined tows can be found in Figure 4.

**Sensor data and area swept**

Sensor data was used to determine when the dredge was on/off bottom. Times on/off bottom were then matched to a GPS record of the ship's position to estimate area swept by the dredge. The NEFSC Survey Sensor Package used during the cooperative survey records latitude, longitude, angle of the dredge (fore/aft and port/starboard), temperature, depth, and internal manifold pressure every second. The frequency and resolution of the output data make it easy to determine when the dredge is on bottom and fishing. SSP data were not collected for some tows during Legs I and II because the battery could not be not fully charged due to lack of time between stations. Also, the SSP was not operational during Leg III due to lack of trained scientific staff. Therefore, SSP sensor data were available for less than half of the sites occupied. Fortunately, backup GPS and sensor data including ambient temperature and pressure (depth) from backup sensors are available for every tow.

The backup GPS and sensors were used to determine time on-bottom and area swept for tows with no SSP data. Backup sensors record depth at a lower resolution (accuracy approximately 5 meters) and at a lower frequency (5 second intervals) than the SSP. It was therefore necessary to use SSP data where available to develop procedures for estimating time on/off bottom and area swept using backup sensor data. The following steps were taken to determine when the dredge was fishing and subsequently estimate the area swept using these sensors for tows where SSP data was not

available:

1. The backup pressure (depth) data for each station was used to estimate times the dredge was on or off bottom. The resolution of the backup pressure data is 5 meters and the apparent trajectory of the dredge during the tow is noisy. In particular, a small change in depth can appear to be a large change. This adds uncertainty to the estimates of time on/off bottom.

2. Initial time on/off bottom estimates based on backup sensor data were compared to estimates from SSP data for 51 surfclam stations with SSP data. In comparing time on/off bottom estimates made using backup sensor and SSP data, it was noted that estimates based on backup sensors lagged SSP estimates by about 15 seconds. Estimates based on backup sensors were therefore corrected by subtraction of 15 seconds. After this adjustment, times on/off bottom differed, on average, by only 1 second (Table 2). Furthermore, after applying this correction, the chance of the backup sensor estimate being ahead of the SSP estimate and the chance of the backup sensor estimate being behind the SSP annotation were equal. The lag method was applied to all tows for which SSP data were lacking.

3. The initial time on/off bottom estimates based on backup sensor data were compared to estimates from SSP data for 34 ocean quahog tows from depletion experiments OQ0801 and OQ0802. Backup sensor estimates of time off bottom matched well with the SSP estimates. However, the backup sensor estimate of time on bottom averaged 15 seconds ahead of the estimates based on SSP data. With the adjustment for a 15 seconds lag described above, the backup sensor estimates differed from the SSP annotations by an average of four seconds. Furthermore, after applying this correction, the chance of the backup sensor estimate being ahead of the SSP estimate and the chance of the backup sensor estimate being behind the SSP annotation were equal. Therefore, the 15 second adjustment was used for all Vemco files across all tows and all experiments for which SSP data were lacking.

4. The SSP and adjusted backup sensor estimates of time on/off bottom were used to determine the area swept.

**COMMENTS**

Having primary (SSP) and backup GPS and sensor data for each tow is critical. Efforts should be made to increase the reliability of the SSP on commercial vessels and to increase the resolution and the recording frequency of backup sensors.

The ambient pressure sensor on the SSP malfunctioned unexpectedly because the tubing connecting it to the dredge had a tendency to plug up. A different approach to mounting the pressure sensor should be used next time.

Backup sensors should include an inclinometer to measure the fore/aft angle of the dredge, which are useful data in determining time on/off bottom.

Power out winches made it difficult to drop the dredge within a specific rectangular area during depletion experiments, and increased difficulties in interpreting time on/off bottom from backup sensor data. Boat operators were able to adjust towing procedures and to drop the dredge reliably in the rectangular area. However, the number of unsuccessful attempted tows increased over the previous years, adding time to the total time required to conduct the experiments. In the future an effort should be made to use free-fall winches.

The chicken wire liner proved to be sturdy and reliable. No repair was needed except at the leading edge behind the knife. Welding a bar across this leading edge in the future would eliminate this one weak point and permit long-term use of a lined dredge for improved estimates of smaller clams.

**SCIENTIFIC CREW**

Below is a list of names and email addresses for the scientific crew that participated in the survey. In addition to the science crew, aboard the vessel for all three legs were the captain, first mate, four crew members, and a cook (16 persons in total on each leg).

**Legs 1 and 2:**

| | |
|---|---|
| Kathryn Ashton-Alcox, HSRL | kathyryn@hsrl.rutgers.edu |
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**Leg 3:**

| | |
|---|---|
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**Table 1.** 2008 Cooperative Industry Surf Clam/Ocean Quahog Survey station list. "Shape on Map" refers to the map in Figure 1 where all stations are plotted using specific shapes to identify the purpose of the station.

| NMFS Site # | NMFS Depletion # | Shape on Map | Site Type | Lat | Long | # of Surf Clam Bushels (Depletion Sites, Tow 1 Only) | # of Quahog Bushels (Depletion Sites, Tow 1 Only) | Comments |
|---|---|---|---|---|---|---|---|---|
| 36 | N/A | STAR | Surf Clam Size Selectivity | 39.8597 | 73.7122 | 4 | 1.33 | |
| 49 | N/A | STAR | Surf Clam Size Selectivity | 39.6523 | 74.0078 | 6 | 0 | |
| 60 | N/A | STAR | Surf Clam Size Selectivity | 39.5688 | 74.1133 | 5.5 | 0 | |
| 64 | N/A | STAR | Surf Clam Size Selectivity | 39.4385 | 74.1782 | 3 | 0 | |
| | | | | | | | | |
| 292 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 40.0633 | 73.6757 | 22.33 | 0.67 | |
| 293 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.9765 | 73.5343 | 22 | 8.25 | |
| 294 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.9427 | 73.588 | 22 | 0.67 | |
| 295 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.8575 | 73.4783 | 22 | 3 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 296 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.7323 | 73.4477 | 29.75 | 0 | |
| 303 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.7213 | 73.8003 | 11 | 0 | |
| 304 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.7723 | 73.844 | 22.25 | 0 | |
| 310 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.8118 | 73.9473 | 17.75 | 0 | |
| 312 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.939 | 73.814 | 17 | 0.01 | |
| 313 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.9788 | 73.7162 | 19.5 | 0.25 | |
| 314 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.9832 | 73.8482 | 9 | 0 | |
| 315 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 40.1027 | 73.7745 | 22 | 0.33 | |
| 316 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 40.1465 | 73.945 | 28 | 0 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 318 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.5633 | 73.9113 | 9.5 | 0 | |
| 319 | N/A | CROSS | Repeat Surf Clam / Surf Clam Size Selectivity | 39.4768 | 73.911 | 11 | 0 | |
| | | | | | | | | |
| 67 | SC08-01 | CIRCLE | Surf Clam Depletion | 39.3073 | 74.054 | 6.5 | 0 | |
| 74 | SC08-02 | CIRCLE | Surf Clam Depletion | 39.188 | 74.0753 | 16.67 | 0 | |
| 297 | SC08-03 | CIRCLE | Surf Clam Depletion | 39.6028 | 73.41 | 16 | 0 | |
| 305 | SC08-04 | CIRCLE | Surf Clam Depletion | 39.8093 | 73.9132 | 11 | 0 | |
| 358 | SC08-05 | CIRCLE | Surf Clam Depletion | 41.1457 | 70.047 | 14 | 0 | The running tide, wind, and waves made it impossible to stay inside the rectangle at this location. Therefore, this site was terminated after 6 tows. |
| N/A | N/A (SC08-09) | CIRCLE | Surf Clam Depletion | 39.3117 | 74.0537 | 14 | 0 | We picked this site as an additional depletion site because SC08-05 was untowable. |
| | | | | | | | | |
| 324 | N/A | SQUARE | Repeat Quahog | 40.8915 | 71.859 | 0 | 14.5 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 326 | N/A | SQUARE | Repeat Quahog | 40.9422 | 71.9528 | 0 | 0 | No catch here. This tow was not run through the hopper because the dredge was filled with large rocks. |
| 333 | N/A | SQUARE | Repeat Quahog | 40.8555 | 72.12 | 0 | 43.33 | |
| 334 | N/A | SQUARE | Repeat Quahog | 40.8138 | 72.1755 | 0 | 20.25 | |
| 336 | N/A | SQUARE | Repeat Quahog | 40.773 | 72.4152 | 0 | 13 | |
| 338 | N/A | SQUARE | Repeat Quahog | 40.726 | 72.6485 | 0 | 14 | |
| 339 | N/A | SQUARE | Repeat Quahog | 40.558 | 72.6467 | 0 | 28 | |
| | | | | | | | | |
| 199 | N/A | INV. TRIANGLE | Quahog Old Wire | 40.2568 | 73.2653 | 0 | 6 | |
| 201 | N/A | INV. TRIANGLE | Quahog Old Wire | 40.1497 | 73.0467 | 0 | 29.25 | |
| 203 | N/A | INV. TRIANGLE | Quahog Old Wire | 40.2747 | 72.9737 | 0 | 27 | |
| 205 | N/A | INV. TRIANGLE | Quahog Old Wire | 40.3165 | 72.7473 | 0 | 18.5 | |
| 207 | N/A | INV. TRIANGLE | Quahog Old Wire | 40.187 | 72.9453 | 0 | 35.75 | |
| 209 | N/A | INV. TRIANGLE | Quahog Old Wire | 40.0577 | 72.8393 | 0 | 37.5 | |
| | | | | | | | | |
| 272 | N/A | TRIANGLE | Quahog New Wire | 40.5608 | 72.2457 | 0 | 22.75 | |
| 274 | N/A | TRIANGLE | Quahog New Wire | 40.6503 | 72.278 | 0 | 6.5 | |
| 276 | N/A | TRIANGLE | Quahog New Wire | 40.7298 | 72.2808 | 0 | 5.25 | |
| 278 | N/A | TRIANGLE | Quahog New Wire | 40.7298 | 72.086 | 0 | 64.5 | |
| 280 | N/A | TRIANGLE | Quahog New Wire | 40.8082 | 71.7798 | 0 | 0.67 | |
| 282 | N/A | TRIANGLE | Quahog New Wire | 40.6865 | 71.948 | 0 | 24.67 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 173 | OQ08-01 | DIAMOND | Quahog Depletion | 40.9363 | 72.0428 | 0 | 31.33 | |
| 287 | OQ08-02 | DIAMOND | Quahog Depletion | 40.2702 | 72.8483 | 0 | 30 | |
| 344 | OQ08-05 | DIAMOND | Quahog Depletion | 40.721 | 71.3465 | 0 | 4 | This site was untowable. |
| 351 | OQ08-06 | DIAMOND | Quahog Depletion | 41.0172 | 70.8558 | 0 | 34 | |
| N/A | N/A (OQ08-09) | DIAMOND | Quahog Depletion | 41.0187 | 70.8559 | 0 | 24 | We picked this site as an extra one because OQ08-05 was untowable, however, we needed to leave this site after 6 tows to bring in a sick crew member. |

**Table 2.** (On following pages): 15-second adjustments made to Vemco sensor on-bottom and off-bottom records to more closely match SSP on-bottom and off-bottom records. Columns 1 and 2, Depletion and Tow or Site #, identify the site. Column 3 and 5, On-Bottom-VEMCO and Off-Bottom-VEMCO, are the times the dredge was on the bottom and fishing and then off bottom, respectively, according to VEMCO sensor annotations. Adjusted + 15 seconds in columns 4 and 6 are the same times, but with a 15-second, or three reading adjustment. Columns 7 and 8, On-Bottom SSP and Off- Bottom SSP, are the times the dredge was on the bottom and fishing and then off bottom, respectively, according to SSP sensor annotations. The last four columns calculate the difference in seconds between the SSP data and the Vemco sensor data annotations before and after the 15-second adjustment was made.

| Depletion Station | Tow or Site # | On Bottom - VEMCO | Adjusted: + 15 seconds | Off Bottom- VEMCO | Adjusted: + 15 seconds | On Bottom- SSP | Off Bottom- SSP | On Bottom Difference: Un-adjusted | Off Bottom Difference: Un-adjusted | On Bottom Difference: adjusted | Off Bottom Difference: adjusted |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SC08-01 | 2 | 14:00:22 | 14:00:38 | 14:12:42 | 14:12:57 | 14:00:50 | 14:12:56 | 0:00:28 | 0:00:14 | 0:00:12 | -0:00:01 |
| SC08-01 | 3 | 14:49:15 | 14:49:30 | 15:01:15 | 15:01:30 | 14:49:25 | 15:01:27 | 0:00:10 | 0:00:12 | -0:00:05 | -0:00:03 |
| SC08-01 | 5 | 16:16:25 | 16:16:40 | 16:28:35 | 16:28:50 | 16:16:44 | 16:28:57 | 0:00:19 | 0:00:22 | 0:00:04 | 0:00:07 |
| SC08-01 | 6 | 16:50:35 | 16:50:50 | 17:03:25 | 17:03:40 | 16:50:27 | 17:03:50 | -0:00:08 | 0:00:25 | -0:00:23 | 0:00:10 |
| SC08-01 | 10 | 18:57:36 | 18:57:51 | 19:10:11 | 19:10:26 | 18:58:00 | 19:10:25 | 0:00:24 | 0:00:14 | 0:00:09 | -0:00:01 |
| SC08-01 | 13 | 20:39:31 | 20:39:46 | 20:51:51 | 20:52:06 | 20:39:48 | 20:52:05 | 0:00:17 | 0:00:14 | 0:00:02 | -0:00:01 |
| SC08-02 | 2 | 2:41:32 | 2:41:47 | 2:51:37 | 2:51:52 | 2:41:55 | 2:51:37 | 0:00:23 | 0:00:00 | 0:00:08 | -0:00:15 |
| SC08-02 | 3 | 3:23:21 | 3:23:36 | 3:33:06 | 3:33:21 | 3:23:45 | 3:33:07 | 0:00:24 | 0:00:01 | 0:00:09 | -0:00:14 |
| SC08-02 | 4 | 3:50:16 | 3:50:31 | 3:59:56 | 4:00:11 | 3:50:36 | 4:00:01 | 0:00:20 | 0:00:05 | 0:00:05 | -0:00:10 |
| SC08-02 | 5 | 4:17:01 | 4:17:16 | 4:27:06 | 4:27:21 | 4:17:27 | 4:27:11 | 0:00:26 | 0:00:05 | 0:00:11 | -0:00:10 |
| SC08-02 | 6 | 4:41:41 | 4:41:56 | 4:51:41 | 4:51:56 | 4:42:04 | 4:52:01 | 0:00:23 | 0:00:20 | 0:00:08 | 0:00:05 |
| SC08-03 | 1 | 2:08:29 | 2:08:44 | 2:16:59 | 2:17:14 | 2:08:55 | 2:17:22 | 0:00:26 | 0:00:23 | 0:00:11 | 0:00:08 |
| SC08-03 | 2 | 2:37:24 | 2:37:39 | 2:46:04 | 2:46:19 | 2:37:46 | 2:46:26 | 0:00:22 | 0:00:22 | 0:00:07 | 0:00:07 |
| SC08-03 | 4 | 3:48:42 | 3:48:57 | 3:57:17 | 3:57:33 | 3:49:04 | 3:57:38 | 0:00:22 | 0:00:21 | 0:00:07 | 0:00:05 |
| SC08-03 | 5 | 4:13:22 | 4:13:38 | 4:21:22 | 4:21:37 | 4:13:30 | 4:21:38 | 0:00:08 | 0:00:16 | -0:00:08 | 0:00:01 |
| SC08-03 | 7 | 5:01:52 | 5:02:07 | 5:10:32 | 5:10:47 | 5:02:14 | 5:10:55 | 0:00:22 | 0:00:23 | 0:00:07 | 0:00:08 |
| SC08-03 | 9 | 6:00:42 | 6:00:57 | 6:08:12 | 6:08:27 | 6:01:08 | 6:08:36 | 0:00:26 | 0:00:24 | 0:00:11 | 0:00:09 |
| SC08-03 | 12 | 7:19:27 | 7:19:42 | 7:28:27 | 7:28:42 | 7:19:56 | 7:28:47 | 0:00:29 | 0:00:20 | 0:00:14 | 0:00:05 |
| SC08-03 | 13 | 8:02:05 | 8:02:20 | 8:09:45 | 8:10:00 | 8:02:29 | 8:10:00 | 0:00:24 | 0:00:15 | 0:00:09 | 0:00:00 |
| SC08-03 | 14 | 12:00:45 | 12:01:00 | 12:10:00 | 12:10:15 | 12:00:49 | 12:10:02 | 0:00:04 | 0:00:02 | -0:00:11 | -0:00:13 |
| SC08-03 | 15 | 13:13:33 | 13:13:48 | 13:23:28 | 13:23:43 | 13:13:42 | 13:23:34 | 0:00:09 | 0:00:06 | -0:00:06 | -0:00:09 |
| SC08-03 | 16 | 13:44:38 | 13:44:53 | 13:54:38 | 13:54:53 | 13:44:51 | 13:54:43 | 0:00:13 | 0:00:05 | -0:00:02 | -0:00:10 |
| SC08-03 | 17 | 14:18:08 | 14:18:23 | 14:27:23 | 14:27:38 | 14:18:27 | 14:27:40 | 0:00:19 | 0:00:17 | 0:00:04 | 0:00:02 |
| SC08-03 | 18 | 15:00:21 | 15:00:36 | 15:09:21 | 15:09:36 | 15:00:41 | 15:09:49 | 0:00:20 | 0:00:28 | 0:00:05 | 0:00:13 |
| SC08-03 | 19 | 15:30:06 | 15:30:21 | 15:39:26 | 15:39:41 | 15:30:16 | 15:39:53 | 0:00:10 | 0:00:27 | -0:00:05 | 0:00:12 |
| SC08-03 | 21 | 16:51:16 | 16:51:31 | 17:00:11 | 17:00:26 | 16:51:36 | 17:00:32 | 0:00:20 | 0:00:21 | 0:00:05 | 0:00:06 |
| SC08-03 | 22 | 17:17:36 | 17:17:51 | 17:27:51 | 17:28:06 | 17:17:58 | 17:28:10 | 0:00:22 | 0:00:19 | 0:00:07 | 0:00:04 |
| SC08-04 | 2 | 22:44:17 | 22:44:32 | 22:55:02 | 22:55:17 | 22:44:26 | 22:55:04 | 0:00:09 | 0:00:02 | -0:00:06 | -0:00:13 |
| SC08-04 | 3 | 23:23:41 | 23:23:56 | 23:34:51 | 23:35:06 | 23:23:56 | 23:35:12 | 0:00:15 | 0:00:21 | 0:00:00 | 0:00:06 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SC08-04 | 5 | 0:50:31 | 0:50:46 | 1:01:56 | 1:02:11 | 0:50:48 | 1:02:08 | 0:00:17 | 0:00:12 | 0:00:02 | -0:00:03 |
| SC08-04 | 7 | 2:36:21 | 2:36:36 | 2:45:31 | 2:45:46 | 2:36:44 | 2:45:46 | 0:00:23 | 0:00:15 | 0:00:08 | 0:00:00 |
| SC08-04 | 8 | 3:10:44 | 3:10:59 | 3:19:49 | 3:20:04 | 3:10:55 | 3:20:10 | 0:00:11 | 0:00:21 | -0:00:04 | 0:00:06 |
| SC08-04 | 9 | 3:43:39 | 3:43:54 | 3:52:44 | 3:52:59 | 3:43:51 | 3:53:07 | 0:00:12 | 0:00:23 | -0:00:03 | 0:00:08 |
| SC08-04 | 10 | 4:13:49 | 4:14:04 | 4:22:59 | 4:23:14 | 4:13:55 | 4:23:19 | 0:00:06 | 0:00:20 | -0:00:09 | 0:00:05 |
| SC08-04 | 11 | 4:50:09 | 4:50:24 | 4:59:19 | 4:59:34 | 4:50:16 | 4:59:42 | 0:00:07 | 0:00:23 | -0:00:08 | 0:00:08 |
| SC08-04 | 12 | 5:23:24 | 5:23:39 | 5:32:29 | 5:32:44 | 5:23:40 | 5:32:49 | 0:00:16 | 0:00:20 | 0:00:01 | 0:00:05 |
| SC08-04 | 13 | 6:28:58 | 6:29:13 | 6:38:18 | 6:38:33 | 6:29:09 | 6:38:36 | 0:00:11 | 0:00:18 | -0:00:04 | 0:00:03 |
| SC08-04 | 14 | 7:00:43 | 7:00:58 | 7:10:13 | 7:10:28 | 7:00:59 | 7:10:30 | 0:00:16 | 0:00:17 | 0:00:01 | 0:00:02 |
| SC08-04 | 15 | 7:33:53 | 7:34:07 | 7:43:08 | 7:43:23 | 7:34:05 | 7:43:30 | 0:00:12 | 0:00:22 | -0:00:02 | 0:00:07 |
| SC08-04 | 16 | 8:01:03 | 8:01:18 | 8:10:08 | 8:10:23 | 8:01:09 | 8:10:28 | 0:00:06 | 0:00:20 | -0:00:09 | 0:00:05 |
| SC08-05 | 1 | 16:51:06 | 16:51:21 | 16:57:06 | 16:57:31 | 16:51:28 | 16:57:20 | 0:00:22 | 0:00:14 | 0:00:07 | -0:00:11 |
| SC08-05 | 2 | 17:13:26 | 17:13:41 | 17:19:31 | 17:19:46 | 17:13:34 | 17:19:51 | 0:00:08 | 0:00:20 | -0:00:07 | 0:00:05 |
| SC08-05 | 3 | 19:08:53 | 19:09:08 | 19:14:28 | 19:14:43 | 19:09:20 | 19:14:43 | 0:00:27 | 0:00:15 | 0:00:12 | 0:00:00 |
| SC08-05 | 6 | 21:04:18 | 21:04:33 | 21:10:48 | 21:11:03 | 21:04:43 | 21:11:01 | 0:00:25 | 0:00:13 | 0:00:10 | -0:00:02 |
| | 304 | 9:37:14 | 9:37:29 | 9:43:54 | 9:44:09 | 9:37:34 | 9:44:10 | 0:00:20 | 0:00:16 | 0:00:05 | 0:00:01 |
| | 303 | 14:17:59 | 14:18:14 | 14:24:14 | 14:24:29 | 14:18:14 | 14:24:37 | 0:00:15 | 0:00:23 | 0:00:00 | 0:00:08 |
| | 36 | 17:10:13 | 17:10:28 | 17:16:43 | 17:16:58 | 17:10:32 | 17:16:57 | 0:00:19 | 0:00:14 | 0:00:04 | -0:00:01 |
| | 312 | 18:43:43 | 18:43:58 | 18:51:28 | 18:51:43 | 18:44:05 | 18:51:41 | 0:00:22 | 0:00:13 | 0:00:07 | -0:00:02 |
| | 313 | 21:46:33 | 21:46:48 | 21:54:28 | 21:54:43 | 21:46:46 | 21:54:39 | 0:00:13 | 0:00:11 | -0:00:02 | -0:00:04 |
| | 314 | 0:22:38 | 0:22:53 | 0:30:13 | 0:30:28 | 0:22:42 | 0:30:13 | 0:00:04 | 0:00:00 | -0:00:11 | -0:00:15 |
| | 316 | 2:48:28 | 2:48:43 | 2:55:08 | 2:55:33 | 2:48:28 | 2:55:48 | 0:00:00 | 0:00:40 | -0:00:15 | 0:00:15 |
| | | | | | | **Average Difference:** | | **0:00:16** | **0:00:16** | **0:00:01** | **0:00:01** |

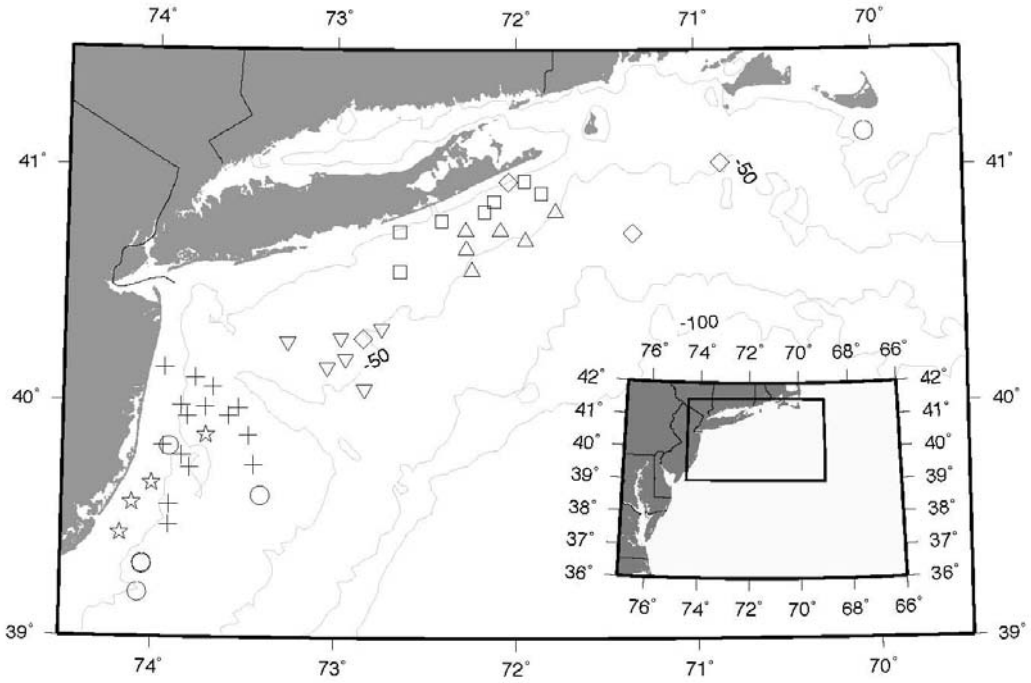



**Figure 1.** Map of site locations from the 2008 Cooperative Industry Surf Clam/Ocean Quahog Survey. Shapes indicate the type of site. See Table 1 for which tows are represented by which shape.

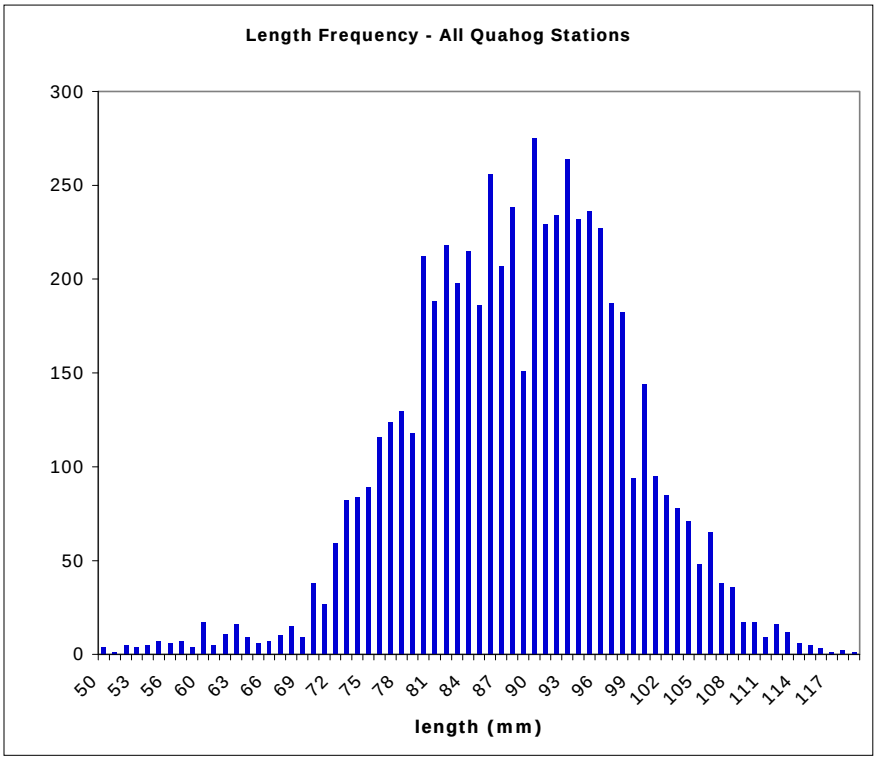



**Figure 2.** The length frequency of all ocean quahogs measured on 2008 Cooperative Industry Surf Clam/Ocean Quahog Survey

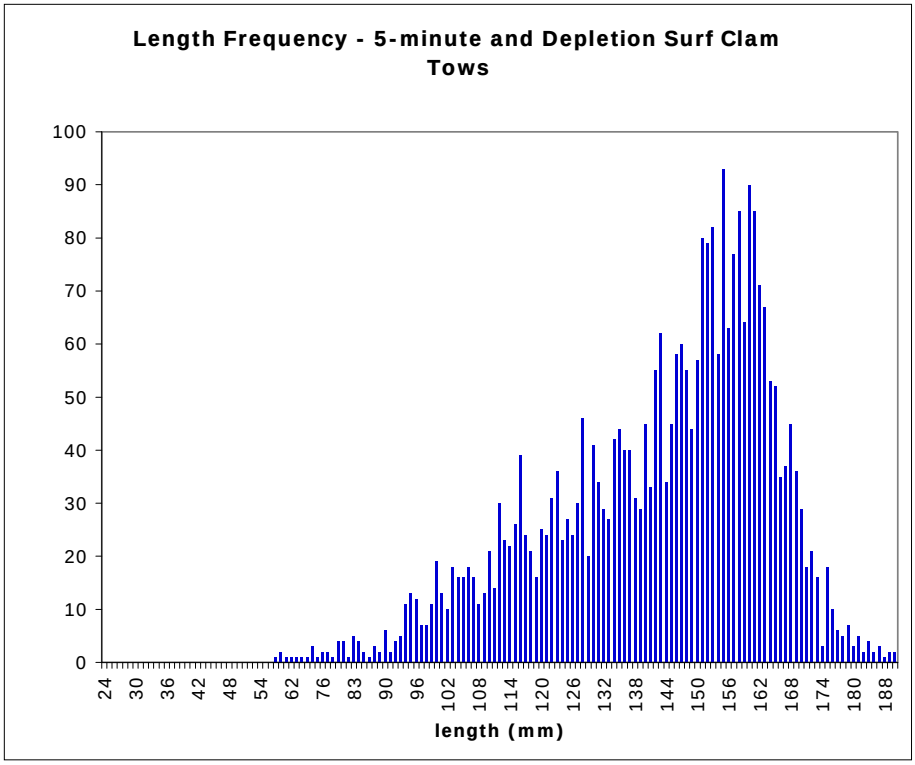



**Figure 3.** The length frequency of all surf clams measured from 5-minute, unlined tows (size-selectivity experiments and depletion experiments) on 2008 Cooperative Industry Surf Clam/Ocean Quahog Survey

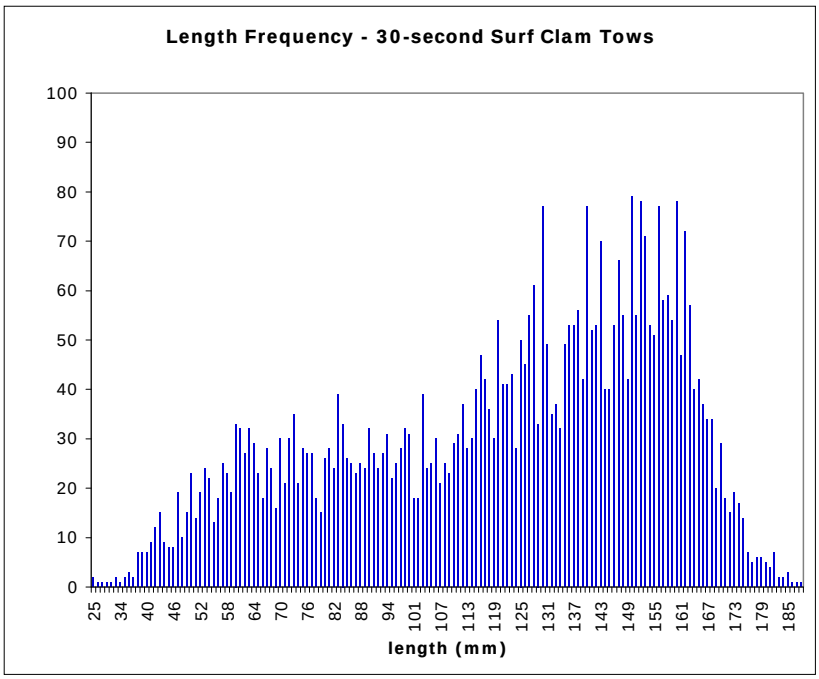



**Figure 4.** The length frequency of all surf clams measured from 30-second, lined tows on 2008 Cooperative Industry Surf Clam/Ocean Quahog Survey

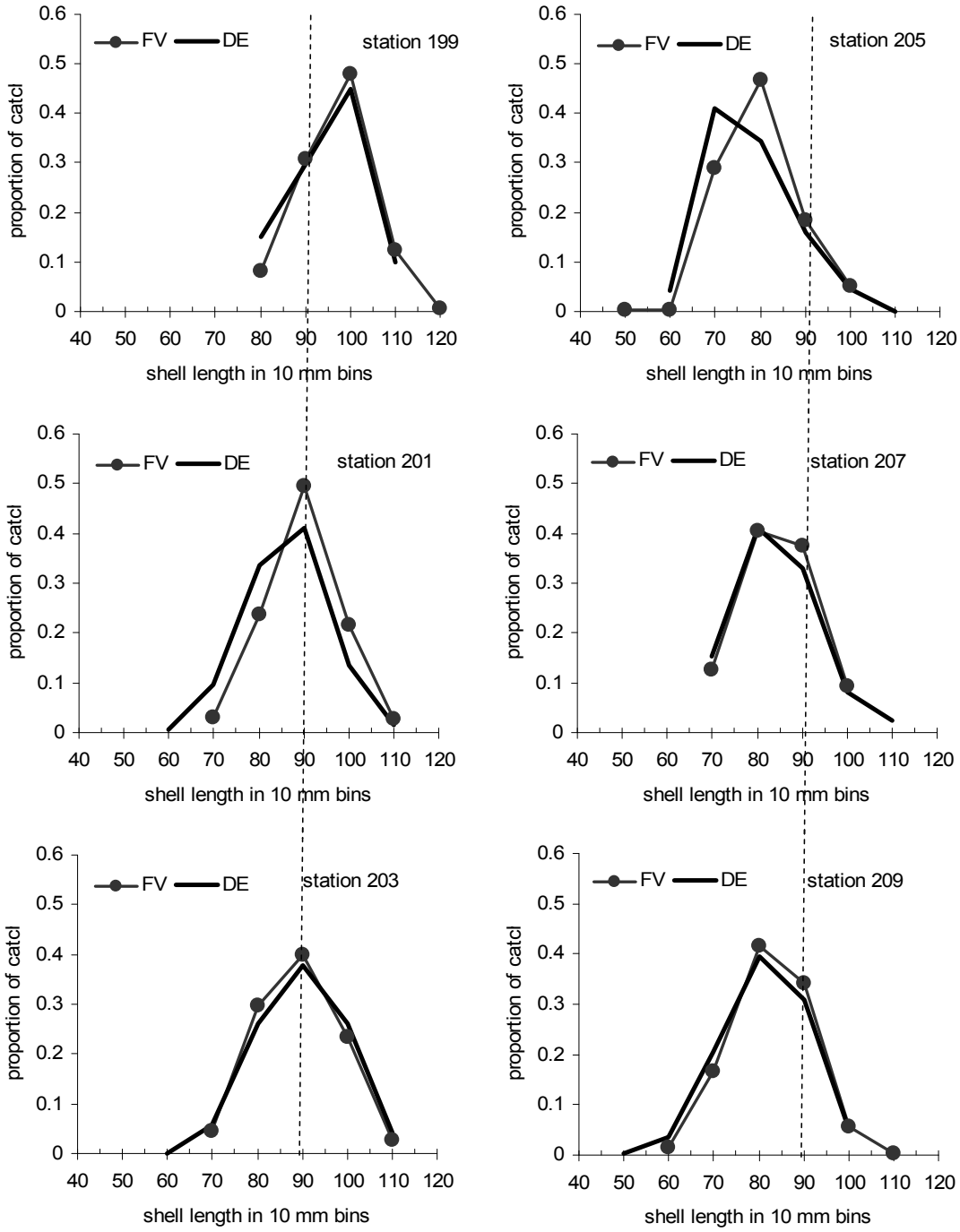



Figure 5. Length composition data for DE2FV repeat tows. For example, 70 mm on the x-axis refers to the 70-79 mm SL bin. Values on the y-axis are proportions of the total.

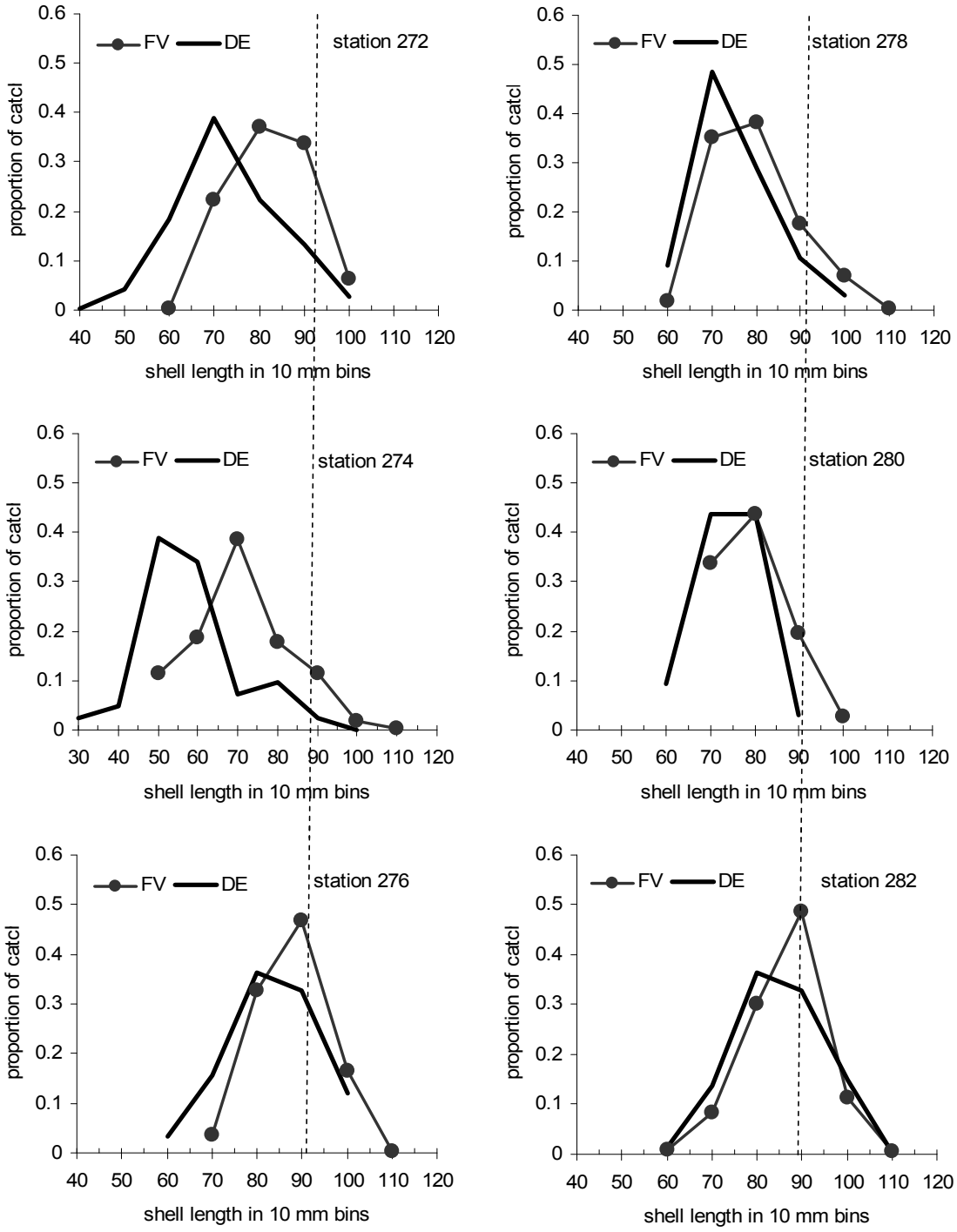
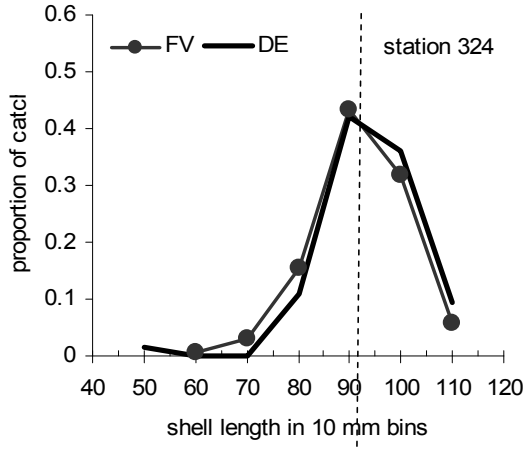
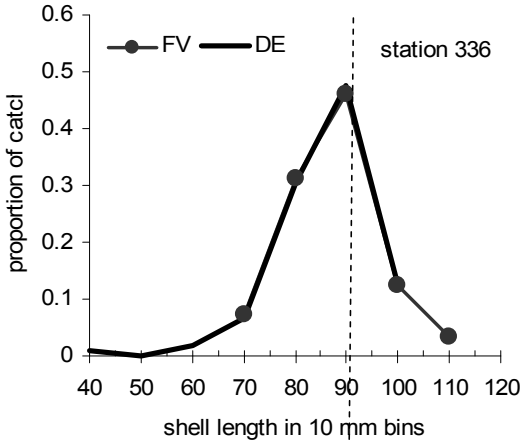
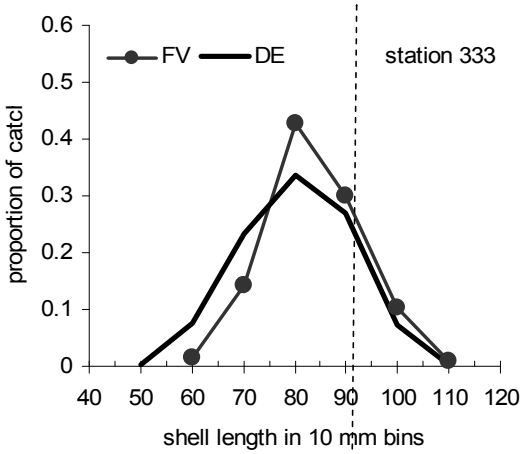
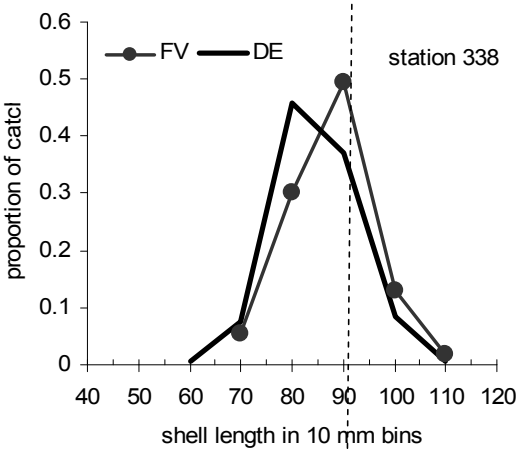


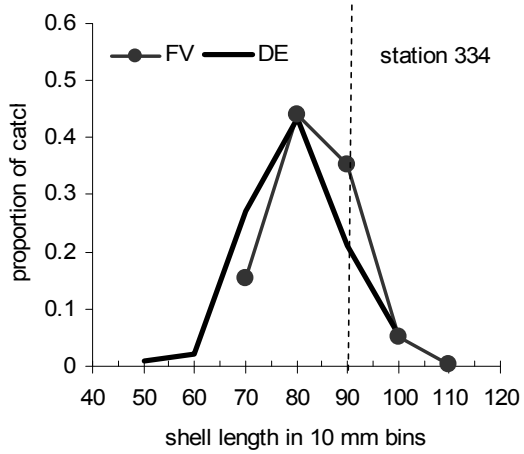

Figure 5. (cont.)

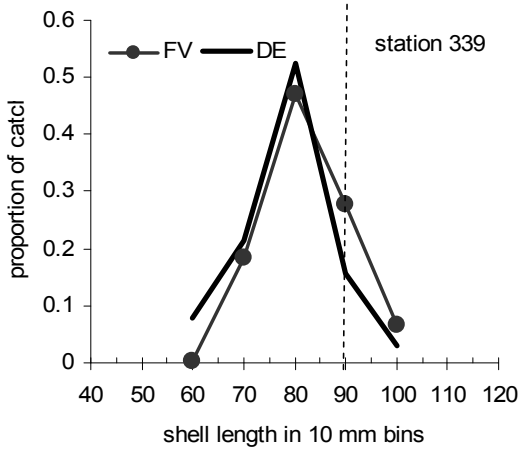

FV
DE
station 324
proportion of catcl
0.6
0.5
0.4
0.3
0.2
0.1
0
40 50 60 70 80 90 100 110 120
shell length in 10 mm bins


FV
DE
station 336
proportion of catcl
0.6
0.5
0.4
0.3
0.2
0.1
0
40 50 60 70 80 90 100 110 120
shell length in 10 mm bins


FV
DE
station 333
proportion of catcl
0.6
0.5
0.4
0.3
0.2
0.1
0
40 50 60 70 80 90 100 110 120
shell length in 10 mm bins


FV
DE
station 338
proportion of catcl
0.6
0.5
0.4
0.3
0.2
0.1
0
40 50 60 70 80 90 100 110 120
shell length in 10 mm bins


FV
DE
station 334
proportion of catcl
0.6
0.5
0.4
0.3
0.2
0.1
0
40 50 60 70 80 90 100 110 120
shell length in 10 mm bins


FV
DE
station 339
proportion of catcl
0.6
0.5
0.4
0.3
0.2
0.1
0
40 50 60 70 80 90 100 110 120
shell length in 10 mm bins