2015 Final Report

Summary

A comparative field experiment was initiated at two intertidal flats in southern Maine (Wells – Webhannet River; Portland – Fore River) during late May 2015. The experiment was designed to examine survival and growth of cultured juveniles of the soft-shell clam, *Mya arenaria* L., in units that were assigned randomly to one of five predator exclusion treatments – control (no predator protection), flexible netting (4.2 mm aperture), flexible netting together with extruded netting (6.4 mm aperture), Pet screening (1.6 mm aperture; top of unit), and Pet screening (top and bottom of unit). The flexible netting was designed to deter large crustacean predators such as rock crabs, *Cancer irroratus* Say, and green crabs (*Carcinus maenas* L.) as well as siphon-nipping fish such as the mummichog, *Fundulus heteroclitus* (L.), and other large, mobile predators. Pet screening was used to deter large predators as well as the nemertean *Cerebratulus lacteus* (Leidy) that is not deterred by the larger aperture netting.

Experiments were initiated near the upper intertidal at both intertidal flats, and two random locations were chosen where three blocks were established (ca. 20 m apart) that each contained two replicates of each predator exclusion treatment. A total of sixty experimental units (plastic horticultural plant pots 15 cm diameter x 15 cm deep (Area = 0.01824 m^2) were used at each flat. Twelve cultured juvenile soft-shell clams (13.1 ± 0.6 mm) were added to each unit after the unit had been filled with ambient sediments and pushed into the flat so that the unit was level with the sediment surface.

After 144 days, units were removed from the flat at each location and the contents of each washed through a 1 mm sieve that retained live wild and cultured clams as well as broken fragments of cultured clam valves. In addition, predators were noted, enumerated, and, in the case of crabs, the carapace width was measured. All live and dead clams were enumerated, and a growth rate estimated by measuring the length of a distinct disturbance line that forms on the valves of the cultured clams when they are added to sediments in the field and then subtracting that measure from the total length of the clam.

Mean survival in units that received no predator netting (controls) was 0% at the Wells flat and < 5% at the Fore River site. Similar results were observed for clams in experimental units placed

near the upper intertidal of both flats in 2014. No consistent significant difference in mean clam survival was observed among any of the predator exclusion treatments at either flat. Pet screening resulted in higher survival at one of the two locations at the Webhannet River site, but similar results were not observed in the Fore River. Predator exclusion netting resulted in a 3-5x enhancement of wild 0-year class soft-shell clams (spat) compared to open controls at both flats. Growth rates were related to predator-exclusion treatment, with significantly lower (44-50%) absolute growth (final SL – initial SL) occurring for clams grown in units protected by Pet screening vs. those in units protected by the flexible netting or the combination of flexible and extruded netting.

Results from 2015 were very similar to those at the same tidal height at both sites in 2014, and suggest, once again, that predation on small clams (both wild and cultured) is intense and can easily explain the recent declines in wild clam populations in many intertidal areas in southern Maine. In this region, highest commercial densities of soft-shell clams are restricted to the uppermost areas of the intertidal zone where, historically, clam harvesters did not dig clams since there were larger, faster-growing populations located near the mid and lower intertidal. Also, previous studies have shown that compared to the lower intertidal, predation intensity is lower near the upper shore.

This study, and the study from the previous year combined with recent field trials in the Freeport area, suggest that a new management strategy is necessary for clam populations in southern Maine. Traditional approaches to soft-shell clam management in this region are no longer effective. Rather than focusing on large tracts (entire mud flats), effort should be placed on enhancing smaller patches where controlled work to deter predators can take place. This may be in the form of public or private aquaculture, but it makes no sense for communities to close large areas of mudflats in hopes that the reduction in commercial harvesting is going to result in higher densities of commercial clams. Quite the opposite appears to happen in an era when increasing seawater temperatures are resulting in an incursion of invasive predators such as the European green crab and the Asian shore crab. In addition, milky ribbon worm densities appear to be high in this region of Maine, and, while this is not an invasive but endemic species, its predatory behavior can cause nearly 100% mortality of soft-shell clams in seeded plots.

Methods

A comparative field experiment was initiated at two upper intertidal sites in the Webhannet River, Wells, Maine (Fig. 1), and the Fore River in South Portland, Maine (Fig. 2) for a 144-day period (25-26 May to 16-17 October 2015) to determine effects of predation on survival of cultured juveniles of the soft-shell clam, *Mya arenaria* L., and on wild clam recruits (i.e., 0-year class individuals (sensu Commito, 1982; Beukema and Dekker, 2005).

At each site, two intertidal locations (ca. 100 m apart) were chosen, and within each location three 2 x 5 blocks ca. 20 m apart (two replicates of each of five treatments) were established with 1m spacing between rows and columns. Experimental units (plastic horticultural pots – 15 cm diameter x 15 cm deep) were used to examine the effect of the predator-exclusion treatments (Table 1) on cultured soft-shell clam growth and survival as well as the presence of 0-year class recruits of *Mya arenaria*. Cultured juveniles of *M. arenaria* ($\bar{x}_{SL}$ =13.1 ± 0.6 mm SL, n = 58) were produced at the Downeast Institute for Applied Marine Research and Education, Beals, Maine (44° 28' 50.5626" N; -67° 35' 54.9342" W) during 2014 and overwintered according to Beal et al. (1995). Experimental units within each block were dug into the sediments to a depth of ca. 15 cm, and then filled with ambient sediments. Twelve juvenile clams were added to each unit by gently pushing each animal several millimeters under the sediment surface within each unit.

After 144 days, the units from each block were removed from the sediments and the contents of each washed through a 2 mm sieve. All live and dead clams were enumerated, and the initial and final SL of all intact clams measured to the nearest 0.01 mm using digital Vernier calipers. Although clams were not marked uniquely, a disturbance line is laid down in the shell upon placing the cultured juveniles in sediments (Beal, 1995) that is used to establish the SL at the beginning of the experiment. The initial SL and final SL were used to estimate relative growth ([Final SL - Initial SL]/Initial SL) and absolute growth (Final SL - Initial SL). Dead clams were divided between those with undamaged valves (DU) and those with chipped or crushed valves (DC). Clams missing from each experimental unit also were noted. In addition to the cultured clams, all 0-year class wild clams (that are visually distinct from the cultured clams because they have no "hatchery mark"), milky ribbon worms, *Cerebratulus lacteus*, and green crabs, *Carcinus* *maenas*, were enumerated. For wild clams and crabs, the SL and carapace width (CW), respectively, was measured to the nearest 0.01 mm. 0-year class individuals were defined as wild clams < 20 mm in SL because most of the clams > 20 mm SL had an obvious winter check/ disturbance line (sensu Beal and Kraus, 2002) within several mm of the umbo.

Analysis of variance was used to determine treatment and other effects on clam survival, growth, and numbers/size of wild clam recruits at each intertidal site (Wells and South Portland) separately. The following linear model was used in each instance:

$Y_{ijkl} = \mu + A_i + B(A)_{j(i)} + C_k + AC_{ik} + CB(A)_{jk(i)} + e_{l(ijk)}$, where:

Y_{ijkl} = Dependent variable (mean percent survival; mean relative and absolute growth; mean number and size of wild recruits)
A_i = Location (i = 1 to 2; factor is fixed);
B_j = Block (j = 1 to 3; factor is random);
C_k = Treatment (k = 1 to 5; factor is fixed);
e_l = Experimental error (unit-to-unit variation within a given treatment, block, and location; n = 2).

Data were transformed when they failed to meet assumptions of normality or variance homogeneity. A decision rule of $\alpha = 0.05$ was used to determine statistical significance. All means are accompanied by their 95% confidence intervals unless otherwise stated.

A series of a priori (orthogonal), single degree-of-freedom contrasts was performed on the treatment source of variation as follows:

a) OPEN vs. REST (compares mean of the dependent variable in open experimental units vs. the mean in units protected from predators. This contrast assesses the effect of predators on each dependent variable);
b) FLEX vs. PET (compares mean of the dependent variable in units protected with flexible and flexible with VEXAR vs. those protected with pet screening.

This contrast assesses the effect of using a relatively large vs. small aperture netting on each dependent variable);

c) FLEX vs. FLEX & VEX (compares mean of the dependent variable in units protected with flexible netting vs. those with both flexible netting and VEXAR. This contrast examines the efficacy of using a single vs. double protective barrier to discourage predation.); and,

d) PET (TOP) vs. PET (TOP & BOTTOM) (compares mean of the dependent variable in units protected with pet screen over the top of the experimental unit vs. units that are protected both on top and bottom of the unit. This contrast assesses the efficacy of eliminating infaunal predation by milky ribbon worms that can access units protected with netting through the holes in the bottom of the experimental units).

A conservative decision rule (α') was used for each contrast based on advice from Winer et al. (1991) who cautioned against excessive type I error by reducing α using the following equation: $\alpha' = 1 - (1 - \alpha)^{1/m}$ where m = the number of contrasts. In this instance, because $m = 4$, $\alpha' = 0.0127$.

Results

Webhannet River

Survival of cultured clams

Predation was intense at both intertidal locations. No live clams were found in any of the six open (unprotected controls) experimental units at either location (Table 2). The effect of deterring predators was an increase in overall mean survival of 47.2 ± 10.5% (n = 48; Table 2). The effect of the predator exclusion treatments on survival was not, however, similar across both intertidal locations (Table 3; Fig. 6). The Location x Treatment source of variation was significant (P = 0.0013; Table 3), and the lone orthogonal contrast of the four for the interaction source of variation that was statistically significant was Location x Flexible Netting vs. Pet Screening (Fig. 7). No significant difference in mean survival was apparent between the two types of predator exclusion treatments (Flex vs. Pet) at Location 2 that was closer to the mouth of the Webhannet River, and where more sandy sediments occurred compared to Location 1 (mean survival across the four netted treatments at Location 2 = 38.9 ± 14.48%, n = 24). At Location 1, there was a mean difference of 52.8 ± 21.8% (n = 24) in clam survival between units protected with the flexible netting (29.2 ± 21.8%, n = 12) vs. those with the pet screening (81.9 ± 7.77%, n = 12). This difference was statistically significant using a Welch's t-test (P = 0.0002). More clams were observed crushed and missing from units with the combination of flexible netting and VEXAR at Location 1 (40.3% and 16.7%, respectively) than at Location 2 (8.3 % and 4.2%, respectively; Table 2).

Green crabs

A total of 50 green crabs, *Carcinus maenas*, were found in the 60 experimental units. Crabs were sampled from 21 of 30 (70%) experimental units at Location 1 and in 11 of 30 (36.7%); however, mean number per unit (0.83 ± 0.27 ind., n = 60) did not differ across locations (P = 0.0806; Table 4). ANOVA did not demonstrate a significant effect due to treatment (P = 0.0755; Fig. 8), and, while none of the four a priori contrasts were statistically significant ($\alpha' = 0.0127$), approximately 4.5x as many crabs were found in units protected with flexible netting and VEXAR (1.50 ± 0.84 ind., n = 12) vs. Pet screen applied to the top of the units (0.33 ± 0.31 ind., n = 12). Mean CW of crabs (11.70 ± 2.52 mm, n = 32) per experimental unit did not differ significantly by location (P = 0.6365) or by predator exclusion treatment (0.1053). Size-frequency distribution of green crabs varied significantly across treatments (P = 0.0011, Fisher's Exact Test; Fig. 9). Crabs > 10 mm were more likely to occur in units with flexible netting or with flexible netting and VEXAR.

0-year class recruits

ANOVA on the mean number of 0-year class recruits (Table 5) indicated that there was no significant difference between locations (Location 1 = 3.67 ± 1.86 ind./unit; Location 2 = 7.70 ± 5.05 ind./unit; n = 30; P = 0.4143). Both the treatment and location x treatment source of variation (Fig. 10) were statistically significant (P = 0.0002 and 0.0411, respectively). The interaction plot (Fig. 10) demonstrates how the lone significant contrast (Location x Pet-Top vs. Pet-Bottom) explains the nature of the overall interaction term. For example, at Location 1 (closer to the upper part of the estuary, and in muddier sediments than Location 2), there was no significant difference between the two means ($\bar{x}_{Pet-Top}$ vs. $\bar{x}_{Pet-Btm}$ = 8.33 ± 8.17 vs. 6.5 ± 3.02 ind./unit, n = 6), but at Location 2, the difference between the means was 2.79 ± 1.75 ind./unit (t = 3.57, df = 10, P = 0.0051) with significantly greater number of recruits found in units protected with pet screening on both top and bottom (4.08 ± 1.65 ind./unit; n = 6).

Mean size of 0-year class soft-shell clams varied significantly over the predator-exclusion treatments (Table 6). Clams in the open units were significantly smaller than those in the units with flexible netting, which were larger than clams in units with Pet screening (Fig. 11). No clams > 20 mm SL were found in open experimental units, and only three units protected with Pet Screen (of 24) contained 1-year class clams (2.6 ± 3.79 ind./unit). Conversely, seven units protected with flexible netting or both flexible netting and VEXAR (of 24) contained the older clams at a density of 10.4 ± 6.7 ind./unit.

Growth of cultured clams

Absolute growth (final SL - Initial SL) was used in all statistical analyses because this estimate, unlike relative growth, was independent of initial clam size (F = 1.14; df = 1, 270; $r^2 = 0.0042$; P = 0.2858). Mean absolute growth was 9.53 ± 0.74 mm over the 144-day period, or 0.066 ± 0.061 mm/day (n = 36); however, rates varied significantly (P = 0.0014) between predator exclusion treatments (Table 6). Clams grew fastest in units with the larger aperture netting (4.2 mm and 6.4 mm – FLEX and FLEX & VEX), and slower in units with Pet screening (PET-TOP and PET-TOP & BTM) (Table 7). Pet screening resulted in an average depression of 51.5% in absolute growth and 30.5% in final SL compared to the larger aperture netting.

Fore River

Survival of cultured clams

Mean clam survival (Table 8) did not vary significantly between the two locations and the effect of the treatments did not vary significantly between the two locations (P = 0.3477 and 0.4938, respectively; Table 9). The treatment effect explained ca. 53% of the total variation in mean survival, with the a priori contrast (Open vs. Rest) demonstrating the relative importance of predation (99.5% of the variation due to the treatment source of variation was explained by this contrast). Pooled across both locations, the difference of 71.35 ± 16.60% in mean clam survival between open (2.78 ± 3.45 %, n = 12) vs. protected units (74.13 ± 8.25%, n = 48) shows clearly that predation on juvenile clams was intense at this intertidal site. The treatment effect due to flexible netting or flexible netting with VEXAR on mean survival (71.53 ± 13.92%, n = 24) did not produce significantly different survival results than units protected with Pet screening either on the top or both top and bottom (76.74 ± 9.90%, n = 24; P = 0.6602; Table 9) suggesting that milky ribbon worm, *Cerebratulus lacteus*, predation was not important at either intertidal locations. Dead clams with undamaged valves (typical of nemertean predation) did not vary significantly between units with Pet screen tops vs. Pet screen tops and bottom screen inserts at either locations (Table 8).

Green crabs

Clam mortality associated with shells that were chipped or crushed varied from 0% in some units protected with Pet screening to as high as 38.9% in some open units (Table 8). Although crushing or chipping could occur due to sources other than green crabs, *Carcinus maenas*, such as rock crabs, *Cancer irroratus* (pers. obs.), only individuals of *C. maenas* were discovered in experimental units on 17 October (n = 21). Of the thirty experimental units in both locations, nine crabs were found Location 1 (30%), and 11 at Location 2 (36.7%). Mean number per unit

(0.35 ± 0.16 ind., n = 60) did not differ significantly across locations (P = 0.7780; Table 10). ANOVA did not demonstrate a significant effect due to treatment (P = 0.1036), and none of the four a priori contrasts were significant (α' = 0.0127); however, no crabs were recovered in open pots (Fig. 14). Mean crab CW was 9.3 ± 3.5 mm (n = 18 units; minimum CW = 4.7 mm, maximum = 28.5 mm), which did not differ between locations (P = 0.8826; Table 11); however, there was both a significant treatment and location x treatment effect (Table 11; Fig. 15). The significant interaction effect likely was due to a larger mean CW of crabs from Location 1 in units from treatments protected with the large netting (flexible and flexible & VEXAR) vs. those in the two other treatments, but the same pattern was not observed at Location 2 (Fig. 15). Size-frequency distribution of *C. maenas* (Fig. 16) did not vary significantly across treatments (Fishers Exact Test, P = 0.7439).

0-year class recruits

At least one wild soft-shell clam recruit was found in every experimental unit. A total of 1,049 recruits (clams < 20 mm SL) were found in the sixty experimental units (an average of ca. 17.5 per unit). Mean number per unit varied significantly by location (P = 0.0328) and treatment (0.0012) (Table 12; Fig. 17). Approximately 80% more wild recruits were recovered from units at Location 2 ($\bar{x} = 22.5 \pm 5.1$ ind./unit – 1235 ± 277.6 ind./m^2, n = 30) than from Location 1 ($\bar{x} = 12.4 \pm 3.4$ ind./unit – 681.7 ± 187.9 ind./m^2, n = 30). In addition, the ANOVA demonstrated that significant enhancement of recruits occurred in units with any type of predator protective netting vs. those without (P = 0.0001; Table 12). Approximately 3x more recruits were recovered in units with netting (20.2 ± 3.6 ind./unit, n = 48) than without (6.7 ± 4.3 ind./unit, n = 12).

Mean shell length of 0-year class soft-shell clams varied significantly across treatments (P = 0.033, Table 13; Fig. 18), with recruits in open units attaining a size of 6.9 ± 2.3 mm (n = 12), and those in the protected units approximately 30% larger (9.0 ± 0.7 mm, n = 48). The a priori contrasts indicated that this difference was statistically significant (P = 0.0081, Table 13). The size-frequency distribution of recruits (Fig. 19), and subsequent analysis of frequencies (sizes grouped into four equal 5 mm bins – 0 to 5 mm, 5.1-10 mm, 10.1-15 mm, 15.1-19.9 mm; Table 14), indicated that sizes of clams in the units with Pet screening were distributed similarly.

Smallest recruits were recovered from open units. Clams > 20 mm SL (n = 84) were found in units across all treatments; however, only 3.5% of these clams were recovered from open units.

Growth of cultured clams

As with the growth analyses for the clams from the Webhannet River, absolute growth was used in all statistical analyses because this estimate was independent of initial clam size (F = 1.78; df = 1,429; $r^2 = 0.00414$; P = 0.1824). Mean absolute growth pooled across all treatments and locations was 8.36 ± 0.95 mm over the 144-day trial, or 0.058 ± 0.007 mm/day (n = 47). Absolute growth differed among treatments (Table 15), with clams in units protected with flexible netting or the combination of flexible netting and VEXAR attaining final SL's that were approximately 78% greater (10.5 ± 0.89 mm, n = 21) than clams in units protected with Pet screening (5.9 ± 0.82 mm, n = 23; Fig. 20). Pet screening resulted in an average depression of 20.4% in final SL (and 44% in absolute growth) compared to clams in units protected with the larger aperture netting.

Discussion

Predation of cultured clams in open units was intense at both study sites (Wells and Portland) for the second consecutive year. In 2015, no clams survived in control (open) experimental units in the Webhannet River, and only four clams (of 144, or 2.8%) in the Fore River. Mean survival of clams in units protected with flexible netting or with flexible netting and VEXAR was ca. 33% in the Webhannet River and more than double that (71.5%) in the Fore. This difference was due, mainly, to the presence of green crabs (see the dead crushed column in Table 2) in experimental units at the two Webhannet locations. A total of 50 green crabs were recovered from units at the Wells site, where 4.5x more crabs occurred in units with the larger aperture netting (i.e., flexible and flexible & VEXAR) than in units protected with Pet screening. This suggests that crabs became entrapped in units with the 4.2 mm flexible netting sometime after the experiment was initiated in late May. On the other hand, at the Fore River site, only 20 green crabs were noted in units in October, and there was no significant difference in mean number of crabs across treatments at that site. Survival in units protected with Pet screening depended on location, with nearly 82% of animals recovered alive at location 1 (Fig. 1) but only about half of that recovered alive at location 2 (42%). Relatively high (i.e., > 60%) survival occurred in all units protected with Pet screening at the Fore River site.

This difference between control and predator-exclusion netting, while clearly not absolute, underscores the importance of predators in these estuarine systems and provides an opportunity to understand effects of shellfish management on wild clam populations in the southern portion of the Maine coast. For example, coastal communities that practice co-management of their soft-shell clam resources with the Maine Department of Marine Resources have many tools at their disposal to protect existing clams and encourage wild recruits to settle on their intertidal soft-bottom flats. One tool that is used by all communities is the closing of certain flats, mostly to reduce harvesting pressure that allows existing clams that may be sub-legal to grow to commercial size while the closure is in effect (Beal and Vencile, 2001). Typically, this indirect approach is not assessed for its effectiveness (such as comparing densities of clams before-vs. after-closure), but results from the present study, combined with similar results from both study sites in 2014 and those from elsewhere in Maine that have examined the role of predation on the survival of soft-shell clam juveniles – Beal and Kraus, 2002 ; Beal, 2006 – suggest that when predators are numerous, closing of flats does not result in high survival rates of clams less than 1-inch. That is, the data from the open units presented here and elsewhere show that survival rates of young (small) clams are extremely low (< 5%). Studies conducted recently (2015) in Freeport suggest that high densities of young clams (0- and 1-year class individuals – ca. 300/m^2) can be protected using large pieces (14-ft x 14-ft) of the flexible netting (4.2 mm aperture) (Beal, pers. obs. and see the third progress report to NOAA/NMFS – SK at http://downeastinstitute.org/2015-field-trials.htm).

While it appears that Pet screening does protect clams better than the larger aperture 4.2 mm flexible netting, approximately 36% of clams in location 2 in the Webhannet River, and 20% of clams in location1 in the Fore River, were recovered dead with undamaged valves. Because no nemertean worms – *Cerebratulus lacteus* – were observed in the units, one hypothesis is that these clams may have succumbed to anoxic conditions due to low flow caused by the small aperture of the mesh; however, no units contained anoxic sediments at the time of processing during fall 2015.

Protecting cultured clams from predators can sometimes result in a "double bonus": higher survival than in unprotected plots, and increased natural recruitment of 0-year class clams. In this study, enhancement of clam recruits (spat) occurred at both study sites, with significantly more wild recruits recovered from protected vs. unprotected units (Figs. 10 & 17).

Clam growth (measured as absolute growth – final SL minus initial SL) at both study sites differed across predator exclusion treatments. While no clams survived in open units at the Wells site, clams grew 51% slower in units protected with Pet screening than with flexible netting. A similar (44%) growth depression due to Pet screening was observed for clams at the Portland site.

In summary, these results, and those obtained from the same sites in 2014 suggest that doing nothing (allowing a flat to fallow for the sake of reducing harvesting pressure by clammers) is not a reasonable management option. If large parcels of the intertidal cannot be protected, then it does not make sense to allow predators to have unrestricted access to the sublegal clams. Upon seeing a green crab or nemertean worm while clamming, harvesters should be encouraged to remove these predators from the flat where they will not be a danger in future to the clams that remain after the harvest.

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TABLES

Table 1. The five experimental treatments used in the seasonal studies in the Webhannet River, Wells, Maine and Fore River, South Portland, Maine (May to October 2015). All treatments were configured using 15 cm diameter x 15 cm deep horticultural plant pots (experimental units) filled with ambient sediments that were placed flush with the mudflat surface. Each pot contained a series of 12 mm holes in the bottom that allowed drainage during periods of low tide. Twelve cultured juveniles of soft-shell clams, *Mya arenaria* (13.1 ± 0.6 mm SL, n = 58), were added to the sediments within each unit.

Treatment	**Description**
OPEN	A piece of 4.2 mm flexible netting[1] surrounds the rim of the unit and extends ca. 12 mm above the surface of the unit. Netting was used to keep clams from crawling outside the unit, but did not keep predators from having access to the clams (Fig. 3).
FLEX	A piece of 4.2 mm flexible netting completely encloses the unit to deter predators from accessing clams within the unit (Fig. 4).
FLEX & VEX	A piece of extruded VEXAR®[2] netting (6.4 mm) covers the top of the unit, and this is held in place by a piece of 4.2 mm flexible netting that completely encloses the unit (Fig. 5).
PET TOP	A piece of Pet screening[3] (1.8 mm aperture) completely encloses the unit to deter predators from accessing the clams within the unit. This level of predator protection is designed to keep out small crabs and the nemertean worm, *Cerebratulus lacteus* from entering the unit from the mud surface.
PET TOP & BTM	A circular piece of Pet screening that is the same diameter as the experimental unit is fitted into the bottom of the unit prior to filling with ambient sediments. Then, a piece of Pet screening is used to completely enclose the unit. This treatment is designed to deter small crabs and the nemertean worm, *Cerebratulus lacteus*, from entering the unit either from the mud surface or from within the sediments through the holes in the bottom of the experimental unit.

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[1] Polypropylene (OV7100; Industrial netting; http://www.industrialnetting.com/ov7100.html).

[2] Polyethylene (XV1170; Industrial netting; http://www.industrialnetting.com/xv1170.html)

[3] Pet screen (http://www.phifer.com/consumerdiy/product/62/petscreen-pet-resistant-screen)

Table 2. Fate of cultured individuals of *Mya arenaria* ($\bar{x}_{SL}$=13.1 ± 0.6 mm SL, n = 58) at two upper intertidal locations within the Webhannet River over a 144-day period (25 May to 16 October 2015; Fig. 1). Twelve clams were planted in each of ten shallow (15 cm x 15 cm) experimental units (horticultural plant pots – see Table 1) in a 2 x 5 matrix (blocks) at each of three sites within each location. The data are pooled across the three blocks at each location. %A = Mean percent recovered alive; %DU = Mean percent recovered dead with undamaged valves; %DC = Mean percent recovered dead with chipped or crushed valves; %M = Mean percent missing. All means are accompanied by a 95% confidence interval. (n = 6)

Location	Treatment	%A	%DU	%DC	%M
1	OPEN	0.00 (-)	1.39 (3.57)	4.17 (7.32)	94.44 (7.14)
	FLEX	34.72 (42.27)	13.89 (31.61)	33.33 (41.02)	18.06 (18.69)
	FLEX & VEX	23.61 (31.49)	19.44 (18.06)	40.28 (29.48)	16.67 (13.48)
	PET (TOP)	80.56 (11.95)	4.17 (7.31)	2.78 (4.52)	12.50 (12.05)
	PET (TOP & BTM)	83.33 (14.63)	4.17 (7.31)	5.56 (14.28)	6.94 (8.59)
2	OPEN	0.00 (-)	0.00 (-)	2.78 (4.52)	97.22 (4.52)
	FLEX	25.00 (34.54)	11.11 (20.45)	36.11 (29.61)	27.78 (26.91)
	FLEX & VEX	47.22 (33.94)	40.28 (31.00)	8.33 (11.07)	4.17 (10.71)
	PET (TOP)	23.61 (27.33)	36.11 (34.39)	16.67 (27.66)	23.61 (31.49)
	PET (TOP & BTM)	59.72 (40.42)	37.50 (42.39)	0.00 (-)	2.78 (4.52)

Table 3. Analysis of variance on the arcsine-transformed mean percent alive data from the Webhannet River (25 May to 16 October 2015). Location refers to two upper intertidal sites within the River System (Fig. 1). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment and Location x Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n = 2)

Source of Variation	DF	Sum of Squares	Mean Square	F-Value	Pr > F
Location	1	1546.613933	1546.613933	0.94	0.3863
Block(location)	4	6554.82917	1638.70729	3.24	0.0253
Treatment	4	23259.15218	5814.78805	26.20	<.0001
Open vs. Rest	1	16183.92616	16183.92616	72.92	<.0001
Flex vs. Pet	1	5723.83318	5723.83318	25.79	0.0001
Flex vs. Vex	1	142.78001	142.78001	0.64	0.4343
Pet Top vs. Pet Top & Btm	1	1208.61284	1208.61284	5.45	0.0330
Location x Treatment	4	6708.67720	1677.16930	7.56	0.0013
Location x Open vs. Rest	1	386.65348	386.65348	1.74	0.2055
Location x Flex vs. Pet	1	3921.39404	3921.39404	17.67	0.0007
Location x Flex vs. Vex	1	1586.67592	1586.67592	7.15	0.0166
Location x PetT vs. PetT&B	1	813.95376	813.95376	3.67	0.0735
Block x Treatment(Location)	16	3551.25038	221.95315	0.44	0.9575
Error	30	15176.62652	505.88755		
Total	59	56797.14938			

Table 4. Analysis of variance on the square root-transformed mean number of green crabs, *Carcinus maenas* from experimental units in the Webhannet River on 16 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 1). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n = 2)

Source of Variation	DF	Sum of Squares	Mean Square	F-Value	Pr > F
Location	1	3.06477603	3.06477603	5.41	0.0806
Block(Location)	4	2.26595356	0.56648839	1.86	0.1438
Treatment	4	3.87277502	0.96819376	2.60	0.0755
Open vs. Rest	1	0.94014934	0.94014934	2.53	0.1316
Flex vs. Pet	1	1.16068360	1.16068360	3.12	0.0965
Flex vs. Vex	1	0.62672203	0.62672203	1.68	0.2128
Pet Top vs. Pet Btm	1	1.14522006	1.14522006	3.08	0.0986
Location x Treatment	4	0.75602454	0.18900614	0.51	0.7308
Block x Treatment(Location)	16	5.95592217	0.37224514	1.22	0.3087
Error	30	9.14699333	0.30489978		
Total	59	25.06244466			

Table 5. Analysis of variance on the square root-transformed mean number of wild recruits from experimental units in the Webhannet River on 16 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 1). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment and Location x Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n = 2)

```
Source                          DF   Sum of Squares   Mean Square    F-Value   Pr > F

Location                         1     3.34892698      3.34892698      0.83    0.4143
Block(Location)                  4    16.17799106      4.04449777      1.97    0.1246
Treatment                        4    65.58303145     16.39575786     10.95    0.0002
  Open vs. Rest                  1    25.45025266     25.45025266     16.99    0.0008
  Flex vs. Pet                   1    22.01817059     22.01817059     14.70    0.0015
  Flex vs. Vex                   1     6.72287882      6.72287882      4.49    0.0501
  Pet Top vs. Pet Btm            1    11.39172938     11.39172938      7.61    0.0140
Location x Treatment             4    19.21116952      4.80279238      3.21    0.0411
  Location x Open v Rest         1     1.21896051      1.21896051      0.81    0.3803
  Location x Flex v Pet          1     2.29800614      2.29800614      1.53    0.2333
  Location x Flex v Vex          1     3.63502779      3.63502779      2.43    0.1388
  Location x PetT v PetB         1    12.05917507     12.05917507      8.05    0.0119
Block x Treatment(Location)     16    23.96143471      1.49758967      0.73    0.7438

Error                           30    61.5869582
Total                           59   189.8695119
```

Table 6. Analysis of variance on mean absolute growth of cultured soft-shell clam juveniles from experimental units in the Webhannet River over a 144-day period from 25 May to 16 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 1). Treatment refers to predator exclusion treatments (Table 1). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. Because not all experimental units contained live clams (36 of 60), the result was an unbalanced data set; hence, Type III sums of squares are presented (Shaw and Mitchell-Olds, 1993) (n = 2)

```
Source                       DF        Squares    Mean Square    F Value    Pr > F
Location                      1     4.11131176     4.11131176       0.48    0.5250
Block(Location)               4     33.9884628      8.4971157       2.20    0.1262
Treatment                     3    619.2228138    206.4076046      10.71    0.0014
Location x Treatment          3    144.5031807     48.1677269       2.50    0.1137
Block x Treatment(Location)  11    211.9204694     19.2654972       4.98    0.0039

Error                        13     50.2781087      3.8675468
Corrected Total              35    973.9106327
```

Table 7. Mean (± 95% CI) absolute growth (mm) and final SL (mm) of cultured soft-shell clam juveniles from experimental units in the Webhannet River over a 144-day period from 25 May to 16 October 2015. n refers to the number of experimental units (of 12) that contained live clams.

Treatment	**n**	**Absolute growth**	**Final SL**
OPEN	0	-	-
FLEX	7	16.7 ± 2.89	30.6 ± 1.84
FLEX & VEX	8	12.9 ± 2.23	26.6 ± 2.67
PET (TOP)	10	8.4 ± 3.39	20.6 ± 3.33
PET (TOP & BTM)	11	6.0 ± 1.91	19.2 ± 2.01

Table 8. Fate of cultured individuals of *Mya arenaria* ($\bar{x}_{SL}$=13.1 ± 0.6 mm SL, n = 58) at two upper intertidal locations within the Fore River over a 144-day period (26 May to 17 October 2015; Fig. 2). Twelve clams were planted in each of ten shallow (15 cm x 15 cm) experimental units (horticultural plant pots – see Table 1) in a 2 x 5 matrix (blocks) at each of three sites within each location. The data are pooled across the three blocks at each location. %A = Mean percent recovered alive; %DU = Mean percent recovered dead with undamaged valves; %DC = Mean percent recovered dead with chipped or crushed valves; %M = Mean percent missing. All means are accompanied by a 95% confidence interval. (n = 6)

Location	**Treatment**	**%A**	**%DU**	**%DC**	**%M**
1	OPEN	4.17 (7.31)	0.00 (-)	30.56 (13.17)	65.27 (8.59)
	FLEX	65.27 (47.71)	2.78 (7.14)	29.17 (45.53)	2.78 (7.14)
	FLEX & VEX	69.44 (36.97)	5.56 (7.14)	22.22 (41.27)	2.78 (7.14)
	PET (TOP)	62.50 (35.31)	20.83 (18.13)	16.67 (42.84)	0.00 (-)
	PET (TOP & BTM)	66.67 (22.80)	19.44 (14.28)	13.89 (31.61)	0.00 (-)
2	OPEN	1.39 (3.57)	1.39 (3.57)	38.89 (21.18)	58.33 (21.42)
	FLEX	70.83 (38.62)	2.78 (4.52)	19.44 (42.00)	6.95 (11.62)
	FLEX & VEX	80.55 (14.28)	9.72 (12.87)	2.78 (7.14)	6.95 (11.62)
	PET (TOP)	87.50 (13.26)	9.72 (14.01)	0.00 (-)	2.78 (4.52)
	PET (TOP & BTM)	90.28 (6.58)	1.39 (3.57)	0.00 (-)	8.33 (7.82)

Table 9. Analysis of variance on the arcsine-transformed mean percent alive data from the Fore River (26 May to 17 October 2015). Location refers to two upper intertidal sites within the River System (Fig. 2). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment and Location x Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n = 2)

Source	DF	Sum of Squares	Mean Square	F-Value	Pr > F
Location	1	1333.372492	1333.372492	1.13	0.3477
Treatment	4	31474.75436	7868.68859	18.66	<.0001
Open vs. Rest	1	31330.28395	31330.28395	74.32	<.0001
Flex vs. Pet	1	84.61809	84.61809	0.20	0.6602
Flex vs. Vex	1	28.84934	28.84934	0.07	0.7970
Pet Top vs. Pet Btm	1	31.00297	31.00297	0.07	0.7897
Location X Treatment	4	1496.11063	374.02766	0.89	0.4938
Block(Location)	4	4719.78256	1179.94564	2.59	0.0567
Block x Treatment(Location)	16	6745.34104	421.58382	0.92	0.5520
Error	30	13673.12387	455.77080		
Total	59	59442.48495			

Table 10. Analysis of variance on the square root-transformed mean number of green crabs, *Carcinus maenas* from experimental units in the Fore River on 17 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 2). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment source of variation. An adjusted decision rule ($\alpha' = 0.0127$) was used for each contrast (Winer et al., 1991). Experimental units ($N = 10$) were arrayed within each of three blocks at each location in a completely generalized randomized block design. ($n = 2$)

Source	DF	Sum of Squares	Mean Square	F-Value	Pr > F
Location	1	0.02189870	0.02189870	0.09	0.7780
Treatment	4	2.21347486	0.55336872	2.30	0.1036
Open vs. Rest	1	1.52741433	1.52741433	6.35	0.0228
Flex vs. Pet	1	0.01518468	0.01518468	0.06	0.8048
Flex vs. Vex	1	0.66666667	0.66666667	2.77	0.1155
PetT vs. PetB	1	0.00420919	0.00420919	0.02	0.8964
Location x Treatment	4	1.34179509	0.33544877	1.39	0.2805
Block(Location)	4	0.96338228	0.24084557	1.11	0.3694
Block x Treatment(Location)	16	3.84979175	0.24061198	1.11	0.3887
Error	30	6.50000000	0.21666667		
Corrected Total	59	14.89034268			

Table 11. Analysis of variance on the mean carapace width of green crabs, *Carcinus maenas* from experimental units in the Fore River on 17 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 2). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n is variable from 1 to 4 – number of experimental units containing crabs; hence, Type III sums of squares are presented.)

```
Source                          DF    Sum of Squares    Mean Square    F-Value    Pr > F

Location                         1        3.66870137     3.66870137       0.02    0.8828
Treatment                        3       195.8265753     65.2755251      28.29    0.0106
Location x Treatment             2       125.3315150     62.6657575      27.16    0.0120
Block(Location)                  4       594.4851521    148.6212880      25.18    0.0043
Block x Treatment(Location)      3         6.9217063      2.3072354       0.39    0.7669

Error                            4        23.6139500      5.9034875
Corrected Total                 17       837.1293285
```

Table 12. Analysis of variance on the square root-transformed mean number of wild soft-shell clam recruits (0-year class individuals; < 20.0 mm SL) from experimental units in the Fore River on 17 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 2). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n = 2)

Source	DF	Sum of Squares	Mean Square	F-Value	Pr > F
Location	1	21.56631185	21.56631185	10.26	0.0328
Treatment	4	41.20266816	10.30066704	7.70	0.0012
Open vs. Rest	1	33.63921340	33.63921340	25.16	0.0001
Flex vs. Pet	1	1.63500390	1.63500390	1.22	0.2852
Flex vs. Vex	1	5.46720615	5.46720615	4.09	0.0602
PetT vs. PetB	1	0.46124470	0.46124470	0.34	0.5652
Location x Treatment	4	9.55407128	2.38851782	1.79	0.1810
Block(Location)	4	8.40606193	2.10151548	1.12	0.3647
Block x Treatment(Location)	16	21.39450808	1.33715675	0.71	0.7587
Error	30	56.1927882	1.8730929		
Corrected Total	59	158.3164095			

Table 13. Analysis of variance on the mean shell length of wild soft-shell clam recruits (0-year class individuals; < 20.0 mm SL) from experimental units in the Fore River on 17 October 2015. Location refers to two upper intertidal sites within the River System (Fig. 2). Treatment refers to predator exclusion treatments (Table 1). A series of single degree-of-freedom contrasts appears below the Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Experimental units (N = 10) were arrayed within each of three blocks at each location in a completely generalized randomized block design. (n = 2)

```
                                          Sum of
Source                             DF     Squares       Mean Square     F-Value    Pr > F

Location                            1    78.86545662    78.86545662       7.03     0.0569
Treatment                           4    66.93564115    16.73391029       3.43     0.0330
  Open vs. Rest                     1    44.46293519    44.46293519       9.13     0.0081
  Flex vs. Pet                      1     3.24678689     3.24678689       0.67     0.4263
  Flex vs. Vex                      1    17.59513680    17.59513680       3.61     0.0756
  PetT vs. PetB                     1     1.63078227     1.63078227       0.33     0.5709
Location x Treatment                4    20.85351470     5.21337868       1.07     0.4035
Block(Location)                     4    44.89446839    11.22361710       1.64     0.1912
Block x Treatment(Location)        16    77.94993801     4.87187113       0.71     0.7625

Error                              30    205.8852452      6.8628415
Corrected Total                    59    495.3842641
```

Table 14. Analysis of size frequency distribution of 0-year class soft-shell clams in experimental units located in the Fore River, Portland, Maine on 17 October 2015. Shell lengths were divided into four size classes (0-5.0 mm, 5.1-10.0 mm, 10.1-15.0 mm, and 15.1-19.9 mm). Each source is represents an orthogonal comparison of treatments.

Source	df	χ^2	P-value
Open units vs. Rest	**3**	**42.2473**	**<0.0001**
Flexible net vs. Rest	**3**	**18.7318**	**<0.0001**
VEXAR & Flex vs. Rest	**3**	**11.2013**	**0.0104**
Pet (Top) vs. Pet (Top & Btm)	**3**	**2.1419**	**0.5435**
Total	**12**	**74.3223**	**<0.0001**

Table 15. Mean (± 95% CI) absolute growth (mm) and final SL (mm) of cultured soft-shell clam juveniles from experimental units in the Fore River over a 144-day period from 26 May to 17 October 2015. n refers to the number of experimental units (of 12) that contained live clams.

Treatment	**n**	**Absolute growth**	**Final SL**
OPEN	3	11.5 ± 14.60	26.1 ± 12.78
FLEX	10	10.5 ± 1.54	23.6 ± 1.23
FLEX & VEX	11	10.6 ± 2.23	23.6 ± 1.36
PET (TOP)	11	5.9 ± 1.34	18.9 ± 1.16
PET (TOP & BTM)	12	5.9 ± 1.20	18.7 ± 1.34

Table 16. Analysis of variance on the mean absolute growth (Final SL – Initial SL) for live clams recovered from experimental units at the Fore River, Portland, Maine (26 May to 17 October 2015). Location refers to one of two upper intertidal sites (see Fig. 2). At each location, three blocks (5 x 2) were arrayed approximately 50 m apart in a completely generalized randomized block design, with two replicates of each of five predator-exclusion treatments (see Table 1). A series of single degree-of-freedom contrasts appears below the Treatment source of variation. An adjusted decision rule (α' = 0.0127) was used for each contrast (Winer et al., 1991). Because not all experimental units were recovered with live clams, the data were unbalanced; hence, Type III sums of squares were used. (n = 2)

Source	DF	Sum of Squares	Mean Square	F-Value	Pr > F
Location	1	19.11667738	19.11667738	1.21	0.3335
Treatment	4	256.0042531	64.0010633	9.95	0.0007
Open vs. Rest	1	26.0619723	26.0619723	4.05	0.0653
Flex vs. Pet	1	228.0571212	228.0571212	35.46	<.0001
Flex vs. Vex	1	0.1283452	0.1283452	0.02	0.8898
PetT vs. PetB	1	0.0064942	0.0064942	0.00	0.9751
Location x Treatment	4	1.7503202	0.4375800	0.07	0.9905
Block(Location)	4	63.3313708	15.8328427	4.96	0.0061
Block x Treatment(Location)	13	83.6093931	6.4314918	2.02	0.0769
Error	20	63.8095513	3.1904776		
Corrected Total	46	485.4774033			

FIGURES

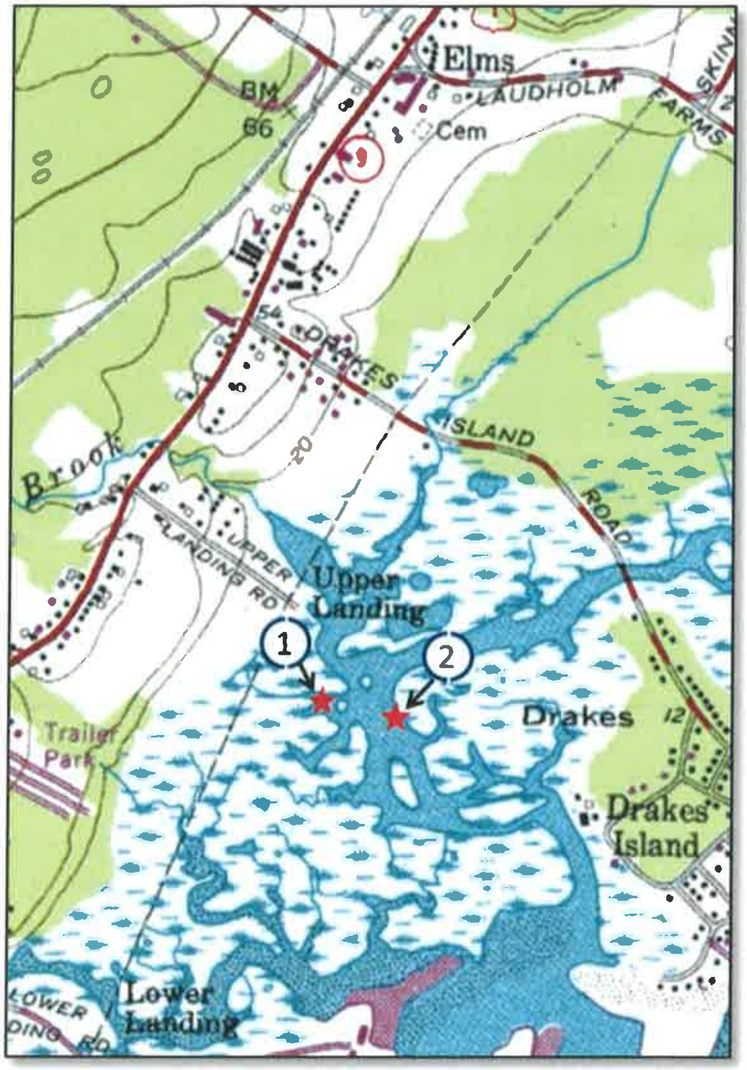

Figure 1. Intertidal study sites in the Upper Webhannet River, Wells, Maine (25 May to 16 October 2015). Three blocks containing two replicates of each treatment (see Table 1) were located approximately 20 m apart at each of the study sites labeled as "1" (43° 19' 39.4062" N; -70° 33' 57.9126" W) and "2" (43° 19' 38.4492" N; -70° 33' 50.652" W). Both sites were located near the upper intertidal.

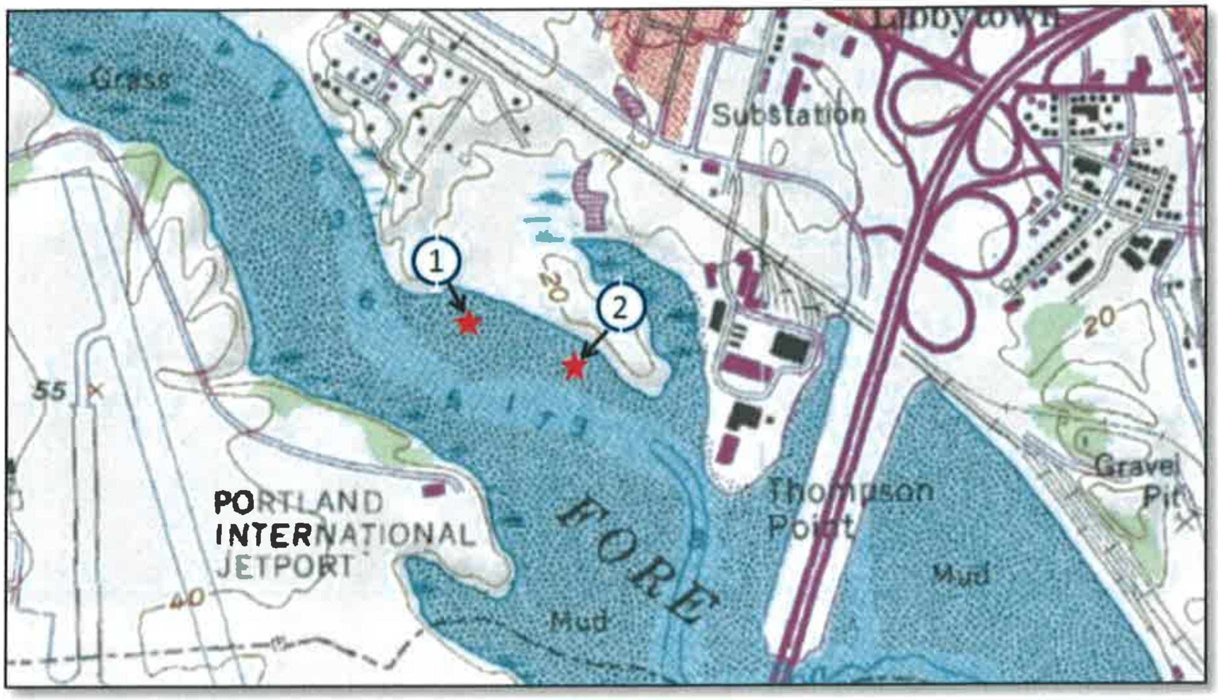

Figure 2. Intertidal study sites in the Fore River, Portland, Maine (26 May to 17 October 2015). Three blocks containing two replicates of each treatment (see Table 1) were located approximately 20 m apart at each of the study sites labeled as "1" (43° 39' 6.7752" N; -70° 17' 51.234" W) and "2" (43° 39' 4.1508" N; -70° 17' 42.9684" W). Both sites were located near the upper intertidal.

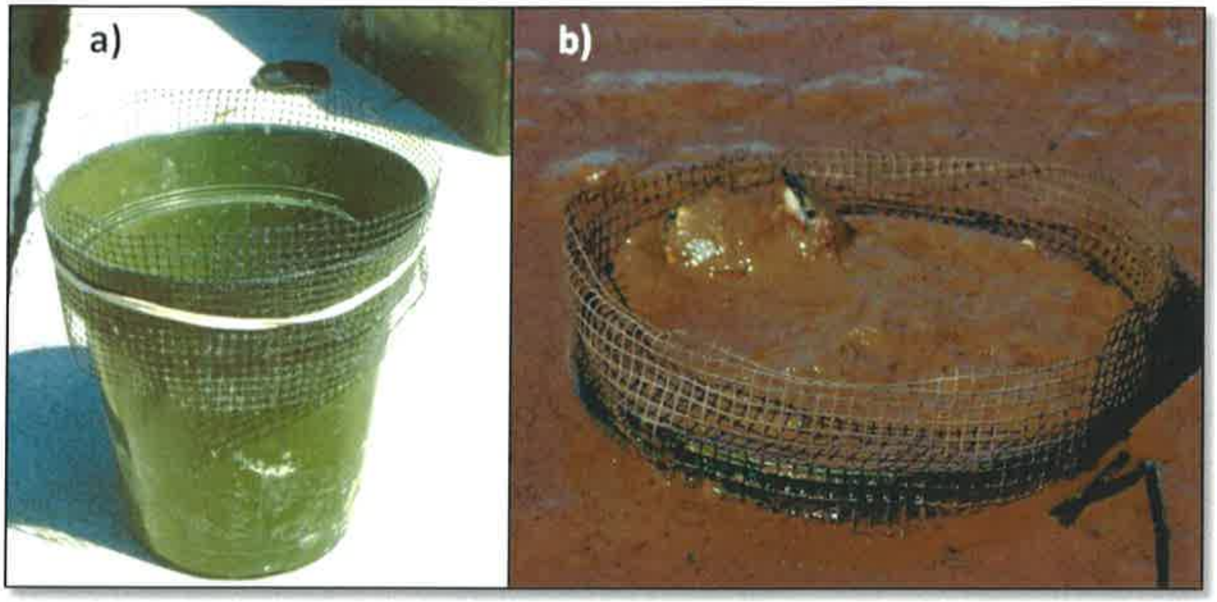

Figure 3. **a)** Open experimental unit with a strip of 4.2 mm mesh surrounding the rim and extending ca. 12 mm above the unit's top; **b)** Open unit deployed in an intertidal flat. The mesh netting does not deter predators from accessing clams planted in the sediments within the unit, but does keep clams from crawling beyond the confines of the unit (Beal, 2006).

Figure 4. Experimental unit with ambient sediments containing juvenile soft-shell clams that is protected by a piece of flexible mesh netting (aperture: 4.2 mm). Treatment = FLEX.

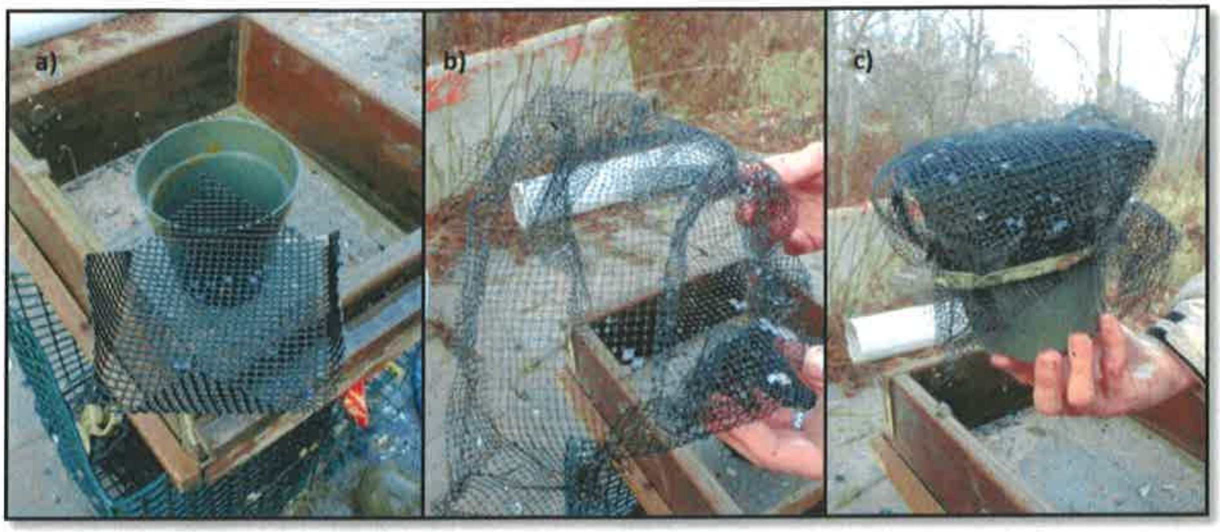

Figure 5. a) Experimental unit with piece of VEXAR; b) piece of 4.2 mm flexible netting that will hold the VEXAR in place on top of the unit; and, c) the experimental unit with the VEXAR and flexible netting held in place using a large rubber band. Treatment = FLEX & VEX.

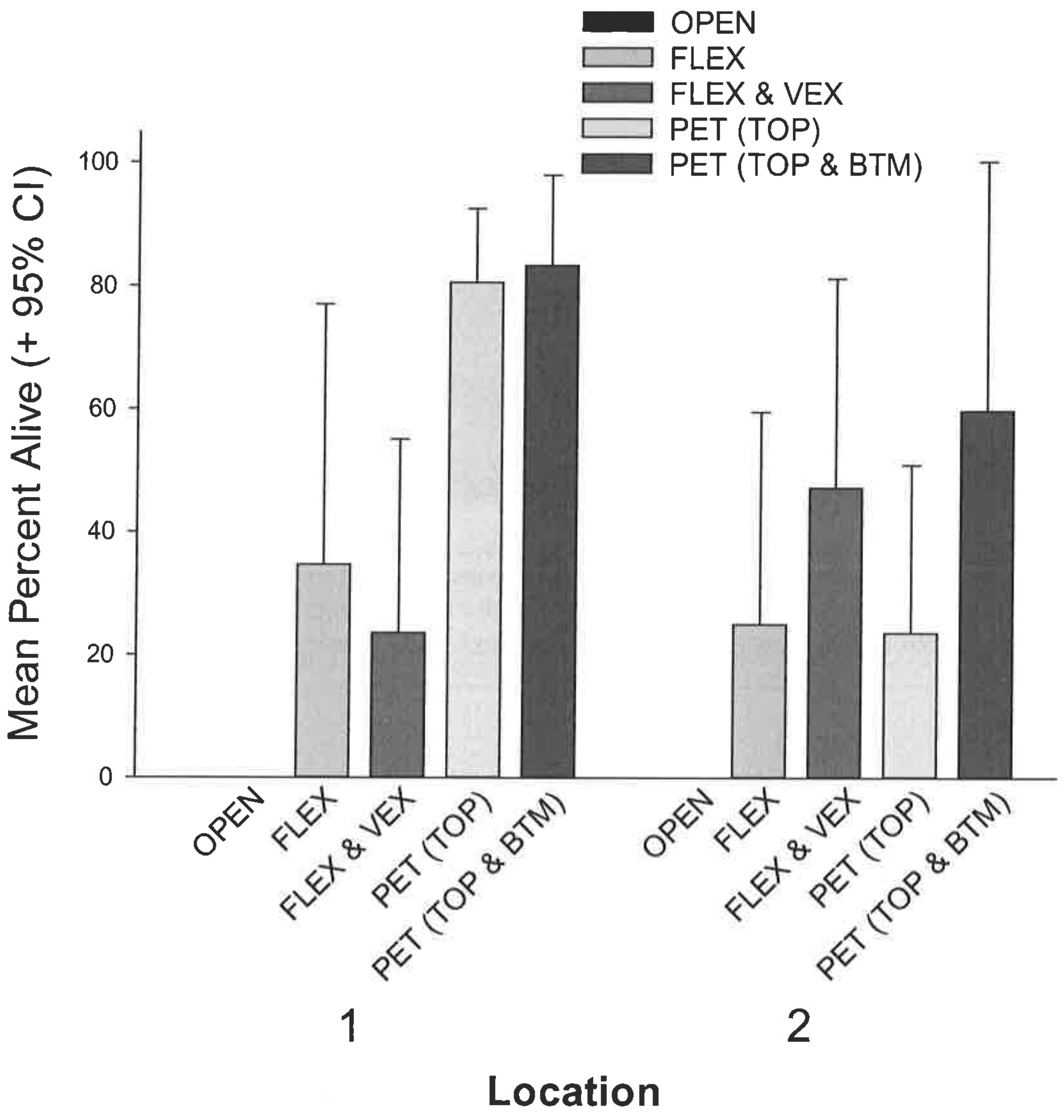

Figure 6. Mean percent alive (+ 95% CI) for cultured individuals of *Mya arenaria* that were added to experimental units on 25 May 2015 at two upper intertidal locations in the Webhannet River, Wells, Maine. After 144 days, the units were retrieved and the contents of each processed by washing the sediment through a 2 mm sieve. See Table 3 for ANOVA results. (n = 6)

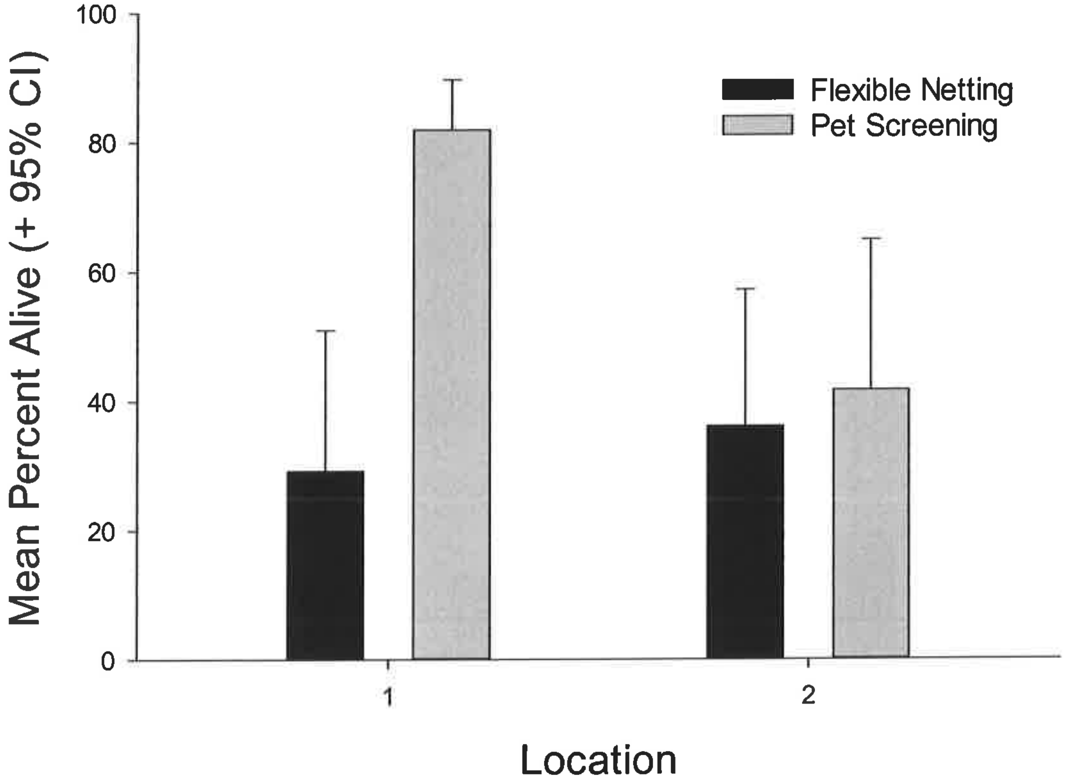

Figure 7. Interaction plot demonstrating the effect of flexible netting vs. pet screening on mean clam survival at both intertidal locations in the Webhannet River, Wells, Maine (25 May to 16 October 2015). The interaction source of variation (Location x Flex vs. Pet) was the only significant orthogonal contrast (P = 0.0007) of the four associated with Location x Treatment (Table 3). (n = 12)

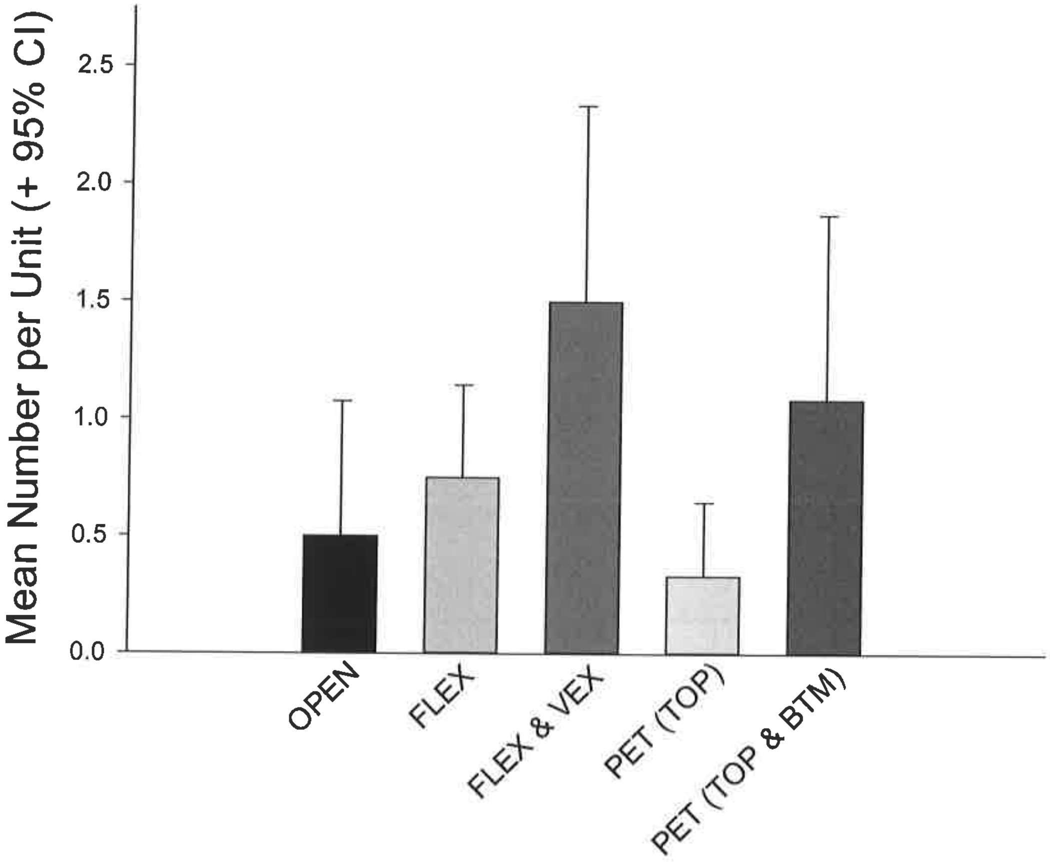

Figure 8. Mean number of green crabs (+ 95% CI) per experimental unit (A = 0.01824 m^2) in the Webhannet River, Wells, Maine at both locations on 16 October 2015. (See Table 4 for ANOVA results.) (n = 12)

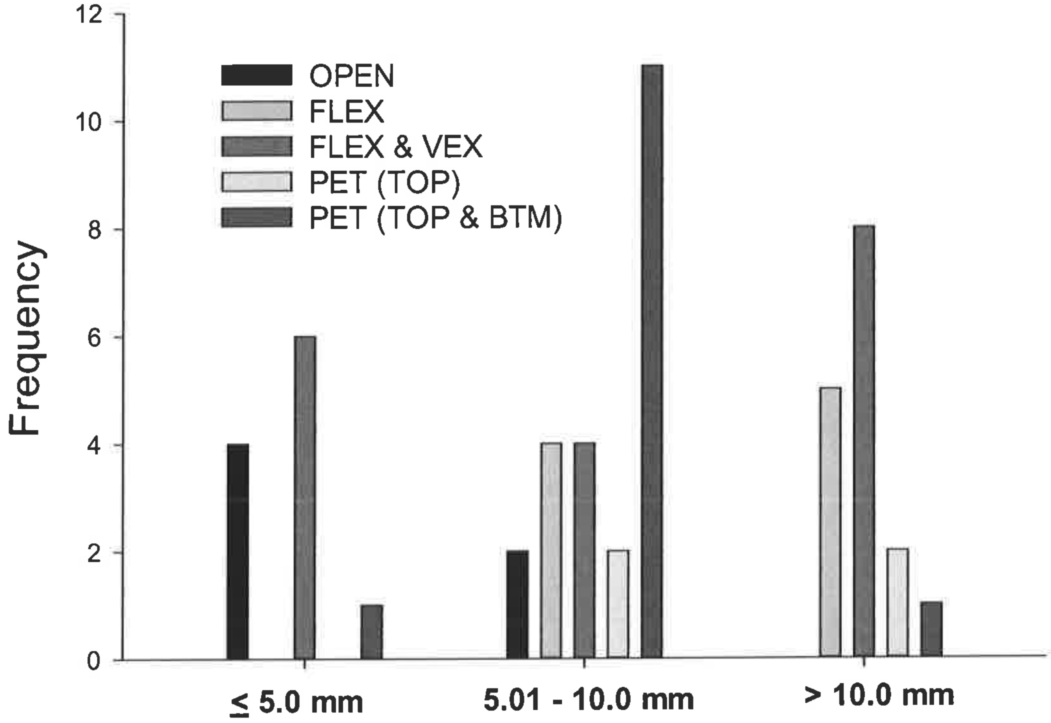

Figure 9. Size-frequency distribution of green crab widths in experimental units from the Webhannet River, Wells, Maine on 16 October 2015. A Fisher's Exact Test indicated that the distribution of widths varied significantly across predator exclusion treatment (P = 0.0011).

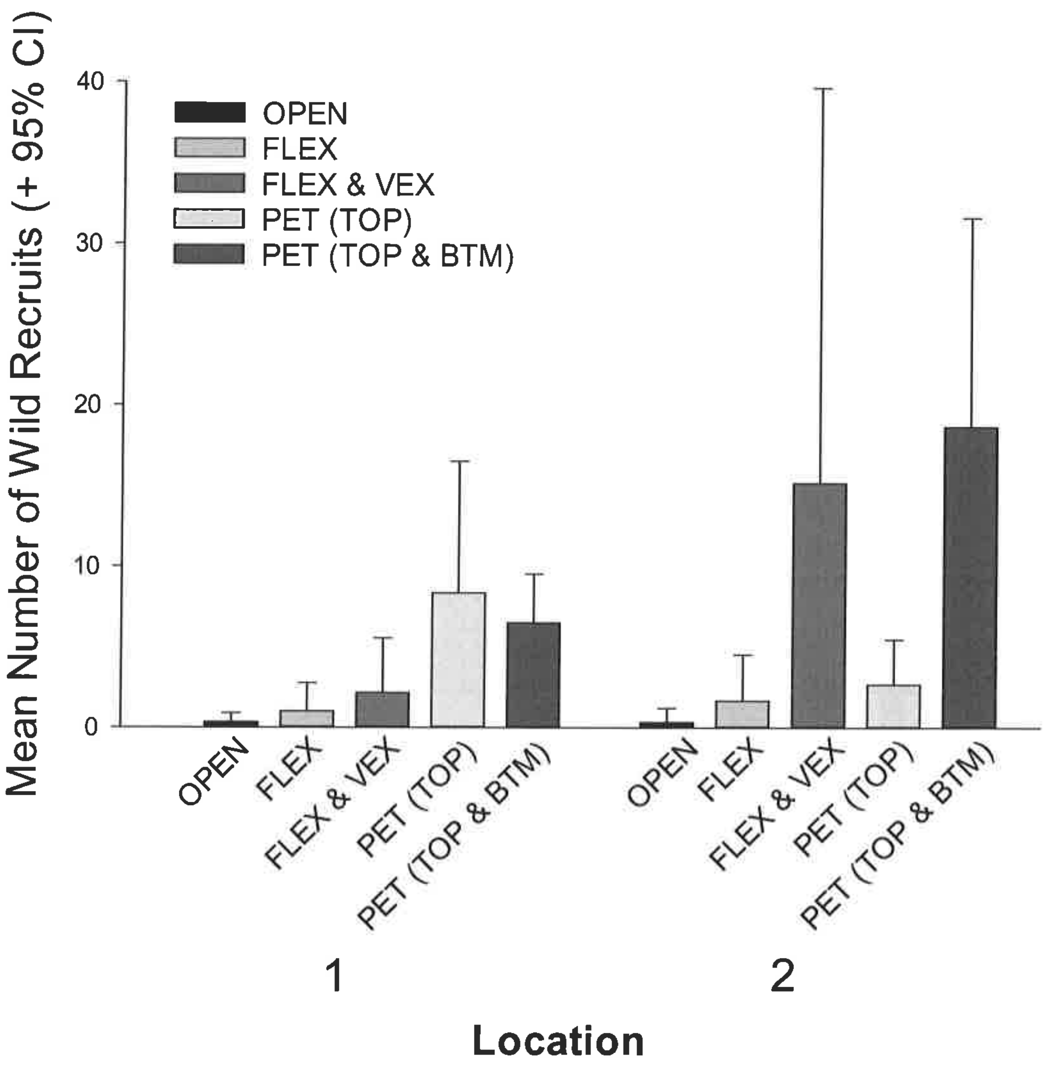

Figure 10. Mean number of wild recruits per experimental unit (0.01824 m^2) at two upper intertidal locations in the Webhannet River, Wells, Maine on 16 October 2015. See Table 5 for ANOVA results. (n = 6)

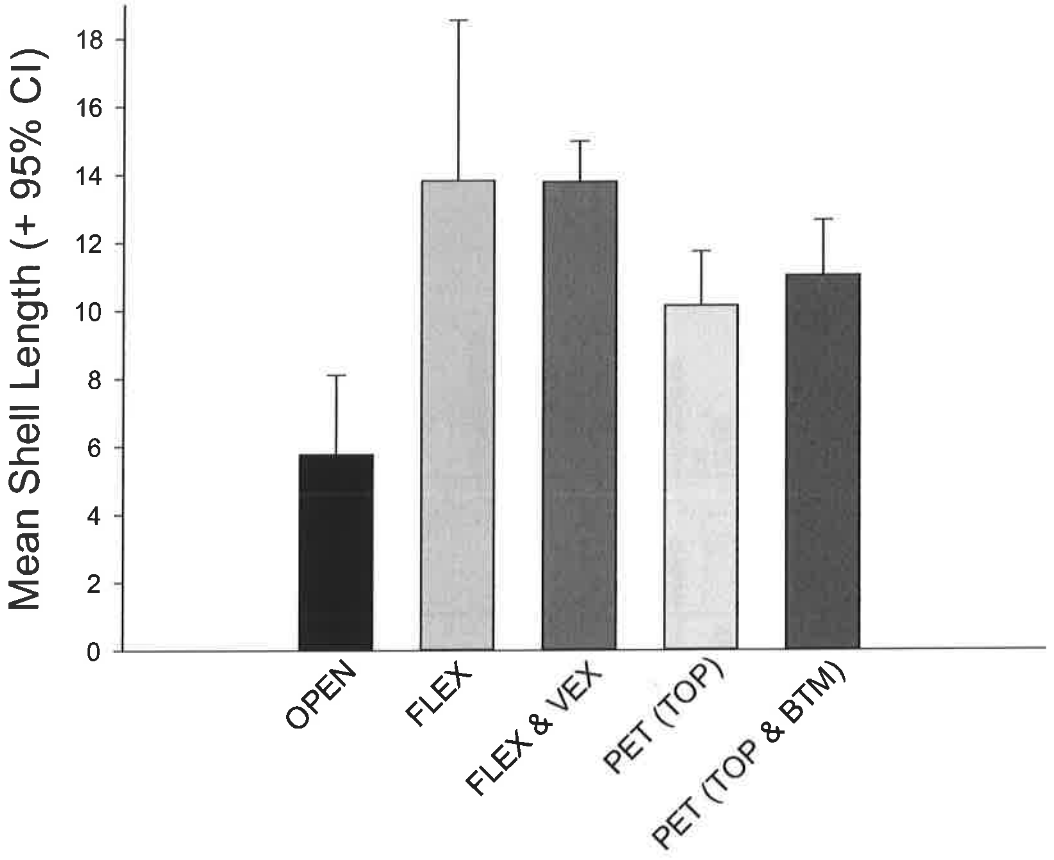

Figure 11. Mean shell length of wild recruits per experimental unit (0.01824 m^2) across the upper intertidal locations in the Webhannet River, Wells, Maine on 16 October 2015. See Table 6 for ANOVA results. ($n_{Open} = 3$; $n_{Flex} = 4$; $n_{Flex\ \&\ Vex} = 6$; $n_{Pet(Top)} = 10$; $n_{Pet(Top\ \&\ Btm)} = 12$;)

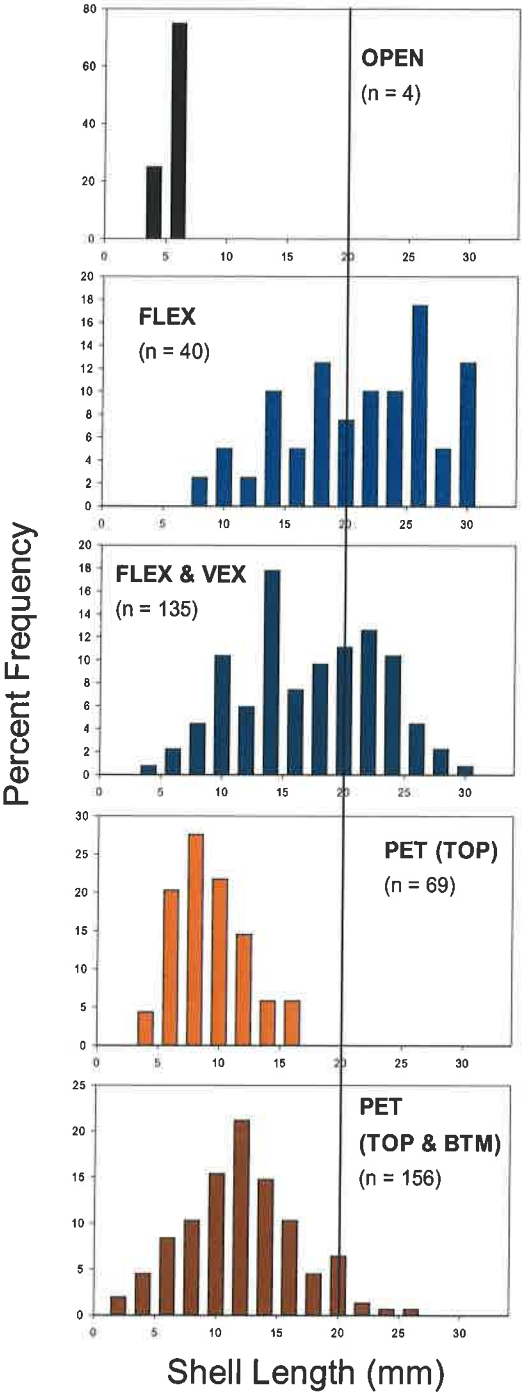

Figure 12. Size-frequency distribution of wild soft-shell clams from experimental units sampled on 16 October from the Webhannet River, Wells, Maine. The vertical line separates the 0- and 1-year class clams. Number of clams from each treatment is given in each graph.

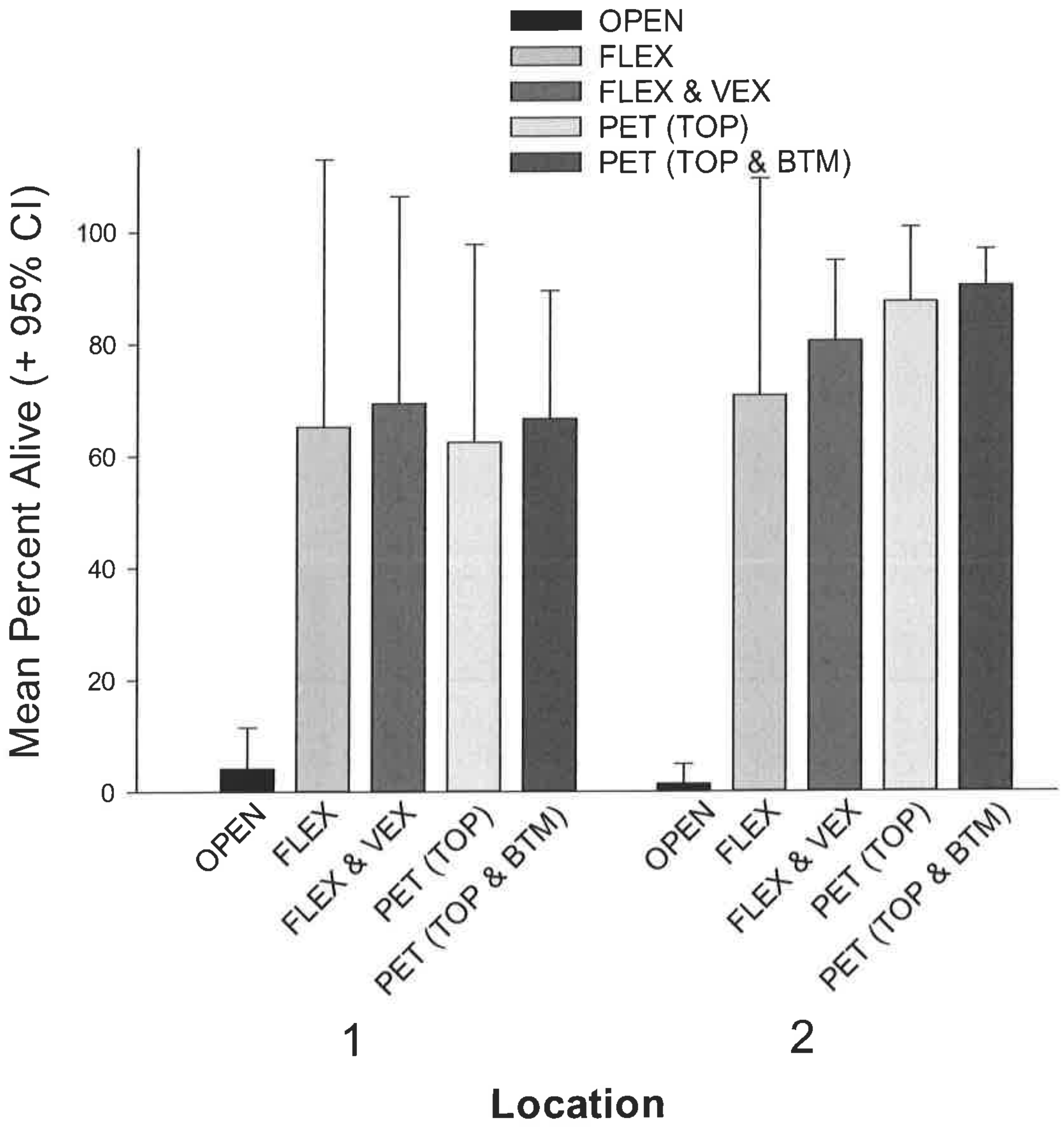

Figure 13. Mean percent alive (+ 95% CI) for cultured individuals of *Mya arenaria* that were added to experimental units on 26 May 2015 at two upper intertidal locations in the Fore River, Portland, Maine. After 144 days, the units were retrieved and the contents of each processed by washing the sediments through a 2 mm sieve. See Table 9 for ANOVA results. (n = 6)

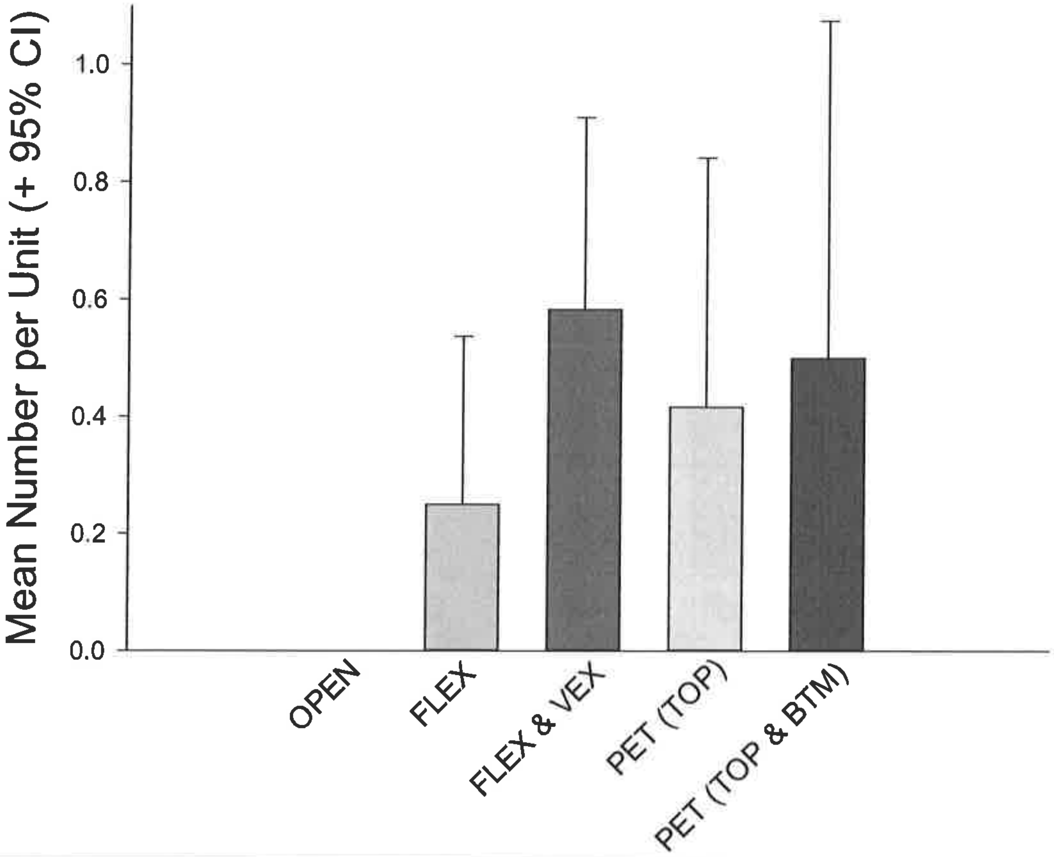

Figure 14. Mean number of green crabs (+ 95% CI) per experimental unit (A = 0.01824 m^2) in the Fore River, Portland, Maine at both locations on 17 October 2015. (See Table 10 for ANOVA results.) (n = 12)

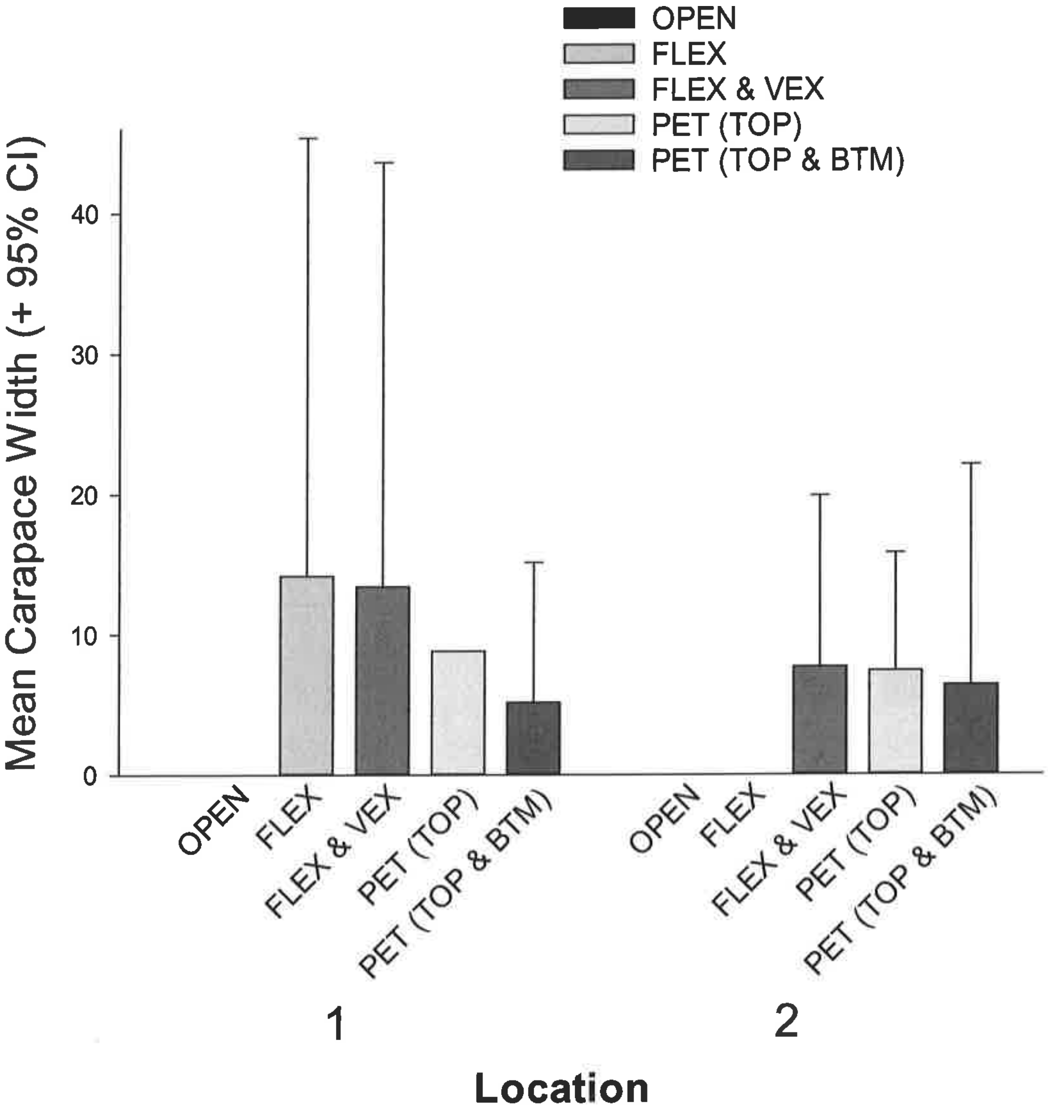

Figure 15. Mean carapace width of green crabs within experimental units at locations 1 & 2 at the Fore River, Portland, Maine (see Fig. 2) for each of the five treatments. ANOVA (Table 11) indicated a significant treatment and treatment x location effect. (n varies from 1 - 4, and represents the number of experimental units crabs were recovered from.)

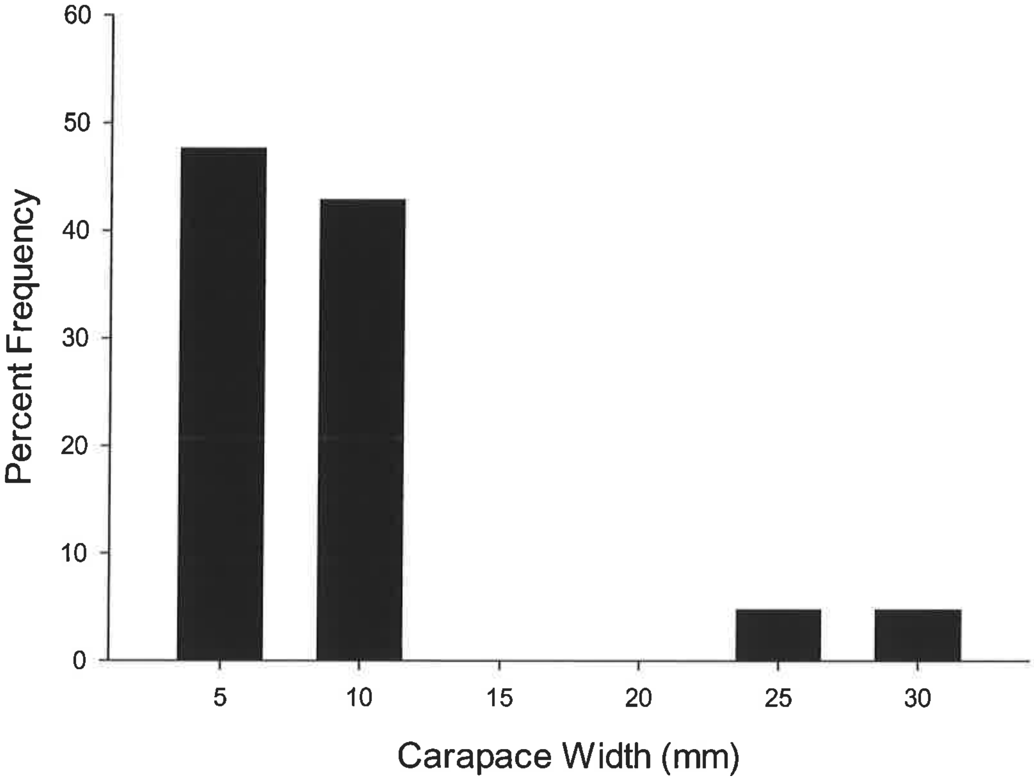

Figure 16. Size-frequency distribution of green crabs in experimental units on 17 October 2015 in the Fore River, Portland, Maine. (n = 21).

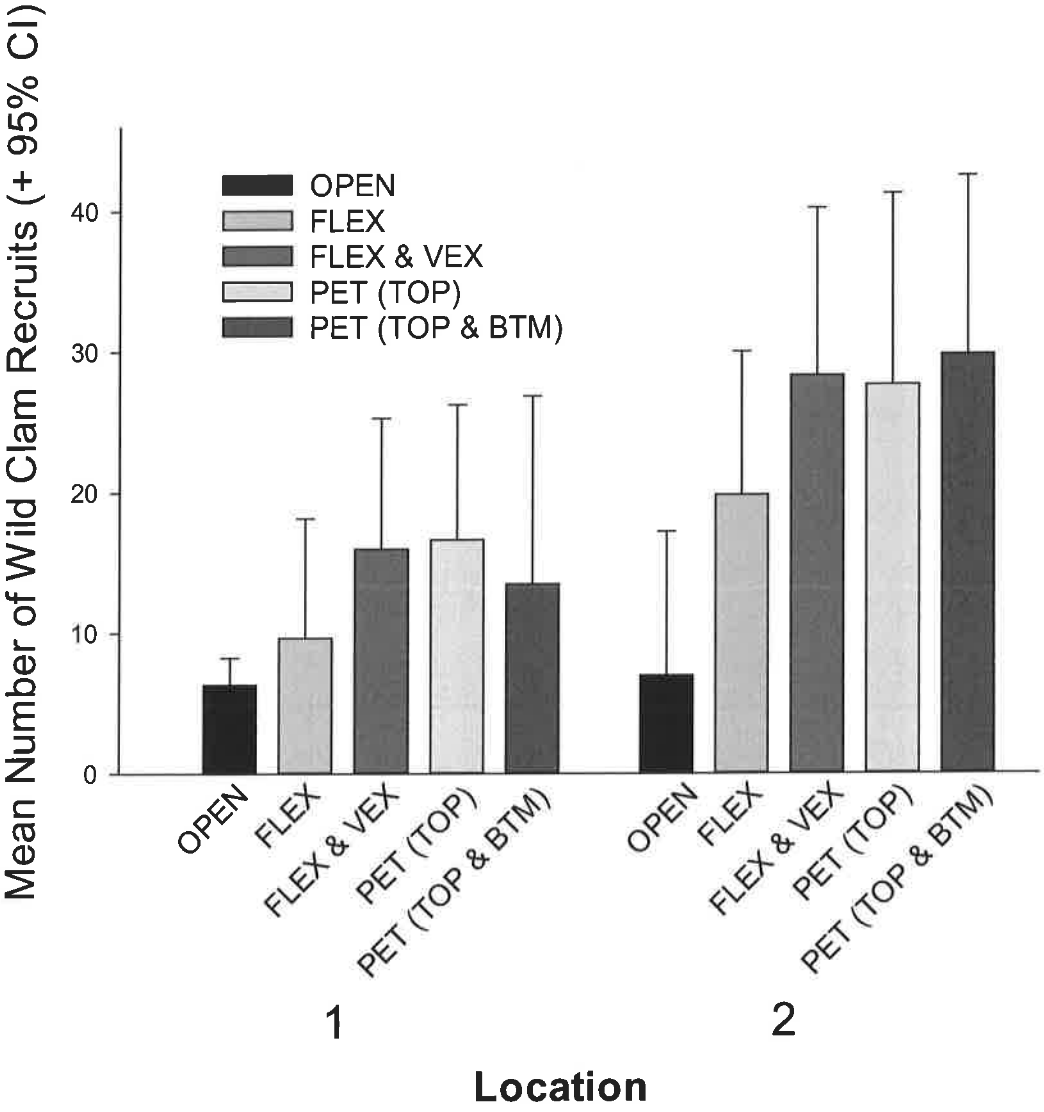

Figure 17. Mean number of wild, 0-year class recruits of *Mya arenaria* in experimental units on 17 October 2015 in the Fore River, Portland, Maine. Both location and treatment were significant sources of variation (see Table 12). (n = 6)

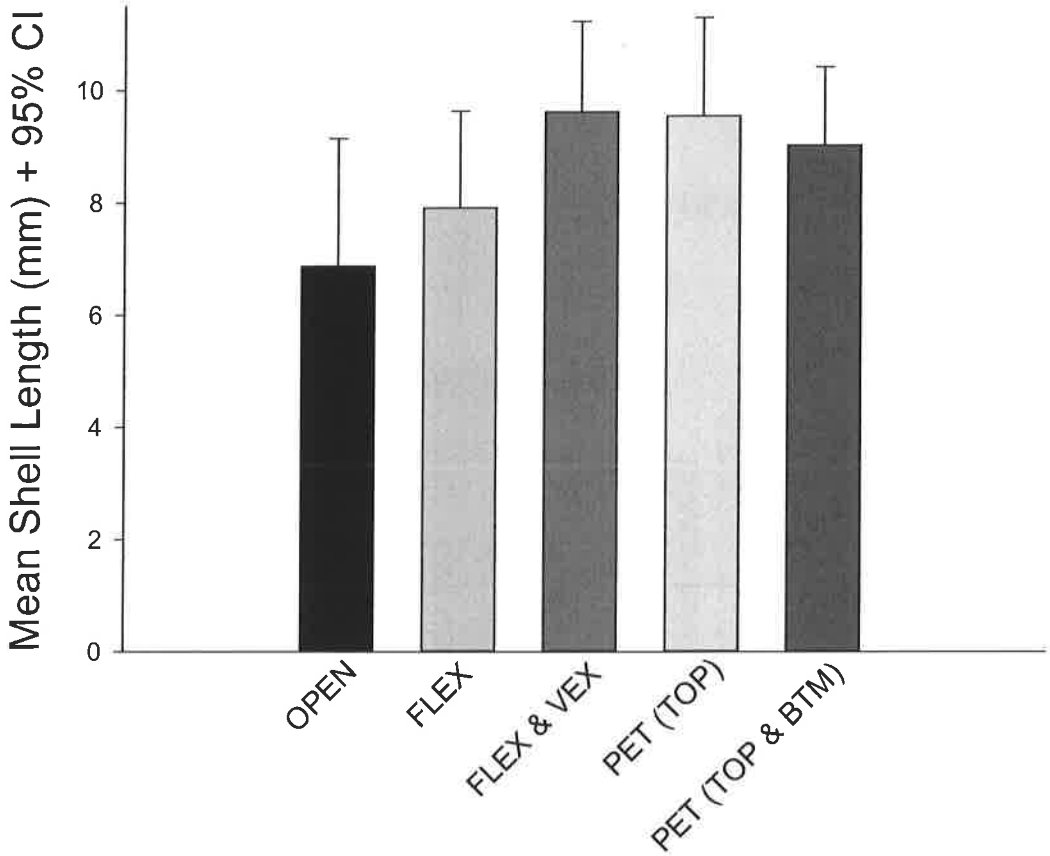

Figure 18. Mean shell length of wild, 0-year class soft-shell clams on 17 October 2015 in experimental units at the Fore River, Portland, Maine. ANOVA indicated that the mean SL of clams in open units was significantly smaller (by nearly 30%) than the mean SL of animals in protected units (Table 13). (n = 12)

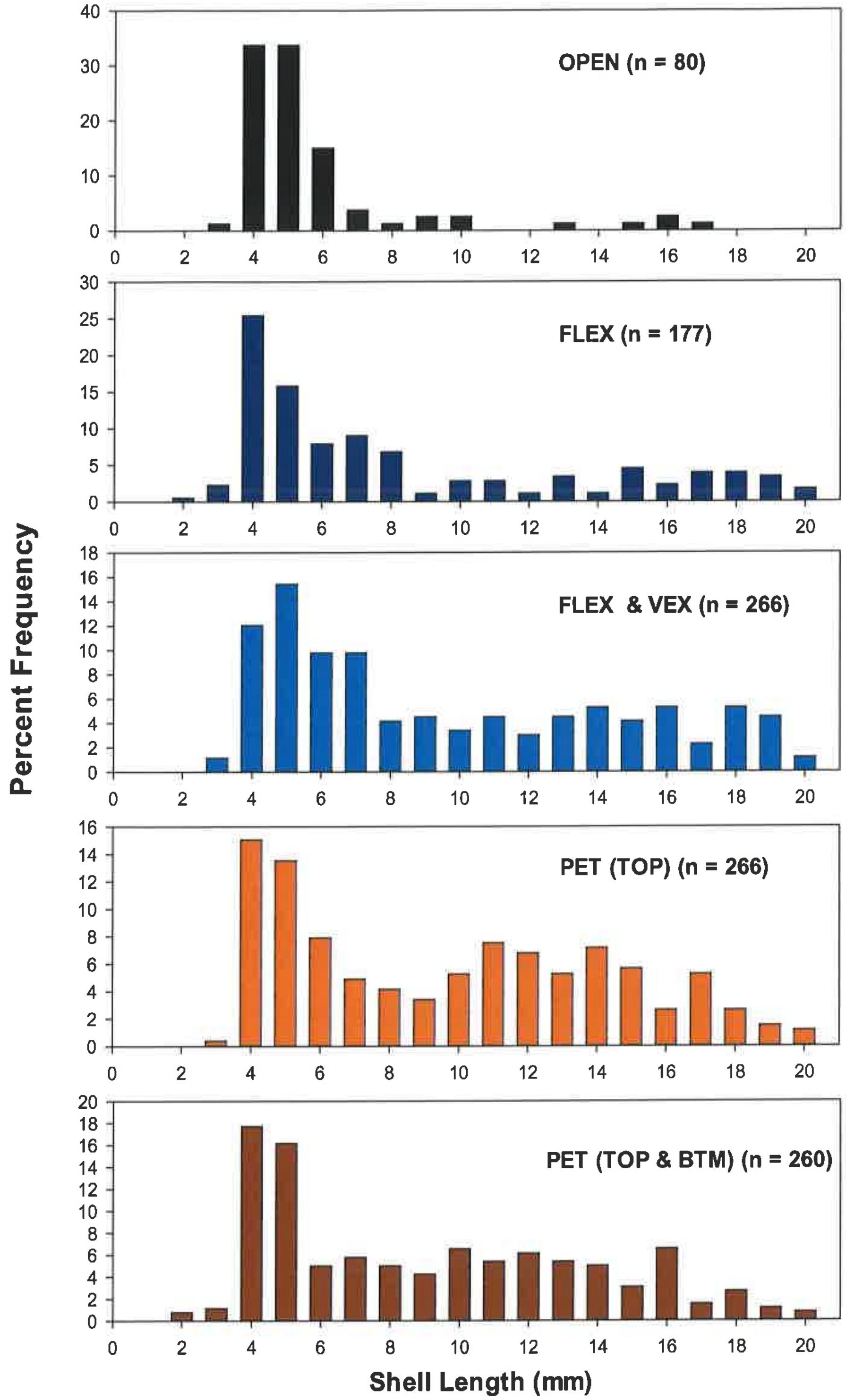

Figure 19. Size-frequency distribution of 0-year class recruits of soft-shell clams in experimental units in the Fore River, Portland, Maine.

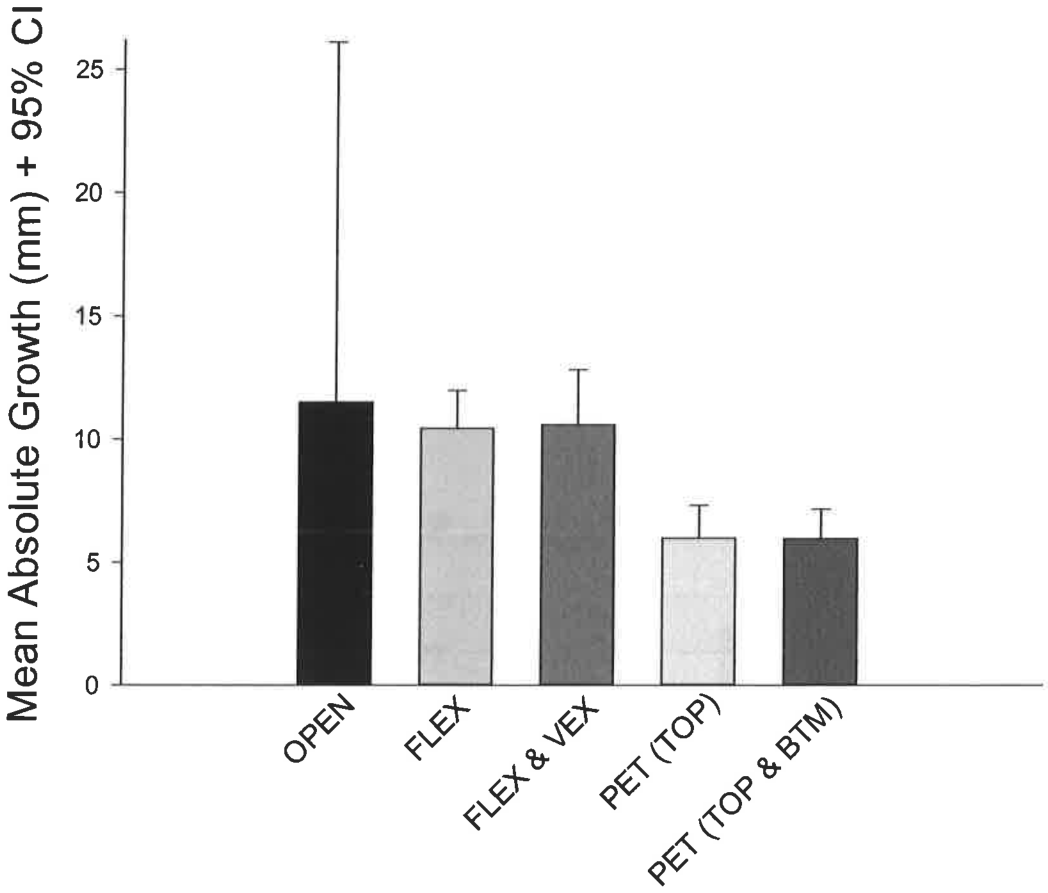

Figure 20. Mean absolute growth (+ 95% CI) of cultured clams in experimental units from the Fore River, Portland, Maine from 26 May to 17 October 2015. (See Table 15 for number of observations – of 12 units – for each treatment). ANOVA (Table 16) demonstrated a difference in mean absolute growth across treatments.