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**MEMORANDUM**

November 2, 2010

To: American Lobster Board

From: American Lobster Technical Committee

Re: Southern New England Exploitation Reduction Recommendations

At the Special July Board meeting the American Lobster Board (Board) tasked the Technical Committee (TC) with evaluating the impacts on Southern New England (SNE) landings by using a variety of management options:

- closed season by state, Lobster Conservation Management Area (LCMA), and time period [1-month intervals],
- closed areas evaluated by state, LCMA and/or statistical area,
- quota based output controls based on landings by state and LCMA,
- trap limits as an input control and determine percent landings reduction associated with levels of trap reductions,
- male only / v-notch program,
- modifications to the minimum and maximum gauge size.

In addition, the Board tasked the TC to evaluate scenarios relative to a 50 or 75% reduction in exploitation to the status quo. The TC has proceeded with the assumption that exploitation reductions are equivalent to an equal percentage in landing reductions for the base years of 2007-2009, as shown in table one. As presented in previous reports, the TC would like to remind the Board that only under favorable natural mortality conditions would deterministic projections result in the SNE stock rebuilding with the proposed exploitation reductions.

There is tremendous uncertainty in the effectiveness of any measure to reduce exploitation short of direct controls on landings. The TC is not able to quantitatively evaluate the impact of each management measure listed above. Regardless, the TC has provided the Board with advice on each measure relative to previous experience in other fisheries, information currently available to the TC from the SNE stock, and a biologically driven approach to provide the maximum benefit to the resource.

*The Technical Committee recommends that the Board use a combination of a quota and season closure (June through September) to achieve a 75% reduction in exploitation. The incorporation* *of a limited closed season in concert with a quota would provide maximum biological benefit during molt, egg extrusion, and high environmental stress periods.*

**I. QUOTAS**

The establishment of a SNE stock quota that is a 50 or 75% reduction from the previous three years' landings is the preferred option to provide maximum benefit to the SNE lobster stock. The TC recommends a quota be distributed for the SNE stock, based on the previous landing trends (Table 1). Furthermore, the TC feels that a quota combined with seasonal closure timed to avoid molting, egg extrusion, and high environmental stress periods from June through September, would provide maximum benefit to the stock. Table 2 and 3 show what the overall SNE quota would be for a 50 and 75% reduction, respectively, based on the average landings for 2007-2009.

It is possible to control the exploitation rate by directly controlling the amount of lobster taken through a quota. The quota could be adjusted to account for changes in the abundance of lobster if the stock begins to rebuild. Quota systems could be established for total and/or individual catch as these systems have different incentives for rate of catch. Quotas place a large administrative burden on resource agencies, and to be effective, require good monitoring and enforcement. Measurements of conservation benefits are generally pre-determined. A quota set lower than the historic catch, constitutes a direct reduction in exploitation. Distributional effects of quota management systems remain an important consideration and should be thoroughly investigated by the social and economic subcommittee.

Quota Management Systems (QMS) have been introduced in a variety of lobster fisheries worldwide. The offshore Canadian Lobster Fishery (LFA 41) established a total allowable catch (TAC) in 1985. Landings in this area have remained at or below the TAC level since introduction, and are remarkably stable when compared to adjacent inshore areas in Canada/US and offshore areas in the US (DFO 2009). Full Individual Transferable Quota (ITQ) systems have been established in New Zealand (1988) and Tasmania lobster fisheries (1998). After eight years of QMS in New Zealand, Annala (1996) reports that the biological status of the stock has improved, discards have been reduced, the stock assessment process/TAC setting has become more transparent and the economic performance of the fishery has improved. In Tasmania, initial results following establishment of a QMS indicate that fishing mortality has measurably declined and fishing effort has declined by nearly 30% (Ford 2001).

**II. SEASON CLOSURES**

In addition to a stock-wide quota, the TC recommends a seasonal closure during June through September to provide maximum benefit during molt, egg extrusion, and periods of high environmental stress. Extending the closure through September would include the entire high water temperature period. The TC recommends a seasonal closure as an effective way of implementing the QMA discussed above, not as a means of achieving a 50 or 75% reduction in exploitation because of the unknown compensatory ability of the fishery to shift exploitation to the open fishing season (i.e. recoupment).

In SNE, a closed season would have the greatest conservation benefit if it occurred during the molt (June-July and secondarily November-December), and/or just prior to the time most females extrude eggs (July-August) so as to allow more females to extrude eggs prior to being captured. Additionally, limiting fishing activity in late spring (April-June) would minimize premature egg loss for females carrying developing (brown/tan) eggs before their hatch (Appendix 1). Extending a closure from June through September would protect the lobster stock during the entire high water temperature period (Figure 1), thereby preventing handling stress and mortality when water temperature are above 20°C, the threshold temperature causing immune, respiratory and cardiac trauma (Dove et al. 2005, Powers et al. 2004).

Currently, lobster landings occur in every month in all states and LCMAs, however they show a strong and consistent seasonal pattern (Figure 2 and Table 4). In 2007-2009, less than 5% of the total was landed per month in the first quarter of the year, while 3-14% (average 7.5%) was landed per month in the second and fourth quarters, and 8-27% (average 17%) was landed per month in the third quarter (Table 4). If fishing patterns do not change, a closure encompassing the third quarter (July-September) would reduce harvest by 50% (Table 5). Closing spring and fall months along with summer months would reduce harvest by 75%. However, there are many factors which would compel fishers to change their fishing patterns to accommodate a closed season by recouping lost harvest during the open season.

Closed seasons have been used to manage American lobster in Canadian waters for many years. The Canadian experience has shown that a short fishing season of several months duration can result in fishing mortality rates comparable to a completely open season because the fishery is able to recoup all of their catch during the months open to harvest. Recoupment can be 100% in areas where the lobster population is particularly stationary. For example, currently winter landings (January-March) in all areas average only 6% of the total; however, prohibiting harvest in preceding months may increase fishing effort as well as resource availability during this historically inactive season.

Economic implications of seasonal closures in Maine were evaluated by Cheng and Townsend (1993); they found that gross revenues would increase from extended seasonal closures (e.g. August to November) due to a redistribution of landings across seasons which evened out prices and strengthened markets. This analysis also showed that short (1-2 months) regional closures in peak months (August and/or September) increased the value of landings, but only by a small amount because landings increased immediately after the closures, seriously depressing prices in the late fall (October-December). Optimal readjustment of landings required moving landings from July through December into January through June. In other words, closures of at least an entire season (3-4 months) were required to stabilize the fishery from an economic standpoint.

Eliminating harvest during the molt and times of high water temperature may substantially reduce total mortality and aid in rebuilding the spawning stock by minimizing gear-induced immediate and delayed mortality as well as sublethal stress. In inshore areas of Southern New England late summer and fall (July-October) bottom water temperatures often exceed 20$^{o}$C, the physiological stress point for American lobster. Warm hypoxic waters are known to herd lobster into ‘islands’ of marginally sustainable habitat. During this time of year, repeated catch and throwback into warm low-oxygen water can be at least stressful if not fatal, especially if major predators are actively feeding in the same area.

## III. AREA CLOSURES

The TC does not recommend using area closures as the primary method of reducing exploitation. Levels of exploitation reduction, using landings as a proxy, can only be assigned Statistical Area scale or approximated to an LCMA with numerous assumptions (see notes in Table 7) Quantifying lobster concentrations on a smaller scale can only be done using patterns in randomized research trawl surveys or anecdotal information, with unacceptable levels of uncertainty associated with either approach. It is therefore impossible to assess what the impacts of smaller areal closures on the SNE stock as a whole. Implementing and enforcing smaller area closures would require restructuring reporting regulations to march closure boundaries. Additional measures would be needed to prevent effort from shifting from closed to open areas.

Analyses of existing closed reserves (Murawski et. al 2000) have shown that optimal closed-area boundaries should be placed so as to protect spawning concentrations and/or nursery areas. These areas have not been clearly identified in all SNE LCMAs and may be quite variable, both seasonally and regionally, due to changes in dispersion/migration of spawning adults and larval drift.

No-take zones and marine reserves have been instituted in areas inhabited by the Florida spiny lobster and the New Zealand spiny lobster (Babcock et. al 1999, Kelly et. al 2002, Cox and Hunt 2005). After several years of protection, lobster populations within these reserves have increased in average size, and therefore reproductive potential, and in some cases increased in overall density compared to abundance outside the reserve boundaries. However, these conservation benefits may be species-specific and depend upon behavior, migration patterns, and size of the reserve. The animal's need to migrate out of a closed area is a critical determinant of the effectiveness of an area closure. Existing spiny lobster reserves range from 350-3000 hectares or 90-777 sq. miles (Babcock et. al 1999, Cox and Hunt 2005). Area closures of this magnitude would be equivalent to a complete moratorium for those fishers whose grounds are closed, or trigger a large influx of effort into open areas. Either outcome would have a significant negative impact on the fishery without clear benefit to the resource.

Currently, the majority of landings in each LCMA are taken a single statistical area (SA) (Table 6 and 7). The exact locations of where fishing occurs are not recorded the landings database. The database only provides landing by statistical area. Closure at the statistical area or LCMA scale would either shut the fishery down or have little or no effect. The greatest poundage is taken in LCMA 3, 69% of which was taken in SA 537 in 2007-2009, followed by 20% taken in SA 616. Similarly, 79% of LCMA 2 landings were taken in SA 539, and 85% of LCMA 4 landings were taken in SA 612. All of LCMA 6 landings were taken in SA 611. Only the fishery in LCMA 5, which contributed 3% to 2007-2009 SNE landings, is dispersed widely enough that closure of one or two statistical areas would almost eliminate the fishery.

## IV. TRAP LIMITS

The TC does not recommend the use of trap reductions alone as a mechanism to reduce exploitation because the recoupment potential for the industry to recover from trap reductions is considerable and poorly understood. There is a poorly understood non-linear relationship between the number of traps fished and landings, therefore we are unable to recommend the number of traps that would need to be removed from the SNE fishery to reduce exploitation by

50 or 75 %. However, it is the TC's belief that the current fishery needs be scaled to the size of the of the SNE stock, and that the total fishing capacity (both active and latent traps) of the SNE fishery severely limits the Boards ability to manage this fishery and to provide adequate conservation to the SNE stock.

If trap reductions were used as a management tool, the TC recommends the Board take an iterative approach, as the relationship between traps and landings in SNE is not known. To achieve a 50 or 75 % reduction in landings we would recommend a 75% reduction in actively fished traps from the 2005-2007 levels. The initial reduction would translate to overall SNE trap levels dropping from 221,000 to 55,000 traps. Additional reductions will likely be needed until the desired levels are achieved. It is important that latent, or unused trap allocations, are not part of the 75% reduction and would not re-enter the fishery unless the resource were to rebuild. We recommend proportional decreases in trap numbers throughout all of the LCMA's within SNE stock area. Trap reductions that do not achieve 50% or 75% reductions in landings could still enhance the benefits of other types of regulation changes.

The number of traps reported as actively fished has dropped by 56% from 2000 (573,931) through 2009 (251,542) (Figure 3). However, traps have not declined proportionally among SNE states. From information that is available, New York has seen the largest decline at 79%; followed by Connecticut, 54%; Massachusetts, 40%; and Rhode Island at 35%. The board should be cognizant that the observed reductions in the active number of traps fished are not always the result of a management measure and do not represent the large amount of latent traps that exist in each LCMA. There is no time series of trap use available for states south of New York.

Trap reductions are eventually expected to result in overall effort reductions, however the number of traps allowed in the fishery is a poor definition of effort. It is generally agreed that one unit of trap reduction will not equal one unit of effort reduction. The numbers of trap hauls, with knowledge of their respective soak times and location represents a more direct measure of effort. However it is difficult to predict how reductions in total traps will affect these other variables.

A recent example of this lack of direct relationship between traps and harvest is in the Florida spiny lobster fishery where traps were recently reduced by just over 40 % resulting in a 16% decline in fishing mortality (Muller et al 1997). Experimental (Wilson 2010) and theoretical (Fogarty and Addison 1997) results suggest that large trap reductions would be required to reduce fishing mortality in the American lobster fishery. This is due to both the excess of gear currently being fished and the ability of the fishing industry to adjust fishing practices.

Regional examples of recoupment of catch by the lobster industry with reduced numbers of traps and/or seasons include the Outer Cape Cod (OCC) LCMA, Monhegan Island Lobster Conservation Area in Maine and the Southwest Nova Scotia fishery (Lobster Fishing Area 34). Following the implementation of the OCC trap allocation plan in 2004 there was 25.6% reduction in the number of active traps reported fished. Despite the decline in traps fished, the number of trap hauls has stayed remarkably stable at roughly 600,000 per year. This indicates that the fishery has maintained its effective level of effort by hauling traps more frequently and over a longer season to compensate for having fewer in number. The OCC LCMA reached the goal of a 20% reduction of active traps fished as intended in Addendum III. However, there has been no reduction in fishing mortality as intended by the trap reduction. In fact there is evidence that there has been a 40% increase in fishing mortality on the Georges Bank stock since 2002 in the OCC LCMA (ASMFC 2009, 2010).

The Monhegan Island Lobster Conservation Area (MILCA) is an approximately 30 $nm^2$ body of water surrounding Monhegan Island, located in the mid-coast Maine. Monhegan Island fishermen have observed a summer closed season since 1907. By statute, MILCA may have a maximum of 17 participants (there are currently 12). Recent legislative action expanded the open fishing to a maximum of 270 days starting no earlier than October 1, but reduced the maximum allowable traps from 600 to 475 (12 M.R.S. §6471). The final season length and trap numbers is at the discretion of Maine's Marine Resource Commissioner. In the past three fishing seasons the Commissioner has set the season length at 270 consecutive days starting October 1 with a maximum of 300 traps. MILCA participants have consistently caught 50% of their annual catch within the first seven weeks of the season. The median catch of MILCA participants exceeds the median catch in southern and mid-coast Maine, areas with a maximum of 800 or 600 traps and a year round fishery (C. Wilson, 2010, personal communication).

Finally, LFA 34 is the most productive lobster fishing area in Canada, accounting for 40% of Canadian landings and 23% of the combined US/CA lobster landings. LFA 34 has a six month open fishing season that opens the last Monday in November and ends May 31 the following year. There are 967 licenses with a maximum trap limit of 375 (an additional 25 traps tags are issued after April 1)(DFO 2006). Annual landings in the last ten years have averaged approximately 30 million pounds. During this period 50% of the annual catch is landed in the first 15-22 days (D. Pezzack ,2010, personal communication) with an average of 3.75 to 5.5 pounds per trap per day at the start of the season. Early season catch rates are approximately ten times those observed in SNE in recent years. When compared to the Maine fishery, LFA 34 has approximately 1/5 the fishermen and 1/10 the traps as Maine.

Although trap reductions may improve profists to some fishermen, they have the most immediate negative impact on those who are fishing all their gear in the most efficient means possible. Unintended negative impacts may also be felt by deck hands, whose services may no longer be required by captains pulling less gear. The perceived economic effects of trap reductions are open to wide debate and have been the topic of many past LCMT deliberations. Trap reductions coupled with a transferability system may improve profits to fishermen and would provide a mechanism for some fishers to survive a stock wide 75% reduction in the exploitation rate.

## V. SIZE LIMITS

The TC does not recommend using additional gauge increases/decreases as the sole means to reduce exploitation in the SNE stock. The TC explored the development of a uniform size window to balance restrictions that approximate equivalent reductions for areas that are dominated by smaller (inshore) and larger (offshore) lobster. However, at the size limits estimated (3 ½" - 3 ¾" or 3 ⅞" for a 50% reduction and 3 ½" - 3 ⅝" or 3 ¾" for a 75% reduction), the fishery would be targeting a very narrow gauge range, 1/4 - 3/8" to acheive a 50% reduction and 1/8-1/4" for a 75% reduction. This would result in extremely high discard rates (approximately 80 to 90 %; Table 8), causing increased stress on lobster due to trapping, handling, and temperature fluctuations and exposure to predation while being hauled to the surface.

Size limits can lead to increased egg production. The minimum gauge size can be set to achieve a desired level of egg production before lobsters are legally susceptible to harvest. SNE sea sampling data indicate approximately 27% of mature female lobster are egg bearing annually (Table 9). The TC does not recommend managing the fishery solely through minimum gauge restrictions because it does not reduce the fisheries' current reliance on newly recruited lobster. At high exploitation rates there would still be complete dependence on newly recruited lobster to sustain the resource and the fishery. Under this scenario annual fluctuations in recruitment can create an unstable fishery and recruitment shortfall, as has occurred in SNE.

In addition, minimum size limits can select for slower growing individuals and may cause evolutionary changes to the population (Conover and Munch, 2002; Williams and Shertzer, 2004). The areas of SNE that have had the greatest effort have the smallest sized lobster. In contrast, maximum size limits can provide protection against recruitment variation because large lobsters have proportionally more eggs which have a greater rate of survival. A pool of large lobster would provide a buffer against recruitment variations and dependence on first time spawners. Additionally, it will conserve the genes of fast growing individuals in the population.

The maximum gauge restriction raises a concern because it will have the biggest impact on offshore fishermen where there is a higher proportion of larger lobster. Lobster above the maximum size represent a permanent loss of yield to the fishery. In inshore areas, where exploitation rates are high, very few lobster live long enough to reach the current maximum size limit (5 1/4 inch). However, if fishing rates where reduced in high exploitation areas then more lobster may survive to the maximum size. Despite these concerns the fishery would benefit from increased egg production and protection from recruitment variation.

However, uniform minimum and maximum gauge sizes in all areas would be desirable to minimize stock assessment uncertainty and social, political, and enforcement problems. In addition, concerns have been raised about diminished conservation value of non-uniform size limits if there is movement of lobster between jurisdictions. However, a uniform gauge will have varying impacts due to differences in lobster size distribution among areas, which varies greatly among areas in SNE. This can be seen in the plot of sea and port samples by LCMA and NMFS statistical area (Figure 4 and Appendix 2). This variation is due to the different LCMA gauge regulations, population characteristics, and sample size. In general, the size distributions of lobster in the inshore LCMAs (2, 4, and 6) are smaller than off shore (LCMA 3) (Figures 5 and 6). The one exception is lobster sampled in LCMA 5 whose size distribution is much larger than the distributions of the other inshore LCMAs and more similar to distributions seen offshore (Figures 5 and 6).

Due to this geographic variation in size distribution, changes in gauge size will affect LCMAs differently. Increases to the minimum gauge while holding the maximum size at 5 ¼" will largely affect the inshore fishery. Decreases in the maximum gauge will mainly affect the offshore fishery (Table 10). To develop a uniform minimum and maximum size limit that would reduce both the inshore and offshore landings by similar proportions, the minimum size limit inshore would need to increase and the maximum size limit offshore would need to decrease. Of the combinations examined in Table 2, a minimum size of 3 ½" and a maximum size between 3 ¾ and 3 ⅞would generally result in a 50% reduction of landings and a minimum size of 3 ½" and a maximum size between 3 ¾ and 3 ⅝ would generally result in a 75% reduction of landings.

The TC has serious concerns about the use of a minimum and maximum size limit as the sole means of achieving a reduction in exploitation.. At the size limits estimated above, the fishery would be fishing on a very narrow range of size, ¼ - ⅜" for 50% reduction and ⅛-¼" for a 75% reduction. This would result in extremely high discard rates, of approximately 80 to 90% (Table 8). This is an additional 13 to 24 % above the current discard rate. While these lobster would be protected from harvest, the high rate of discard would cause increased stress on lobster due to trapping, handling, and exposure to temperature fluctuations while being hauled to the surface. Lobster may also experience increased exposure to predators while being discarded. In addition, the efficiency of the fishery would decrease significantly since an increased percentage of the lobster caught would need to be discarded. It may be possible to modify trap gear to decrease the discard rate by increasing the vent size and decreasing the entrance size, but this would still affect the efficiency of the fishery. The TC does not recommend that changes to the minimum and maximum size limits be used as a primary management tool due to the concerns about the increased discard rate and decreased efficiency in the fishery. However, they feel that changes to the minimum and maximum size could have substantial benefit if used in a complimentary fashion with other management tools.

## VI. MALE ONLY/V-NOTCH FISHERY

The TC does not recommend a management strategy that focuses solely on single sex harvest. This type of management would be precedent setting for American lobster and the TC can not predict the affect this management strategy would have on the reproductive dynamics of the SNE stock. There are several areas within SNE, where the sex ratio is already highly skewed toward females.

Male Only Fishery

The TC strongly cautions the Board about the use a of male-only harvest strategy. While it would likely cause a substantial reduction in catch (40 to 80%), this reduction would not be equitable among LCMA's and states, nor would it be equitable within LCMA's, states, and regions. This strategy would likely lead to increases in effort, and to changes in the distribution of fishing gear which would lead to gear conflicts. The impact of a highly female skewed sex ratio on American lobster populations is largely unknown, but could be damaging to the reproductive dynamics of the SNE stock.

American lobster are known to segregate by gender seasonally. In general, male lobster tend to be more resilient to changes in temperature and salinity and as a result are more likely to be found in shallow estuarine waters and tend to make smaller scale seasonal migrations. Female lobster are more likely to be found in deeper water where temperature and salinity are more stable. This phenomenon appears to be related to behavioral thermoregulation, whereby egg-bearing females undergo seasonal migrations along depth contours to maintain stable water temperature for developing embryos. As a result of these sex specific behavioral tendencies, the bathymetry and oceanographic conditions of a specific location have a large influence on the population demographics (density, gender, maturity status, molt stage) of the lobster living there. Ultimately it is these demographics which determine the composition of the catch in these areas.

The sex ratios of the commercial catch from 2007 and 2009 were examined spatially and temporally to determine the impact of a male-only harvest program on the SNE lobster fishery, and it's potential effectiveness as a management strategy. The percentage of the commercial catch comprised of females in the SNE stock varies substantially among seasons, among statistical areas, and even within statistical areas (Table 11). The shallower embayments tend to be closer to a 1:1 female to male sex ratio, or even slightly male dominated; the deeper portions of inshore waters and nearshore waters tend to be female dominated; and the SNE canyons tend to be male dominated. As a result the impact of a male-only harvest strategy on the Southern New England lobster fishery would be dramatically different among LCMA's, within segments of LCMA's, within segments of statistical areas, and within states. As expected, the reduction in catch would be most dramatic in areas with female dominated sex-ratios. For example a male only fishery would result on average in > 80% reduction in catch within statistical area 538, whereas it would result in only a 51% reduction in catch in central Long Island Sound. These differences in sex ratio within specific portions of LCMA's would likely cause some fishermen to move their gear into areas with higher proportions of males to obtain higher catch rates. Therefore it is not possible for the TC to accurately predict the overall impact of a male-only harvest strategy on the SNE stock, a specific LCMA, or even within a state.

The TC also has concern that a male-only harvest strategy will cause fishermen to increase their effective effort (trap hauls) to compensate for the loss of catch. This would cause increased pressure on the male portion of the stock, and would also cause increased stress to female lobster that will likely be caught and released multiple times in the process. The TC also anticipates that a male-only harvest strategy will substantially skew the sex-ratio toward females. This raises additional concern about potential problems with sperm limitation within the Southern New England stock. There is no concrete evidence of sperm limitation occurring in American lobster, however, male-only harvest strategies have been linked sperm limitation and disruption of the reproductive output of opilio crabs (Sainte-Marie et al 2008) and spiny king crabs (Sato *et al.* 2007).

V-Notch Fishery

The TC does not have any empirical evidence to support that a mandatory v-notch program or a mitigation style v-notch program would be successful at reducing the exploitation rate of the total SNE stock by 50 or 75%. The TC reiterates its concerns about a management strategy that focuses solely on females and cautions the Board about using a management strategy that requires the fishery to maintain substantial harvest rates to be successful.

It is difficult for the TC to provide meaningful advice relative to the effectiveness of a v-notch program without having specific details about the nature of any proposed program. Currently, the observed proportion of v-notched female lobster in the overall SNE catch is low. Those that are observed are the result of remnants of the North Cape Oil Spill Mitigation Program, the CT v-notch management initiative in 2008, as well as result of a small number of fishermen actively v-notching. The current observed rates of v-notching in the SNE stock do not reflect the results of any on-going management program.

A mandatory v-notch program would have the potential to substantially reduce exploitation on the female portion of the stock if there were good compliance with this management measure. In Maine, where v-notching has been a "management staple" since the late 1940's and the fishery has been extremely productive in the last decade, v-notching protects roughly 35% of the exploitable female population from harvest. The amount protected in the SNE fishery by this type of management program would depend on the exploitation rate, the rate of compliance, and the length of time a female would be protected by the v-notch definition used. Given the condition of the SNE fishery the TC warns that there would be substantial financial disincentive to participate in a mandatory v-notch program and that this management measure is difficult to enforce.

## References cited


12 M.R.S. Section 6471. Monhegan Island Lobster Conservation Area.
http://www.mainelegislature.org/legis/statutes/12/title12sec6471.html

Annala, John (1996) New Zealand's ITQ system: have the first eight years been a success or a failure?
Reviews in Fish Biology and Fisheries Vol 6(1)43-62.

ASMFC. (2010). A review of the Outer Cape Cod Area Lobster Fishery and Management Program. Lobster Technical Committee Report to the ASMFC Lobster Management Board. Pp. 1-10.

ASMFC, 2009. Stock Assessment Report No. 09-01.

Babcock, RC, S Kelly, NT Shears, JW Walker, TJ Willis, 1999. Changes in community structure in temperate marine reserves. Marine Ecology Progress Series, 189:125-134.
Cox, C and JH Hunt, 2005. Change in size and abundance of Caribbean spiny lobster Panulirus argus in a marine reserve in the Florida Keys National Marine Sanctuary, USA. Marine Ecology Progress Series, 294: 227-239.

Cheng, HT and RE Townsend, 1993. Potential impact of seasonal closures in the US lobster fishery. Marine Resource Economics, 8:101-117.

Conover, D.O. and S.B. Munch. 2002. Sustaining fisheries yields over evolutionary time scales. Science Vol 297: 94-96.

DFO. 2009. Assessment of Lobster in Lobster Fishing Area 41 (4X + 5Zc). DFO Can. Sci. Advis.
Sec. Sci. Advis. Rep. 2009/033.

DFO. (2006). Framework Assessment for Lobster (Homarus americanus) in Lobster Fishing Area(LFA) 34. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/024.

Ford, Wes (2001) Restructuring the Tasmanian rock-lobster fishery - the effect of two years of management under individual transferable quotas. Mar. Fresh. Res. 52(8) 1641-1648.

Fogarty, M.J. and Julian T. Addison (1997) Modelling capture processes in individual traps: entry, escapement and soak time. ICES Journal of Marine Science Volume54, Issue2 Pp. 193-205.

Kelly, S, D Scott, AB MacDiarmid, and RC Babcock, 2000. Spiny lobster, Jasus edwardsii, recovery in New Zealand marine reserves. Biological Conservation, 92(3):359-369.

Murawski, SA, R Brown, HL Lai, PJ Rago, L Hendrickson, 2000. Large-scale closed areas as a fishery-management tool in temperate marine systems: the Georges Bank experience. Bulletin of Marine Science, 66(3):775-798.

Muller, R.G., John H. Hunt, Thomas R. Matthews and William C. Sharp (1997) Evaluation of effort reduction in the Florida Keys spiny lobster, Panulirus argus, fishery using an age-structured population analysis. Marine and Freshwater Research 48(8) 1045 - 1058

Pezzack, Doug. (2010). Email to Carl Wilson October 20, 2010.

Sainte-Marie, B. , T. Gosselin, J. M. Sevigny, and N. Urbani. 2008. The snow crab mating system: opportunity for natural and unnatural selection in a changing environment. Bull. Mar. Sci., 83: 131-161.

Sato, T., M. Ashidate, T. Jinbo, and S. Goshima. 2007. Does male-only fishing influence reproductive success of the female spiny king crab, *Paralithodes brevipes*? Can. J. Fish. Aquat. Sci., 64: 735-742.

Williams, E.H. and K.W. Shertzer. 2004. Effects of fishing on growth traits: a simulation analysis. Fish. Bull. 103(2): 392-403.

Wilson, C.J. (2010) Manipulative Trapping Experiments In The Monhegan Island Lobster Conservation Area. Completion report to the North East Consortium (NEC Award #05-949) pp 1-43.

Wilson, Carl. (2010) Email to George Lapointe, August 2010.

# Tables

Table 1. 2007-2009 Average State SNE Landings (Pounds) By Month

| State | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total | %Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Connecticut | 26,446 | 9,946 | 9,511 | 18,335 | 32,943 | 60,792 | 133,432 | 90,873 | 24,353 | 7,427 | 16,789 | 36,869 | 467,714 | 9% |
| Massachusetts | 20,375 | 13,165 | 21,326 | 35,550 | 54,358 | 78,795 | 146,226 | 151,753 | 120,858 | 96,033 | 55,594 | 33,431 | 827,465 | 15% |
| New York | 26,647 | 7,313 | 10,329 | 25,018 | 54,613 | 94,751 | 196,153 | 171,495 | 106,399 | 65,008 | 43,790 | 31,547 | 833,062 | 15% |
| NJ-DE-MD-VA | 19,658 | 12,215 | 14,059 | 45,132 | 79,463 | 111,265 | 123,702 | 105,959 | 82,176 | 88,608 | 64,349 | 45,107 | 791,693 | 14% |
| Rhode Island | 64,302 | 28,975 | 31,619 | 64,956 | 171,720 | 317,532 | 503,107 | 441,070 | 336,239 | 281,536 | 194,301 | 115,556 | 2,550,912 | 47% |
| Grand Total | 157,428 | 71,614 | 86,845 | 188,991 | 393,097 | 663,136 | 1,102,619 | 961,149 | 670,025 | 538,612 | 374,822 | 262,510 | 5,470,846 | |

Table 2. SNE Stock Quota by state based on a 50% reduction in the average landings from 2007-2009

| State | Quota |
|---|---|
| Connecticut | 233,857 |
| Massachusetts | 413,733 |
| New York | 416,531 |
| NJ-DE-MD-VA | 395,847 |
| Rhode Island | 1,275,456 |
| Grand Total | 2,735,423 |

Table 3. SNE Stock Quota by state based on a 75% reduction in the average landings from 2007-2009

| State | Quota |
|---|---|
| Connecticut | 116,928 |
| Massachusetts | 206,866 |
| New York | 208,266 |
| NJ-DE-MD-VA | 197,923 |
| Rhode Island | 637,728 |
| Grand Total | 1,367,712 |

Table 4. 2007-2009 Average SNE Landings (Percentage) By Month and LCMA

| LMA | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3.1% | 1.4% | 1.8% | 3.4% | 5.6% | 13.3% | 25.2% | 18.1% | 10.9% | 7.3% | 5.4% | 4.6% | 100% |
| 3 & 5 | 2.0% | 1.1% | 1.5% | 2.9% | 7.5% | 10.7% | 14.5% | 16.5% | 15.5% | 14.3% | 9.0% | 4.4% | 100% |
| 4 | 2.8% | 1.5% | 1.7% | 5.9% | 9.7% | 14.2% | 17.1% | 14.7% | 10.6% | 8.9% | 7.2% | 5.7% | 100% |
| 6 | 4.6% | 1.5% | 1.5% | 3.7% | 7.5% | 12.7% | 27.2% | 20.5% | 7.8% | 3.8% | 3.8% | 5.5% | 100% |
| All of SNE | 2.9% | 1.3% | 1.6% | 3.5% | 7.2% | 12.1% | 20.2% | 17.6% | 12.2% | 9.8% | 6.9% | 4.8% | 100% |

Table 5. Percent of Annual Landings Occurring in Various Seasons by LCMA and for the Total Stock

| LCMA | Jul-Sept | Jun- Sept | May-Sept | Jun-Oct | Jul-Nov |
|---|---|---|---|---|---|
| 2 | 54% | 67% | 73% | 75% | 67% |
| 6 | 56% | 68% | 76% | 72% | 63% |
| 4 | 42% | 57% | 66% | 66% | 59% |
| 3 & 5 | 46% | 57% | 65% | 71% | 70% |
| All of SNE | 50% | 62% | 69% | 72% | 67% |

Table 6. 2007-2009 Average Landings (pounds) by Statistical Area

| Stat Area | Total Pounds | %Total |
|---|---|---|
| 537 | 1,655,963 | 30% |
| 538 | 184,546 | 3% |
| 539 | 1,171,210 | 21% |
| 611 | 1,098,707 | 20% |
| 612 | 431,461 | 8% |
| 613 | 75,207 | 1% |
| 614-615 | 118,222 | 2% |
| 616-533 | 452,309 | 8% |
| 621-622 | 123,879 | 2% |
| 623 | 127,077 | 2% |
| 624-633 | 32,266 | 1% |
| Total | 5,470,846 | 100% |

Table 7. 2007-2009 Average Landings (pounds) by LCMA

| LCMA | Total Pounds | %Total |
|---|---|---|
| 2 | 1,476,313 | 27% |
| 3 | 2,237,475 | 41% |
| 4 | 506,701 | 9% |
| 5 | 165,912 | 3% |
| 6 | 1,084,445 | 20% |
| Total | 5,470,846 | 100% |

| | |
|---|---|
| Massachusetts: | Stat Area 538 and 539 landings were assigned to LMA 2; Stat Area 537 landings were assigned to LMA 3. |
| Rhode Island: | Landings from all stat areas were assigned to LMA based on annual tallies of license holders' known fishing practises and permit history. |
| Connecticut: | Stat Area 611 landings were assigned to LMA 6 except those from subarea 149 which were assigned to LMA 2. |
| New York: | Landings from all stat areas were assigned to LMA based on annual tallies of license holders' known fishing practises and permit history. |
| New Jersey: | Inshore Stat Area landingss were assigned to LMA 5 (614 & 615), LMA 4 (612 & 613), and LMA 6 (611); all other landings were assigned to LMA 3. |
| DE, MD, VA: | Compliance report total reported landings for 2008 and 2009 were apportioned to Stat Areas based on NMFS partial reporting; (2008: 42,960 lbs expanded to 52,570 lbs; 2009: 30,390 lbs expanded to 49,861 lbs). 2007 landings as reported in Assessment. Inshore Stat Area landingss were assigned to LMA 5 (614,615,621,625,631,635) or LMA 4 (612); all other landings were assigned to LMA 3. |

Table 8. Percentage of catch discarded due to size limit changes, and percentage increase of discards over current levels.

| | LCMA 2 | | LCMA 3 | | LCMA 6 | | SNE | |
|---|---|---|---|---|---|---|---|---|
| **% Released at Current Slot Limit** | 70% | Addn'l bycatch above current levels | 59% | Addn'l bycatch above current levels | 76% | Addn'l bycatch above current levels | 66% | Addn'l bycatch above current levels |
| | | | | | | | | |
| **% of total catch released at:** | | | | | | | | |
| **Alternative Minimum Sizes (5-1/4" max)** | | | | | | | | |
| > 3-1/2" (88.9 - 133.4mm) | 82% | 12% | 59% | 0% | 88% | 12% | 73% | 7% |
| > 3-17/32" (89.7 - 133.4mm) | 84% | 14% | 62% | 3% | 90% | 14% | 75% | 9% |
| > 3-9/16" (90.5 - 133.4mm) | 86% | 16% | 65% | 5% | 92% | 16% | 77% | 11% |
| > 3-19/32" (91.3 - 133.4mm) | 87% | 17% | 65% | 6% | 93% | 17% | 78% | 12% |
| > 3-5/8" (92.1 - 133.4mm) | 91% | 21% | 71% | 11% | 95% | 19% | 82% | 16% |
| > 3-21/32" (92.9 - 133.4mm) | 92% | 23% | 73% | 14% | 96% | 20% | 84% | 18% |
| >3-3/4 (95.3 - 133.4 mm) | 96% | 26% | 80% | 21% | 98% | 23% | 89% | 23% |
| | | | | | | | | |
| **3-3/8 Minimum & Alternative Maximum** | | | | | | | | |
| > 3-3/8" - 4" (85.7 - 101.6mm) | 71% | 1% | 42% | -17% | 76% | 0% | 59% | -7% |
| > 3-3/8" - 3-5/8" (85.7 - 92.1mm) | 79% | 9% | 66% | 6% | 81% | 5% | 73% | 7% |
| > 3-3/8" - 3-17/32" (85.7 - 89.7mm) | 86% | 16% | 74% | 15% | 86% | 10% | 80% | 14% |
| > 3-3/8" - 3-1/2" (85.7 - 88.9mm) | 88% | 18% | 77% | 18% | 88% | 12% | 83% | 17% |
| > 3-3/8" - 3-15/32" (85.7 - 88.1mm) | 91% | 21% | 80% | 21% | 90% | 14% | 85% | 19% |
| > 3-3/8" - 3-7/16" (85.7 - 87.3mm) | 94% | 24% | 85% | 25% | 93% | 17% | 89% | 23% |
| | | | | | | | | |
| **3-1/2 Minimum & Alternative Maximum** | | | | | | | | |
| > 3-1/2" - 5" (88.9 - 127.0mm) | 82% | 12% | 60% | 0% | 88% | 12% | 73% | 7% |
| > 3-1/2" - 4" (88.9 - 101.6mm) | 83% | 13% | 66% | 7% | 88% | 13% | 76% | 10% |
| > 3-1/2" - 3-7/8" (88.9 - 98.4mm) | 83% | 13% | 71% | 12% | 89% | 13% | 79% | 13% |
| > 3-1/2" - 3-3/4" (88.9 - 96.8mm) | 86% | 16% | 79% | 20% | 90% | 14% | 84% | 17% |
| > 3-1/2" - 3-5/8" (88.9 - 92.1mm) | 91% | 21% | 89% | 30% | 93% | 17% | 90% | 24% |
| > 3-1/2" - 3-19/32" (88.9 - 91.3mm) | 93% | 23% | 92% | 32% | 94% | 19% | 93% | 26% |

Table 9. 2007 - 2009 Percent of egg bearing females 1-5mm below legal size

| State | 2007 | 2008 | 2009 | 2007-2009 Average |
|---|---|---|---|---|
| CT | 41.7% | 29.3% | 30.1% | 33.2% |
| MA | 31.5% | 38.7% | 33.8% | 34.7% |
| NJ | NA | 12.5% | 13.2% | 12.8% |
| NY | 17.2% | 13.2% | 15.5% | 15.3% |
| RI | 32.8% | 37.8% | 42.5% | 37.7% |
| Average SNE | 30.8% | 26.3% | 27.0% | 26.7% |

Table 10. Percentage Reduction in Landings due to size limit changes (gray boxes indicate where there is a > 50% reductions and bolded boxes where there is > 75% reductions.

| Alternative Minimum Sizes (5-1/4" max) | LCMA 2 | LCMA 3 | LCMA 4 | LCMA 5 | LCMA 6 | SNE |
|---|---|---|---|---|---|---|
| > 3-1/2" (88.9 - 133.4mm) | -37.1% | -3.9% | -26.3% | -7.1% | -45.6% | -22.8% |
| > 3-17/32" (89.7 - 133.4mm) | -45.3% | -8.4% | -32.1% | -9.4% | -54.0% | -28.5% |
| > 3-9/16" (90.5 - 133.4mm) | -53.4% | -13.3% | -39.0% | -11.7% | -61.9% | -35.0% |
| > 3-19/32" (91.3 - 133.4mm) | -62.8% | -17.8% | -46.9% | -14.5% | -70.8% | -42.2% |
| > 3-5/8" (92.1 - 133.4mm) | -69.8% | -22.8% | -53.9% | -16.5% | **-75.0%** | -48.5% |
| > 3-21/32" (92.9 - 133.4mm) | **-75.1%** | -27.4% | -59.9% | -18.6% | **-79.4%** | -54.0% |
| >3-3/4 (95.3 - 133.4 mm) | **-88.0%** | -41.4% | **-75.7%** | -27.3% | **-90.4%** | -68.7% |
| | | | | | | |
| **3-3/8 Minimum & Alternative Maximum** | | | | | | |
| > 3-3/8" - 4" (85.7 - 101.6mm) | -1.9% | -26.2% | -5.7% | -55.3% | -2.1% | -11.1% |
| > 3-3/8" - 3-5/8" (85.7 - 92.1mm) | -30.2% | **-75.6%** | -46.1% | **-83.5%** | -25.0% | -51.1% |
| > 3-3/8" - 3-17/32" (85.7 - 89.7mm) | -54.7% | **-90.4%** | -67.9% | **-90.6%** | -46.0% | -71.3% |
| > 3-3/8" - 3-1/2" (85.7 - 88.9mm) | -62.9% | **-94.9%** | -73.7% | **-92.9%** | -54.4% | **-77.0%** |
| > 3-3/8" - 3-15/32" (85.7 - 88.1mm) | -70.3% | **-97.7%** | **-78.8%** | **-94.8%** | -63.4% | **-81.9%** |
| > 3-3/8" - 3-7/16" (85.7 - 87.3mm) | **-79.4%** | **-99.4%** | **-85.6%** | **-96.8%** | **-74.5%** | **-87.8%** |
| | | | | | | |
| **3-1/2 Minimum & Alternative Maximum** | | | | | | |
| > 3-1/2" - 5" (88.9 - 127.0mm) | -37.1% | -5.8% | -26.4% | -12.6% | -45.6% | -23.4% |
| > 3-1/2" - 4" (88.9 - 101.6mm) | -39.0% | -31.3% | -32.0% | -62.5% | -47.7% | -34.1% |
| > 3-1/2" - 3-7/8" (88.9 - 98.4mm) | -41.4% | -44.7% | -38.0% | -69.8% | -50.1% | -41.2% |
| > 3-1/2" - 3-3/4" (88.9 - 96.8mm) | -49.1% | -67.7% | -50.6% | **-79.8%** | -53.0% | -55.1% |
| > 3-1/2" - 3-5/8" (88.9 - 92.1mm) | -67.3% | **-80.8%** | -72.5% | **-90.7%** | -70.6% | -74.1% |
| > 3-1/2" - 3-19/32" (88.9 - 91.3mm) | **-74.4%** | **-86.1%** | **-79.4%** | **-92.7%** | **-76.7%** | **-80.6%** |

Table 11. Percentage of the "marketable" comprised of female lobsters by statistical areas – 2007–2009; **a.)** SA 611 – LMA 6, **b.)**SA 538 – LMA 2, **c.)** SA 539 – LMA 2, **d.)** SA 537 – LMA 2 & 3, **e.)** SA 616 – LMA 3.

A. **Connecticut - Stat Area 611 - inshore**

| % Female - marketable lobsters only | | | |
|---|---|---|---|
| | 2007 - 2009 Average | | |
| | EAST | CENTRAL | WEST |
| Jan | 47% | 38% | 40% |
| Feb | 64% | | 44% |
| Mar | 71% | | |
| Apr | | | |
| May | | 49% | 33% |
| Jun | 77% | 40% | 83% |
| Jul | 73% | 43% | 52% |
| Aug | 85% | 72% | 78% |
| Sep | 79% | 80% | 45% |
| Oct | 57% | | |
| Nov | 51% | 71% | 42% |
| Dec | 44% | 28% | 18% |

*box is gray where the sample size < 50

**B. Massachusetts Stat Area 538 - inshore**

| % Female - marketable lobsters only | | | |
|---|---|---|---|
| | 2007 | 2008 | 2009 |
| May | 77% | 67% | 82% |
| Jun | 83% | 83% | 90% |
| Jul | 73% | 57% | 77% |
| Aug | 85% | 72% | 70% |
| Sep | 83% | 90% | |
| Oct | 86% | 93% | 89% |
| Nov | 86% | 91% | 93% |

C. **Rhode Island - Stat Area 539 - inshore**

| % Female - marketable lobsters only | | | | | | |
|---|---|---|---|---|---|---|
| | 2007 | | 2008 | | 2009 | |
| | NARRAGANSETT BAY | RI SOUND | NARRAGANSETT BAY | RI SOUND | NARRAGANSETT BAY | RI SOUND |
| Jan | 53% | 55% | 52% | 76% | 54% | 74% |
| Feb | 26% | 55% | 51% | 59% | 38% | 93% |
| Mar | 28% | 57% | 50% | 39% | 37% | 71% |
| Apr | 39% | 47% | 52% | 72% | 40% | 48% |
| May | 24% | 38% | 36% | 88% | 29% | 61% |
| Jun | 52% | 58% | 34% | 59% | 18% | 37% |
| Jul | 70% | 65% | 49% | 41% | 51% | 42% |
| Aug | 69% | 67% | 51% | 81% | 60% | 51% |
| Sep | 70% | 69% | 44% | 84% | 46% | 88% |
| Oct | 42% | 74% | 32% | 88% | 31% | 85% |
| Nov | 37% | 88% | 24% | 92% | 23% | 85% |
| Dec | 49% | 80% | 49% | 84% | 28% | 88% |

**D. Rhode Island - Stat Area 537- offshore**

| % Female - marketable lobsters only | | | |
|---|---|---|---|
| | 2007 | 2008 | 2009 |
| Jan | 27% | 25% | 18% |
| Feb | 32% | 32% | 40% |
| Mar | 28% | 29% | 27% |
| Apr | 33% | 39% | 25% |
| May | 32% | 28% | 25% |
| Jun | 27% | 23% | 25% |
| Jul | 21% | 19% | 27% |
| Aug | 26% | 27% | 28% |
| Sep | 42% | 30% | 37% |
| Oct | 31% | 40% | 38% |
| Nov | 53% | 63% | 39% |
| Dec | 51% | 41% | 42% |

**E. Rhode Island - Stat Area 616- offshore**

| % Female - marketable lobsters only | | | |
|---|---|---|---|
| | 2007 | 2008 | 2009 |
| Jan | | 40% | 24% |
| Feb | | 39% | 20% |
| Mar | | 38% | 33% |
| Apr | | 28% | 39% |
| May | | 22% | 34% |
| Jun | 21% | 16% | 21% |
| Jul | 22% | 24% | 17% |
| Aug | 22% | 34% | 33% |
| Sep | 45% | 40% | 36% |
| Oct | 40% | 31% | 37% |
| Nov | 39% | 31% | 38% |
| Dec | 33% | 32% | 30% |

# Figures

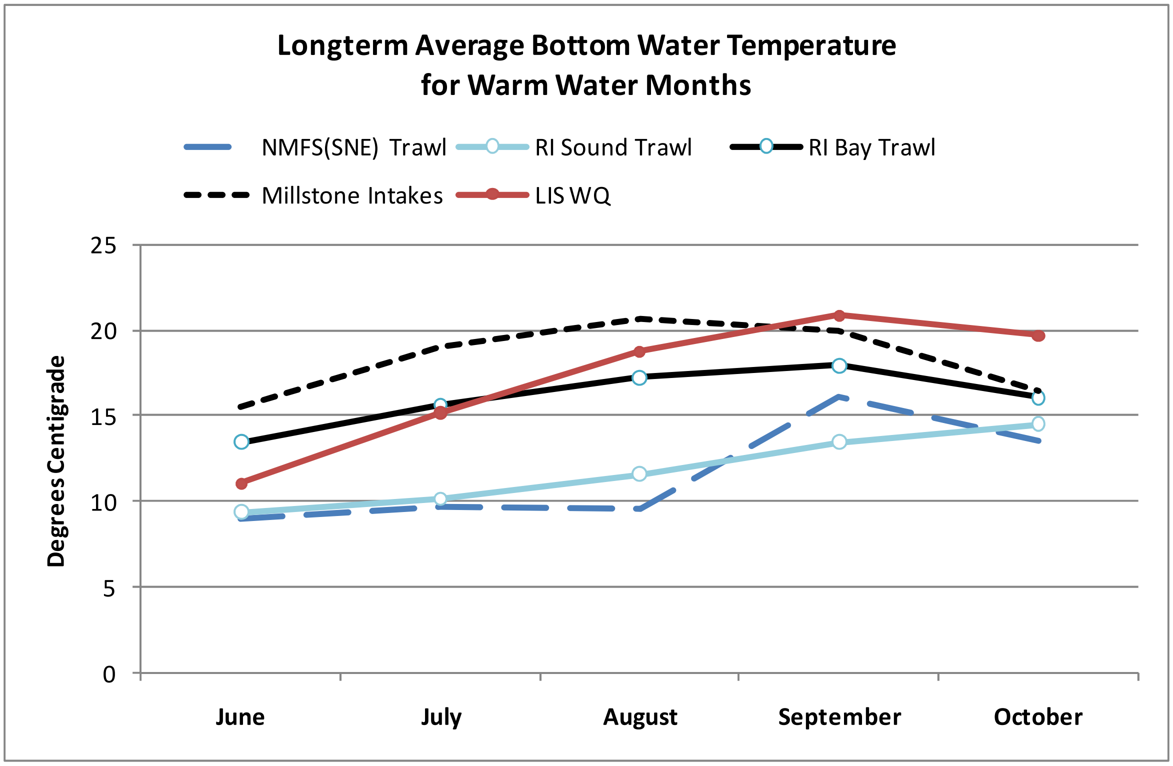



Figure 1. Longterm average bottom water temperature for warm water months.
Average temperatures (°C) taken is four longterm monitoring programs: NMFS bottom trawl survey at SNE sites (1964-2009); RI Trawl Survey at RI Sound sites and Lower Narragansett Bay sites (1995-2009); Millstone Power Station intakes in eastern Long Island Sound (1976-2009); and CT DEP Long Island Sound (LIS) Water Quality (WQ) Survey (1991-2008).

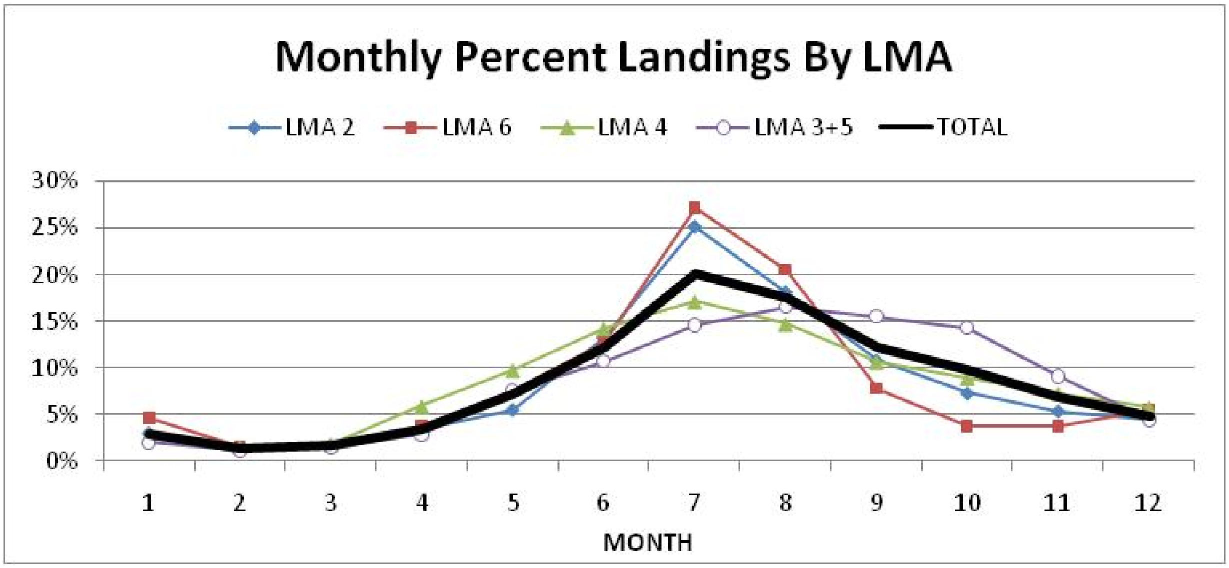



Figure 2. 2007-2009 Monthly Lobster Landings in SNE by LCMA.

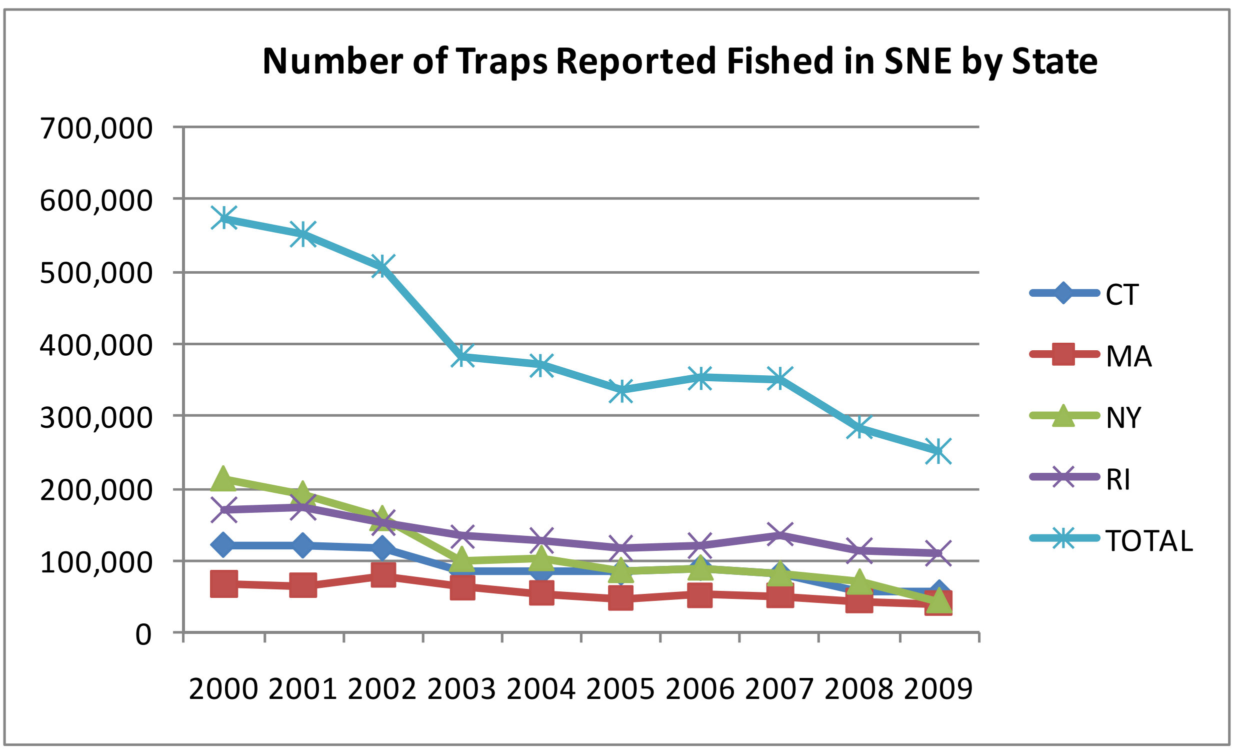



Figure 3. Number of traps reported fished from 2000-2009 by state in SNE (the 2009 number for CT was not available at the time of the report, the 2008 number was used as a proxy for 2009. This number will be updated when the 2009 number is available).

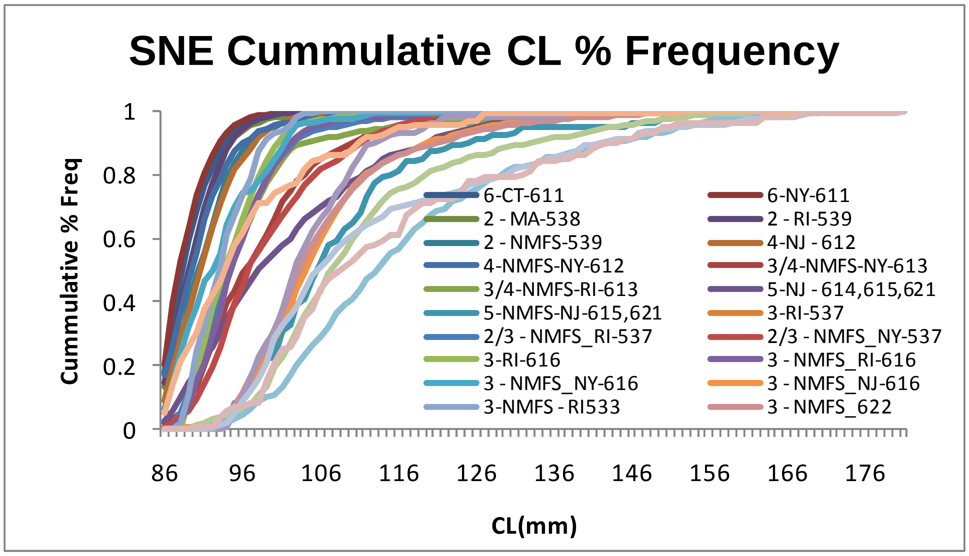



Figure 4. Cumulative % frequency of SNE sea and port samples by agency, LCMA and stat area

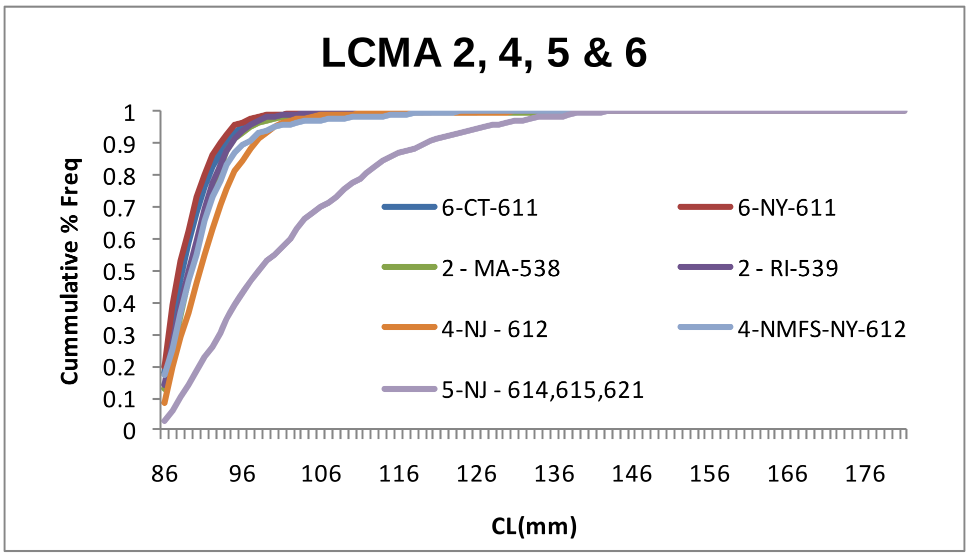



Figure 5. Inshore LCMA size distribution.

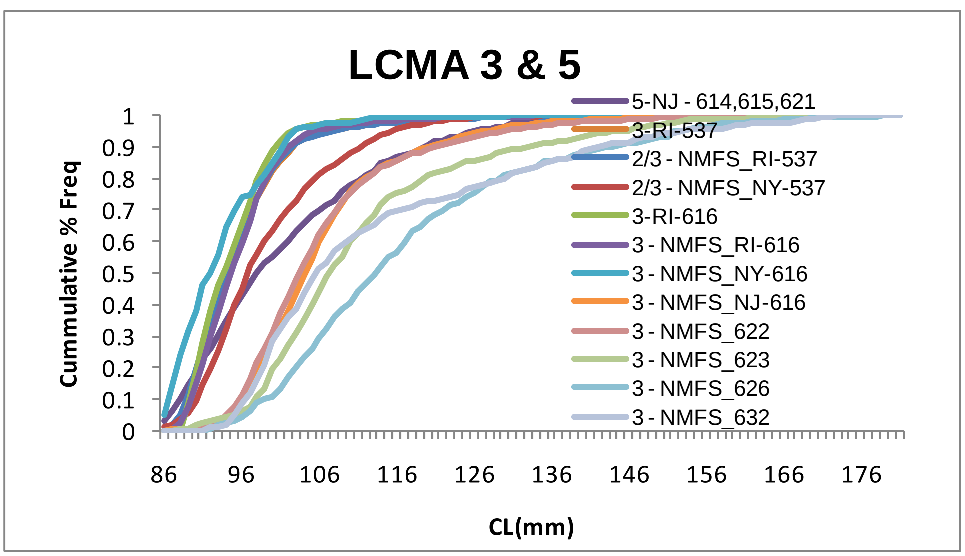
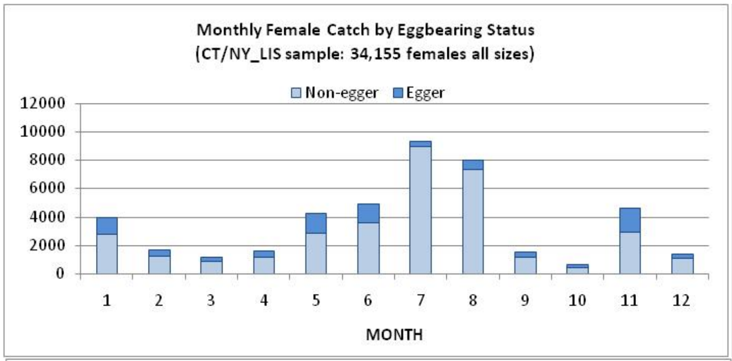
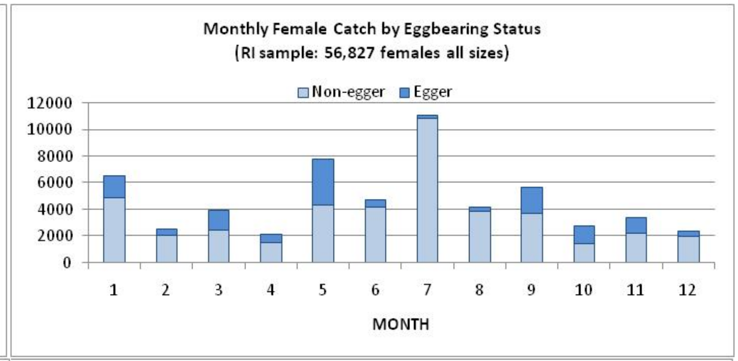


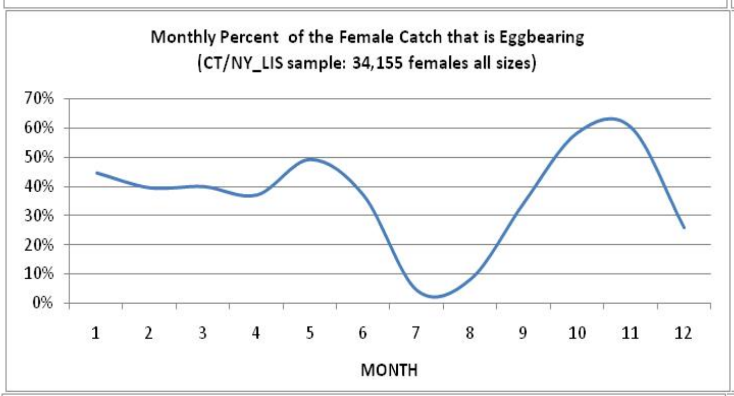
Figure 6. Offshore size distribution (LCMA 3 and 5)

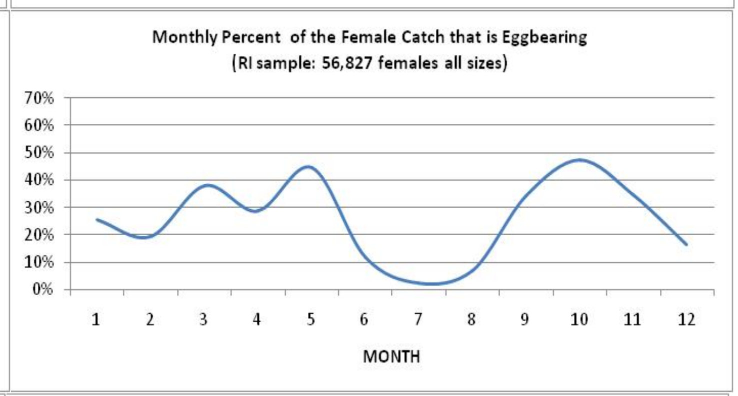
# Appendix 1

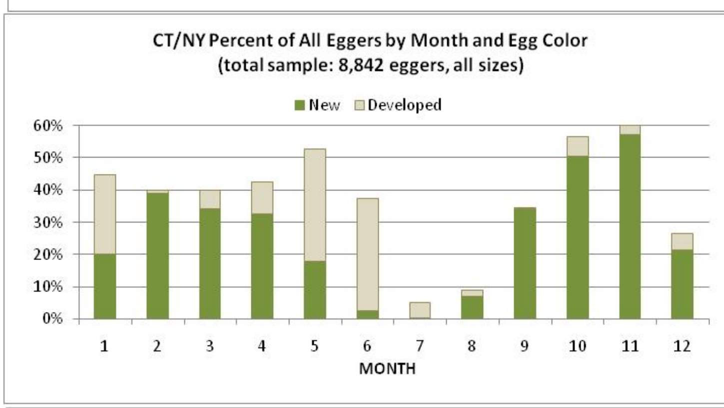
## SOUTHERN NEW ENGLAND LOBSTER CATCH CHARACTERISTICS
## 2007-2009 Sea Sampling Data

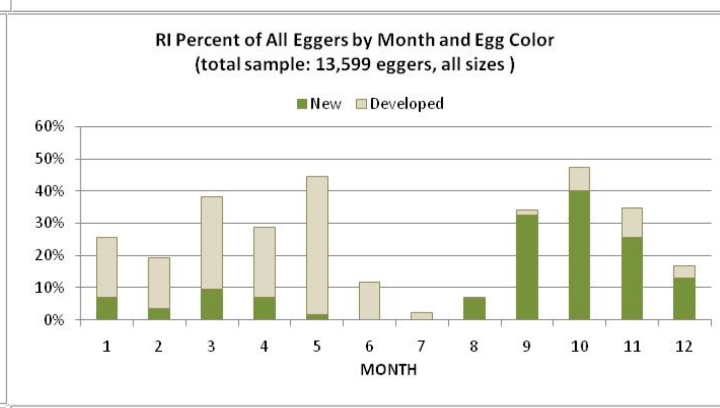


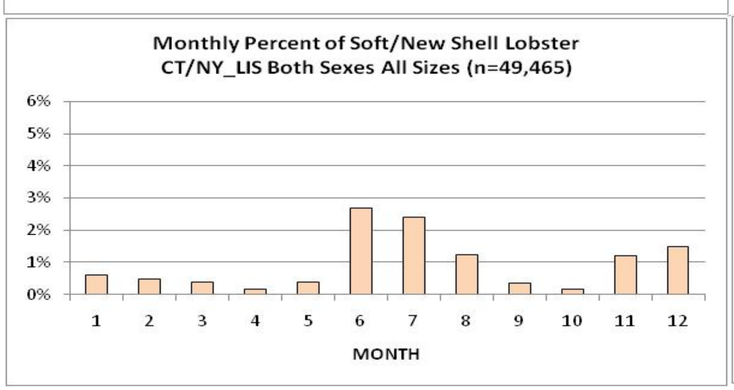



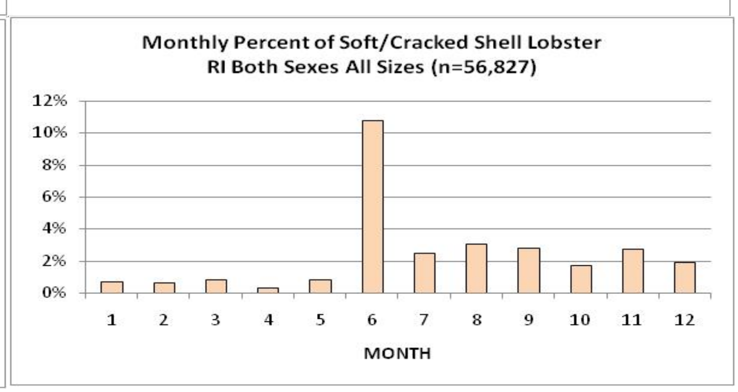



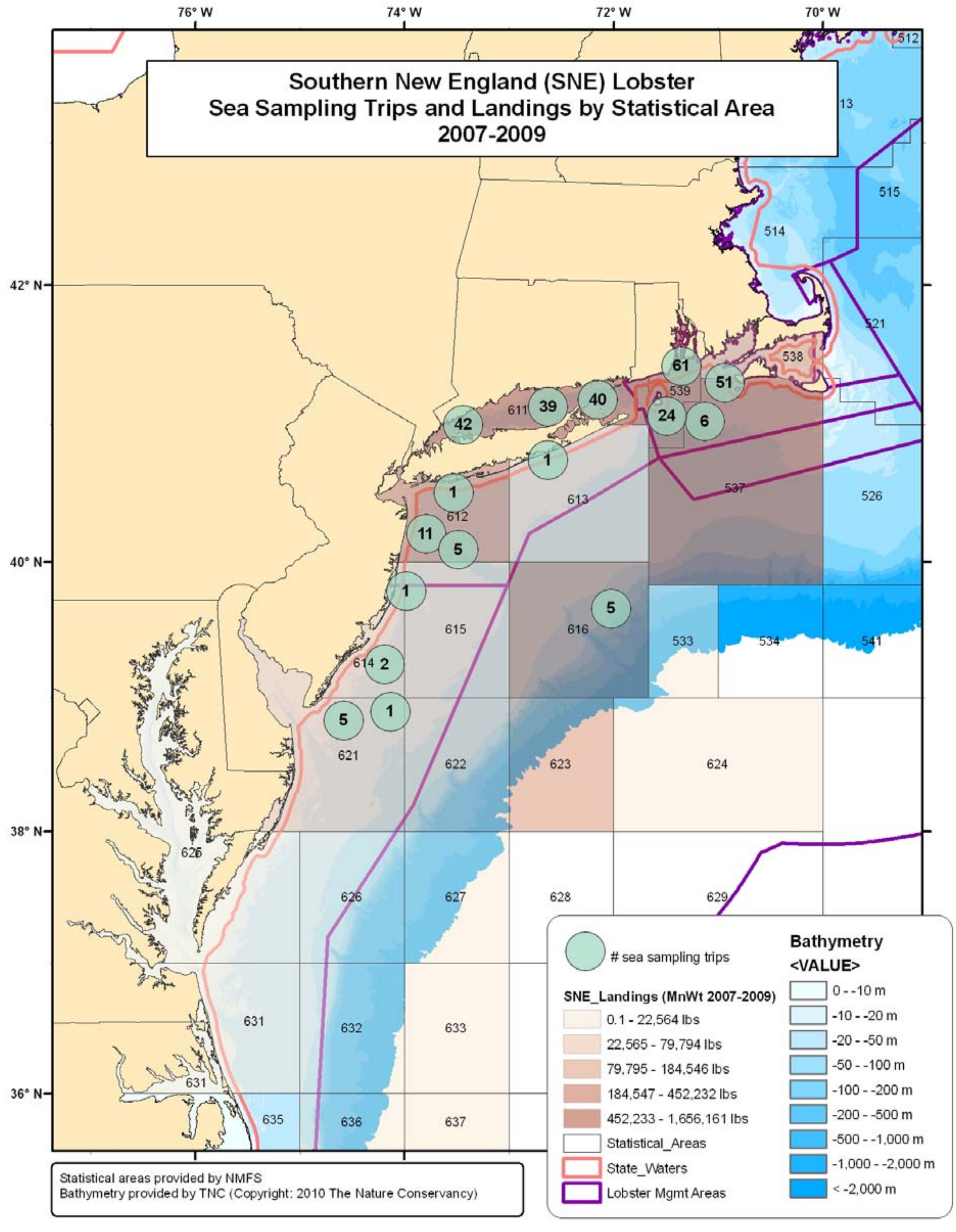



## Appendix 2



Southern New England (SNE) Lobster
Sea Sampling Trips and Landings by Statistical Area
2007-2009
76° W
74° W
72° W
70° W
42° N
40° N
38° N
36° N
# sea sampling trips
SNE_Landings (MnWt 2007-2009)
0.1 - 22,564 lbs
22,565 - 79,794 lbs
79,795 - 184,546 lbs
184,547 - 452,232 lbs
452,233 - 1,656,161 lbs
Statistical_Areas
State_Waters
Lobster Mgmt Areas
Bathymetry
<VALUE>
0 - -10 m
-10 - -20 m
-20 - -50 m
-50 - -100 m
-100 - -200 m
-200 - -500 m
-500 - -1,000 m
-1,000 - -2,000 m
< -2,000 m
Statistical areas provided by NMFS
Bathymetry provided by TNC (Copyright: 2010 The Nature Conservancy)