Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: January 19, 2016

SUBJECT: Projections for the SNE Lobster Stock

The American Lobster Technical Committee (TC) met on December 8th to review projections for the Southern New England (SNE) lobster stock. Below are the series of projections that the TC unanimously recommends for Board consideration. These projections represent two potential scenarios. In the first scenario, recruitment is assumed to be independent of stock biomass and stable at current estimated levels. While this can limit the potential for rebuilding, it is perhaps the more realistic of the two scenarios given that recruitment has been declining for the past couple decades.

In the second scenario, future recruitment is linked to the spawning stock via a Beverton-Holt stock-recruitment relationship. This is perhaps less realistic than the first scenario with regards to stock rebuilding but more realistic for the continued decline of the population because recruitment decreases with further depletion of the spawning stock.

Under the first scenario with fixed recruitment, an 80% to 90% reduction in harvest rate is projected to stabilize the stock at current levels, assuming natural mortality also stabilizes at current levels; even lower harvest rates show some potential for recovery. Under the second scenario with recruitment linked to spawning stock, a 75% reduction in harvest rate would be needed to stabilize the stock under current natural mortality conditions.

This memo is divided into three parts. The first section reviews the projection configurations including variations in fishing mortality, natural mortality, units (N or SSB), and recruitment relationships. The second section, which can be found on page 4, reviews the projections from the first scenario which the TC feels is most realistic given the current condition of the stock. The third section, which begins on page 15, outlines the projections from the more optimistic scenario which assumes a Beverton-Holt stock-recruit relationship. A reference table outlining all projection variations, their configurations, and associated figures can be found on page 25.

1. *Stock Projection Configuration*

The TC ran stock projections to examine population responses under various levels of natural mortality (M) and fishing mortality (F). It is important to note that here F is used to represent the proportion of current catch levels by weight, not a fishery removal rate as is typical. In plots where F was fixed at zero, M varied from 0.15 to 0.5. The effect of varying M on population projections is presented and highlights the sensitivity to the assumed value of M. Analysis of model fit at different natural mortality rates showed that the most likely value of M in recent years is around 0.255 to 0.270, similar to or slightly lower than the M=0.285 used for the final model years in the 2015 Benchmark Stock Assessment (Figure 1). For consistency with the peer-reviewed assessment, an M = 0.285 was used in projection runs where M was held constant and F (catch weight) varied from 0 to 100% of current landings. These runs force the extraction of the same weight of lobsters each year until there are no legal lobsters left in the population. As a result, declining populations tend to decrease rapidly.

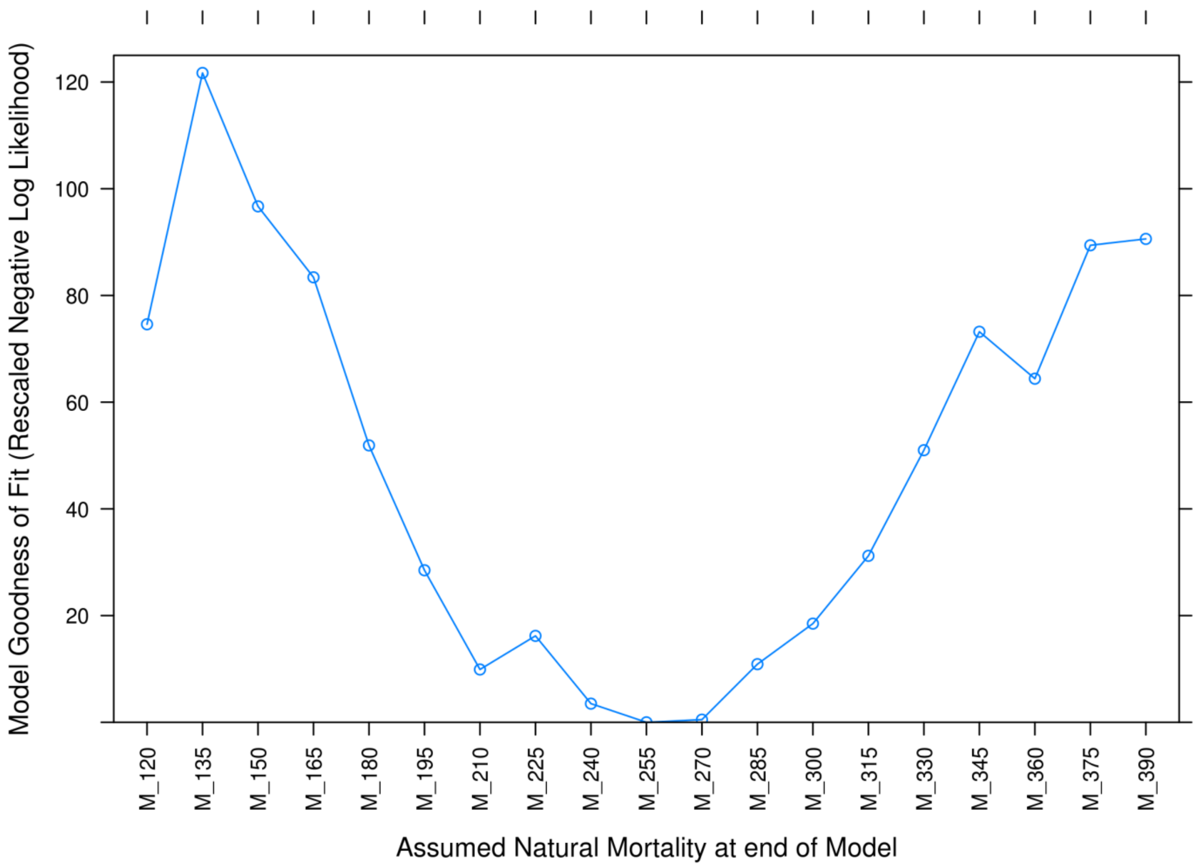

Figure 1: Rescales negative log likehoods (NLL) from model fits using different values of M, with F=0. Lower negative log likelihood values indicate better model fit to the data. Thus, the most likely value of M in recent years is around 0.255 to 0.270.

The projections are shown in two different units: reference abundance (N) and spawning stock biomass (SSB). Reference abundance is the number of lobsters 78+ mm carapace length on January 1st plus the number that will molt and recruit to the 78+ group during the year. Current reference points are also expressed in N. SSB is the total weight of mature lobsters (both sexes) in the stock. In the projections, SSB shows greater recovery potential than reference abundance because SSB is the product of abundance at-size, the probability of maturity at-size, and weight at-size. As a result, SSB increases more rapidly than N because larger individuals weigh more than smaller lobsters.

Two types of recruitment are explored in the projections. In the first scenario, the projections assume constant recruitment at levels similar to those observed from 2011-2014. In the second and most optimistic scenario, recruitment is assumed to follow the Beverton-Holt stock-recruit relationship, which models a positive relationship between spawning stock and the number of recruits. Analysis of the relationship between SSB and recruits since 1995 shows that the assumption of constant recruitment is more plausible than a Beverton-Holt relationship, but likely still represents a relatively optimistic scenario. Specifically, Figure 2 shows that after 2003, recruitment plummeted while SSB remained fairly constant. This suggests that depensatory mechanisms may be at play in the SNE lobster stock, such that recruitment drops to very low levels well before SSB reaches zero unlike a traditional Beverton-Holt assumption of recruitment dropping off rapidly only when SSB nears zero. Thus, the resulting rate of recruitment appears to now be decoupled from SSB, potentially as a result of reduced mating success, environmentally-mediated changes in survivorship of early life history stages, and/or increased predation.

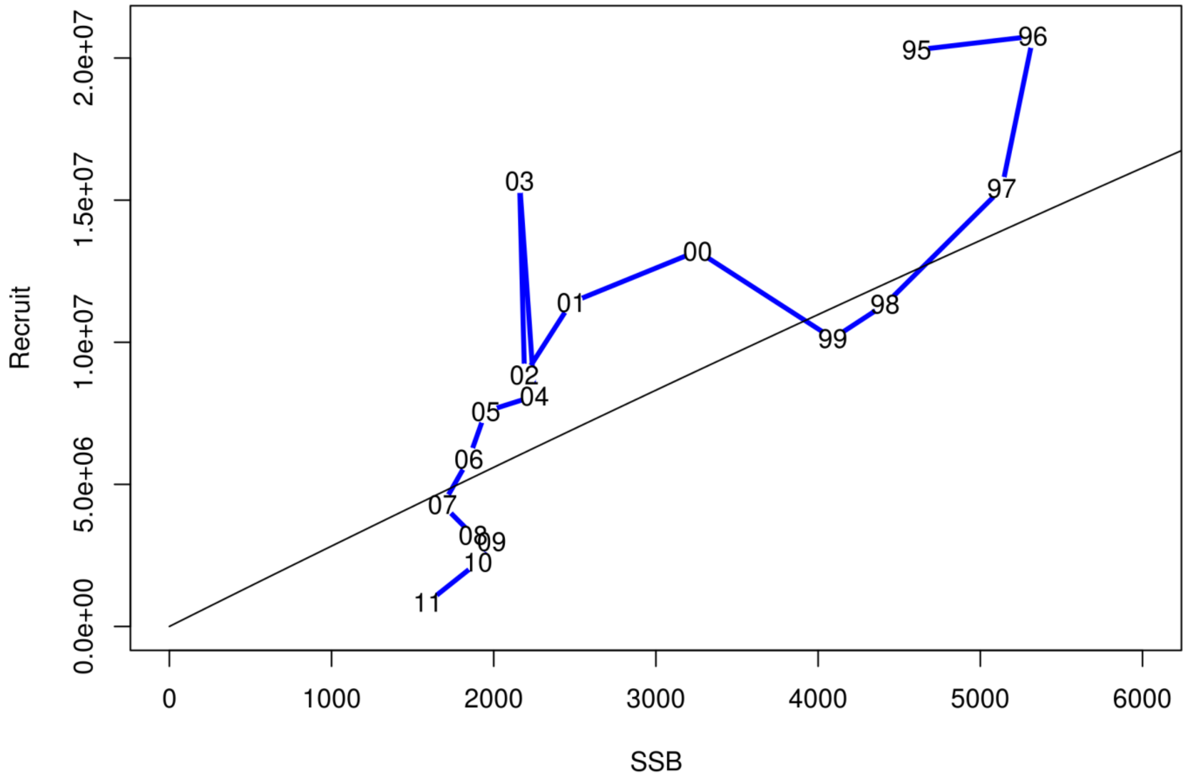

Figure 2: Relationship between model-based spawning stock biomass and recruits from 1995 to 2011. The blue line denotes the trajectory from 1995 – 2011 (recruiting to the model from 1998 to 2014). The black line represents the stock recruit relationship fit to the data with lognormal errors. Note that recruitment sharply declined to a time series low in 2011, despite relatively constant SSB.

Evidence suggests that all of these mechanisms could be occurring in SNE. As such, it should be expected that low levels of recruitment will continue in the immediate future. Furthermore the TC would like to emphasize that the "optimistic" scenarios presented within this document are highly unlikely to occur given the empirical trends in SSB/R and the additional evidence for an environmentally-driven regime shift.

2. Stock Projections Using Constant Recruitment

Figures 3 – 11 show the projection results from the first scenario, which assumes constant recruitment at levels similar to those observed from 2011 to 2014. The TC feels that this is the more realistic projection scenario for rebuilding potential given the current status of the SNE stock unless environmental conditions and lobster health improves.

Figures 3 and 4 show SNE stock projections under the assumption of no harvest (F=0) and variable M. The units are in reference abundance. These figures show that, with no harvest, populations have the potential to increase or stabilize at M less than or equal to 0.3 but increases beyond 0.3 could cause the stock abundance to further decline.

Figures 5 and 6 show the same projections as Figures 3 and 4 (constant recruitment, variable M, no F) but the units are SSB (metric tons). The projections suggest that SSB would remain stable at M =0.35 in the absence of fishing mortality, with some potential for increasing at lower levels but would further decline at higher levels.

Figures 7 and 8 show the projection results if M is held constant at 0.285 and F is allowed to vary between 0 and 95% of current harvest rate. The units are in reference abundance. Under the assumption of constant recruitment, the model runs show that a 90% reduction (to F=0.10) in harvest rate would be necessary to stabilize the stock at current levels. Reductions in harvest greater than this could result in increasing stock abundance while reductions in F of less than 90% could result in further declines in stock abundance.

Figures 9 and 10 show the same projections as Figures 7 and 8 (constant recruitment, variable F, M=0.285) but the units are SSB. In this case, the projections show that an 80% reduction in fishing mortality (F=0.2) would be needed to stabilize SSB at current levels. Reductions in fishing mortality greater than this could result in increasing SSB while reductions in F of less than 80% could result in further stock declines.

Figure 11 shows the weight of spawning stock in the population at the end of each projection year and the weight removed by harvesting or natural mortality, assuming M=0.285. Currently, more spawning stock is being removed by harvesting than is estimated to remain at the end of a calendar year. At F>0.20, more spawning stock is being removed by harvesting than natural mortality while natural mortality is the larger source of biomass removal for F<0.20.

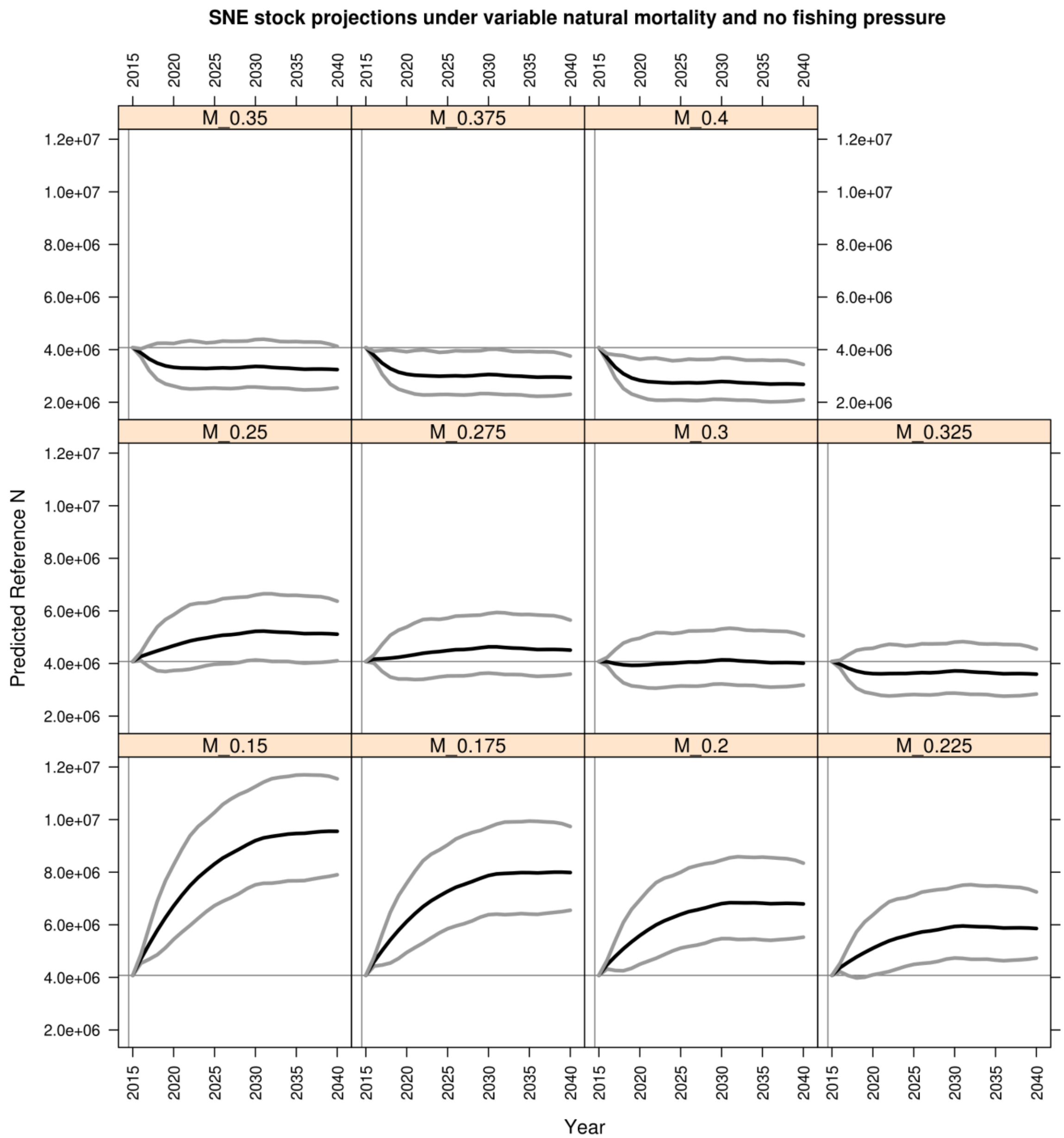

Figure 3: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) under various levels of M. F is fixed at zero. The units are reference abundance. Black line is the mean trend +/- 2SD (gray lines).

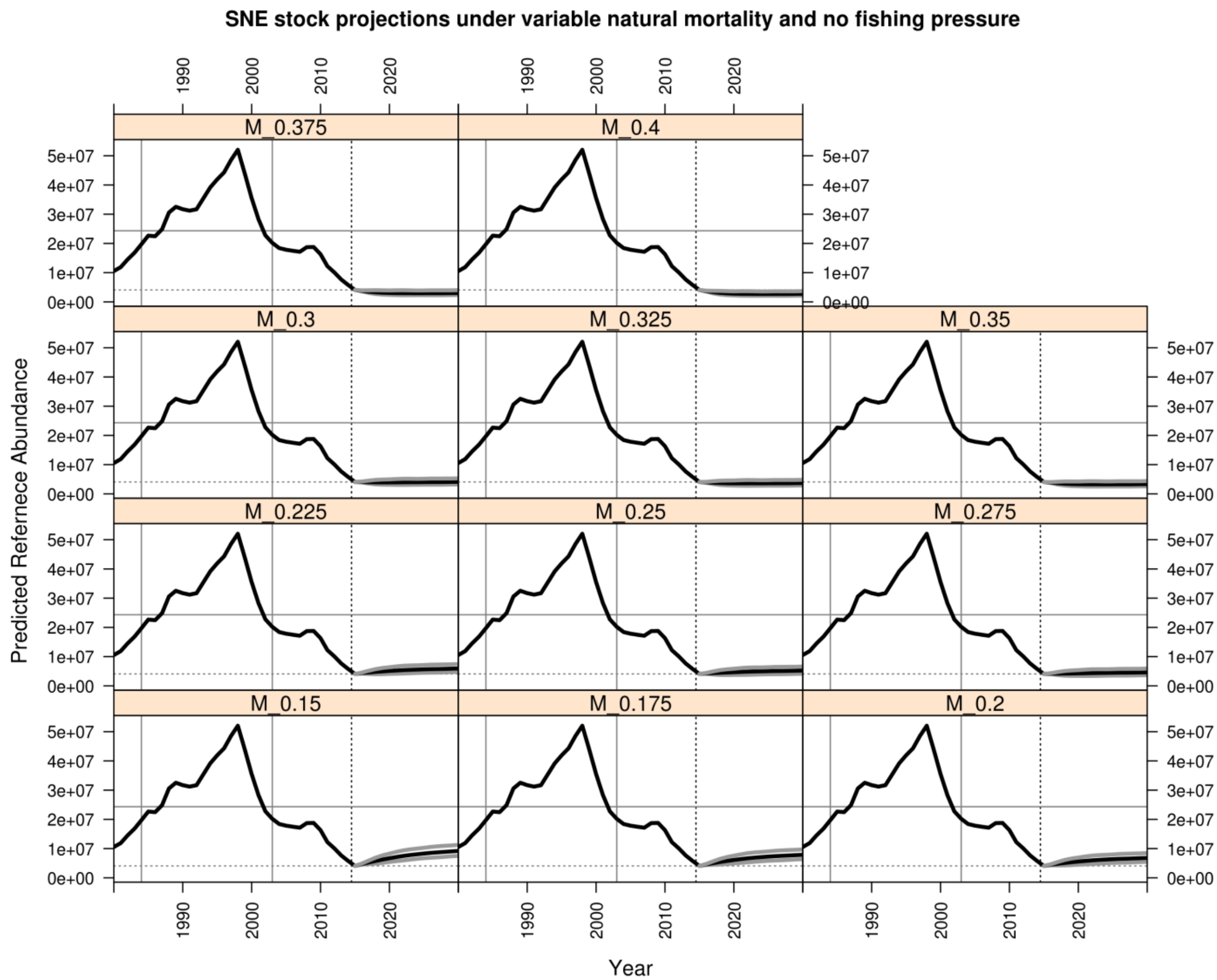

Figure 4: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) with an expanded time series from 1980 to 2040. Various levels of M are shown under fixed F=0. The units are reference abundance. The reference period and trend-based reference point are shown in solid gray lines.

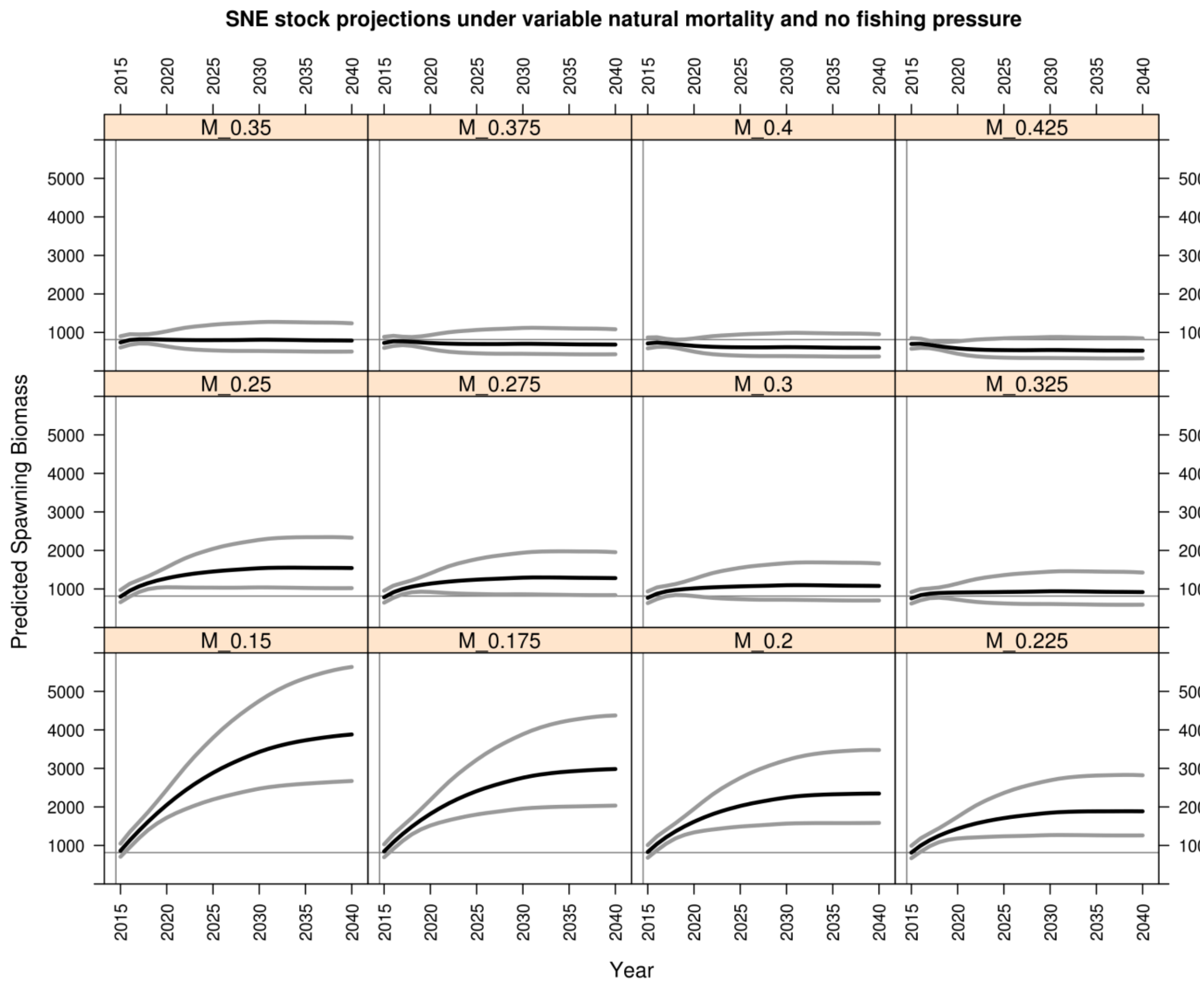

Figure 5: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) under various levels of M. F is fixed at zero. The units are SSB. Black line is the mean trend +/- 2SD (gray lines).

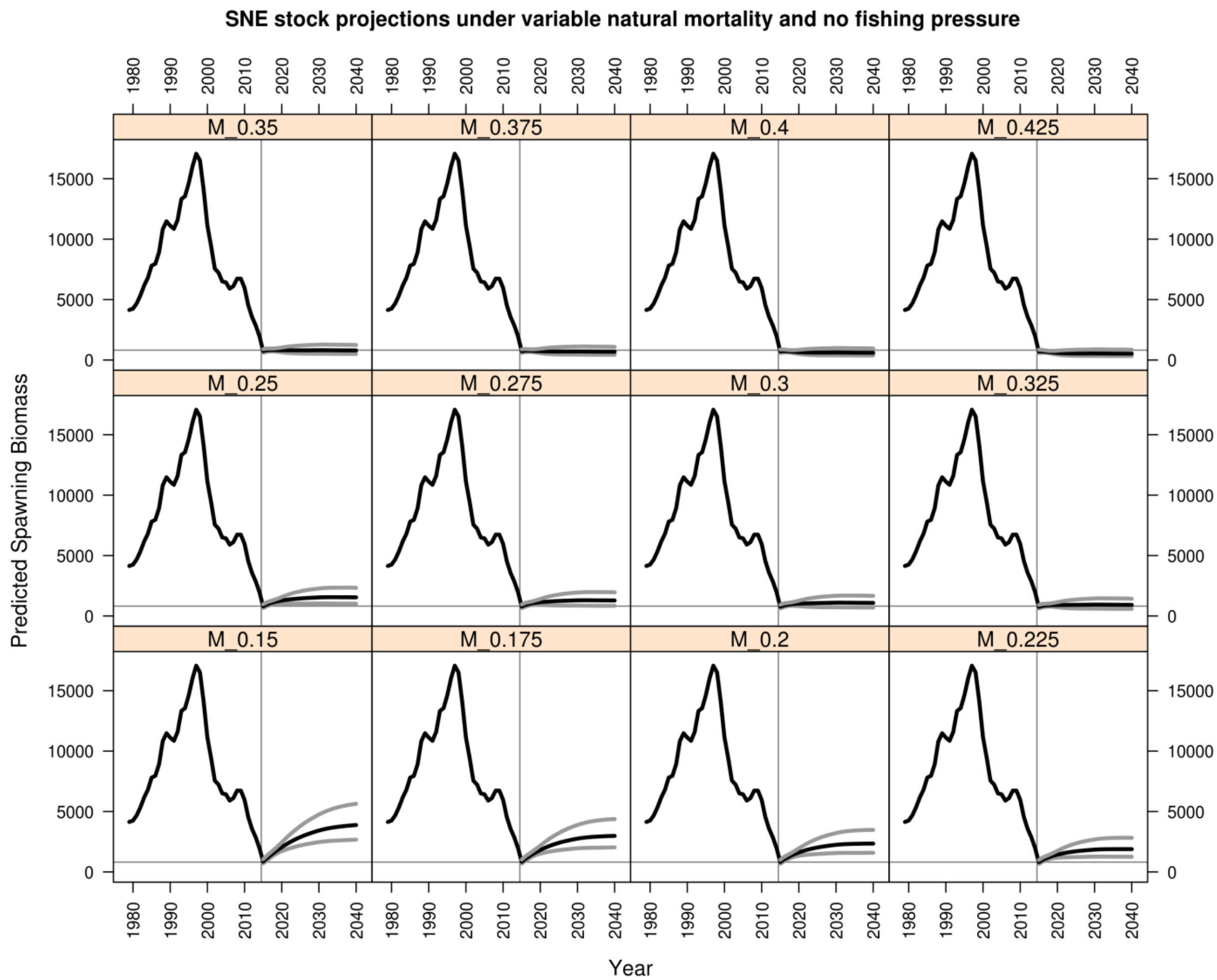

Figure 6: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) with an expanded time series from 1980 to 2040. Various levels of M are shown under fixed F=0. The units are SSB.

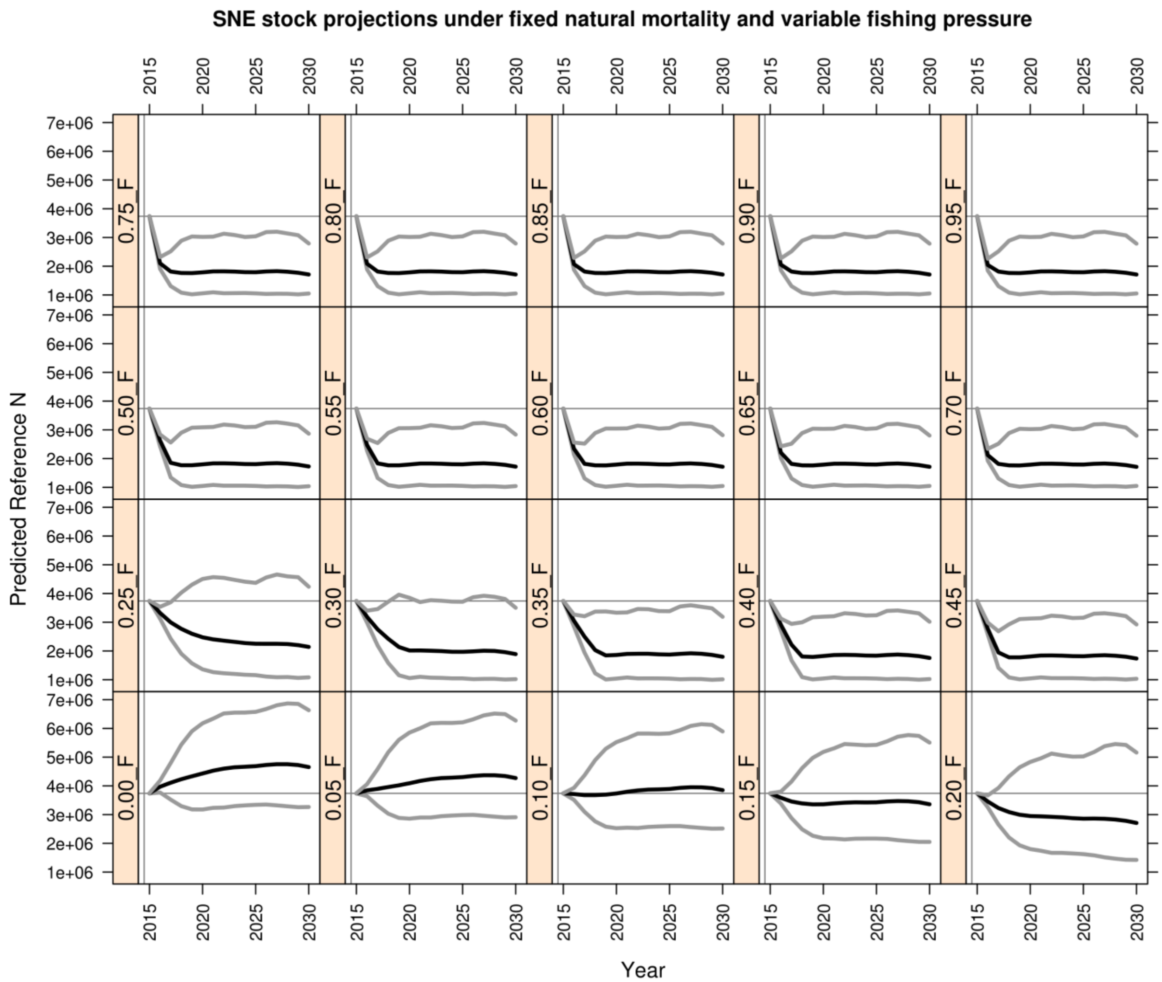

Figure 7: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) under various levels of F. M is fixed at 0.285. The units are reference abundance. Black line is the mean trend +/- 2SD (gray lines).

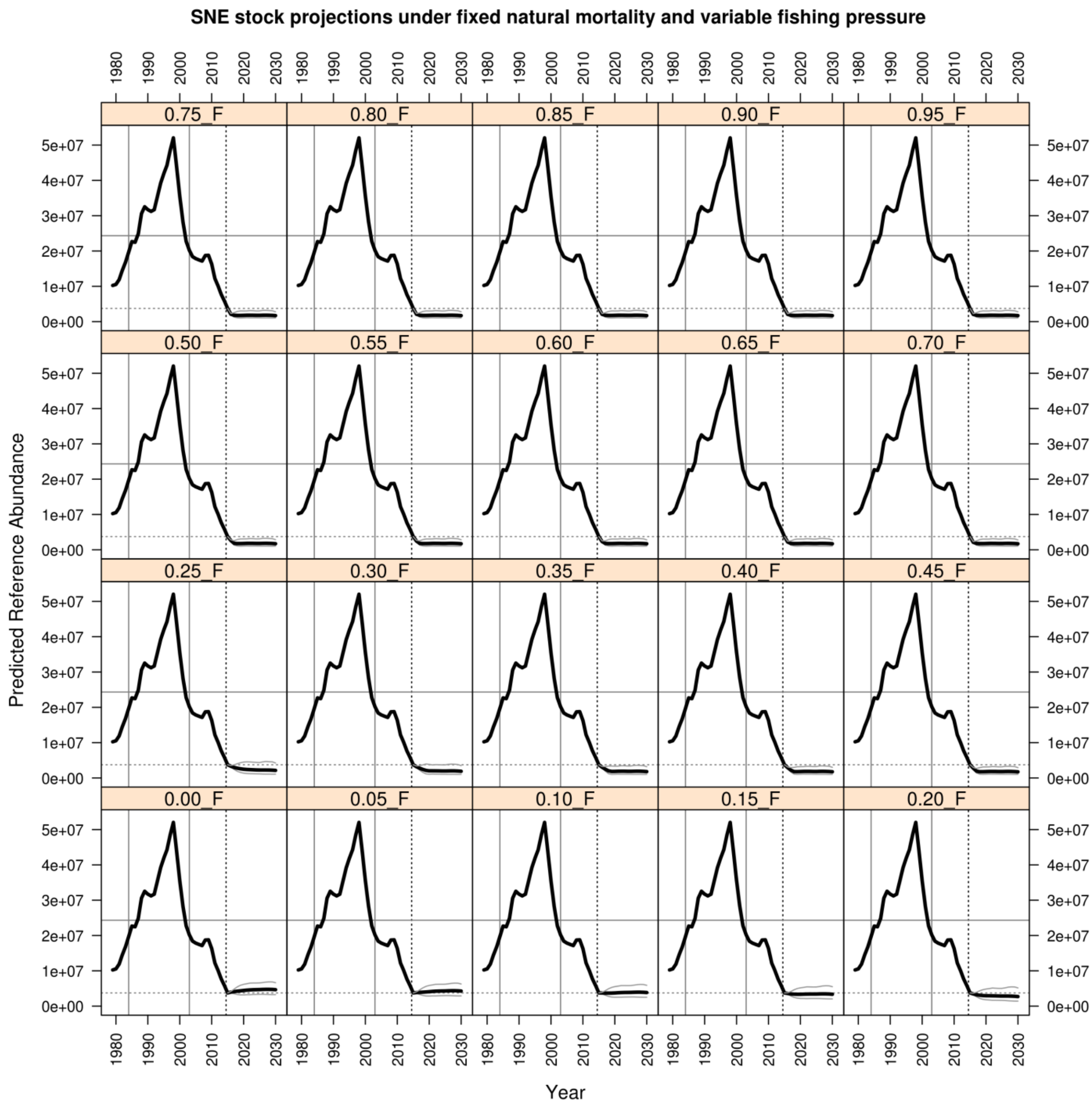

Figure 8: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) with an expanded time series from 1980 to 2040. Various levels of F are shown under fixed M=0.285. The units are reference abundance. The reference period and trend-based reference point are shown in solid gray lines.

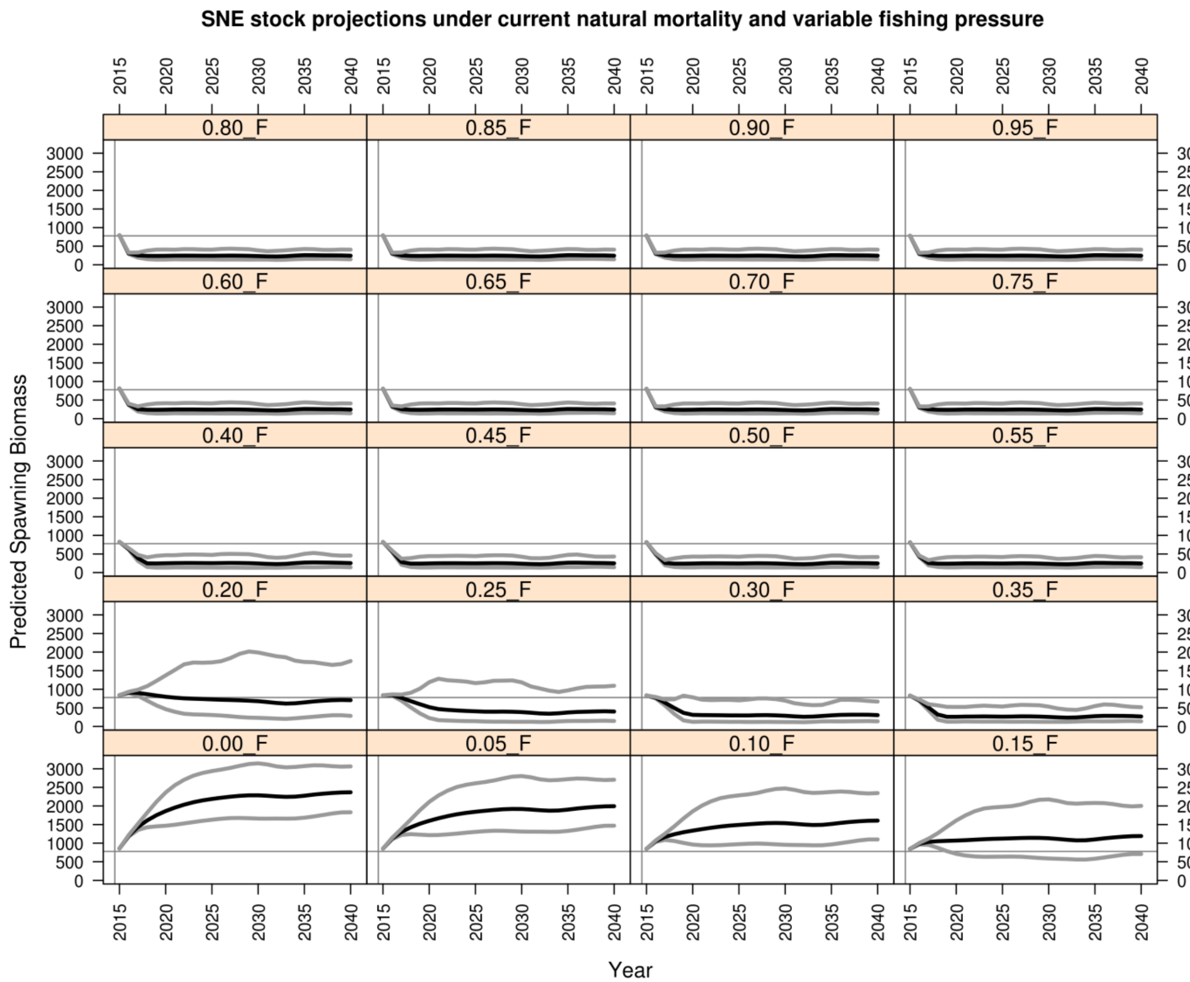

Figure 9: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) under various levels of F. M is fixed at 0.285. The units are SSB. Black line is the mean trend +/- 2SD (gray lines).

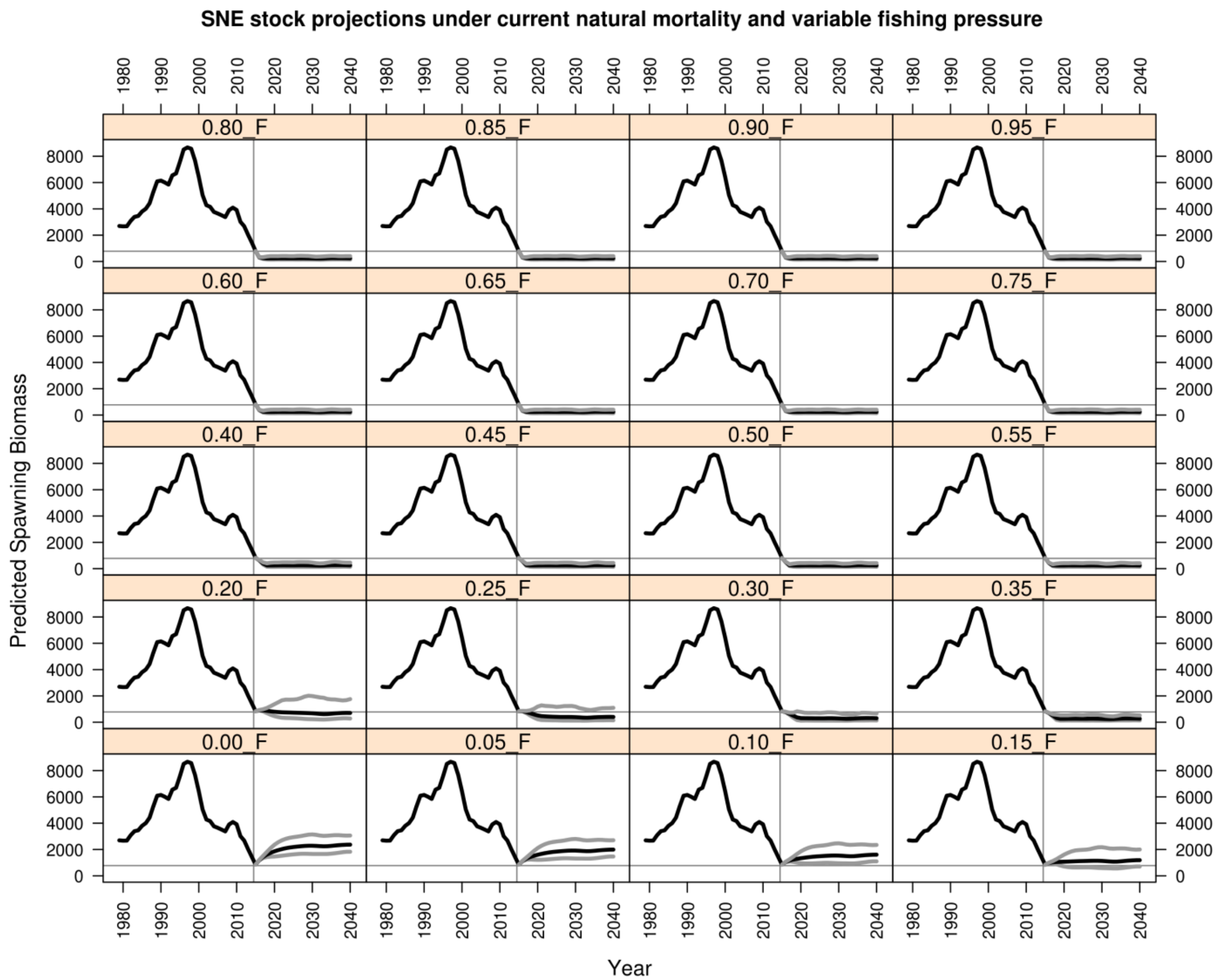

Figure 10: SNE stock projections assuming constant recruitment (similar to levels seen from 2011 to 2014) with an expanded time series from 1980 to 2040. Various levels of F are shown under fixed M=0.285. The units are SSB.

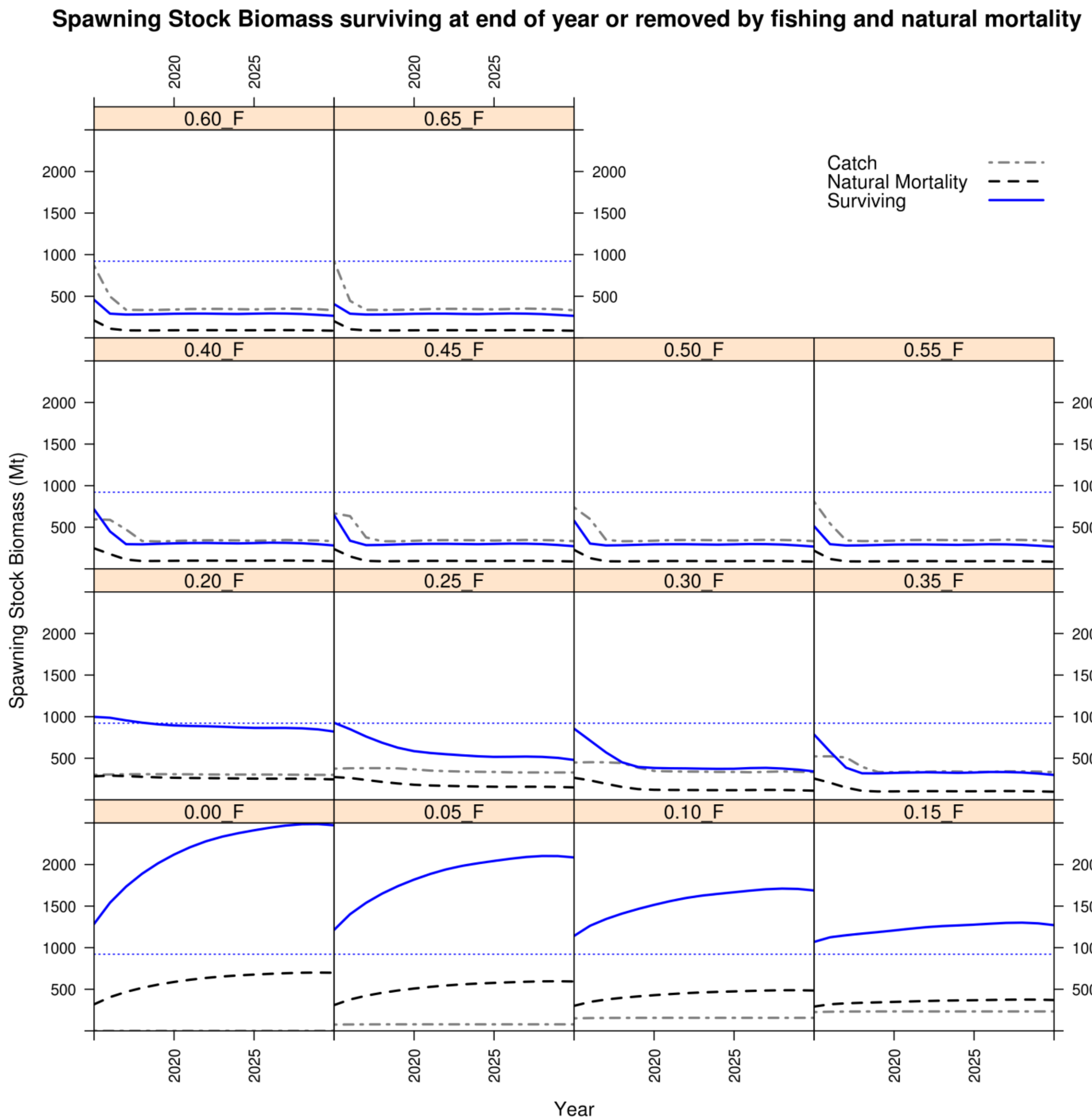

Figure 11. Mean spawning stock surviving to the end of year and removals by fishing and natural mortality, under different levels of fishing extraction. M is fixed at 0.285. At F>0.20, more spawning stock is being removed by harvesting than natural mortality while natural mortality is the larger source of biomass removal for F<0.20. For F>0.5 more biomass is removed by the fishery in the early years of the projections than survive to the end of the year. The blue dotted line is current SSB.

3. Stock Projections with Beverton-Holt Stock Recruit Relationship

Figures 12 – 20 show the projection results from the second scenario which assumes a Beverton-Holt stock recruit relationship. The TC feels that these are the most optimistic, albeit unrealistic, projections for rebuilding, given the current status of the SNE stock, but more realistic for projecting further declines in the stock.

Figures 12 and 13 show SNE stock projections under the assumption of no F and variable M. The units are in reference abundance. These figures show that the reference abundance could remain stable or recover at natural mortality levels up to 0.4 but an M>0.4 could cause the stock abundance to decline in the absence of fishing.

Figures 14 and 15 show the same projections as Figures 12 and 13 (Beverton-Holt recruitment, variable M, no F) but the units are SSB. Similar to reference abundance, SSB has the potential to remain stable or recover at natural mortality levels up to 0.4 but an M>0.4 could cause SSB to decline further in the absence of fishing. The steepness of the predicted recovery in SSB hints at the unrealistic nature of this projection run.

Figures 16 and 17 show the projection results if M is held constant at 0.285 and F is allowed to vary between 0 and 95% of current fishing pressure. The units are in reference abundance. Under the assumption of Beverton-Holt recruitment, the projections suggest that a 75% reduction in fishing mortality (F=0.25) would be needed to stabilize the stock at current levels. Reductions in fishing mortality greater than this could result in increasing stock abundance while reductions in F of less than 75% could result in further stock declines. However, with recruitment tied to spawning stock, the stock has the potential to decline to much lower levels than in the previous projections where recruitment was held constant.

Figures 18 and 19 show the same projections as Figures 16 and 17 (Beverton-Holt recruitment, variable F, M=0.285) but the units are SSB. These model runs also show that a 75% reduction in fishing mortality (F=0.25) would be needed to stabilize the stock at current levels.

Figure 20 shows the weight of spawning stock in the population at the end of each projection year and the weight removed by harvesting or natural mortality, assuming M=0.285. Again, more spawning stock is currently being removed by harvesting than is estimated to remain at the end of a calendar year. At F>0.20, more spawning stock is being removed by harvesting than natural mortality while natural mortality is the larger source of biomass removal for F<0.20.

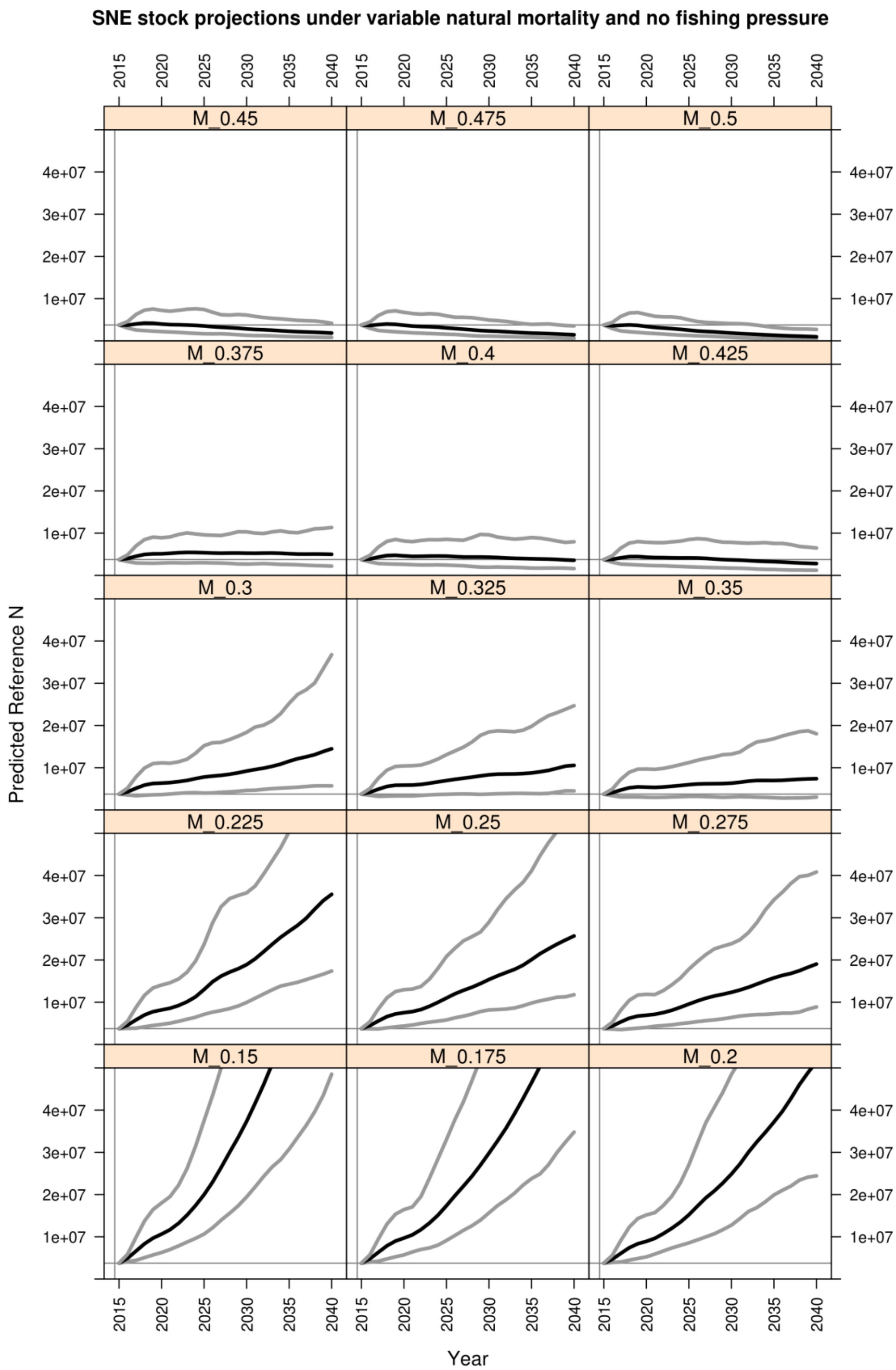

Figure 12: SNE stock projections assuming a Beverton-Holt stock recruit relationship under various levels of M. F is fixed at zero. The units are reference abundance.

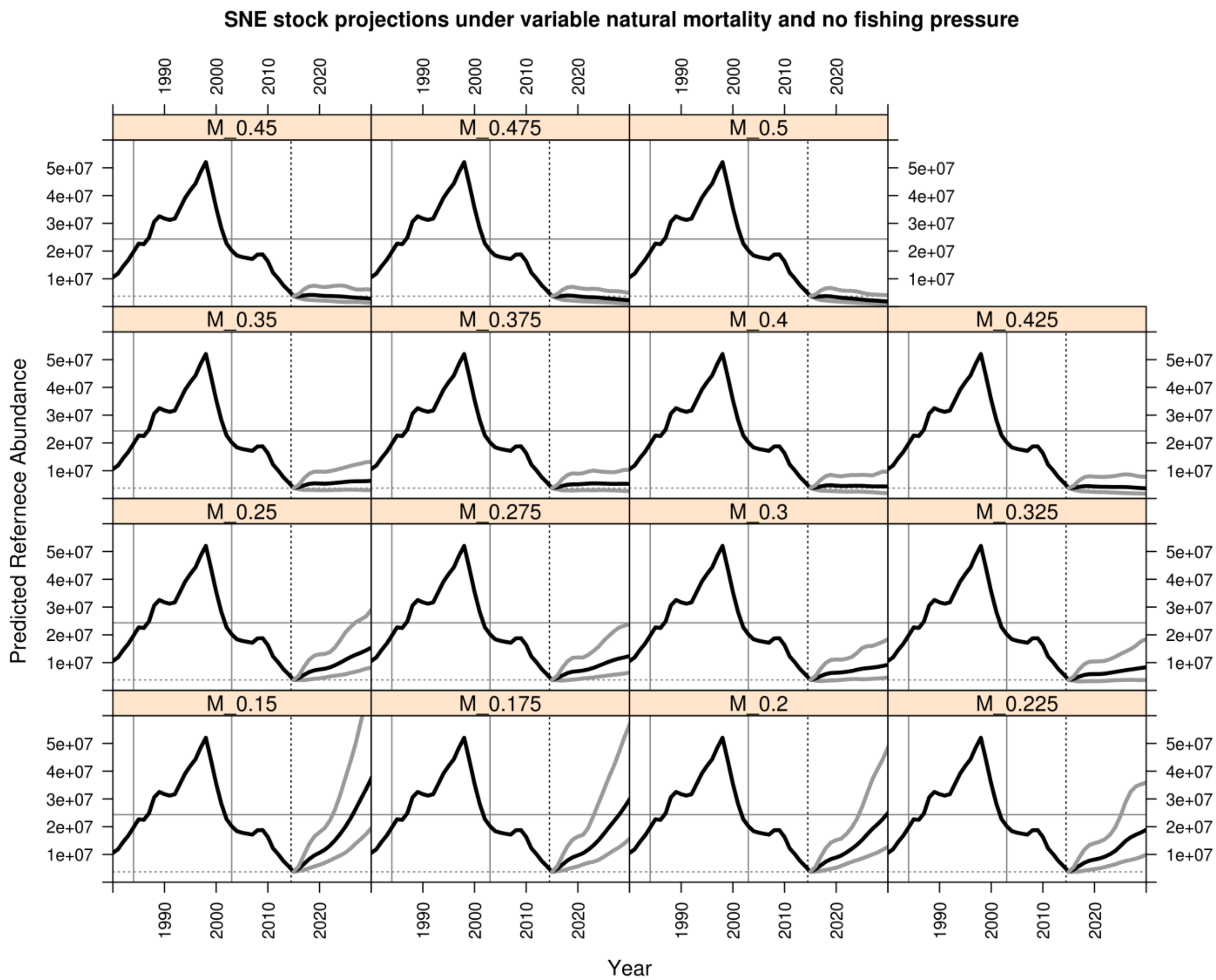

Figure 13: SNE stock projections assuming a Beverton-Holt stock recruit relationship with an expanded time series from 1980 to 2040. Various levels of M are shown under fixed F=0. The units are reference abundance. The reference period and trend-based reference point are shown in solid gray lines.

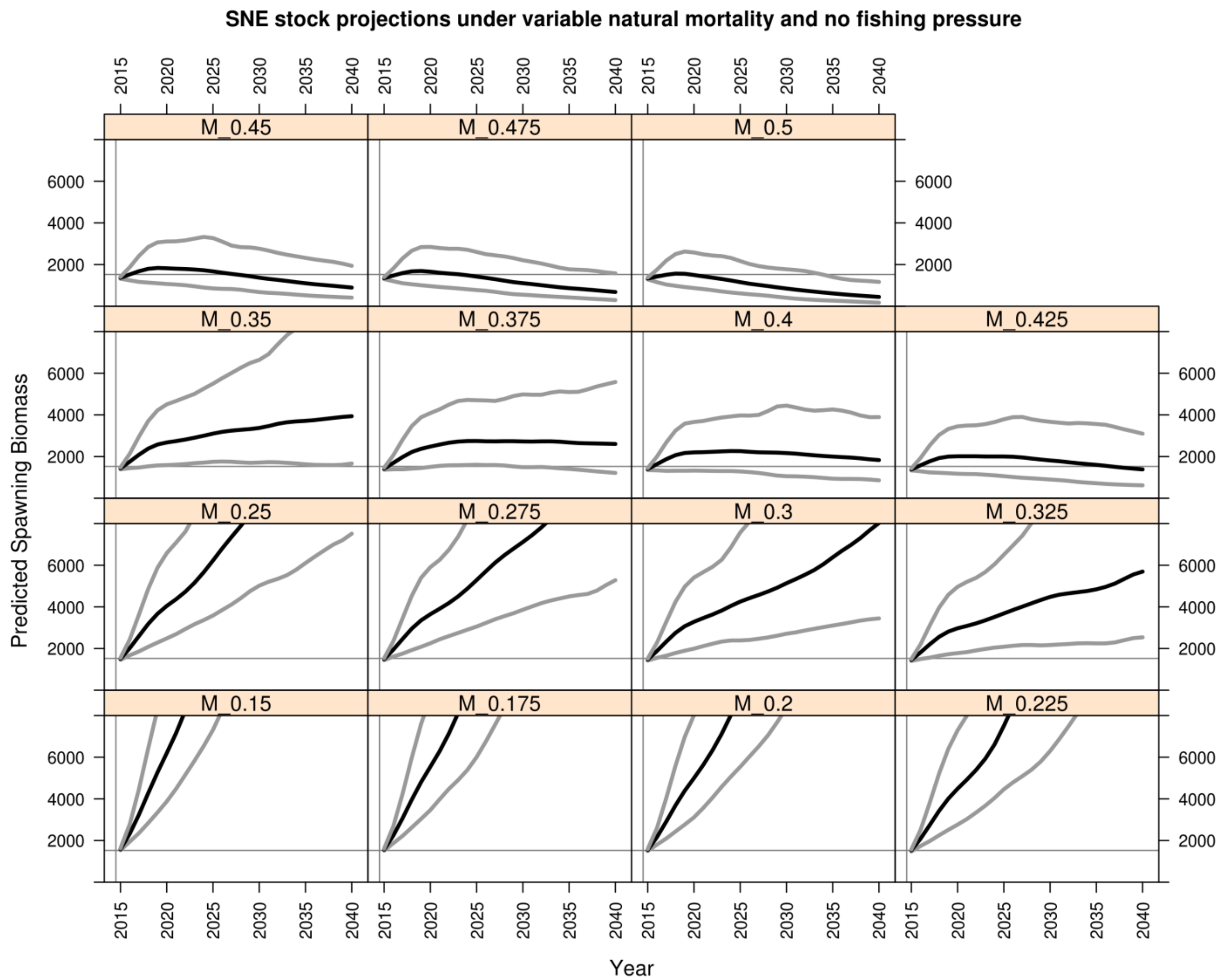

Figure 14: SNE stock projections assuming Beverton-Holt recruitment under various levels of M. F is fixed at zero. The units are SSB

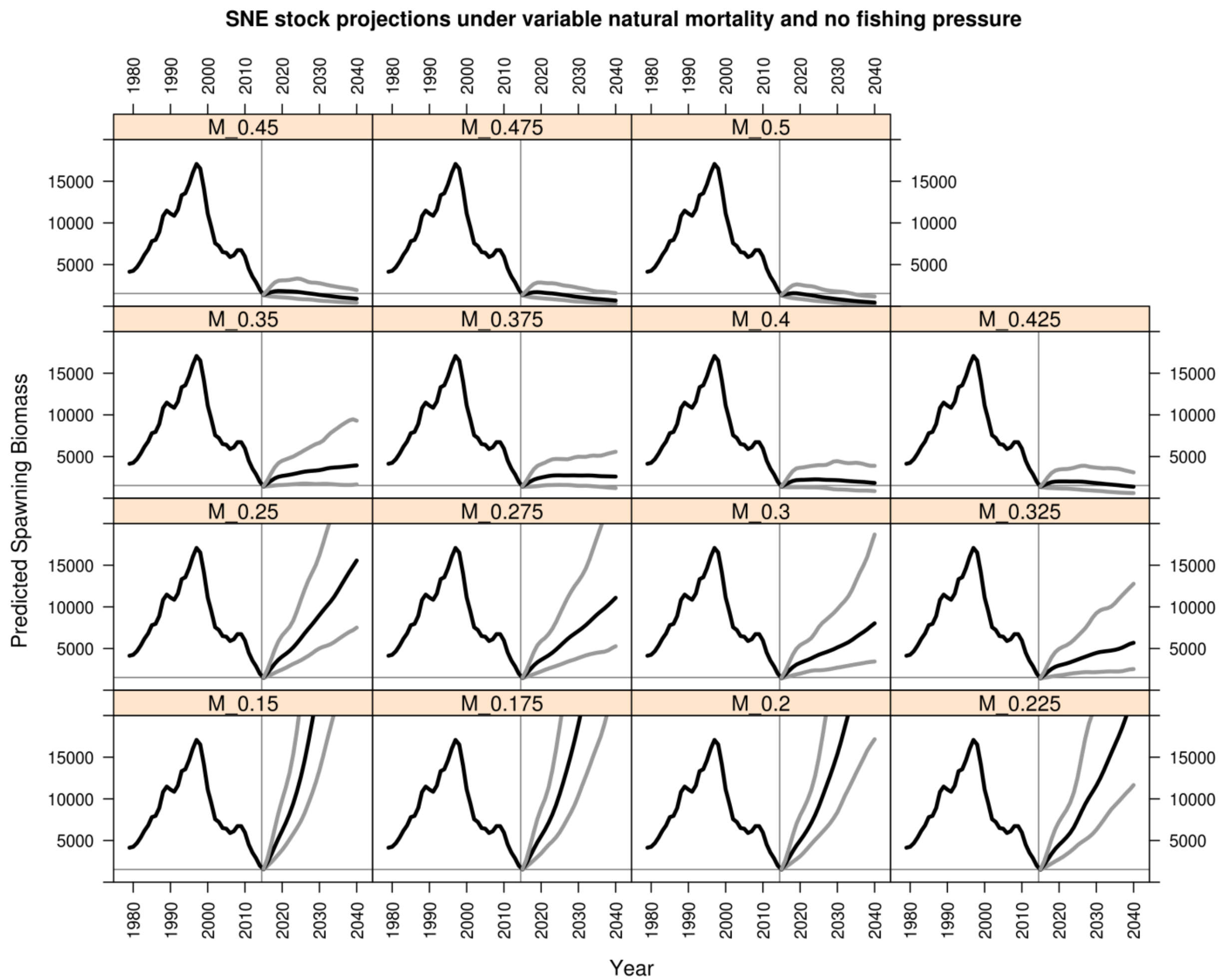

Figure 15: SNE stock projections assuming Beverton-Holt recruitment with an expanded time series from 1980 to 2040. Various levels of M are shown under fixed F=0. The units are SSB.

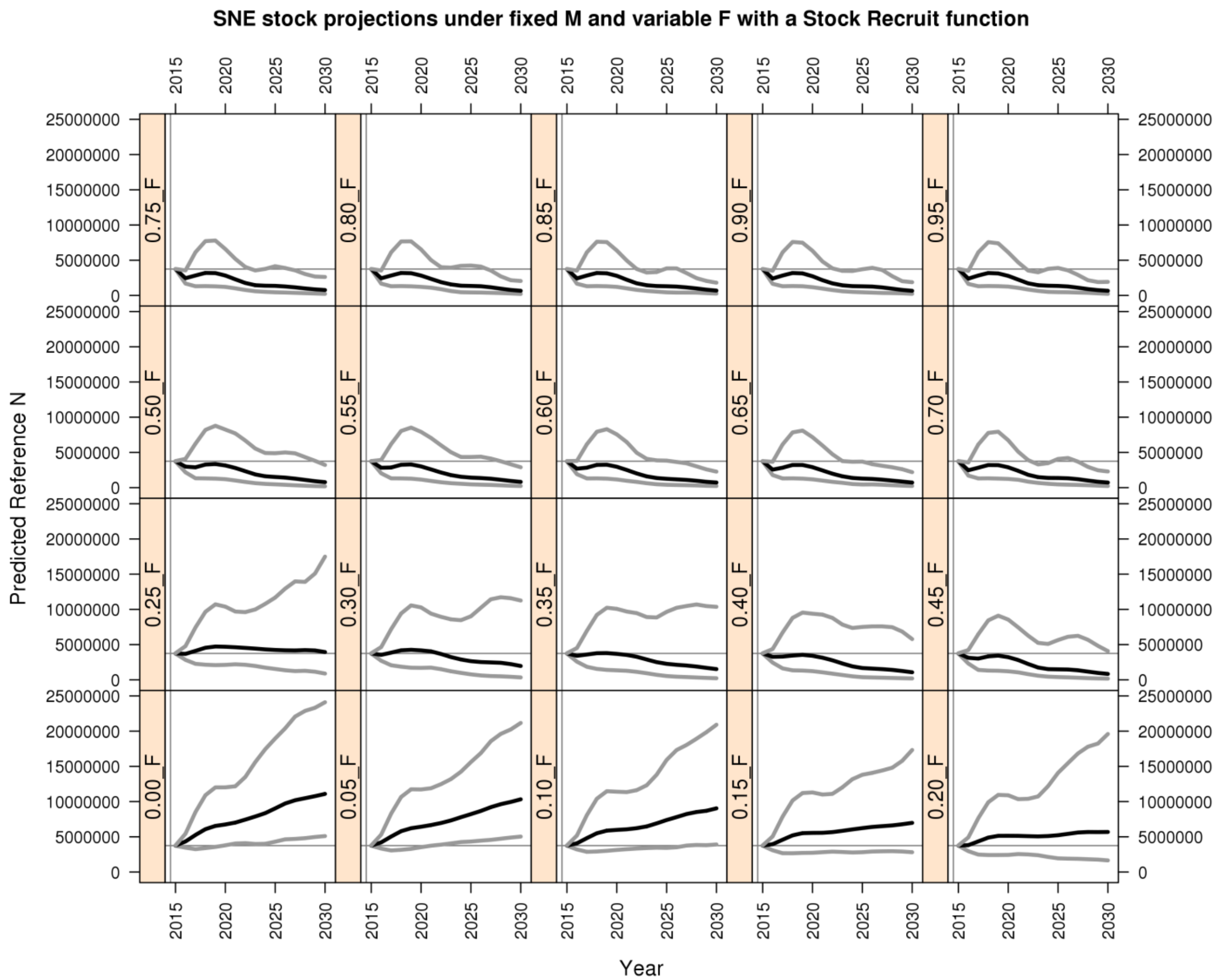

Figure 16: SNE stock projections assuming Beverton-Holt recruitment under various levels of F. M is fixed at 0.285. The units are reference abundance.

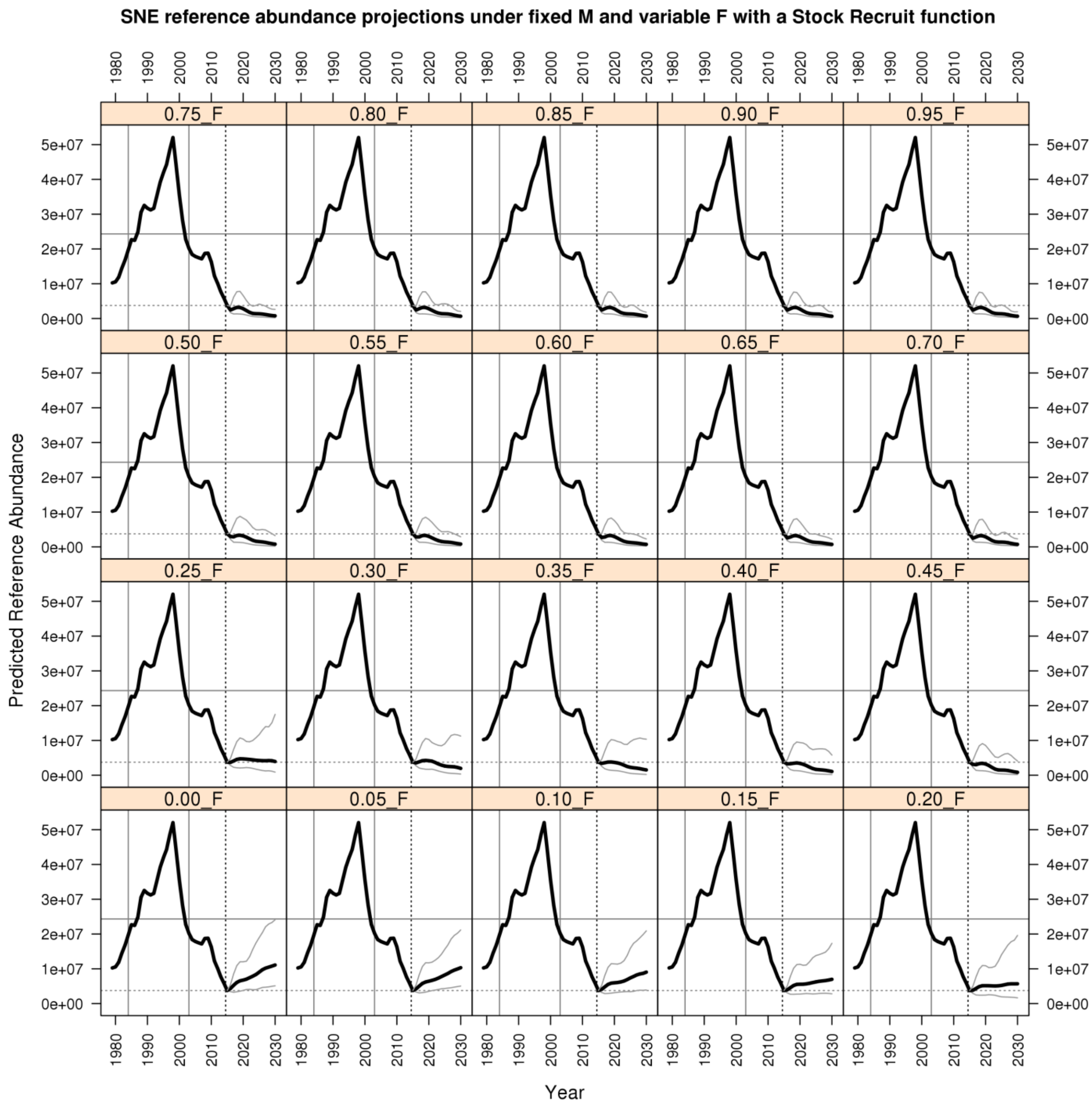

Figure 17: SNE stock projections assuming Beverton-Holt recruitment with an expanded time series from 1980 to 2040. Various levels of F are shown under fixed M=0.285. The units are reference abundance. The reference period and trend-based reference point are shown in solid gray lines.

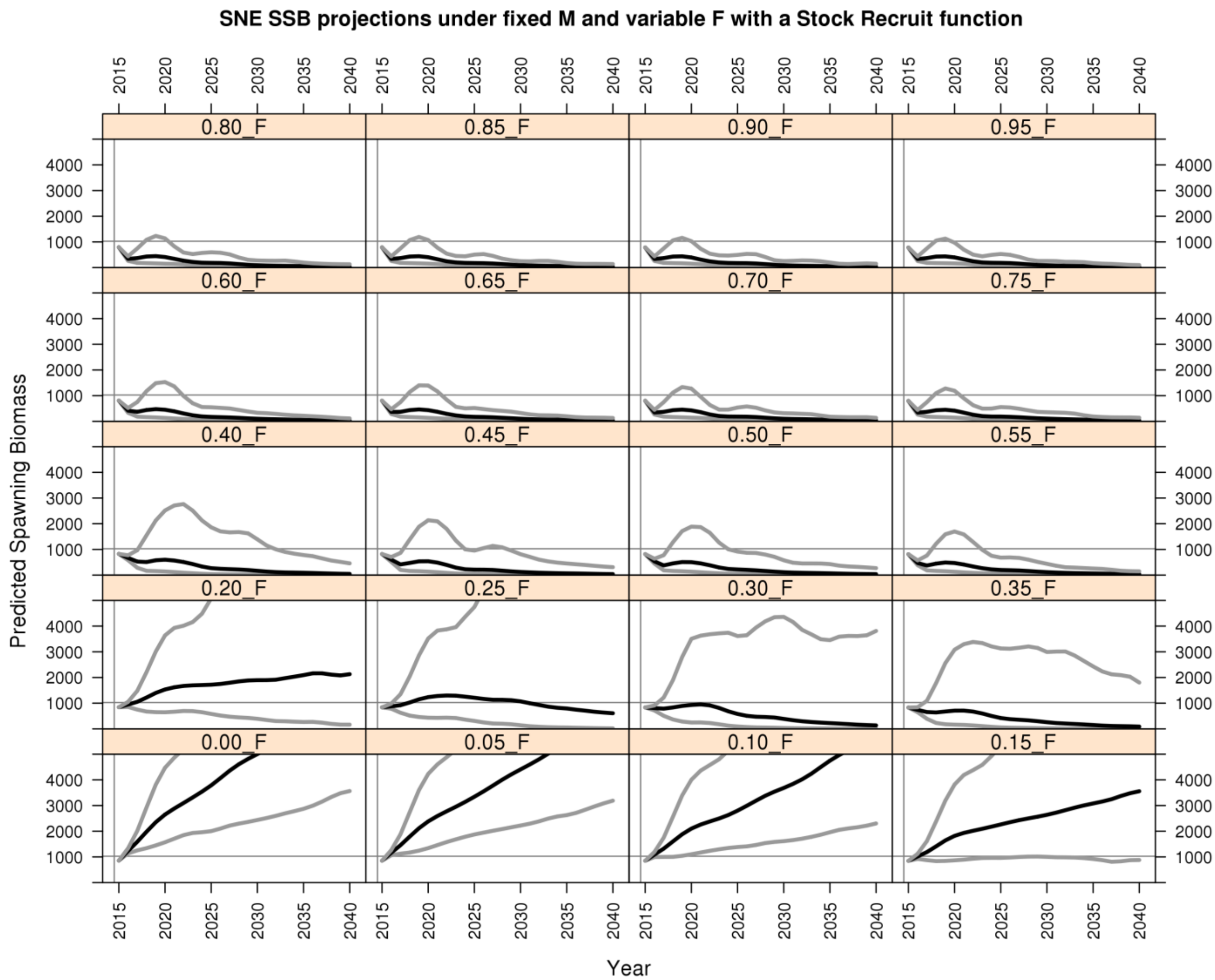

Figure 18: SNE stock projections assuming Beverton-Holt recruitment under various levels of F. M is fixed at 0.285. The units are SSB.

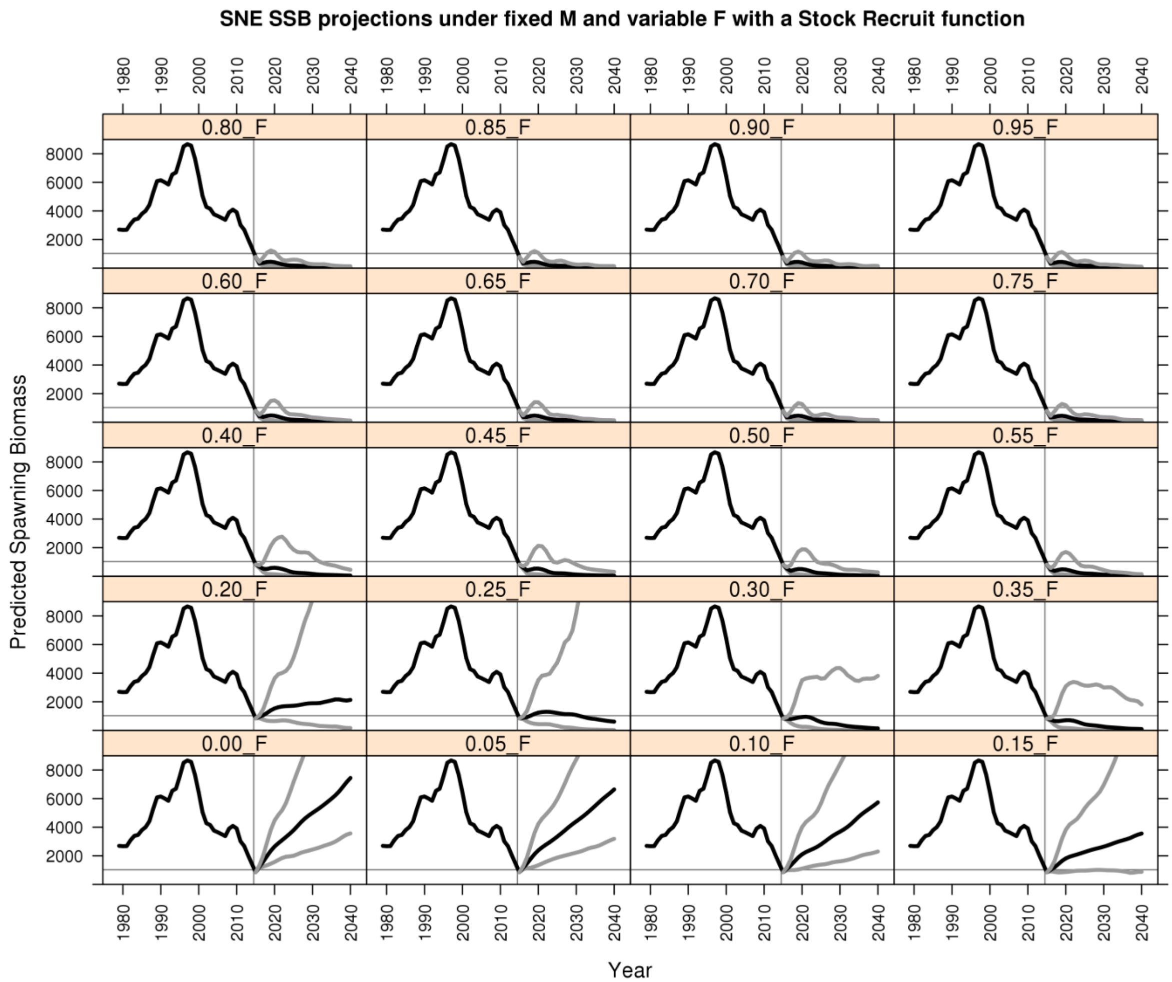

Figure 19: SNE stock projections assuming Beverton-Holt recruitment with an expanded time series from 1980 to 2040. Various levels of F are shown under fixed M=0.285. The units are SSB.

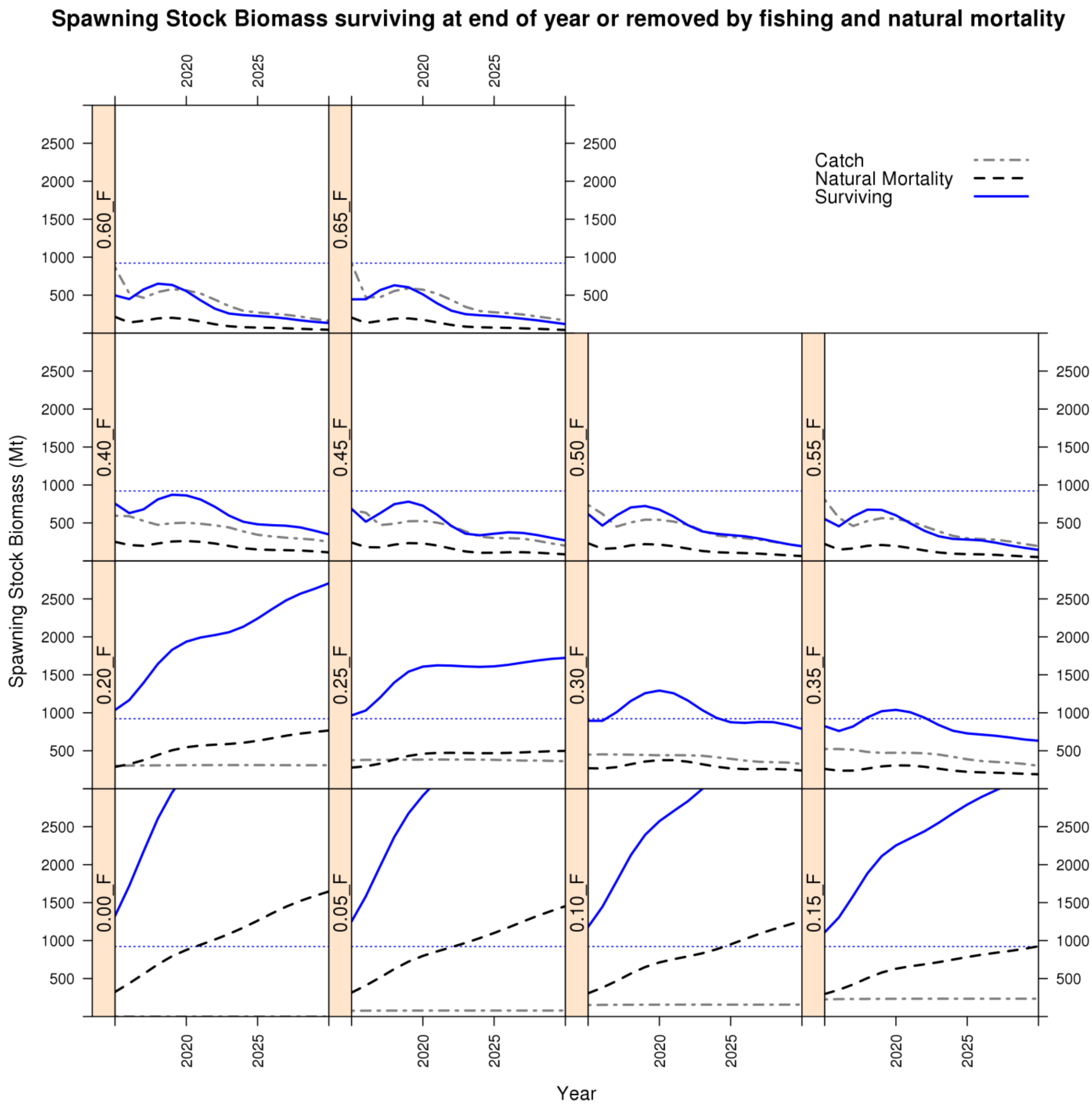

Figure 20. Mean spawning stock surviving to the end of year and removals by fishing and natural mortality, under different levels of fishing extraction. At F>0.20, more spawning stock is being removed by harvesting than natural mortality while natural mortality is the larger source of biomass removal for F<0.20. For F>0.5 more biomass is removed by the fishery in the early years of the projections than survive to the end of the year. The blue dotted line is current SSB.

Reference Table for All Projection Figures

Figure #	Recruitment	M	F	Units	Years	Stabilize Stock At
3	Constant	Variable	0	Ref N	2015-2040	M=0.3
4	Constant	Variable	0	Ref N	1980-2040	M=0.3
5	Constant	Variable	0	SSB	2015-2040	M=0.35
6	Constant	Variable	0	SSB	1980-2040	M=0.35
7	Constant	0.285	Variable	Ref N	2015-2040	90% reduction in F
8	Constant	0.285	Variable	Ref N	1980-2040	90% reduction in F
9	Constant	0.285	Variable	SSB	2015-2040	80% reduction in F
10	Constant	0.285	Variable	SSB	1980-2040	80% reduction in F
11	Constant	0.285	Variable	SSB	2015-2040	NA (spawning stock removals)
12	Beverton-Holt	Variable	0	Ref N	2015-2040	M=0.4
13	Beverton-Holt	Variable	0	Ref N	1980-2040	M=0.4
14	Beverton-Holt	Variable	0	SSB	2015-2040	M=0.4
15	Beverton-Holt	Variable	0	SSB	1980-2040	M=0.4
16	Beverton-Holt	0.285	Variable	Ref N	2015-2040	75% reduction in F
17	Beverton-Holt	0.285	Variable	Ref N	1980-2040	75% reduction in F
18	Beverton-Holt	0.285	Variable	SSB	2015-2040	75% reduction in F
19	Beverton-Holt	0.285	Variable	SSB	1980-2040	75% reduction in F
20	Beverton-Holt	0.285	Variable	SSB	2015-2040	NA (spawning stock removals)

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MEMORANDUM

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: January 19, 2016

SUBJECT: Report on TC Tasks from the Nov. 2015 Board Meeting

The American Lobster Technical Committee (TC) met via conference call on November 17, 2015, December 1, 2015, and January 19, 2016 and in person on December 8th to complete the tasks assigned by the American Lobster Management Board (Board) at their November 2nd meeting. The following report is a compellation of work completed by the TC. Each task is addressed individually and in the order in which it was assigned to the TC. A review of the Southern New England (SNE) projections can be found in the memo entitled "Projections for the SNE Lobster Stock" which is also included in the meeting materials for the February 2016 Lobster Board meeting.

1. ***Investigate Methods to Increase Egg Production & Examine the Biological Cost/Benefit of Existing Regulations***

The current minimum size (86 mm) coupled with the small size at maturity in SNE (98% of females are sexually mature at legal minimum size) ensure that a substantial portion of the total egg production of the stock occurs prior to lobsters recruiting to the fishery. Additional increases in minimum size would increase the egg production per recruit; however, this would not likely be an effective management measure in SNE because of the extremely high total mortality rate (natural mortality + fishing mortality) and continued declines in abundance the stock is experiencing. The primary issue effecting egg production in SNE is that the SSB is severely depleted. The TC recommends that the most effective way to enhance egg production in SNE is to lower the total mortality rate on the stock to preserve as much SSB as possible.

The TC is currently working on projections which look at the impacts of increasing the minimum gauge size on SSB. Due to the large size of the lobsters included in these projections, there is a significant amount of uncertainty in the model runs, especially in regards to the underlying growth assumptions and the effect of low stock size and shell disease on their reproductive success. There is little data available on large lobsters since we see so few of them. The TC is working to quantify this uncertainty and will provide the analysis to the Board when work is complete.

2. Recalculate Reference Points

The Southern New England (SNE) lobster stock has declined to record low abundance levels. There is concern that the stock may be experiencing a regime shift and that the current abundance reference point may not be appropriate. The Lobster Board requested that the Technical Committee explore an alternative abundance reference point by removing the peak abundance years of 1989 through 1999, abundance levels which may be unattainable in the current environment. The current abundance reference point for the SNE stock is the 25th percentile of reference abundance from 1984 through 2003, which is 24.3 million lobsters. The revised reference point, after removing the reference abundance values from 1989 through 1999, is 22.5 million lobsters. This is still well above the current status estimate of 10 million lobsters (mean reference abundance from 2011 through 2013). Further exploration revealed that the minimum reference abundance value during the 1984 through 2003 reference period was 19.7 million lobsters, which is almost twice the current estimate of abundance.

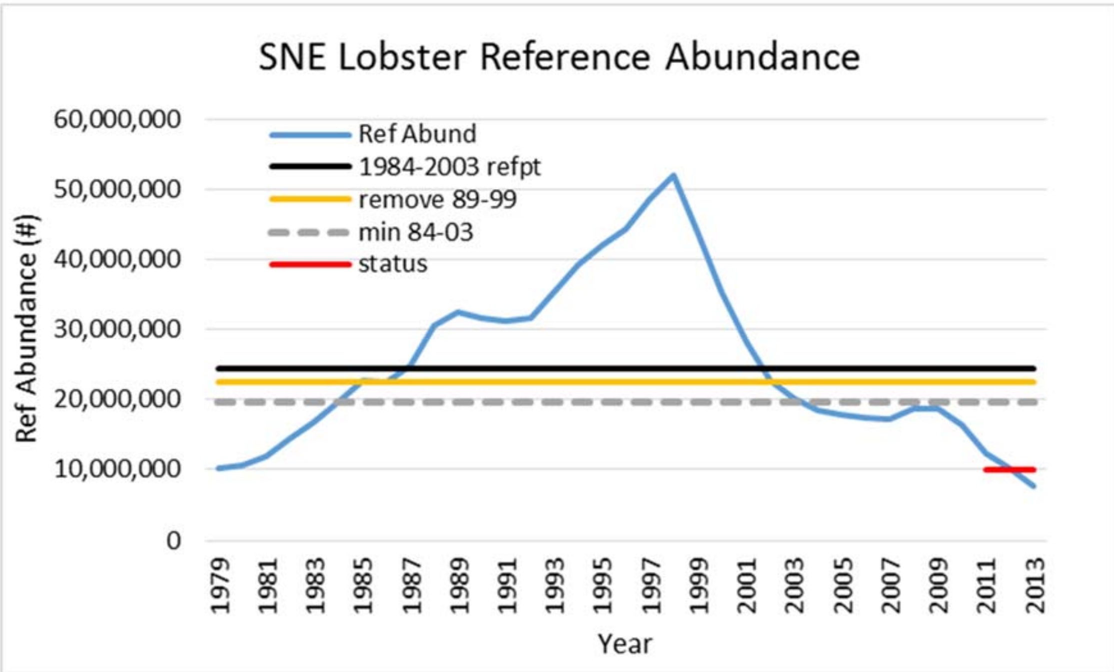

Figure 1: Recalculated reference abundance for the SNE lobster stock. Reference abundance is defined as the number of lobsters 78+ mm CL on January 1 plus the number that will molt and recruit into the 78+ mm CL group during the year.

3. Examine the Relationship between the Inshore and Offshore Stocks

There is a clear link between the inshore and offshore portions of the SNE lobster stock. Under "normal" environmental conditions the life history model for lobsters is as follows:

- Egg-bearing female lobsters migrate from offshore areas into shallow coastal areas in May/June to hatch their eggs.

- Larval lobsters develop through 4 stages over a period of 2 to 4 weeks in the mid to late summer. The well mixed warm coastal water promotes rapid development of larvae and set up perfect conditions for post-larvae to settle on prime nursery habitat. Prime nursery habitat consists of shallow water environments (<10 m) with complex substrate (cobble and eel grass where burrows can be made). The warmer, highly productive, complex shallow water environments allow early benthic phase (5 to 40 mm CL) lobsters to grow quickly and minimize exposure to predators during this most vulnerable life history phase.
- During their first several years of life lobsters are largely shelter restricted and have fairly small home ranges.
- As lobsters get larger and start to reach sexual maturity the extent of their home range increases and they begin to make seasonal migrations in the late fall to deeper waters.
- Adult lobsters make directed seasonal migrations offshore in the fall and return inshore in the spring. These migrations allow the lobster to maintain optimal temperatures for growth and egg development throughout the year. It is likely that lobsters only migrate as far as they need to find optimal temperatures (12 – 18° C).

Adult Connectivity

Seasonal migrations of adult lobsters have been documented from the coastal inshore areas of Buzzards Bay (MADMF unpublished data, Pugh et al. 2011), Rhode Island Sound (Fogarty et al., 1980), Eastern Long Island Sound (Lund 1973, Dominion Nuclear Connecticut 2015, CTDEP 2008), and inshore coastal New Jersey/ New York Bight (Andrews 1980) to the mid-shelf and the canyons along the continental shelf. Conversely, movements of adult lobsters from the offshore canyons to the inshore portions of SNE have also been documented (Cooper and Uzmann 1971, Andrews 1980). These inshore/offshore movements of adult lobsters clearly demonstrate connectivity between the inshore and offshore portions of the SNE stock.

Larval Connectivity

Lobster larvae are passive drifters while in their first 3 stages of development and as a result their delivery to settlement habitat is primarily dependent on large scale hydrographic processes. The southern New England shelf is dominated by a strong coastal current that flows from the north east to the south west. This current is the primary factor determining lobster larval delivery along the SNE shelf and dictates that the larval source of a given area originates from eggs hatched upstream. Water transport suggests that small-scale self-seeding is improbable in offshore habitats. As a result recruitment in offshore habitat is dependent upon emigration of juvenile lobsters from inshore habitats or from settlement from upstream larval sources. The coastal embayments of SNE, namely Buzzards Bay, Narragansett Bay, and Long Island Sound, have little influence from the coastal current and are primarily influenced by localized tidal and wind driven currents. These areas tend to be retention areas for larvae and larval delivery is primarily dependent on eggs hatched within these systems.

Larval delivery is highly sensitive to the location of egg hatch. Slight changes in the location of where egg hatch occurs have tremendous influence on lobster settlement dynamics in SNE. Historically egg-bearing females make seasonal migrations to coastal embayments to hatch their eggs in the late spring. Since the late 1990's there has been a shift in the distribution of egg-bearing females in the spring at the time of hatch. Very few egg-bearing females are now found within the embayments in the spring. This is due to both the severe depletion of lobster SSB, and warming inshore waters; female lobsters are no longer migrating as far inshore and are now hatching their eggs in deeper waters along the open coast.

Viability of Offshore Habitat for Settlement

The warmer water, good light penetration, higher primary productivity and better food availability make shallow (< 10 m) coastal waters with complex substrate the most productive lobster nursery habitat.

An examination of water temperature profiles of shelf waters indicate that thermal habitat in offshore waters is appropriate (>12° C) for settlement by the fall season. However, it is questionable if the timing of the seasonal warming of shelf waters is out of synch with the timing of post-larval delivery. Egg hatching has been occurring earlier than normal, and the rate of larval development has been accelerated by warming waters, which suggest that larval settlement is more likely to occur by mid-summer, before bottom temperatures reach appropriate levels offshore.

Nonetheless, some pre-recruit sized lobsters are observed in traps and trawl survey nets in deep offshore areas indicating some degree of settlement. The relative influence on recruitment from local offshore settlement versus migration from inshore areas is hard to quantify. There are no larval surveys, settlement surveys, or ventless traps surveys occurring offshore or at depths >200'. There is also no existing information on survival or growth rates of EBP lobsters in deep, offshore, low-relief habitats. These factors make the contribution from offshore areas to the total recruitment in SNE highly uncertain.

Regardless of the viability of lobster settlement in offshore areas, it should be noted that a large portion of the highest quality nursery habitat in shallow coastal waters is no longer productive in many years because of environmentally-mediated decreases in larval supply and reduced larval survivorship. This has led to recruitment failure in the SNE stock and has greatly diminished the total productivity of the SNE stock.

Genetic Evidence for Connectivity

The most recent genetics study did not collect samples from offshore Southern New England, so it does not provide updated data to address this question (Benestan et al. 2015). Existing work by Crivello et al. (2005b) indicates that egg-bearing females sampled from several Long Island Sound locations were genetically similar to those sampled from the Hudson Canyon region. Similarly, larvae sampled from within Long Island Sound originated from Hudson Canyon females (Crivello et al. 2005a). Thus female lobsters are moving between the inshore and offshore environments, and larvae produced by both inshore and offshore females can be found within Long Island Sound.

Western Long Island Sound lobsters appear to be the exception, and were determined to differ genetically from females sampled in central and eastern LIS and Hudson Canyon (Crivello et al. 2005b).

4. *Review Statement of Problem in Addendum XVII*

Section 2.1.3 of Addendum XVII outlined management challenges in the lobster fishery resulting from limitations in the quality and quantity of biological and fisheries data. The TC was asked to review this information and provide an update on current data deficits in the lobster fishery. The update is split into three parts: 1) Landings and Effort Data; 2) Biological Data; and 3) Management Limitations Related to Data.

A. Landings and Effort Data

In general, the catch disposition of the state waters portion of the SNE lobster fishery is fairly well characterized. Fishery-dependent monitoring programs currently in place are sufficient to detect and assess the effectiveness of input controls, such as changes in the minimum and maximum legal size and v-notch programs in the state waters portion of SNE.

In contrast, the catch disposition for a substantial portion of the SNE lobster fishery which occurs in federal waters is poorly characterized. NOAA fisheries does not require vessels which only have a federal lobster permit to submit Vessel Trip Reports (VTR's) or otherwise report their landings. Vessels with federal lobster permits who hail out of Massachusetts, Rhode Island, Connecticut, or New York are required to submit harvest reports to their respective state programs; however, the states of New Jersey, Delaware, Virginia, and Maryland do not have such requirements. As a result it is difficult to detect and assess the effectiveness of commonly used input controls in the federal waters portion of SNE.

Another issue with harvest reporting is the level of compliance amongst the states. The compliance rate with trip level reporting in New York is poor, and could be related to the fact that New York has not fully implemented a compliance program for non-reporting. New Jersey does not administer a harvester reporting system; instead they require fishermen to submit landings and effort information data through the federal VTR system. A lack of enforcement in New Jersey to fill out the federal VTR is an issue with harvester reporting. In addition, effort data at the trap haul level is not collected consistently by all states. Total traps is not an adequate measure of fishery effort.

B. Biological Data

The biological data collection programs currently administered in SNE are sufficient to characterize the disposition of the catch in the state waters portion of SNE. The states of Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Maryland all administer commercial sea-sampling programs. Furthermore, Massachusetts, Rhode Island, Connecticut, New Jersey, and NOAA Fisheries all administer bottom trawl surveys which have sufficient resolution to provide estimates of relative abundance for lobster in the SNE stock. In state waters, these data are complimented by the Regional

Ventless Lobster Trap Surveys in Massachusetts and Rhode Island. These programs make it possible to detect and monitor the effects of input control based management, such as changes in the minimum and maximum legal size, v-notching programs, and closed seasons.

The resolution of these programs is lacking in federal waters where a substantial portion (> 50%) of the SNE fishery currently occurs. NOAA Fisheries has an extensive fishery dependent observer program; however, historically, lobster has not been a sampling priority for this program. As such there are very limited commercial sea-sampling data for lobster in federal waters.

C. Management Limitations Related to Data

As stated in Addendum XVII, the current system of landings reporting used for the SNE lobster fishery is not adequate for monitoring a quota based management program. To allow for adequate accounting of a quota it would be necessary to implement the following changes to the landings reporting system:

- Implement 100% trip level reporting for ALL state and federally licensed vessels.
- Substantially shorten the time lag between harvest and harvester reporting to allow for timely accounting of a quota. Massachusetts, Connecticut, and New York require fishermen to submit their logs monthly, Rhode Island requires them to submit reports quarterly. The minimum time lag between harvest and accounting for the catch is roughly 40 days. However, the average time lag between harvest and accounting for the catch in most cases is substantially greater than that because of poor compliance with reporting deadlines, minimal deterrents for not reporting in a timely fashion, and seasonal staff limitations.
- Collect spatial information (statistical area and LCMA) for the landings data reported to SAFIS.
- Assign a unique id to all licensed vessels that would be used in both the harvester and dealer reporting systems to allow for 100% reconciliation of the two data types.
- Address dockside sales and capture the reporting of dockside sales in a timely manner. Currently, SAFIS does not account for dockside cash sales to the public or for personal consumption.

5. Characterize the 2014 Existing Effort by LCMA

A. Landings

Landings have continued to decline in most of the inshore/nearshore regions, reaching all-time lows in 2013-2014 in LMAs 2, 4, and 6 (Figure 2). Only LMA 5 had recent landings close to the time series average, although these are down from a period of higher landings that occurred from around 2004-2009 (Figure 2).

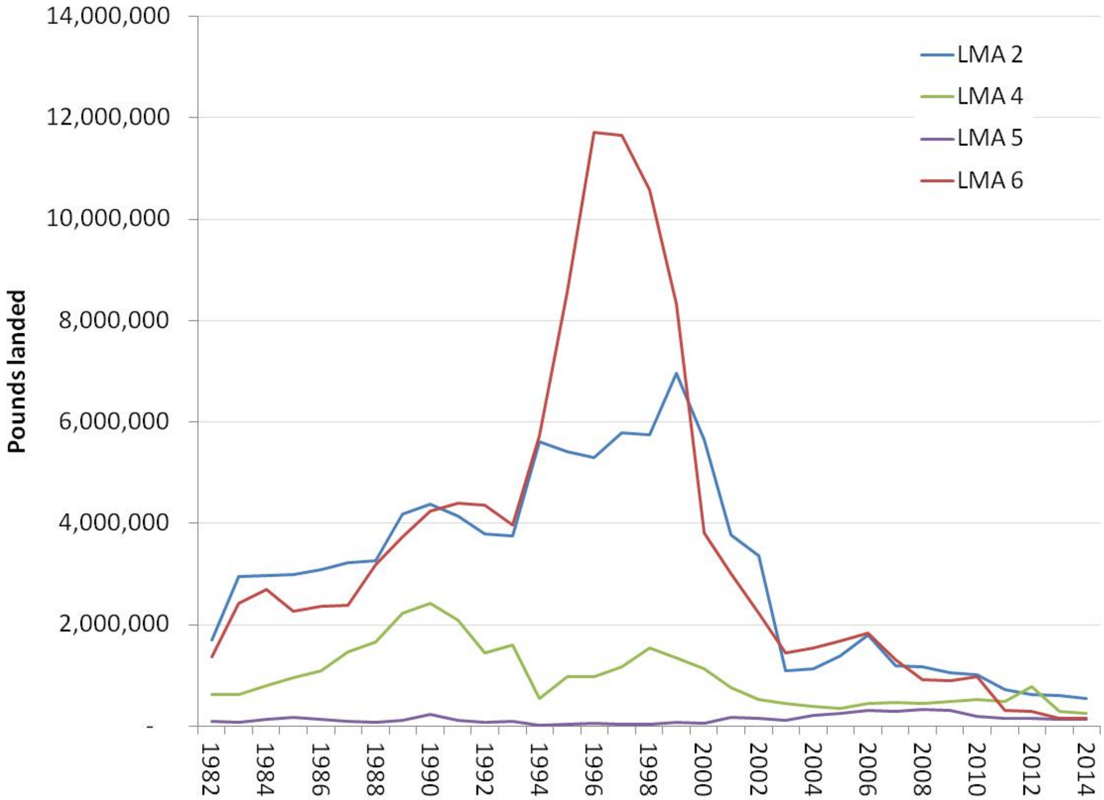

Figure 2. Pounds of lobsters landed in inshore/nearshore LMAs 2, 4, 5, and 6 from 1982 – 2014.

In the offshore regions, landings trends appear to be more stable. However landings in the last 5 years (2010 – 2014) have been generally low relative to the time series, remaining at or below the 25th percentile in LMA 3 and LMA 3/5, and having increased slightly to vary around the 25th percentile in LMA 2/3 (Figure 3).

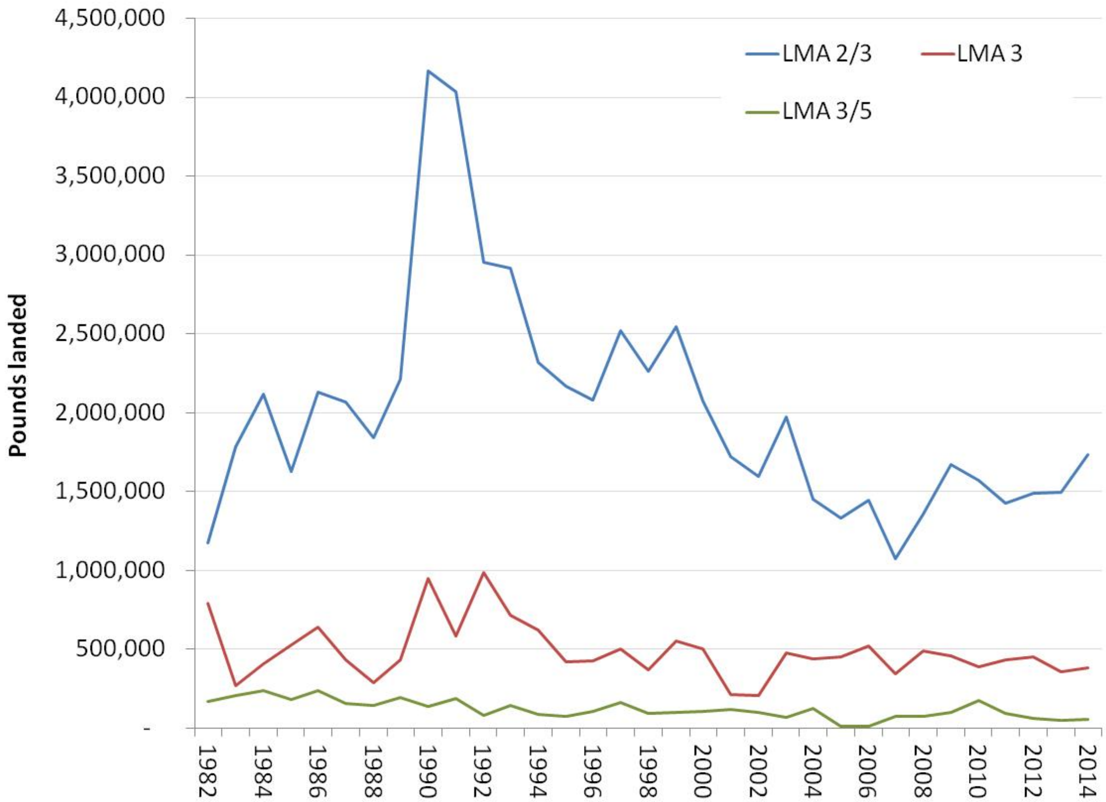

Figure 3. Pounds of lobsters landed in offshore LMAs 2/3 (NMFS Area 537), LMA 3/5 (NMFS Areas 622, 626, 632, 635), and LMA 5 from 1982 – 2014.

The number of active permits (actively reporting landings) in MA, RI, and CT has declined dramatically over time, and in the last year were well below their respective time series averages (Figure 4). Active permits have remained relatively steady in NJ in the last several years with available data, but have been below the average (Figure 4). For NY, only total number of permits issued is available, and this value has also declined dramatically over time (Figure 4).

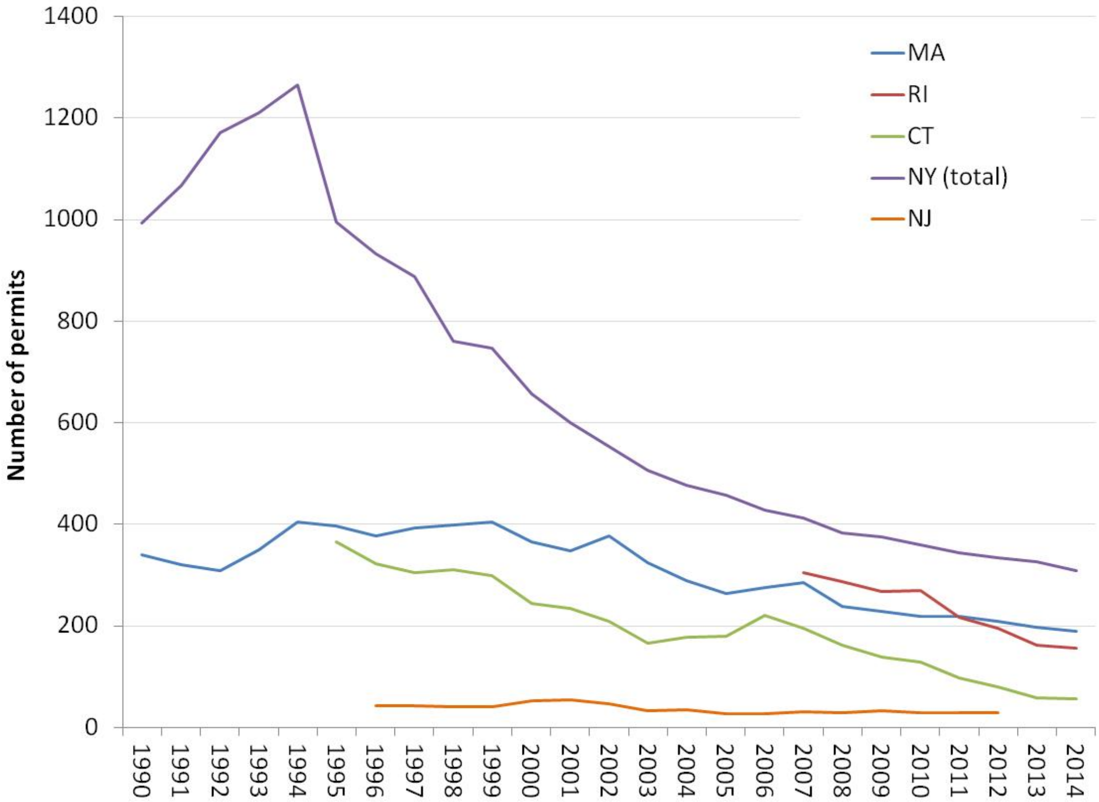

Figure 4. The number of active permits (MA, RI, CT, NJ) or total permits (NY) in the SNE stock.

B. Traps (total traps)

Annual traps fished has declined since peaking in the late 1990s, and were at all-time lows in CT and NY for the last two years (2013-2014) (Figure 5). The total number of traps fished appear to have stabilized in MA since the mid 2000's, while in RI traps fished declined from 2007 through 2011, but have since stabilized (Figure 5). Effort remains higher in MA and RI than in CT and NY, likely since MA and RI have relatively large offshore components to their fisheries unlike CT and NY. Effort in NJ increased from the early to mid-2000's and has only slightly declined since.

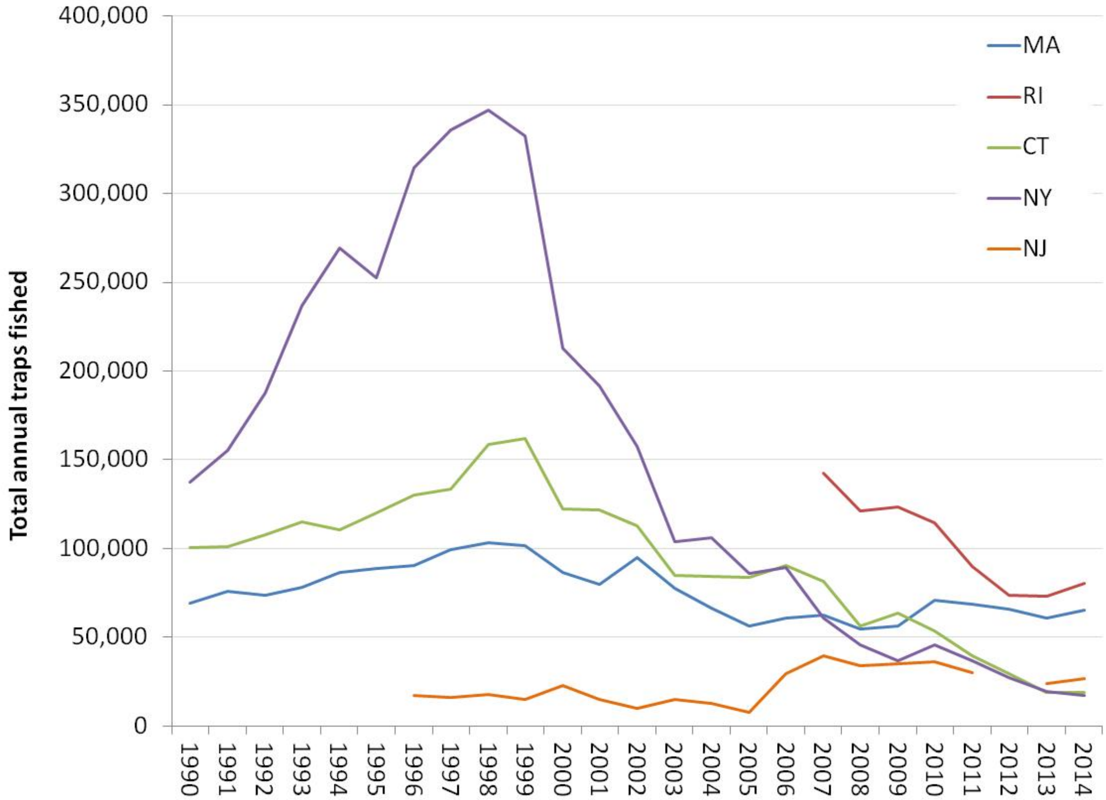

Figure 5. Total annual traps reported fished by state.

6. Update Trends from Fishery Independent Surveys

The TC updated the abundance indicators presented in the 2015 Benchmark Stock Assessment to include data from 2014 and 2015, where available. Below is a description of the changes to the indicators for all lobster stocks. Associated tables can be found on pages 12-22.

A. GOM Indicators

The additional three years of data (where available) for the GOM abundance indicators follow the same pattern as presented in the 2015 assessment. The 2011 – 2015 mean spawning stock abundance, full recruit abundance, and recruit abundance all remain positive, above the 75% percentile of the reference time period for all surveys. The 2011 – 2015 mean survey lobster encounter rate improved, with five of the six surveys now above the 75% percentile. However, the YOY indices now show a downwards trend in all areas, particularly in the southern portion of GOM (Area 514 and western Area 513) where annual values from 2012 onwards are below the 25^{th} percentile. In 2015, four of the five indices were below the 25^{th} percentile (note: 2015 ME data are preliminary). The 2011 – 2015 mean values for the more north-eastern areas remain positive, eastern Area 513 is neutral, and the two southern regions are negative.

B. GB Indicators

Three of the four updated abundance indicators (2011 – 2015 mean) for the GB stock were positive, while the recruits indicator was negative for both spring and fall surveys. These results are the same as those presented in the 2015 assessment.

C. GOM/GB Combined Indicators

The 2011 – 2015 mean abundance indicators for spawning stock abundance, full recruit abundance, and recruit abundance all remain positive for the combined GOM/GB stock (note fall 2015 data from ME and NEFSC surveys were not yet available). The 2011 – 2015 mean survey lobster encounter rate was positive for five of the six surveys, with only the MA spring survey qualified as neutral. However, the YOY indices now show a downward trend in all areas, particularly in the southern portion of GOM (Area 514 and western Area 513) where annual values from 2012 onwards are below the 25th percentile. In 2015, four of the five indices were below the 25th percentile (note: 2015 ME data are preliminary). The 2011 – 2015 mean values for the more north-eastern areas remain positive, eastern Area 513 is neutral, and the two southern regions are negative.

D. SNE Indicators

The 2011 – 2015 mean abundance indicators remain at or below the time series median values. Spawning stock abundance was negative in five of the eight surveys (5 of 6 inshore surveys) with the remaining surveys classified as neutral. Recruit abundance was negative in six of the eight surveys. The 2011 – 2015 mean full recruit abundance was negative in half of the surveys, neutral in three, and positive in one survey (spring NEFSC survey, due to an anomalously high value observed in 2014). The 2011 – 2015 mean survey lobster encounter rate was negative in six of the eight surveys, and below the median value in all surveys. Three of the four YOY indices were negative (note that the CT/NY summer larval survey ceased operating after 2012). In most instances, particularly inshore, the updated indicator data were either similar to or have declined since the 2015 assessment.

Gulf of Maine Abundance Indicators

SPAWNING STOCK ABUNDANCE Mean weight (g) per tow of mature females						
Survey	NESFC		ME/NH		MA 514	
	fall	spring	fall	spring	fall	spring
1981	127.57	303.66			342.80	251.36
1982	20.19	78.56			404.26	90.43
1983	118.43	176.40			537.29	32.40
1984	159.77	347.71			336.33	78.90
1985	311.91	2189.79			563.45	32.32
1986	155.64	375.38			135.10	50.24
1987	29.47	356.77			146.15	82.80
1988	106.70	173.52			94.55	42.74
1989	205.15	169.48			123.19	114.57
1990	116.49	368.43			538.08	100.27
1991	131.02	301.70			142.51	101.77
1992	115.27	304.54			262.54	110.74
1993	167.68	337.77			53.48	117.58
1994	233.02	521.60			376.55	132.17
1995	284.29	252.38			222.57	91.04
1996	422.24	601.51			262.89	72.61
1997	354.21	757.88			87.30	49.64
1998	216.98	832.32			113.80	81.44
1999	931.76	572.69			178.35	194.17
2000	318.65	875.14	3425.58		287.35	133.73
2001	312.96	1058.84	1858.63	462.60	105.26	151.41
2002	1247.40	1450.71	3707.47	967.67	163.87	105.74
2003	675.87	1688.03	3988.26	847.68	101.81	45.15
2004	411.40	1988.81	3497.55	682.69	86.24	189.23
2005	288.34	1163.74	4062.27	1505.13	167.88	358.32
2006	457.21	1298.00	2909.52	885.80	118.39	290.44
2007	291.48	1094.86	3010.80	735.09	138.01	91.86
2008	497.90	1357.83	3423.42	712.51	354.40	222.36
2009	1111.88	1332.23	5525.54	1138.18	396.60	135.71
2010	1796.57	1720.01	3879.74	1322.90	1176.34	157.93
2011	1334.21	1387.80	4446.97	868.71	782.58	151.85
2012	1964.23	2372.91	2964.59	1190.50	524.55	68.82
2013	2010.87	1672.97	4144.70	671.93	761.16	187.97
2014	2997.61	2037.40	3985.00	1326.88	569.74	300.09
2015	NA	2313.49	NA	881.35	1443.63	269.89
2011 - 2015 ave.	**2076.73**	**1956.91**	**3885.32**	**987.87**	**816.33**	**195.72**
25th	121.58	302.41	3033.84	655.14	116.15	55.84
median	211.06	371.91	3566.52	847.68	171.11	90.73
75th	317.23	813.71	3777.66	907.67	324.09	113.62

FULL RECRUIT ABUNDANCE (SURVEY) Abundance of lobsters > 82 mm CL (sexes combined)						
Survey	NEFSC		ME/NH		MA 514	
	fall	spring	fall	spring	fall	spring
1981	0.24	0.36			1.91	1.83
1982	0.05	0.21			2.80	0.57
1983	0.21	0.20			3.08	0.51
1984	0.29	0.34			4.09	0.49
1985	0.55	1.81			3.94	0.50
1986	0.45	0.55			1.71	0.54
1987	0.15	0.44			0.53	0.56
1988	0.14	0.27			1.51	0.56
1989	0.38	0.28			2.27	0.79
1990	0.25	0.44			4.92	0.97
1991	0.35	0.46			3.18	0.69
1992	0.22	0.36			2.35	0.87
1993	0.40	0.47			0.63	1.00
1994	0.50	0.70			3.15	0.76
1995	0.98	0.47			2.50	0.58
1996	0.89	0.99			2.50	0.33
1997	0.70	1.02			1.69	0.62
1998	0.45	0.96			0.88	0.49
1999	1.55	0.51			1.93	0.72
2000	0.61	1.35	14.22		2.20	0.97
2001	0.62	1.50	9.83	2.25	0.72	0.53
2002	1.89	1.81	12.57	3.40	1.02	0.43
2003	1.14	2.38	16.65	3.08	0.42	0.22
2004	1.18	2.55	16.18	3.14	0.33	0.78
2005	0.62	1.64	21.09	6.53	0.56	0.95
2006	0.83	1.67	14.85	5.33	1.03	0.68
2007	0.51	1.50	14.13	4.19	0.48	0.32
2008	0.90	1.94	20.72	3.06	1.55	0.67
2009	1.82	1.66	30.48	6.32	1.70	0.54
2010	3.06	2.61	21.42	6.29	2.30	0.40
2011	3.15	2.14	23.83	5.14	3.80	0.55
2012	3.35	3.38	16.51	5.94	3.18	0.31
2013	3.29	2.43	21.45	4.50	3.74	0.87
2014	5.77	2.74	26.38	9.33	2.91	0.77
2015	NA	3.98	NA	6.48	5.69	1.26
2011 - 2015 ave.	**3.89**	**2.93**	**22.04**	**6.28**	**3.86**	**0.75**
25th	0.26	0.38	11.88	2.67	1.14	0.50
median	0.45	0.49	13.39	3.08	2.24	0.56
75th	0.68	1.01	14.83	3.24	3.01	0.75

Gulf of Maine Abundance Indicators Con't

RECRUIT ABUNDANCE (SURVEY)						
Abundance of lobsters 71 - 80 mm CL (sexes combined)						
Survey	***NEFSC***		***ME/NH***		***MA 514***	
	fall	***spring***	***fall***	***spring***	***fall***	***spring***
1981	0.03	0.06			4.84	6.38
1982	0.17	0.13			3.85	2.74
1983	0.42	0.14			9.76	1.76
1984	0.13	0.10			6.13	2.15
1985	0.65	0.10			9.60	4.48
1986	0.53	0.11			3.80	3.01
1987	0.28	0.23			1.16	2.47
1988	0.51	0.25			4.12	2.52
1989	0.62	0.00			7.51	4.48
1990	0.90	0.21			15.40	6.11
1991	0.74	0.28			7.55	2.73
1992	0.57	0.25			8.95	4.31
1993	0.49	0.11			3.19	5.12
1994	1.15	0.09			13.80	7.59
1995	0.77	0.77			12.10	4.54
1996	2.05	0.33			12.10	3.09
1997	0.86	0.95			6.41	4.57
1998	1.00	0.76			7.47	4.50
1999	1.34	0.60			8.73	4.26
2000	1.26	1.73	23.82		8.86	4.24
2001	0.66	0.58	17.53	9.16	1.58	4.30
2002	0.75	0.74	22.12	22.63	5.00	3.43
2003	0.20	0.60	23.78	13.71	0.66	1.96
2004	1.06	0.39	15.96	9.69	1.30	2.46
2005	0.39	0.30	30.88	23.85	2.11	4.35
2006	0.58	1.14	23.27	23.15	5.30	6.09
2007	0.39	0.71	21.62	20.24	1.61	0.75
2008	1.05	0.49	40.45	22.90	6.12	2.54
2009	1.17	0.97	41.84	31.77	8.88	3.18
2010	1.51	0.71	46.24	22.40	9.39	2.22
2011	2.70	1.96	58.53	47.39	15.00	5.24
2012	1.61	2.32	47.28	44.81	11.30	3.03
2013	3.21	1.97	48.24	39.71	12.20	4.83
2014	4.19	1.88	53.06	78.58	7.06	3.35
2015	NA	2.82	NA	45.20	17.91	7.05
2011 - 2015 ave.	**2.93**	**2.19**	**51.78**	**51.14**	**12.69**	**4.70**
25th	0.50	0.12	20.97	11.43	3.92	2.73
median	0.66	0.25	22.95	13.71	7.49	4.25
75th	0.89	0.60	23.79	18.17	9.44	4.50

YOUNG-OF-YEAR INDICES					
	YOY	**YOY**	**YOY**	**YOY**	**YOY**
Survey	***ME***	***ME***	***ME***	***ME***	***MA***
	511	*512*	*513 East*	*513 West*	*514*
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989			1.64		
1990			0.77		
1991			1.54		
1992			1.30		
1993			0.45		
1994			1.61		
1995		0.02	0.66		0.56
1996		0.05	0.47		0.00
1997		0.05	0.46		0.17
1998		0.00	0.14		0.02
1999		0.04	0.65		0.36
2000		0.10	0.13	0.17	0.19
2001		0.43	2.08	1.17	0.38
2002	0.13	0.29	1.38	0.85	0.89
2003	0.22	0.27	1.75	1.22	0.68
2004	0.18	0.36	1.75	0.67	1.20
2005	1.59	1.36	1.77	0.82	0.82
2006	0.58	1.13	0.84	0.82	0.32
2007	0.84	1.34	2.01	1.27	1.22
2008	0.42	0.83	1.08	0.97	0.24
2009	0.69	0.48	1.25	0.45	0.13
2010	0.28	0.72	0.80	0.47	0.45
2011	0.41	1.10	2.33	0.67	0.63
2012	0.53	0.73	1.06	0.22	0.21
2013	0.10	0.20	0.48	0.12	0.09
2014	0.16	0.43	0.83	0.33	0.09
2015*	0.11	0.22	0.43	0.05	0.00
2011 - 2015 ave.	**0.26**	**0.54**	**1.03**	**0.28**	**0.20**
25th	0.15	0.04	0.47	0.68	0.17
median	0.17	0.05	0.77	1.01	0.36
75th	0.19	0.27	1.57	1.18	0.56

* 2015 Maine data are preliminary

Gulf of Maine Abundance Indicators Con't

SURVEY LOBSTER ENCOUNTER RATE						
Proportion of postive tows						
Survey	***NEFSC***		***ME/NH***		***MA 514***	
	fall	***spring***	***fall***	***spring***	***fall***	***spring***
1981					0.73	0.86
1982	0.18	0.36			0.70	0.50
1983	0.33	0.26			0.76	0.76
1984	0.36	0.28			0.76	0.76
1985	0.49	0.38			0.67	0.71
1986	0.47	0.33			0.83	0.68
1987	0.24	0.43			0.54	0.85
1988	0.30	0.31			0.58	0.76
1989	0.36	0.19			0.95	0.78
1990	0.32	0.42			0.95	0.86
1991	0.32	0.42			0.94	0.87
1992	0.25	0.40			0.77	0.93
1993	0.39	0.41			0.82	0.97
1994	0.40	0.45			0.93	1.00
1995	0.36	0.41			0.93	0.93
1996	0.54	0.54			0.95	0.91
1997	0.35	0.64			0.86	0.93
1998	0.40	0.52			0.69	0.76
1999	0.43	0.51			0.91	0.73
2000	0.42	0.61	0.94		0.98	0.93
2001	0.40	0.57	0.86	0.88	0.72	0.93
2002	0.53	0.75	0.95	0.94	0.73	0.91
2003	0.44	0.69	0.97	0.98	0.55	0.82
2004	0.31	0.87	0.94	0.93	0.56	0.84
2005	0.36	0.77	0.97	0.98	0.67	0.95
2006	0.60	0.72	0.97	0.97	0.88	0.91
2007	0.43	0.72	1.00	0.97	0.54	0.51
2008	0.49	0.84	1.00	1.00	0.75	0.83
2009	0.63	0.82	0.98	0.99	0.87	0.89
2010	0.75	0.85	1.00	0.99	0.98	0.87
2011	0.74	0.83	0.98	1.00	0.85	0.89
2012	0.78	0.86	0.99	0.97	0.95	0.91
2013	0.73	0.87	1.00	1.00	0.95	0.96
2014	0.71	0.90	1.00	1.00	0.96	0.79
2015	NA	0.93	NA	1.00	0.95	0.98
2011 - 2015 ave.	**0.74**	**0.88**	**0.99**	**0.99**	**0.93**	**0.90**

25th	0.32	0.37	0.92	0.91	0.70	0.76
median	0.37	0.42	0.95	0.94	0.79	0.85
75th	0.42	0.53	0.96	0.96	0.93	0.93

Georges Bank Abundance Indicators

SPAWNING STOCK ABUNDANCE		
Mean weight (g) per tow of mature females		
Survey	*NESFC fall*	*NESFC spring*
1981	491.28	35.84
1982	438.48	69.86
1983	419.35	71.77
1984	221.61	19.94
1985	345.21	22.28
1986	260.02	191.52
1987	345.02	70.47
1988	451.51	195.65
1989	624.96	89.30
1990	480.53	59.08
1991	542.93	96.84
1992	489.66	90.59
1993	397.36	50.43
1994	500.49	15.84
1995	634.74	21.41
1996	700.78	315.81
1997	446.10	28.19
1998	678.70	31.56
1999	927.74	238.22
2000	610.24	60.00
2001	1162.15	151.11
2002	1463.52	190.11
2003	728.49	540.30
2004	1047.89	191.92
2005	925.37	325.08
2006	1534.94	280.99
2007	1260.32	490.01
2008	2113.99	1271.28
2009	2595.35	925.63
2010	1514.98	723.68
2011	3182.30	676.37
2012	1849.56	954.20
2013	1676.45	929.70
2014	2117.89	1158.19
2015	NA	988.19
2011 - 2015 ave.	**2206.55**	**941.33**
25th	424.14	36.28
median	495.08	71.12
75th	667.71	180.36

FULL RECRUIT ABUNDANCE (SURVEY)		
Abundance of lobsters ≥ 90 mm CL (sexes combined)		
Survey	*NESFC fall*	*NESFC spring*
1981	0.62	0.09
1982	0.61	0.20
1983	0.57	0.17
1984	0.49	0.05
1985	0.50	0.12
1986	0.59	0.28
1987	0.38	0.11
1988	0.68	0.40
1989	0.86	0.22
1990	0.58	0.08
1991	0.75	0.16
1992	0.58	0.27
1993	0.53	0.21
1994	0.64	0.06
1995	0.57	0.07
1996	0.70	0.40
1997	0.77	0.06
1998	0.62	0.06
1999	0.97	0.45
2000	0.75	0.19
2001	1.21	0.32
2002	1.55	0.40
2003	0.68	0.65
2004	1.16	0.24
2005	0.92	0.39
2006	1.16	0.40
2007	1.21	0.53
2008	1.91	1.12
2009	1.97	0.84
2010	1.15	0.91
2011	2.67	0.77
2012	1.57	1.12
2013	1.68	0.72
2014	1.73	1.34
2015	NA	1.00
2011 - 2015 ave.	**1.91**	**0.99**
25th	0.57	0.09
median	0.63	0.20
75th	0.75	0.31

RECRUIT ABUNDANCE (SURVEY)		
Abundance of lobsters 71 - 80 mm CL (sexes combined)		
Survey	*NESFC fall*	*NESFC spring*
1981	0.20	0.03
1982	0.22	0.13
1983	0.15	0.06
1984	0.24	0.08
1985	0.08	0.11
1986	0.29	0.17
1987	0.23	0.09
1988	0.17	0.49
1989	0.05	0.13
1990	0.14	0.14
1991	0.14	0.07
1992	0.29	0.06
1993	0.16	0.31
1994	0.08	0.04
1995	0.13	0.01
1996	0.17	0.03
1997	0.26	0.00
1998	0.16	0.01
1999	0.09	0.12
2000	0.22	0.17
2001	0.29	0.31
2002	0.24	0.03
2003	0.26	0.11
2004	0.08	0.07
2005	0.10	0.03
2006	0.05	0.09
2007	0.16	0.03
2008	0.06	0.06
2009	0.15	0.07
2010	0.04	0.06
2011	0.15	0.01
2012	0.06	0.03
2013	0.06	0.04
2014	0.08	0.03
2015	NA	0.02
2011 - 2015 ave.	**0.09**	**0.03**
25th	0.14	0.05
median	0.17	0.10
75th	0.24	0.14

SURVEY LOBSTER ENCOUNTER RATE		
Proportion of postive tows		
Survey	*NESFC fall*	*NESFC spring*
1981		
1982	0.44	0.24
1983	0.44	0.18
1984	0.41	0.10
1985	0.37	0.20
1986	0.37	0.24
1987	0.33	0.18
1988	0.40	0.34
1989	0.42	0.17
1990	0.44	0.19
1991	0.49	0.18
1992	0.48	0.24
1993	0.38	0.25
1994	0.42	0.11
1995	0.42	0.12
1996	0.36	0.17
1997	0.48	0.11
1998	0.43	0.12
1999	0.53	0.21
2000	0.42	0.21
2001	0.47	0.25
2002	0.57	0.27
2003	0.44	0.26
2004	0.51	0.18
2005	0.54	0.16
2006	0.53	0.25
2007	0.46	0.23
2008	0.52	0.27
2009	0.55	0.33
2010	0.63	0.38
2011	0.70	0.30
2012	0.58	0.33
2013	0.66	0.31
2014	0.61	0.34
2015	NA	0.25
2011 - 2015 ave.	**0.64**	**0.31**
25th	0.40	0.17
median	0.43	0.20
75th	0.46	0.24

Gulf of Maine/Georges Bank Combined Abundance Indicators

SPAWNING STOCK ABUNDANCE						
Mean weight (g) per tow of mature females						
Survey	**NESFC**		**ME/NH**		**MA 514**	
	fall	**spring**	**fall**	**spring**	**fall**	**spring**
1981	304.27	173.96			342.80	251.36
1982	223.09	74.35			404.26	90.43
1983	264.22	125.99			537.29	32.40
1984	189.82	188.73			336.33	78.90
1985	328.01	1138.49			563.45	32.32
1986	206.27	286.30			135.10	50.24
1987	179.30	219.81			146.15	82.80
1988	271.72	184.18			94.55	42.74
1989	407.16	130.78			123.19	114.57
1990	289.98	220.91			538.08	100.27
1991	326.86	204.07			142.51	101.77
1992	293.28	202.01			262.54	110.74
1993	277.73	200.30			53.48	117.58
1994	360.16	280.51			376.55	132.17
1995	452.00	141.92			222.57	91.04
1996	555.40	465.08			262.89	72.61
1997	398.24	410.45			87.30	49.64
1998	438.12	449.94			113.80	81.44
1999	929.85	411.02			178.35	194.17
2000	457.89	484.73	3425.58		287.35	133.73
2001	718.46	625.39	1858.63	462.60	105.26	151.41
2002	1350.72	849.37	3707.47	967.67	163.87	105.74
2003	701.10	1139.33	3988.26	847.68	101.81	45.15
2004	716.95	1141.16	3497.55	682.69	86.24	189.23
2005	593.44	762.80	4062.27	1505.13	167.88	358.32
2006	968.92	811.80	2909.52	885.80	118.39	290.44
2007	752.12	805.69	3010.80	735.09	138.01	91.86
2008	1270.51	1316.45	3423.42	712.51	354.40	222.36
2009	1811.80	1140.39	5525.54	1138.18	396.60	135.71
2010	1662.97	1249.92	3879.74	1322.90	1176.34	157.93
2011	2206.17	1053.94	4446.97	868.71	782.58	151.85
2012	1910.13	1703.54	2964.59	1190.50	524.55	68.82
2013	1853.09	1322.28	4144.70	671.93	761.16	187.97
2014	2582.54	1622.58	3985.005	1326.879	569.74	300.09
2015	NA	1688.19	NA	881.3482	1443.63	269.89
2011 - 2015 ave.	**2137.98**	**1478.11**	**3885.32**	**987.87**	**816.33**	**195.72**
25th	273.23	191.62	3033.84	655.14	116.15	55.84
median	344.08	250.71	3566.52	847.68	171.11	90.73
75th	456.42	461.30	3777.66	907.67	324.09	113.62

FULL RECRUIT ABUNDANCE (SURVEY)						
Abundance of lobsters > 82 mm CL (sexes combined)						
Survey	**NEFSC**		**ME/NH**		**MA 514**	
	fall	**spring**	**fall**	**spring**	**fall**	**spring**
1981	0.42	0.23			1.91	1.83
1982	0.32	0.21			2.80	0.57
1983	0.38	0.18			3.08	0.51
1984	0.39	0.20			4.09	0.49
1985	0.52	0.99			3.94	0.50
1986	0.52	0.42			1.71	0.54
1987	0.26	0.28			0.53	0.56
1988	0.40	0.33			1.51	0.56
1989	0.61	0.25			2.27	0.79
1990	0.41	0.27			4.92	0.97
1991	0.54	0.32			3.18	0.69
1992	0.39	0.32			2.35	0.87
1993	0.46	0.35			0.63	1.00
1994	0.57	0.39			3.15	0.76
1995	0.78	0.28			2.50	0.58
1996	0.80	0.71			2.50	0.33
1997	0.74	0.56			1.69	0.62
1998	0.53	0.53			0.88	0.49
1999	1.27	0.48			1.93	0.72
2000	0.68	0.79	14.22		2.20	0.97
2001	0.90	0.94	9.83	2.25	0.72	0.53
2002	1.73	1.14	12.57	3.40	1.02	0.43
2003	0.92	1.55	16.65	3.08	0.42	0.22
2004	1.17	1.46	16.18	3.14	0.33	0.78
2005	0.77	1.04	21.09	6.53	0.56	0.95
2006	0.99	1.06	14.85	5.33	1.03	0.68
2007	0.84	1.04	14.13	4.19	0.48	0.32
2008	1.38	1.55	20.72	3.06	1.55	0.67
2009	1.89	1.27	30.48	6.32	1.70	0.54
2010	2.15	1.81	21.42	6.29	2.30	0.40
2011	2.93	1.50	23.83	5.14	3.80	0.55
2012	2.51	2.32	16.51	5.94	3.18	0.31
2013	2.53	1.62	21.45	4.50	3.74	0.87
2014	3.87	2.08	26.38	9.33	2.91	0.77
2015	NA	2.57	NA	6.48	5.69	1.26
2011 - 2015 ave.	**2.96**	**2.02**	**22.04**	**6.28**	**3.86**	**0.75**
25th	0.40	0.28	11.88	2.67	1.14	0.50
median	0.53	0.37	13.39	3.08	2.24	0.56
75th	0.77	0.67	14.83	3.24	3.01	0.75

Gulf of Maine/Georges Bank Combined Abundance Indicators Con't

RECRUIT ABUNDANCE (SURVEY)

Abundance of lobsters 71 - 80 mm CL (sexes combined)

Survey	NEFSC		ME/NH		MA 514	
	fall	spring	fall	spring	fall	spring
1981	0.11	0.05			4.84	6.38
1982	0.20	0.13			3.85	2.74
1983	0.31	0.10			9.76	1.76
1984	0.19	0.09			6.13	2.15
1985	0.40	0.10			9.60	4.48
1986	0.42	0.14			3.80	3.01
1987	0.26	0.17			1.16	2.47
1988	0.36	0.38			4.12	2.52
1989	0.37	0.07			7.51	4.48
1990	0.55	0.18			15.40	6.11
1991	0.46	0.19			7.55	2.73
1992	0.45	0.16			8.95	4.31
1993	0.35	0.22			3.19	5.12
1994	0.64	0.07			13.80	7.59
1995	0.46	0.41			12.10	4.54
1996	1.16	0.19			12.10	3.09
1997	0.58	0.50			6.41	4.57
1998	0.61	0.40			7.47	4.50
1999	0.76	0.37			8.73	4.26
2000	0.78	0.99	23.82		8.86	4.24
2001	0.50	0.45	17.53	9.16	1.58	4.30
2002	0.51	0.41	22.12	22.63	5.00	3.43
2003	0.25	0.37	23.78	13.71	0.66	1.96
2004	0.61	0.24	15.96	9.69	1.30	2.46
2005	0.25	0.17	30.88	23.85	2.11	4.35
2006	0.33	0.64	23.27	23.15	5.30	6.09
2007	0.29	0.39	21.62	20.24	1.61	0.75
2008	0.58	0.29	40.45	22.90	6.12	2.54
2009	0.70	0.55	41.84	31.77	8.88	3.18
2010	0.82	0.41	46.24	22.40	9.39	2.22
2011	1.50	1.05	58.53	47.39	15.00	5.24
2012	0.89	1.24	47.28	44.81	11.30	3.03
2013	1.74	1.06	48.24	39.71	12.20	4.83
2014	2.25	1.01	53.06	78.58	7.06	3.35
2015	NA	1.50	NA	45.20	17.91	7.05
2011 - 2015 ave.	**1.60**	**1.17**	**51.78**	**51.14**	**12.69**	**4.70**
25th	0.35	0.13	20.97	11.43	3.92	2.73
median	0.45	0.19	22.95	13.71	7.49	4.25
75th	0.57	0.40	23.79	18.17	9.44	4.50

YOUNG-OF-YEAR INDICES

Survey	YOY ME 511	YOY ME 512	YOY ME 513 East	YOY ME 513 West	YOY MA 514
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989			1.64		
1990			0.77		
1991			1.54		
1992			1.30		
1993			0.45		
1994			1.61		
1995		0.02	0.66		0.56
1996		0.05	0.47		0.00
1997		0.05	0.46		0.17
1998		0.00	0.14		0.02
1999		0.04	0.65		0.36
2000		0.10	0.13	0.17	0.19
2001		0.43	2.08	1.17	0.38
2002	0.13	0.29	1.38	0.85	0.89
2003	0.22	0.27	1.75	1.22	0.68
2004	0.18	0.36	1.75	0.67	1.20
2005	1.59	1.36	1.77	0.82	0.82
2006	0.58	1.13	0.84	0.82	0.32
2007	0.84	1.34	2.01	1.27	1.22
2008	0.42	0.83	1.08	0.97	0.24
2009	0.69	0.48	1.25	0.45	0.13
2010	0.28	0.72	0.80	0.47	0.45
2011	0.41	1.10	2.33	0.67	0.63
2012	0.53	0.73	1.06	0.22	0.21
2013	0.10	0.20	0.48	0.12	0.09
2014	0.16	0.43	0.83	0.33	0.09
2015*	0.11	0.22	0.43	0.05	0.00
2011 - 2015 ave.	**0.26**	**0.54**	**1.03**	**0.28**	**0.20**
25th	0.15	0.04	0.47	0.68	0.17
median	0.17	0.05	0.77	1.01	0.36
75th	0.19	0.27	1.57	1.18	0.56

* 2015 Maine data are preliminary

Gulf of Maine/Georges Bank Combined Abundance Indicators Con't

SURVEY LOBSTER ENCOUNTER RATE						
Proportion of postive tows						
Survey	***NEFSC***		***ME/NH***		***MA 514***	
	fall	***spring***	***fall***	***spring***	***fall***	***spring***
1981	0.40	0.34			0.73	0.86
1982	0.33	0.29			0.70	0.50
1983	0.40	0.22			0.76	0.76
1984	0.39	0.18			0.76	0.76
1985	0.43	0.28			0.67	0.71
1986	0.42	0.28			0.83	0.68
1987	0.29	0.28			0.54	0.85
1988	0.35	0.32			0.58	0.76
1989	0.39	0.18			0.95	0.78
1990	0.39	0.30			0.95	0.86
1991	0.41	0.28			0.94	0.87
1992	0.37	0.31			0.77	0.93
1993	0.38	0.32			0.82	0.97
1994	0.41	0.27			0.93	1.00
1995	0.39	0.26			0.93	0.93
1996	0.45	0.34			0.95	0.91
1997	0.42	0.36			0.86	0.93
1998	0.42	0.33			0.69	0.76
1999	0.47	0.34			0.91	0.73
2000	0.42	0.39	0.94		0.98	0.93
2001	0.44	0.39	0.86	0.88	0.72	0.93
2002	0.55	0.50	0.95	0.94	0.73	0.91
2003	0.44	0.46	0.85	0.92	0.55	0.82
2004	0.42	0.49	0.86	0.89	0.56	0.84
2005	0.46	0.44	0.91	0.95	0.67	0.95
2006	0.56	0.48	0.93	0.93	0.88	0.91
2007	0.45	0.44	0.85	0.97	0.54	0.51
2008	0.51	0.52	0.86	0.92	0.75	0.83
2009	0.58	0.57	0.92	0.98	0.87	0.89
2010	0.68	0.61	0.93	0.98	0.98	0.87
2011	0.72	0.54	0.96	0.99	0.85	0.89
2012	0.67	0.61	0.98	0.98	0.95	0.91
2013	0.70	0.58	0.93	1.00	0.95	0.96
2014	0.66	0.63	1.00	1.00	0.96	0.79
2015	NA	0.59	NA	1.00	0.95	0.98
2011 - 2015 ave.	**0.69**	**0.59**	**0.97**	**0.99**	**0.93**	**0.90**

25th	0.39	0.28	0.86	0.90	0.70	0.76
median	0.41	0.31	0.90	0.92	0.79	0.85
75th	0.42	0.34	0.94	0.93	0.93	0.93

Southern New England Abundance Indicators

Survey	NESFC Fall	NESFC spring	MA fall	MA spring	RI Fall	RI spring	CT Fall	CT spring
SPAWNING STOCK ABUNDANCE — Mean weight (g) per tow of mature females								
1981	198.93	15.71	9.21	99.78	161.55	111.57		
1982	156.07	118.29	50.04	26.42	53.52	43.52		
1983	120.20	35.51	0.72	59.62	87.86	141.69		
1984	192.38	44.50	4.04	51.67	203.58	259.91	2331.33	
1985	132.96	138.13	1.88	36.90	125.09	60.22	1040.42	1155.01
1986	59.83	61.35	87.60	19.06	128.49	136.78	1548.94	751.75
1987	143.76	67.33	44.51	35.12	475.51	86.13	1869.91	932.49
1988	122.36	121.34	13.16	46.33	662.07	100.75	1081.60	639.82
1989	124.57	44.65	233.88	70.68	363.92	151.06	853.74	1193.87
1990	175.83	75.87	59.02	150.21	230.17	258.72	1818.59	2369.93
1991	160.99	53.14	125.79	236.11	367.25	698.35	2185.29	2692.42
1992	178.88	61.38	179.80	47.84	321.95	117.18	1905.99	3598.02
1993	139.25	71.48	99.33	25.59	1286.74	1595.77	3335.55	2320.25
1994	54.70	36.40	126.00	82.42	359.96	164.37	3402.43	1170.49
1995	145.39	10.18	10.89	92.76	410.53	153.14	2253.58	3302.56
1996	227.08	32.01	59.61	54.16	861.32	353.55	3018.00	3882.27
1997	121.74	137.20	29.11	225.15	654.91	439.93	7173.56	5994.27
1998	161.20	44.97	52.73	138.81	251.53	286.59	2573.44	7738.30
1999	69.56	122.59	24.53	81.12	171.54	324.62	2546.24	8261.90
2000	95.66	60.02	20.08	142.78	268.99	303.32	1744.69	4430.68
2001	95.78	36.43	21.28	16.61	267.62	535.45	1513.56	3363.78
2002	85.56	146.86	0.00	44.75	35.68	572.35	365.12	2044.42
2003	52.83	31.71	0.00	5.97	205.85	110.43	1187.14	698.04
2004	47.10	47.01	37.18	3.58	288.49	591.60	626.96	522.99
2005	110.36	42.31	101.87	23.02	353.53	243.36	473.26	479.71
2006	65.03	90.62	0.00	60.77	465.26	788.63	219.99	465.37
2007	44.60	34.20	41.79	10.32	350.43	206.96	188.98	595.89
2008	25.90	58.14	0.00	19.67	401.73	194.57	248.63	760.88
2009	36.92	24.49	3.95	31.29	184.35	250.00	305.31	371.95
2010	101.74	46.39	130.73	32.09	166.07	177.64	na	361.72
2011	89.95	22.79	36.96	8.55	148.47	152.43	30.24	64.00
2012	205.12	39.64	14.13	9.93	31.16	118.13	6.28	88.85
2013	52.95	42.05	23.96	35.49	2.02	67.76	24.56	39.81
2014	50.93	198.30	0.10	20.95	190.12	24.98	23.00	34.02
2015	na	44.83	54.57	1.72	62.34	15.60	na	23.02
2011 - 2015 ave.	**99.74**	**69.52**	**25.95**	**15.33**	**86.82**	**75.78**	**21.02**	**49.94**

25th	93.14	42.48	12.59	36.45	205.28	131.88	1431.95	1162.75
median	128.76	60.69	36.81	52.92	295.47	259.32	1887.95	2369.93
75th	161.04	87.24	90.53	104.27	426.78	375.15	2553.04	3740.14

Southern New England Abundance Indicators Con't

FULL RECRUIT ABUNDANCE (SURVEY)								
Abundance of lobsters > 85 mm CL (sexes combined)								
Survey	***NEFSC***		***MA***		***RI***		***CT***	
	Fall	***spring***	***fall***	***spring***	***Fall***	***spring***	***Fall***	***spring***
1981	0.24	0.03	0.00	0.02	0.01	0.03		
1982	0.17	0.13	0.07	0.02	0.04	0.03		
1983	0.13	0.03	0.00	0.07	0.13	0.08		
1984	0.24	0.04	0.07	0.03	0.16	0.31	2.67	
1985	0.12	0.07	0.00	0.00	0.10	0.07	0.81	1.06
1986	0.06	0.12	0.05	0.00	0.08	0.11	2.73	0.63
1987	0.19	0.05	0.05	0.05	0.31	0.04	1.62	0.99
1988	0.15	0.04	0.00	0.03	0.83	0.09	1.26	0.82
1989	0.20	0.07	0.20	0.07	0.24	0.05	1.00	1.41
1990	0.19	0.05	0.05	0.05	0.38	0.10	2.39	1.35
1991	0.20	0.04	0.23	0.19	0.44	0.37	1.34	3.26
1992	0.20	0.07	0.22	0.05	0.34	0.10	2.37	1.44
1993	0.14	0.10	0.12	0.02	1.12	1.42	1.55	0.68
1994	0.08	0.03	0.00	0.00	0.55	0.10	3.75	0.50
1995	0.15	0.01	0.01	0.05	0.33	0.07	2.20	1.85
1996	0.22	0.02	0.06	0.08	0.82	0.19	1.97	1.96
1997	0.11	0.19	0.02	0.10	0.98	0.08	4.00	4.44
1998	0.25	0.00	0.04	0.00	0.17	0.17	1.48	4.10
1999	0.08	0.07	0.00	0.16	0.27	0.26	1.70	3.27
2000	0.08	0.08	0.08	0.08	0.30	0.32	0.95	2.44
2001	0.10	0.07	0.02	0.03	0.10	0.32	0.35	2.47
2002	0.08	0.08	0.00	0.08	0.00	0.20	0.03	1.35
2003	0.08	0.05	0.00	0.06	0.29	0.07	0.62	0.35
2004	0.07	0.04	0.04	0.00	0.26	0.41	0.27	0.30
2005	0.12	0.07	0.06	0.00	0.30	0.33	0.21	0.25
2006	0.11	0.06	0.00	0.14	0.24	0.65	0.03	0.20
2007	0.07	0.03	0.05	0.01	0.32	0.15	0.03	0.24
2008	0.07	0.06	0.00	0.02	0.74	0.12	0.19	0.66
2009	0.07	0.03	0.00	0.01	0.17	0.19	0.24	0.32
2010	0.11	0.05	0.15	0.07	0.07	0.12	na	0.26
2011	0.10	0.04	0.07	0.00	0.14	0.16	0.01	0.07
2012	0.19	0.05	0.03	0.02	0.02	0.09	0.03	0.06
2013	0.08	0.09	0.03	0.07	0.00	0.02	0.03	0.07
2014	0.07	0.18	0.00	0.02	0.00	0.00	0.01	0.04
2015	na	0.06	0.05	0.02	na	0.00	na	0.02
2011 - 2015 ave.	**0.11**	**0.08**	**0.03**	**0.03**	**0.04**	**0.06**	**0.02**	**0.05**

25th	0.08	0.04	0.00	0.03	0.17	0.07	0.99	0.91
median	0.14	0.06	0.04	0.05	0.31	0.10	1.59	1.41
75th	0.20	0.08	0.07	0.08	0.46	0.28	2.38	2.46

Southern New England Abundance Indicators Con't

RECRUIT ABUNDANCE (SURVEY) Abundance of lobsters 71 - 80 mm CL (sexes combined)								
Survey	NEFSC		MA		RI		CT	
	Fall	spring	fall	spring	Fall	spring	Fall	spring
1981	0.40	0.05	0.07	0.65	1.31	0.89		
1982	0.29	0.24	0.04	0.10	0.62	0.26		
1983	0.28	0.14	0.04	0.09	0.43	0.94		
1984	0.19	0.04	0.01	0.42	1.21	1.03	8.62	
1985	0.34	0.78	0.09	0.34	0.97	0.26	5.03	4.73
1986	0.14	0.09	0.20	0.17	1.30	0.75	8.22	3.45
1987	0.20	0.33	0.17	0.27	2.53	0.79	9.46	3.90
1988	0.26	0.09	0.16	0.24	4.14	0.42	4.82	2.16
1989	0.52	0.04	0.43	0.14	3.26	0.93	6.32	5.51
1990	0.36	0.29	0.31	2.29	1.38	2.17	10.31	9.53
1991	0.24	0.18	0.87	1.18	3.05	4.77	14.23	15.39
1992	0.38	0.06	0.57	0.10	1.97	0.67	12.25	16.55
1993	0.17	0.29	0.52	0.25	8.29	7.81	21.46	10.69
1994	0.12	0.10	0.42	0.95	3.64	1.00	18.87	5.90
1995	0.28	0.00	0.03	1.14	4.48	1.36	15.30	16.31
1996	0.77	0.14	0.32	0.40	6.42	1.60	14.91	16.30
1997	0.56	0.62	0.12	1.45	6.10	2.58	40.43	25.49
1998	0.46	0.37	0.11	1.09	3.38	1.63	18.61	37.56
1999	0.20	0.92	0.19	0.75	2.10	1.64	20.22	40.84
2000	0.40	0.30	0.13	0.54	1.83	1.54	12.71	20.72
2001	0.17	0.14	0.03	0.18	2.21	3.03	11.94	19.12
2002	0.17	0.62	0.00	0.34	0.75	2.73	3.52	11.44
2003	0.12	0.21	0.00	0.07	1.00	0.29	5.56	4.58
2004	0.12	0.11	0.00	0.05	1.48	1.86	4.52	2.92
2005	0.08	0.06	0.00	0.08	2.48	1.02	2.14	2.67
2006	0.12	0.14	0.03	0.08	2.26	3.63	1.38	2.12
2007	0.11	0.12	0.00	0.08	2.76	0.73	1.35	2.86
2008	0.12	0.14	0.01	0.16	2.98	0.64	1.43	3.10
2009	0.05	0.05	0.05	0.16	1.36	1.14	1.72	1.55
2010	0.14	0.05	0.18	0.06	1.21	0.44	na	1.41
2011	0.12	0.03	0.00	0.18	1.02	0.42	0.19	0.42
2012	0.16	0.04	0.21	0.07	0.27	0.61	0.14	0.50
2013	0.10	0.02	0.04	0.11	0.02	0.18	0.06	0.23
2014	0.14	0.52	0.00	0.04	0.14	0.02	0.05	0.15
2015	NA	0.01	0.30	0.07	na	0.05	na	0.15
2011 - 2015 ave.	**0.13**	**0.12**	**0.11**	**0.09**	**0.36**	**0.26**	**0.11**	**0.29**

25th	0.17	0.09	0.08	0.23	1.36	0.78	7.74	5.12
median	0.25	0.20	0.17	0.37	2.37	1.45	12.09	11.44
75th	0.38	0.34	0.35	0.99	3.77	2.27	16.13	17.84

Southern New England Abundance Indicators Con’t

YOUNG-OF-YEAR INDICES				
	YOY	YOY	Larvae	Postlarvae
Survey	***MA***	***RI***	***CT / ELIS*** *Summer*	***CT_NY / WLIS*** *Summer*
1981				
1982				
1983				14.48
1984			0.43	6.89
1985			0.53	66.75
1986			0.90	4.58
1987			0.78	18.98
1988			0.74	49.27
1989			0.74	5.88
1990		1.31	0.81	19.66
1991		1.49	0.55	9.97
1992		0.63	1.44	14.12
1993		0.51	1.19	26.23
1994		1.23	0.98	96.52
1995	0.17	0.33	1.46	18.20
1996	0.00	0.15	0.31	12.07
1997	0.08	0.99	0.21	13.69
1998	0.20	0.57	0.55	4.85
1999	0.03	0.92	2.83	39.70
2000	0.33	0.34	0.78	14.28
2001	0.10	0.75	0.32	9.46
2002	0.10	0.25	0.64	1.99
2003	0.03	0.79	0.25	2.60
2004	0.03	0.42	0.45	6.10
2005	0.13	0.53	0.49	6.90
2006	0.17	0.44	0.71	1.70
2007	0.10	0.36	0.37	18.10
2008	0.00	0.14	0.37	8.10
2009	0.03	0.08	0.19	7.62
2010	0.00	0.11	0.35	9.91
2011	0.03	0.00	0.26	5.90
2012	0.00	0.09	0.12	2.77
2013	0.13	0.22	0.16	no data
2014	0.07	0.22	0.06	no data
2015	0.00	0.14	na	no data
2011 - 2015 ave.	**0.05**	**0.13**	**0.15**	**4.34**
25th	0.03	0.39	0.50	6.64
median	0.10	0.69	0.74	13.91
75th	0.17	0.97	0.92	21.30

SURVEY LOBSTER ENCOUNTER RATE								
Proportion of postive tows								
Survey	***NEFSC***		***MA***		***RI***		***CT***	
	Fall	***spring***	***fall***	***spring***	***Fall***	***spring***	***Fall***	***spring***
1981			0.15	0.38	0.54	0.49		
1982	0.34	0.24	0.21	0.28	0.59	0.30		
1983	0.22	0.14	0.16	0.21	0.36	0.45		
1984	0.27	0.09	0.18	0.40	0.45	0.59	0.76	0.72
1985	0.30	0.20	0.22	0.51	0.50	0.31	0.69	0.57
1986	0.25	0.19	0.38	0.39	0.43	0.64	0.61	0.67
1987	0.23	0.13	0.18	0.28	0.47	0.33	0.76	0.63
1988	0.27	0.08	0.21	0.39	0.59	0.49	0.66	0.65
1989	0.37	0.11	0.33	0.50	0.55	0.52	0.63	0.75
1990	0.43	0.14	0.44	0.66	0.54	0.66	0.76	0.73
1991	0.29	0.13	0.39	0.41	0.69	0.77	0.78	0.81
1992	0.31	0.23	0.23	0.51	0.57	0.41	0.69	0.78
1993	0.26	0.09	0.26	0.54	0.73	0.50	0.77	0.74
1994	0.23	0.09	0.20	0.51	0.57	0.56	0.74	0.73
1995	0.33	0.06	0.13	0.44	0.67	0.55	0.68	0.77
1996	0.41	0.08	0.16	0.30	0.76	0.79	0.78	0.68
1997	0.28	0.24	0.21	0.45	0.71	0.75	0.81	0.71
1998	0.30	0.11	0.13	0.54	0.55	0.59	0.71	0.83
1999	0.29	0.18	0.21	0.41	0.59	0.76	0.79	0.78
2000	0.30	0.13	0.15	0.45	0.63	0.68	0.73	0.82
2001	0.24	0.18	0.18	0.28	0.61	0.64	0.58	0.77
2002	0.21	0.19	0.03	0.28	0.45	0.63	0.59	0.73
2003	0.25	0.11	0.03	0.14	0.40	0.53	0.63	0.71
2004	0.20	0.10	0.03	0.28	0.50	0.54	0.66	0.61
2005	0.20	0.08	0.15	0.34	0.45	0.50	0.55	0.63
2006	0.23	0.13	0.03	0.43	0.61	0.81	0.53	0.61
2007	0.19	0.15	0.10	0.34	0.54	0.43	0.53	0.70
2008	0.24	0.11	0.10	0.33	0.52	0.55	0.65	0.63
2009	0.28	0.16	0.05	0.50	0.40	0.57	0.55	0.49
2010	0.30	0.09	0.24	0.23	0.45	0.47	na	0.54
2011	0.32	0.11	0.05	0.18	0.23	0.29	0.28	0.46
2012	0.32	0.12	0.15	0.18	0.16	0.29	0.20	0.44
2013	0.24	0.09	0.08	0.18	0.09	0.20	0.15	0.28
2014	0.24	0.23	0.08	0.13	0.23	0.07	0.10	0.26
2015	na	0.054	0.05	0.10	na	0.12	0.10	0.27
2011 - 2015 ave.	**0.28**	**0.12**	**0.08**	**0.15**	**0.18**	**0.19**	**0.17**	**0.34**
25th	0.25	0.09	0.16	0.37	0.49	0.52	0.65	0.70
median	0.29	0.13	0.20	0.42	0.57	0.59	0.72	0.73
75th	0.31	0.18	0.24	0.51	0.64	0.66	0.76	0.77