Figure B1. Total catch from from 1887 to 2008. Annual catch data are missing for some years prior to 1930 and total catch between 1965 and 1988 includes discards estimated by applying an average of discard rates for trawl gear estimated between 1989 and 1999 to annual landings of all species between 1965 and 1988 by trawl gear.
Figure B2. Total (circle), US (triangle), and foreign (diamond) landings and estimated discards (x) of butterfish between 1965 and 2008.
Figure B3. US, foreign, and total *Loligo* landings and total allowable catches (TACs).
Figure B4. Coefficient of variation of total catch estimates reflecting variance estimates associated with discard estimates.
Figure B5. Size composition data from commercial landings of butterfish during 1995-2003.
Figure B6. Size composition data from commercial landings of butterfish between 2004 and 2008 accounting for sampling by market category.
Figure B7. Length composition for NMFS Observer Program for butterfish between 1989 and 1998 with kept fish in black and discard in white. Size of a bar of a given color is the proportion of total length samples in the length interval and corresponding disposition.
Figure B8. Length composition for NMFS Observer Program for butterfish between 1999 and 2008 with kept fish in black and discard in white. Size of a bar of a given color is the proportion of total length samples in the length interval and corresponding disposition.
Figure B9. Strata used for NEFSC spring survey biomass indices.
Figure B10. Strata used for NEFSC fall survey biomass indices.
Figure B11. Strata used for NEFSC winter survey biomass indices.
Figure B12. NEFSC spring (triangle), and autumn (circle) and winter (diamond) survey stratified mean number per tow for butterfish. Spring estimates include data from offshore strata (1-14, 16, 19, 20, 23, 25, and 61-76), fall estimates include data from inshore (1-92) and offshore (1-14, 16, 19, 20, 23, 25, and 61-76) strata, and winter estimates include data from offshore strata(1-14 and 61-76).
Figure B13. NEFSC spring (triangle), and autumn (circle) and winter (diamond) survey stratified mean weight per tow for butterfish. Spring estimates include data from offshore strata (1-14, 16, 19, 20, 23, 25, and 61-76), fall estimates include data from inshore (1-92) and offshore (1-14, 16, 19, 20, 23, 25, and 61-76) strata, and winter estimates include data from offshore strata (1-14 and 61-76).
Figure B14. Coefficient of variation (CV) for NEFSC spring (triangle), and autumn (circle) and winter (diamond) survey stratified mean weight per tow for butterfish. Spring estimates include data from offshore strata (1-14, 16, 19, 20, 23, 25, and 61-76), fall estimates include data from inshore (1-92) and offshore (1-14, 16, 19, 20, 23, 25, and 61-76) strata, and winter estimates include data from offshore strata (1-14 and 61-76).
Figure B15. Age composition of butterfish in NEFSC spring bottom trawl surveys, 1982-2008.
Figure B16. Annual (1982-1990) age composition (numbers/tow) for the NEFSC fall survey combining inshore and offshore strata.
Figure B17. Annual (1991-1999) age composition (numbers/tow) for the NEFSC fall survey combining inshore and offshore strata.
Figure B18. Annual (2000-2008) age composition (numbers/tow) for the NEFSC fall survey combining inshore and offshore strata.
Figure B19. Age composition of butterfish in NEFSC fall bottom trawl surveys, 1968-2008.
Figure B20. Massachusetts state survey stratified mean number per tow for butterfish in spring (triangle), and fall (circle).
Figure B21. Massachusetts state survey stratified mean weight per tow for butterfish in spring (triangle), and fall (circle).
Figure B22. Coefficient of variation (CV) of Massachusetts state survey stratified mean weight per tow for butterfish in spring (triangle), and fall (circle).
Figure B23. Connecticut state survey (Long Island Sound) number per tow for butterfish in spring (triangle), and autumn (circle).
Figure B24. Connecticut state survey (Long Island Sound) weight per tow for butterfish in spring (triangle), and autumn (circle).
Figure B25. Average Julian day for NEFSC and Massachusetts state annual surveys.
Figure B26. Attributed model age and weight and predicted weight at age from fitted Schnute (1985) growth model fit to NEFSC survey data from 1992-2009.
Figure B27. Mean butterfish catch (kg) per tow by stratum in the NEFSC spring survey for all sampled stations between 2006 and 2008 and location of stations where greater than 5 kg were observed.
Figure B28. Mean butterfish catch (kg) per tow by stratum in the NEFSC fall survey for all sampled stations between 2006 and 2008 and location of stations where greater than 5 kg were observed.
Butterfish Catch by Otter Trawls in 2007

Figure B29. Observed commercial bottom trawl tows in 2007 where butterfish were absent (green circle), present and kept (blue +), and present and discarded (red x).
Butterfish Catch by Otter Trawls in 2008

Figure B30. Observed commercial bottom trawl tows in 2008 where butterfish were absent (green circle), present and kept (blue +), and present and discarded (red x).
Figure B31. Empirical distribution (solid black) of the catchability parameter (swept area catchability on the top axis) for the NEFSC fall adult index as a product of known scalars and of random variables for unknown components and beta distribution (dashed black) with the same mean and variance used as a prior in the final model. Blue and red represent corresponding distributions when maxima for the ratio of survey and stock area and the efficiency of the Bigelow are 0.85 and 0.95. Vertical solid lines are the means of the distributions.
Figure B32. Total Catch including US landings, foreign catch and US new discard estimates (black) or US discards as reported by Waring and Anderson (1983) and NEFSC (1990) (red).
Figure B33. Estimates of spawning biomass from the final model when revised discard estimates between 1973 and 1986 are used in the total catch (black) (final model) or the discard estimates provided in early assessment documents are used in the total catch (red).
Figure B34. Estimates of recruit biomass from the final model when revised discard estimates between 1973 and 1986 are used in the total catch (black) (final model) or the discard estimates provided in early assessment documents are used in the total catch (red).
Figure B35. Estimates of fishing mortality from the final model when revised discard estimates between 1973 and 1986 are used in the total catch (black) (final model) or the discard estimates provided in early assessment documents are used in the total catch (red).
Figure B36. Estimates of spawning biomass from the final model under assumed maxima for the ratio of survey to stock area and the efficiency of the *Henry B. Bigelow*. 
Figure B37. Estimates of recruitment biomass from the final model under assumed maxima for the ratio of survey to stock area and the efficiency of the Henry B. Bigelow.
Figure B38. Estimates of spawning biomass from the final model under assumed maxima for the ratio of survey to stock area and the efficiency of the *Henry B. Bigelow*.
Figure B39. Estimates of spawning biomass from the final model under assumed natural mortality rates between 0.6 and 1.0.
Figure B40. Estimates of recruitment biomass from the final model under assumed natural mortality rates between 0.6 and 1.0.
Figure B41. Estimates of fishing mortality from the final model under assumed natural mortality rates between 0.6 and 1.0.
Figure B42. Retrospective behaviour of spawning biomass estimates from the final model.
Figure B43. Retrospective behaviour of recruitment biomass estimates from the final model.
Figure B44. Retrospective behaviour of fishing mortality estimates from the final model.
Figure B45. Estimated spawning biomasses from NEFSC (2004) (grey) and final model (black).

Figure B46. Estimated recruitment biomasses from NEFSC (2004) (grey) and final model (black).
Figure B47. Estimated fishing mortality from NEFSC (2004) (grey) and final model (black).
Figure B48. Recruitment and spawning biomass estimates from the final model. Red line represents bias corrected (1.29) estimated Beverton-Holt spawner-recruit curve.
Figure B49. Relationship between recruitment vs spawning stock biomass (SSB) in year $t$ for years 1974 to 2008. The point label refers to year of spawning. The nonparametric kernel distributions of R and SSB are depicted in the margins. Median R (61,860 mt) and SSB (98,700 mt) values are represented by dashed lines. The solid diagonal lines represent replacement lines for $F_{0.1}=1.04$ (steeper slope) and $F=0$ (shallow slope).
Figure B50. Standardized Residuals over time from final model for NEFSC survey indices.
Figure B51. Observed NEFSC survey indices (black) and predicted values from the final model (red).
Figure B52. Observed Catches (kmt) (black) and predicted values from the final model (red).
Figure B53. Annual estimates of total instantaneous mortality by year and age from spring survey age composition estimates (Table B17).
Figure B54. Annual estimates of total instantaneous mortality by year and age from fall survey age composition estimates (Table B18).
Figure B55. Equilibrium ratio of catch biomass to recruitment biomass with constant fishing mortality. Results are obtained by using the BOOTADM bootstrapping and SPROJDDIF projection software written for the KLAMZ model by Dr. Larry Jacobson. Non-stochastic projections were carried out 50 years into the future.
Figure B56. Equilibrium ratio of spawning biomass to recruitment biomass with constant fishing mortality. Results are obtained by using the BOOTADM bootstrapping and SPROJDDIF projection software written for the KLAMZ model by Dr. Larry Jacobson. Non-stochastic projections were carried out 50 years into the future.
Figure B57. Equilibrium spawning potential ratio with constant fishing mortality. Results are obtained by using the BOOTADM bootstrapping and SPROJDDIF projection software written for the KLAMZ model by Dr. Larry Jacobson. Non-stochastic projections were carried out 50 years into the future.
Figure B58. Fox surplus production curve as estimated internal to the final KLAMZ model.

MSY = 17400 mt  
Bmsy = 74550 mt  
Fmsy = 0.233
Figure B59. Probabilities of median biomass being below the corresponding candidate SSB_{MSY} proxies when fishing at candidate F_{MSY} proxies and the entire recruitment series is used.
Figure B60. Probabilities of median spawning biomass being below the corresponding candidate SSB_{MSY} when fishing at candidate F_{MSY} proxies and recruitment is based on recruitment estimates for the last 10 years (1999-2008).
Figure B61. Probabilities of median spawning biomass being below the proposed SSB_{MSY} for potential constant fishing mortality rates (F=F_{2008}=0.02, F=0.52, and F=0.72) when recruitment is based on recruitment estimates for the last 10 years (1999-2008).
Figure B62. Median spawning biomass and catch for constant fishing at $F=F_{2008}=0.02$ when recruitment is based on recruitment estimates for the last 10 years (1999-2008).