

Figure A1. Commercial fishery statistical areas for northern (SA 511-515, 521, 522, 551, and 561) and southern (SA 525, 526, 533-539, 541-543, 552, 562, 611-639) silver hake in the northwest Atlantic.

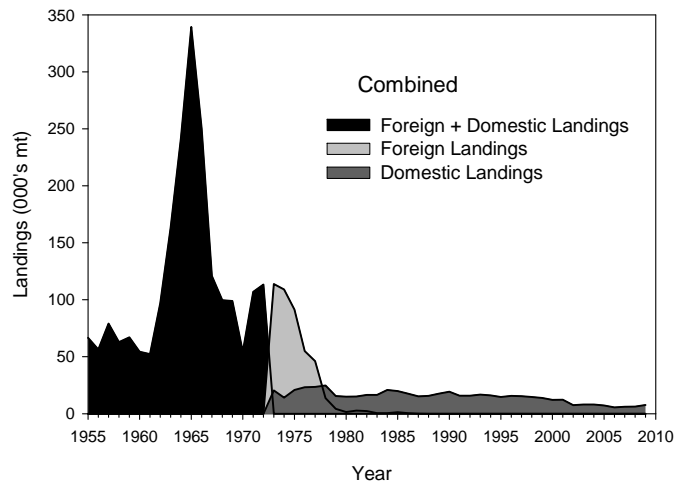
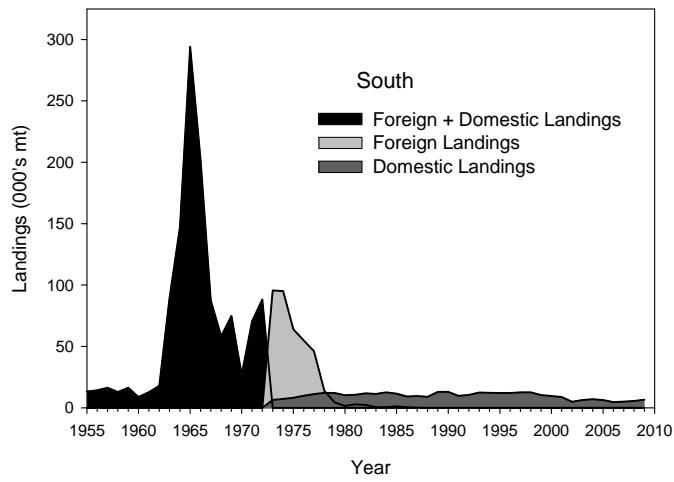
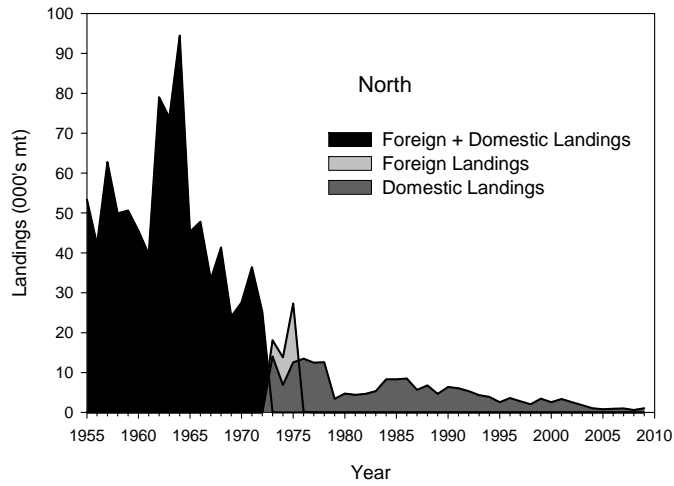


Figure A2: Silver hake catch in thousands of metric tons for the north (Top), south (middle) and combined stock areas (bottom).

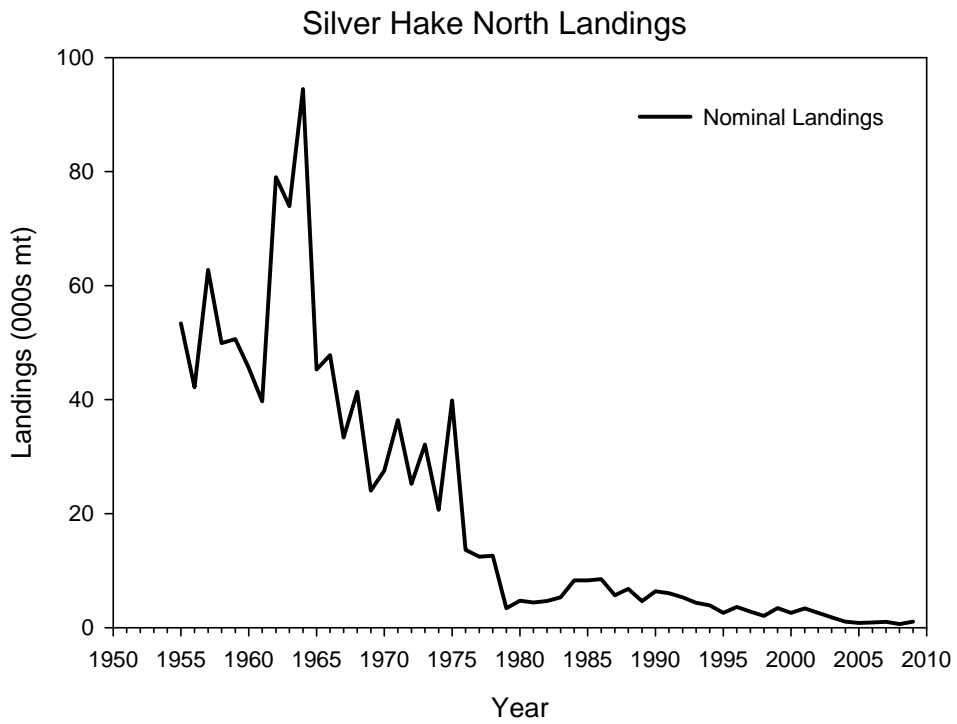


Figure A3. Nominal landings of silver hake (mt) from the northern stock.

Silver Hake South Landings

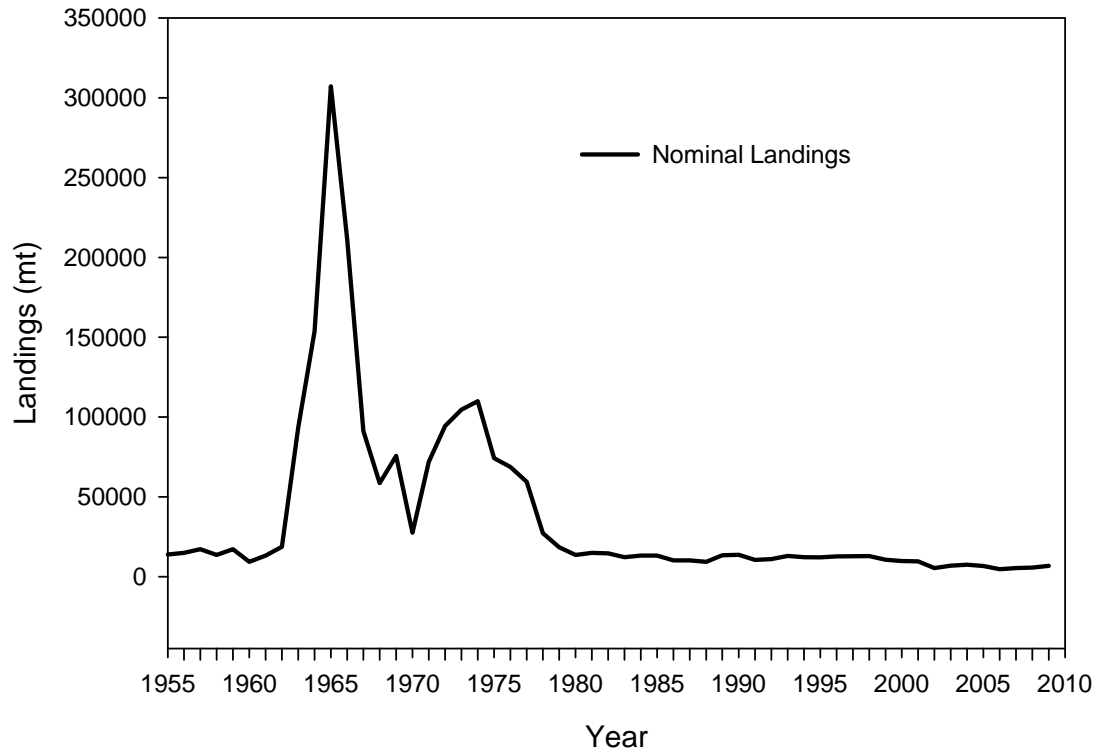


Figure A4. Comparison of nominal landings with the two model-based estimates for silver hake from the southern stock.

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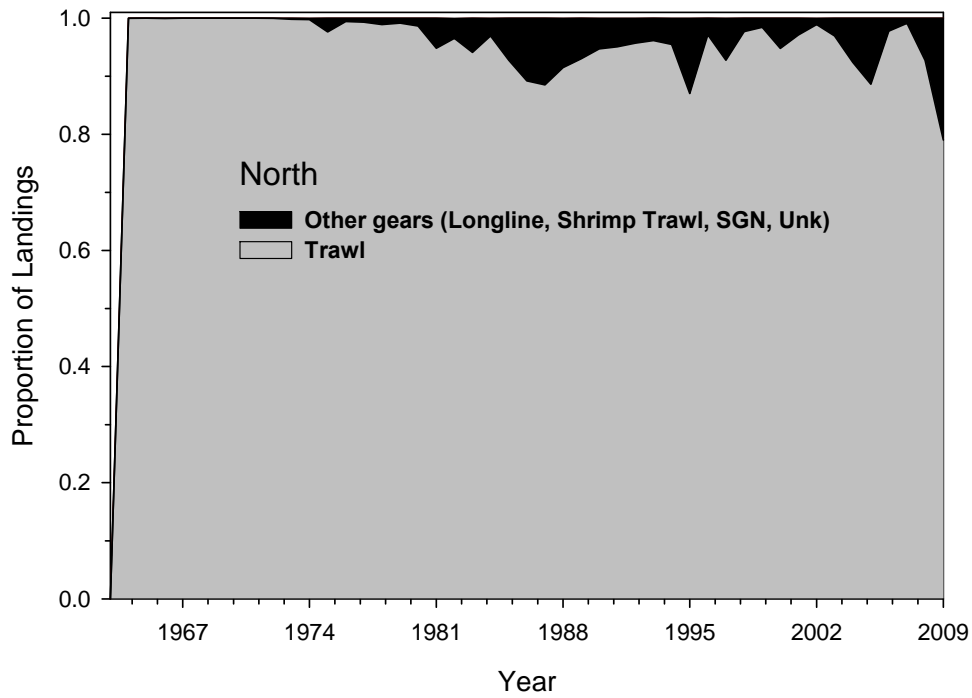
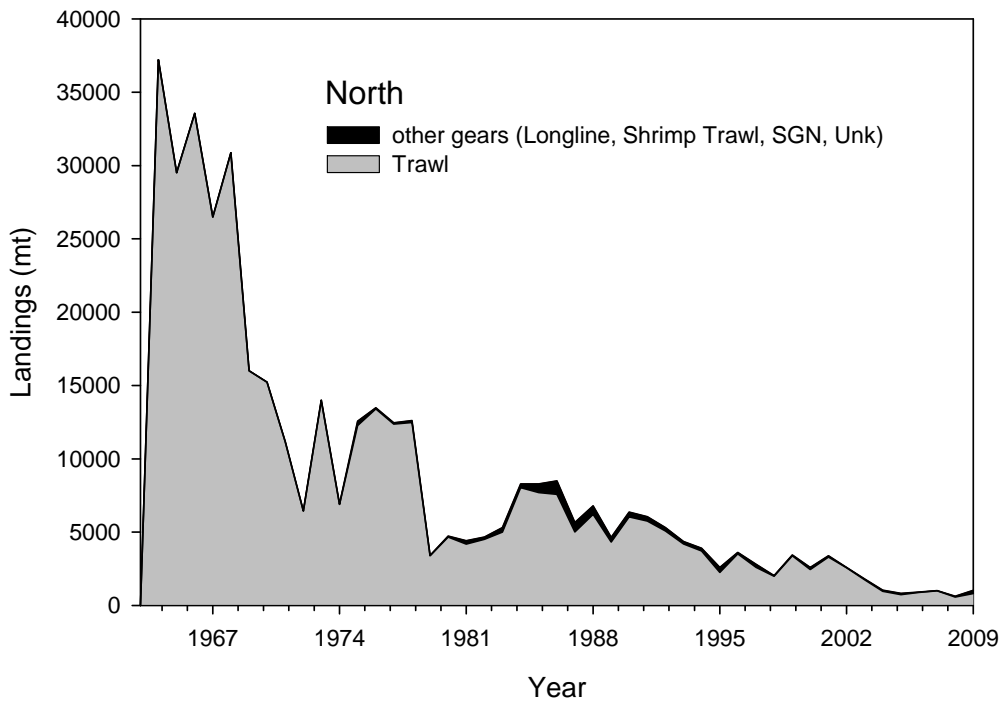


Figure A5. Landings of Silver hake (mt) by gear from the northern stock.

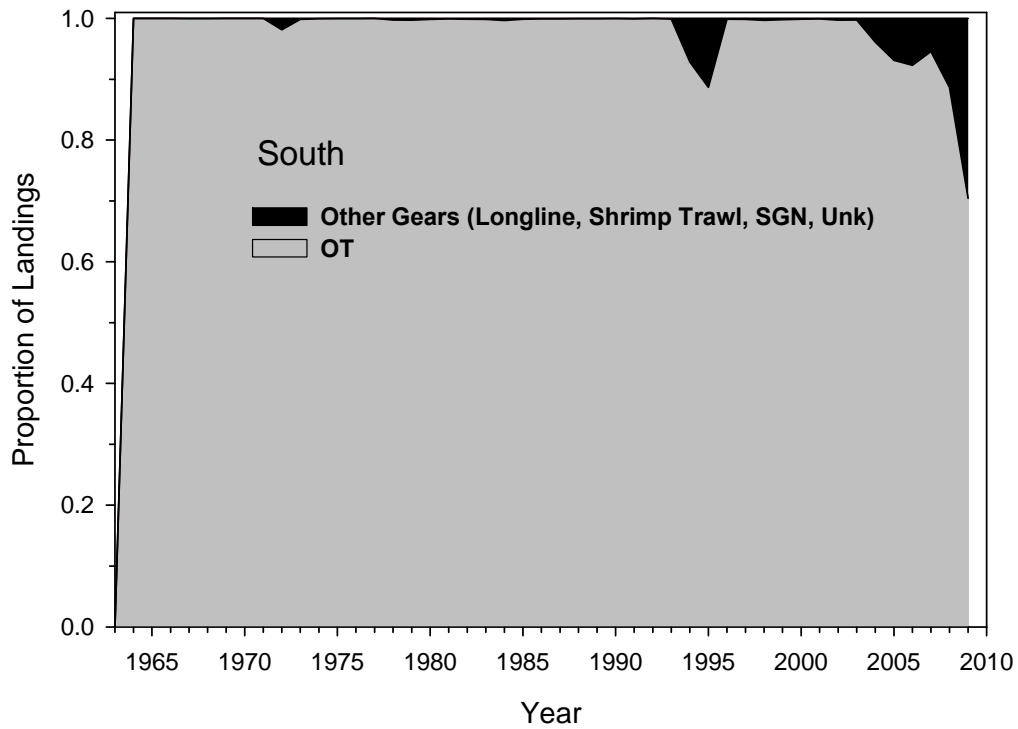
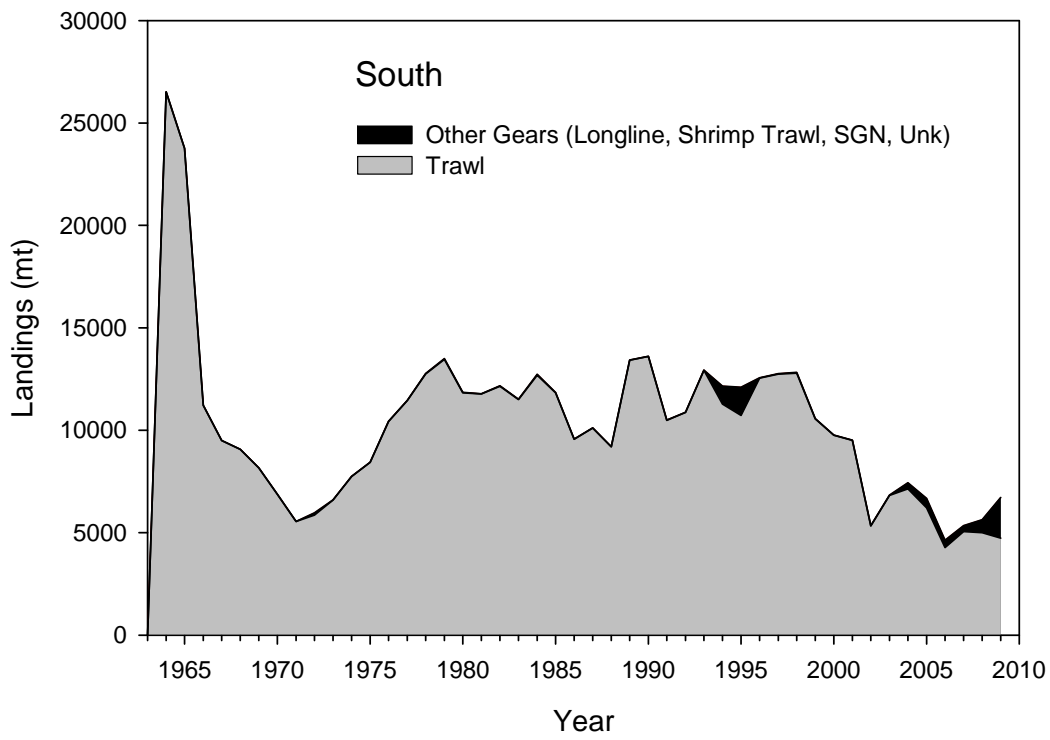


Figure A6. Landings of Silver hake (mt) by gear from the southern stock.

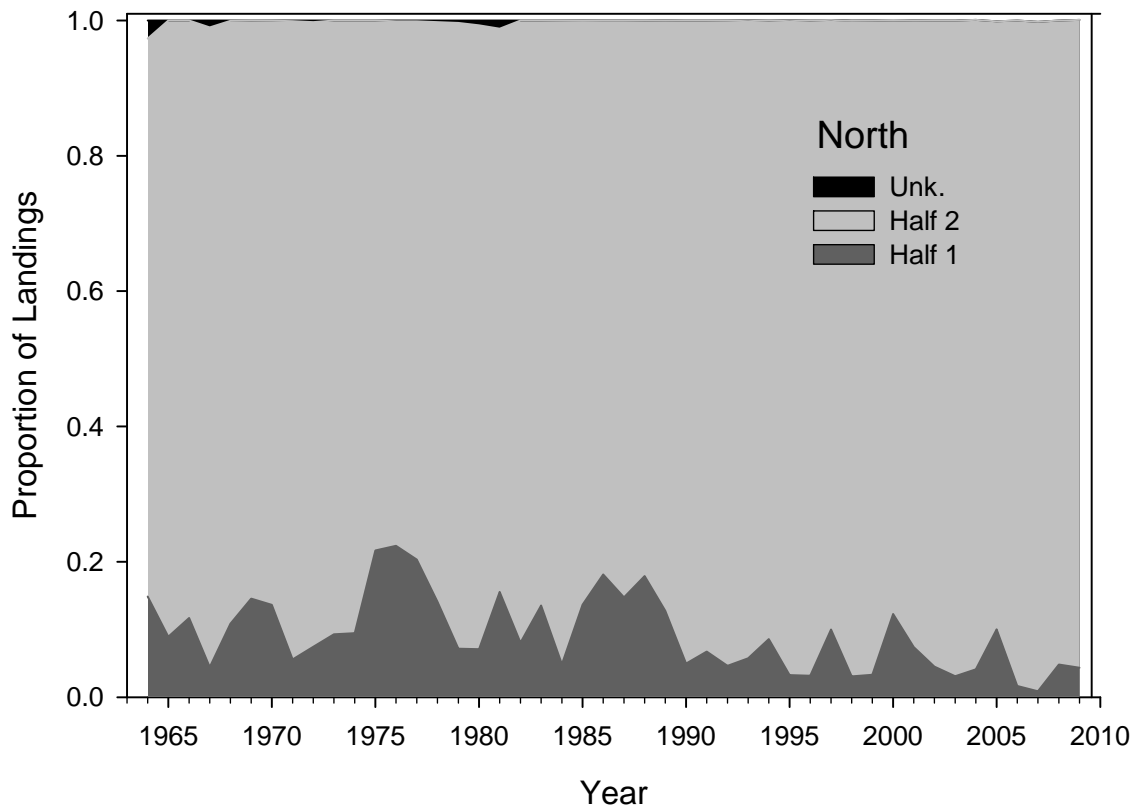


Figure A7. Landings of Silver hake by half year in the northern stock.

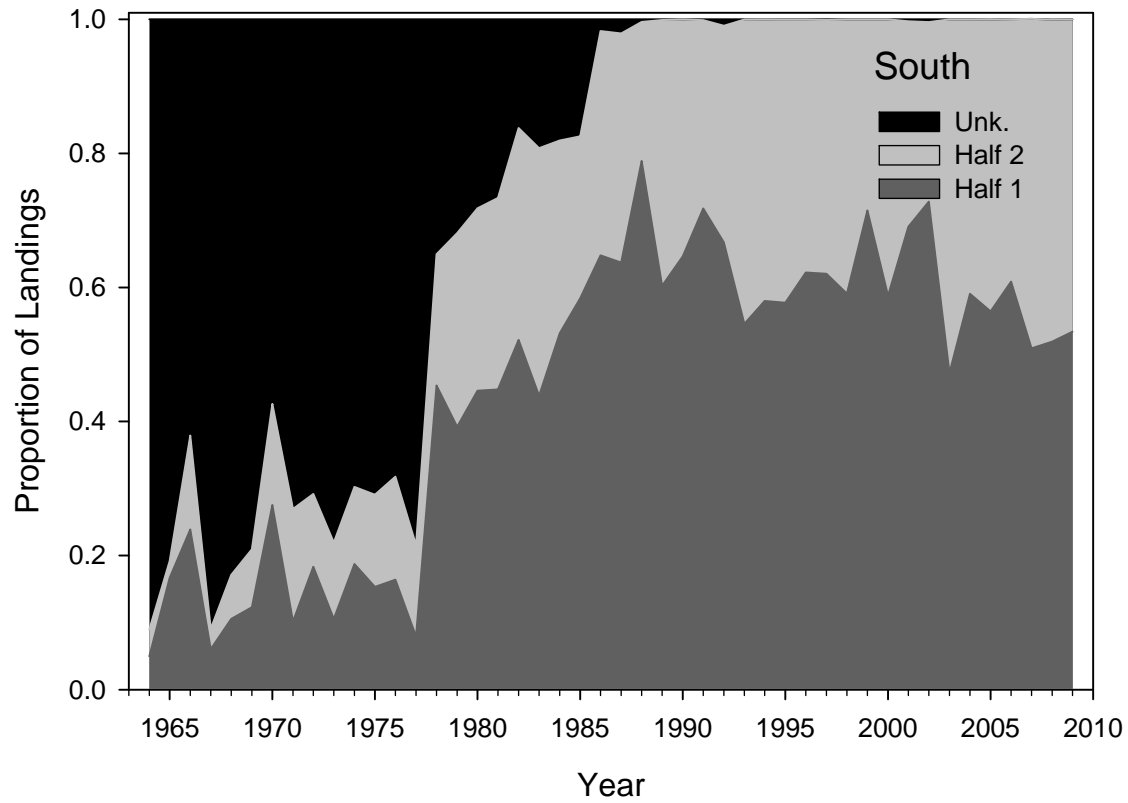


Figure A8. Landings of silver hake by half year in the southern stock.

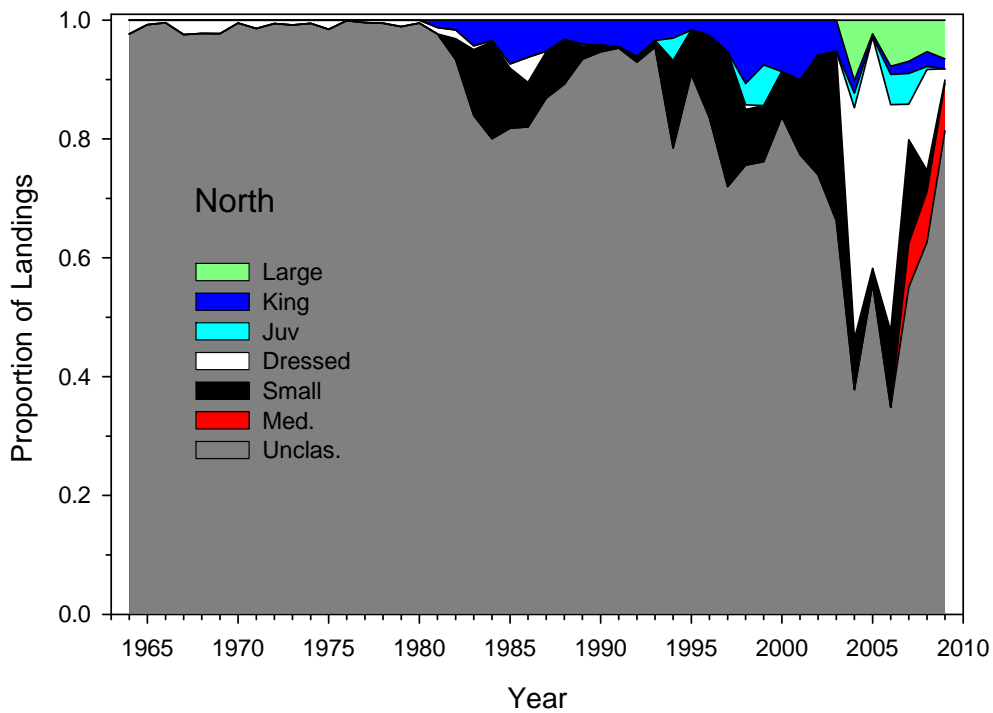
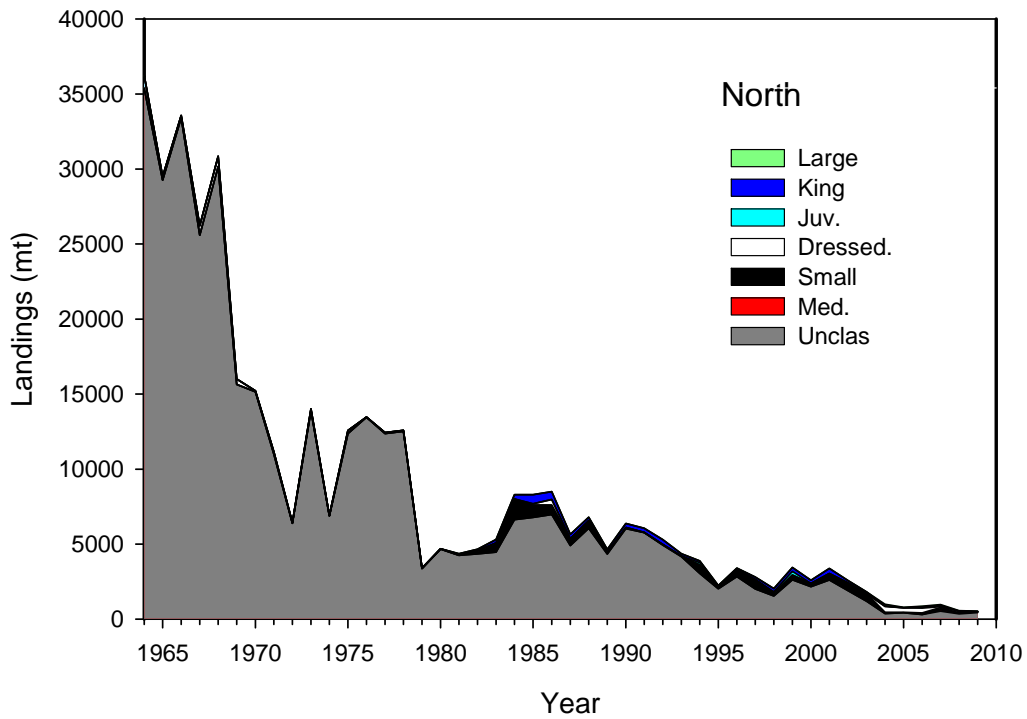


Figure A9. Landings of silver hake (mt) by market category from the northern stock.

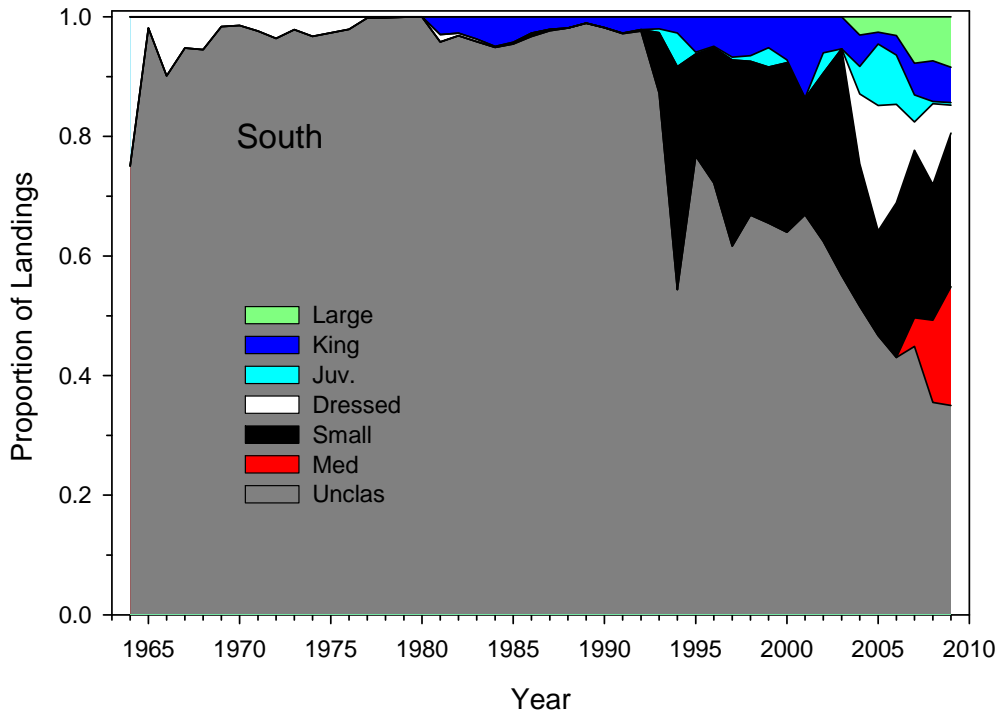
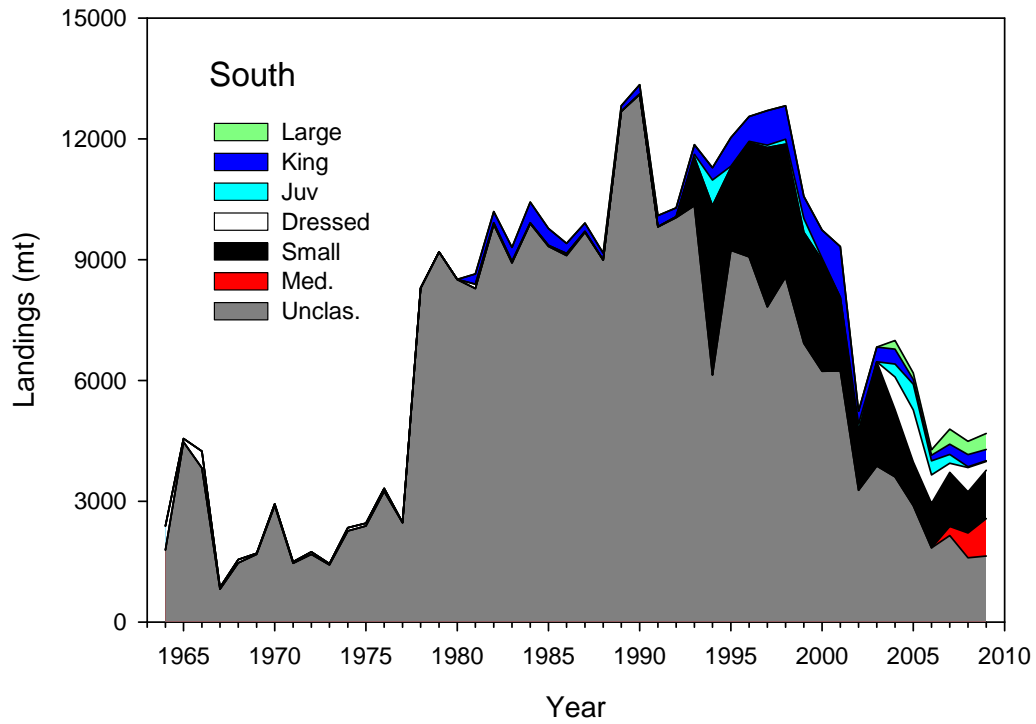


Figure A10. Landings of silver hake (mt) by market category from the southern stock.

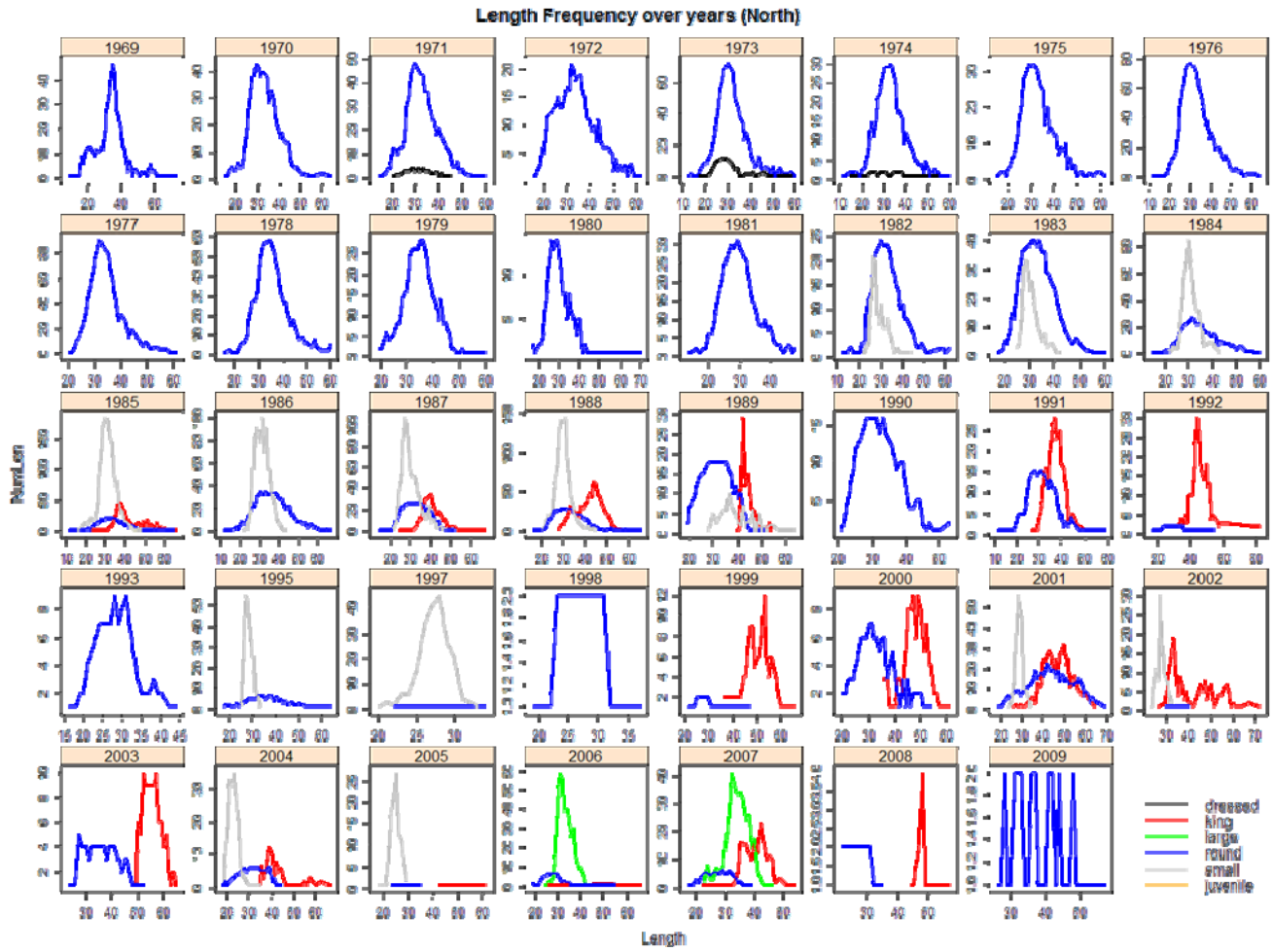


Figure A11: Silver hake length samples by market category in the northern region.

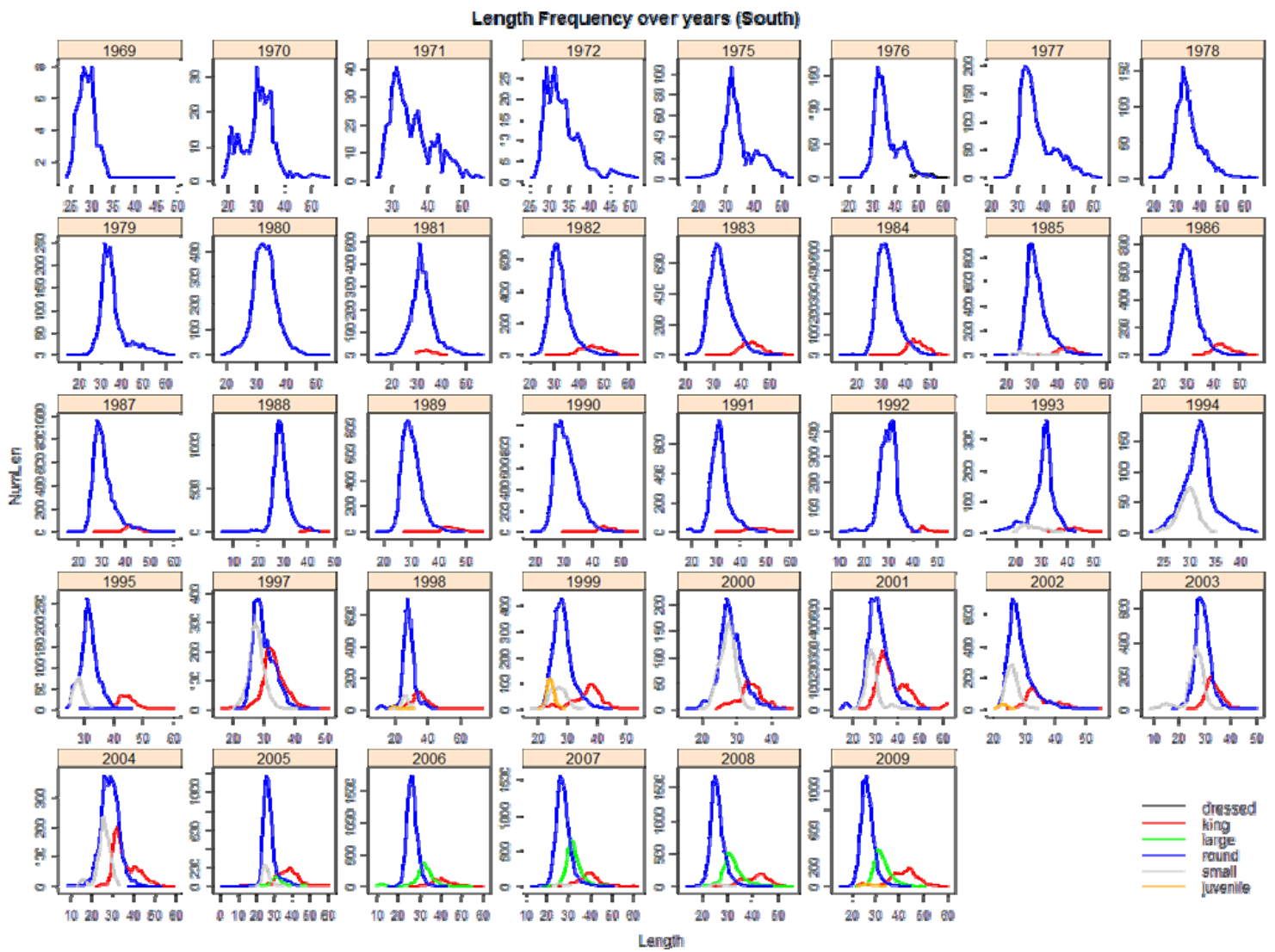


Figure A12: Silver hake length samples by market category in the southern region.

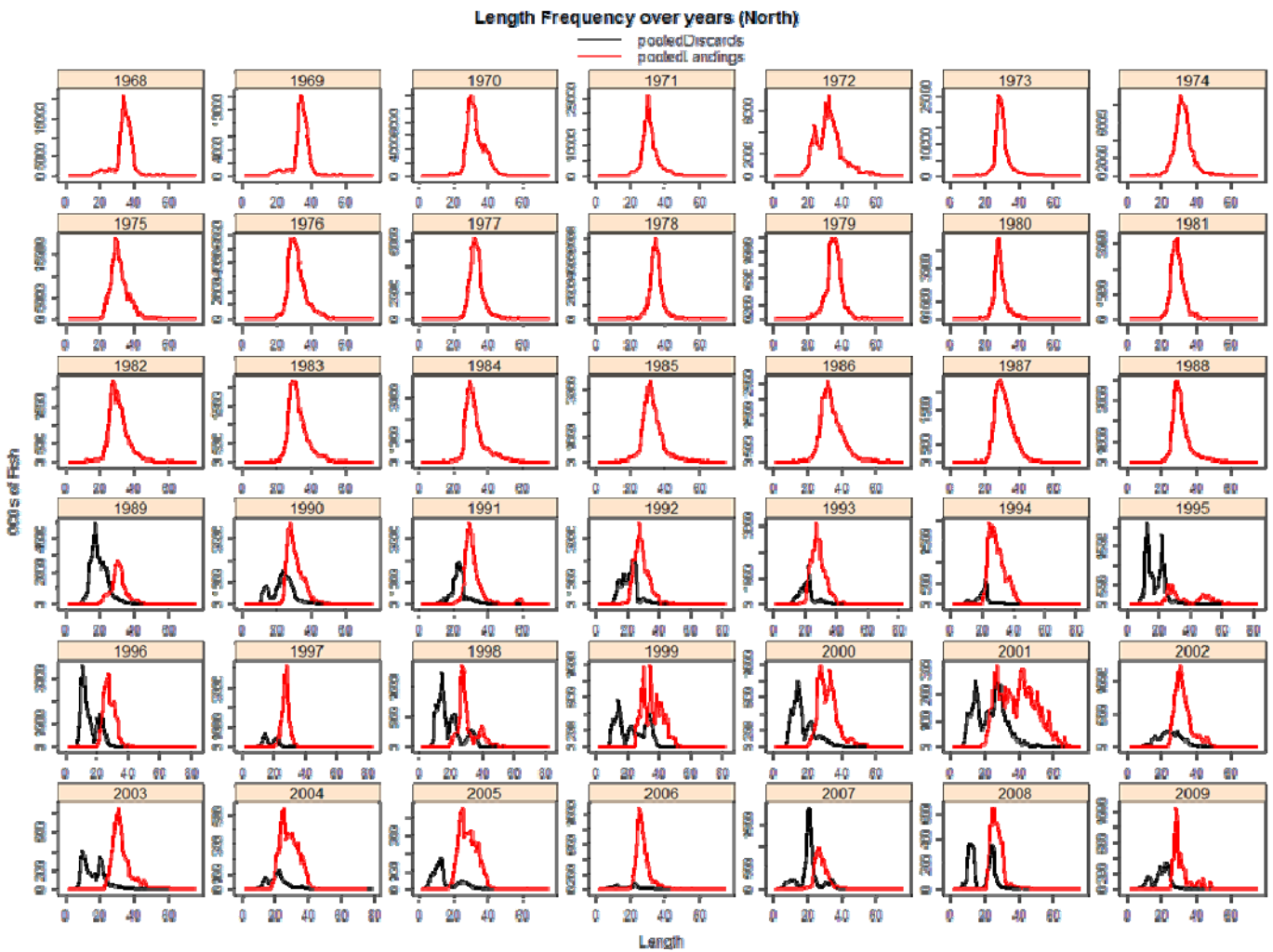


Figure A13. Silver hake length in thousands of fish frequencies from the northern region.

Length Frequency over years (South)

— pooledDiscards
— pooledLandings

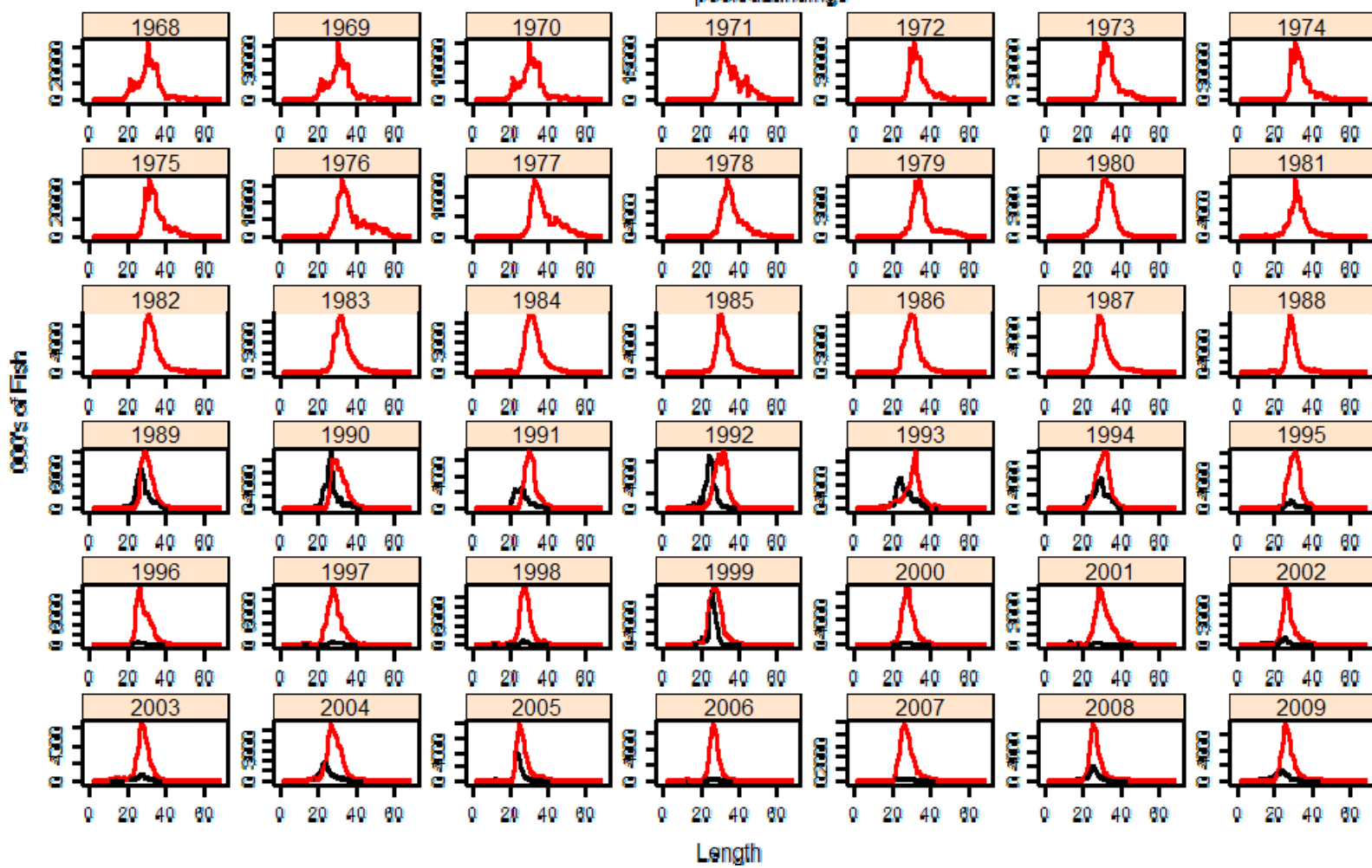


Figure A14. Silver hake length in thousands of fish frequencies from the southern region.

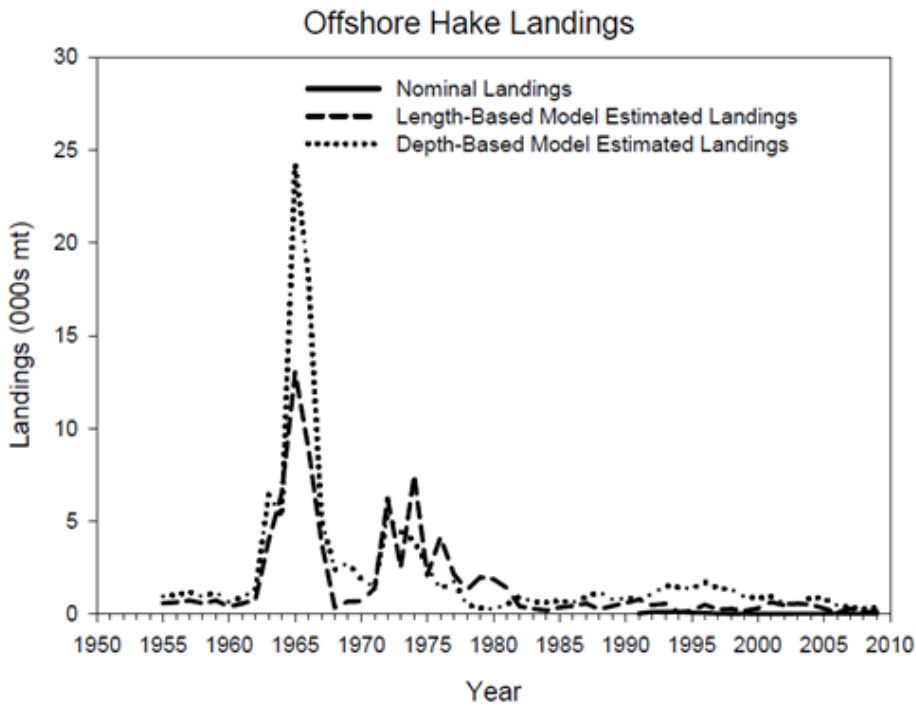
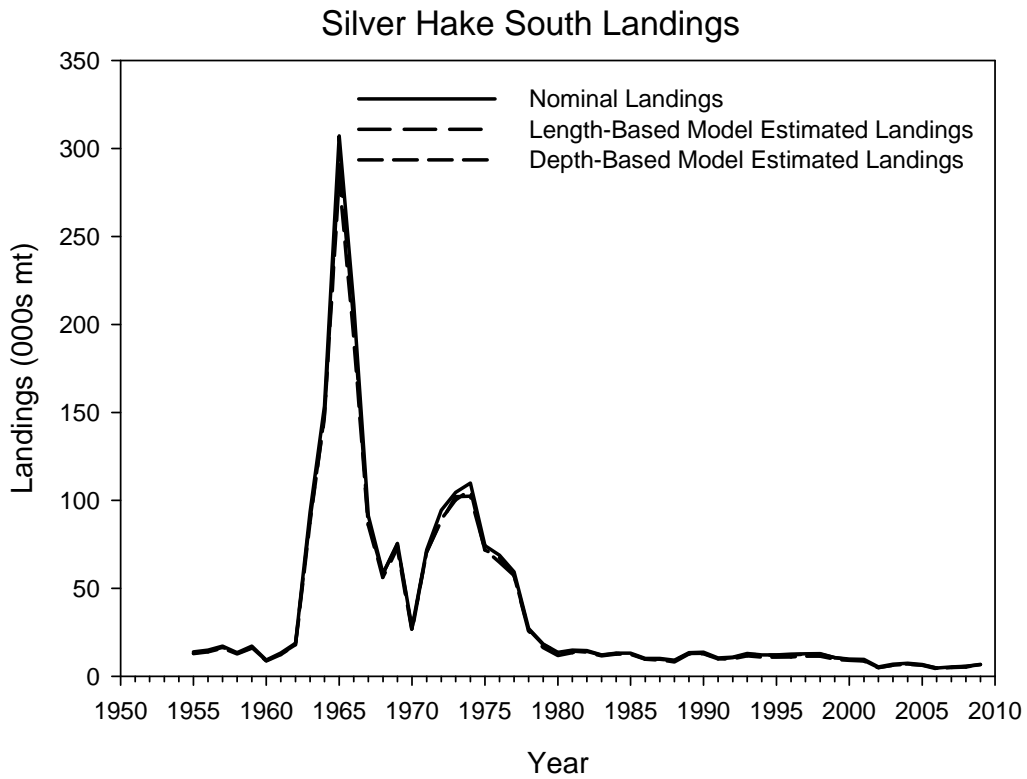


Figure A15. Comparison of nominal landings with the two model-based estimates for silver hake and offshore hake in the southern region.

Northern Stock Catch at Age

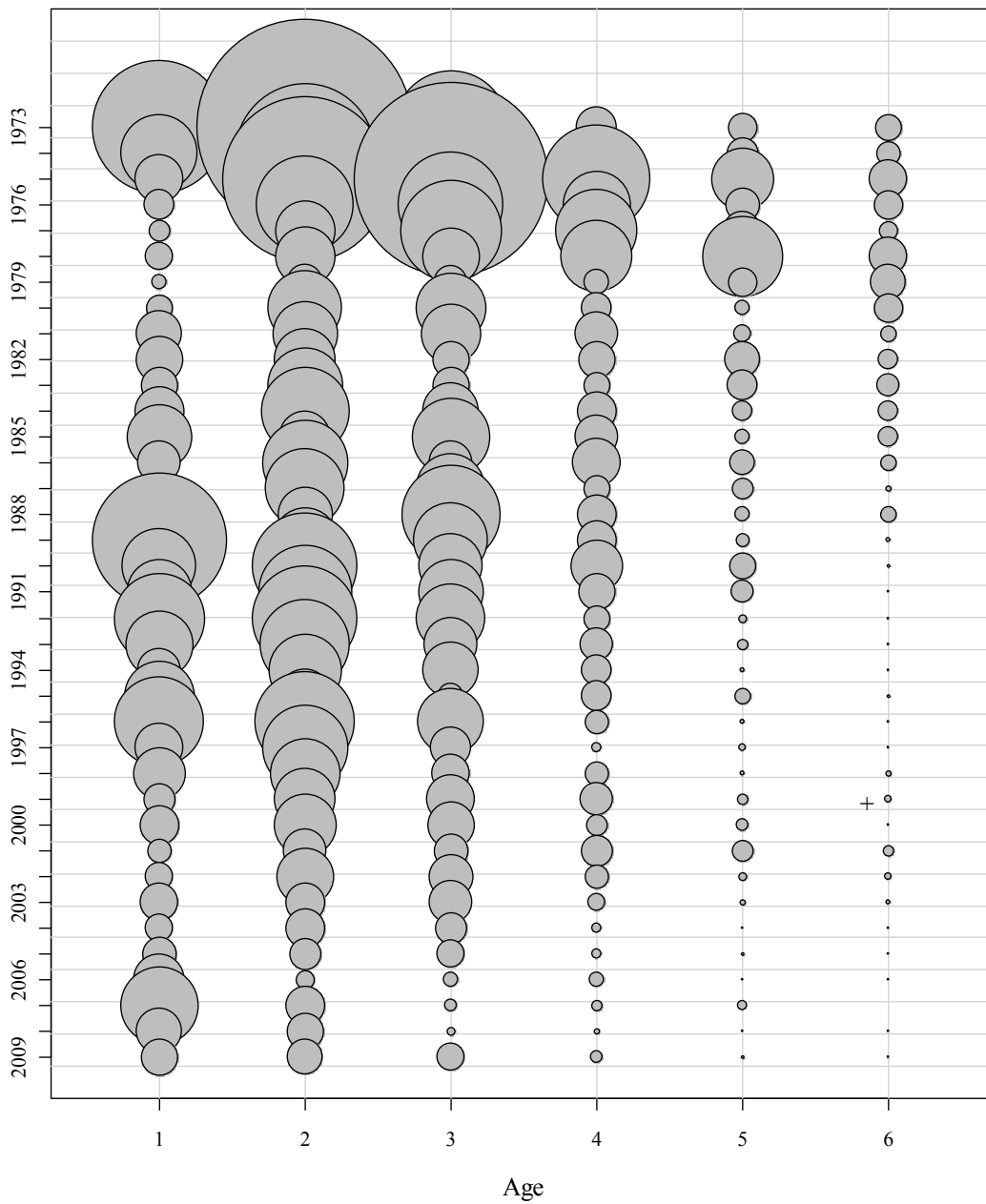


Figure A16. Catch at age of silver hake in the northern stock. (The area of the bubble is proportional to the magnitude of the catch).

Southern Stock Catch at Age

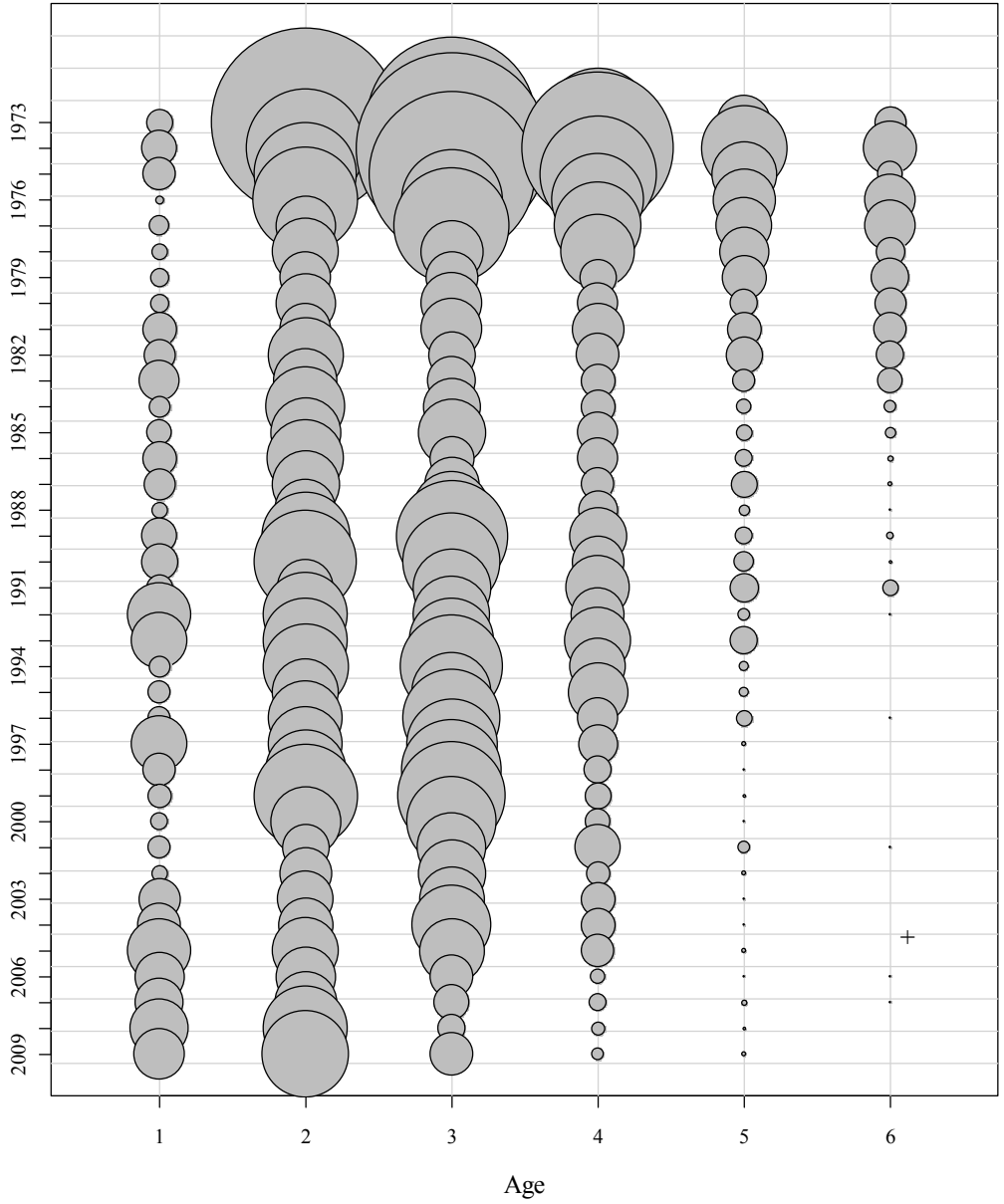


Figure A17. Catch at age of silver hake in the southern stock. (The area of the bubble is proportional to the magnitude of the catch).

Combined Stock Area Catch at Age

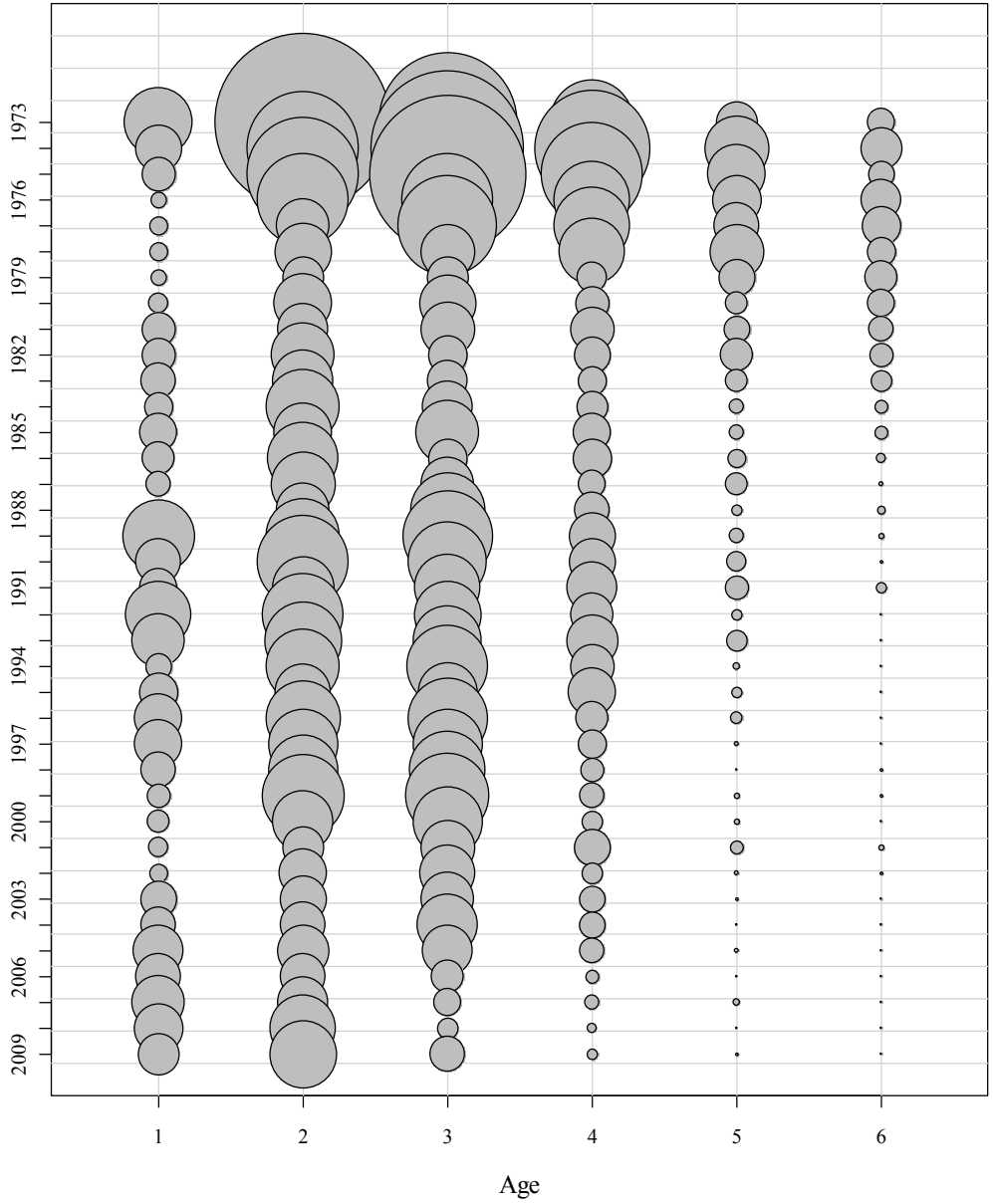


Figure A18. Catch at age of silver hake for the combined stock area. (The area of the bubble is proportional to the magnitude of the catch).

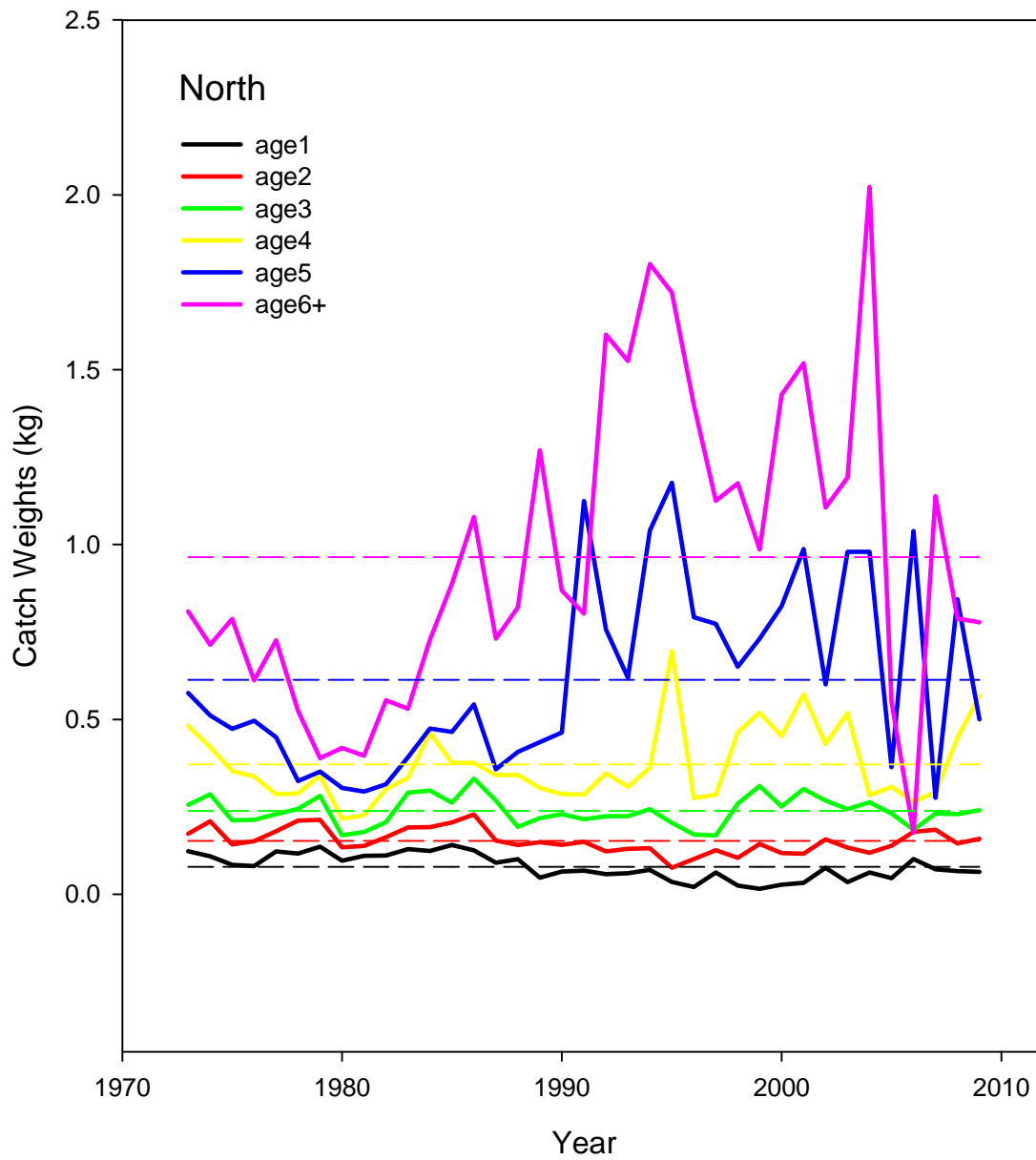


Figure A19. Trends in mean weight at age of silver hake from the northern stock. Dash lines denote the time series average.

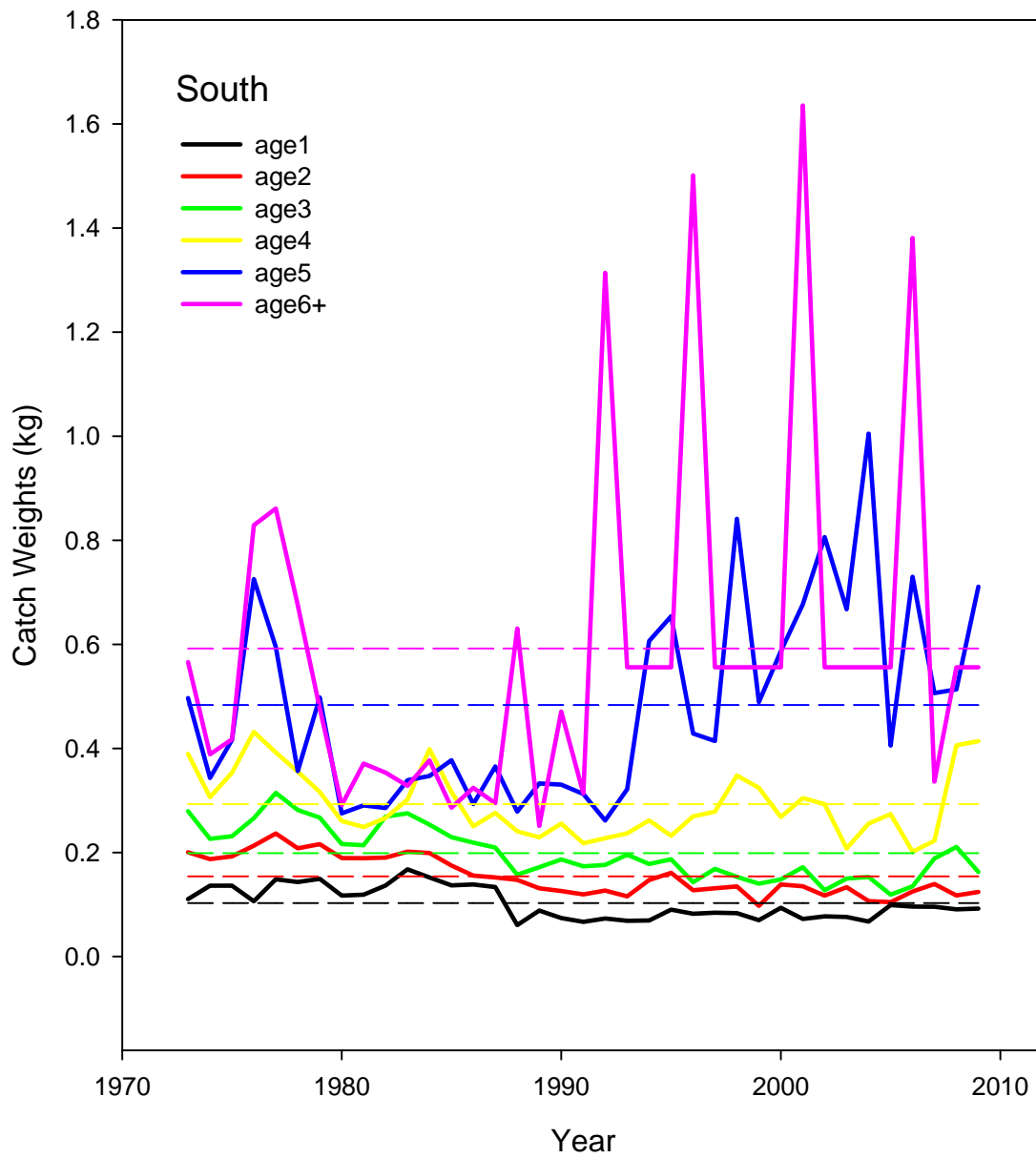


Figure A20. Trends in mean weight at age of silver hake from the southern stock. Dash lines denote the time series average.

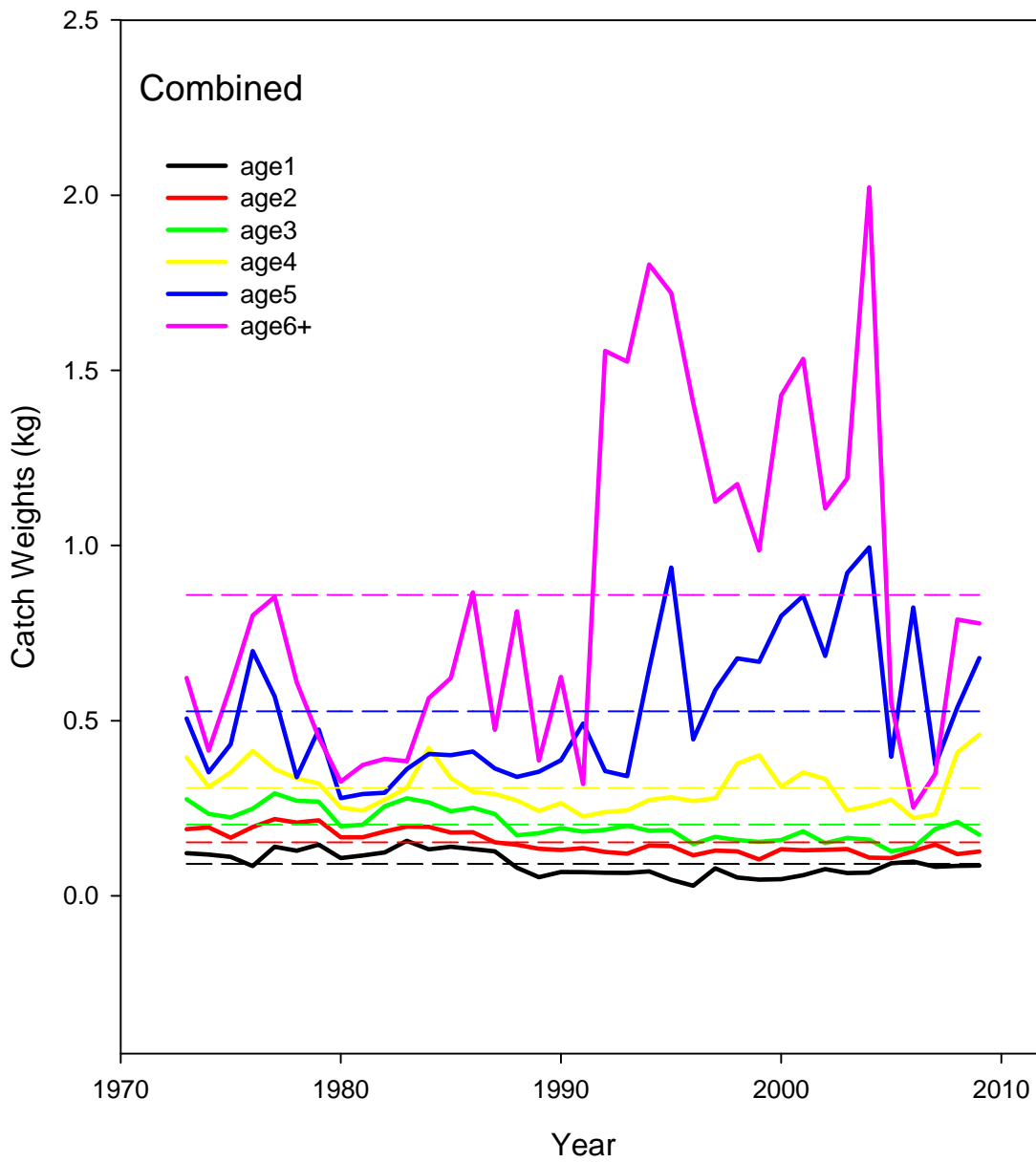


Figure A21. Trends in mean weight at age of silver hake for the combined stock areas. Dash lines denote the time series average.

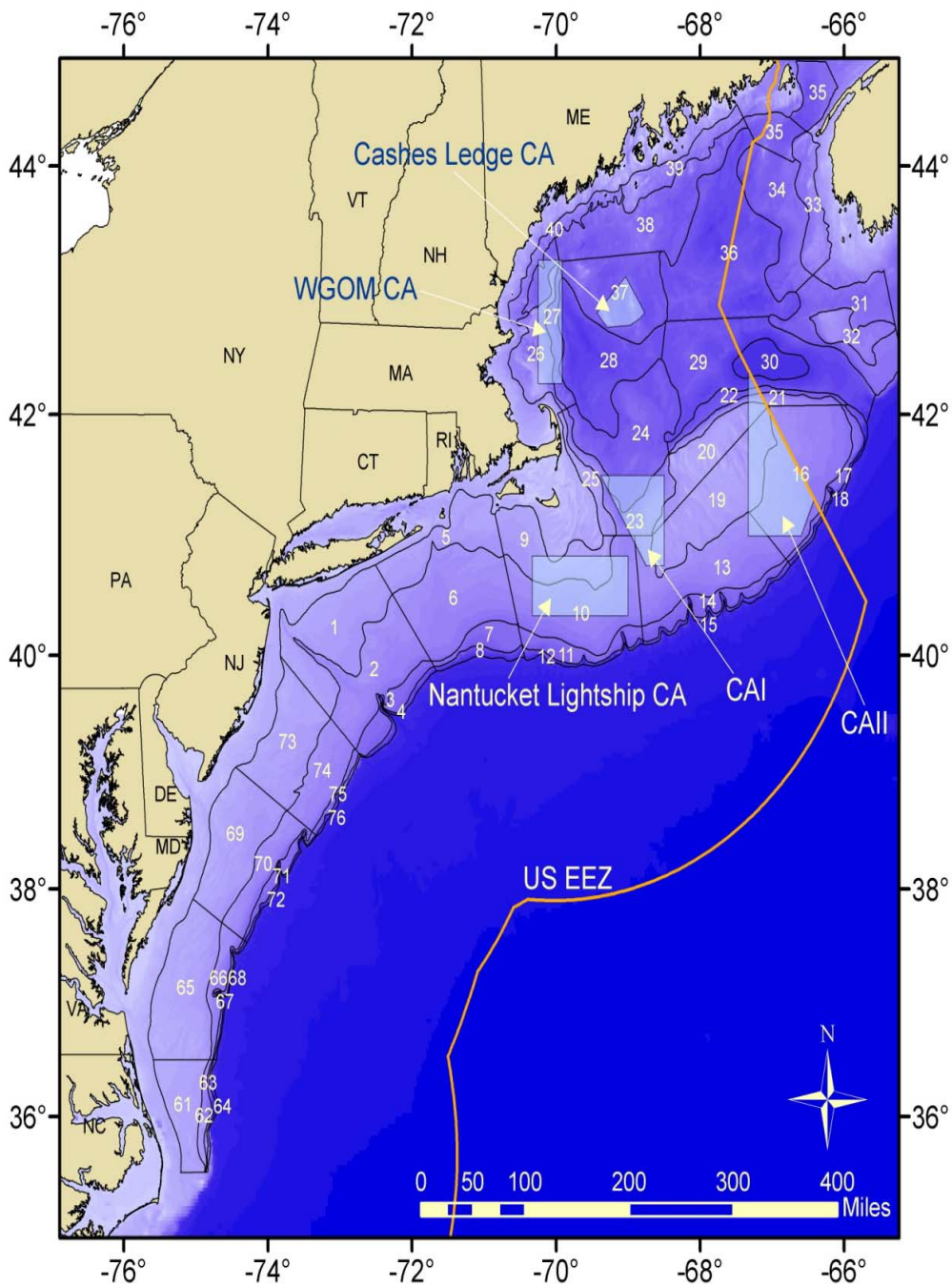


Figure A22. NEFSC bottom trawl survey strata for the northern (offshore strata 20-30 and 36-40) and southern (offshore strata 1-19 and 61-76) silver hake in the northwest Atlantic.

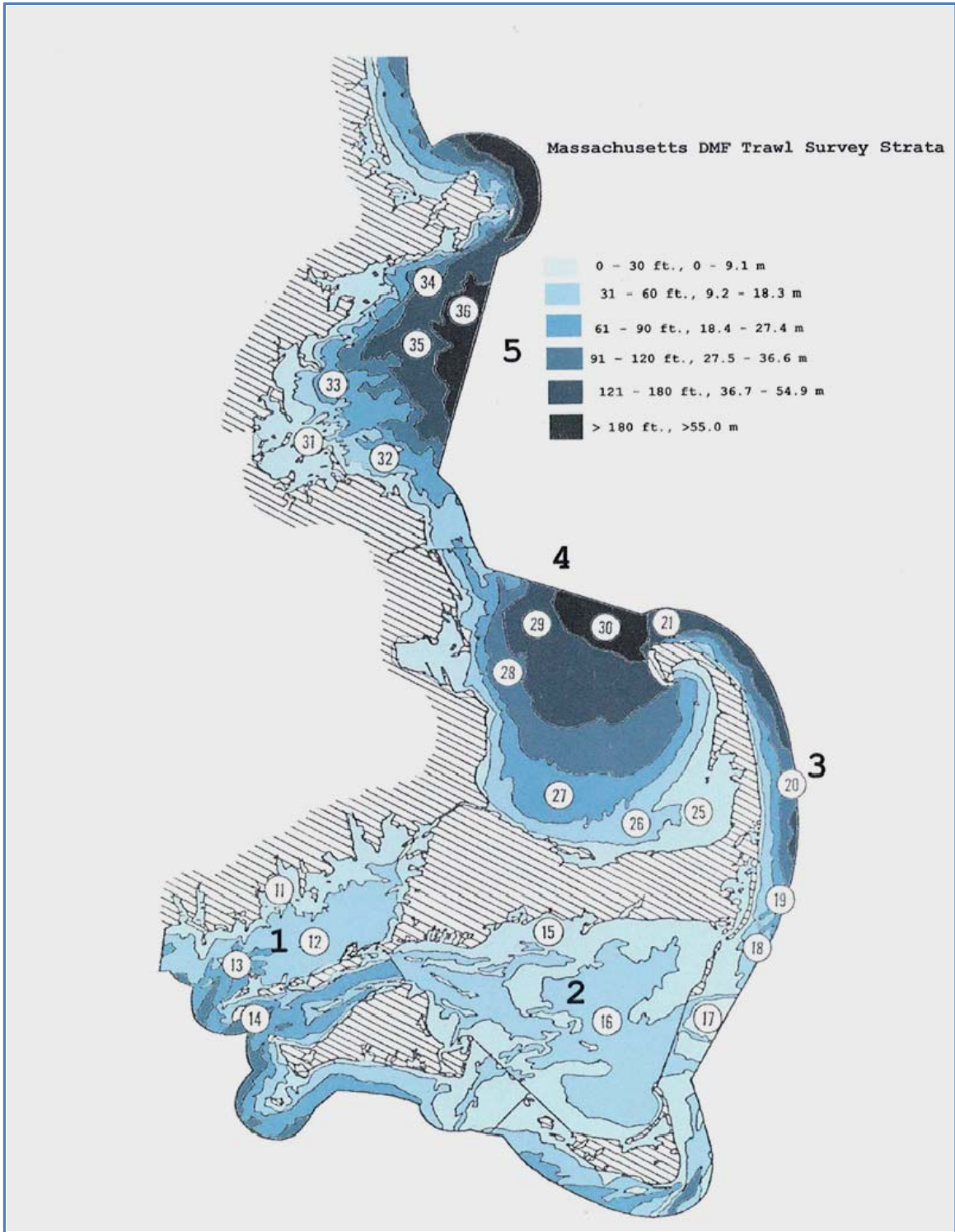
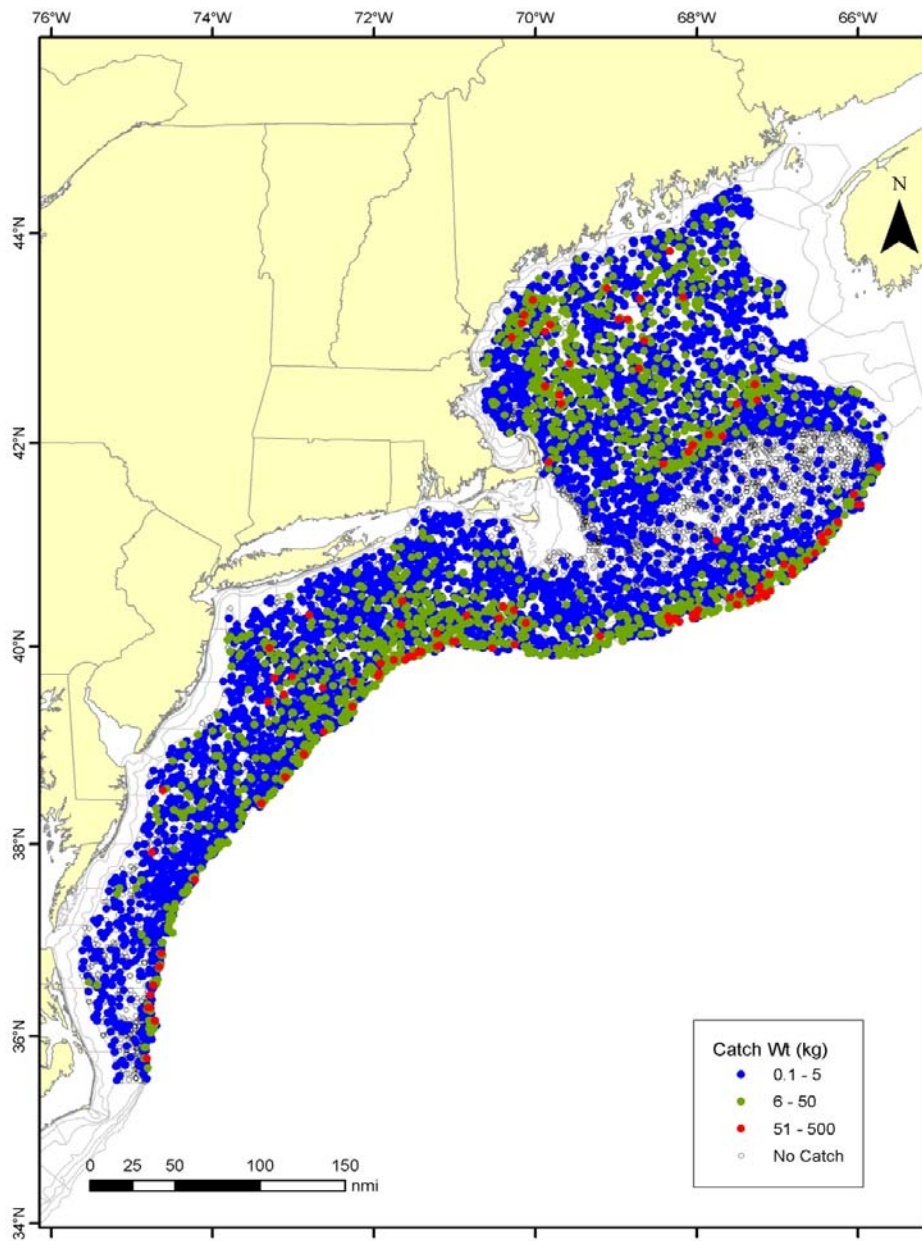


Figure A23. Massachusetts Division of Marine Fisheries (MADMF) survey strata.

Silver Hake Distribution NEFSC Spring BTS 1968-2009



A24. Spring survey distribution of silver hake from the NEFSC bottom trawl surveys, 1968-2009.

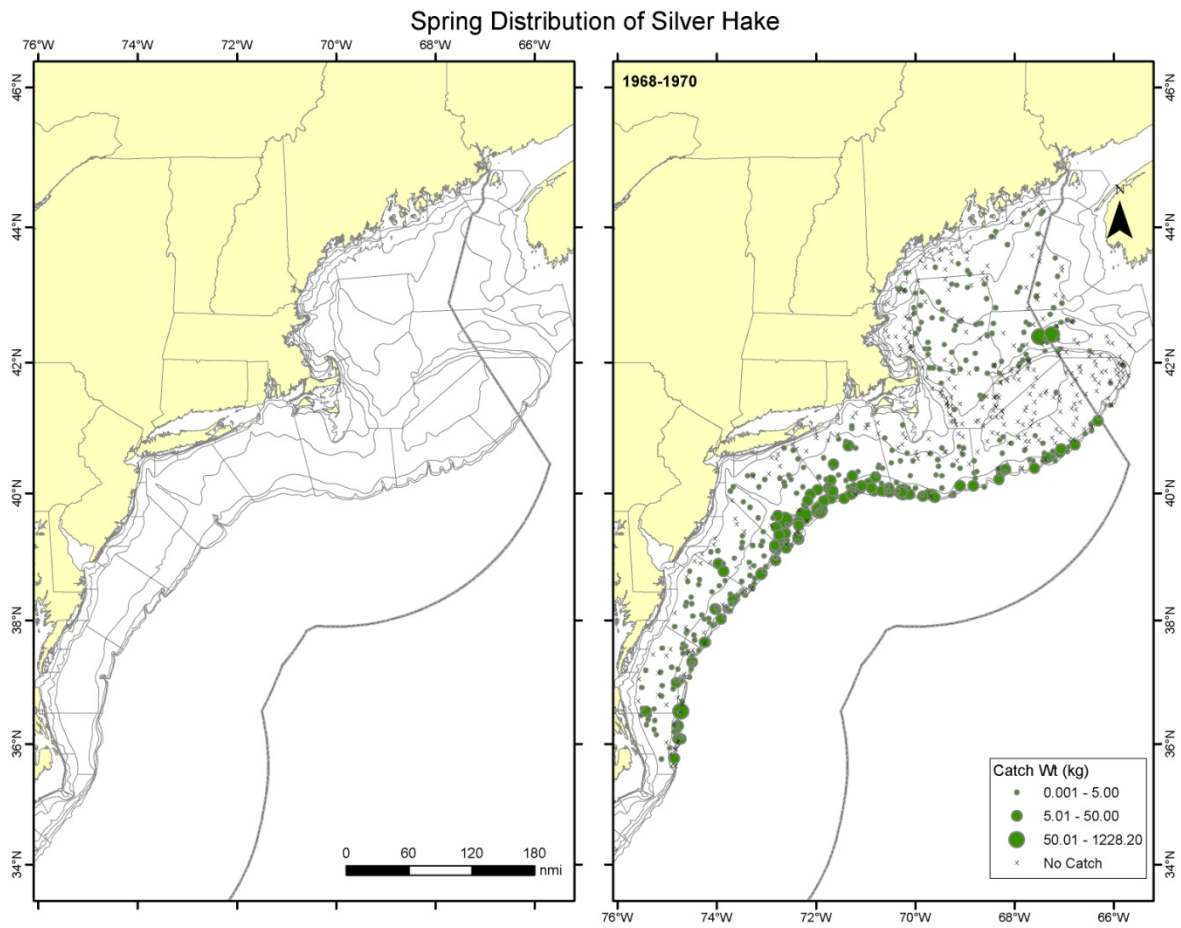


Figure A25. NEFSC distribution maps for silver hake during the spring bottom trawl surveys, 1968-1970.

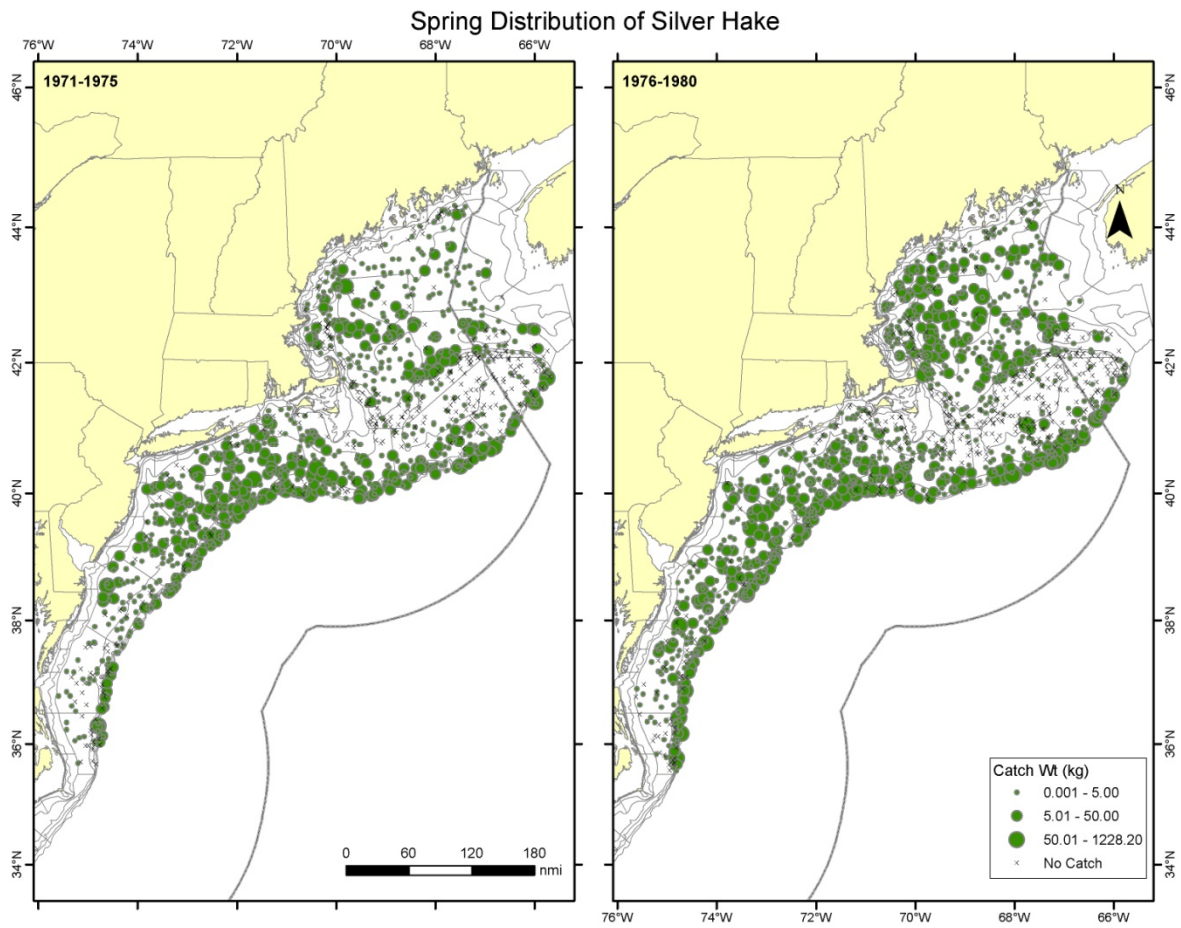


Figure A26. NEFSC distribution maps for silver hake during the spring bottom trawl surveys, 1971-1980.

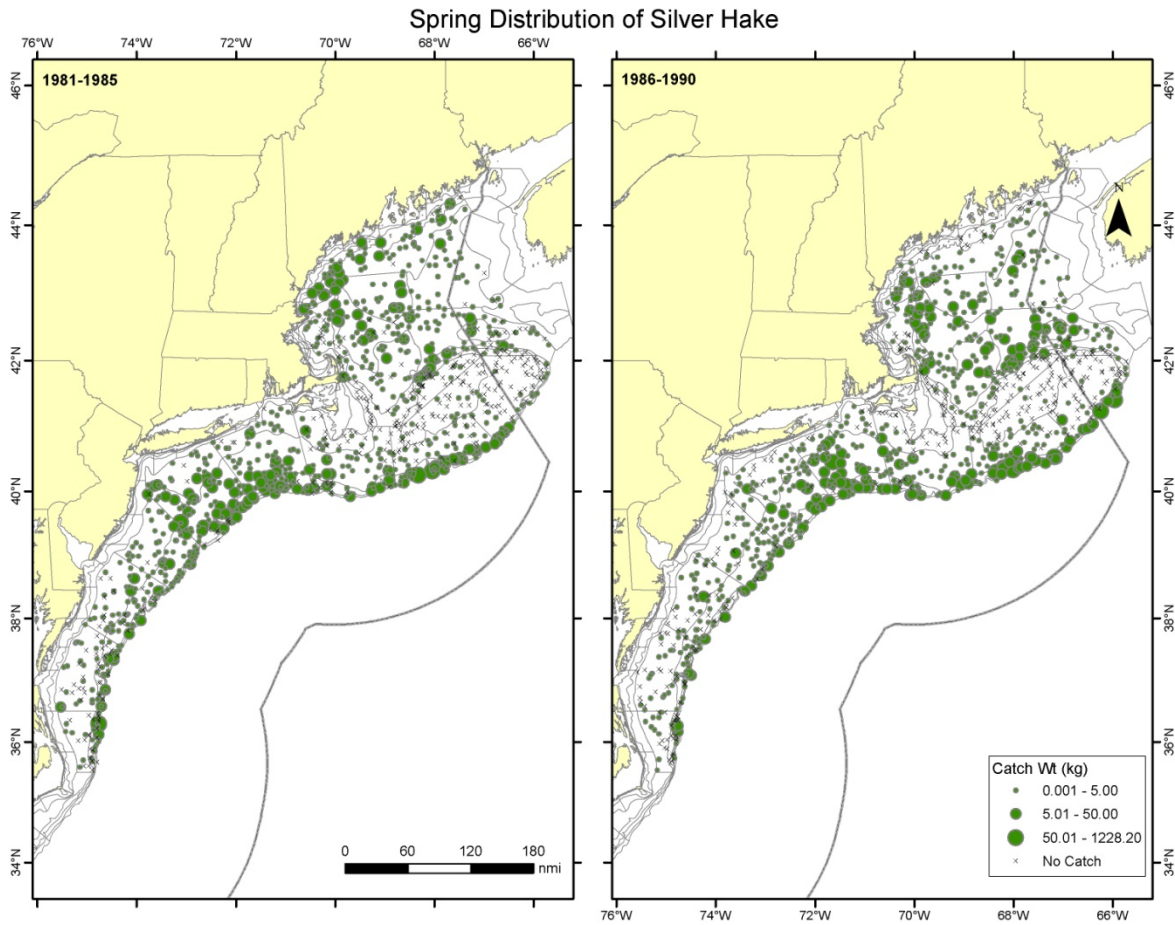


Figure A27. NEFSC distribution maps for silver hake during the spring bottom trawl surveys, 1981-1990.

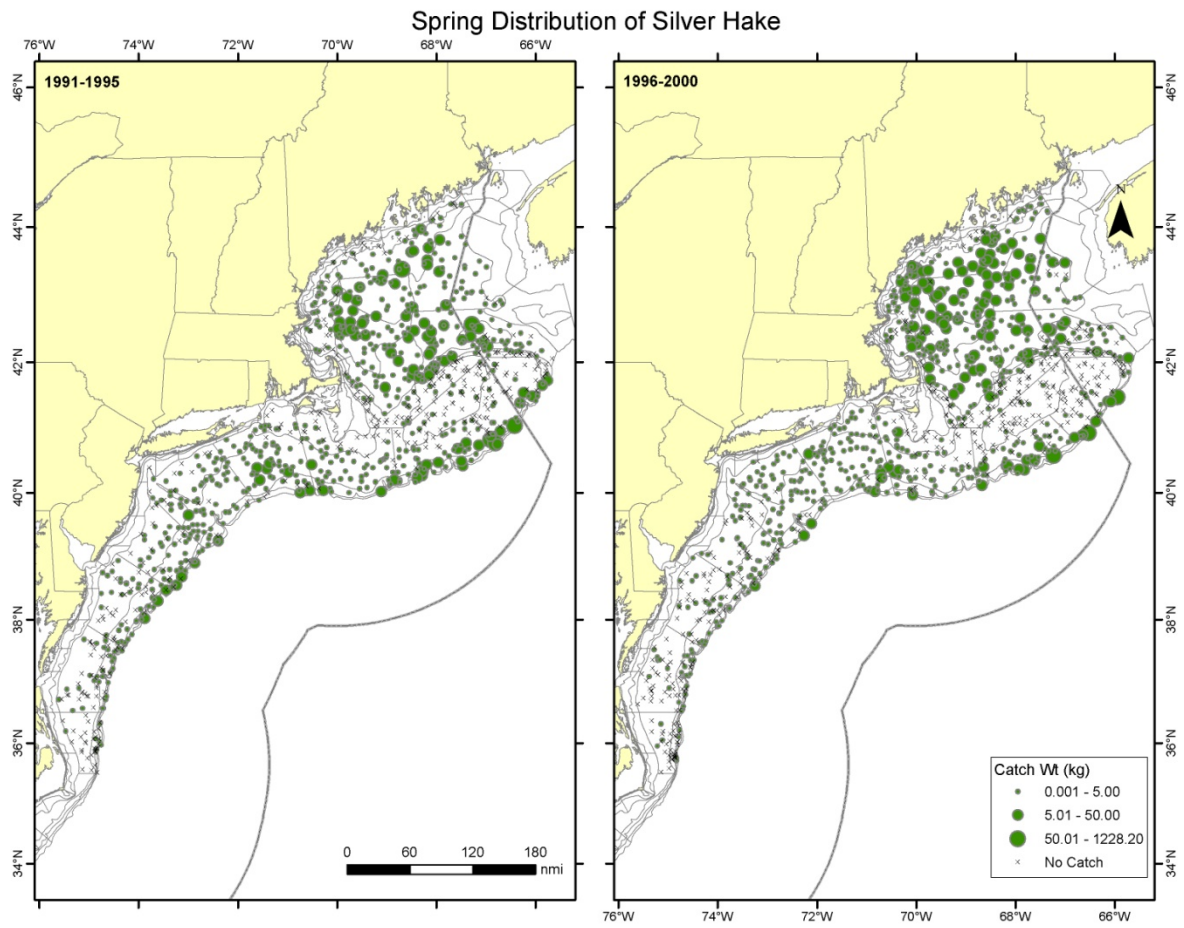


Figure A28. NEFSC distribution maps for silver hake during the spring bottom trawl surveys, 1991-2000.

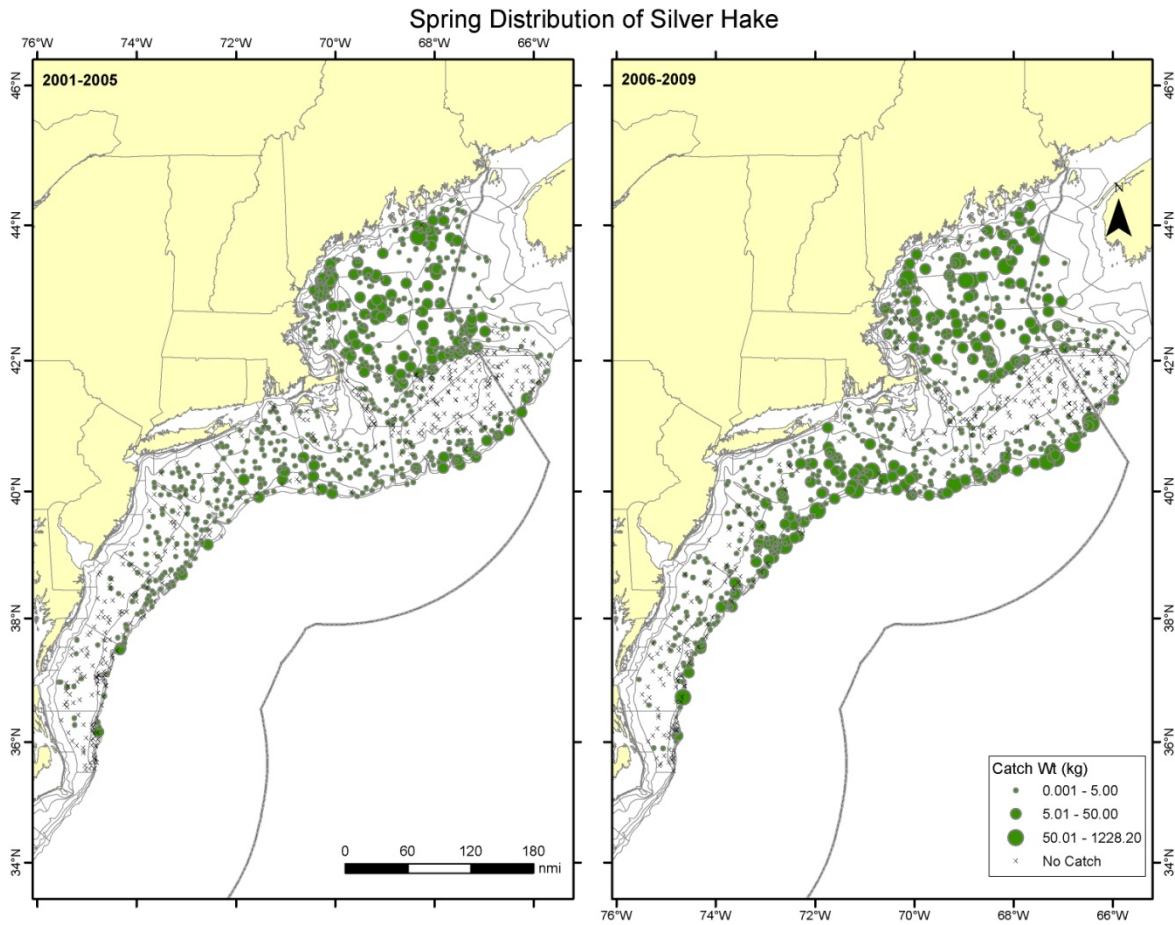


Figure A29. NEFSC distribution maps for silver hake during the spring bottom trawl surveys, 2001-2009.

Silver Hake Distribution NEFSC Fall BTS 1963-2009

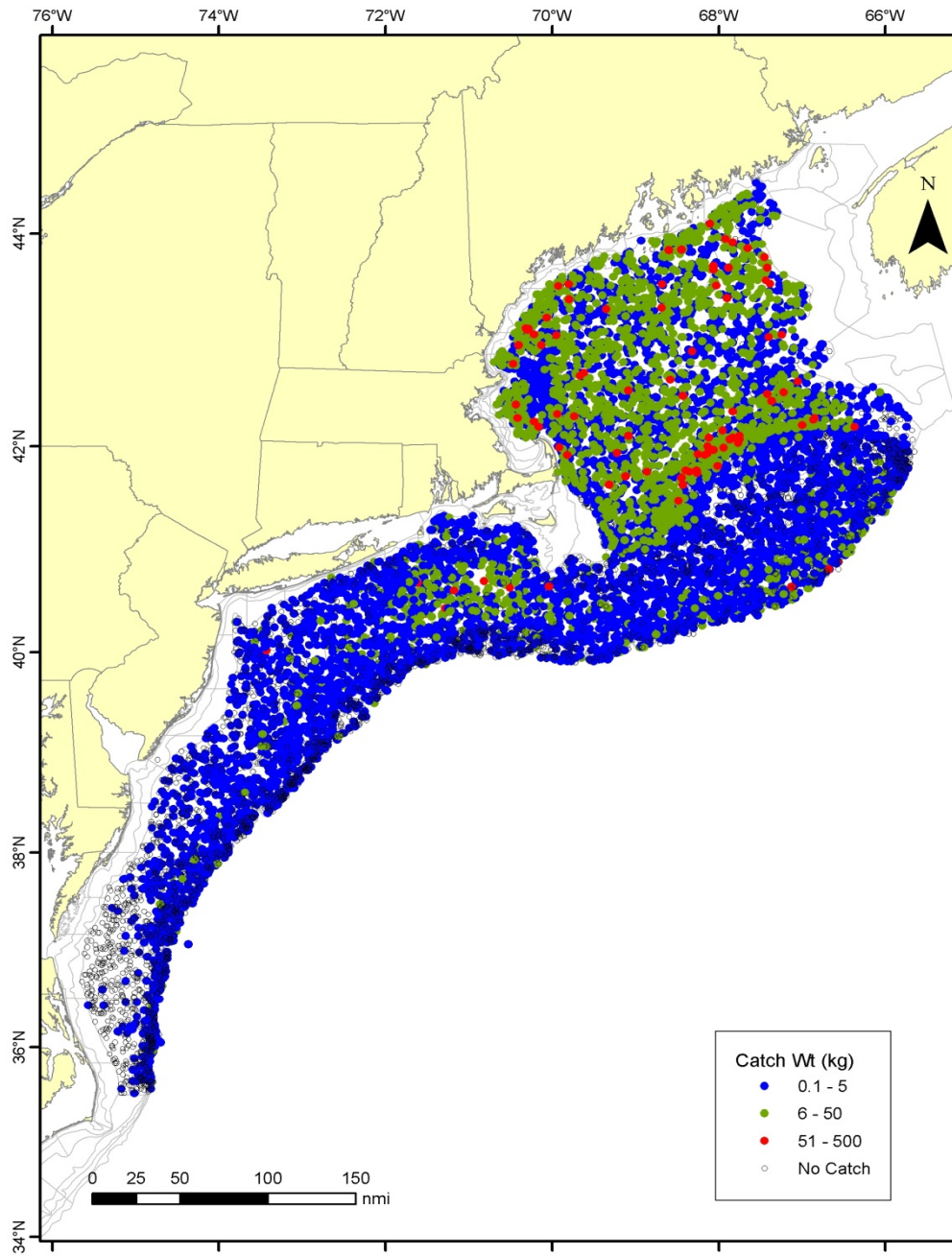


Figure A30. Fall survey distribution of silver hake from the NEFSC bottom trawl surveys, 1963-2009.

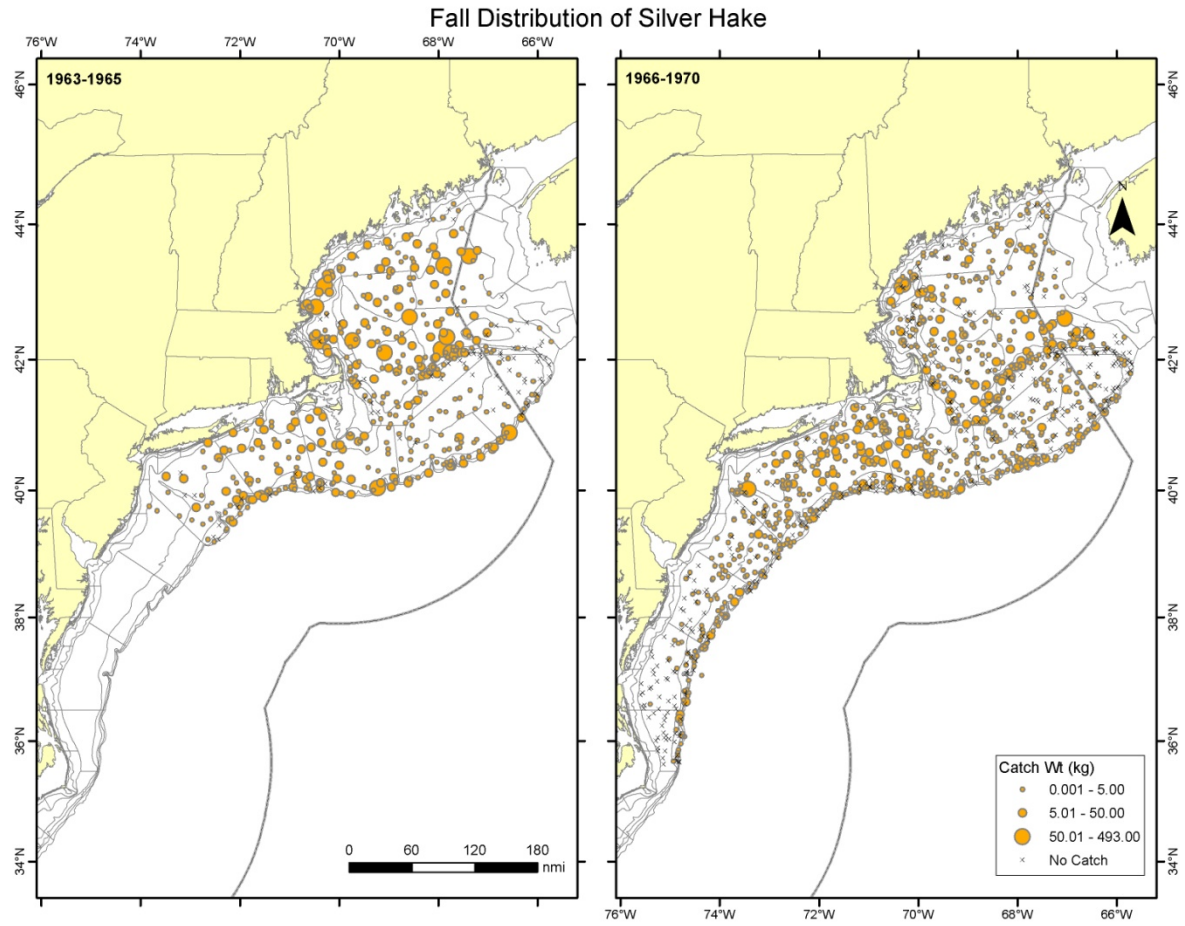


Figure A31. NEFSC distribution maps for silver hake during the fall bottom trawl surveys, 1963-1970.

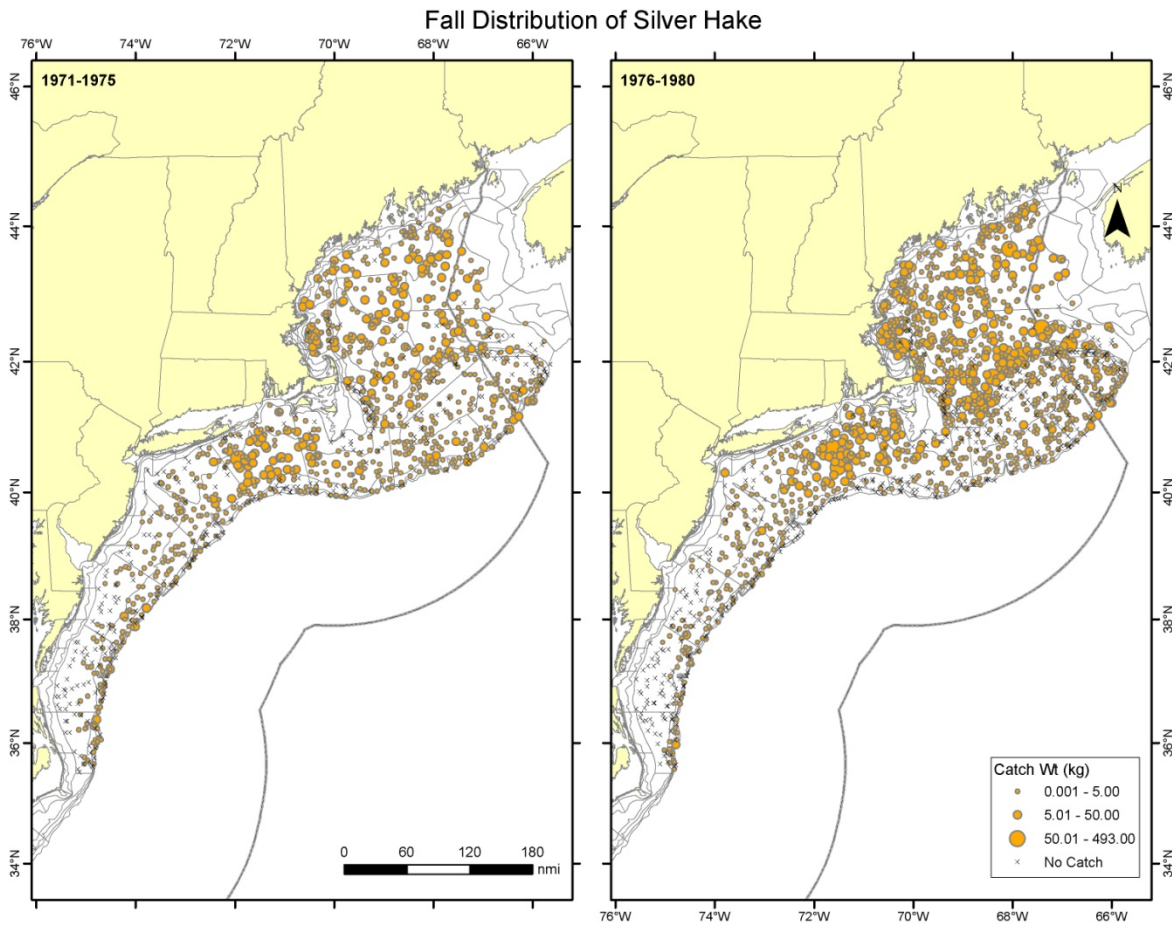


Figure A32. NEFSC distribution maps for silver hake during the fall bottom trawl surveys, 1971-1980.

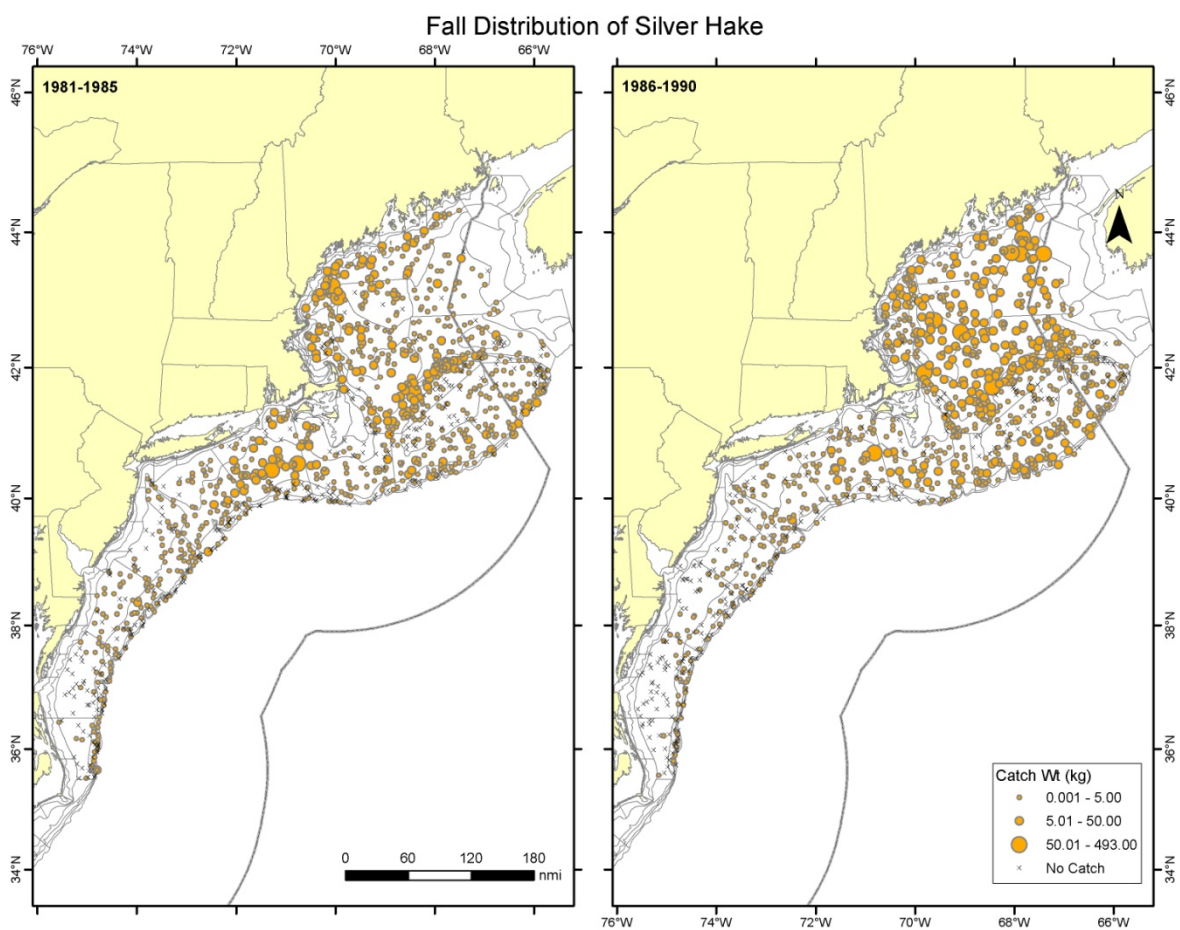


Figure A33. NEFSC distribution maps for silver hake during the fall bottom trawl surveys, 1981-1990.

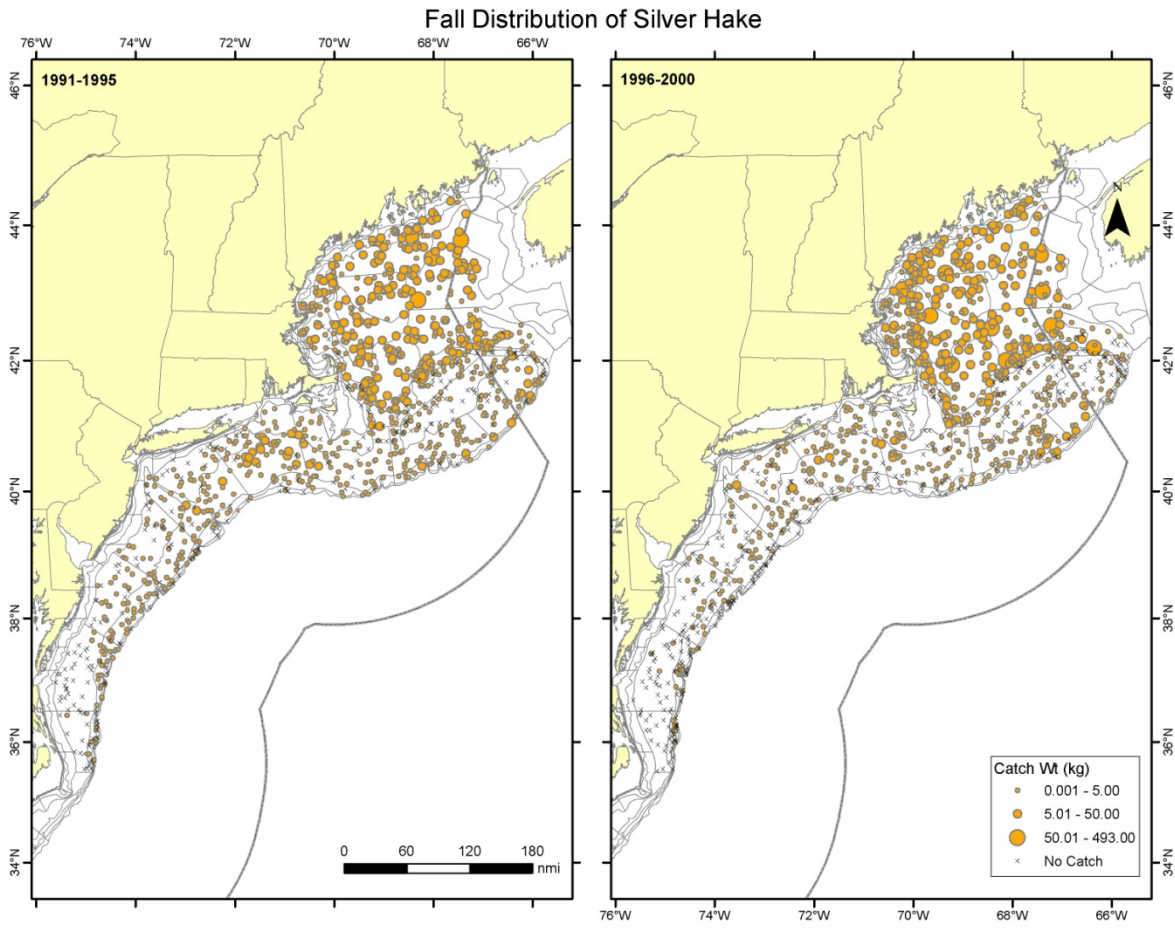


Figure A34. NEFSC distribution maps for silver hake during the fall bottom trawl surveys, 1991-2000.

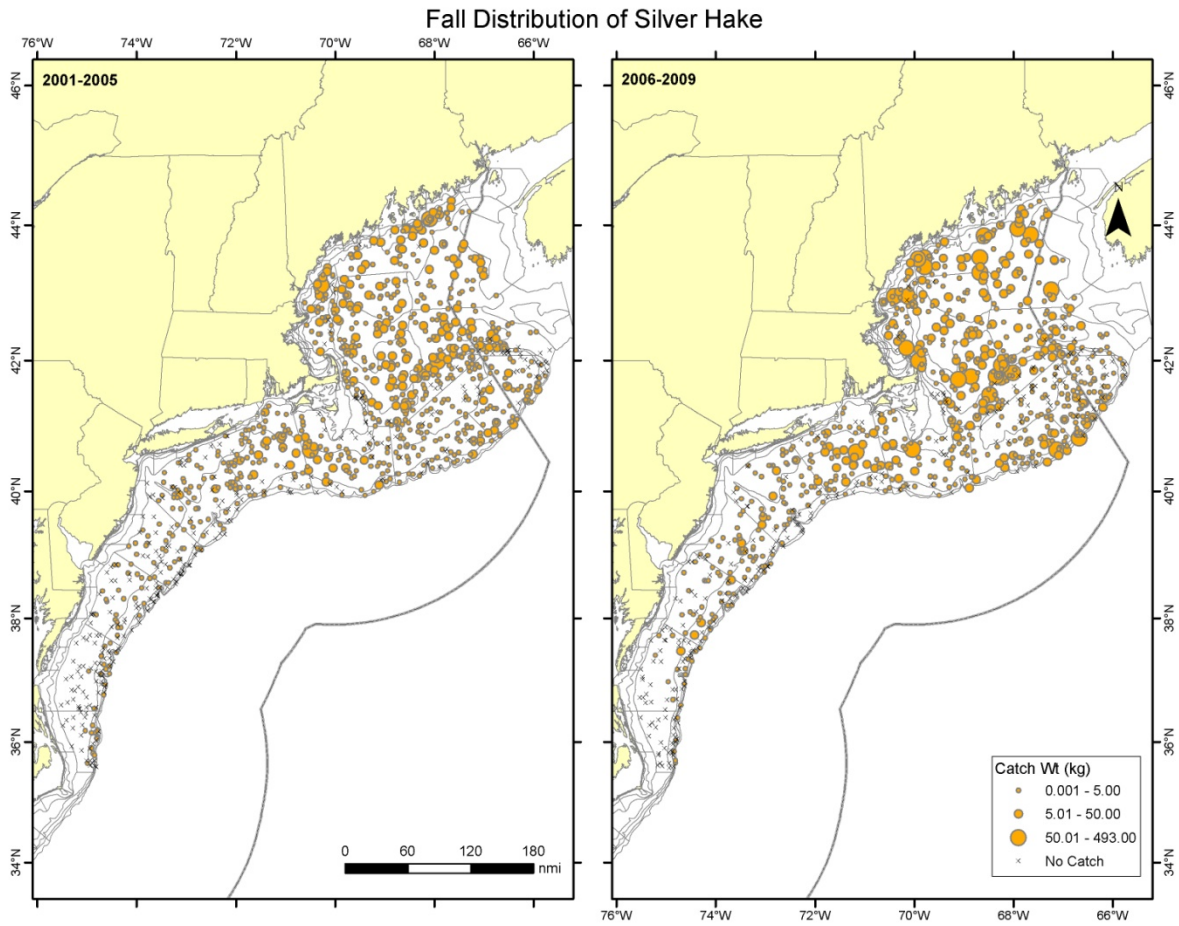


Figure A35. NEFSC distribution maps for silver hake during the fall bottom trawl surveys, 2001-2009.

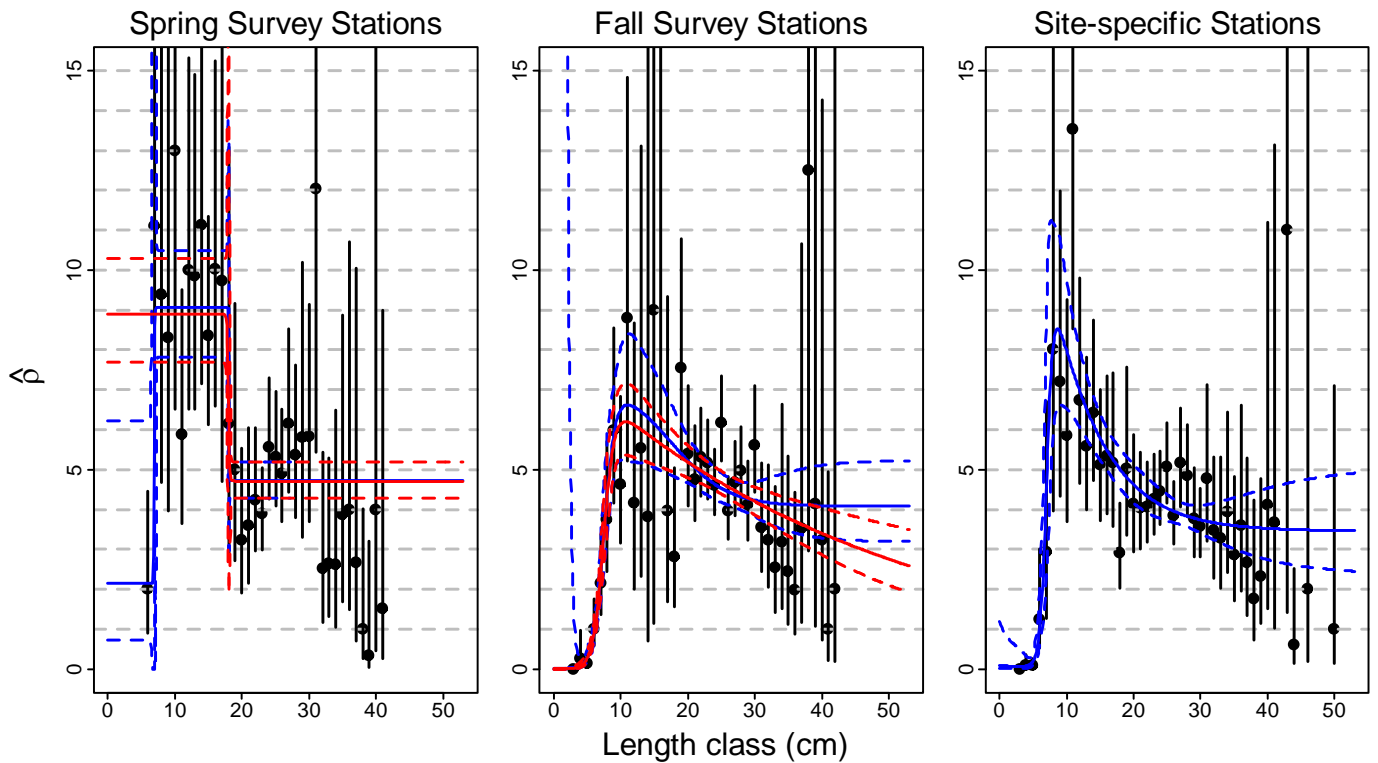


Figure A36: Beta-binomial based estimates of calibration factors and corresponding 95% confidence intervals by length class (1 cm bins) for **silver hake**. The black points and vertical bars represent results where different calibration factors are estimated for each length class. The blue lines represent results from fully parameterized double-logistic models. For the spring, the red lines represent results for a (single) logistic model whereas they represent results for a double logistic model with no minima for the ascending or descending logistic function for the fall.

NORTH FALL

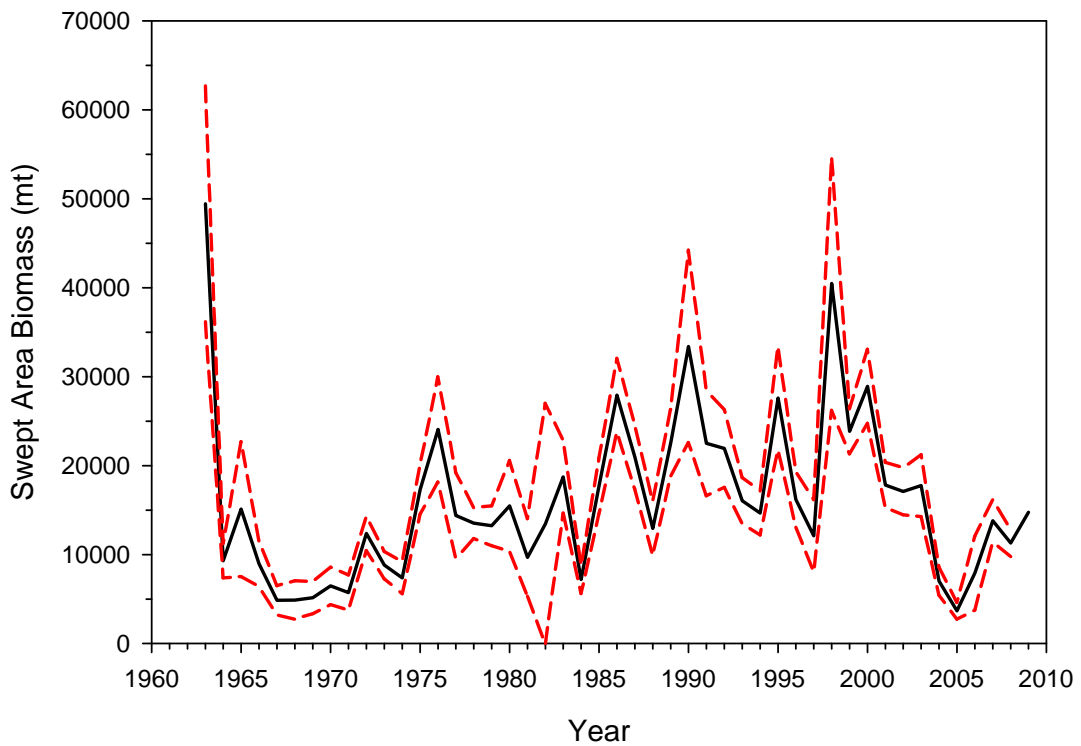
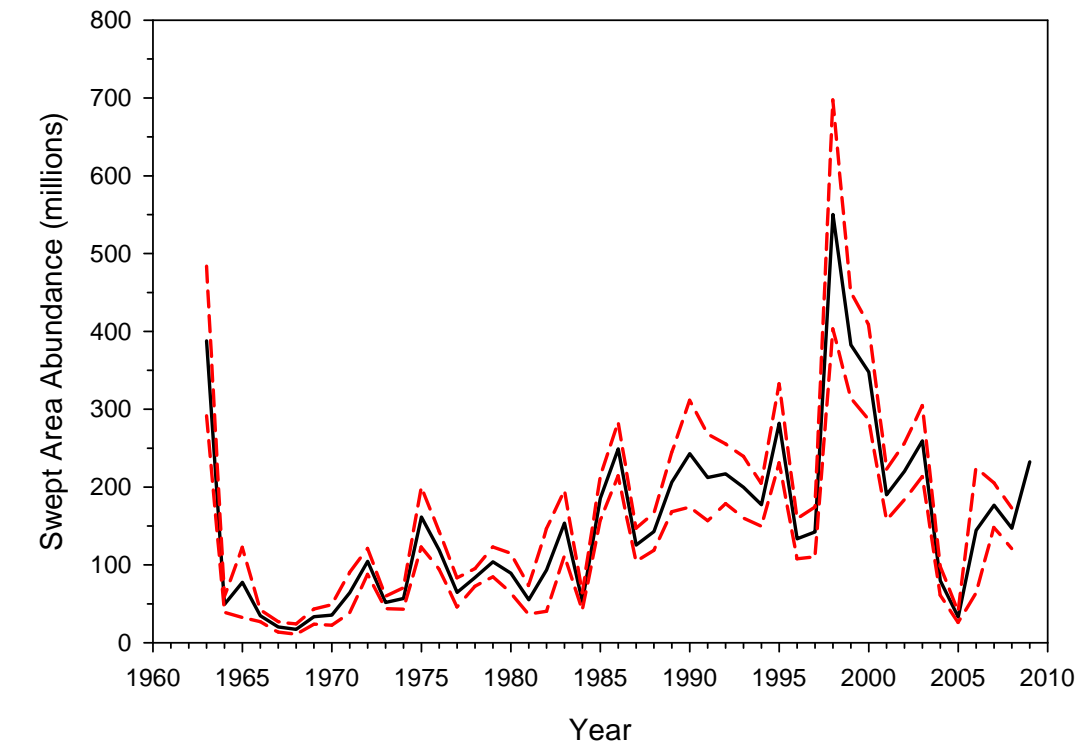


Figure A37. Trends in fall Survey abundances (top) and biomass (bottom) estimates for Silver hake in the northern stock expressed as minimum swept area estimates. Solid lines represent point estimates while the dash lines are the confidence intervals.

NORTH SPRING

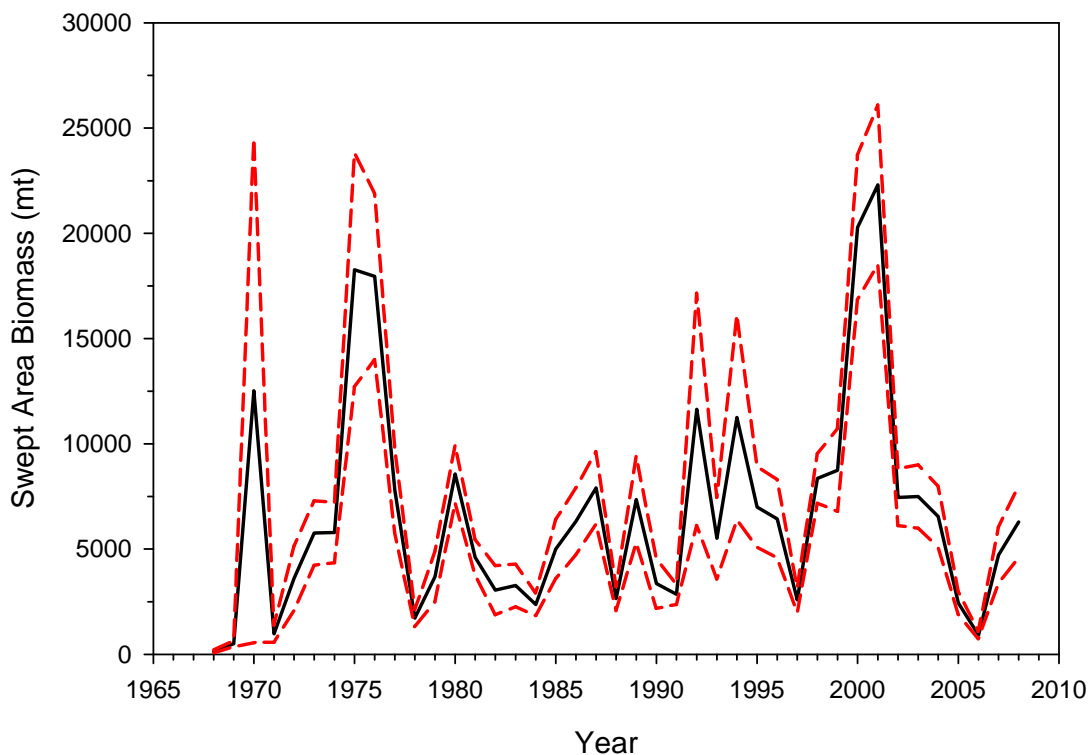
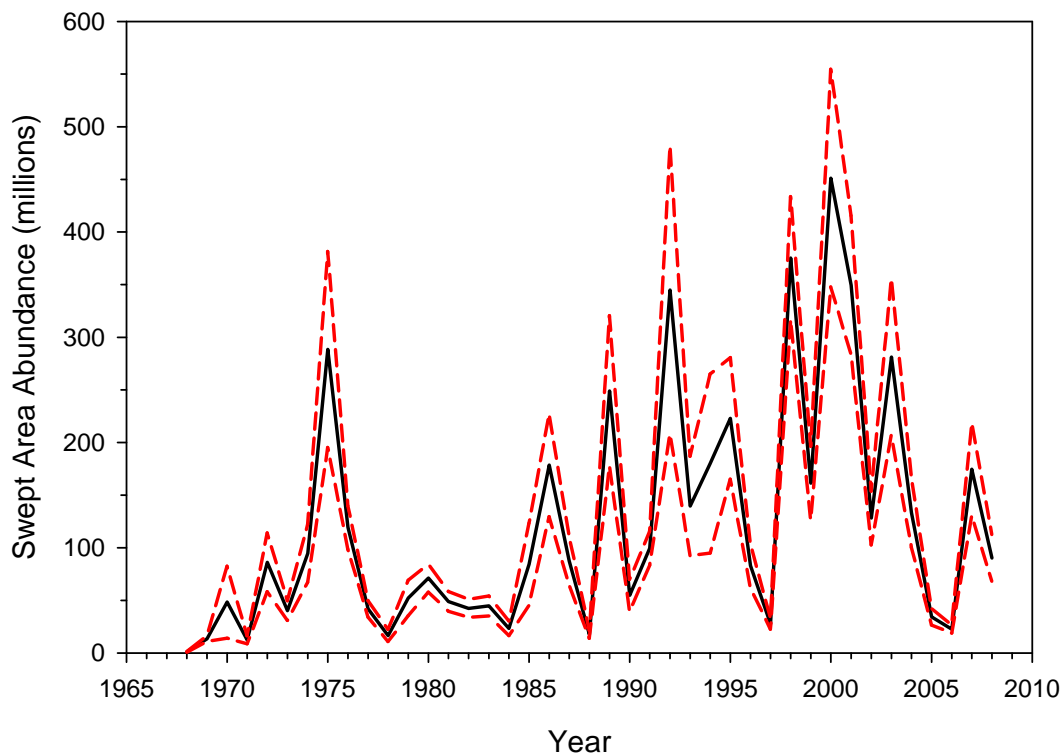


Figure A38. Swept area abundance (top) and biomass (bottom) with confidence intervals for the NEFSC spring survey in the northern management region.

SHRIMP NORTH FALL

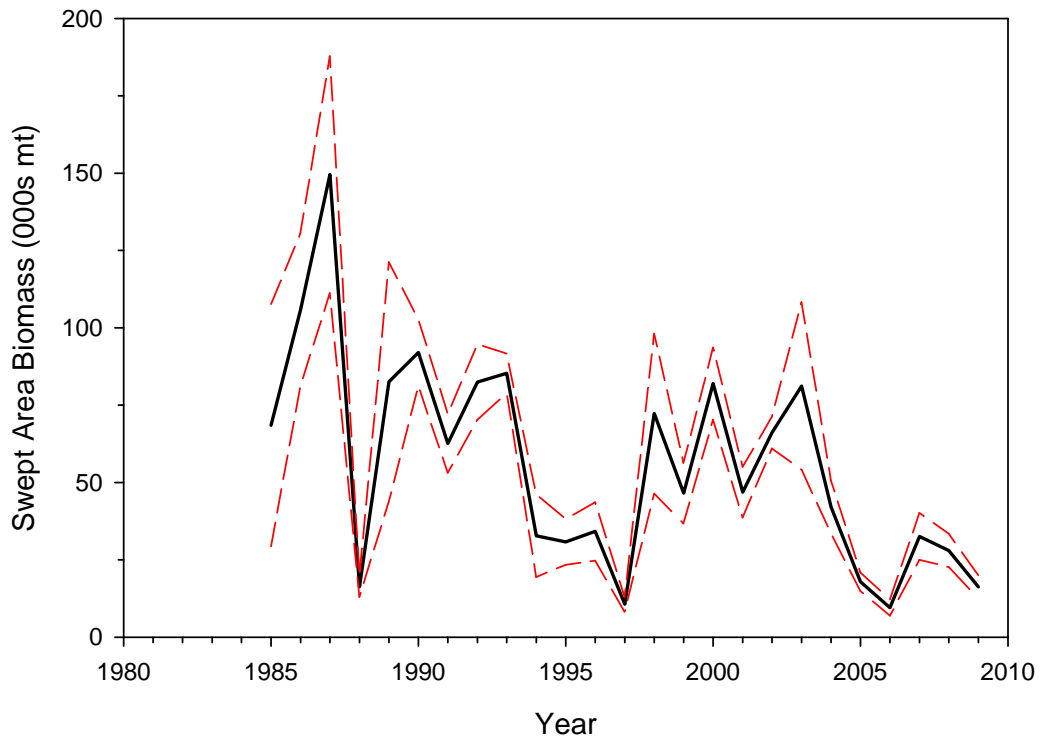
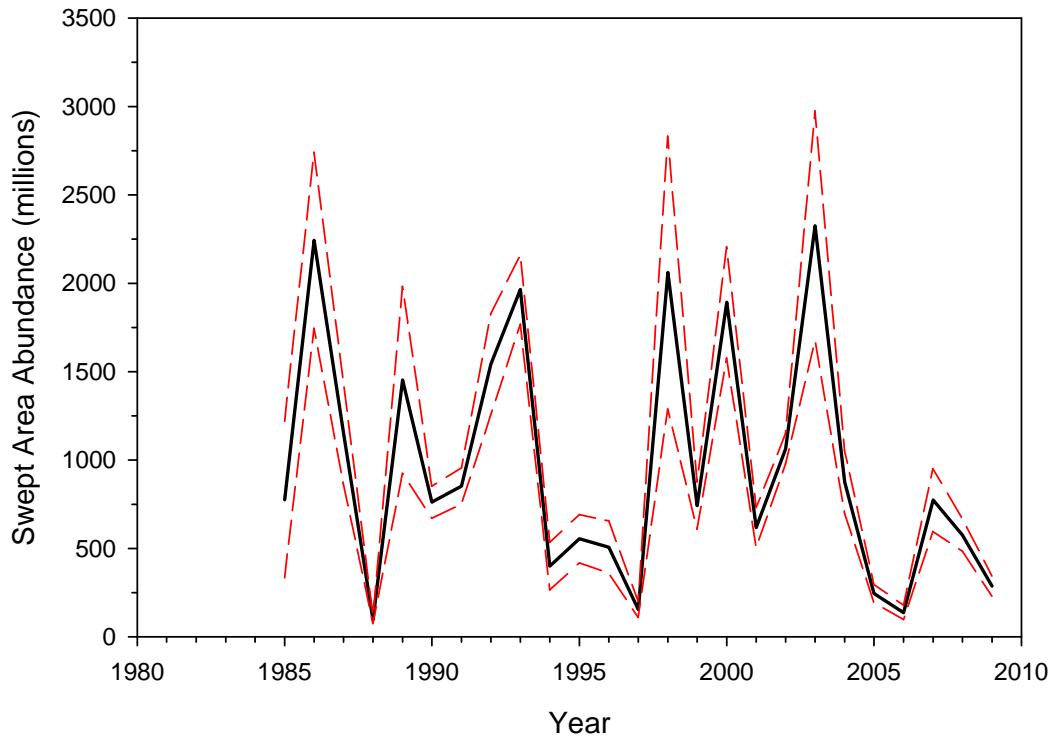


Figure A39. Swept area abundance (top) and biomass (bottom) with confidence intervals for the NEFSC shrimp survey.

MADMF NORTH SPRING

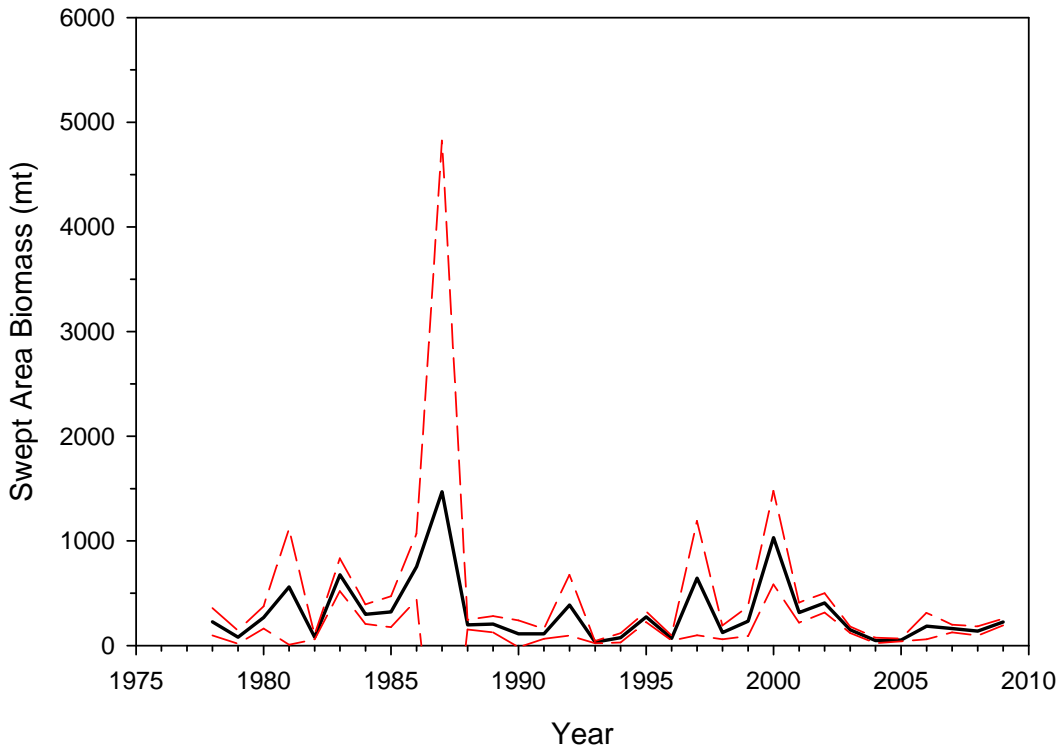
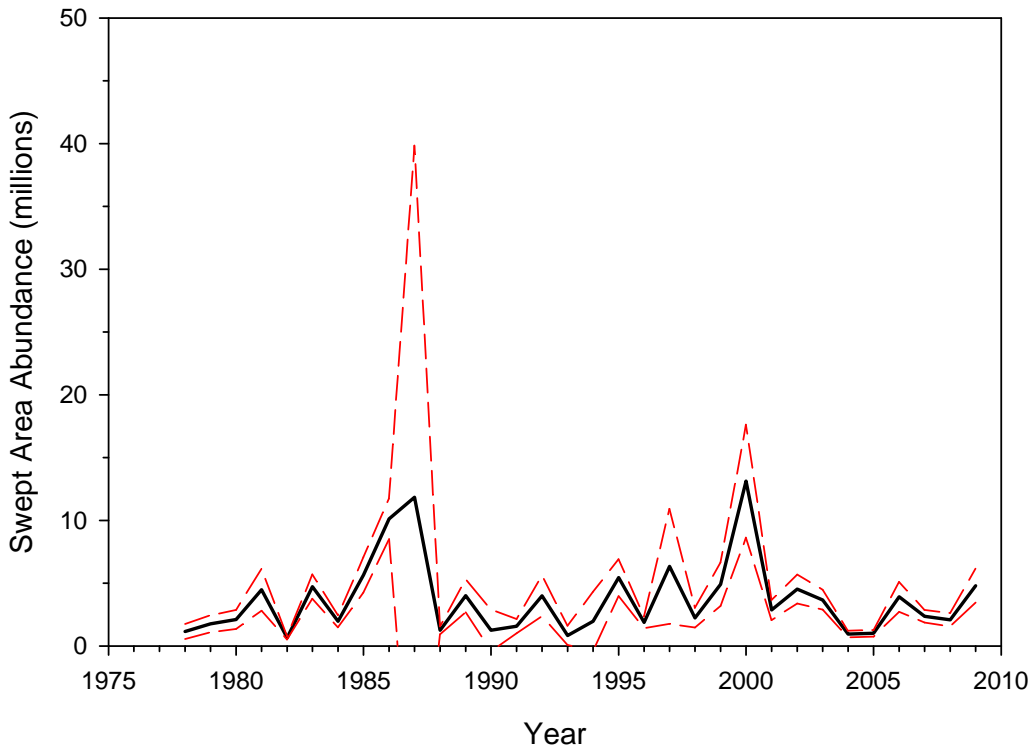
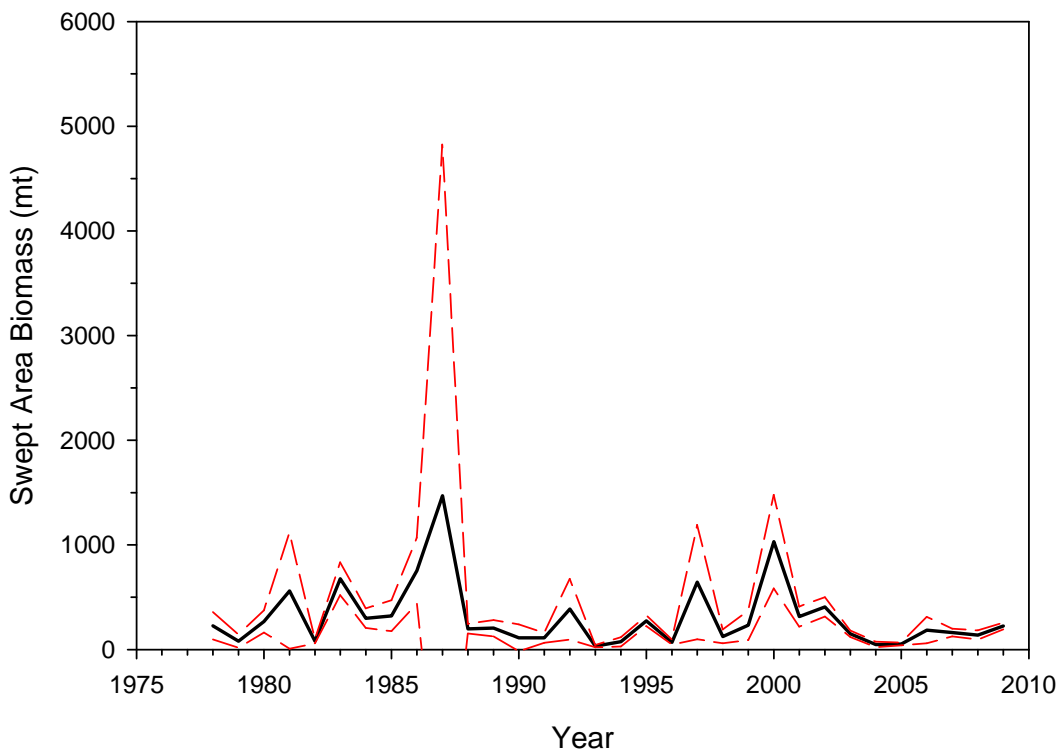
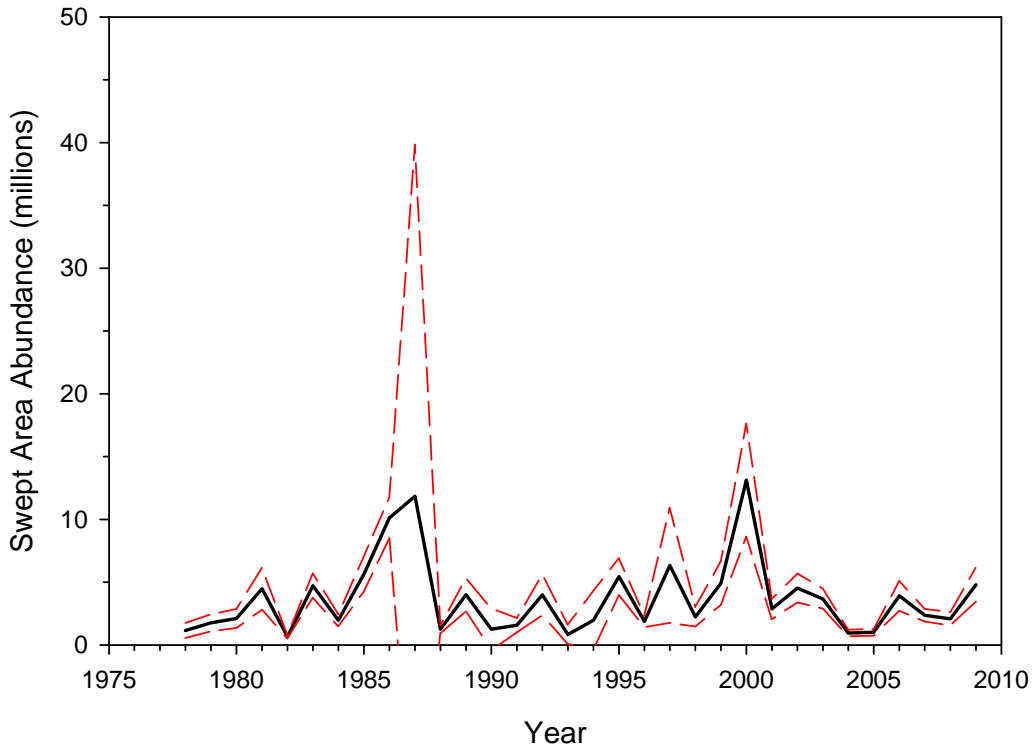
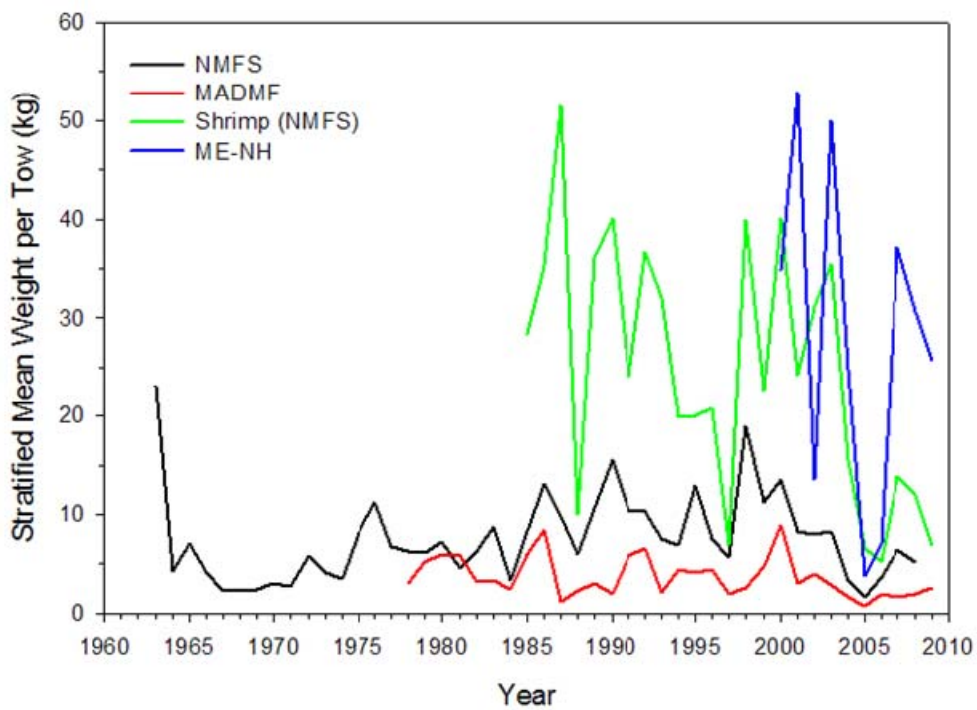
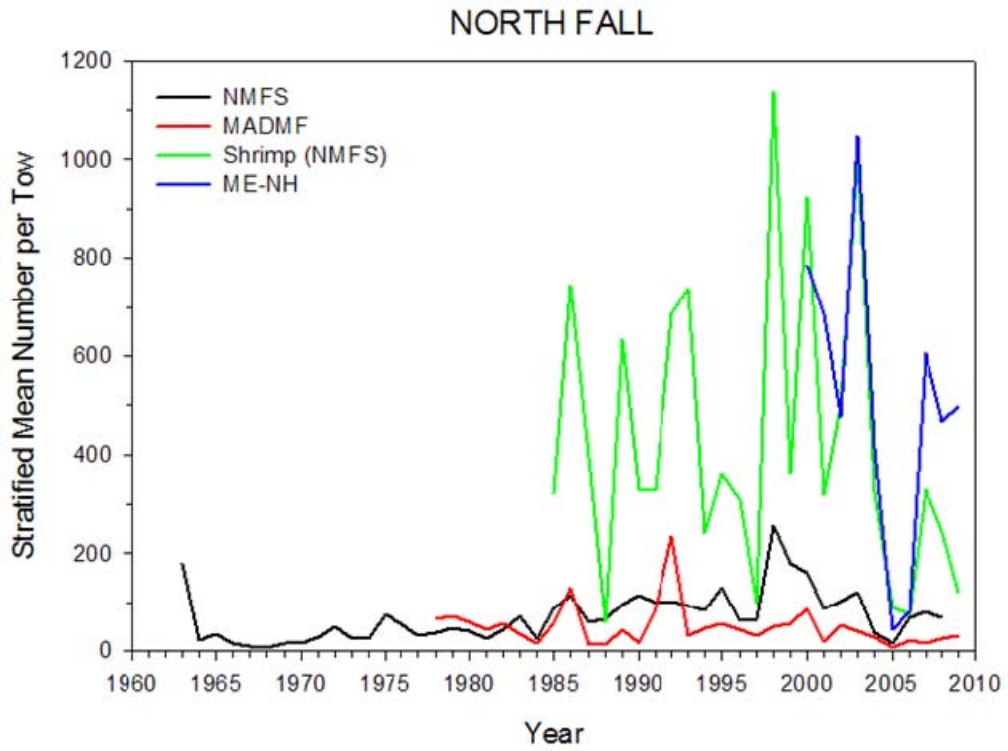


Figure A40. Swept area abundance (top) and biomass (bottom) with confidence intervals for silver hake from the Massachusetts Division of Marine Fisheries fall north survey (strata 18-36).

MADMF NORTH SPRING



A41. Swept area abundance (top) and biomass (bottom) with confidence intervals for silver hake from the Massachusetts Division of Marine Fisheries spring north survey (strata 18-36).



Figure

A42. Survey abundances (millions of fish) and biomass (mt) for silver hake from the fall NEFSC, MADMF, and shrimp surveys.

NORTH SPRING

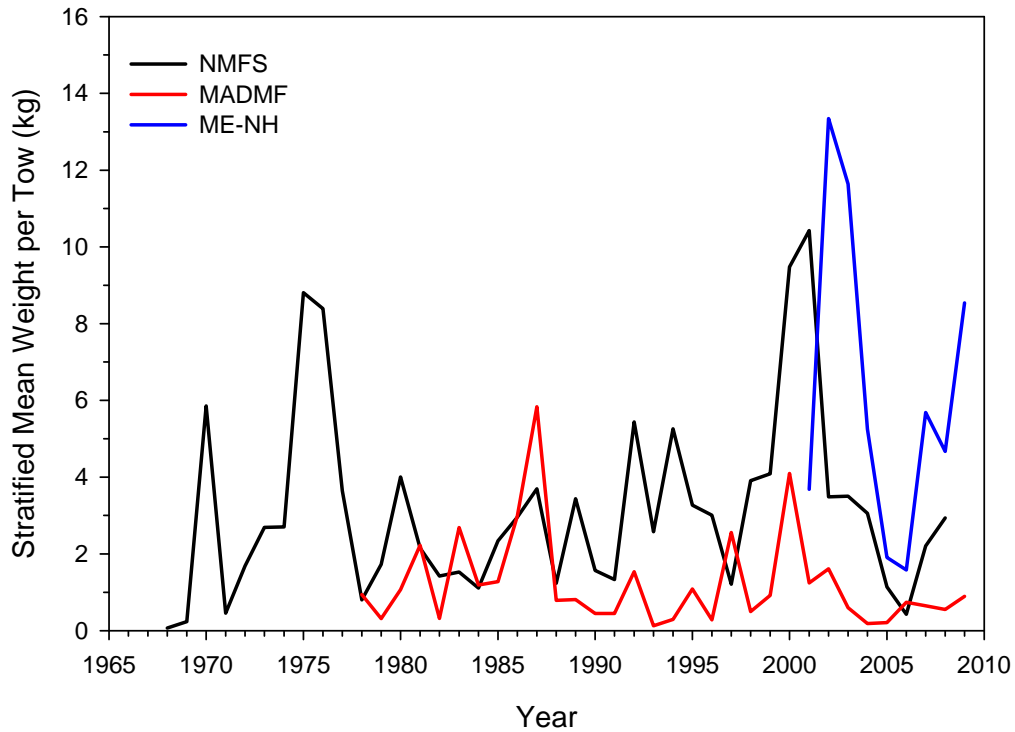
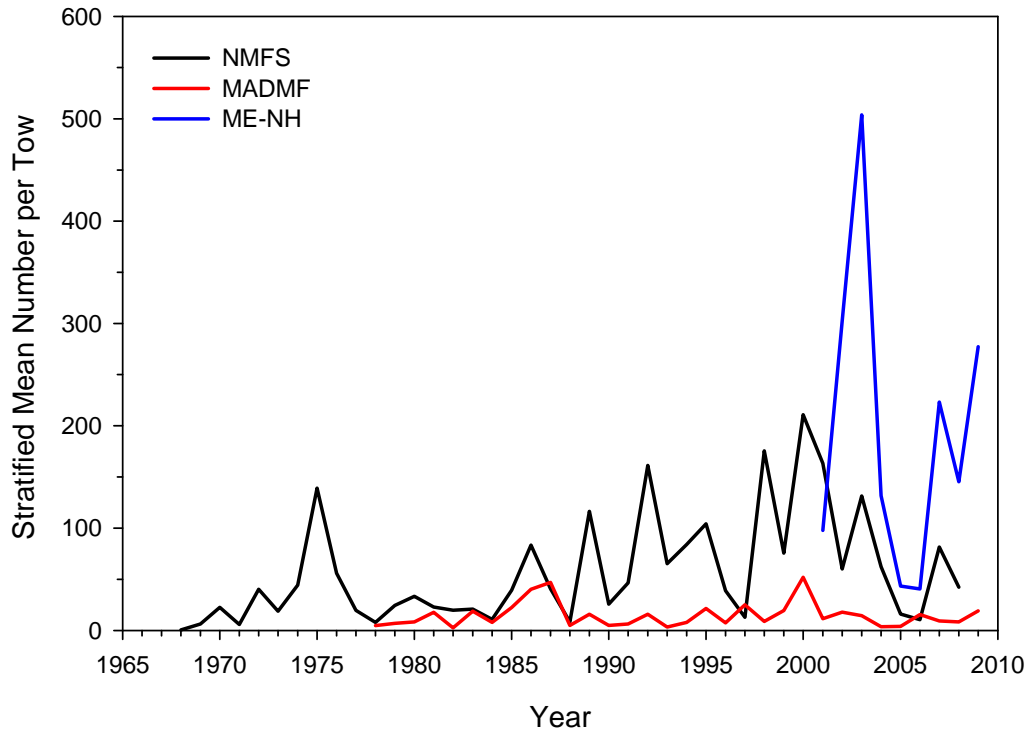


Figure A43. Survey abundances (millions of fish) and biomass (mt) for silver hake from the spring NEFSC, MADMF, and Maine-New Hampshire state surveys.

Northern Fall Survey Abundances at Age

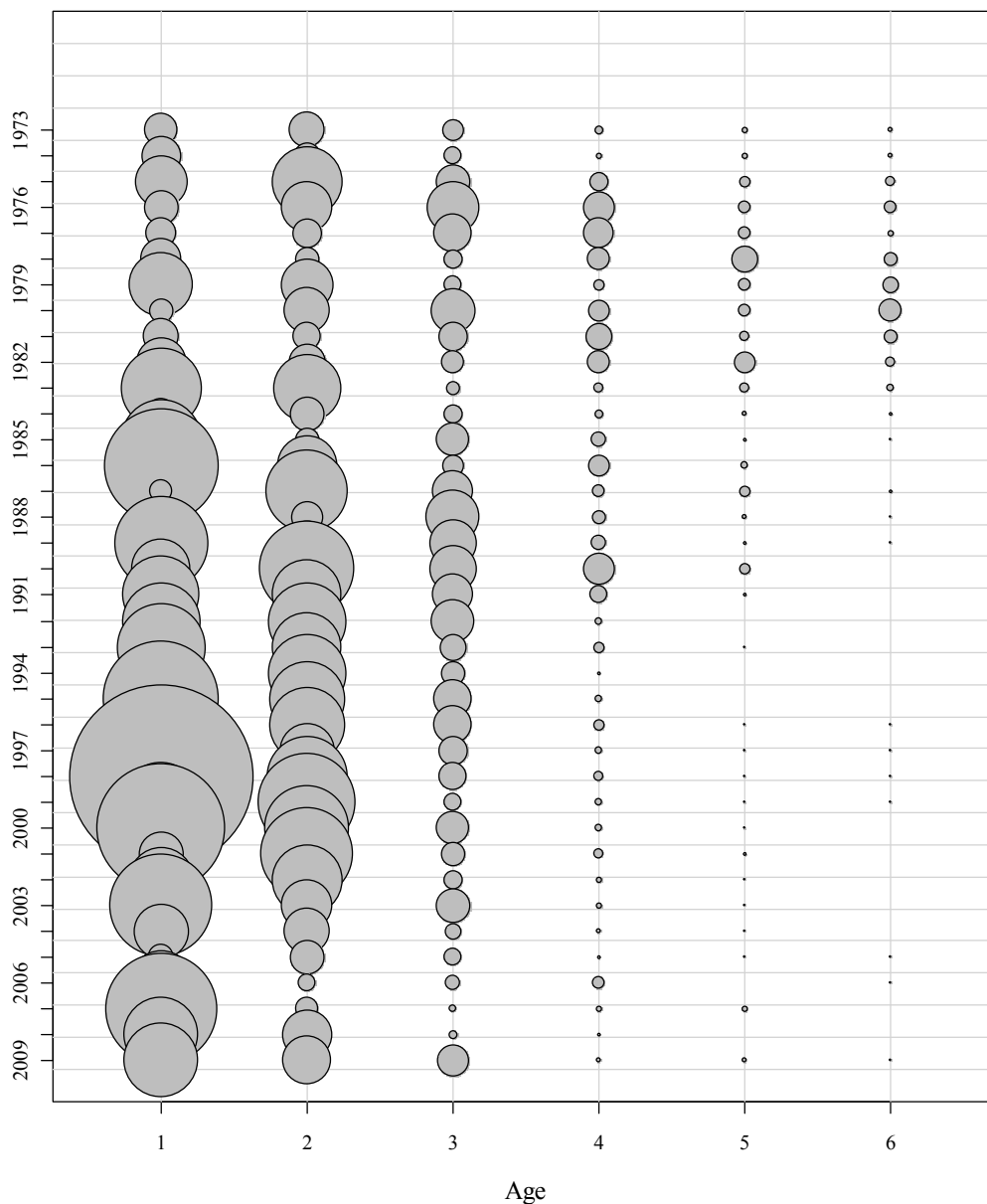


Figure A44. Silver hake age specific indices of abundance for the fall survey in the northern stock area. The area of the bubble plot is proportional to the magnitude.

Northern Spring Survey Abundances at Age

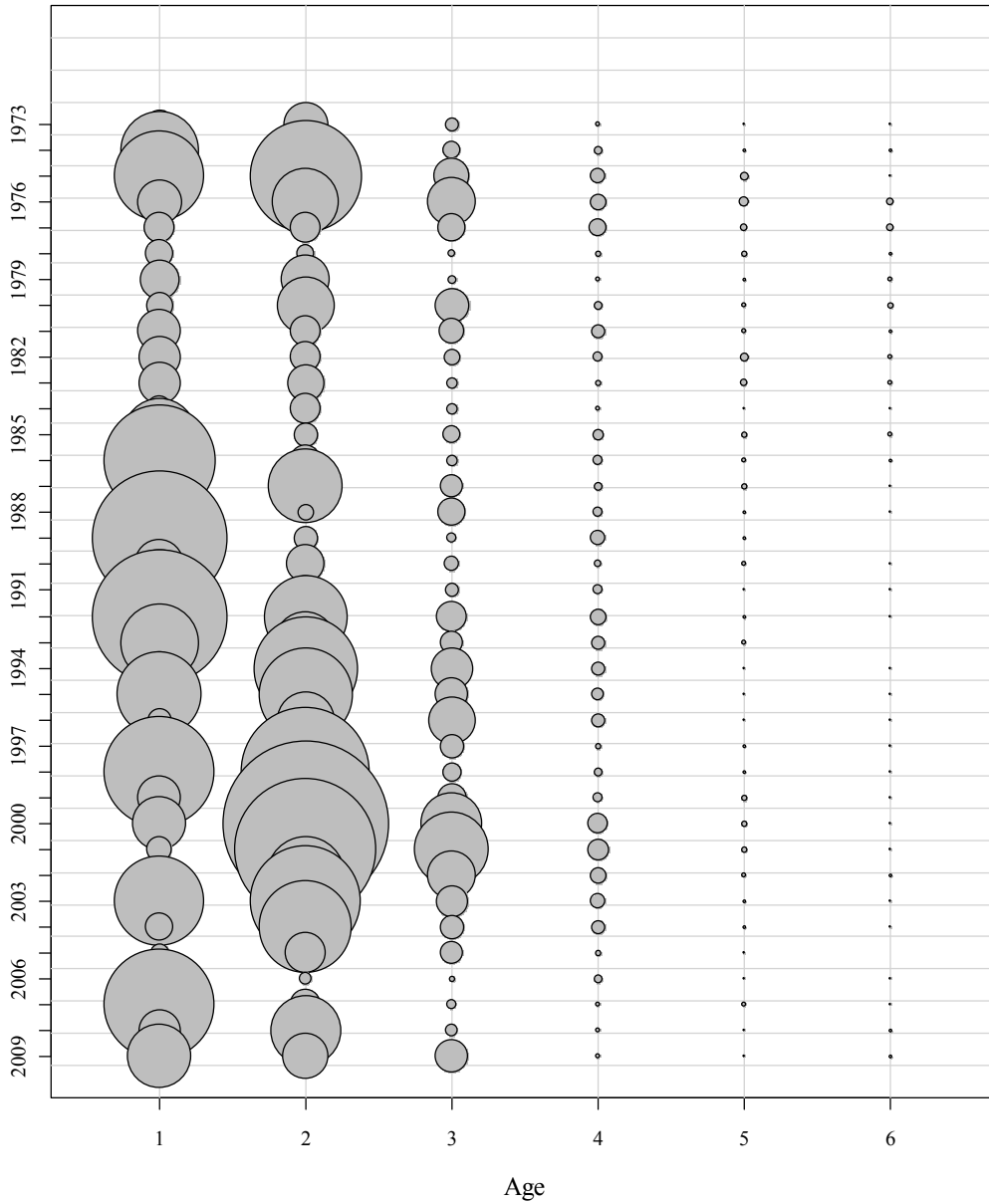


Figure A45. Silver hake age specific indices of abundance for the spring survey in the northern stock area. The area of the bubble plot is proportional to the magnitude.

SOUTH FALL

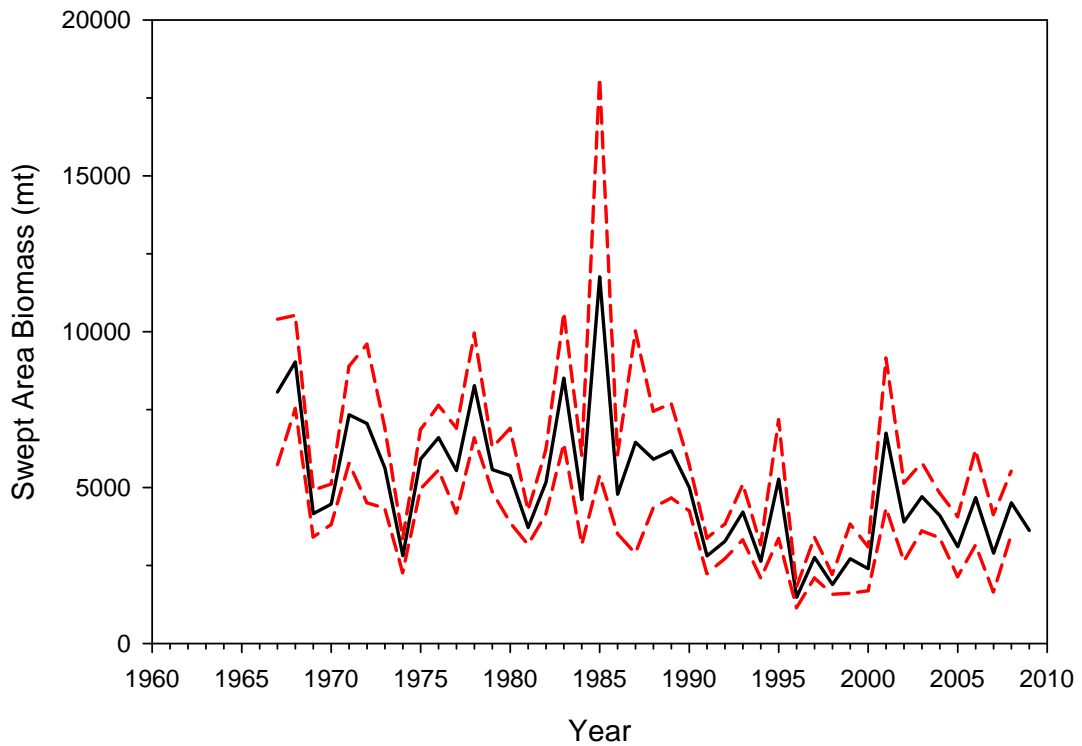
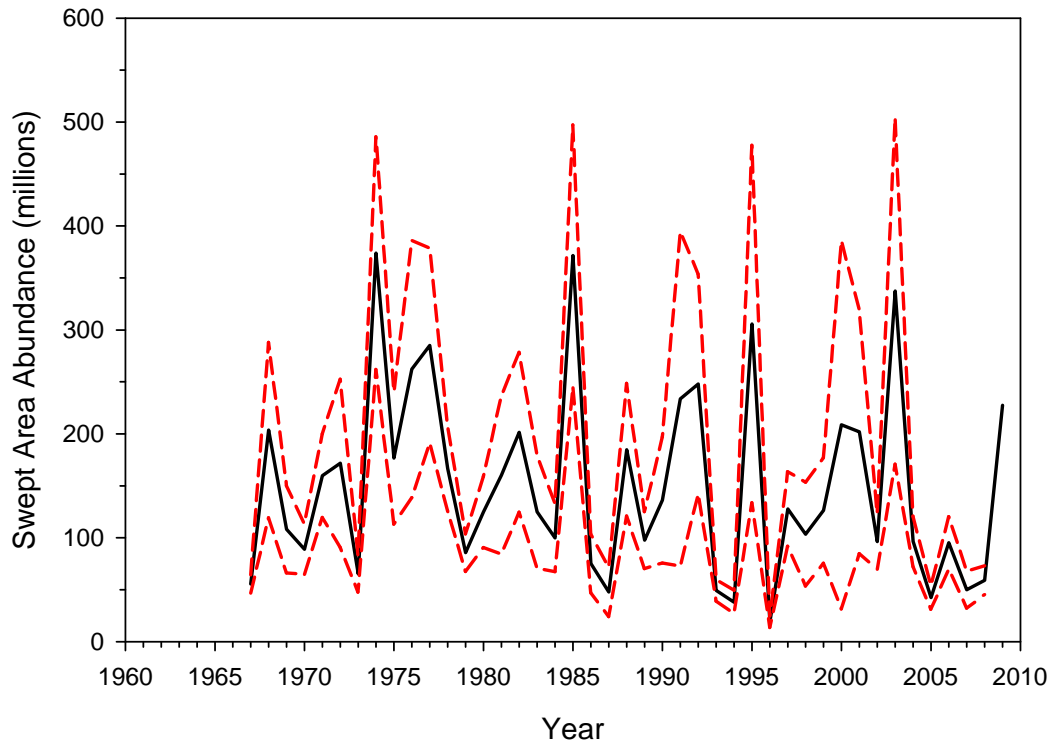


Figure A46. Swept area abundance (top) and biomass (bottom) with confidence intervals for the NEFSC fall survey in the southern management region.

SOUTH SPRING

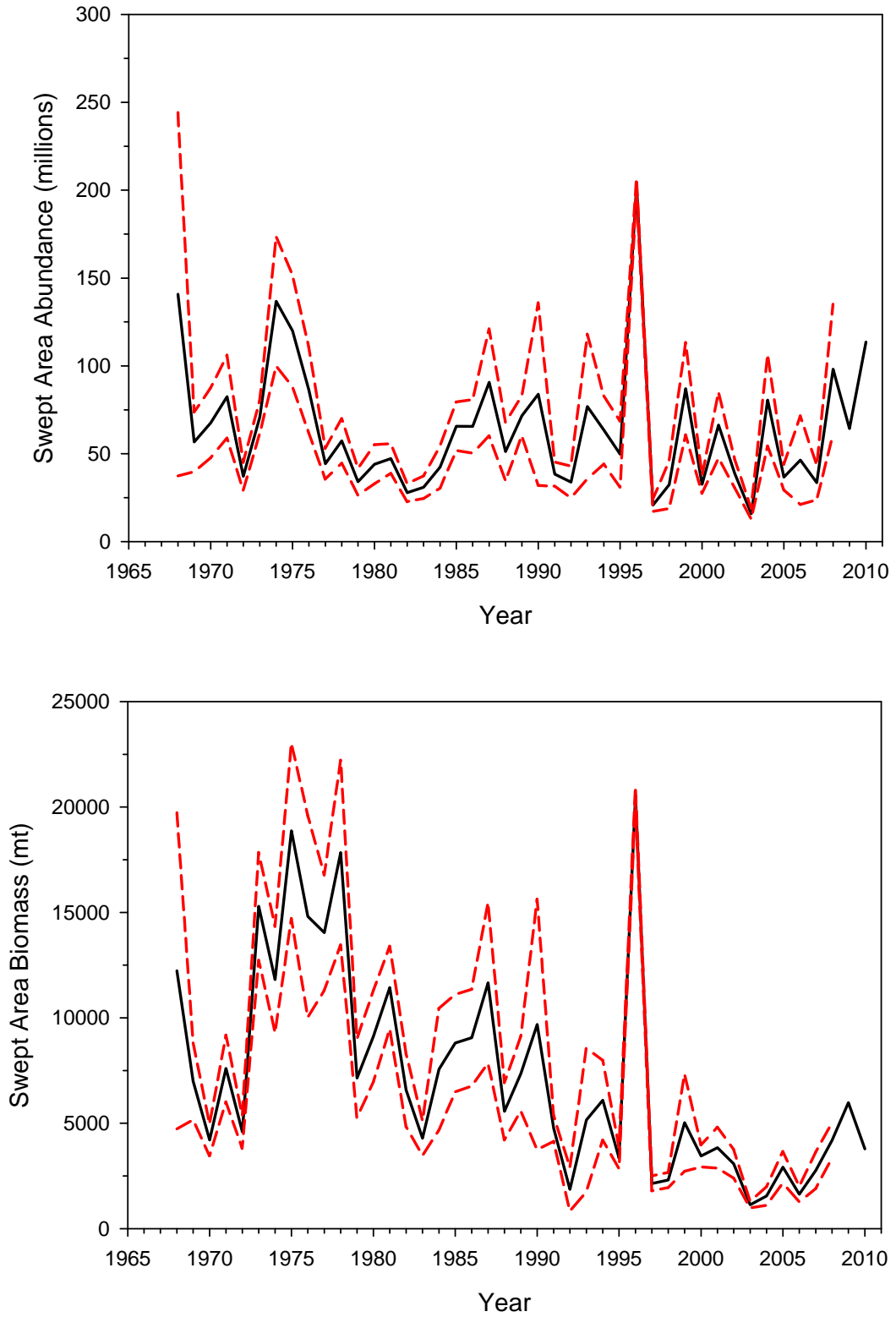


Figure A47. Swept area abundance (top) and biomass (bottom) with confidence intervals for the NEFSC spring survey in the southern management region.

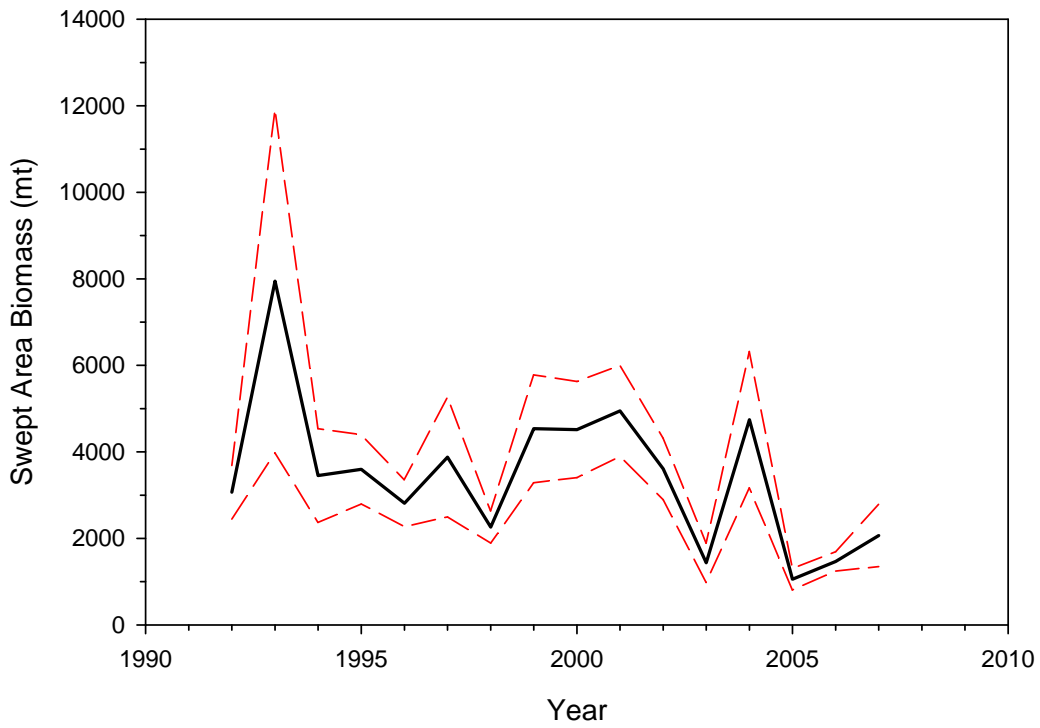
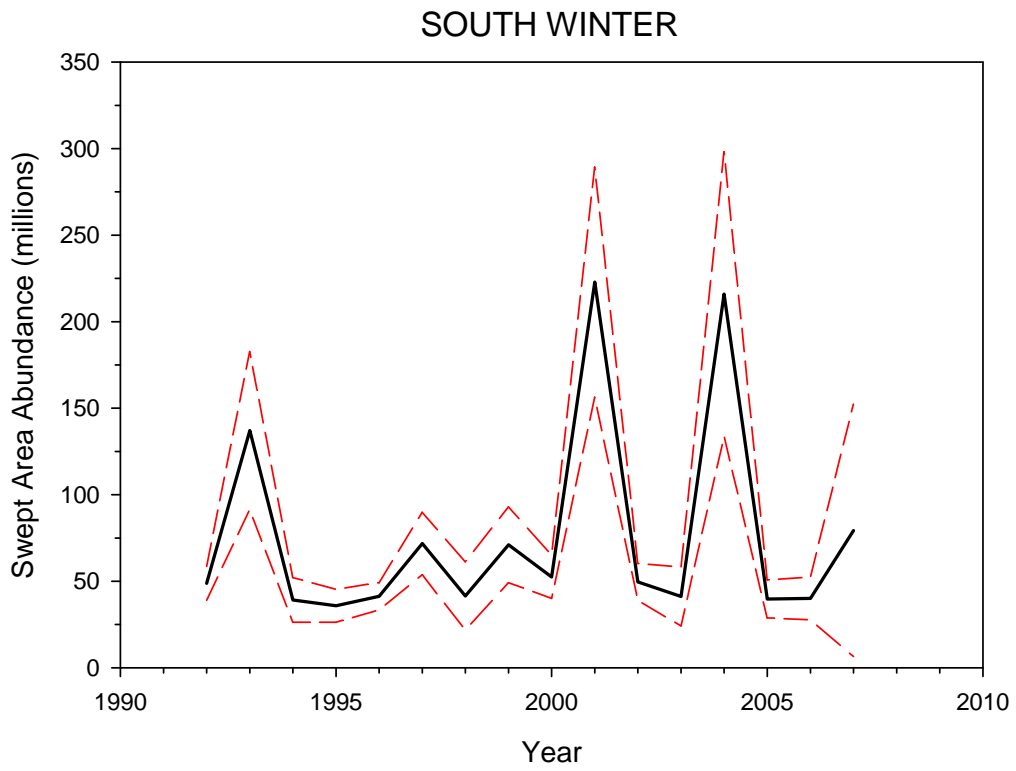


Figure A48. Swept area abundance and biomass with upper and lower confidence intervals for silver hake from the NEFSC winter survey in the southern management region.

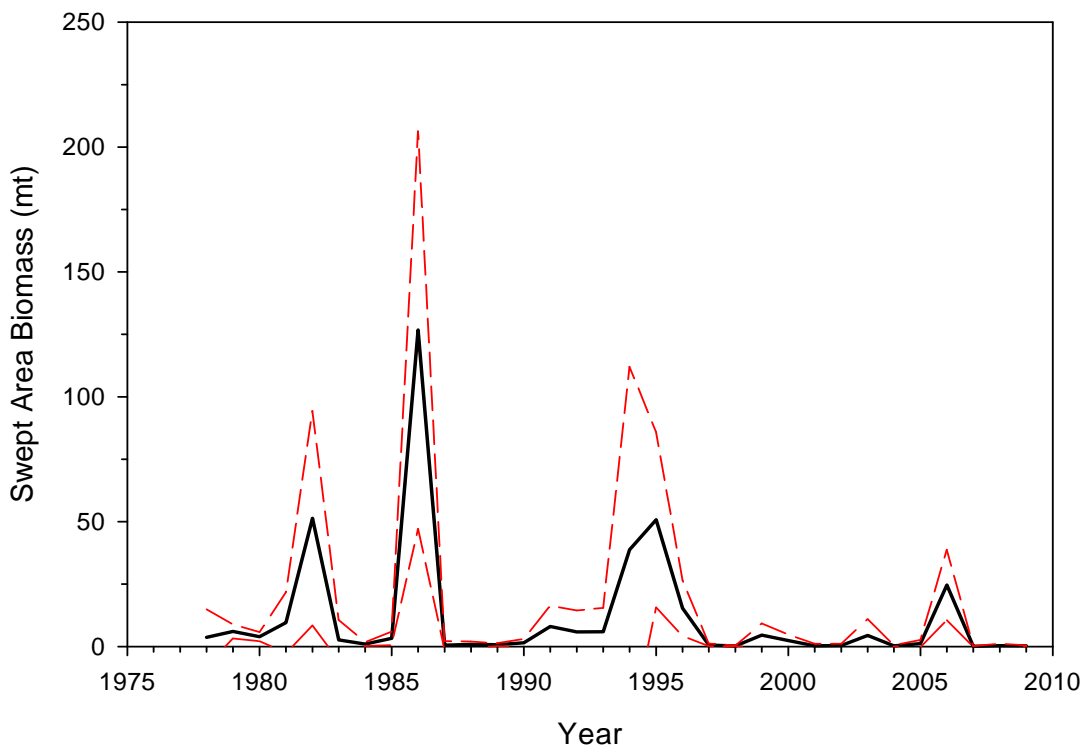
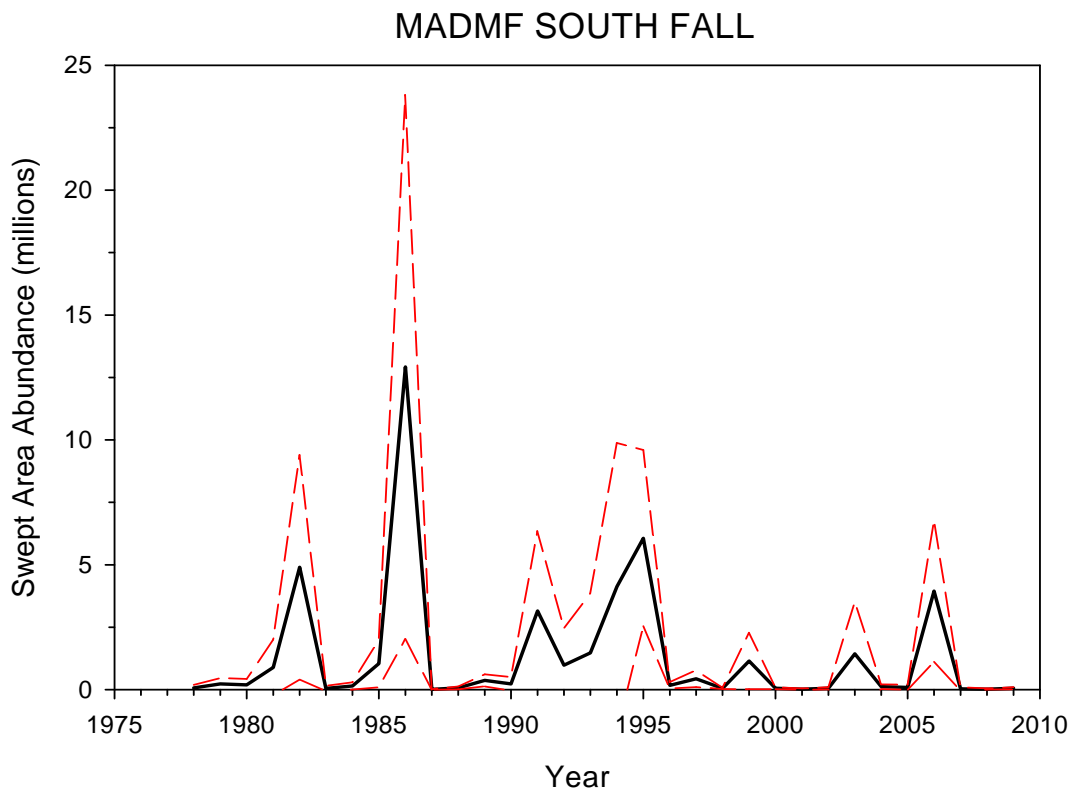


Figure A49. Swept area abundance (top) and biomass (bottom) with confidence intervals for silver hake from the Massachusetts Division of Marine Fisheries fall south survey (strata 11-17).

MADMF SOUTH SPRING

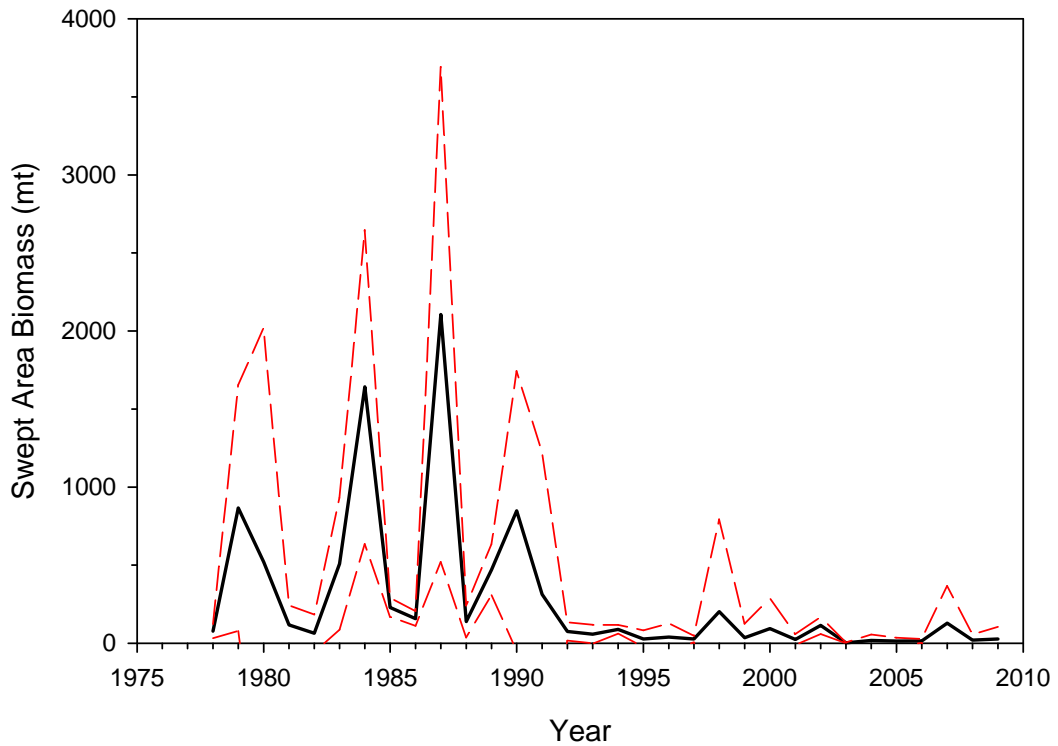
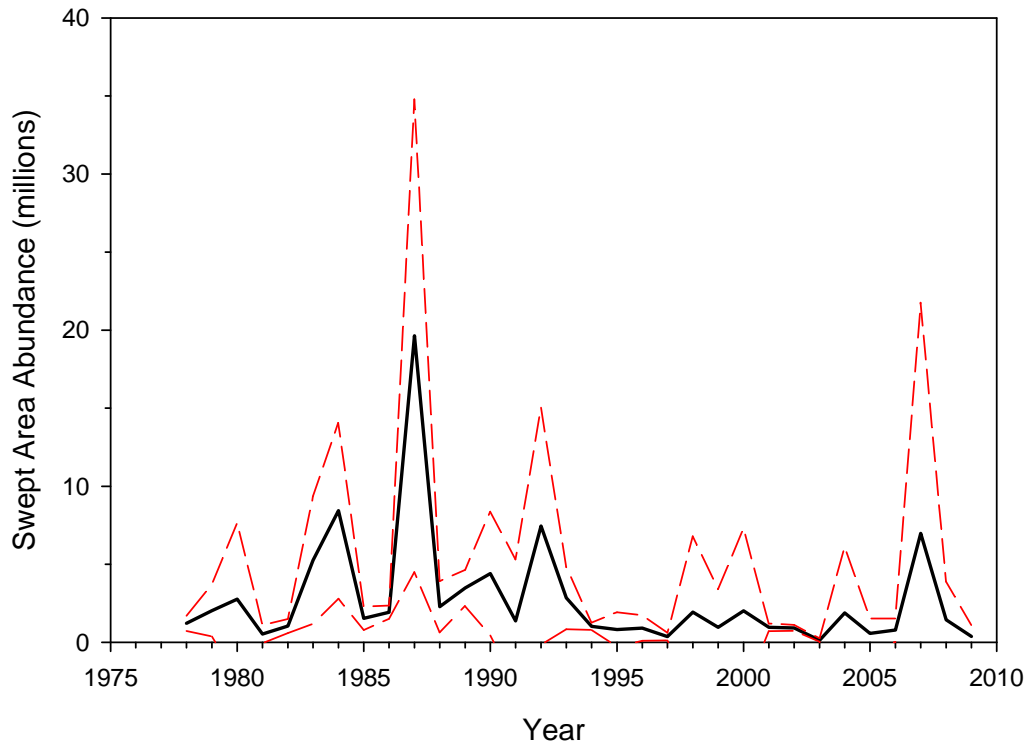


Figure A50. Swept area abundance (top) and biomass (bottom) with confidence intervals for silver hake from the Massachusetts Division of Marine Fisheries spring south survey (strata 11-17).

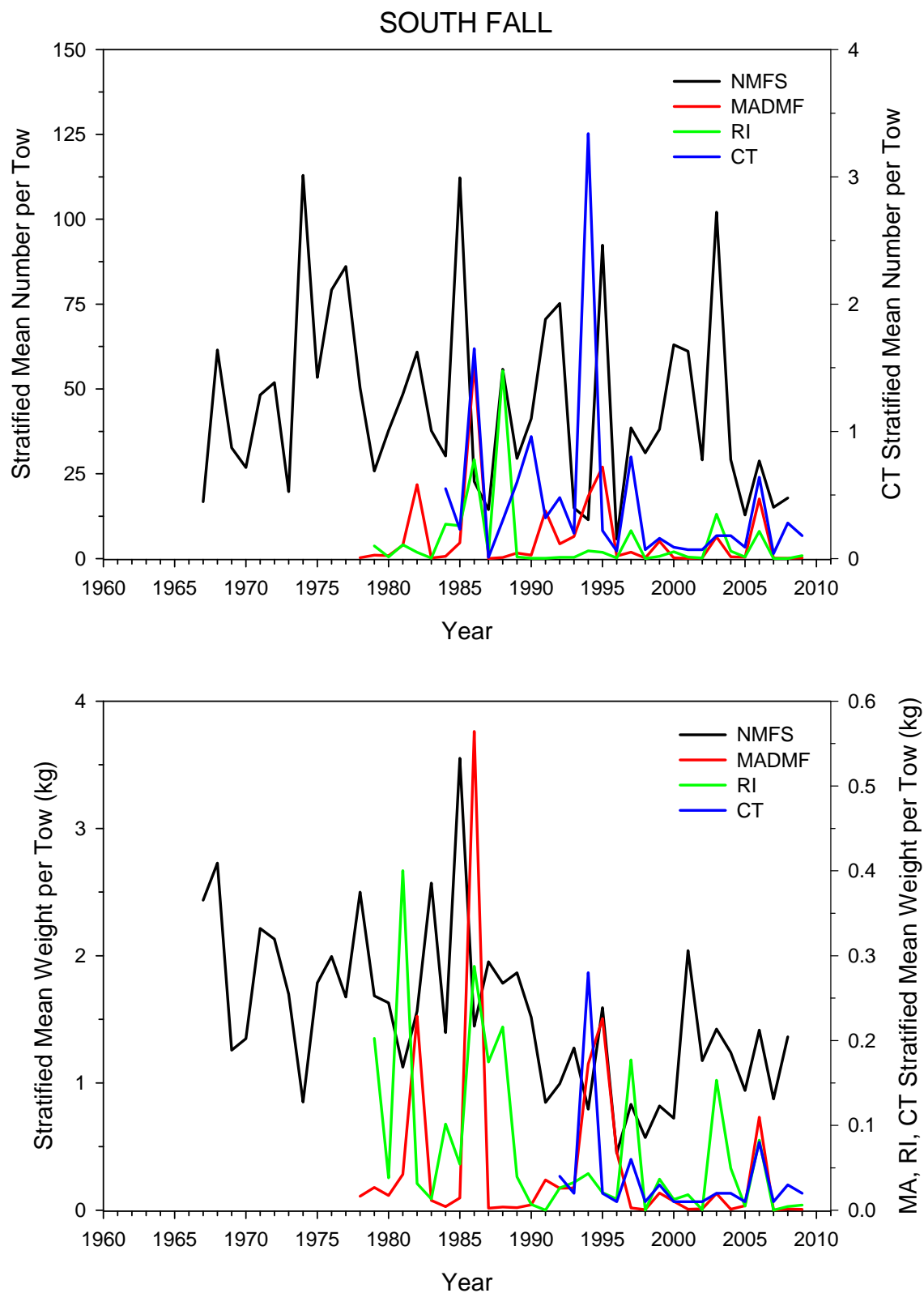


Figure A51. Stratified mean number and weight per tow (kg) for silver hake from the fall NEFSC, MADMF, Rhode Island and Connecticut state surveys.

SILVER SPRING/WINTER

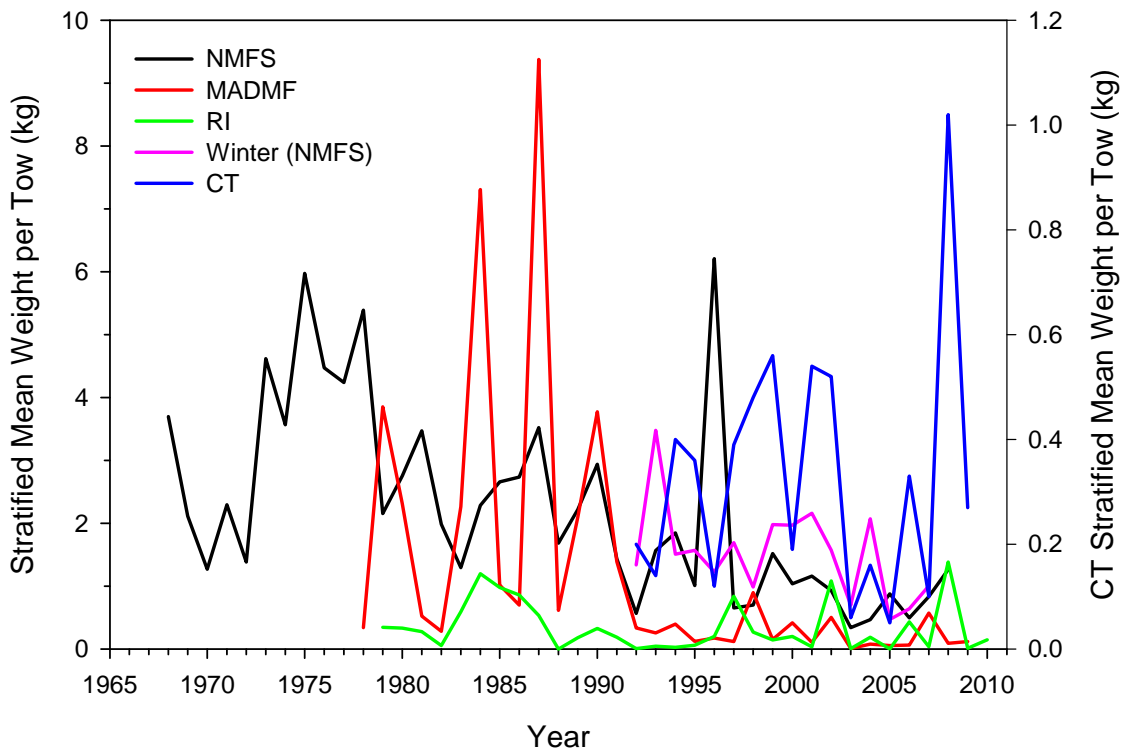
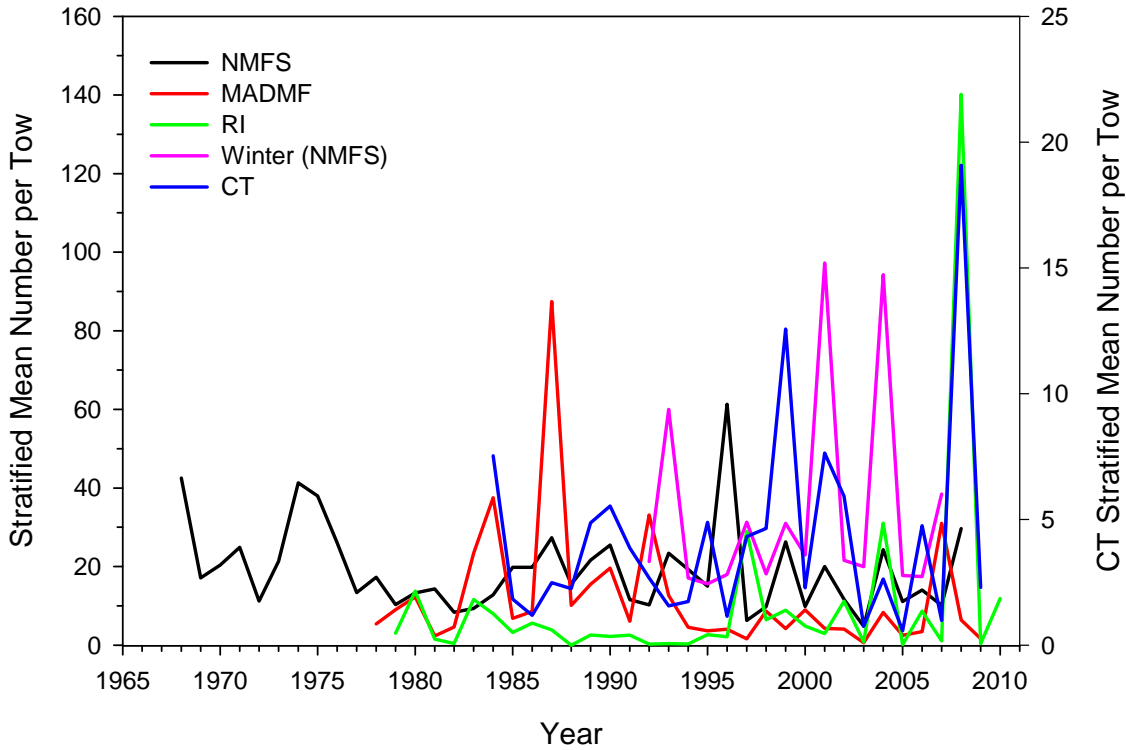


Figure A52. Stratified mean number and weight per tow (kg) for silver hake from the spring and winter NEFSC, MADMF, Rhode Island and Connecticut state surveys.

Southern Fall Survey Abundances at Age

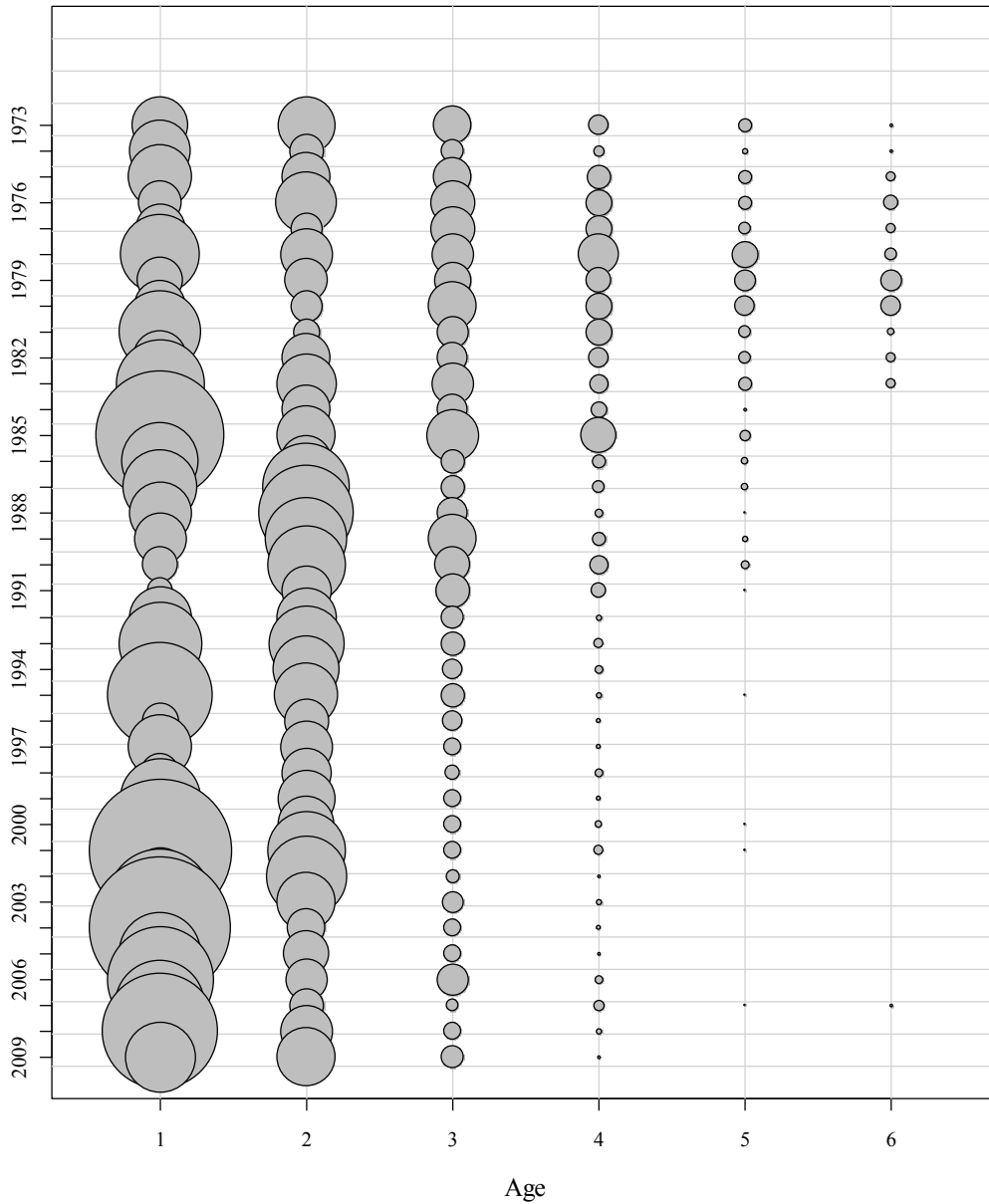


Figure A53. Silver hake age specific indices of abundance for the fall survey in the southern stock area. The area of the bubble plot is proportional to the magnitude.

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Southern Spring Survey Abundances at Age

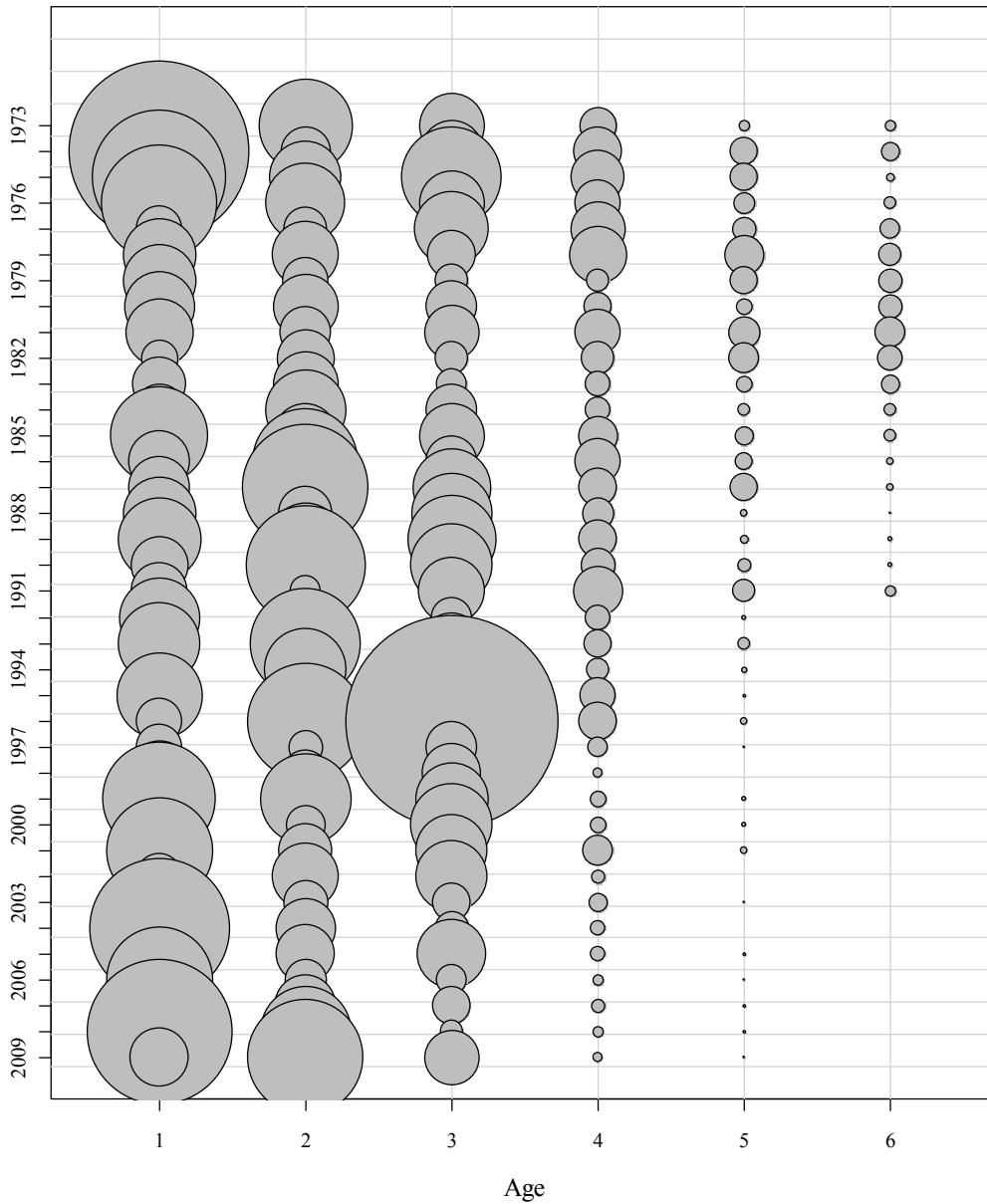


Figure A54. Silver hake age specific indices of abundance for the spring survey in the southern stock area. The area of the bubble plot is proportional to the magnitude.

COMBINED FALL

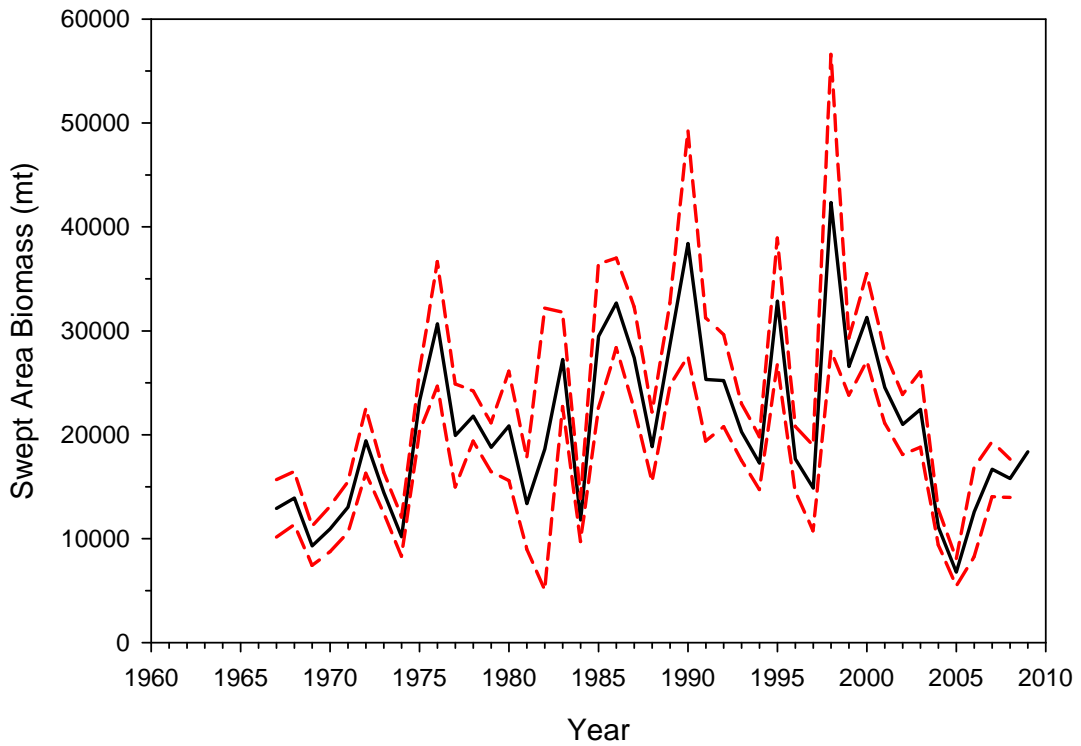
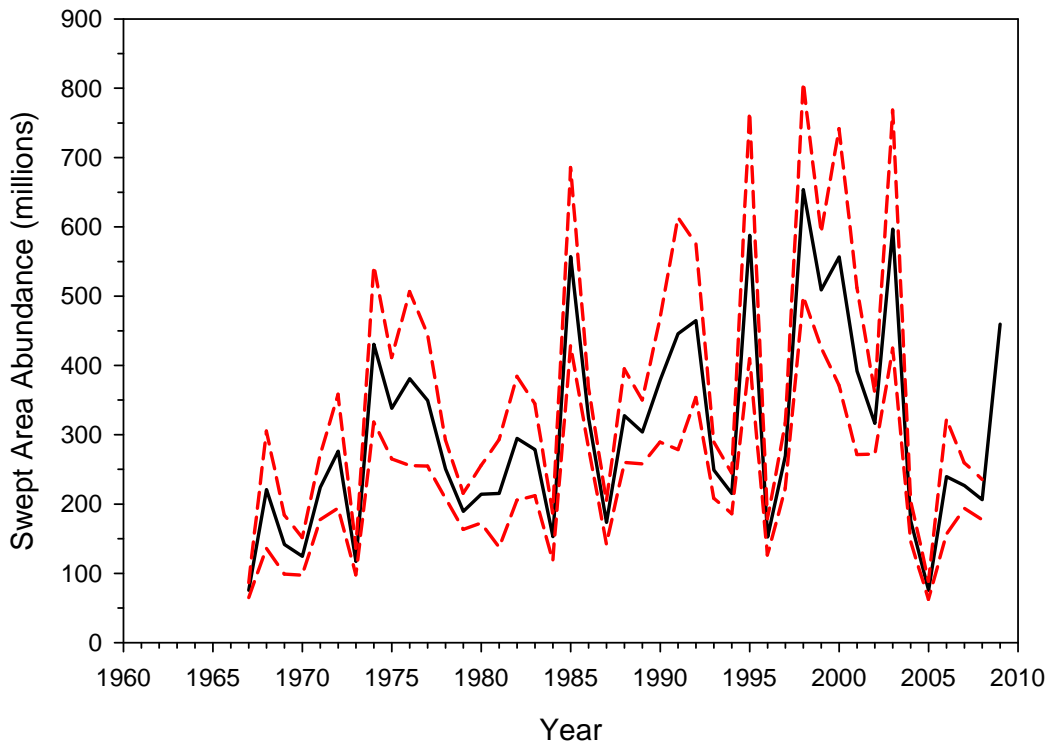


Figure A55. Swept area abundance and biomass and upper and lower confidence intervals for silver hake from the NEFSC fall bottom trawl surveys in the northern and southern management regions combined.

COMBINED SPRING

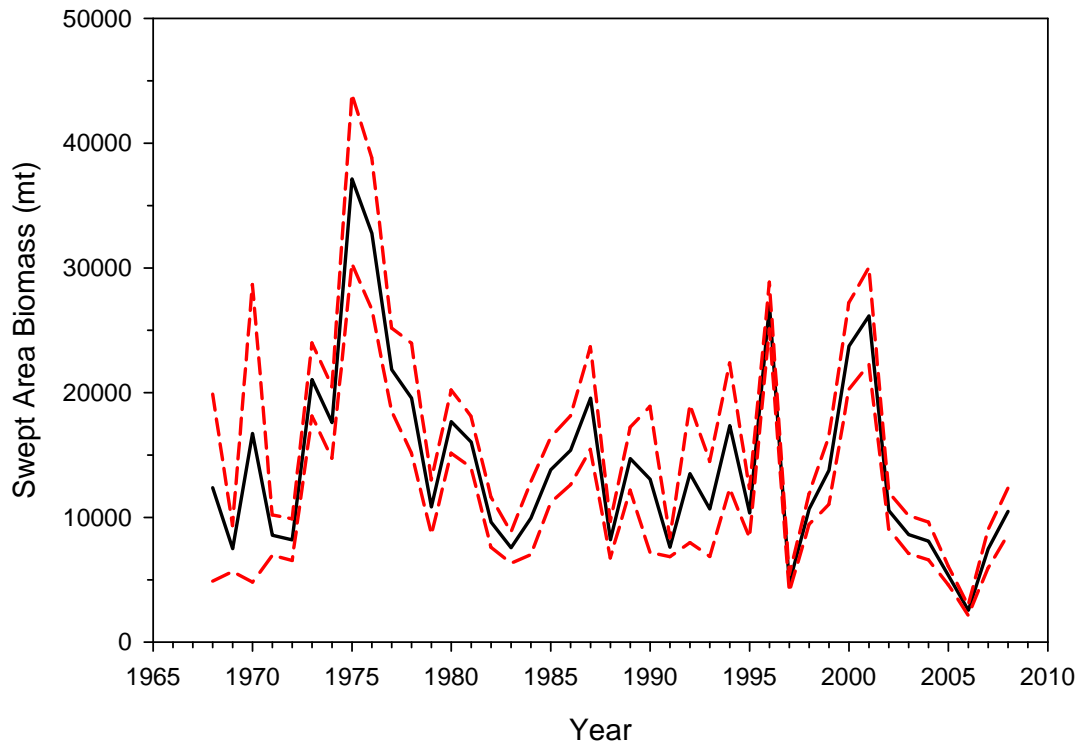
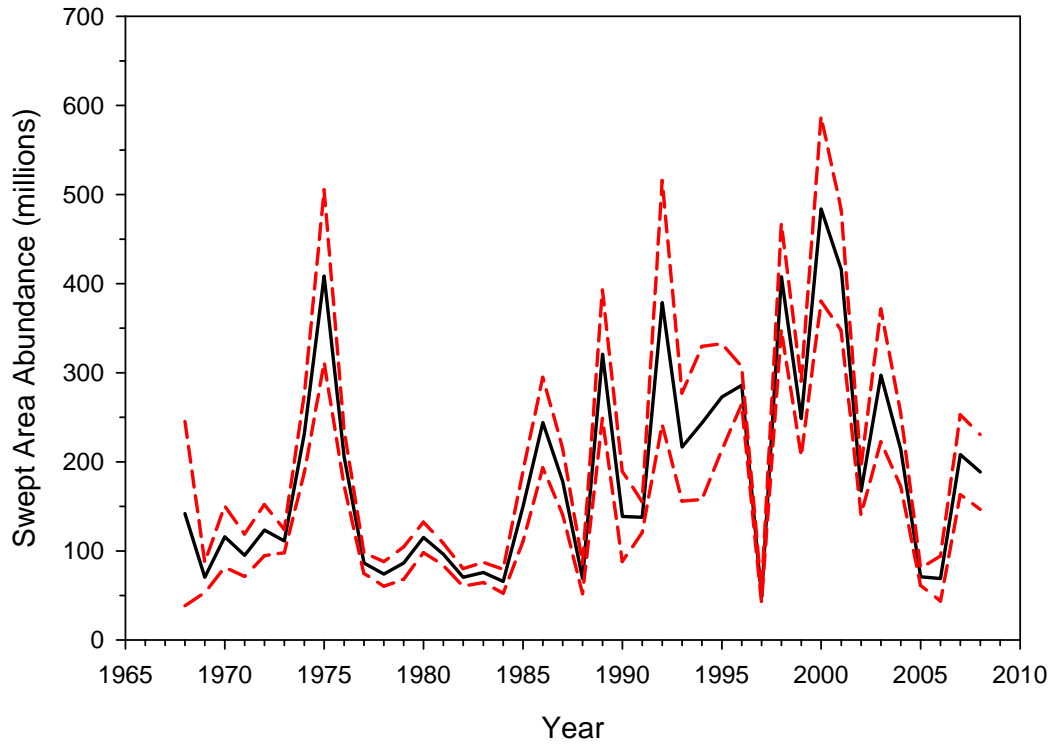


Figure A56. Swept area abundance and biomass and upper and lower confidence intervals for silver hake from the NEFSC spring bottom trawl surveys in the northern and southern management regions combined.

Combined Area Fall Survey Abundances at Age

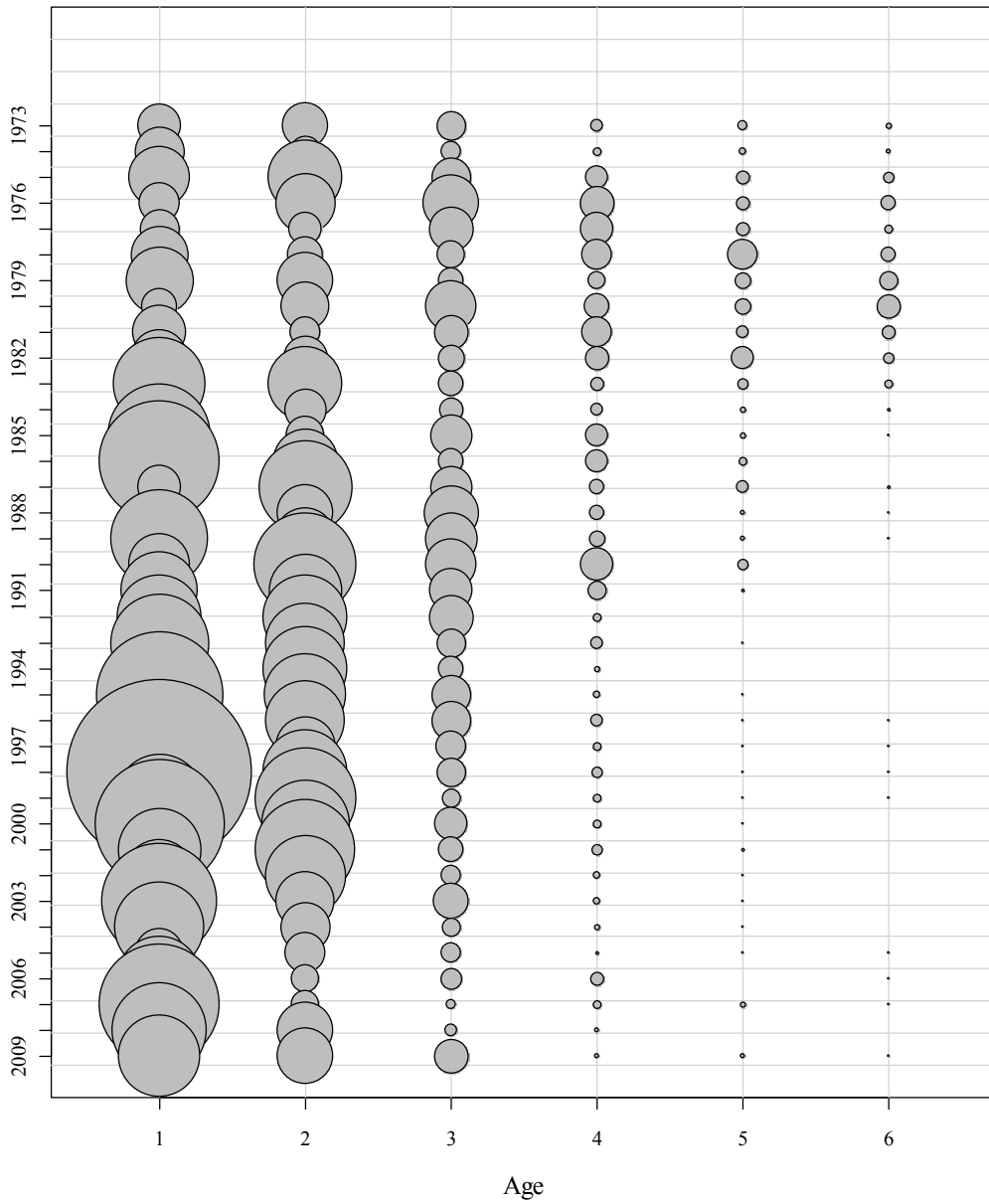


Figure A57 Silver hake age specific fall survey indices of abundance for the combined stock areas. The area of the bubble plot is proportional to the magnitude.

Combined Area Spring Survey Abundances at Age

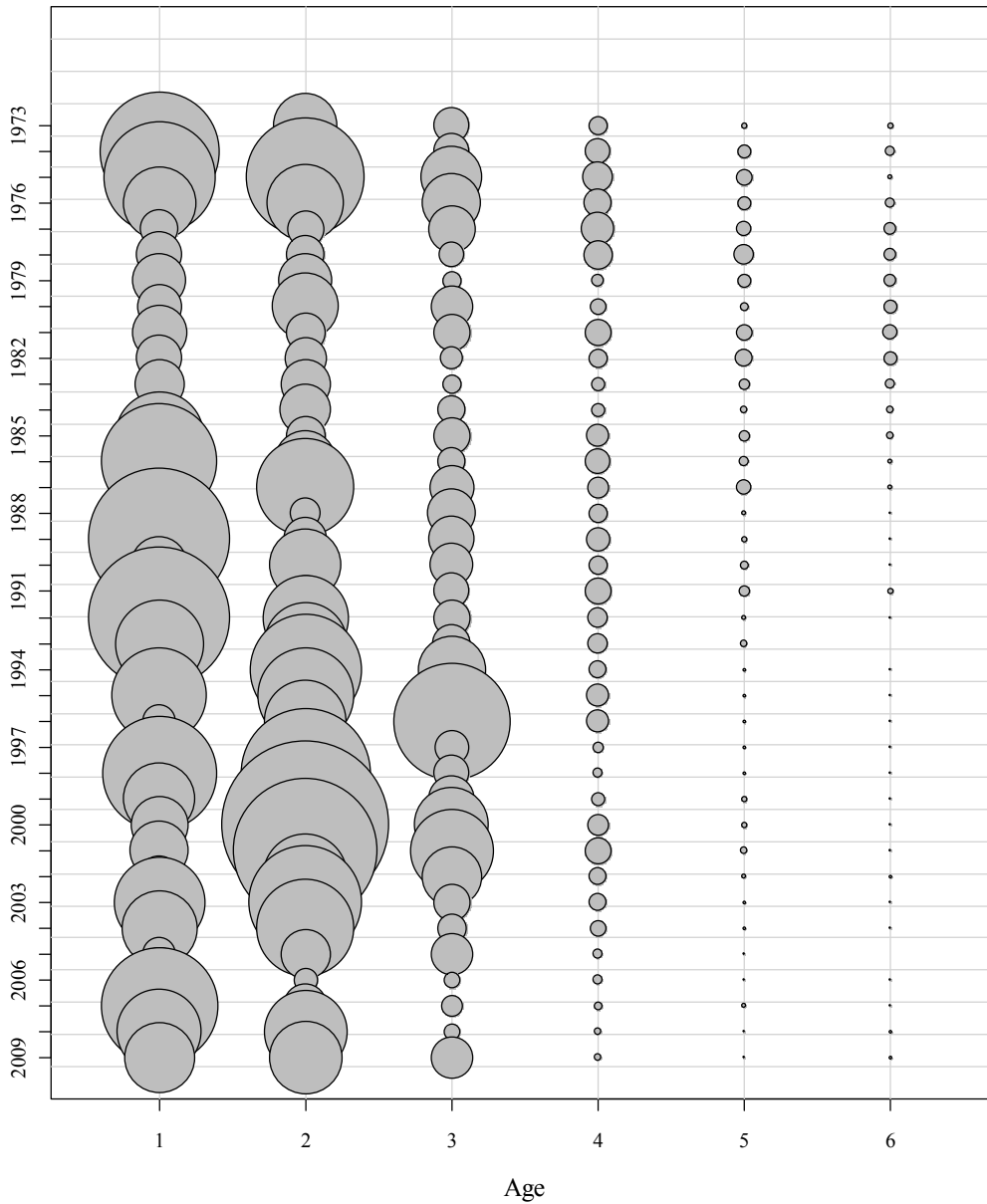


Figure A58. Silver hake age specific spring survey indices of abundance for the combined stock areas. The area of the bubble plot is proportional to the magnitude.

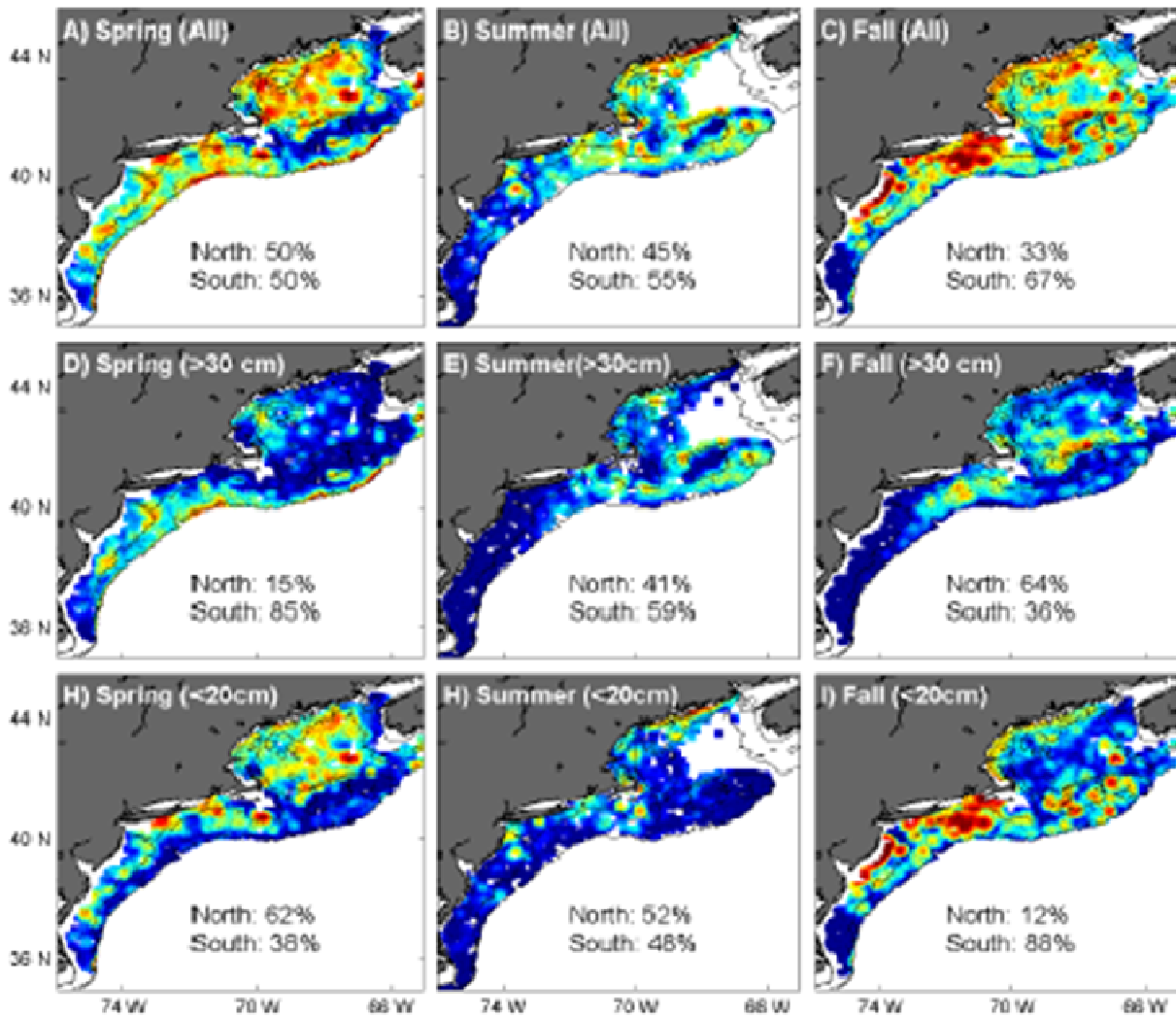


Figure A59: Distribution of silver hake during the NEFSC trawl surveys in the spring, summer and fall of 1977-1981. The summer >30 cm size class should correspond to the spawning distribution of silver hake.

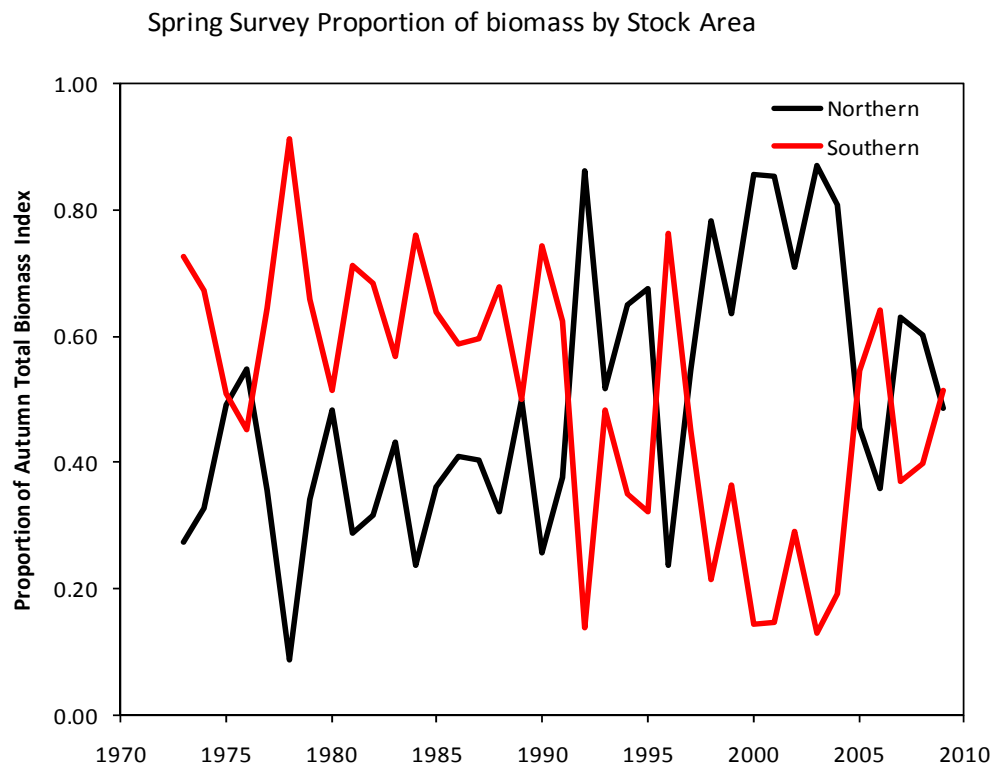
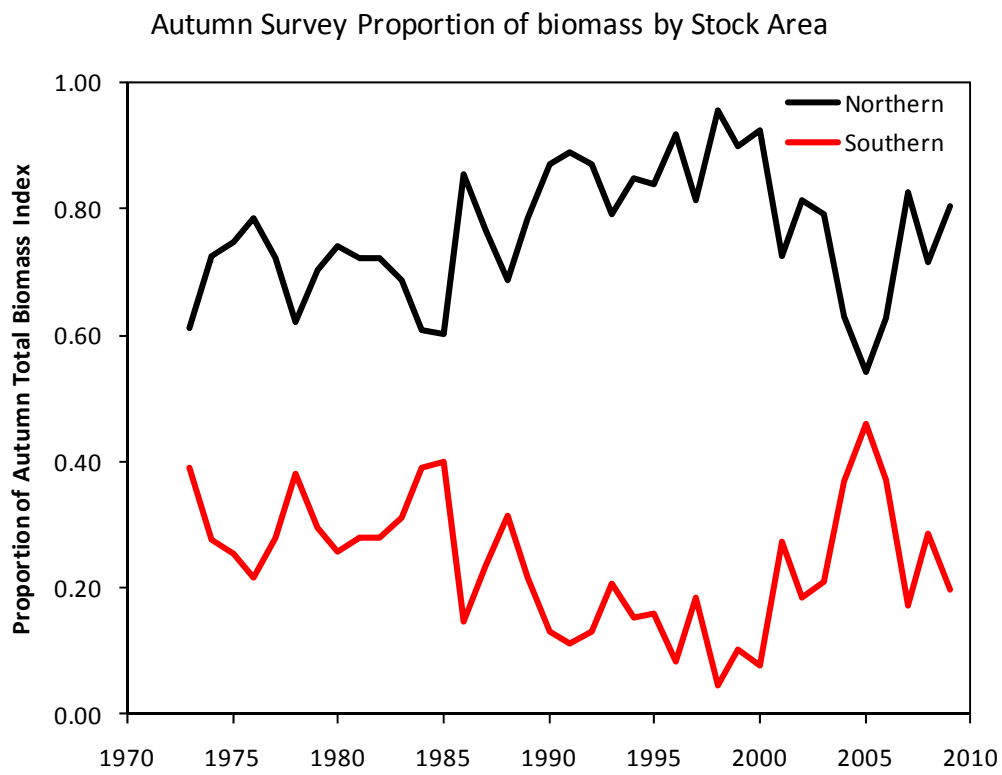


Figure A60: Autumn (top) and spring (bottom) survey distribution of silver hake by area.

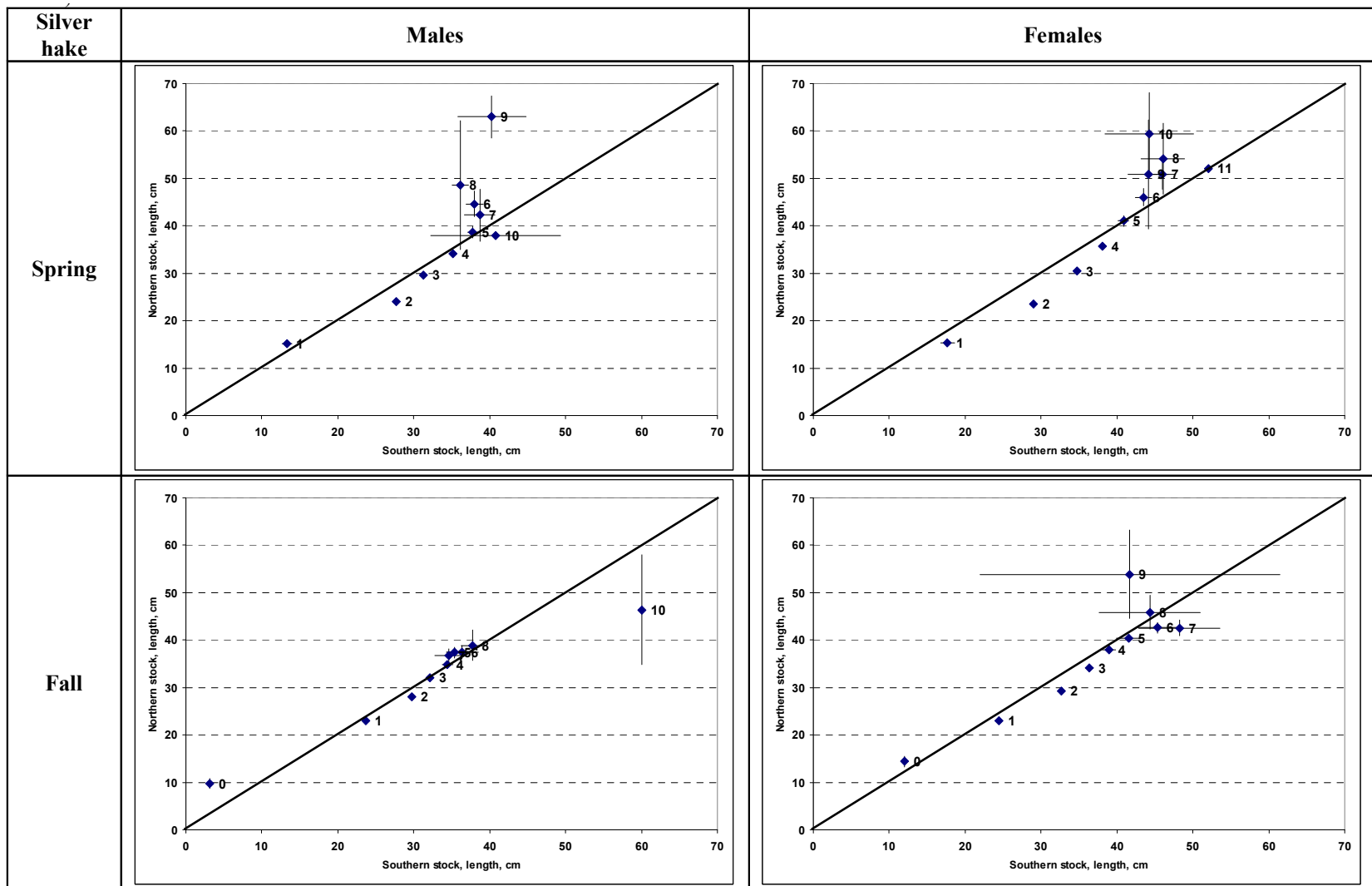


Figure A61. Size (cm total length) at age comparison between silver hake caught in strata 1-19, 61-76 (Southern stock) and strata 20-40 (Northern stock) for 1962-1979 cohorts.

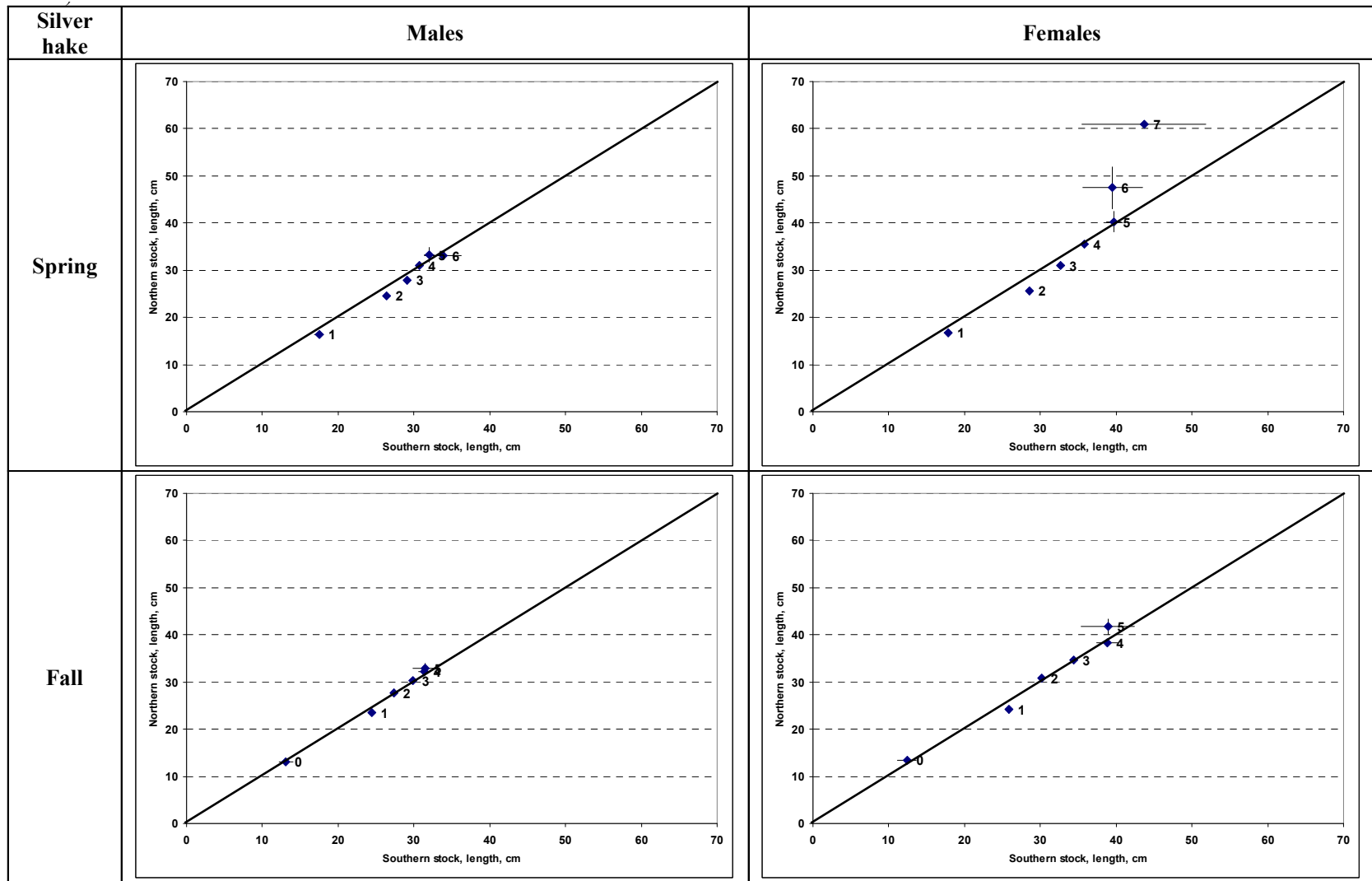


Figure A62. Size (cm total length) at age comparison between silver hake caught in strata 1-19, 61-76 (Southern stock) and strata 20-40 (Northern stock) for 1980-1989 cohorts.

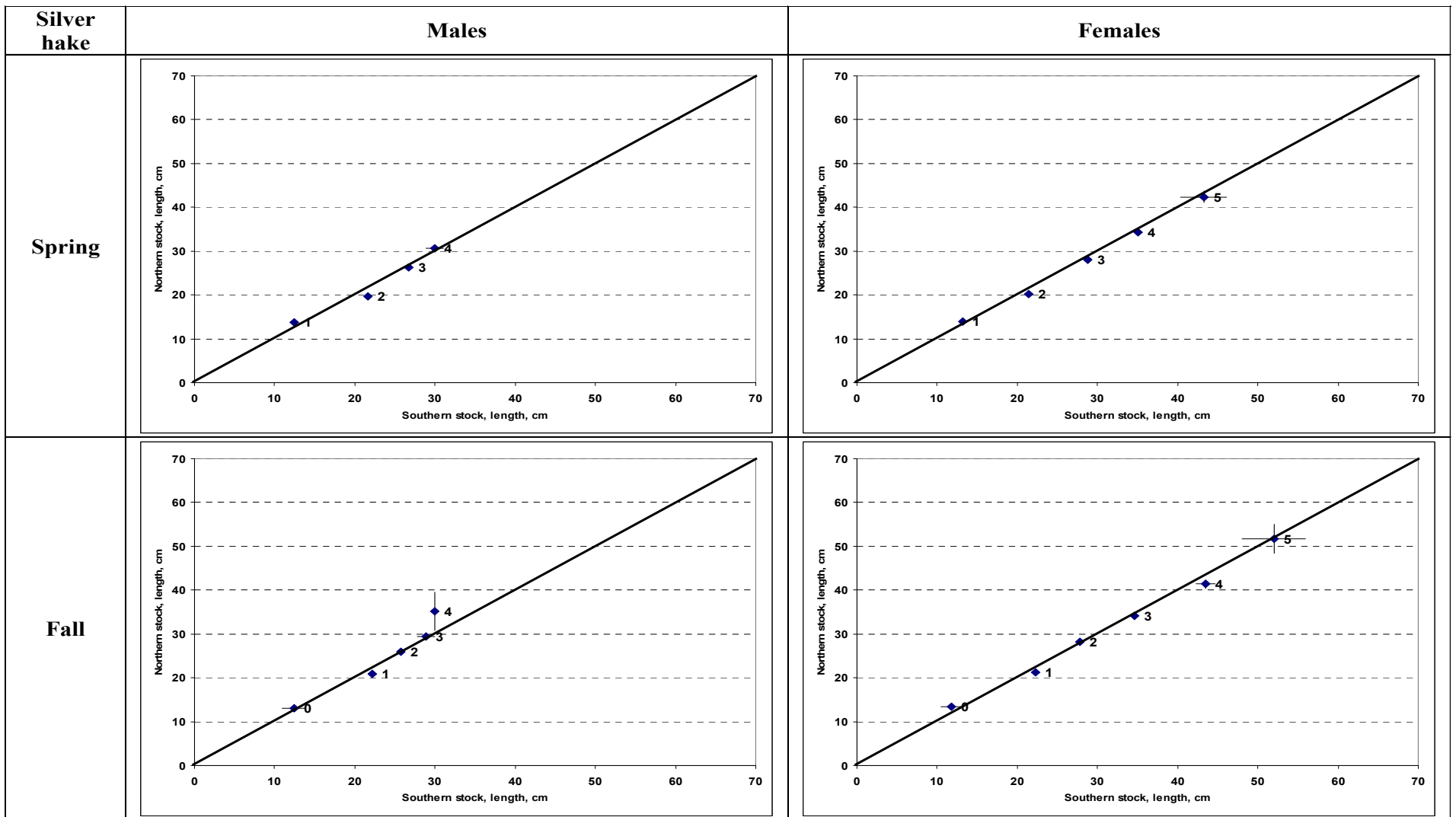


Figure A63. Size (cm total length) at age comparison between red hake caught in strata 1-19, 61-76 (Southern stock) and strata 20-40 (Northern stock) for 1990-1999 cohorts.

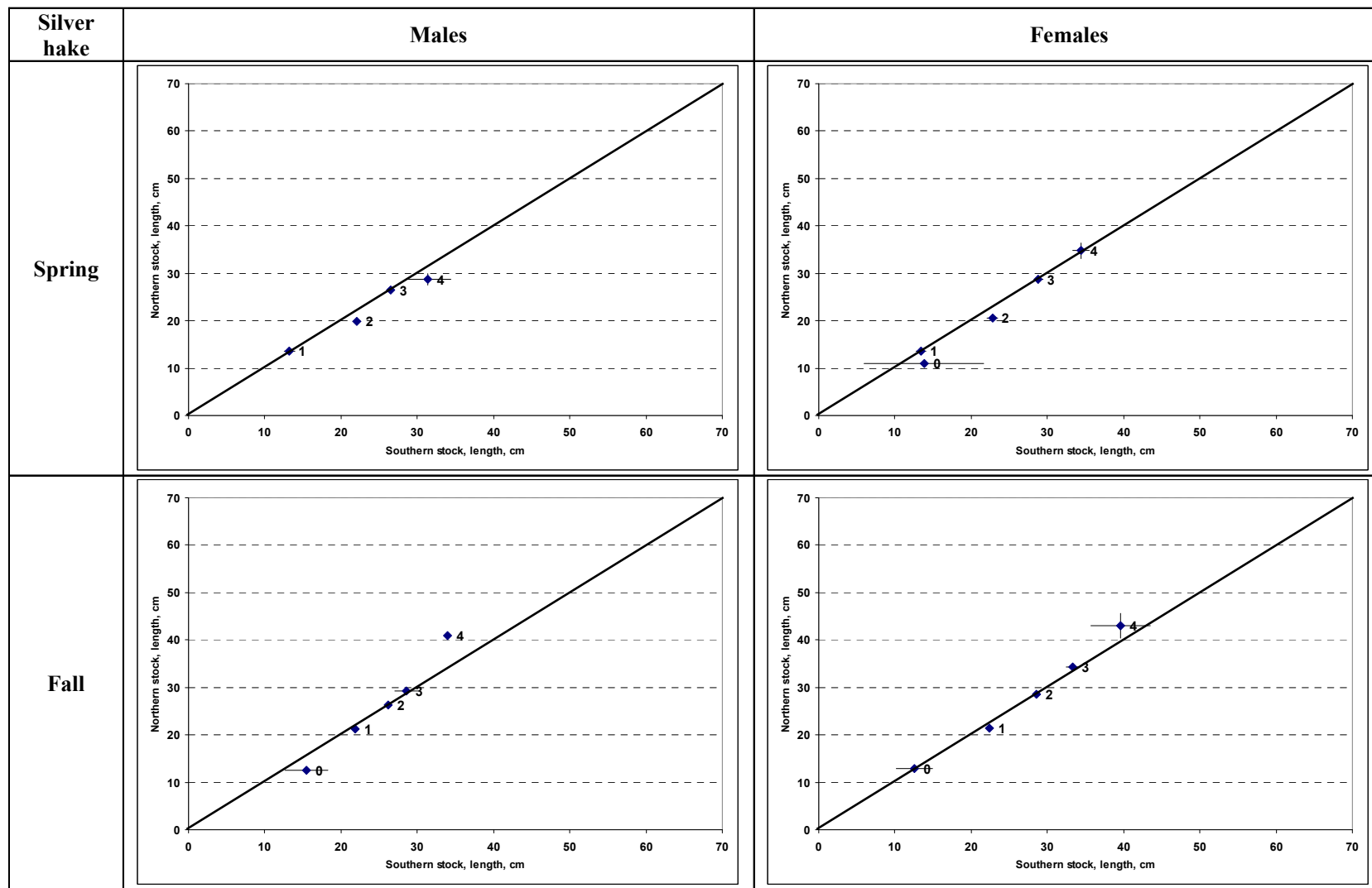


Figure A64. Size (cm total length) at age comparison between red hake caught in strata 1-19, 61-76 (Southern stock) and strata 20-40 (Northern stock) for 2000-2009 cohorts.

A50 North and South Silver Hake

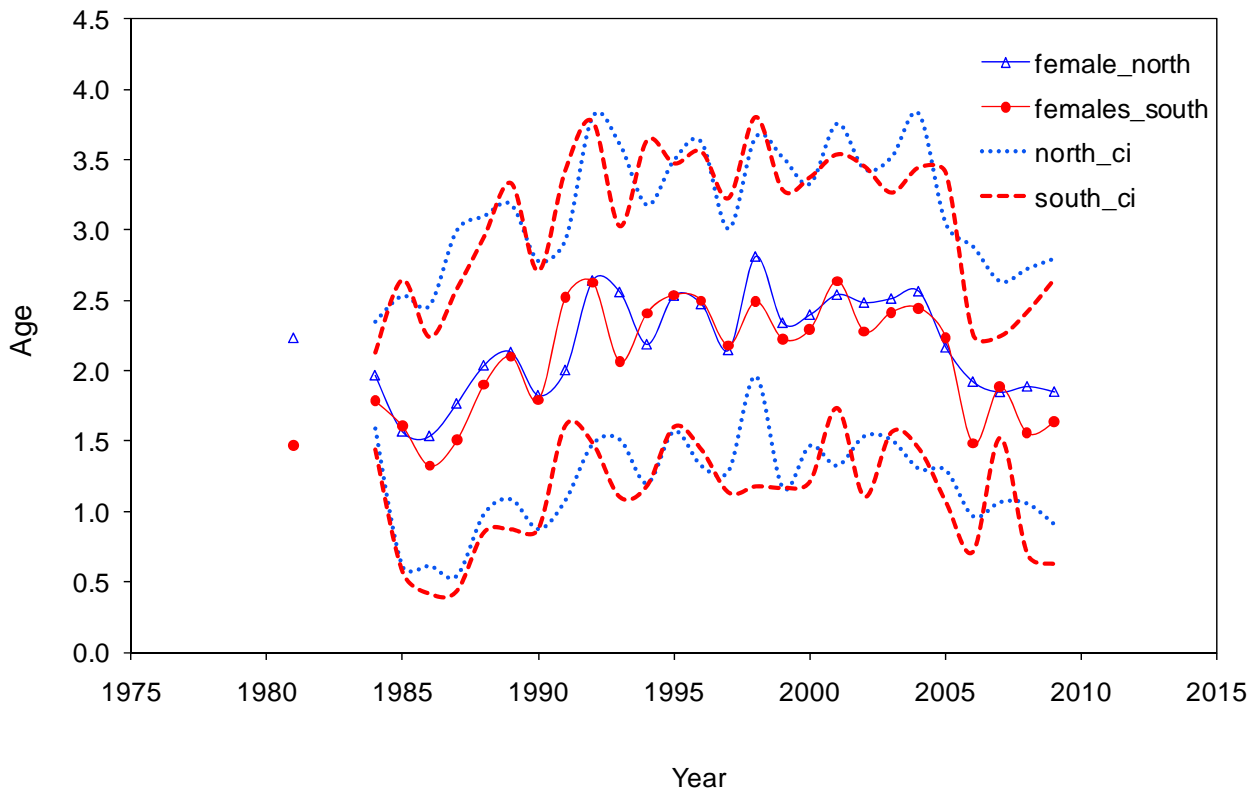
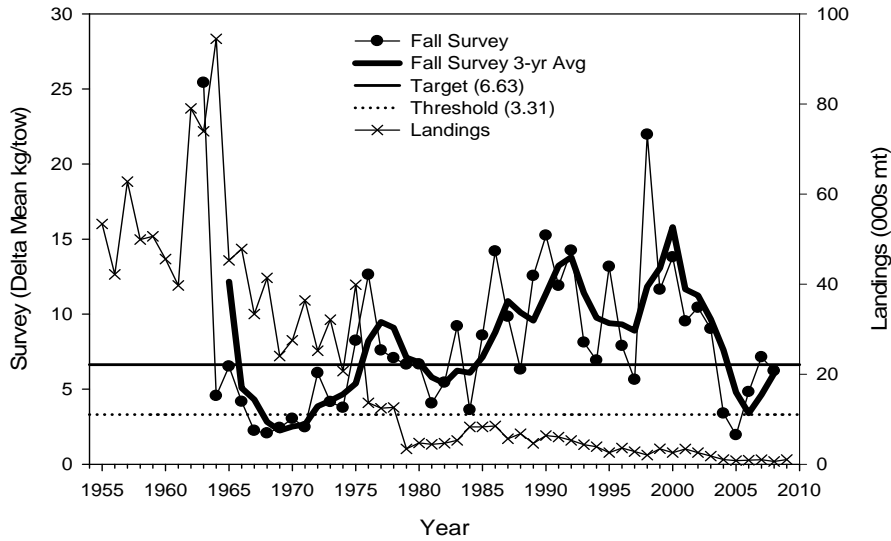


Figure A65: Time series of median size at maturity (A50) and 95% confidence interval for silver hake in the northern and southern management area

Northern Silver Hake



Northern Silver Hake Relative Exploitation Indices

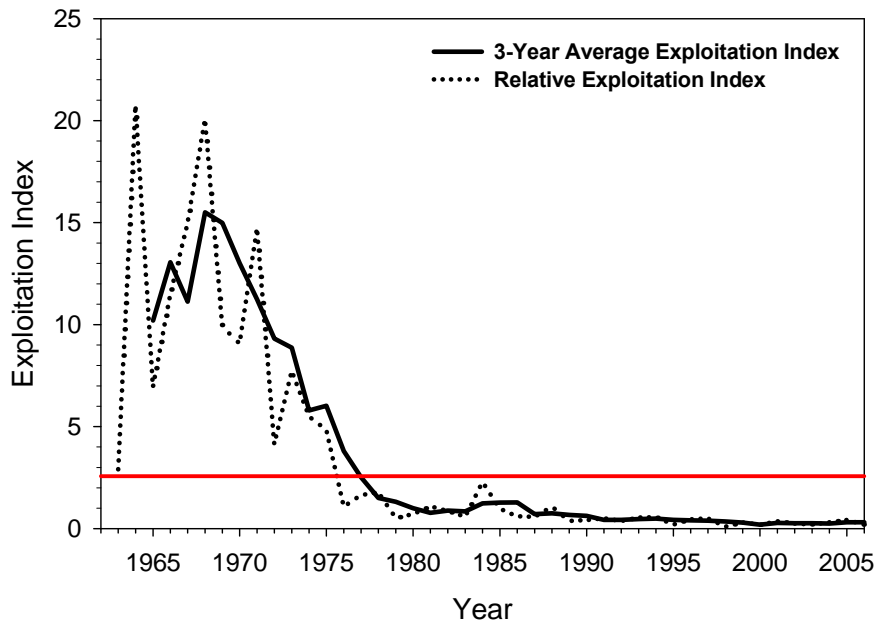
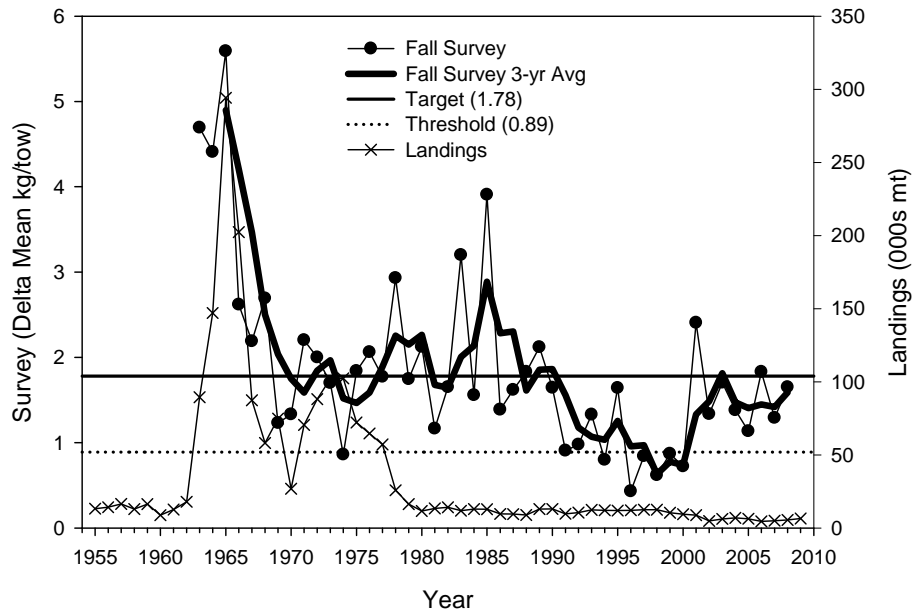


Figure A66. Abundance and exploitation indices for the northern stock of silver hake. Top: Fall abundance index (delta mean/tow) with 3 yr running average and current reference points for biomass. Bottom: landings/delta fall survey biomass (exploitation index)

Southern Silver Hake



Southern Silver Hake Relative Exploitation Indices

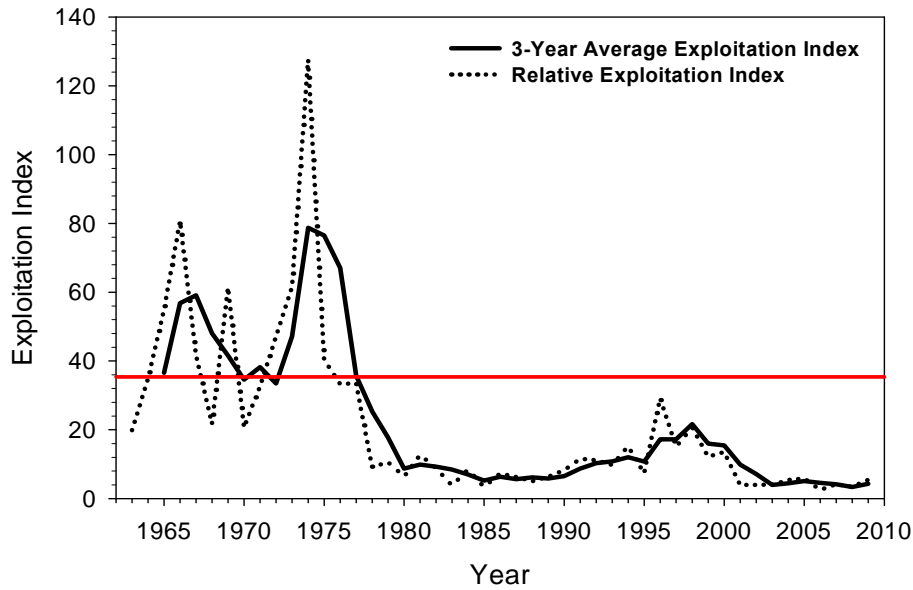


Figure A67. Abundance and exploitation indices for the southern stock of silver hake. Top: Fall abundance index (delta mean/tow) with 3 yr running average and current reference points for biomass. Bottom: landings/delta fall survey biomass (exploitation index)

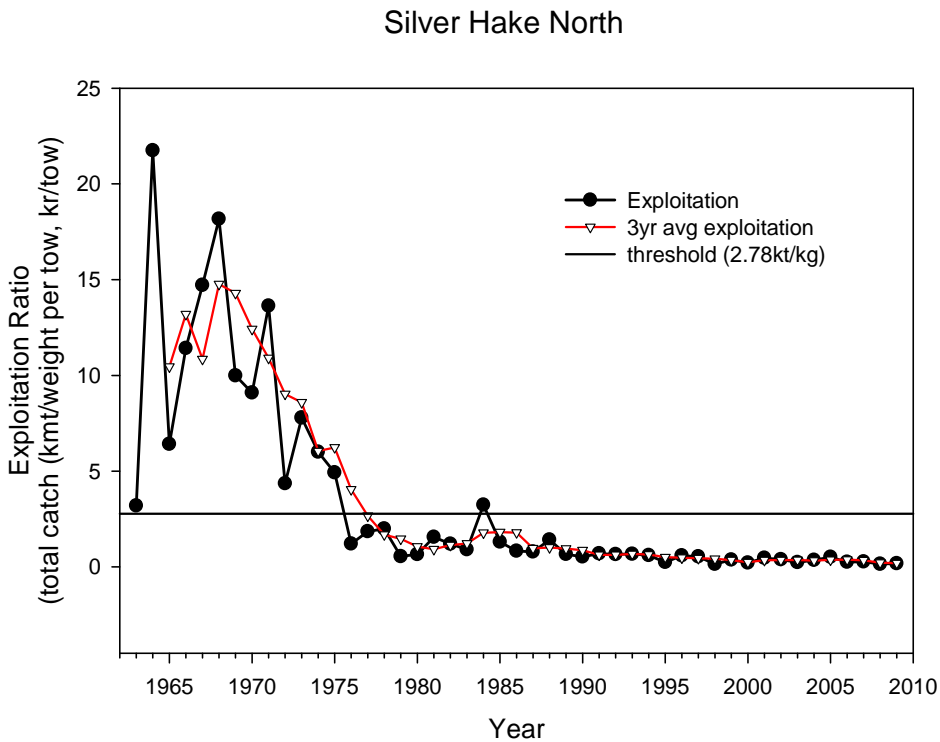
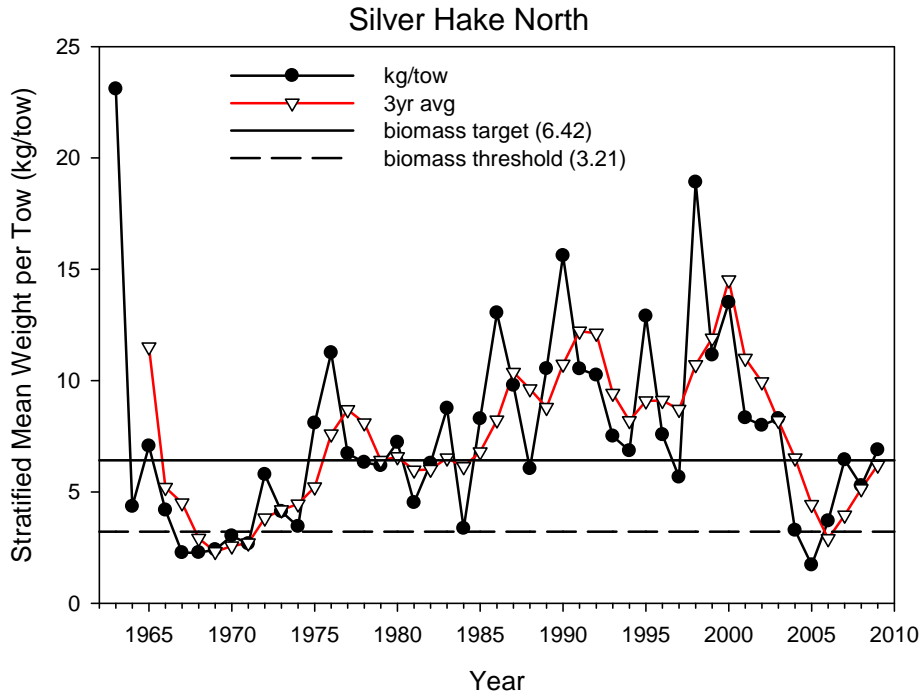


Figure A68. Abundance and exploitation indices for the northern stock of silver hake. Top: Fall abundance index (arithmetic mean/tow) with 3 yr running average and current reference points for biomass. Bottom: catch/arithmetic fall survey biomass (exploitation index)

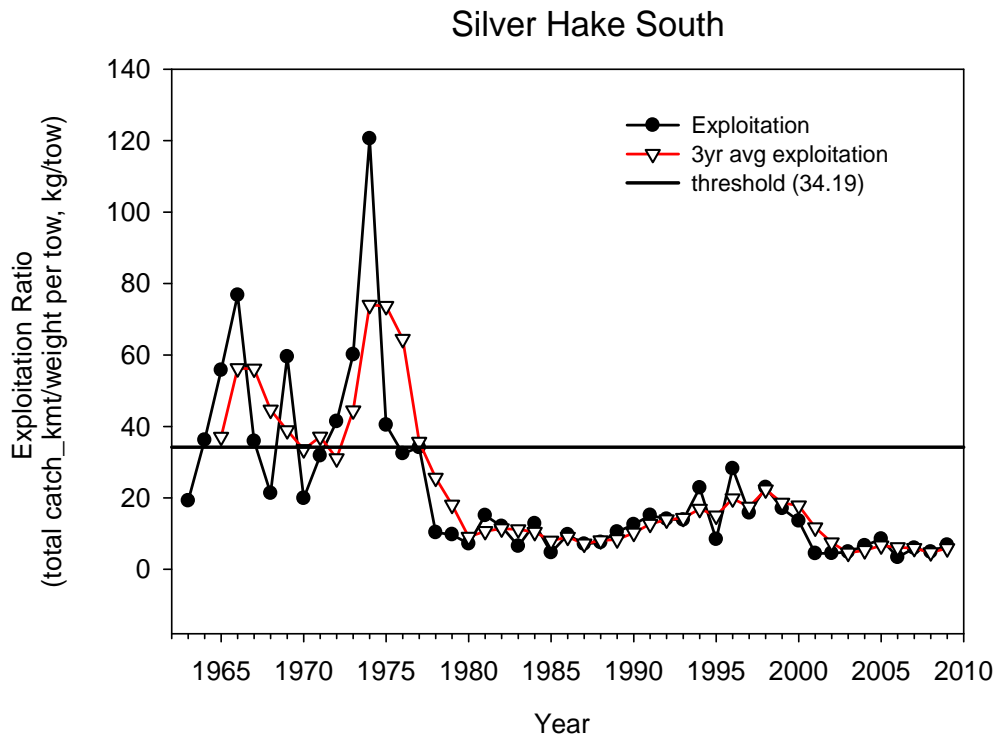
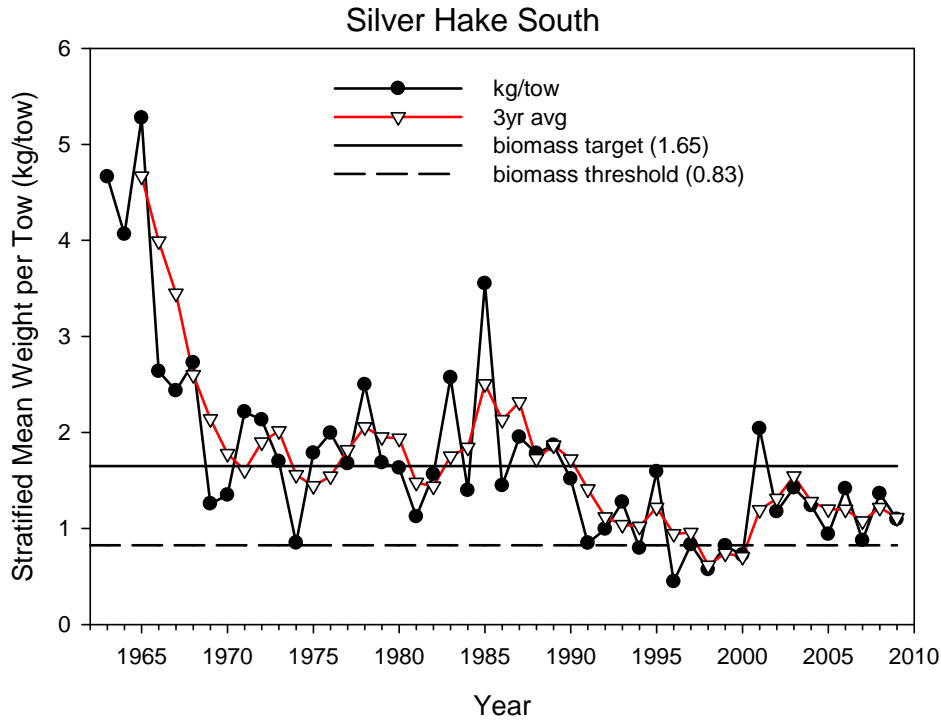


Figure A69. Abundance and exploitation indices for the southern stock of silver hake. Top: Fall abundance index (arithmetic mean/tow) with 3 yr running average and current reference points for biomass. Bottom: catch/arithmetic fall survey biomass (exploitation index)

Silver Combined NEFSC Fall Survey

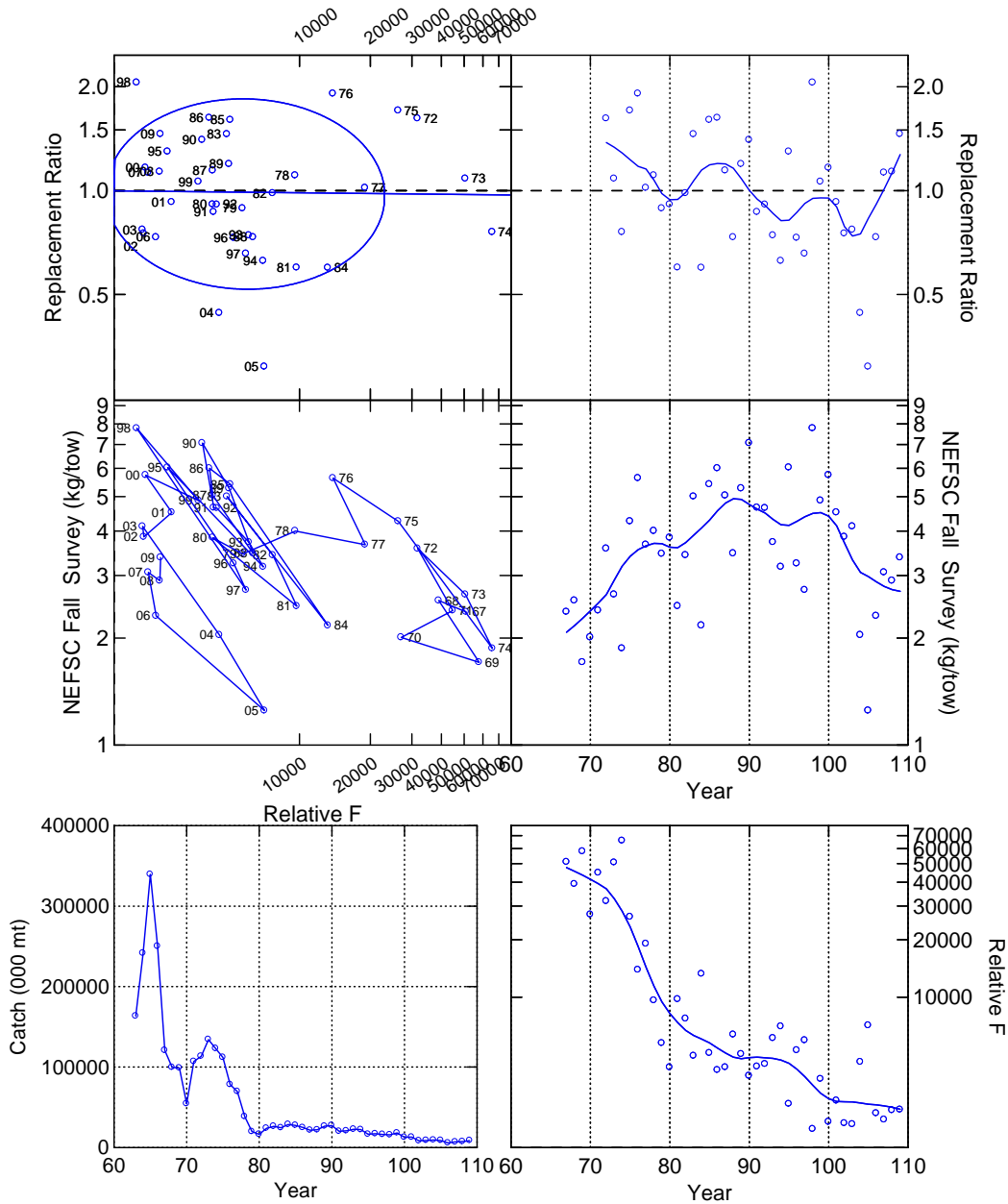


Figure. A70. Six panel plot for silver hake depicting trends in relative biomass, landings, relative fishing mortality and replacement ratios for the NEFSC Fall bottom trawl survey index and landings based on the Sosebee method. Horizontal dashed lines (---) represent replacement ratios in the top two panels and the replacement F in the lower right panel. Smooth lines represent Lowess smooths (tension = 0.3). The confidence ellipse in the top left panel has a nominal probability level of 0.68. The regression line in the top left panel is a robust regression using bisquare downweighting of residuals.

Silver Combined NEFSC Spring Survey

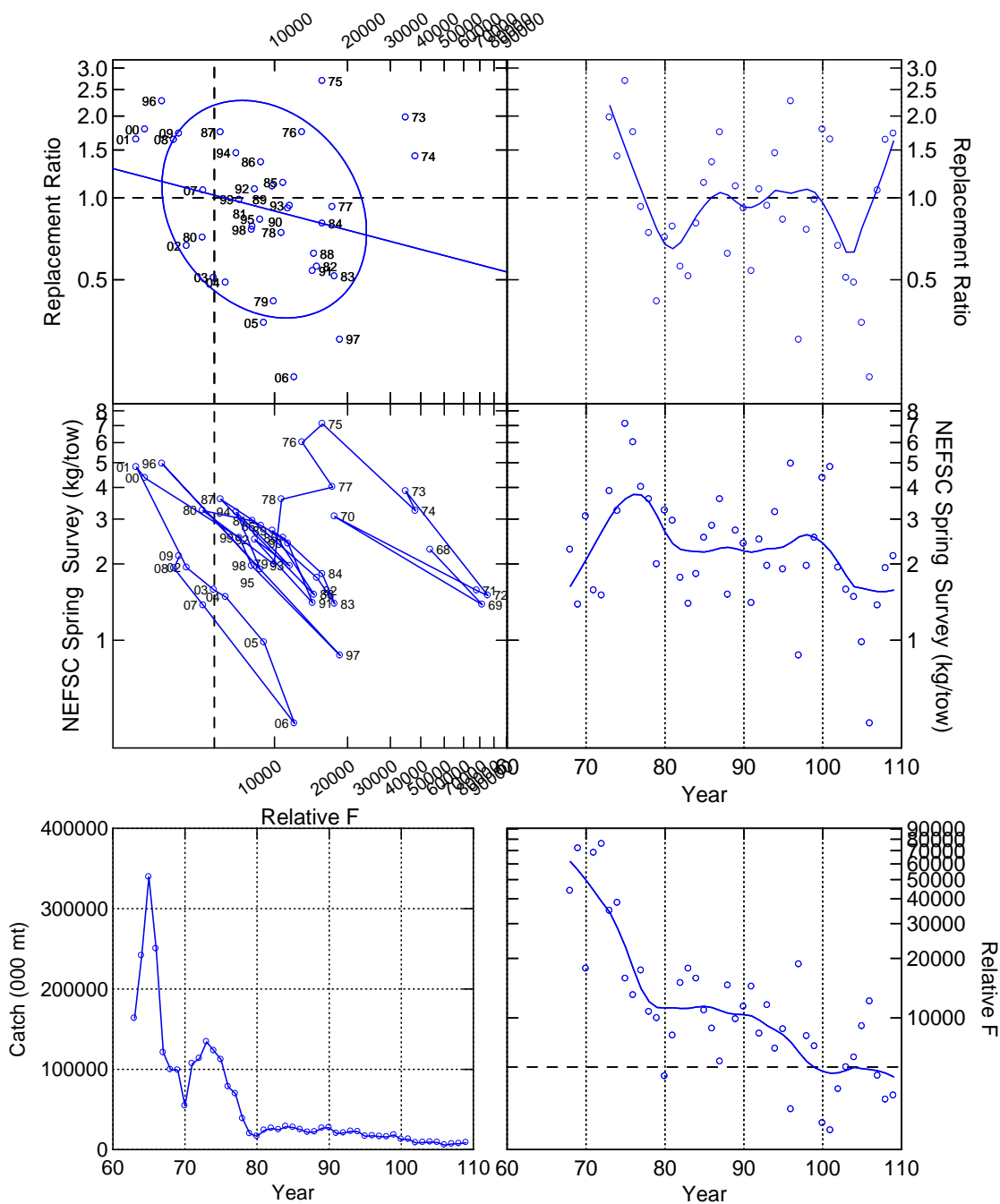


Figure. A71. Six panel plot for silver hake depicting trends in relative biomass, landings, relative fishing mortality and replacement ratios for the NEFSC spring bottom trawl survey index and landings based on the Sosebee method. Horizontal dashed lines (---) represent replacement ratios in the top two panels and the replacement F in the lower right panel. Smooth lines represent Lowess smooths (tension = 0.3). The confidence ellipse in the top left panel has a nominal probability level of 0.68. The regression line in the top left panel is a robust regression using bisquare downweighting of residuals.

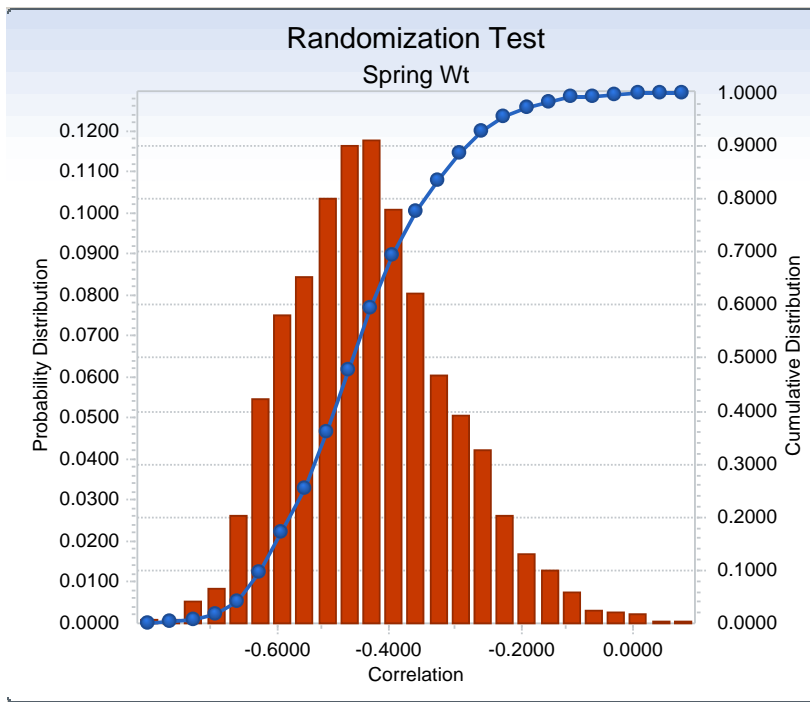
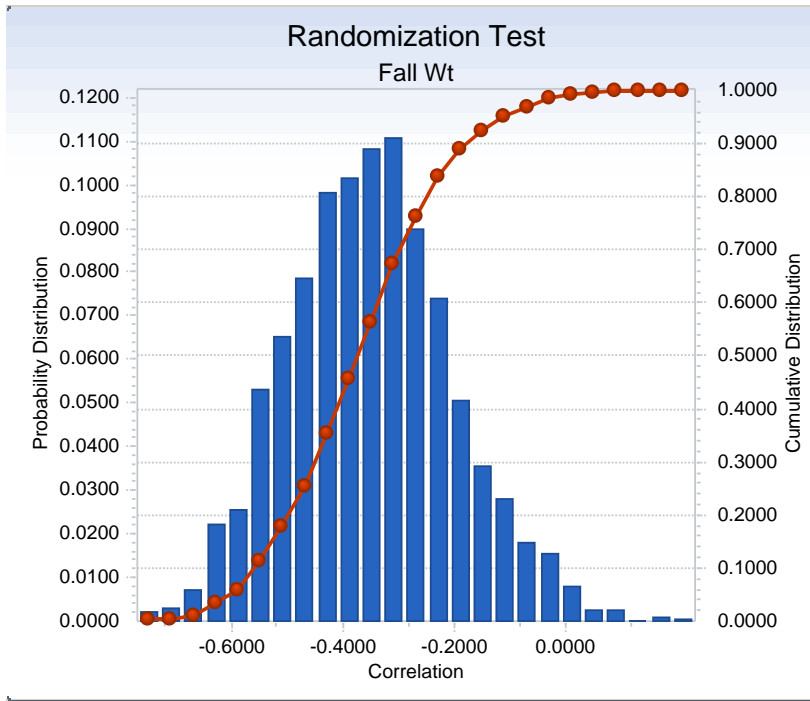


Figure A72 Randomization tests summary of sampling distribution of correlation coefficient between replacement ratio and relative F for fall(top) and spring (bottom) survey indices.

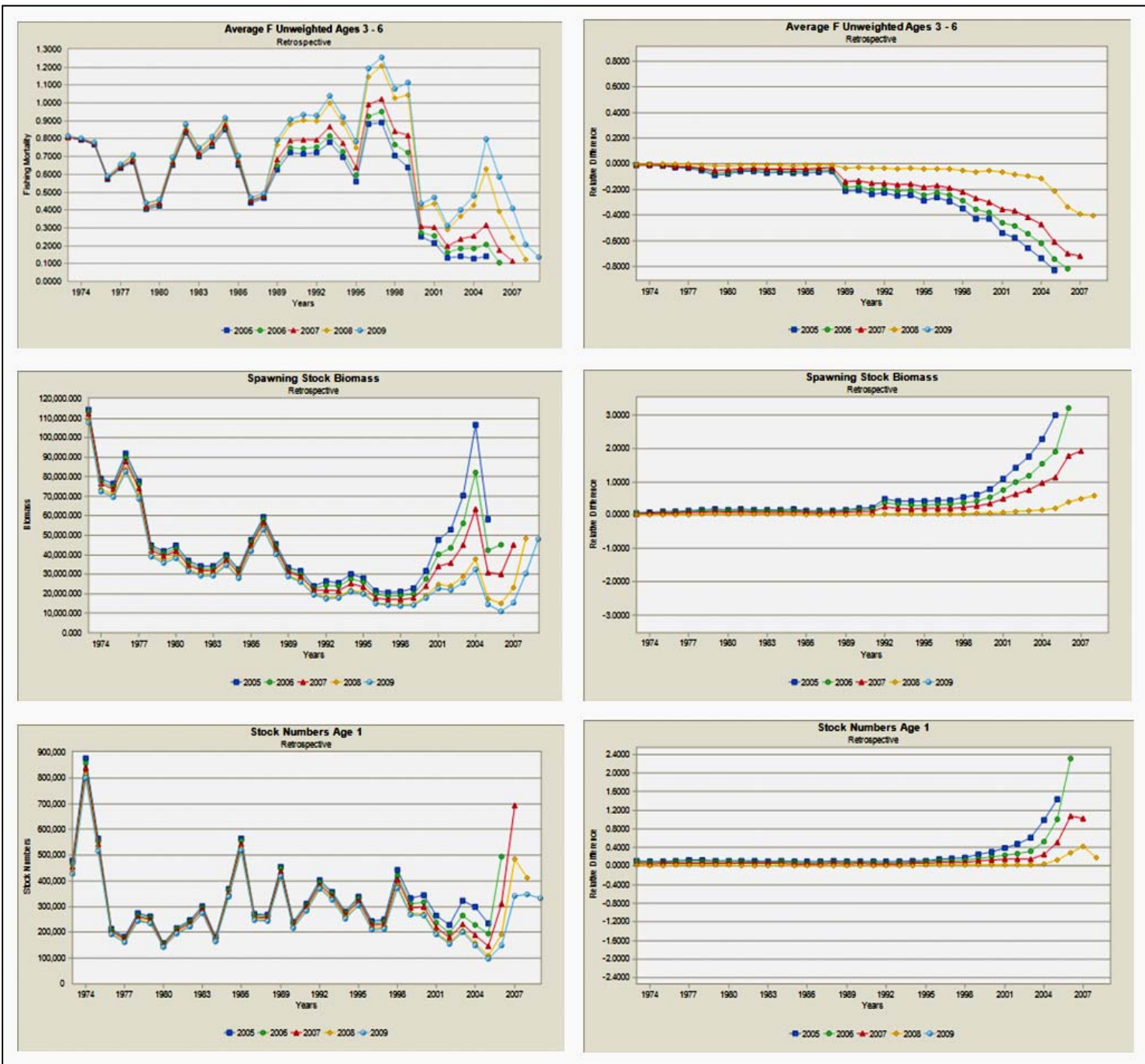


Figure A73: Age 6+ ASAP formulation ($M = 0.4$ model with NO consumption) - Retrospective plots of fully selected F, SSB and Recruitment.

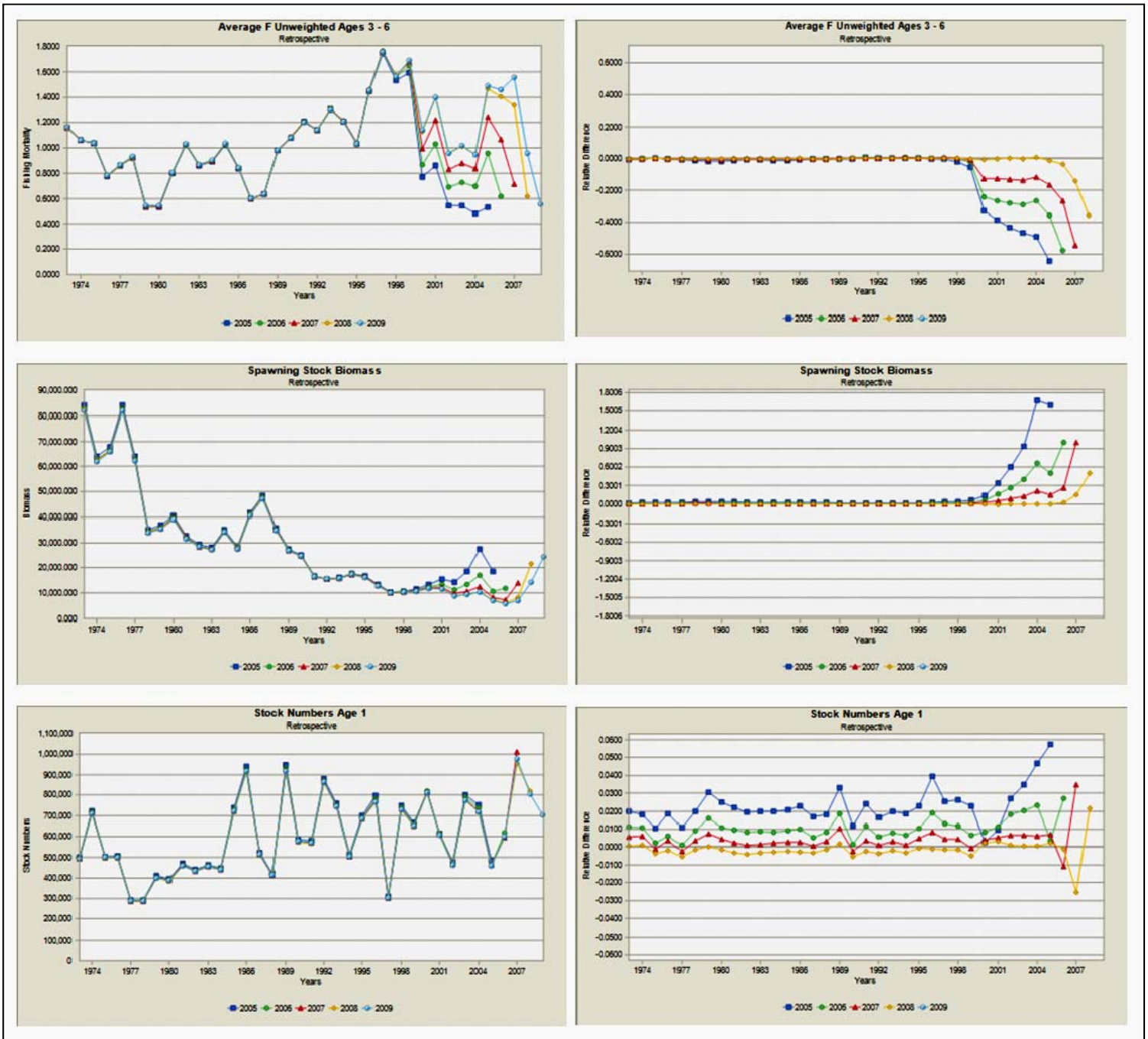


Figure A74 Age 6+ ASAP formulation ($M = 0.15$ model WITH consumption) - Retrospective plots of fully selected F, SSB and Recruitment.

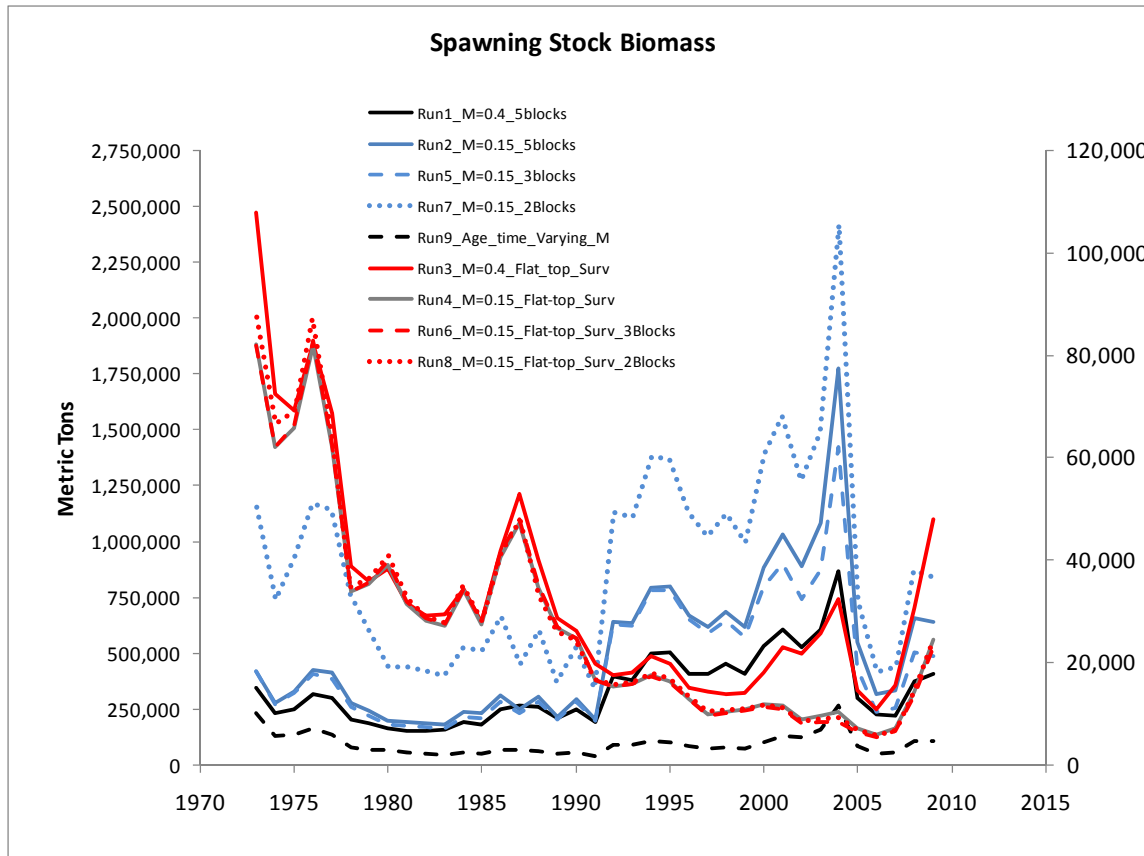


Figure A75: Silver hake SSB sensitivity analyses to the base combined ASAP model.

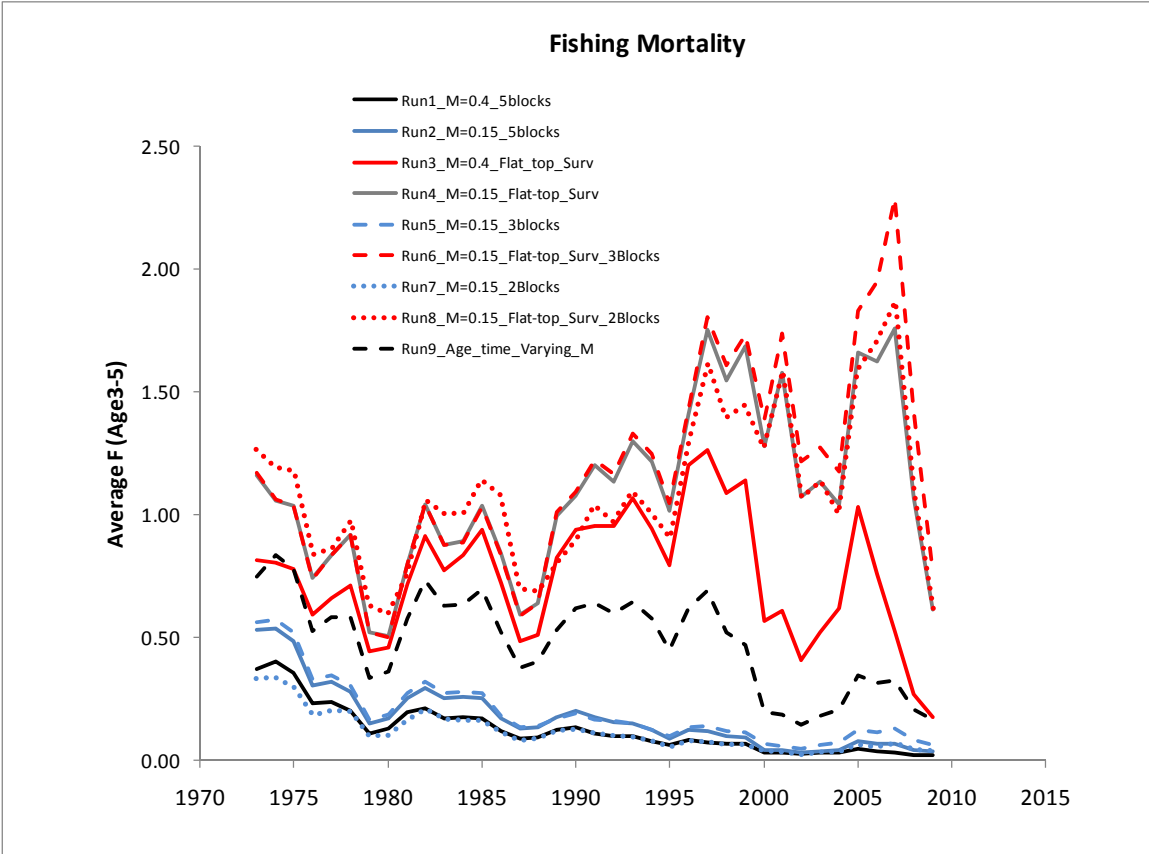


Figure A76: Silver hake SSB sensitivity analyses to the base combined ASAP model.

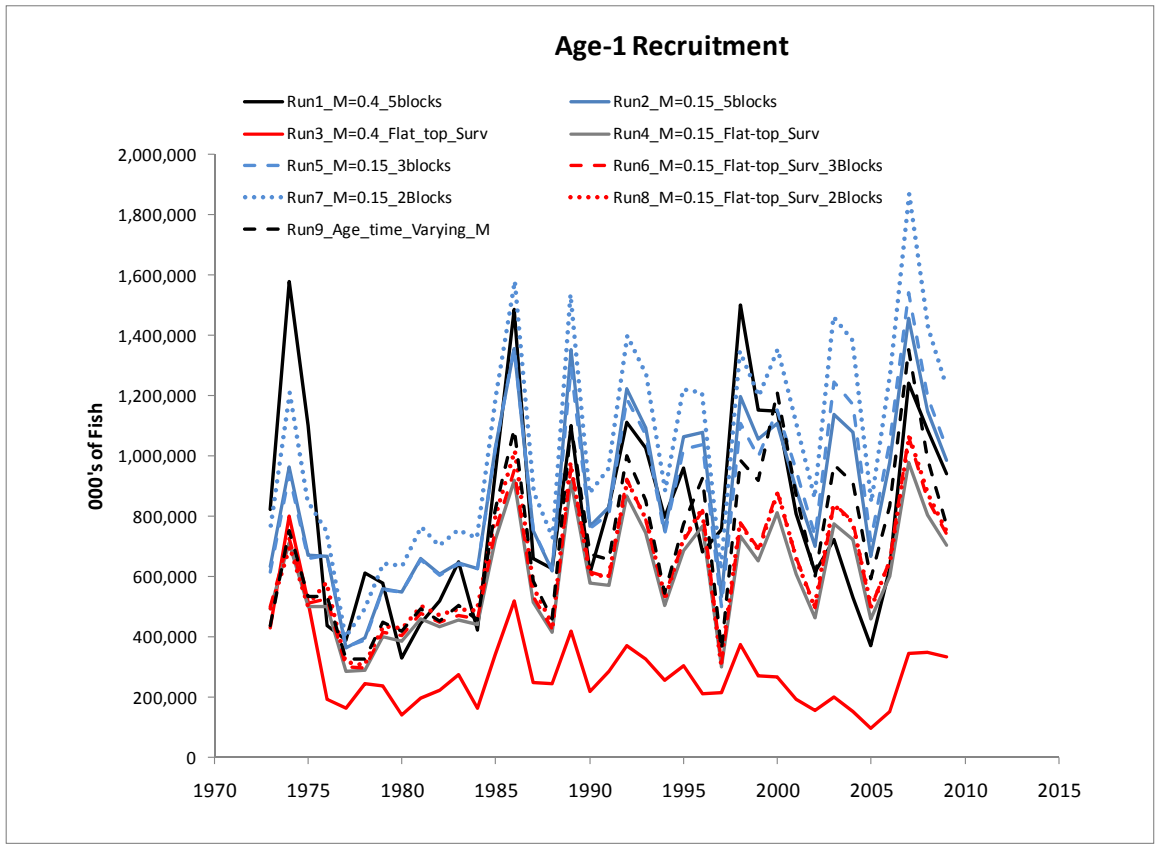


Figure A77: Silver hake SSB sensitivity analyses to the base combined ASAP model.

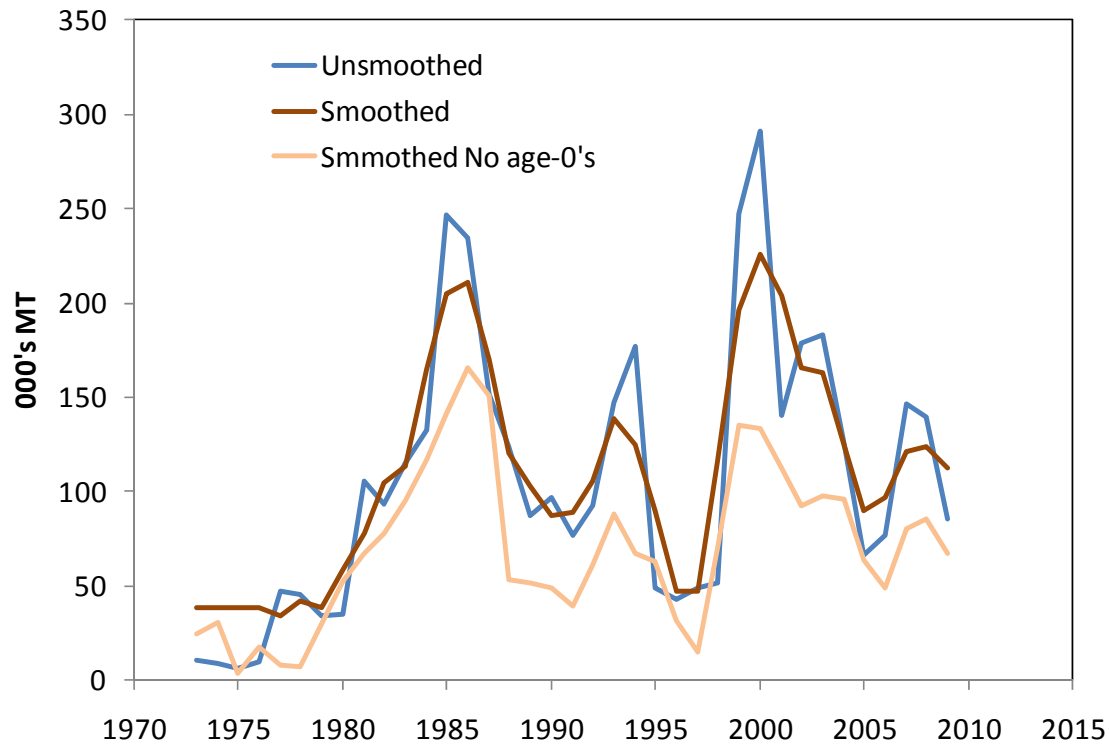


Figure A78. A comparison of silver hake consumption trends with and without the 3 year moving average including the adjustment for age-0.

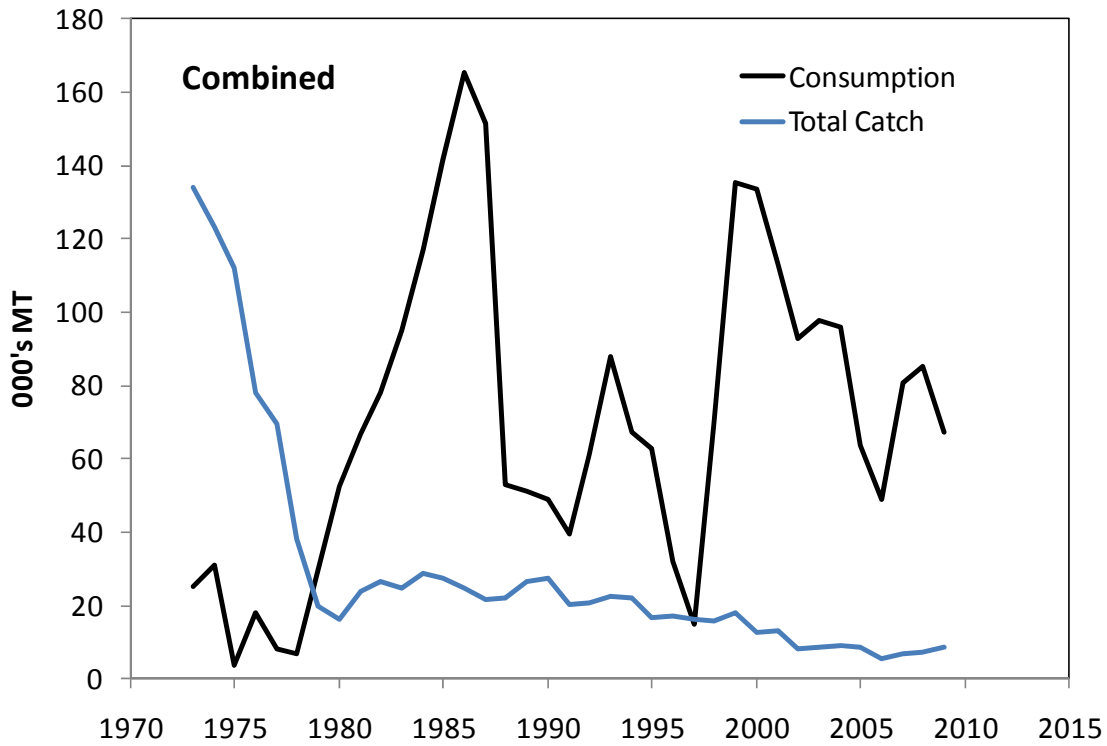


Figure A79. Estimates of total silver hake biomass removed, as that consumed by major fish predators and total catch in the fishery. A three year smoothed estimate of consumption is also shown.

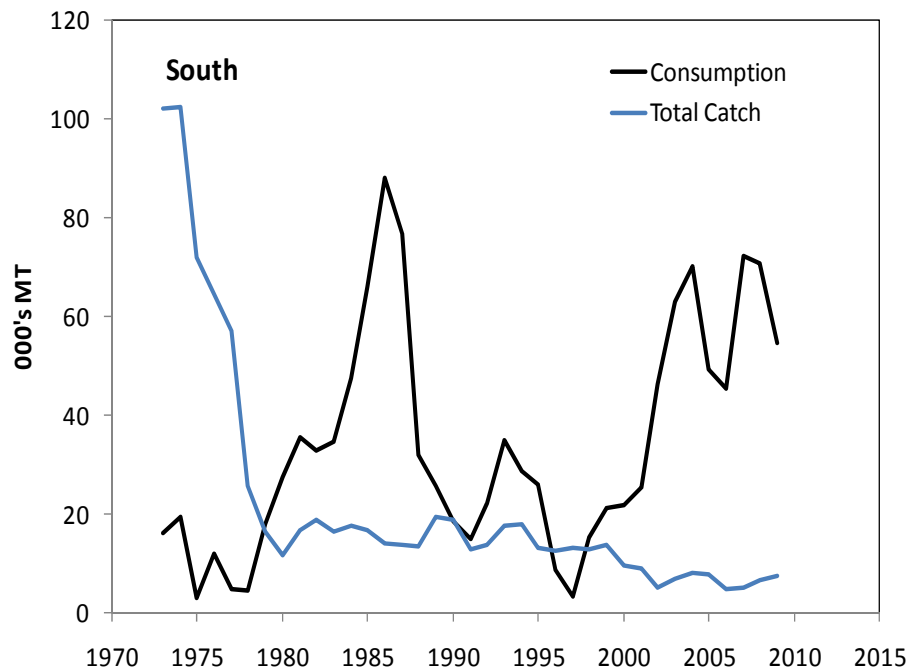
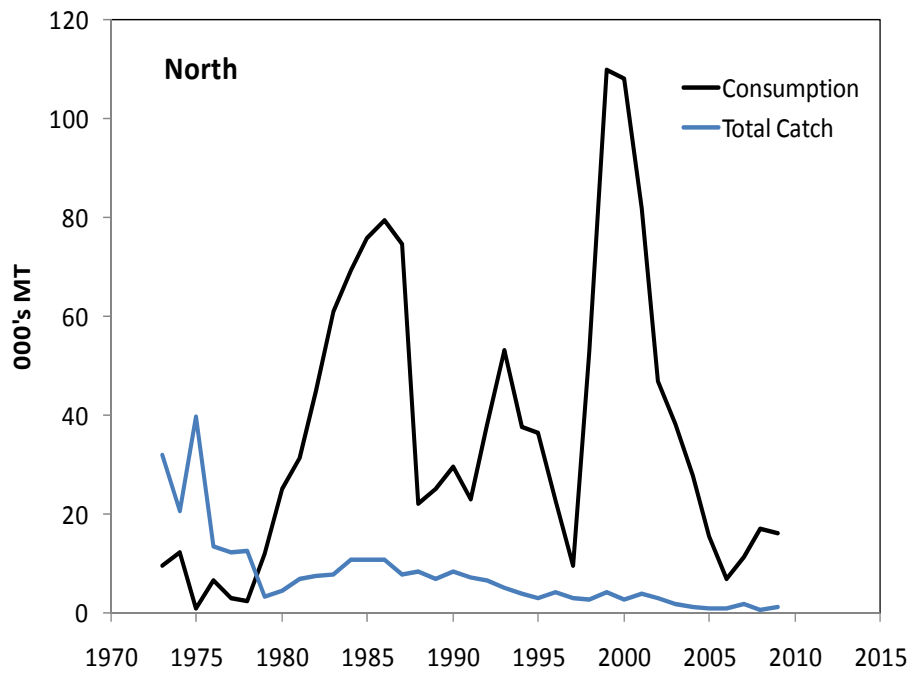


Figure A80. Estimates of total silver hake biomass removed, as that consumed by major fish predators and total catch in the fishery for the north (top) and south (bottom). A three year smoothed estimate of consumption is also shown.

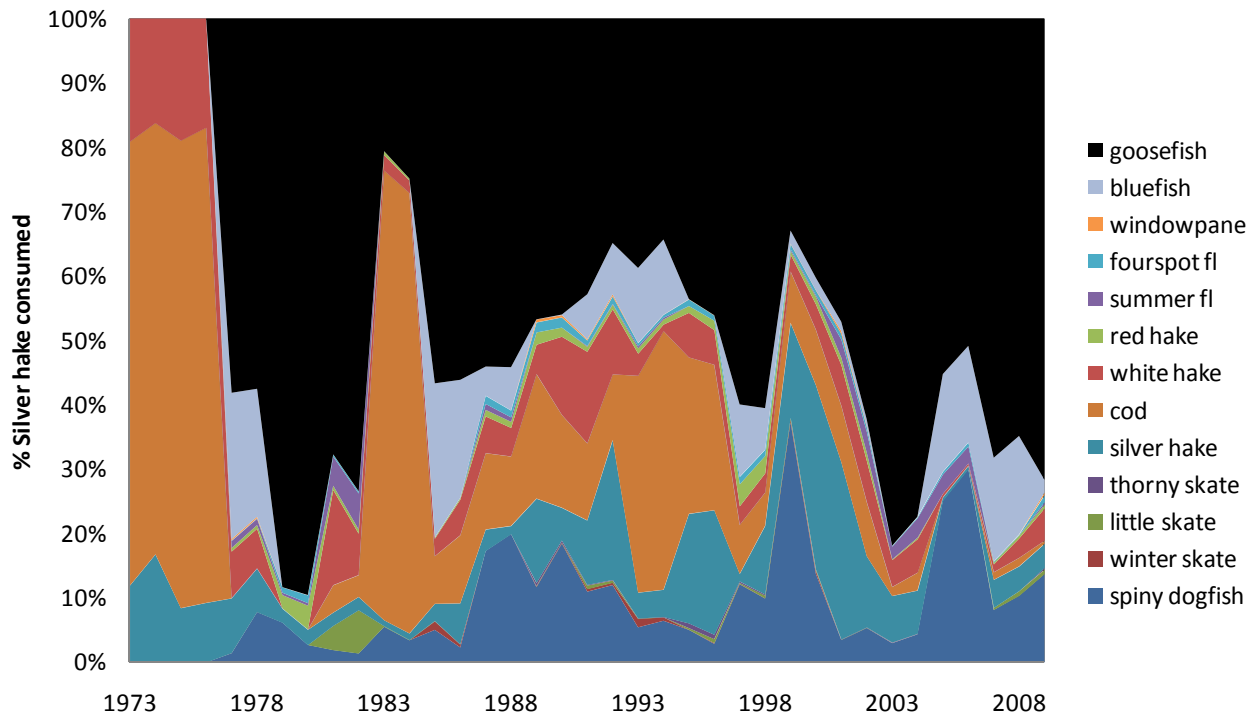


Figure A81. Consumption of silver hake by predator, for all predators, in both areas.

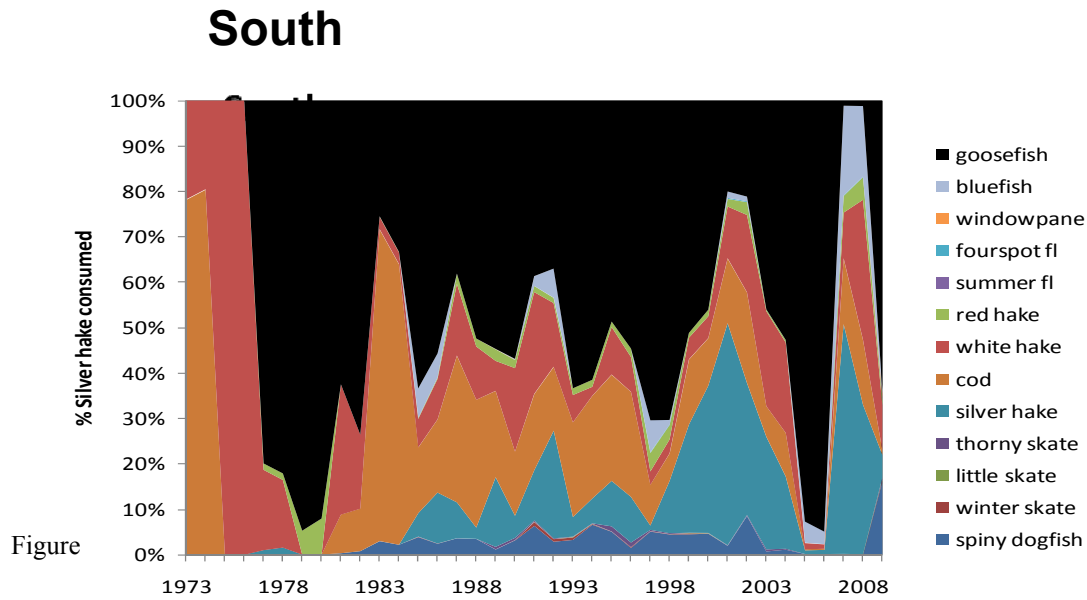
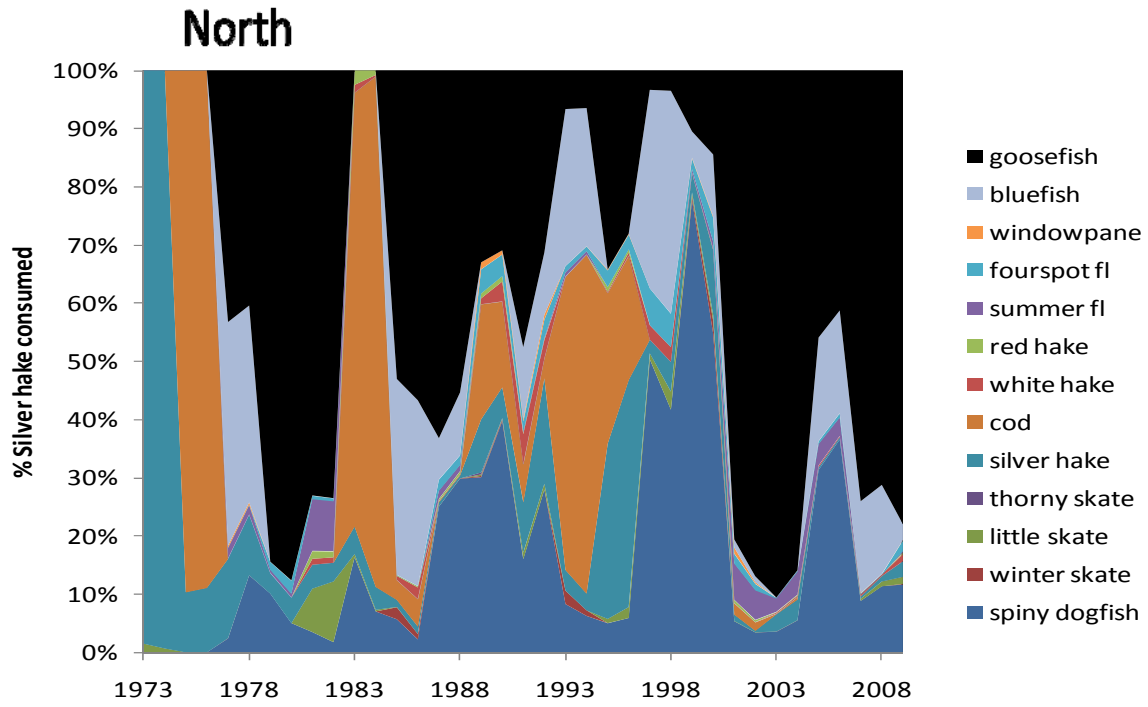


Figure A82. Consumption of silver hake by predator, for all predators, for north (top) and south (bottom)

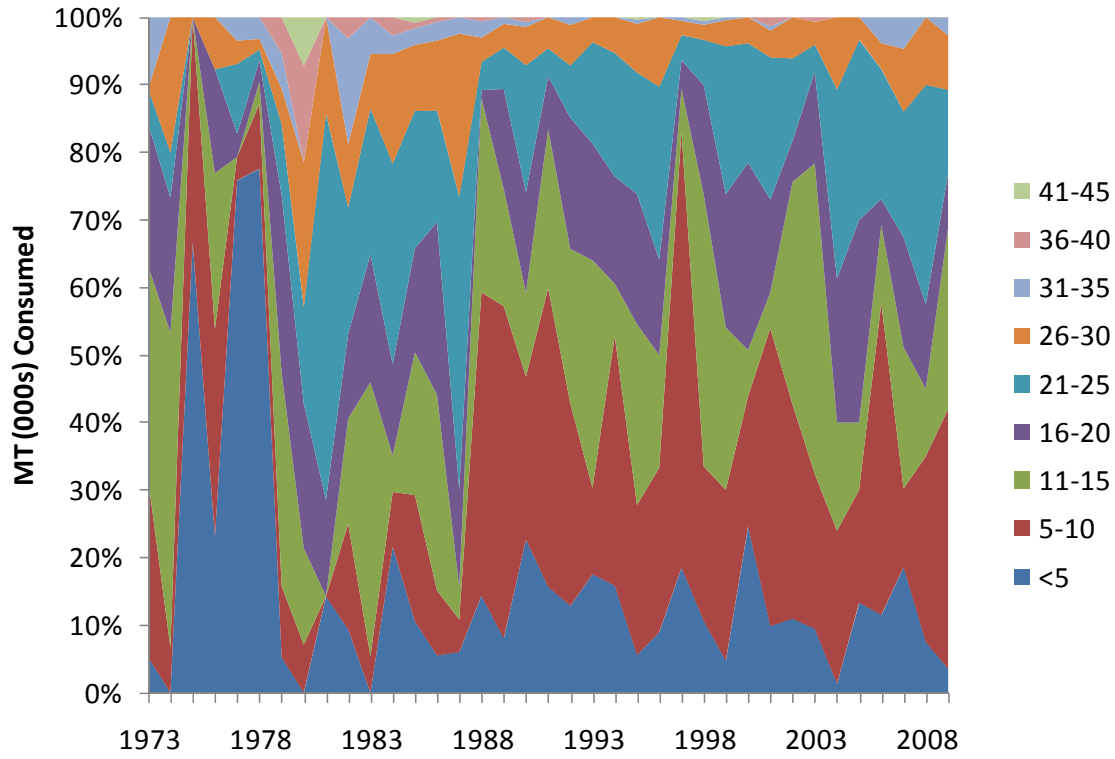


Figure A83. Proportion of total consumption by size classes of silver hake eaten by the predators in this study.

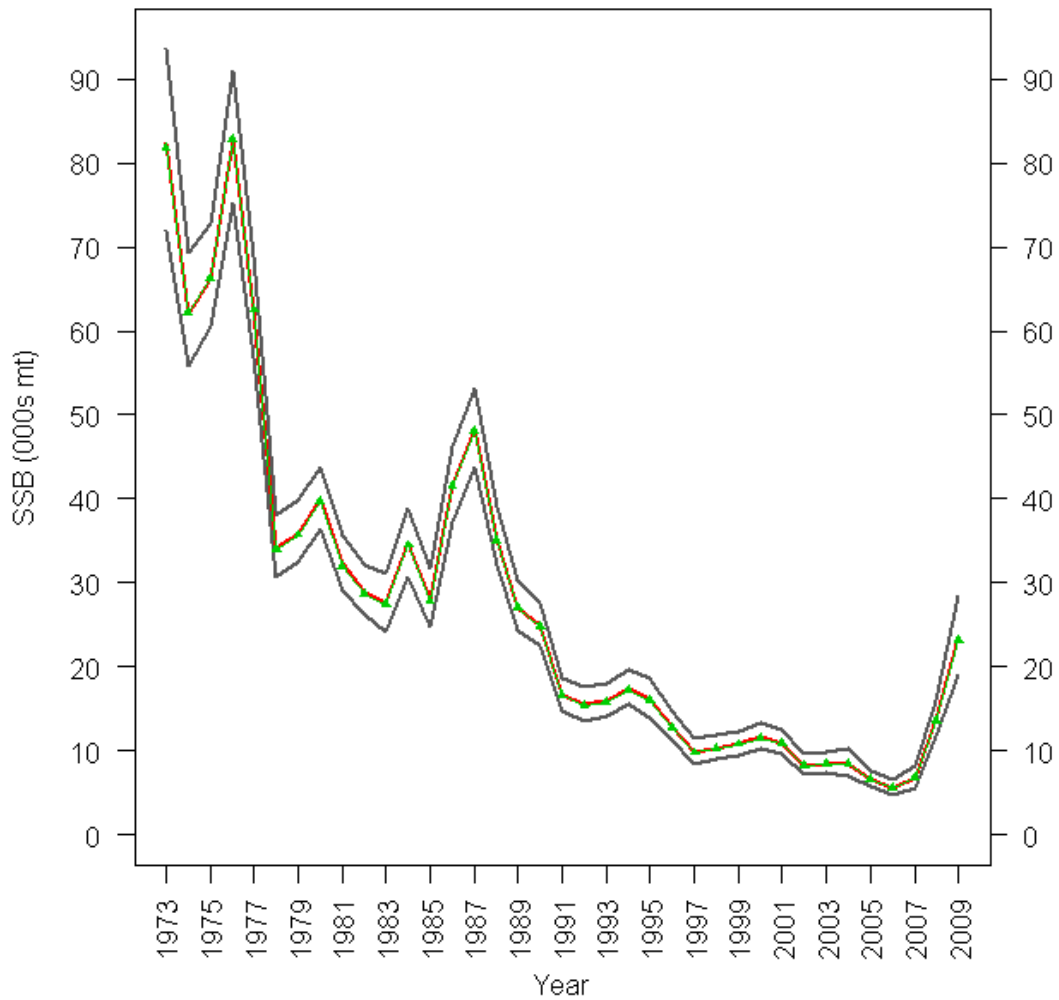


Figure A84. A 90% probability interval for silver hake spawning stock biomass (SSB) in thousands of mt is plotted for the entire time series. The median value is in red, while the 5th and 95th percentiles are in dark grey. The point estimate from the base model (joint posterior modes) is shown in the thin green lined with filled triangles. (ASAP base model).

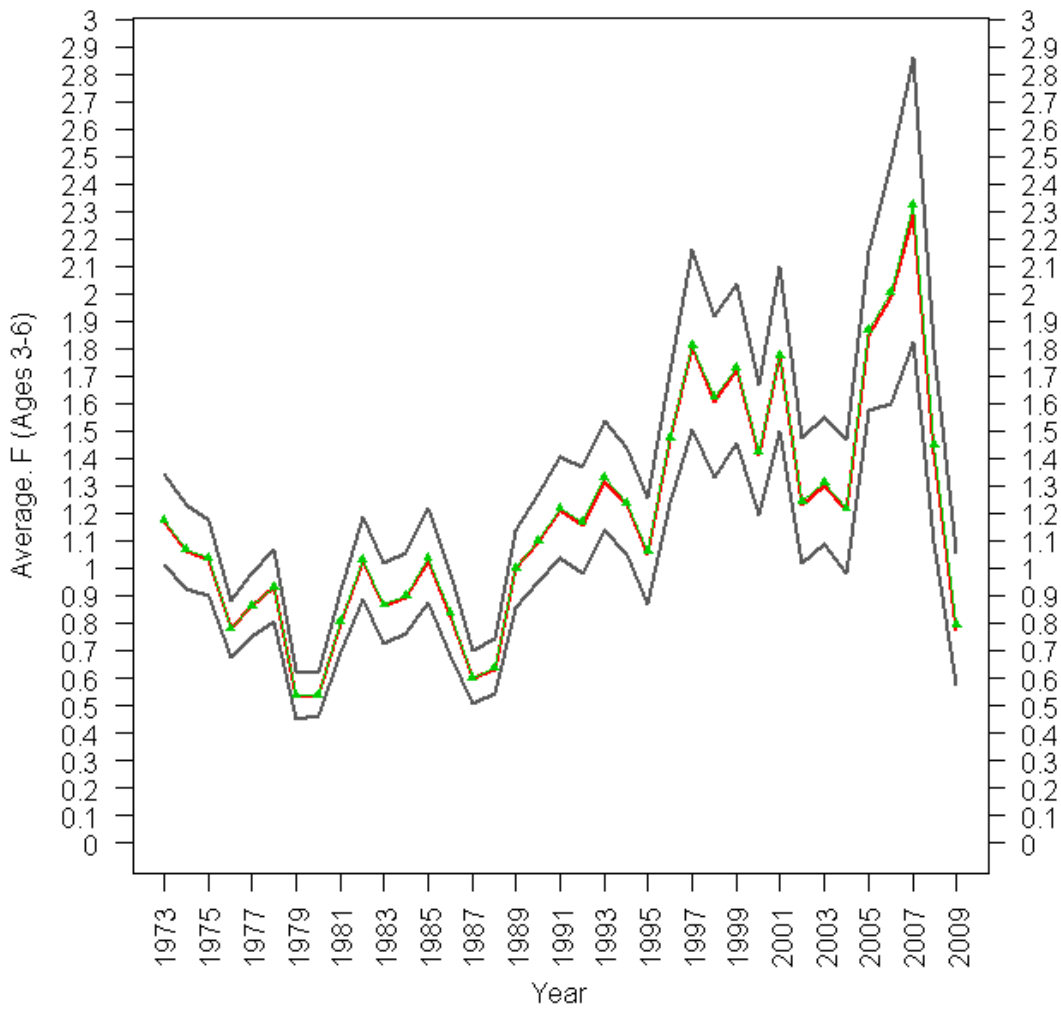


Figure A85. A 90% probability interval for the average F on ages 5-7 (F5-7) for silver hake is plotted for the entire time series. The median value is in red, while the 5th and 95th percentiles are in dark grey. The point estimate from the base model (joint posterior modes) is shown in the thin green lined with filled triangles. (ASAP base model).

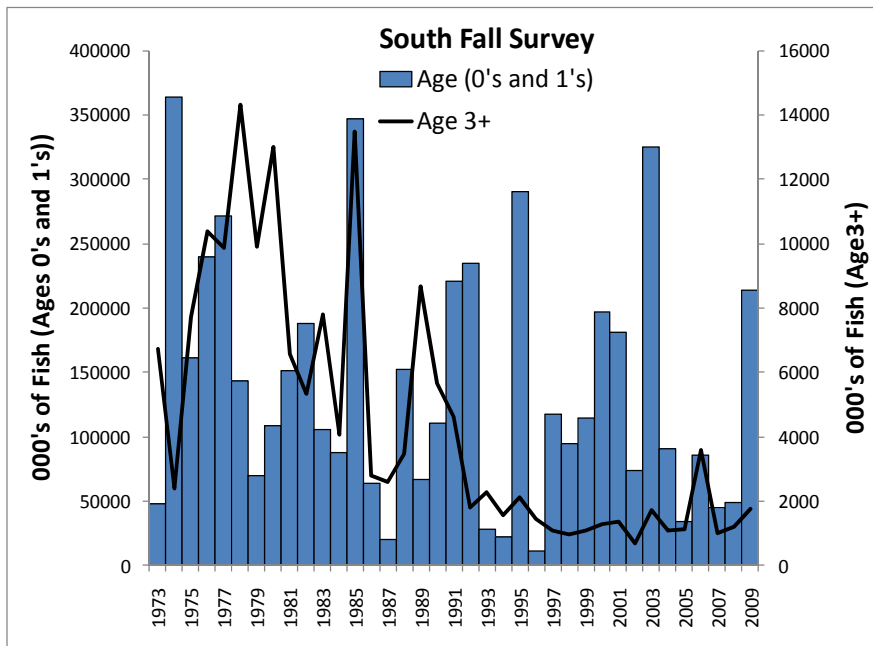
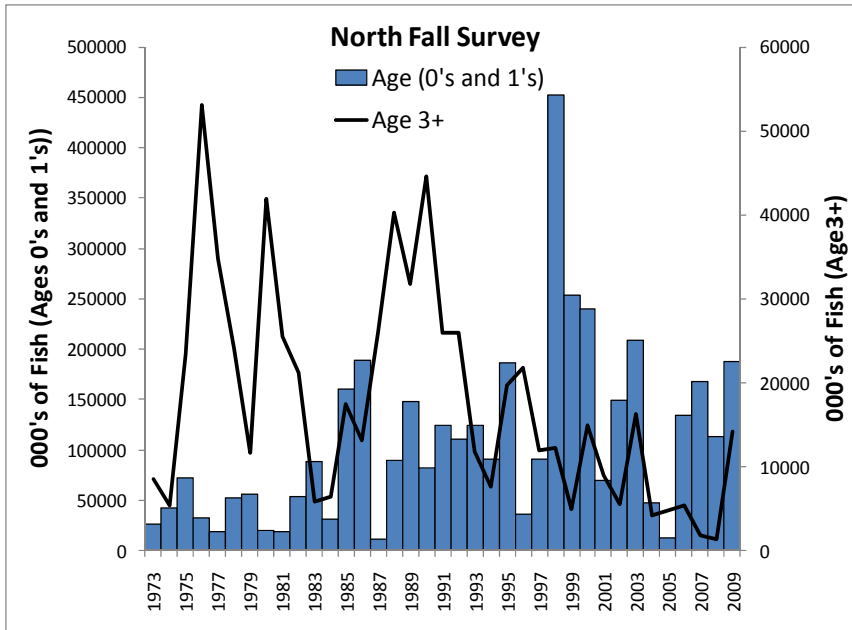


Figure A86: Recruitment (ages 0's and 1's) and adult abundances (ages 3+) derived from the NEFSC Fall bottom trawl Survey in the northern (TOP) and southern (BOTTOM) management areas