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Part I of American Plaice Div. 3LNO Research Recommendations: Data Explorations with ADAPT Analyses

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Abstract

During the 2005 SC meeting, STACFIS recommended that a number of ADAPT formulations be explored for Div. 3LNO American plaice. This paper addresses some of the items recommended including using the most recent time series (Campelen data only) for the Canadian RV surveys as a tuning index and using only unconverted data for Canadian surveys by gear (Engels and Campelen). In addition, a comparison of abundance and biomass between the Canadian surveys of Div. 3LNO and the Spanish Div. 3NO survey in the NAFO Regulatory Area (NRA) is provided, as well as an ADAPT formulation that includes the Spanish Div. 3NO survey data. Future work continues on estimation of M and the timing of changes in M.

Introduction

VPA

An accepted VPA using a formulation of ADAPT (Gavaris, MS, 1999) has been the basis of the assessment of American plaice in NAFO Divisions 3LNO since 2001 (see Morgan *et al.* MS 2001, 2002, 2003; Dwyer *et al.*, 2005). STACFIS noted that there were some concerns with a number of issues with regards to the formulation used for this stock given the uncertainties around the estimate of natural mortality (M), and that some time had passed since different formulations had been examined (Morgan et al., 1999; Morgan and Brodie 2001).

Therefore STACFIS at the 2005 SC meeting recommended the following for American plaice Div. 3LNO:

STACIFS noted that it had been some time since alternative formulations of the population model for this stock had been explored. Therefore STACFIS recommends that a number of ADAPT formulations be explored for Div. 3LNO American plaice, including shortening or splitting the tuning indices in conjunction with varying natural mortality that is included in the current model. In addition, further comparisons between the Canadian surveys of Div. 3LNO and the Spanish Div. 3NO survey in the NRA of Div. 3NO should be carried out, including comparisons of trends in overall abundance, age by age abundance and a comparison of retrospective patterns in recruitment for VPA formulations including and excluding the Spanish Div. 3NO survey.

This paper presents the first attempts at responding to the recommendations, and includes a number of ADAPT runs, the residuals and statistics from these runs, and some output information. As well, the paper

updates and provides more information on the comparison between the Canadian spring RV surveys and the Spanish Div. 3NO survey.

Methods

In 2005, the formulation for the ADAPT included the following:

- Catch-at-age for ages 5-14 with a plus group at age 15 which included all catch from ages 15 to 21.
- The ratio of F on the plus group to F on the last true age was set at 1.0. M was set at 0.2 except at 0.53 for all ages from 1989 to 1996 (Morgan and Brodie, 2001).
- M was set at 0.2 except at 0.53 for all ages from 1989 to 1996 (Morgan and Brodie, 2001).
- Survey ages 5 to 14 were used in the calibration matrix.
- Numbers at age 5 to 14 from the Canadian spring (1985 to 2004) and fall (1990 to 2003) surveys were used. Numbers are Campelen plus Campelen-converted data.

An ADAPT run using the above formulation provided a model with a good fit to the data. See Table 1 and Figures 1-4 for output statistics from the 2005 VPA base run.

The following alternative input datasets were explored using the same model formulation as in the 2005 assessment:

1) Exclusion of converted survey data (ie using Campelen data only)

All inputs the same as 2005 formulation except tuning indices as follows:

- Canadian RV spring survey 1996-2004
- Canadian RV fall survey 1995-2003

2) No conversion of survey data (Engels and Campelen data as separate indices)

All inputs the same as 2005 formulation except tuning indices as follows:

- Canadian spring survey 1985-1995 (Engels data)
- Canadian fall survey 1990-1994 (Engels data)
- Canadian spring 1996-2004 (Campelen data)
- Canadian fall survey 1995-2003 (Campelen data)

3) Inclusion of Spanish Div. 3NO survey data

Repeat 2005 assessment run, adding:

- Spanish Div. 3NO survey mean numbers per tow, ages 5-14, 1998-2004

Results

From the 2005 assessment run, survey catchabilities (q) show that q is lower for the youngest fish (age 5) and also somewhat lower for the older fish in the fall, whereas the q for spring seems more constant across age (Figure 1; see Dwyer *et al.* 2005). There is some tendency for there to be a lag between the predicted and observed survey estimates at age for the fall survey but a better fit for the spring survey (Figure 2). The residuals from the spring survey showed little pattern although there was a tendency for them to be larger in more recent years. The residuals from the fall survey seem to display some pattern which is caused by some all positive years in the early part of the time series, and two almost all negative years in 1996 and 1997 (Figure 3). The most recent year also shows almost all negative residuals. Residuals are larger for the older ages in the fall survey (Figure 4).

Residuals were examined and compared to the ADAPT used in the 2005 assessment.

1) Exclusion of converted survey data (Campelen data only)

Plots of catchability of spring and fall surveys using Campelen data only indicate that the fall survey generally catches more fish and especially more young fish (Figure 5). This may be a result of higher temperatures in the fall, or the fact that plaice are thought to undergo some seasonal movement to deeper water. In the spring some fish may be out of the survey area, both because they have not migrated back on to the bank and because the survey doesn't go to deeper water. Both surveys catch about the same amount of fish > 10 years old.

In the plots of predicted versus observed survey estimates, the fall survey indicates a good fit (with the exception of the 1996 point) whereas the data do not fit the model as well for the spring survey (Figure 6).

The residuals from the spring survey show a slightly better pattern in more recent years but there are some year effects: 1997 was an all-negative year and 1999 was an all-positive year (Figure 7). There is less of a pattern in the fall time series (Figure 7). The 13- and 14-year-old fish are always most positive or most negative in most years. It is noted that the age 13 fish tend to have the highest errors in each of the survey series (Figure 8).

2) No conversion of survey data (Engels and Campelen data as separate indices)

Patterns in catchabilities are consistent between spring and fall Engels (fish similar depths both seasons). However catchabilities are higher for the spring Engels time series. Both series catch more older fish, whereas the Campelen series have lower catcabilities and catch more younger fish. Spring and fall Campelen show different catchability patterns (different depths between seasons) (Figure 9).

All survey indices show a reasonably good fit of observed versus predicted survey estimates. The fit of the model to the Campelen data series is not as good (Figure 10).

Spring Engels shows an increase in size of residuals in the latter part of the time series whereas in the early part were almost all negative. In the Spring Campelen 1997 is all negative and 1999 all positive (as before). In Fall Engels the 1990 year is all negative and 1993 is all positive. In general there is an increasing trend in residuals over time. In the Fall Campelen time series, although 1996 is all positive, there doesn't seem to be much of a trend otherwise (Figure 11).

Again, the older fish in each survey show the highest residuals: however, the 13 year old fish are higher than 14 year olds in ¾ surveys (Figure 12).

3) Inclusion of Spanish Div. 3NO survey data

There are similar patterns in catchabilities for Spring and Fall surveys; however, pattern of q from the Spanish Div. 3NO survey has a different pattern (Figure 13).

The converted time series for Canadian RV spring and fall show a good fit with a slight lag in fall series (as is seen in the base 2005 VPA). The scale of the plot of observed to predicted data for the Spanish Div. 3NO survey is smaller than from the Canadian RV surveys (Figure 14).

There is a slight increasing trend in Canadian RV spring survey residuals by year; some all positive years from the Canadian RV fall survey. Scale indicates Spanish Div. 3NO survey has an overall better fit (Figure 15).

There is the same trend of large residuals for older ages (especially on age 13s) for each survey as noted in many of the other runs (Figure 16).

Examining output

1) Exclusion of converted survey data (Campelen data only)

There is a slightly lower abundance/biomass and recruits and higher Fs in recent years estimated from Campelen data only (Figure 17).

2) No conversion of survey data (Engels and Campelen data as separate indices)

There is very little difference in output when compared to the 2005 VPA base run (Figure 18).

3) Inclusion of Spanish Div. 3NO survey data

There are slightly higher estimates of 5+ abundance, recruitment and Fs estimated when the Spanish Div. 3NO survey is included (Figure 19).

Comparison of Canadian RV spring survey and Spanish Div. 3NO survey

Overall trends

In 2002, overall trends in abundance and biomass were compared between the Canadian spring survey and the Spanish Div. 3NO survey (Dwyer *et al.*, 2002). It was concluded that although trends were similar in the NRA between both surveys, the Spanish Div. 3NO survey showed a different trend than the entire Canadian spring survey of Div. 3LNO. Based on the fact that the Spanish Div. 3NO survey covers only a small part of the entire stock area, it was decided that the Spanish Div. 3NO survey would not be used as an index in the American plaice Div. 3LNO assessment in 2005.

However, it is noted that other assessments use indices from surveys that cover less area than the entire stock and, in addition, there has been a change in the Spanish Div. 3NO survey to Campelen survey gear in 2001 and prior data converted to Campelen units. There are now 3 more years of data and this issue deserves to be examined again.

There appears to be a general trend of increase in biomass and abundance estimated from Can. spring surveys and Spanish Div. 3NO survey. However, there are some differences, especially in the last 2 years (Figure 20).

Age by age abundance trends

Age by age abundance comparison between surveys were plotted and used as inputs in the American plaice Divs. 3LNO assessment. These are plotted using an exploratory data analysis package, Fisheries Library in R (FLR; www.flr-project.org) and are standardized using the mean and standard deviation of each index. The plots show that the Spanish Div. 3NO survey shows the same age trends as the Canadian spring survey (Figure 21).

Retrospective patterns in recruitment

A comparison of retrospective patterns in recruitment for the base VPA formulation from 2005 including and excluding the Spanish Div. 3NO survey was also carried out by sequentially removing one year of data from the input data sets. It was noted that inclusion of the Spanish Div. 3NO survey to the ADAPT base formulation caused an increase in the retrospective pattern. This may in part be due to higher estimates of the 1998 cohort from the Spanish Div. 3NO survey at ages 5 and 6, relative to estimates of these cohorts in the Canadian surveys at these ages.

Conclusions and Comments

All three runs show reasonably good fits to the data, with the separate indices run showing the lowest MSE. This run also has the lowest error on catchabilities and better error on population numbers. However, this run also has patterns in the residuals that appear to be slightly worse than the patterns in the residuals of the 2005 base run. The residuals from the Campelen only run had slightly less pattern than those of the 2005 base run. The residuals from the run which included the Spanish Div. 3NO survey data were lower than the residuals in the surveys of the other two surveys in that run but the fit of predicted to observed index was not good. There does not seem to be one run "better" than the base run nor one alternative "better" than the other.

Trends in biomass and abundance for American plaice in Divs. 3LNO from both surveys appear to be generally increasing over the time series, with some differences in the most recent years and in 2000. Age by age abundance comparisons indicate that all of the surveys have similar patterns. However, concern was expressed regarding the inclusion of an index that covers such a small area of the entire stock pattern.

It was also noted that addition of the Spanish Div. 3NO survey data to the calibration data set led to more pronounced retrospective patterns in recruitment. This is caused by a stronger recruitment signal in the Spanish Div. 3NO survey.

It was concluded that separating the converted and non-converted data did not improve the fit of the model. It was also decided that the Spanish Div. 3NO survey would be added to the current ADAPT model with the caveat that the inclusion of this index be examined periodically to ensure it continues to track the index especially if the status of the stock begins to improve in Div. 3L.

There will be a further re-working of ADAPTs next year when varying M is examined in more detail as well as the timing of the change in M. Some of the above may change then.

References

Dwyer, K.S., W. B. Brodie, and M. J. Morgan. 2002. Comparison of Canadian and Spanish Survey Results for American Plaice and Yellowtail Flounder from the NAFO Regulatory Area in Divisions 3NO. NAFO SCR Doc. 02/65, Serial No. 4677, 10p.

Dwyer, K. S., M. J. Morgan, D. Maddock Parsons, W. B. Brodie, B. P. Healey, P.A. Shelton and H. Murua. 2005. An assessment of American plaice in NAFO Divisions 3LNO. NAFO SCR Doc. 05/61, Ser. No. N5147.

FLR. http://flr-project.org/

Gavaris, S. MS. 1999. ADAPT User's Guide. Version 3.0.

Morgan, M.J., W.B. Brodie, and D. Maddock Parsons. 1999. Virtual population analyses of the American plaice stock in Div. 3LNO from 1975 to 1997. NAFO SCR Doc. 99/58, Ser. No. N4117, 36p.

Morgan, M. J., and W. B. Brodie. 2001. An exploration of virtual population analyses for Div. 3LNO American plaice. NAFO SCR Doc. 01/4, Ser. No. N4368, 20p.

Morgan, M.J., W.B. Brodie, B.P. Healey, D Maddock Parsons, D. Stansbury, and D. Power. 2001. An assessment of American plaice in NAFO Divisions 3LNO. NAFO SCR Doc. 01/59, Ser. No. N4437, 70p.

Morgan, M.J., W.B. Brodie, B.P. Healey, D. Maddock Parsons, K.S.Dwyer and D. Power. MS 2002. An assessment of American plaice in NAFO Divisions 3LNO. NAFO SCR Doc. 02/70, Ser. No. N4683, 68p.

Morgan, M. J., W. B. Brodie, D. Maddock Parsons and B. P. Healey. 2003. An assessment of American plaice in NAFO Divisions 3LNO. NAFO SCR Doc. 03/56, Ser. No. N4874.

Table 1.

VPA statistics from ADAPT output			
	MSE	Rel Error on Pop. Est.	Rel. Error on *q*s
2005 Assessment	0.28	0.2-0.55	< 0.2
Exclusion of converted survey data (Campelen data only)	0.276	0.3-0.57	<0.22
No conversion of survey data (Engels and Campelen data as separate indices)	0.230	0.27-0.52	<0.22
Inclusion of EU survey data	0.280	0.21-0.39	<0.22

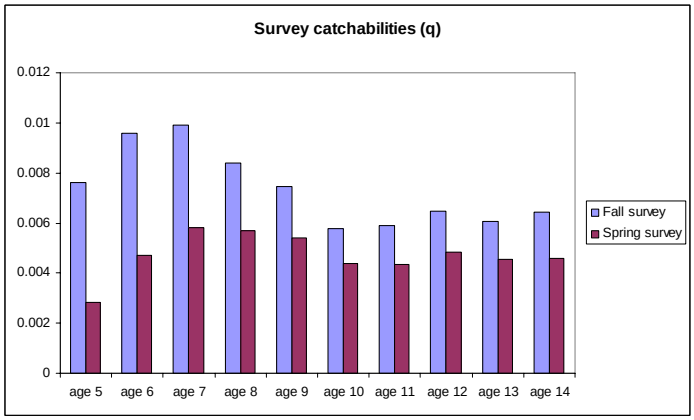


Figure 1. Survey catchabilities (*q*s) for each survey by age from 2005 VPA final run.

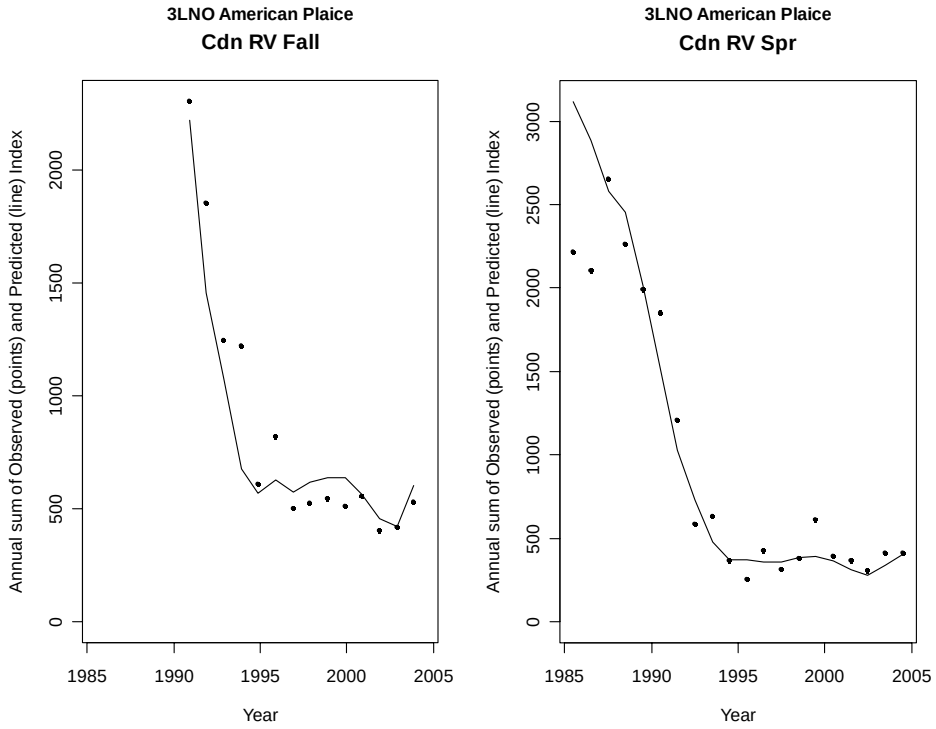


Figure 2. Observed versus predicted abundance for fall and spring indices over time for 2005 VPA final run.

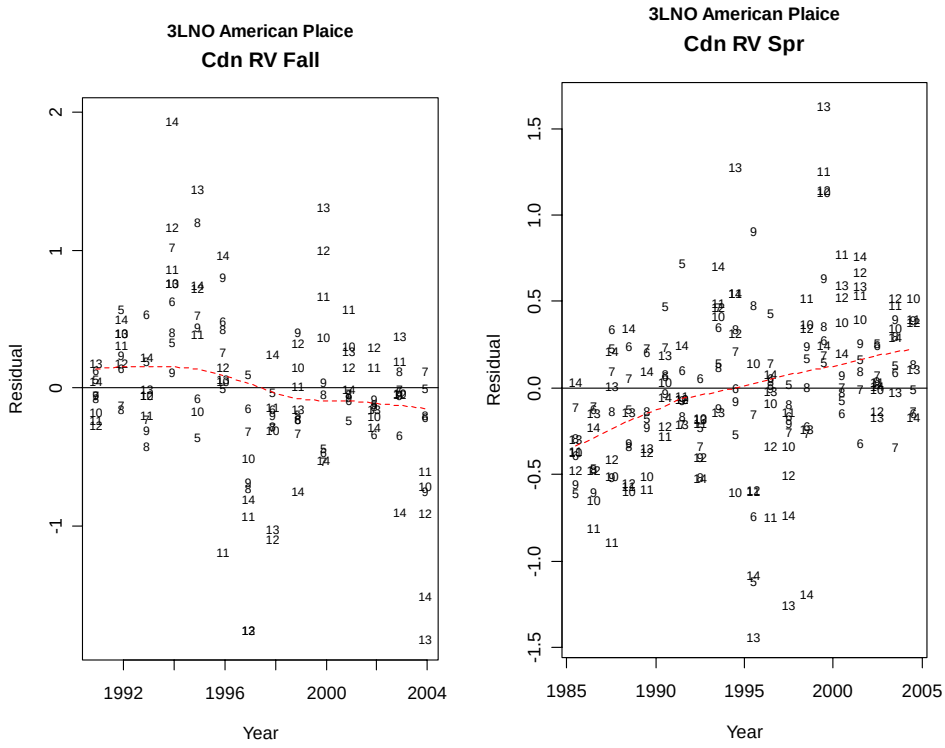


Figure 3. Residuals by year and month (numbers represent ages) for Canadian fall survey (left) and spring survey (right) from 2005 VPA final run. Red line is a Lowess smoother. Note the scales are different for each plot.

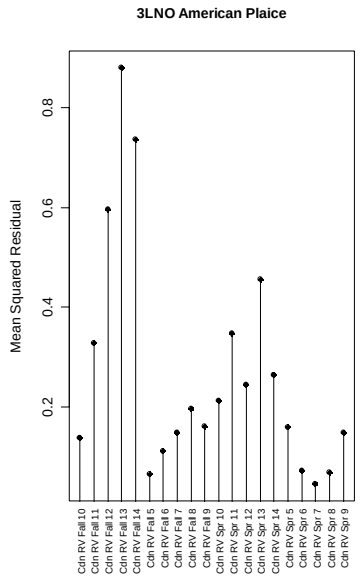


Figure 4. Mean squared residuals by age for each of fall and spring surveys from 2005 VPA final run.

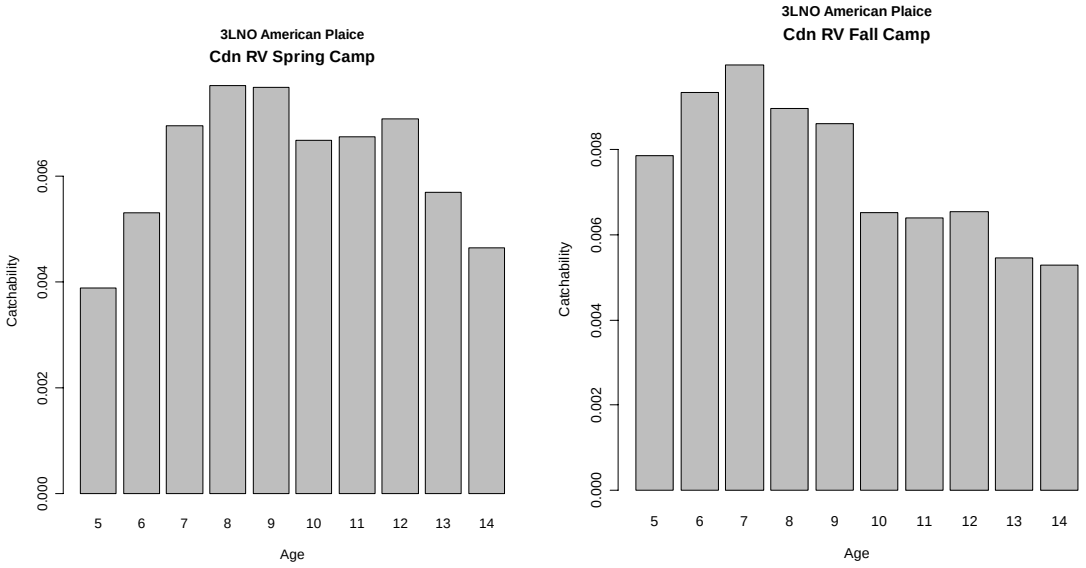


Figure 5. Survey catchabilities (*q*s) for each survey by age from Run 1 (exclusion of converted data).

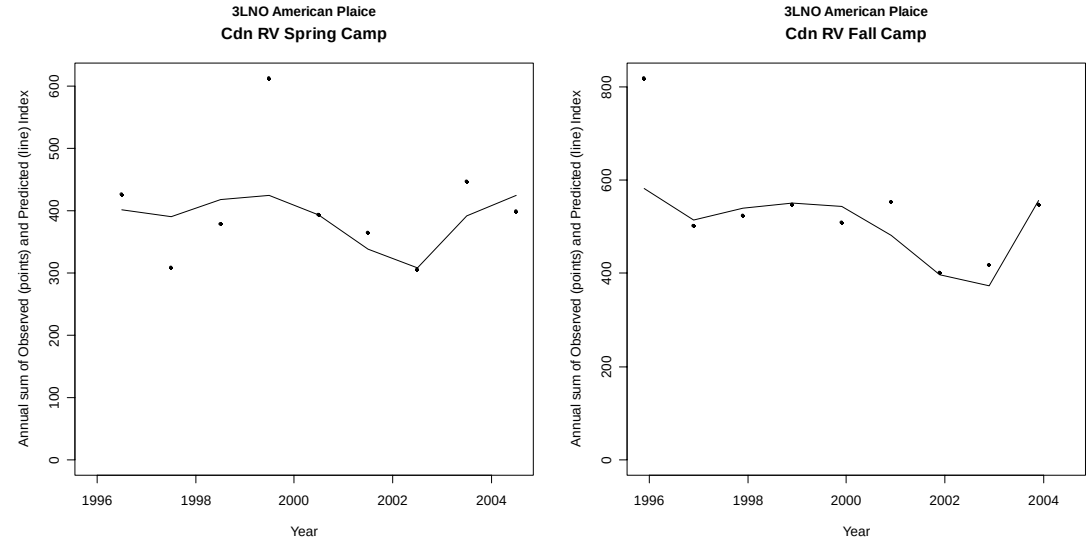


Figure 6. Observed versus predicted abundance for fall and spring indices over time for Run 1 (exclusion of converted data).

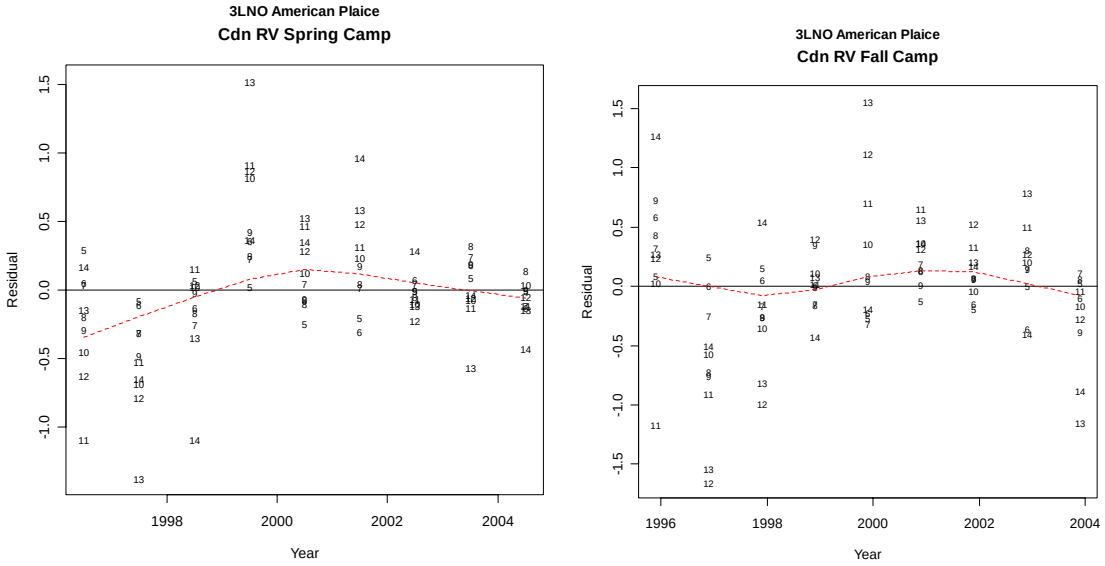


Figure 7. Residuals by year and month (numbers represent ages) for Canadian fall survey (left) and spring survey (right) from Run 1 (exclusion of converted data). Red line is a Lowess smoother. Note the scales are different for each plot.

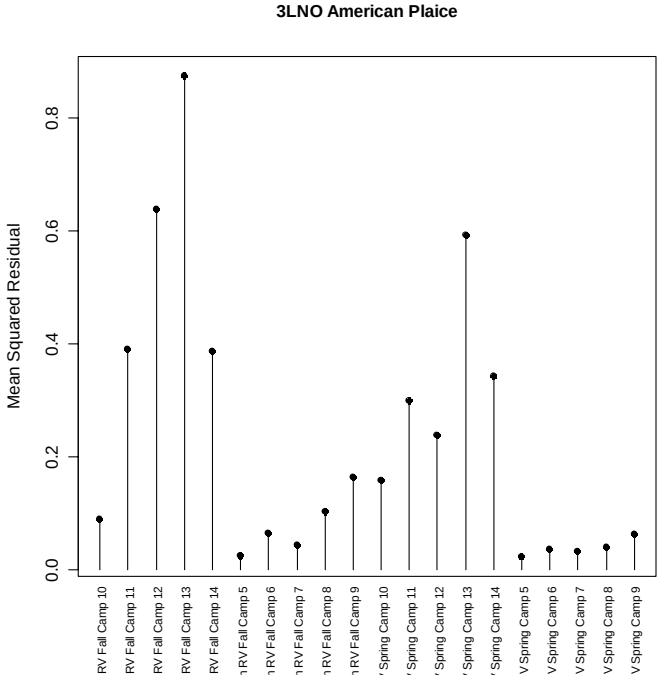


Figure 8. Mean squared residuals by age for each of fall and spring surveys from Run 1 (exclusion of converted data).

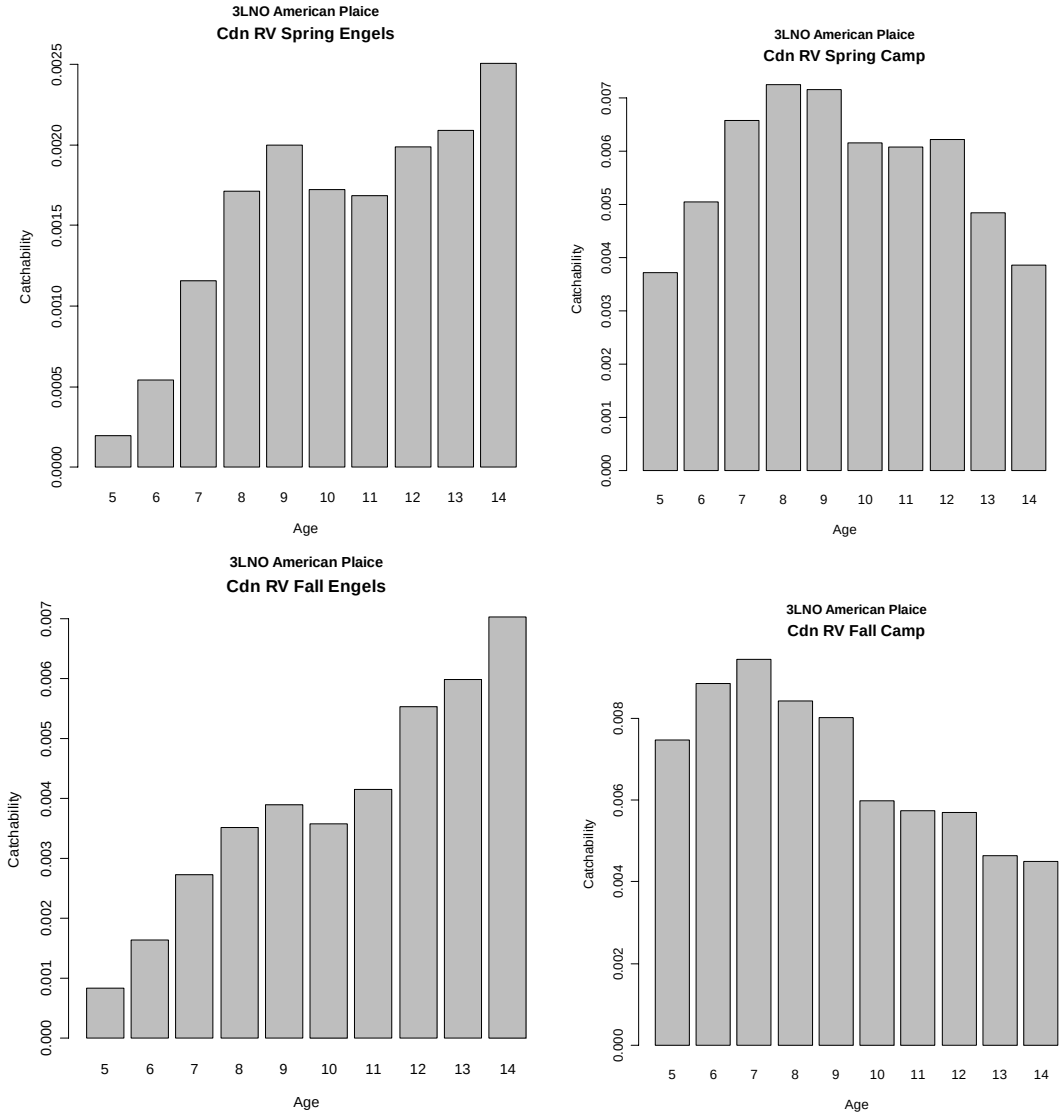


Figure 9. Survey catchabilities (*q*s) for each survey by age from Run 2 (no conversion of survey data).

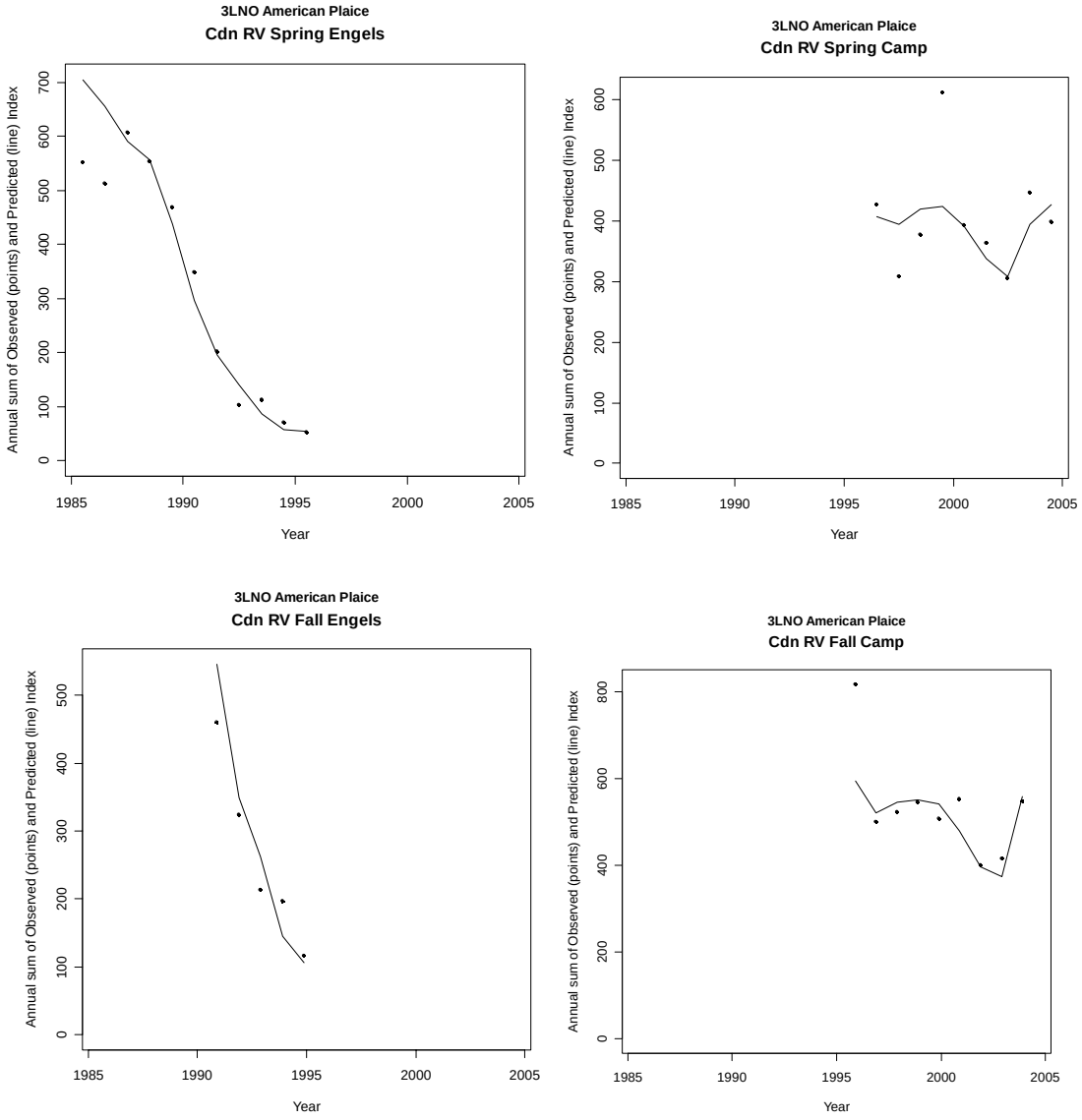


Figure 10. Observed versus predicted abundance for spring (top; Engels and Campelen) and fall (bottom; Engels and Campelen) indices over time for Run 2 (no conversion of survey data).

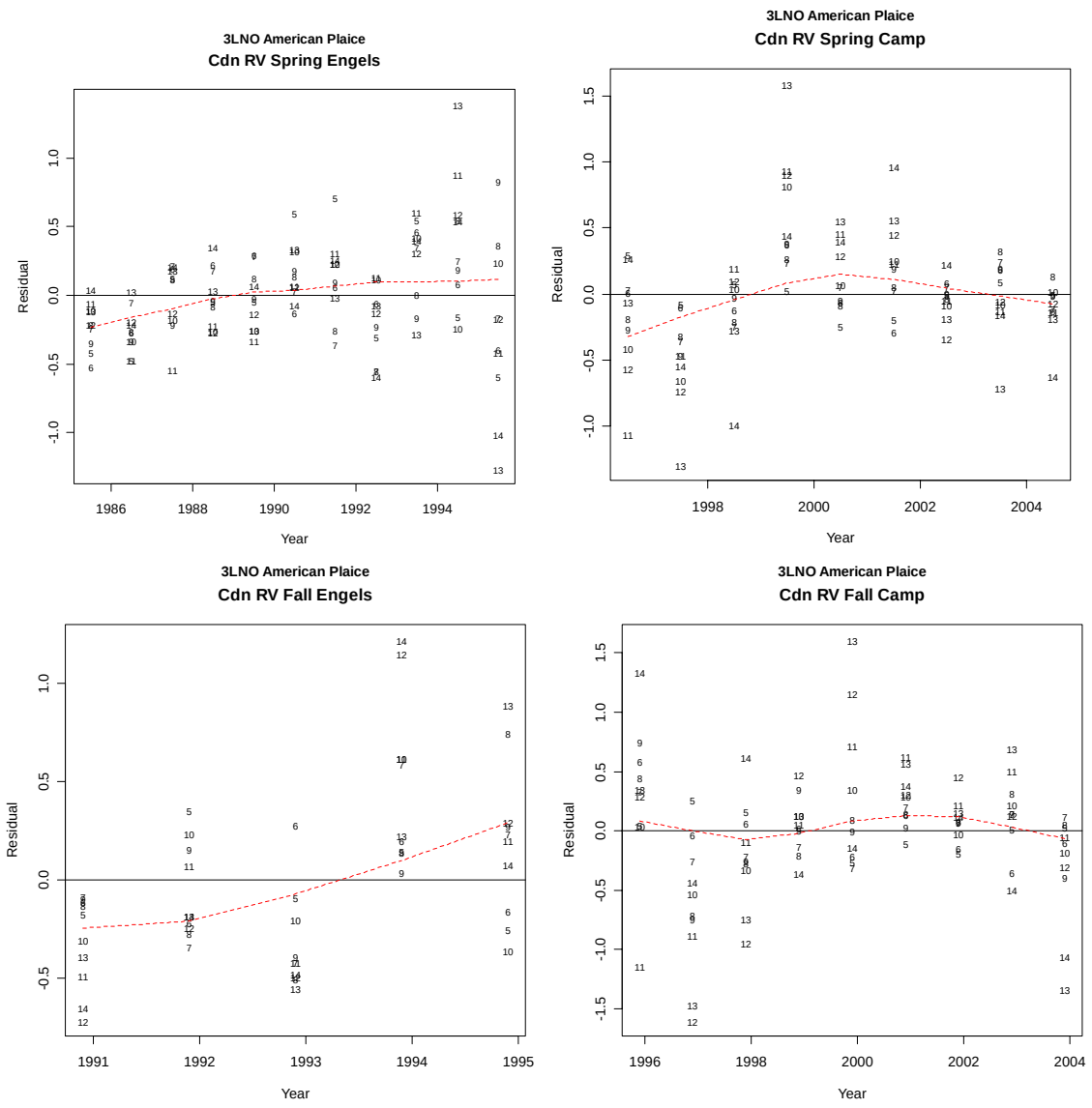


Figure 11. Residuals by year and month (numbers represent ages) for Canadian spring survey (top) and fall survey (bottom) from Run 2 (no conversion of survey data). Red line is a Lowess smoother. Note the scales are different for each plot.

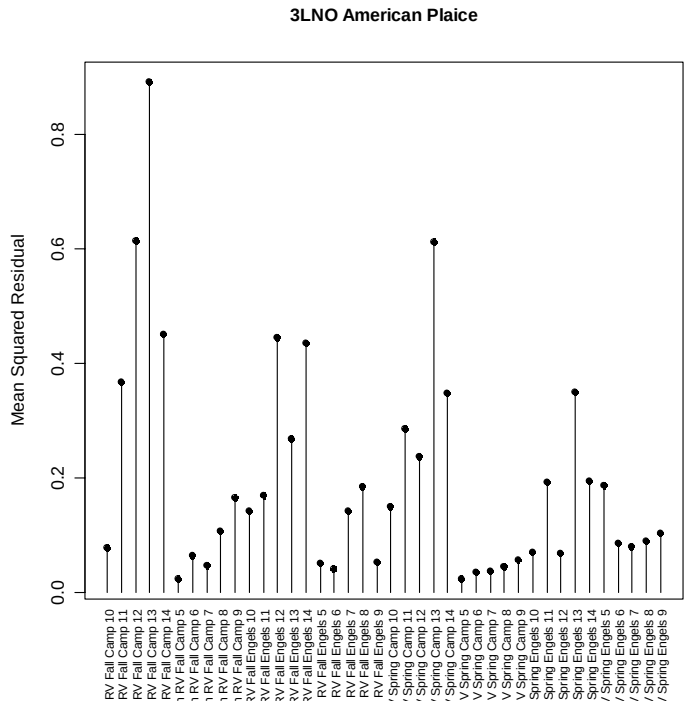


Figure 12. Mean squared residuals by age for fall (Engels and Campelen) and spring (Engels and Campelen) surveys from Run 2 (no conversion of survey data).

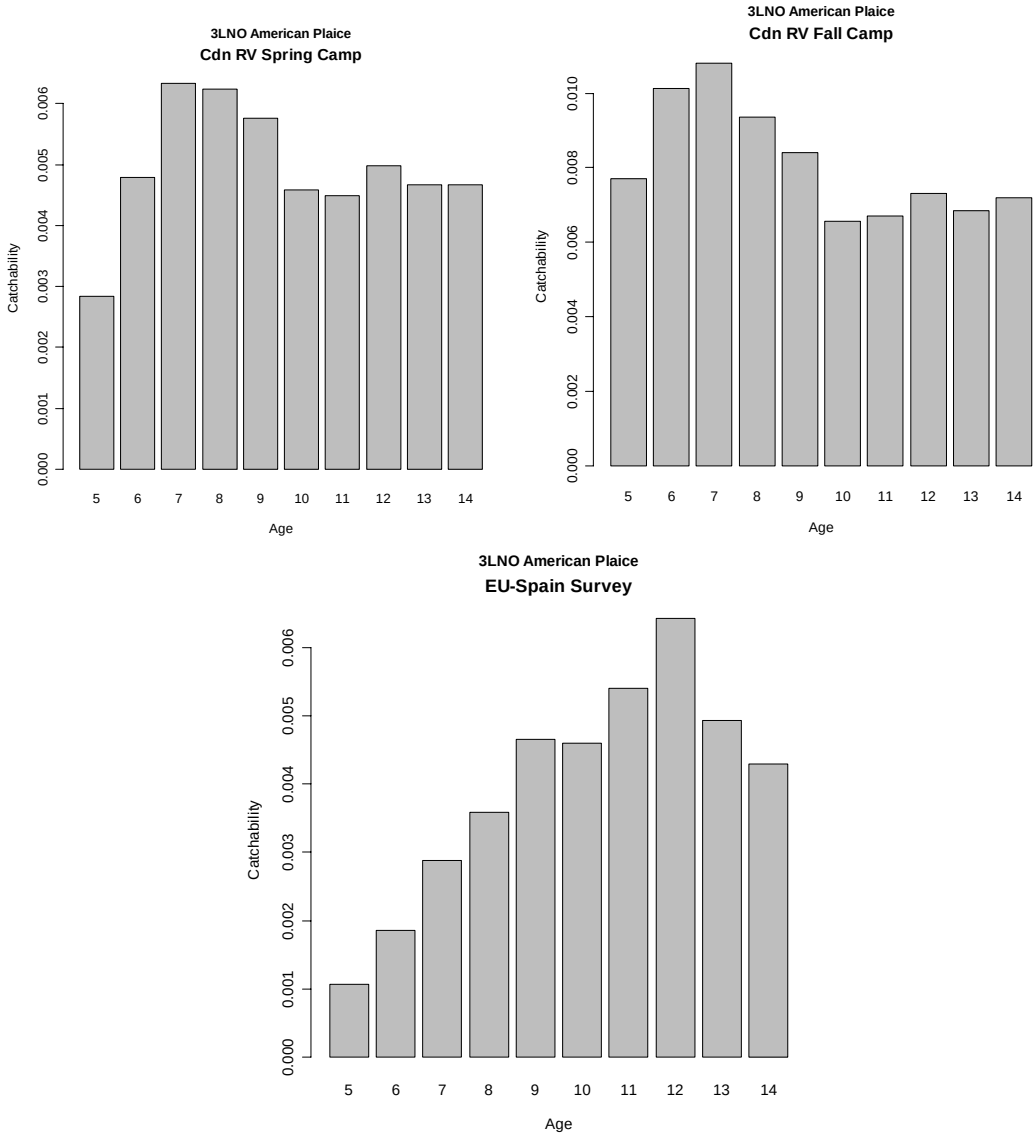


Figure 13. Survey catchabilities (*q*s) for each survey by age from Run 3 (base run from 2005 with Spanish Div. 3NO survey included). Note that Spanish Div. 3NO survey units are mean numbers per tow.

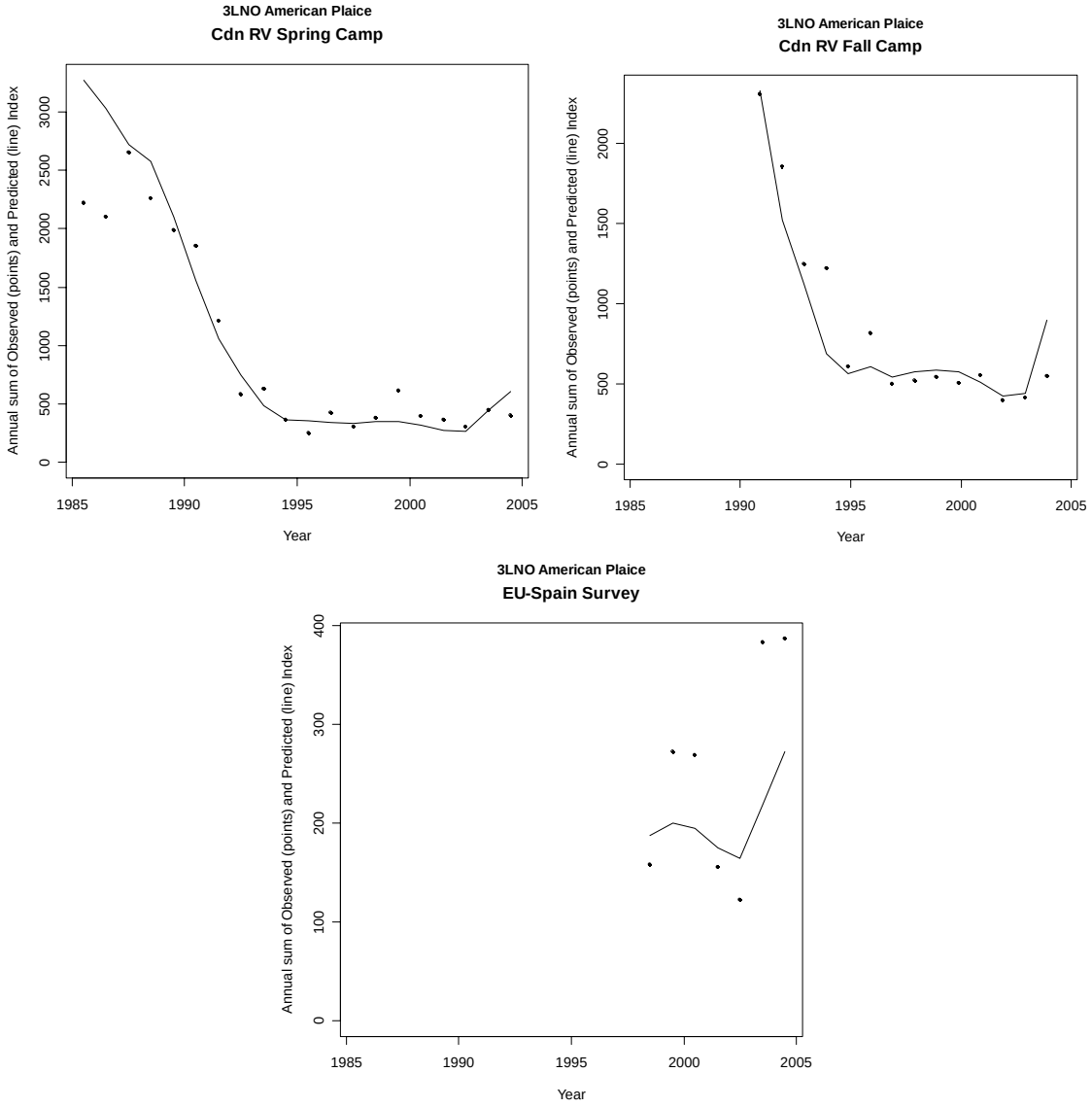


Figure 14. Observed versus predicted abundance for spring (top left), fall (top right) Canadian RV surveys and Spanish Div. 3NO survey (bottom) indices over time for Run 3 (base run from 2005 with Spanish Div. 3NO survey included).

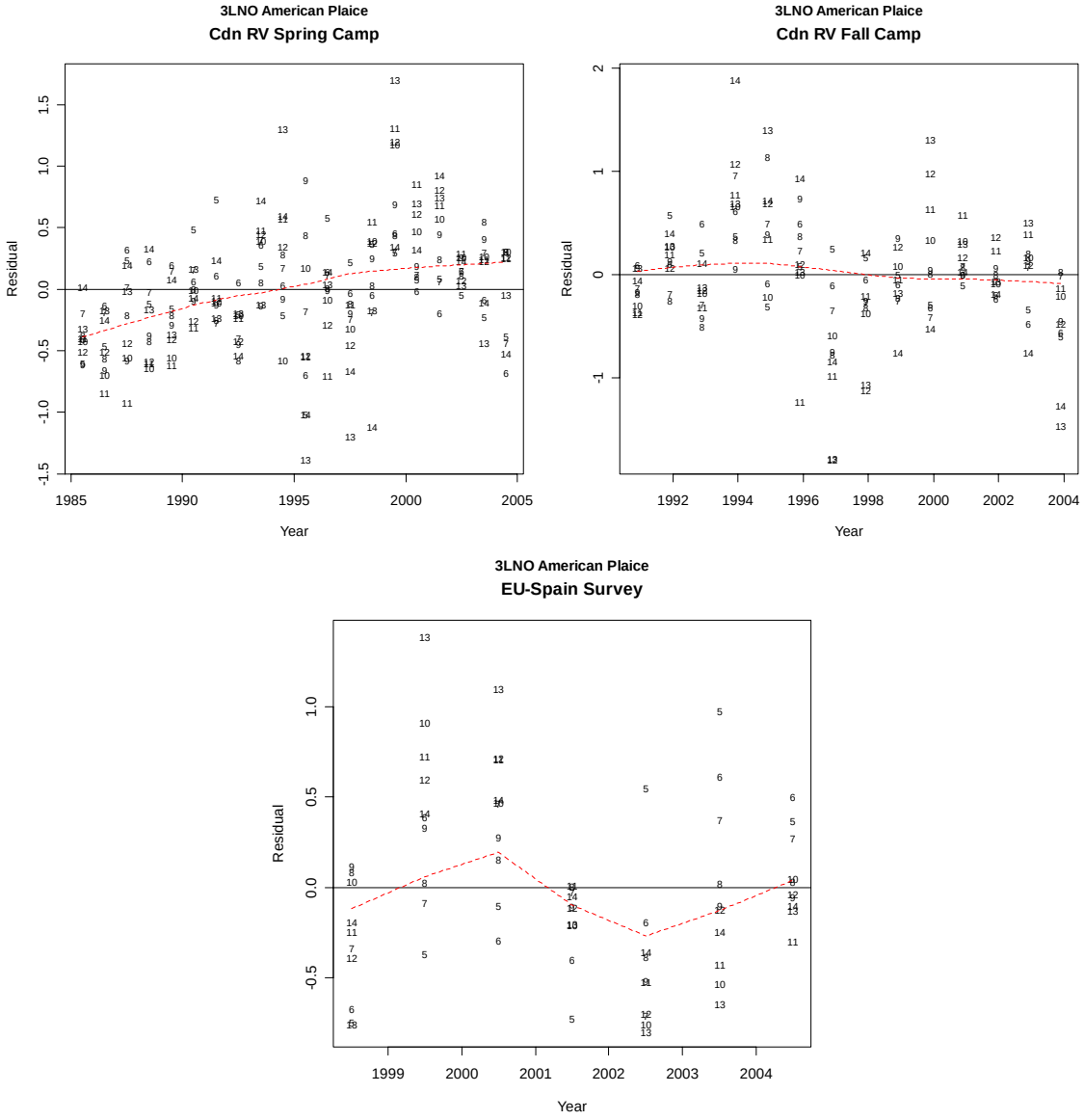


Figure 15. Residuals by year and month (numbers represent ages) for Canadian spring survey (top left), fall (top right) and Spanish Div. 3NO survey (bottom) from Run 3 (base 2005 run with Spanish Div. 3NO survey included). Red line is a Lowess smoother. Note the scales are different for each plot.

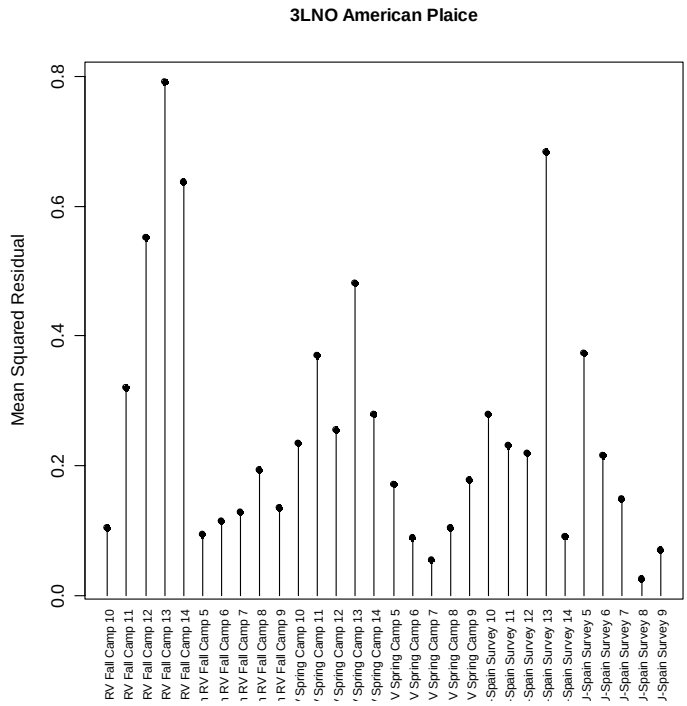


Figure 16. Mean squared residuals by age for Canadian fall, spring and Spanish Div. 3NO surveys from Run 3 (base 2005 run with Spanish Div. 3NO survey included).

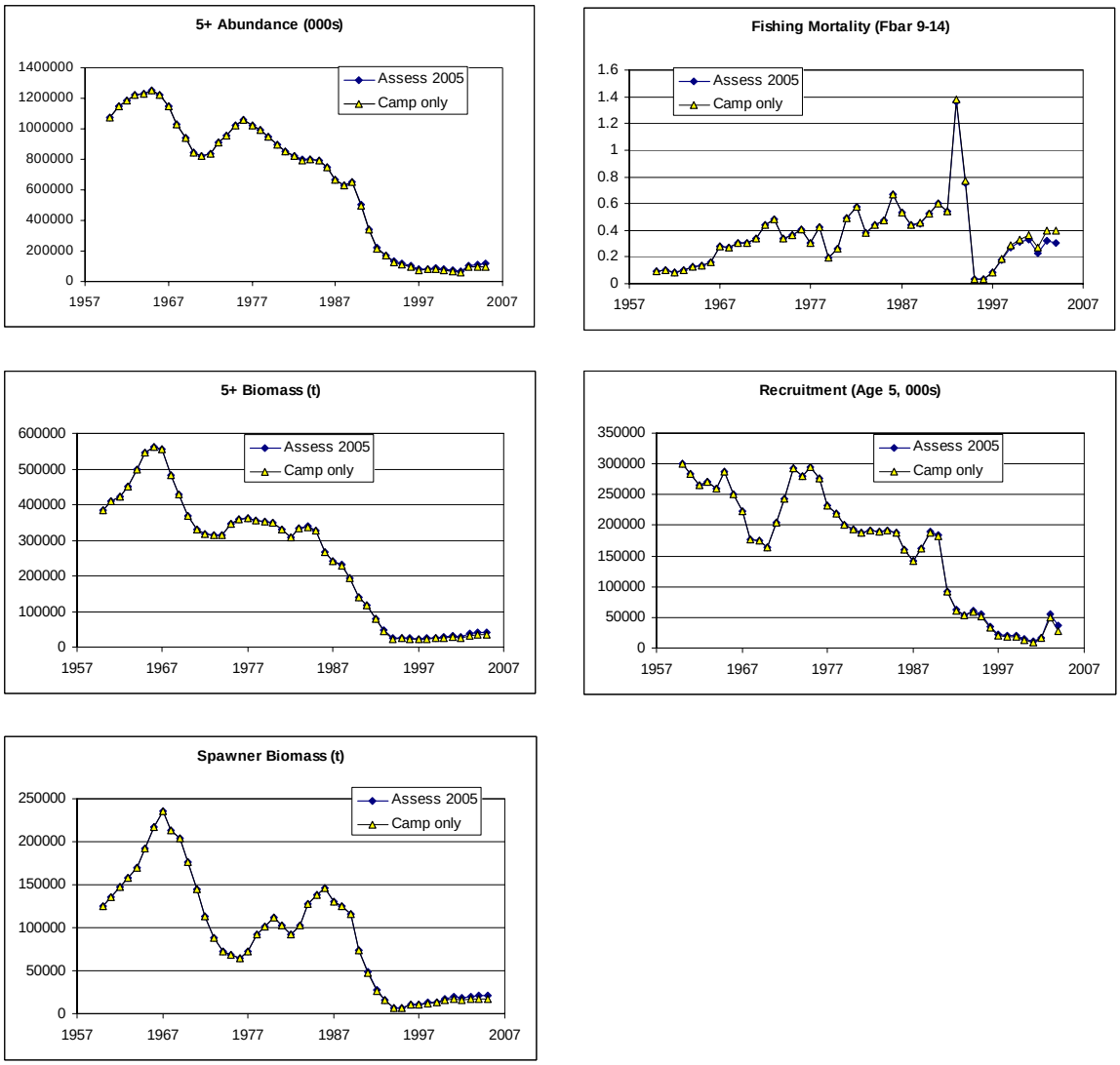


Figure 17. Output graphs showing 5+ abundance, average fishing mortality on ages 9-14, 5+ biomass, recruitment (at age 5), and spawner biomass from Run 1 VPA (exclusion of converted data).

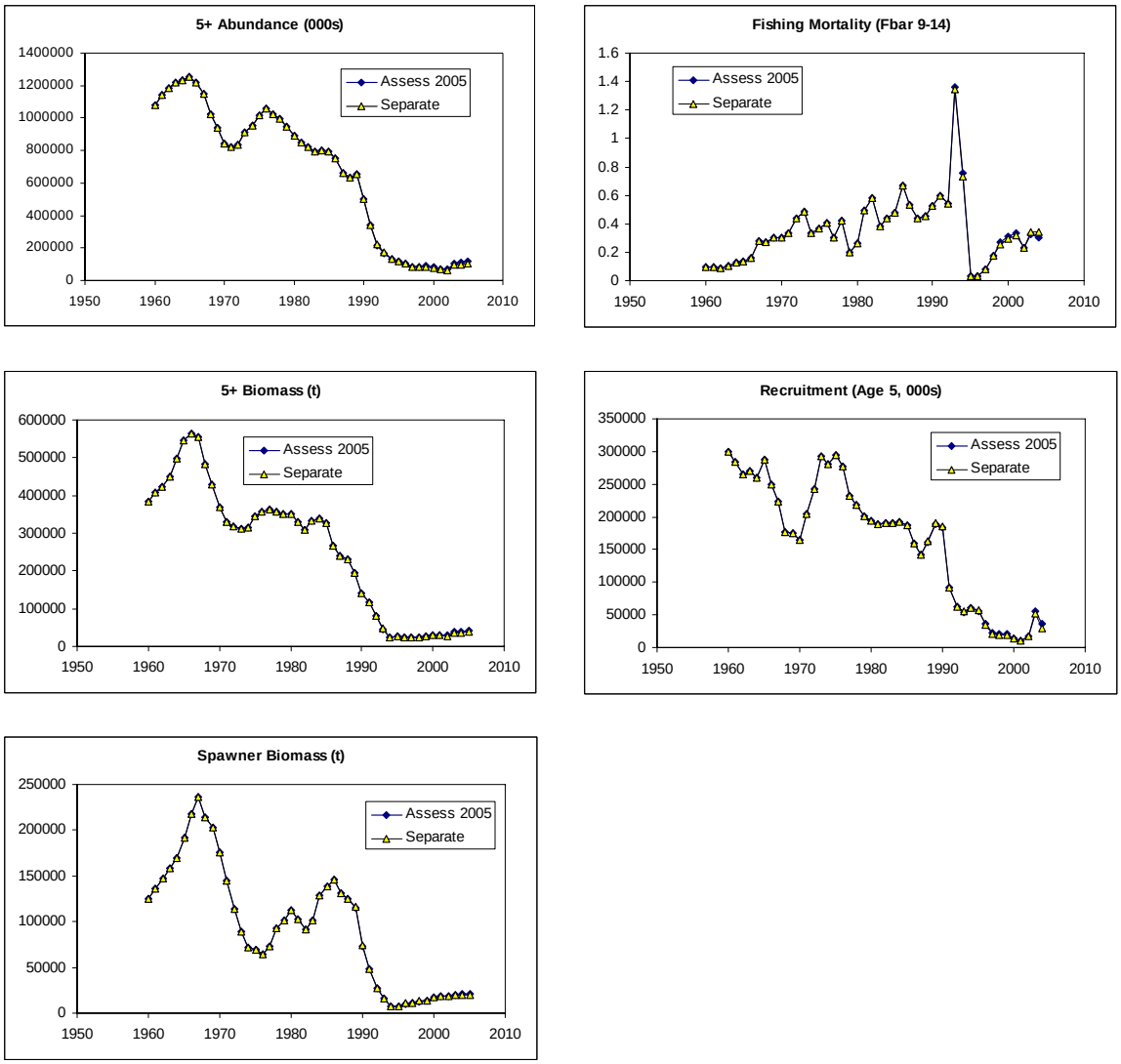


Figure 18. Output graphs showing 5+ abundance, average fishing mortality on ages 9-14, 5+ biomass, recruitment (at age 5), and spawner biomass from Run 2 VPA (no conversion of survey data).

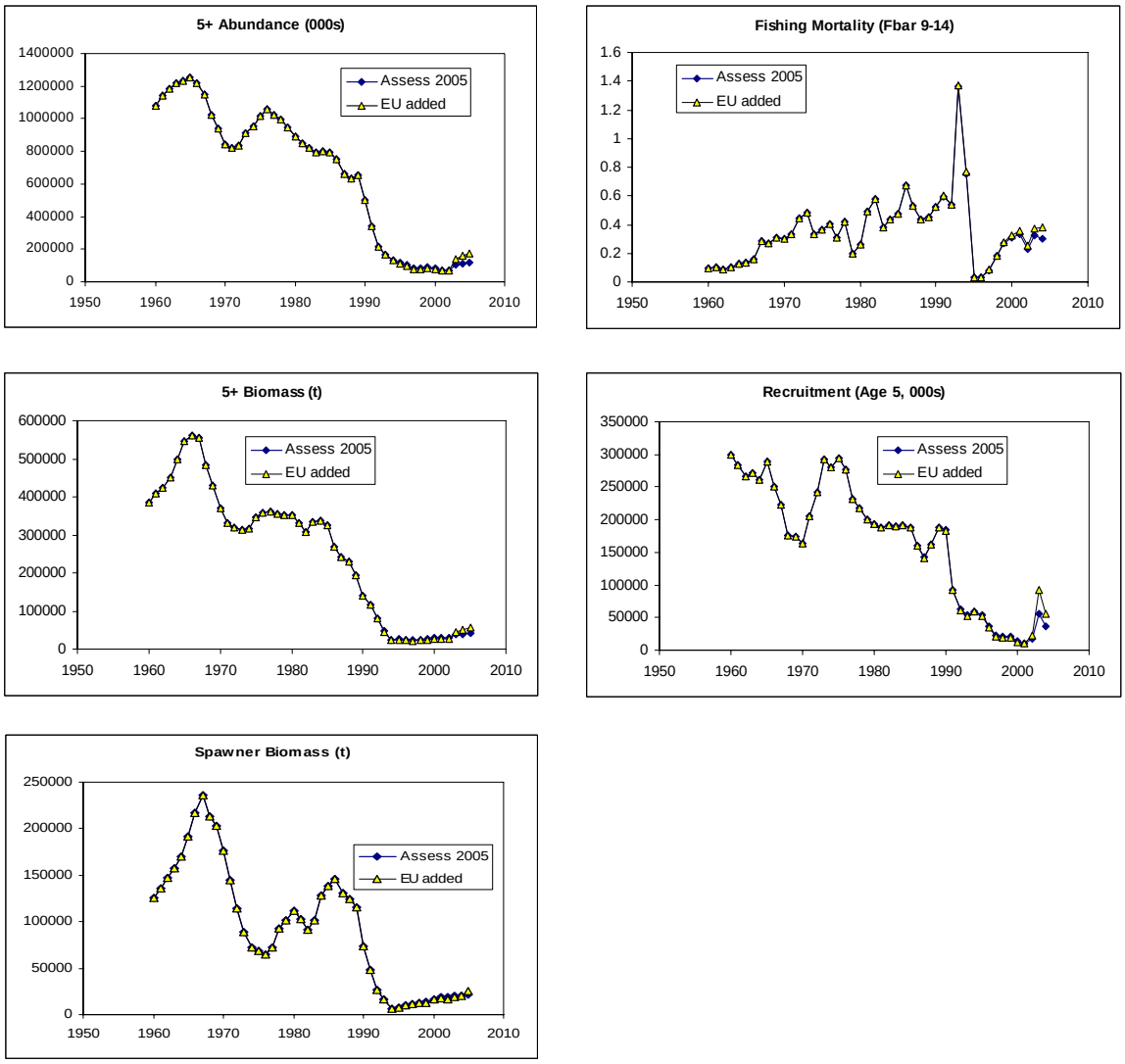
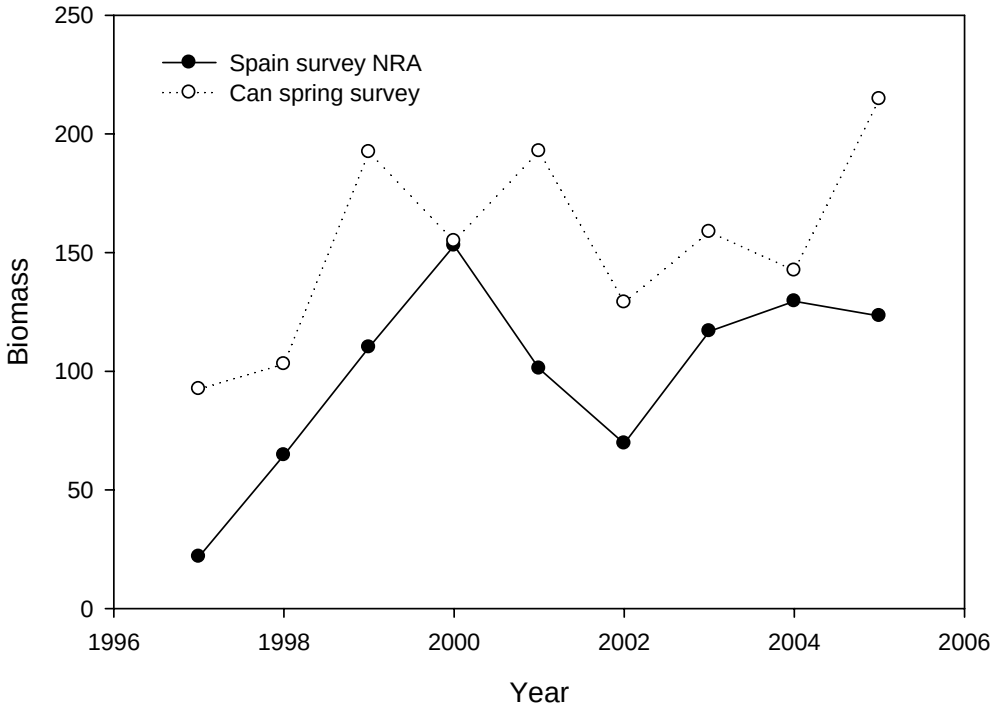


Figure 19. Output graphs showing 5+ abundance, average fishing mortality on ages 9-14, 5+ biomass, recruitment (at age 5), and spawner biomass from Run 3 VPA (base 2005 run with Spanish Div. 3NO survey included).



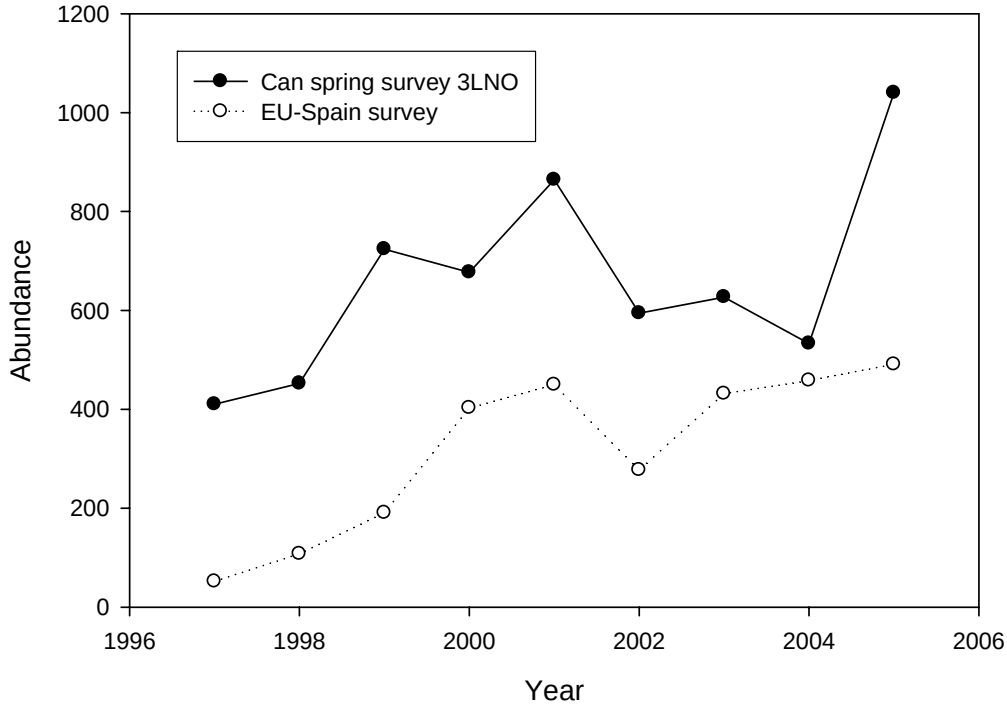


Figure 20. Comparison of biomass (top) and abundance (bottom) between the Canadian spring survey for Divs. 3LNO and the Spanish Div. 3NO survey.

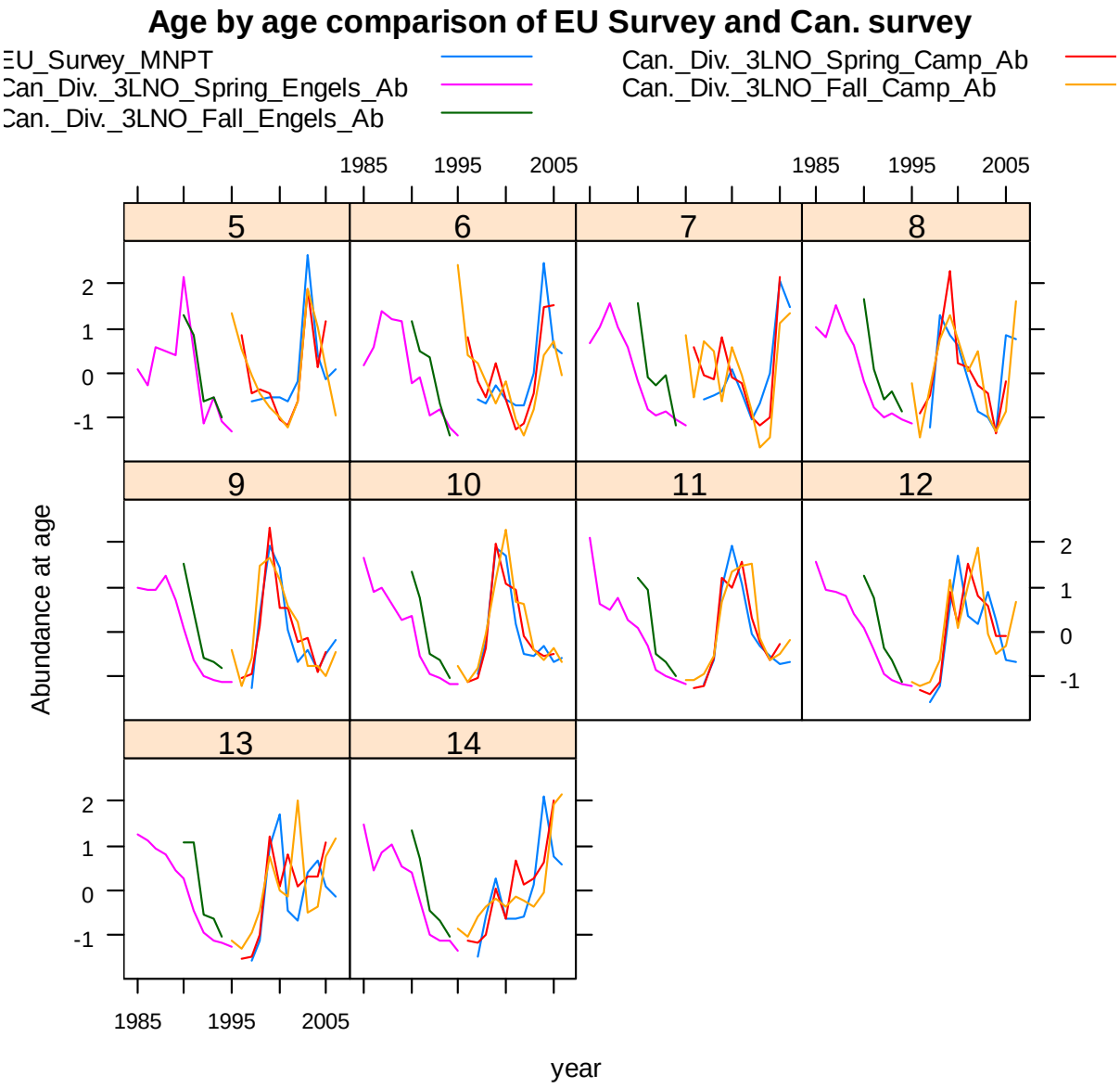


Figure 21. Standardized age by age abundance between Canadian RV and Spanish Div. 3NO survey (FLR). Note data from Canadian Fall RV survey 2004 is included.

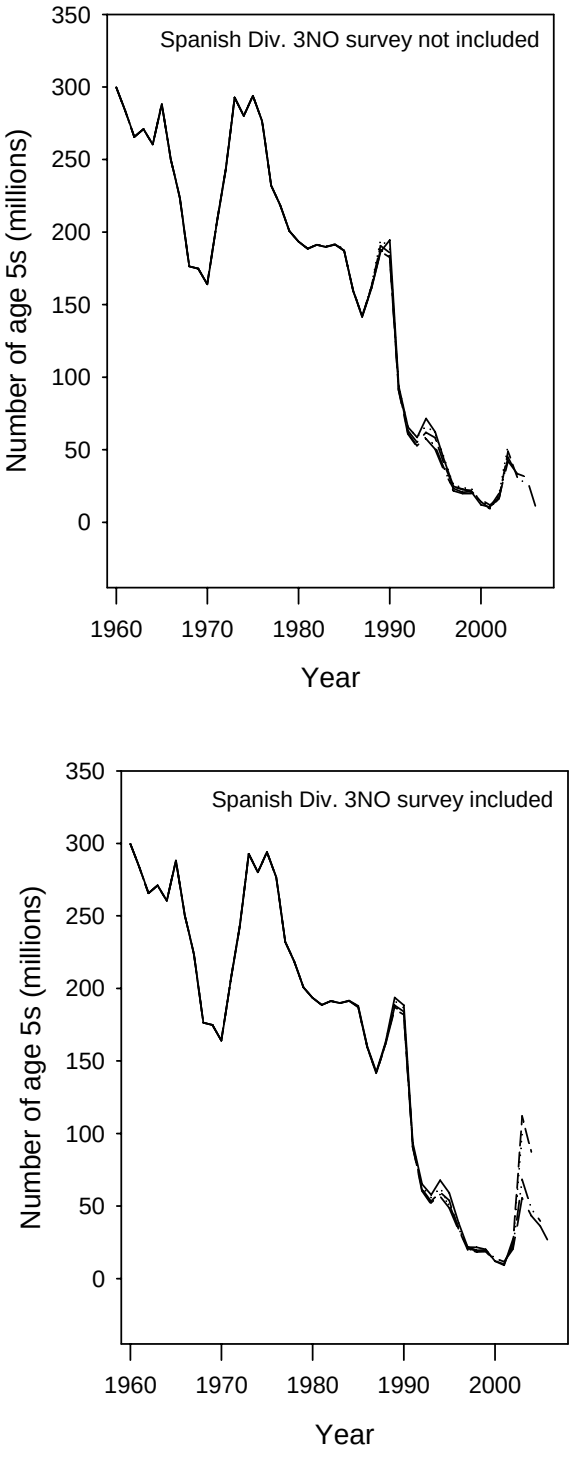


Figure 22. Retrospective analysis for age 5 recruits estimated from ADAPT. The top panel shows retrospective analysis from the VPA run with the Spanish Div. 3NO survey excluded from the analysis and the bottom panel shows the retrospective analysis from the VPA run with the Spanish Div. 3NO survey included.