North Carolina Cooperative Extension Service

NC STATE UNIVERSITY

College of Agriculture and Life Sciences
Extension Poultry Science
Scott Hall/Campus Box 7608
Raleigh, North Carolina 27695

919-515-2621 (phone)
919-515-7070 (fax)

August 7, 2012

History of the North Carolina Layer Tests

Detailed Description of Housing and Husbandry Changes Made From

1958 through 2009

Research conducted at the:

North Carolina Department of Agriculture and Consumer Services
Piedmont Research Station
Poultry Unit
8350 Sherrill's Ford Road
Salisbury, NC 28147

Summarized by

Dr Kenneth E. Anderson, Director
North Carolina Layer Performance and Management Program

And

Dr. Gerald B. Havenstein, Professor and Head Emeritus

North Carolina State University
Department of Poultry Science
Box 7608
Raleigh, NC 27695-7608

Introduction

During the course of its 50+ years of existence the North Carolina Layer Performance and Management Test (NCLP&MT) has been identified by other names. It was first established as the North Carolina Random Sample Egg Laying Test and was known in this manner from 1958-1980. IN 1981 the transition to its current name began when it was briefly known as the North Carolina Layer Production and Management Test for 0ne test from1981-1982. With the arrival of the next director of the test the name was changed to the North Carolina Layer Performance and Management Test from 1983-2010. In 2010 the name changes slightly to the North Carolina Layer Performance and Management Program which is now the administrative unit for the 2 tests. The two tests subsequently designated as the Layer Performance and Management Test and the Layer performance and Alternative Management Test.

Pullet Housing and Husbandry

The following briefly summarizes information concerning changes that were made over the years in some of the testing facilities while the 37 North Carolina layer test flocks were being conducted, beginning with the 1st flock in 1958 and ending with the latest complete flock in 2009, *i.e.* the 37th NCLP&MT (Anderson, 2009). Fertile hatching eggs were brought onto the North Carolina Piedmont Station for each of those 37 flocks, and all of the strains were hatched on site using Robbins incubators in a separate hatching facility.

1st through 5th NCRSLT: The pullets in the first 5 RST were housed in litter pens with 60 pullets housed in 16.26 sq. m pens for a bird density of 0.27 m per bird. The pullets were provided with an all mash starter diet for 8 wks followed by a grower diet until 20 weeks of age. They were not beak trimmed for those 5 tests. The vaccination program for the 1st 5 tests included Newcastle Bronchitis at 1d; Coccid at 5d and 10 wk; a Newcastle Dust at 34 d; Fowl

Pox at 84 d; and Newcastle-Bronchitis Dust at 114 d (Martin, 1959, 1960, 1961, 1962, 1963). For the 5th RST, the starter and grower diets were described as having 20 % Crude Protein; 1914 Kcal/kg and 16 % Crude Protein; 1892 Kcal/kg, respectively.

6th through 12th NCRSLT: Sixty pullets were grown in each 16.26 sq m pen for the 6th through the 12th NCRSLTs. The pen floors for the 1st six NCRSLT were dirt, however beginning with the 7th test the floors were changed to concrete and were covered with wood shavings. Slats were added to the pens for the 8th to the 12th tests so that the pens consisted of 63% slat:37% litter. At the same time the floor space was reduced to 0.14 sq m/pullet and was further reduced to 0.13 sq m in the 12th RST. Vaccination programs were expanded in the 6th test to include avian encephalomyelitis given at 129 d. In the 8th test an additional vaccination was given for Coccidiosis. Low level trithiodol at 9 wks was given to the pullets in the 9th test. Beginning with the 12th test, and thereafter, the option of a cage rearing environment was introduced. The cages were 61 cm x 56 cm, and the chicks were brooded at 114 sq cm/chick to 2 wks; 170 sq cm/chick to 5 wks; then 397sq cm/pullet through the end of the growing period when the birds were moved into the lay house. One major point of concern during this time was the emergence of Marek's disease. The first outbreak of Marek's took place during the 11th test, and it resulted in a significant amount of mortality.

13th through 19th NCRSLT: Pullets were grown in a number of environments during the 13th through the 19th NCRSLTs, as the industry transitioned from floor to cage rearing of pullets. The test director limited the number of strain entries to 10, and slat/litter pens continued as a portion of the rearing program with a density of 1301 sq cm/bird until the 19th test when the density was reduced to 1273 sq cm/bird. A second light controlled growing facility was added before the start of the 13th test to go with the curtain-sided pullet house. The rearing cage densities during the brooding period were 154 sq cm through 5 wks then the cage populations were split and the final density through 20 weeks was 361 sq cm for the curtain sided facility and 148 sq cm through 5 weeks followed by 445 sq cm until 20 wks. This allowed for a light control program comparison with the curtain-sided house's lighting period being held constant to match the longest day of the growing period, and the light controlled facility's light being maintained at 9 hr of light throughout the rearing period. Marek's vaccine was administered at hatch beginning with the 13th NCRST. The feeding program for the pullet rearing period was also changed to better reflect how commercial flocks were being reared. This involved feeding a starter diet through 6 wks, and a grower diet from7 weeks to housing. The starter diet contained 21% crude protein with 1804 Kcal ME/kg, and the grower diet contained 14.3% crude protein with 1813 Kcal ME/kg. During the transition from the rearing to the laying facilities, the pullets were supplemented with Mg. For the 18th NCRST, the pullets were provided feed 2 hr after they had consumed all of the feed in the trough. The 19th NCRST saw an end to all other North American RSTs that were located west of the Appalachian mountain range.

20th NCRSLT through the 25th NCLP&MT: Beginning with the 20th NCRST, rearing of the test pullets was done totally in cages. Rearing densities in the curtain-sided house during the brooding period for the 20th and 21st tests were 155 sq cm through 5 wks of age, when the cage populations were split to provide 368 sq cm through 20 weeks of age. For the light controlled house, the pullets were given 135 sq cm through 5 weeks of age, followed by 413 sq cm until 20 wks of age. For the 22nd NCRST, the major comparison was between curtain-sided and light control housing, so all of the pullets were brooded at 142 sq in until 5 wks of age, and then 284 sq cm thereafter through 20 wks of age. The grow light period for the curtain-sided house was set to match the longest day of the rearing period, and the light period for the light controlled facility was maintained at 9.5 hr of light throughout the rearing period. The documentation of the rearing diets became more detailed starting with the 22nd NCRST: The starter ration was 20% CP with 2893 ME Kcal/kg of feed; the grower ration was 16.7% CP with 2875 Kcal ME/kg of feed; and the developer ration contained14.1% CP and 2880 Kcal ME/kg of feed. Beginning with the 23rd NCRST, a new curtain-sided house was added to the test. Unfortunately, there were operational issues with the new facility that resulted in significant mortality during the 1st wk of the flock's life. All of the pullets for the new curtain-sided house were started with 323 sq cm/bird of floor space. The light period in the light controlled house being 23 L/1 D for 2 d, and was then changed to 9 hr L/ 15 D. The pullets in the curtain-sided laying house were given a constant day length that matched the longest day during the laying period. The rearing diets were altered slightly: the starter ration was 20.7% CP, 2875 Kcal ME/kg; the grower ration was 17.4% CP, 2922 Kcal ME/kg; and the developer ration was14.8% CP, 2924 Kcal ME/kg. In addition, the pullet rearing period was shortened to 19 wks. The North Carolina layer testing program was changed from a pure RST to the North Carolina Layer Performance and Management Test (NCLP&MT) beginning with the 24th flock. All tests thereafter carried that designation, and they began producing not only genetic strain comparisons, but also comparisons of alternative management procedures. For the 24th NCLP&MT the rearing density was finalized at 310 sq cm/bird and a rearing dietary regimen was established with: a starter ration having 20% CP, 2838 Kcal ME/kg that was fed from 0 to 6 wks; a grower ration having 17% CP, 2849 Kcal ME/kg that was fed from 7 to 13 or 15 wks; a developer ration having 14% CP, 2849 Kcal ME/kg that was fed from 14 to 18.5 wks; and a pre-lay ration having 14% CP, 2849 Kcal ME/kg and 1.5% Ca that was fed from the time the flock reached 3-5% production. For the 25th NCLP&MT, the name change was finalized, and the rearing lighting program for both houses was started with 23 hr L. On the 3rd day the light period was dropped to 9 hr in the ligh-controlled house, and to the longest natural day length for the growing period in the curtain-sided house. In both houses light was increased to 15.5 hr by 21 wks of age.

26th through the 28th NCLP&MT: For the 26th through the 28th NCLP&MTs, all of the laying strains were reared in replicate blocks of cages (one cage/strain/replicate) that were randomly located throughout the rearing facility (intermingled). Pullet density for both white and brown egg strains was identical for the growing period. In the 26th and 27th tests a brooding density of 93 sq cm was used for 6 wks then 40 sq in per bird was used thereafter until the flock was moved to the laying house. Density was returned to 258 sq cm from 7 wk to the end of the growing period in the 28th test. The age of transfer to the laying house was decreased so that by the 28th test the hens were moved to the lay house at 18 wks of age. In the 27th test, the diets used for the rearing program were further broken down so the nutrient consumption of the pullets could be reviewed. Bi-weekly body weight samples were also started beginning with the 27th test. In addition, the step-down step-up lighting program in the rearing phase became standard so that the pullets reached 15 hr of light just prior to their transfer to the laying house and before 1% production.

29th through the 36th NCLP&MT: The rearing phase of the 29th through the 36th NCLP&MTs were very standardized, and all measurements were reported in metric units. Beginning with the 29th NCLP&MT, a hatch report was provided. The lighting programs in the pullet facilities were similar to those used in the 25th test, and it remained generally the same until the 36th NCLP&MT when light was held constant at 10 hr through 16 wks of age and stimulation did not begin until the pullets were in the laying house. The pullet testing phase was made easier starting with the 33rd test with the elimination of the curtain-sided rearing facility. Thereafter, the entire flock was reared in a single light-controlled house. That house was similar to the type of pullet rearing facilities being used by the commercial egg industry. A standardized 3 phase rearing dietary regimen was in place and it was maintained isocaloric at approximately 2900 Kcal/kg consisting of a starter with 20% CP, grower with 18% CP, and a developer with 16% CP. Pullets were transferred to the laying house at 16 weeks of age and all of the pullet reports culminated at 16 wks after which they were transferred to the laying facilities and placed on a Pre-Lay diet with 22% CP and 4.5% Ca at approximately 15 wks of age.

37th NCLP&MT and Currently: For the 37th NCLP&MT, because of the increasing interest in organic farming and cage free rearing systems, a floor/range rearing scenario was conducted on a trial basis. This program has been continued into the 38th NCLP&MT, and will continue on into the foreseeable future for both the range production aspect of the test and the inclusion of the cage-free production system.

Summary of Other Significant Events That Happened During the Rearing Phase of Some Tests

In the 8th NCRSLT, the use of litter versus slat floor housing was initiated, along with beak trimming. Marek's disease resulted in a high rate of disease losses during the rearing period in the 11th RST. Cages were added in the 12th NCRSLT, and Marek's vaccine was first used in the 13th NCRSLT. Feed restriction during the pullet rearing phase of the 18th NCRSLT was used from 12 to 20 wks of age one time only. A light controlled pullet growing facility was added beginning with the 20th NCRSLT, and a new curtain sided house was added for the 23rd NCRSLT, and problems with its function led to higher than normal pullet mortality. The curtain sided house was enclosed into a light tight facility with Quad deck pullet cages for the 33rd NCLP&MT, and thereafter, all pullets were grown in that single house.

Layer Housing and Husbandry

1st through 7th NCRSLT: Hens were housed on litter floors for the first 7 NCRSLTs. Beginning with test 8, concrete was added to the pen floors, and litter was placed over the concrete. The layer density in the floor pens during the laying period was 3.5 sq ft/bird for those 7 tests. In addition a single ration was used for the entire production period which was 16% CP and 840 Kcal/lb in winter and 82Kcal/lb in summer months.

8th through 11th NCRSLT: Three laying house environments (cage, all slat, and 50% litter and 50% slat) were established beginning with the 8th NCRSLT. The hens in the half slat/half litter pens were housed at 1394 sq cm/bird, while the hens in the all slat pens were housed at 929 sq cm/bird, and the hens in 2 bird cages were housed with 589 sq in/bird. This was consistent for the 8th through the 11th tests.

12th through the 18th NCRSLT: Three different laying house environments were used beginning with the 12th NCRSLT: 1) 50% slat and 50% litter floor pens with the hens housed at 1579 sq cm/bird; 2) 2 bird cages with the hens having 581 sq cm/bird; and 7 bird cages with the hens having 445 sq cm/bird. These environments continued through the 18th test. For the 15th test only 10 strains were entered into the test, which was down from 20 in the previous tests. For the 17th test the hens in the 7 bird cages were toe trimmed during the rearing period. That was the only test in which toe trimming was used.

19th through the 25th NCLP&MT: During the period of time in which the 19th NCRSLT through the 25th NCLP&MT were conducted, a number of laying house environmental changes were gradually made. The first change involved the construction of a light and ventilation controlled laying facility that included 3 bird cages that provided 464 sq cm/bird. That house was first utilized in the 19th NCRSLT. The birds in the new house were then compared with those housed in the curtain-sided slat/litter and 2 hen/cage (sq cm/bird) houses. In addition, a step up lighting program was instituted for the laying period that culminated with a 17L:7D light cycle that continued to be used throughout the lay period. For the 20th NCRSLT, two cage densities were used that provided either 361 or 413 sq cm/hen. All hens were fed using a phase feeding program that was based on the breeder's recommendations. Two additional house types were included in the 22nd NCRSLT in addition to the light and ventilation controlled facility, namely, a high rise curtain sided house, and a flush pit curtain sided house. Each of these houses was equipped with a system that included both shallow and deep cages, and the test also included hens that were housed with 3 or 4 hens/cage in both cage types (?? and ?? sq cm/hen). The feeding program remained as a phase feeding program to meet breeder recommendations. The 23rd NCRSLT used the same layer housing environments, but only one laying diet. Due to a reduction in the state budget, the high rise 3-bird cage house was not used in the 24th, and 25th tests.

26th through 37th NCLP&MT: The inclusion of molting programs commenced with the 26th and has continued through the 37th NCLP&MT. The 26th through the 33rd tests utilized a fasting-type molting program that was very similar to what was at that time being used by the commercial layer industry in the United States. The 34th through the 37th tests included comparisons of the fasting molt program with several anorexic programs (i.e. low density, high fiber diets) for the induction of the molt. These tests culminated with the emergence and acceptance by the industry participants of a non-anorexic molting program that was specifically developed for the NCLP&MT. Starting with the 36th NCLP&MT test, a report was included which looked at the performance of a single cycle flock that was in production from 17 to 82 wk of age, in comparison to the performance of the groups that were on the various molting programs. During the 26th through the 37th tests, several minor housing changes were made, with the production facilities continuing to be the high rise and flush pit house. Both houses were equipped with cages which were 40.6 cm deep and varied in width from 30.5 to 81.3 cm with densities ranging from 310 to 542 sq cm/hen. Density and hen population studies were conducted throughout this period.

Remodeling of Facilities:

In 1997, both production houses were remodeled to include new cages with 40.6 x 61 and 40.6 x 81.3 cm cages, and the flush pit house was converted to a light tight force ventilated scraper pit house. Due to severe reductions in state budget allocations, the high rise house was not used in the 35th test. In the 36th NCLP&MT the scraper pit house and the new Battery Cage house were used. In the 37th NCLP&MT, the high rise and scraper pit houses were again used for the laying facilities, and in addition a preliminary trial run was conducted utilizing range production facilities. The latter portion of the NCLP&MT was designated as a supplemental Alternative Environment program. The Alternative Environment program utilized a step up lighting program that maximized the day length at 16L:8D during the first and 16.5L:7.5D during the second production cycle. The lighting program was altered beginning with the 36th test to delay the onset of age at 50% production by moving the pullets into the laying facilities when they were on a 10L:14D light schedule. The light period was then gradually increased to 16 hrs during the period from 17 to 31 wks. Hens were fed using phased feeding programs recommended by the breeders from the 26th through the 37th NCLP&MT.

Summary of Other Significant Events that Occurred During the Production Phase of Some Tests

An Mg outbreak occurred and progressed slowly through the flock during the 19th NCRSLT. A power failure took place at 412 days of age in that same test, and it resulted in the loss of 72 hens. During the 21st NCRSLT, it was determined that one of the strains was not being fed according to the breeder's recommendation for at least 20 wks of the production cycle.

Pullet Growth Parameters

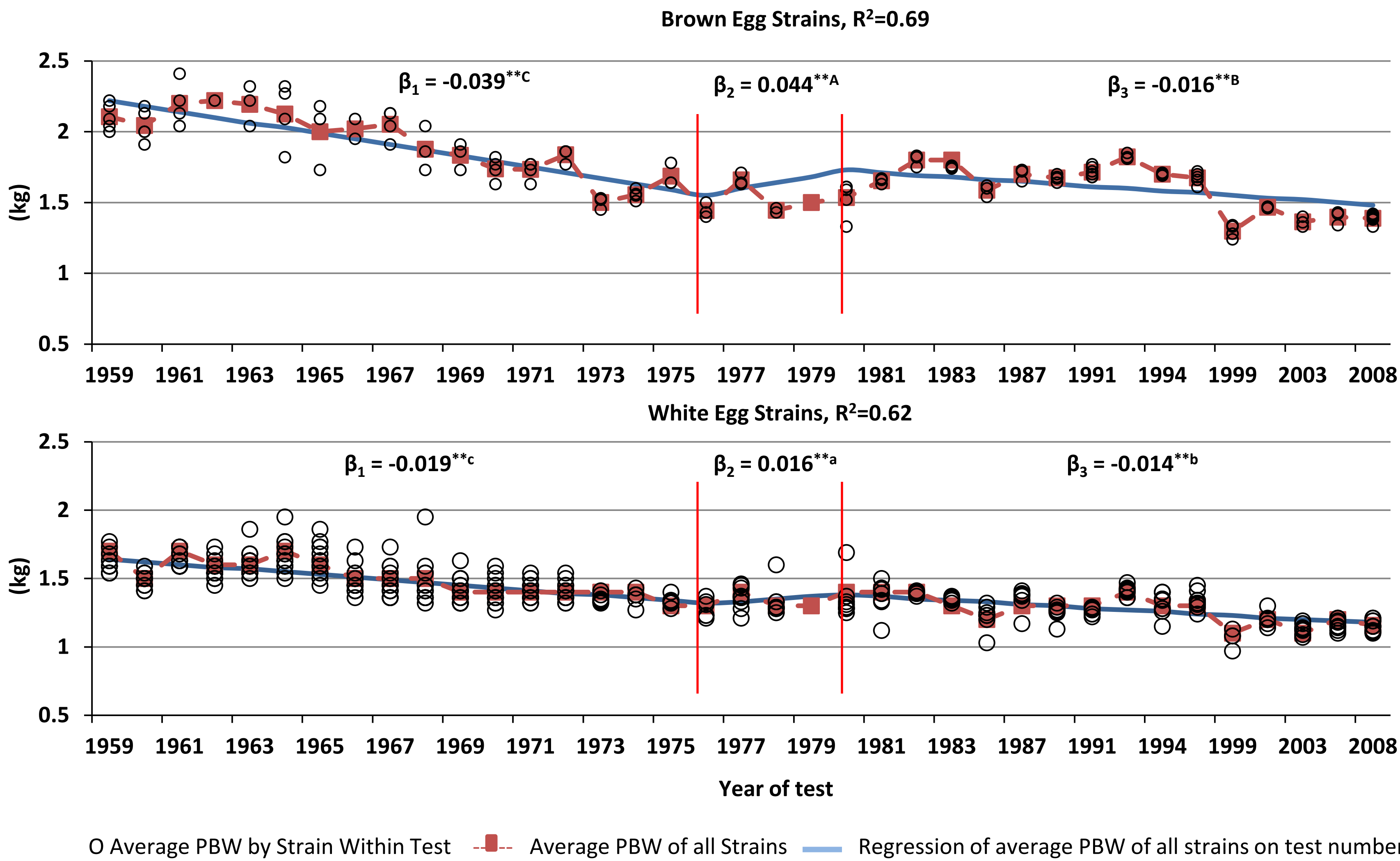
Table 1. Pullet body weight, total feed, and mortality for the brown and white egg strains entered into the 1st through the 37th North Carolina layer tests

NCLP&MT Test	Body Weight	Total Feed	Mortality
(Brown egg strains)	(kg)	(kg)	(%)
1958-1st NCLP&MT	2.11[A]	10.28[A]	6.64[a]
2009-37th NCLP&MT	1.39[B]	6.00[B]	0.75[b]
Std Err	±0.03	±0.08	±0.90
(White egg strains)			
1958-1st NCLP&MT	1.61[A]	8.85[A]	1.76
2009-37th NCLP&MT	1.16[B]	5.84[B]	1.19
Std Err	±0.02	±0.04	±0.37

[ab]Means significantly different within column and egg type ($p<0.05$).

[AB] Means significantly different within column and egg type ($p<0.0001$).

Figure 1. Pullet body weights (PBW) by strain within test, and the regression of the average PBW of all strains on the test number within three groups of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.

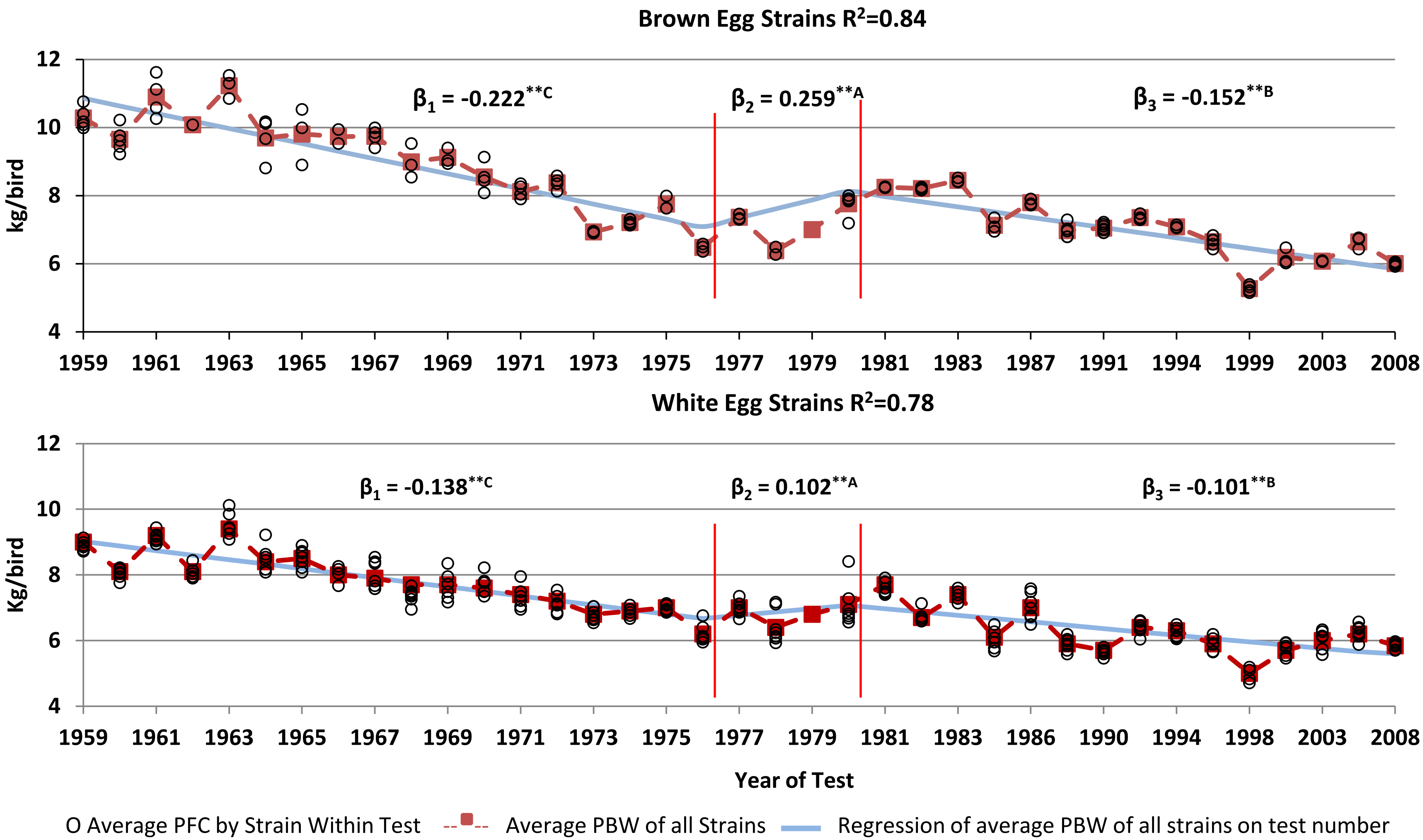


** Slope significantly different from 0 ($P<0.01$)

[ABC]Slopes with different superscripts are significantly different ($P<0.01$)

[abc]Slopes with different superscripts are significantly different ($P<0.05$)

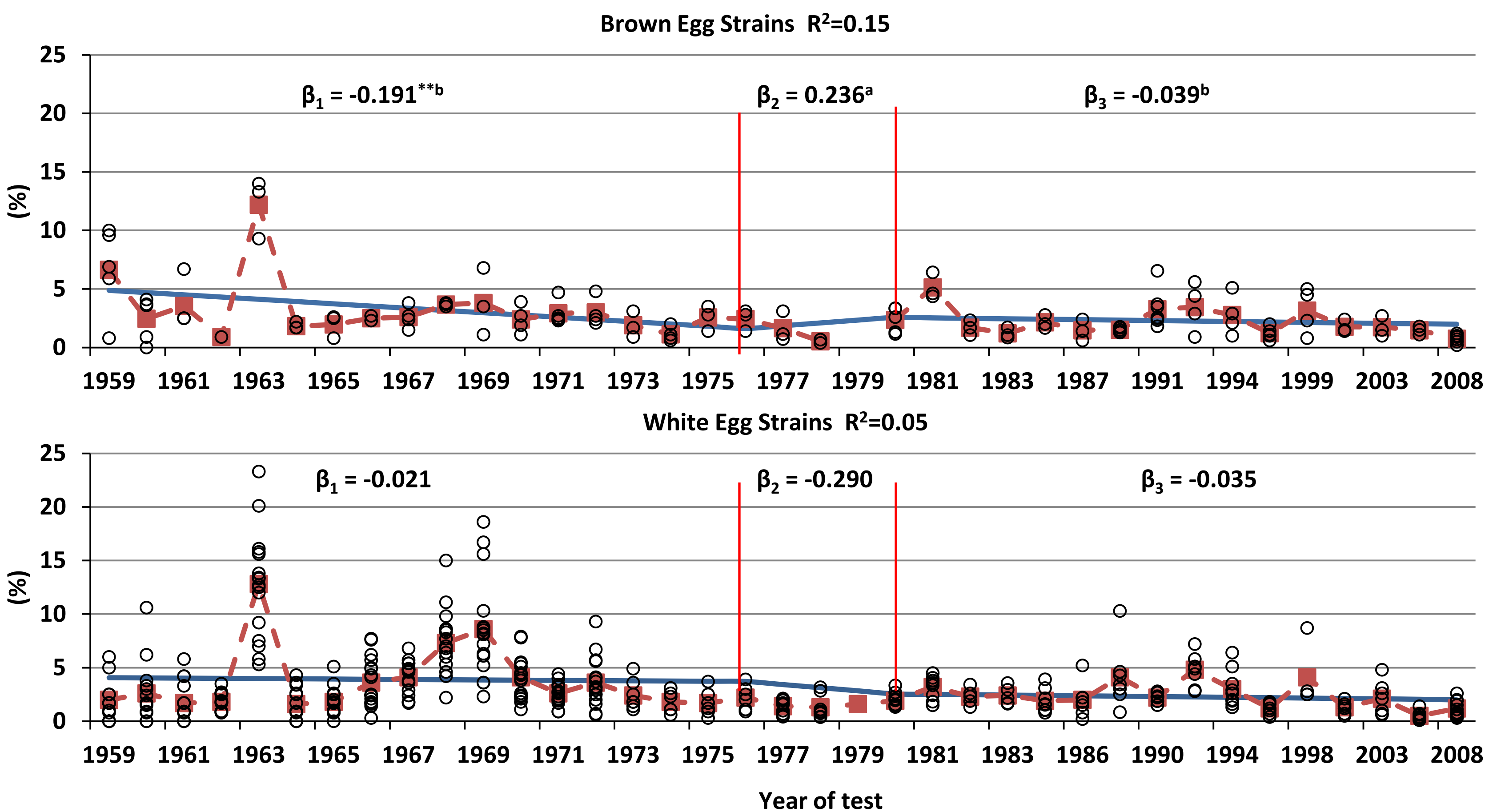
Figure 2. Pullet feed consumption (PFC) by strain within test, and the regression of the average PFC of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

Figure 3. Percent grow mortality (%GM) by strain within test, and the regression of the average %GM of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



O Average %GM by Strain Within Test — Average PBW of all Strains — Regression of average PBW of all strains on test number

** Slope significantly different from 0 (P<0.01)

abc Slopes with different superscripts are significantly different (P<0.05)

Layer Production Parameters, Age at 50% Production (Maturity) and Body weight

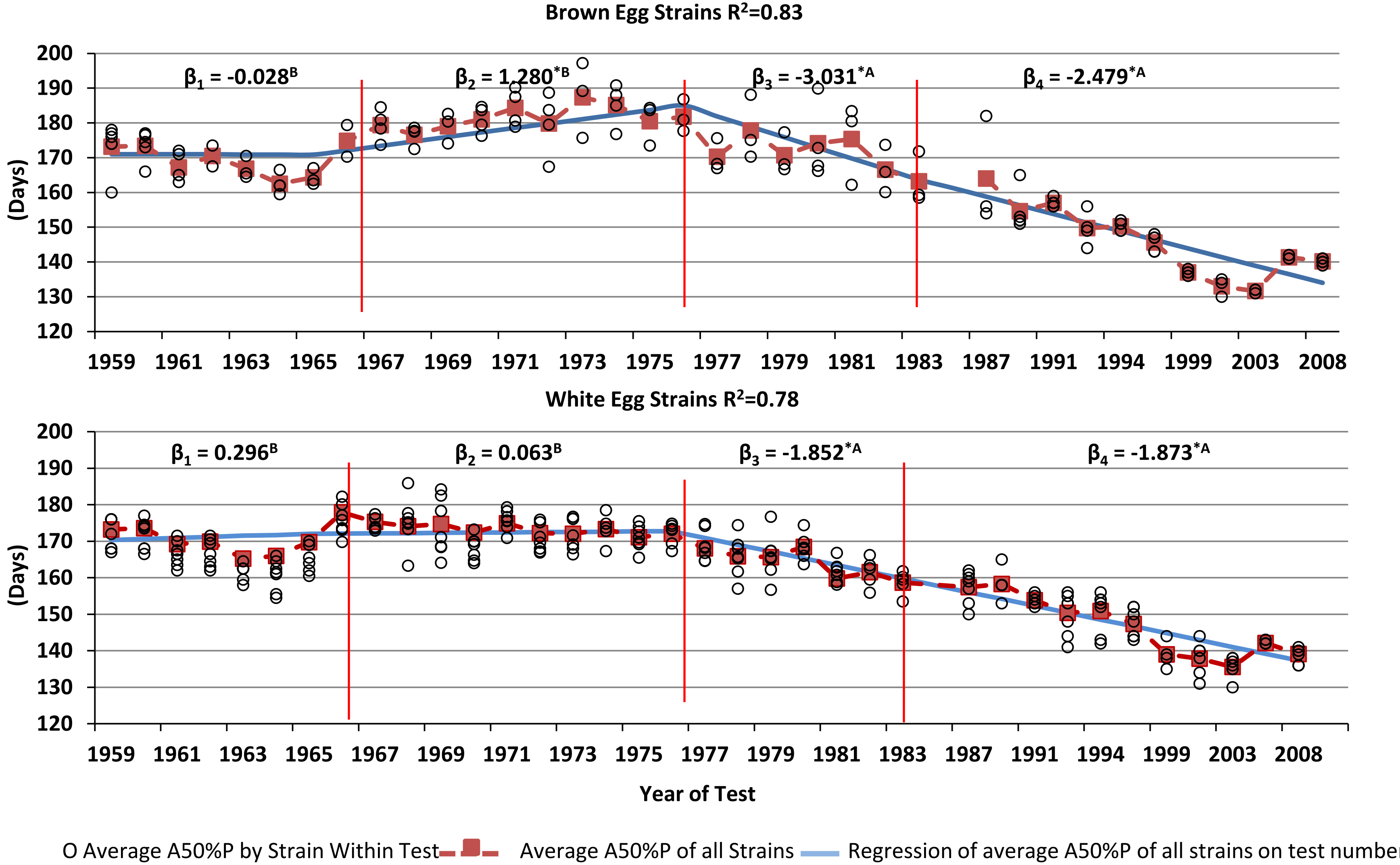
Single Production Cycle

Table 2. Maturity, HD production, and HH eggs for the brown and white egg strains entered into the 1st through the 37th North Carolina layer tests

NCLP&MT Test	Age at 50% Production	Hen-Day Production	Hen-Housed Eggs
(Brown Egg Strains)	(days)	(%)	(eggs/hen)
1958-1st NCLP&MT	166.2^{A}	65.9^{B}	214^{B}
2009-37th NCLP&MT	139.4^{B}	85.1^{A}	281^{A}
Std Err	±1.5	±1.0	±5
(White Egg Strains)			
1958-1st NCLP&MT	173.2^{A}	70.1^{B}	212^{B}
2009-37th NCLP&MT	139.1^{B}	85.8^{A}	276^{A}
Std Err	±0.8	±0.9	±3

^{AB}Means significantly different within column and egg type ($p<0.0001$).

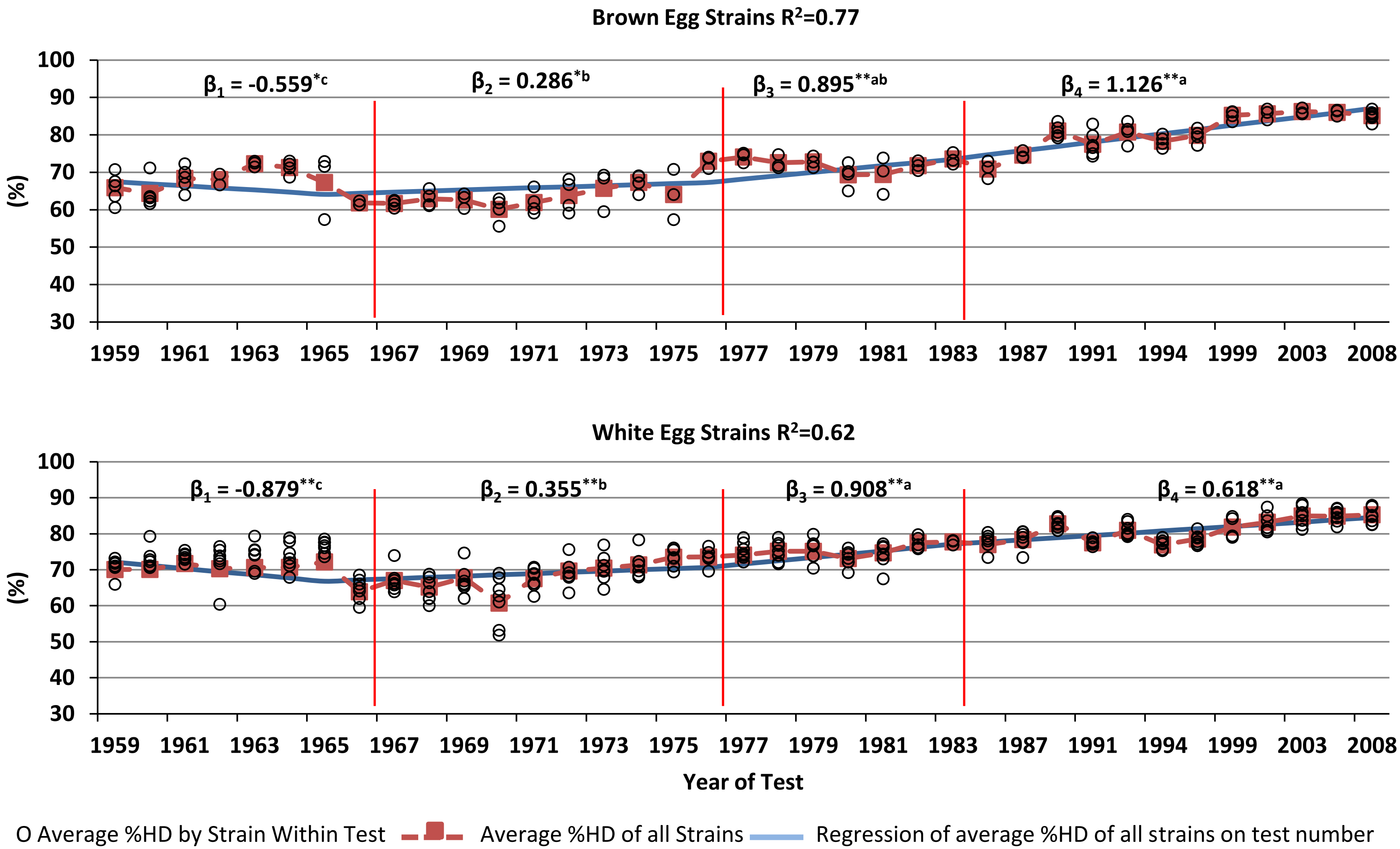
Figure 4. Age at 50% production (A50%P) by strain within test, and the regression of the average A50%P of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



* Slope significantly different from 0 (P<0.05)

ABCSlopes with different superscripts are significantly different (P<0.01)

Figure 5. Percent Hen-Day production (%HD) by strain within test, and the regression of the average %HD of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.

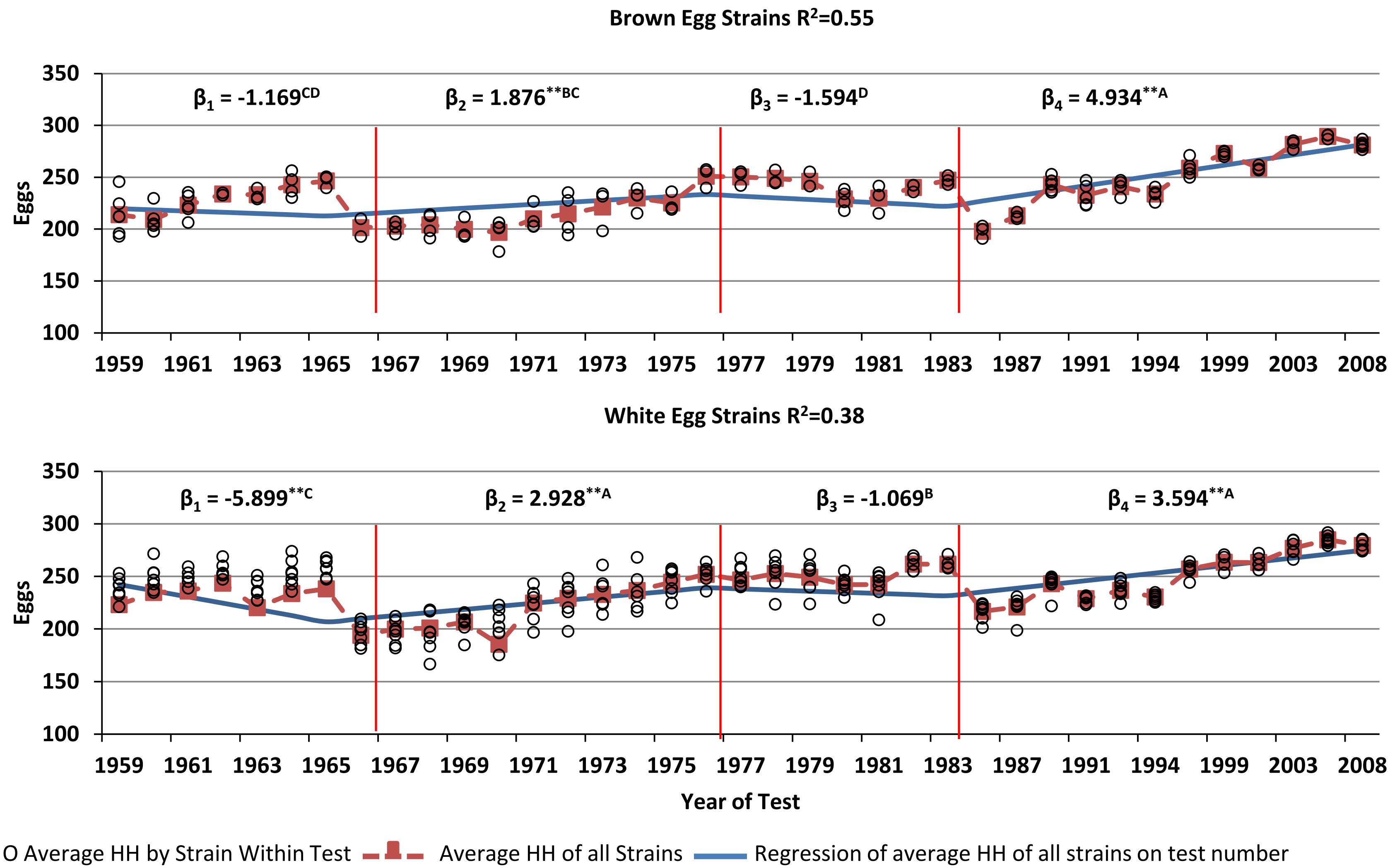


* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

abcSlopes with different superscripts are significantly different (P<0.05)

Figure 6. Hen-Housed Egg number (HH) by strain within test, and the regression of the average HH of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



** Slope significantly different from 0 (P<0.01)

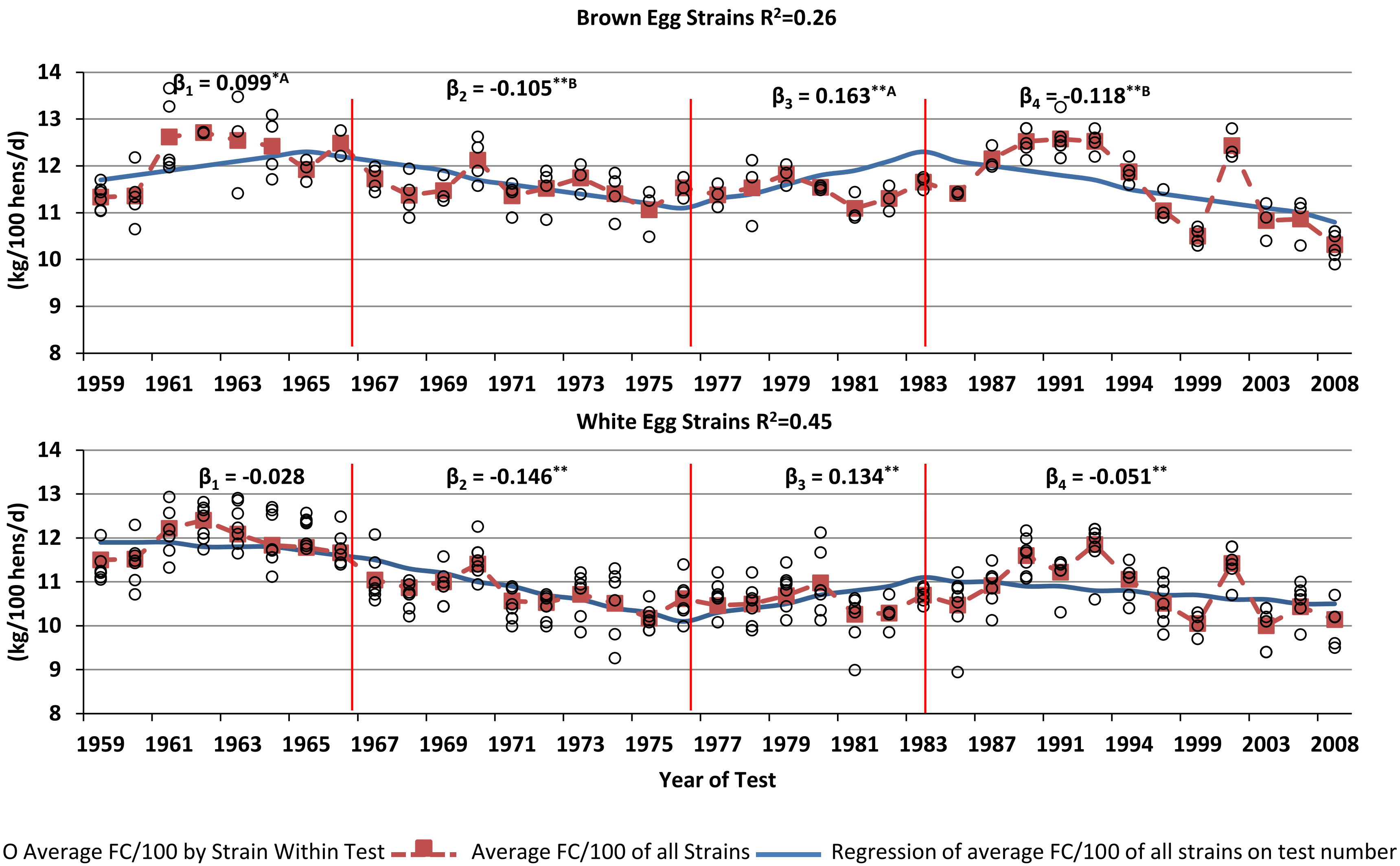
ABCD Slopes with different superscripts are significantly different (P<0.01)

Table 3. Feed consumption and conversion, and mortality for the brown and white egg strains entered into the 1st through the 37th North Carolina layer tests

NCLP&MT Test	Feed Cons.	Feed Conv.	Mortality
(Brown Egg Strains)	(kg/100 hens)	(g egg/g feed)	(%)
1958-1st NCLP&MT	11.3^{A}	0.326^{B}	16.6^{A}
2009-37th NCLP&MT	10.3^{B}	0.492^{A}	5.5^{B}
Std Err	±0.1	±0.008	±1.7
(White Egg Strains)			
1958-1st NCLP&MT	11.3^{A}	0.345^{B}	10.9^{A}
2009-37th NCLP&MT	9.9^{B}	0.501^{A}	6.4^{B}
Std Err	±0.1	±0.005	±1.4

^{AB}Means significantly different within column and egg type ($p<0.0001$).

Figure 7. Feed consumption per 100 hens (FC/100) by strain within test, and the regression of the average FC/100 of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1[st] through the 37[th] North Carolina layer tests.

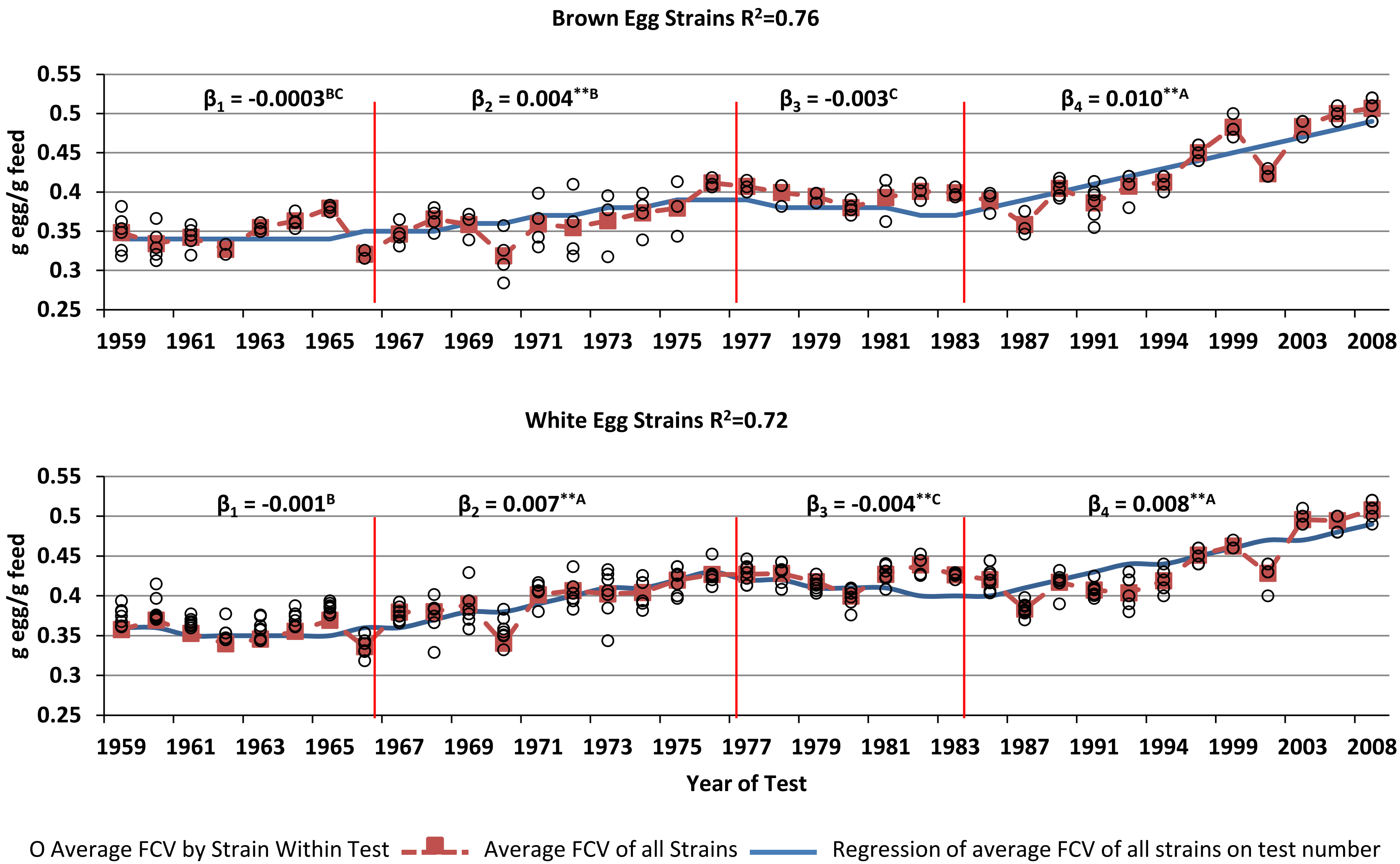


* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

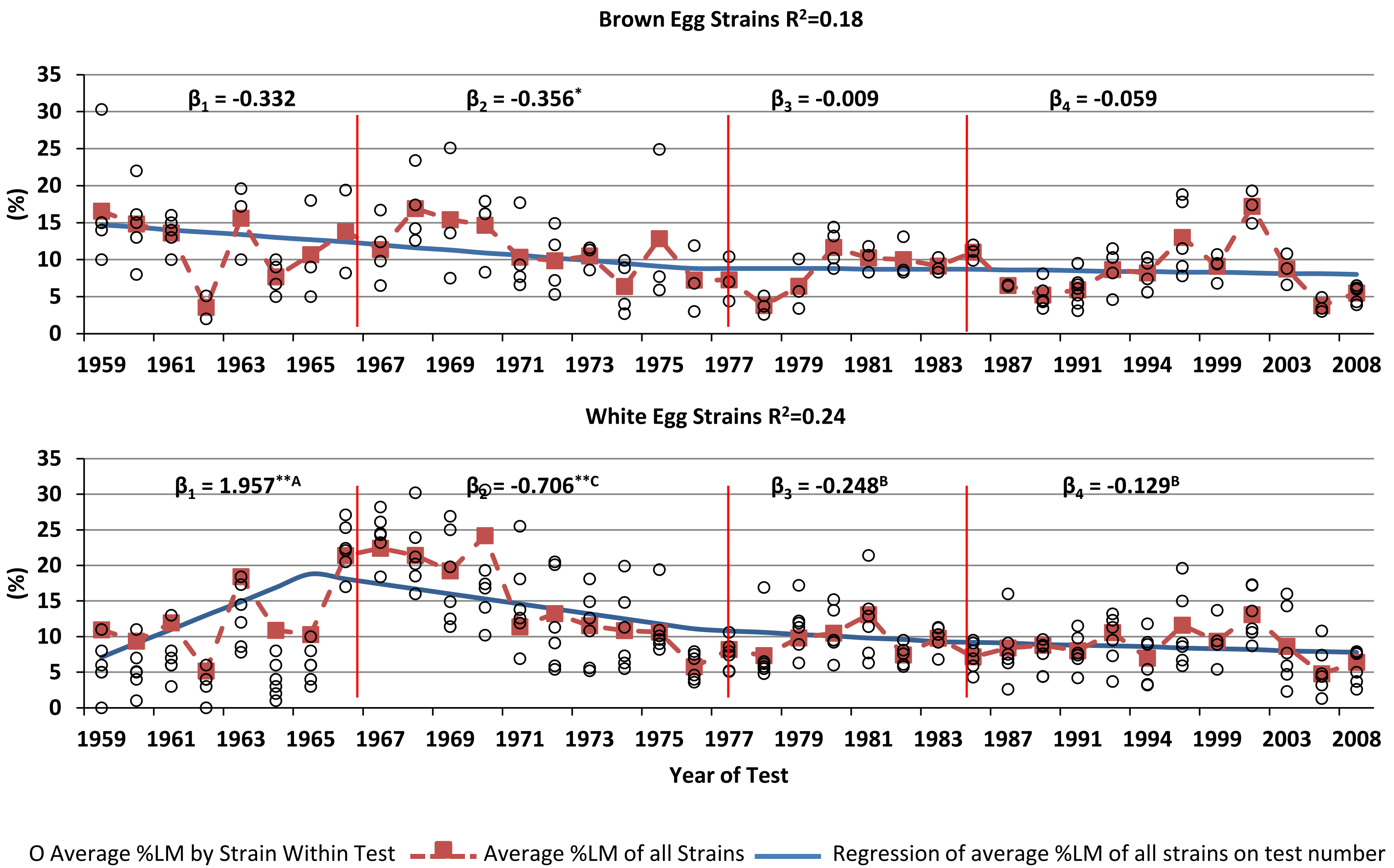
Figure 8. Feed conversion (FCV = g egg/g feed)) by strain within test, and the regression of the average FCV of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



** Slope significantly different from 0 (P<0.01)

[ABC]Slopes with different superscripts are significantly different (P<0.01)

Figure 9. Percent Lay house mortality (%LM) by strain within test, and the regression of the average %LM of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.

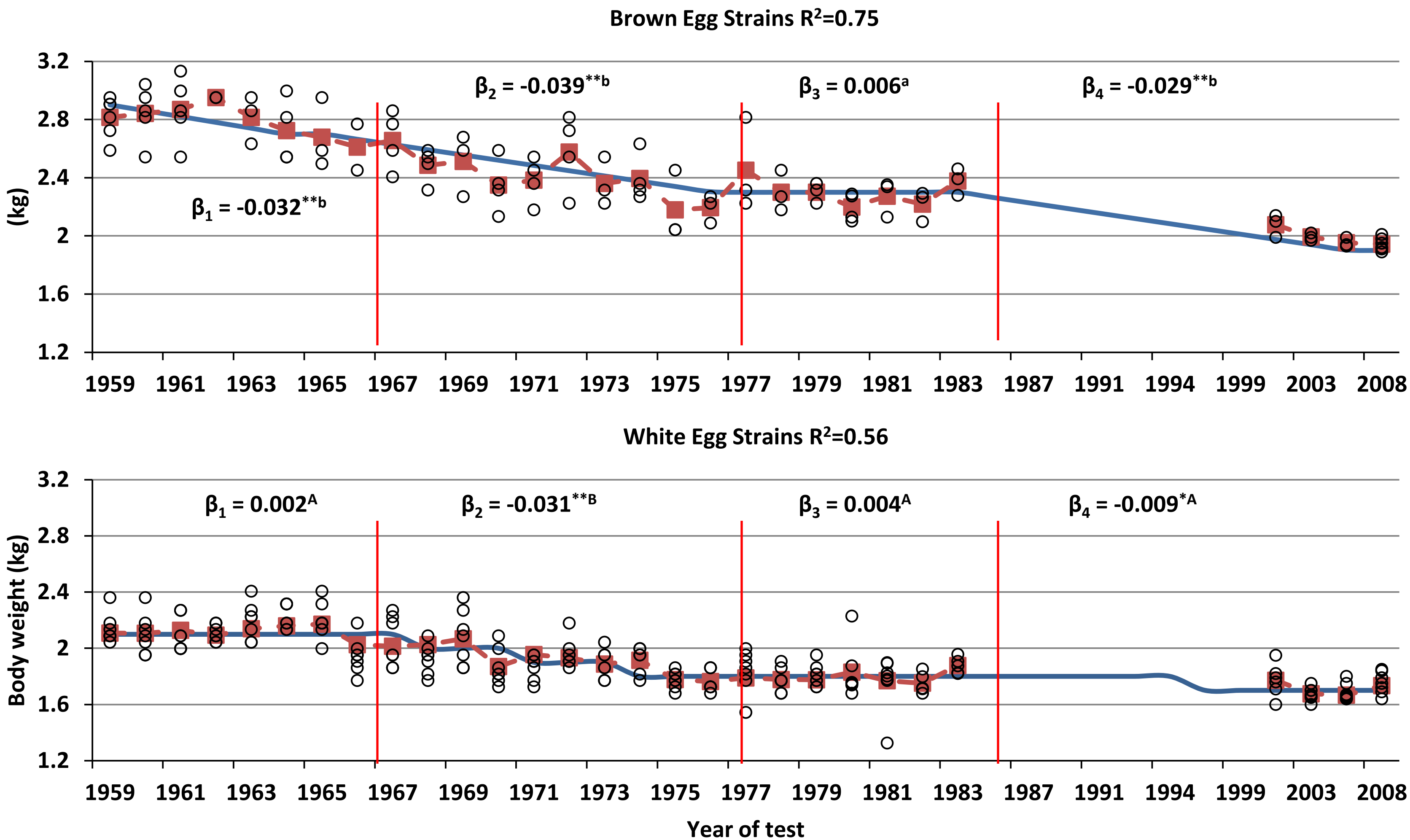


* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

Figure 10. Body Weight at 500 days of age (BW500) by strain within test, and the regression of the average BW500 of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



O Average BW500 by Strain Within Test — Average BW500 of all Strains — Regression of average BW500 of all strains on test number

* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

abc Slopes with different superscripts are significantly different (P<0.05)

Egg Weight
and
Size Distribution

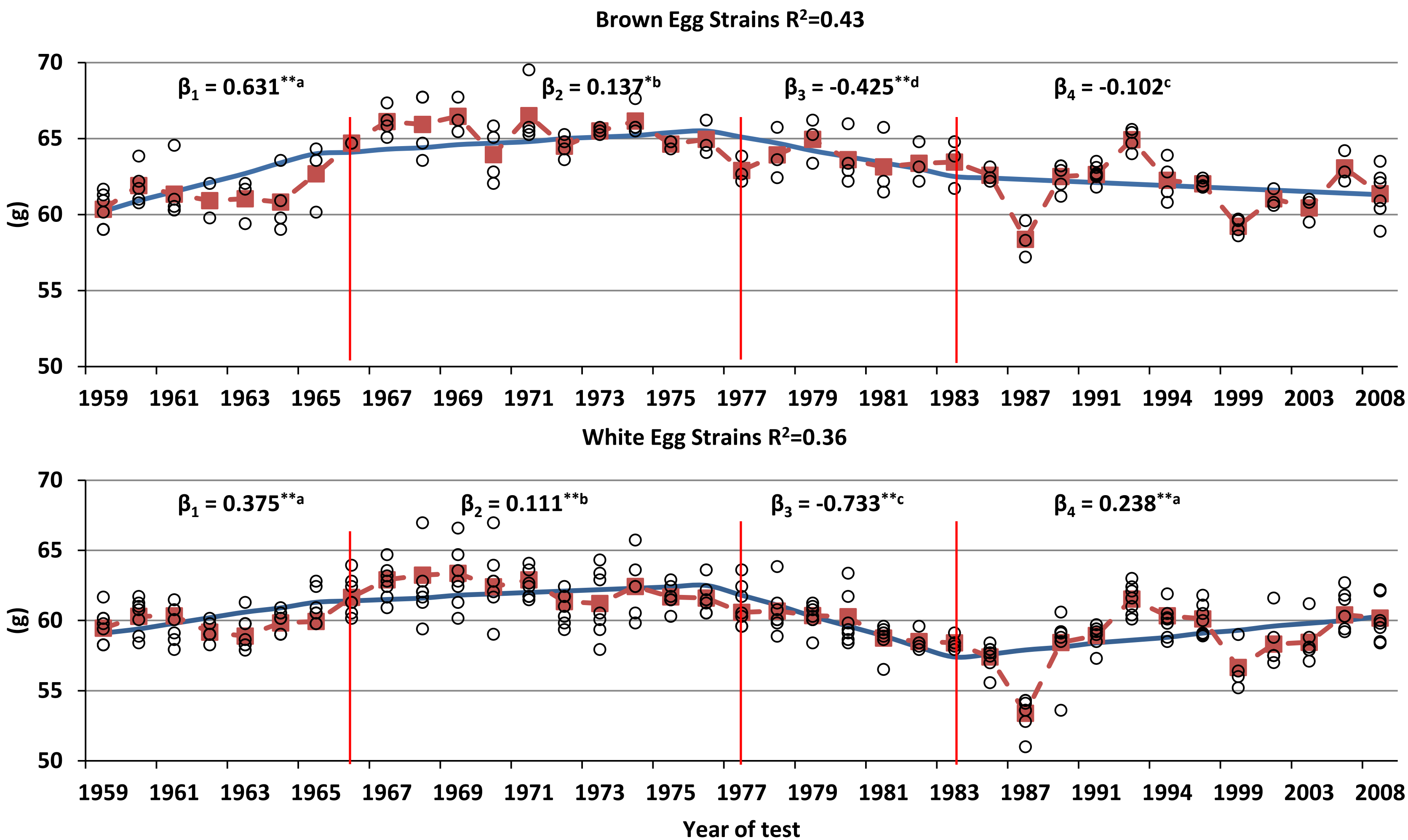
Single Production Cycle

Table 4. Egg weight, and size distribution for the brown and white egg strains entered into the 1st through the 37th North Carolina layer tests

NCLP&MT Test	Egg wt	X Lg	Lg	Med	Sm
(Brown Egg Strains)	(g)	(%)	(%)	(%)	(%)
1958-1st NCLP&MT	60.3	42.9^{B}	34.3^{a}	17.6^{a}	4.3^{a}
2009-37th NCLP&MT	61.4	67.6^{A}	22.0^{b}	9.4^{b}	0.9^{b}
Std Err	±0.6	±2.8	±1.8	±1.1	±0.4
(White Egg Strains)					
1958-1st NCLP&MT	59.5	38.0^{B}	37.1^{A}	19.9^{A}	4.4^{A}
2009-37th NCLP&MT	60.2	60.3^{A}	26.1^{B}	12.2^{B}	1.3^{B}
Std Err	±0.4	±2.1	±1.3	±0.8	±0.3

^{AB}Means significantly different within column and egg type ($p<0.0001$).

Figure 11. Average Egg Weight (EW) by strain within test, and the regression of the average EW of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



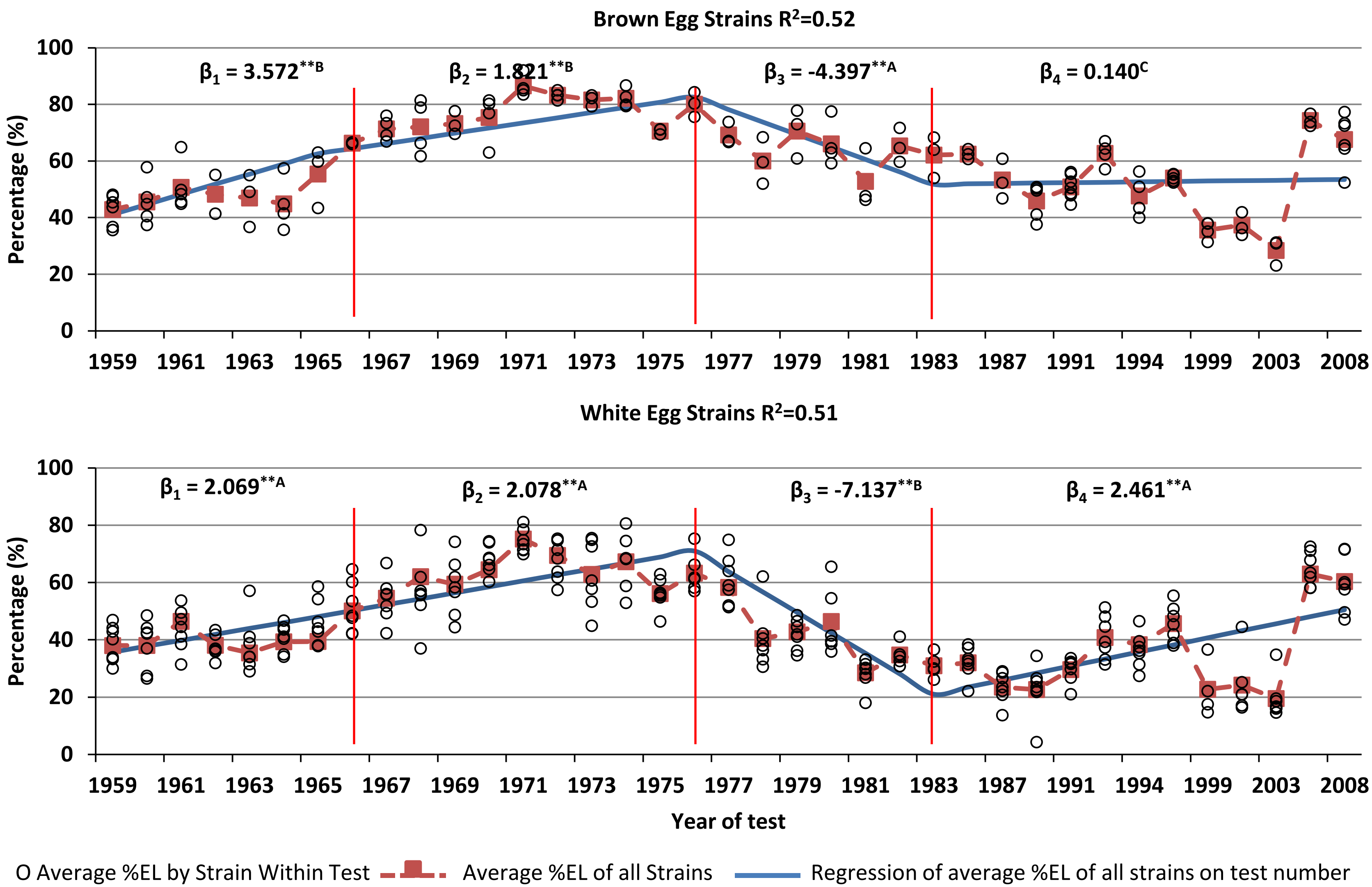
O Average EW by Strain Within Test — Average EW of all Strains — Regression of average EW of all strains on test number

* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

[abc]Slopes with different superscripts are significantly different (P<0.05)

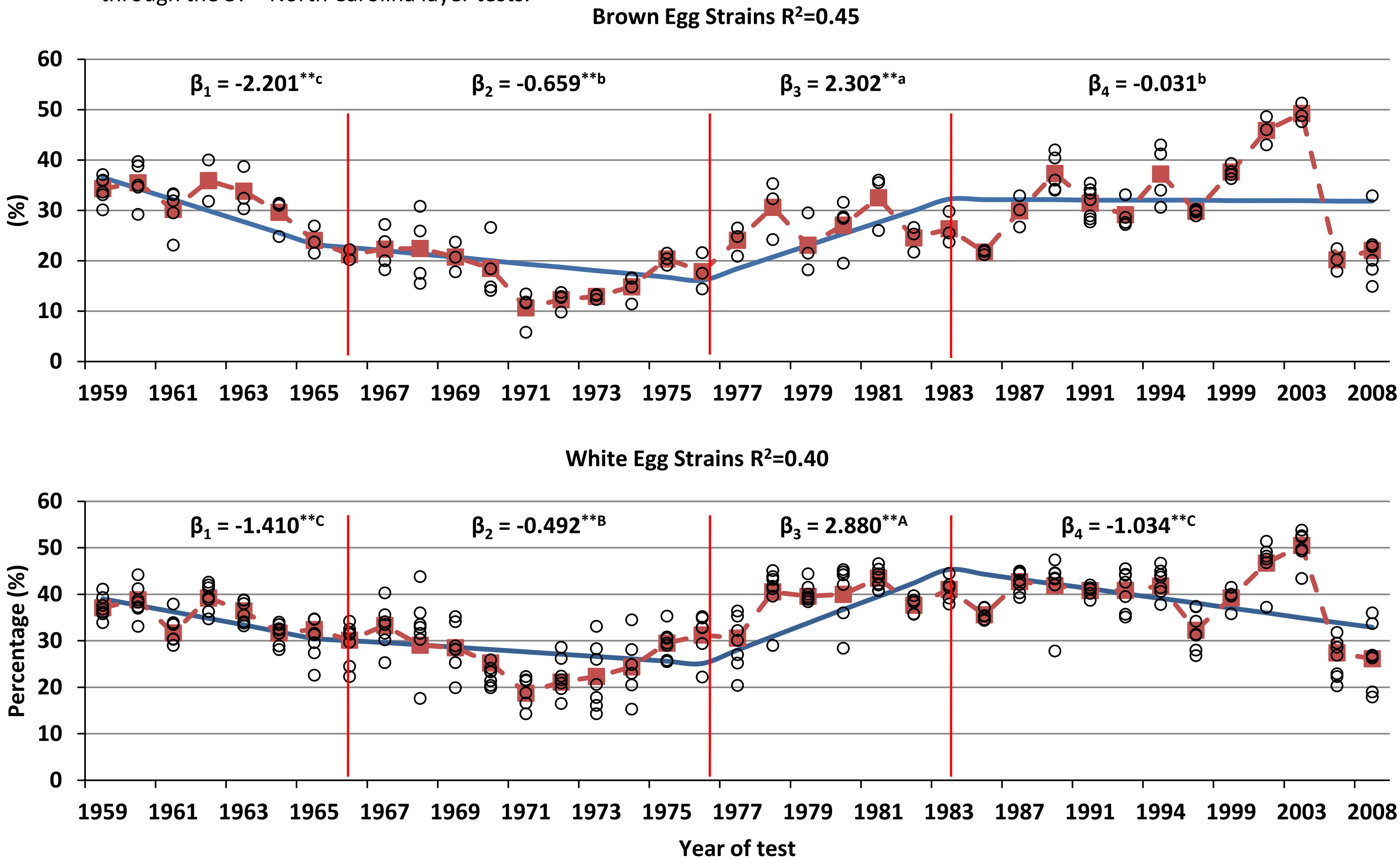
Figure 12. Percent % Extra Large Eggs (%EL) by strain within test, and the regression of the average %EL of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



** Slope significantly different from 0 (P<0.01)

ABCSlopes with different superscripts are significantly different (P<0.01)

Figure 13. Percent Large Eggs (%L) by strain within test, and the regression of the average %L of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



O Average %L by Strain Within Test — Average %L of all Strains — Regression of average %L of all strains on test number

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

abc Slopes with different superscripts are significantly different (P<0.05)

Figure 14. Percent Medium Eggs (%M) by strain within test, and the regression of the average %M of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1[st] through the 37[th] North Carolina layer tests.

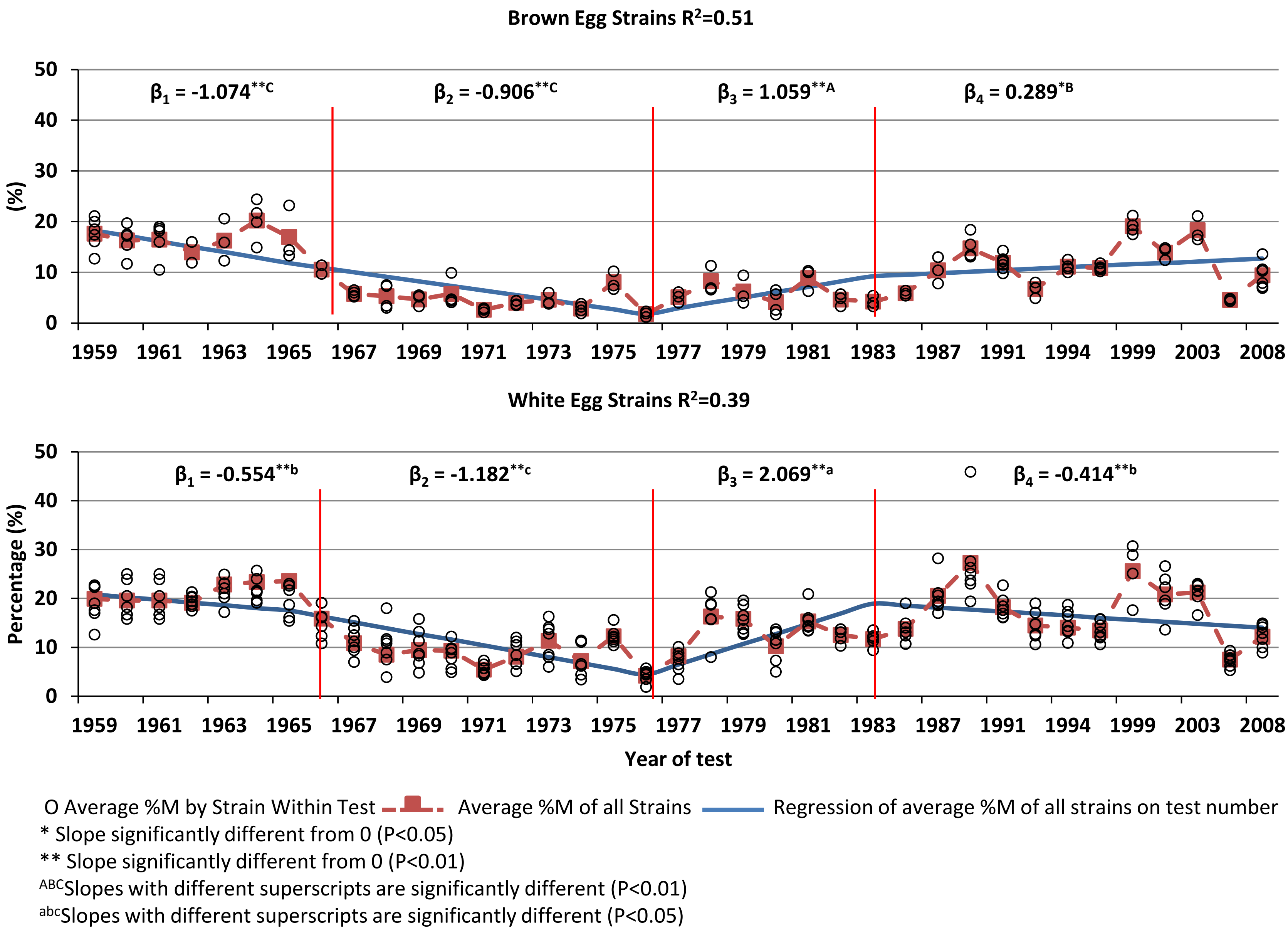
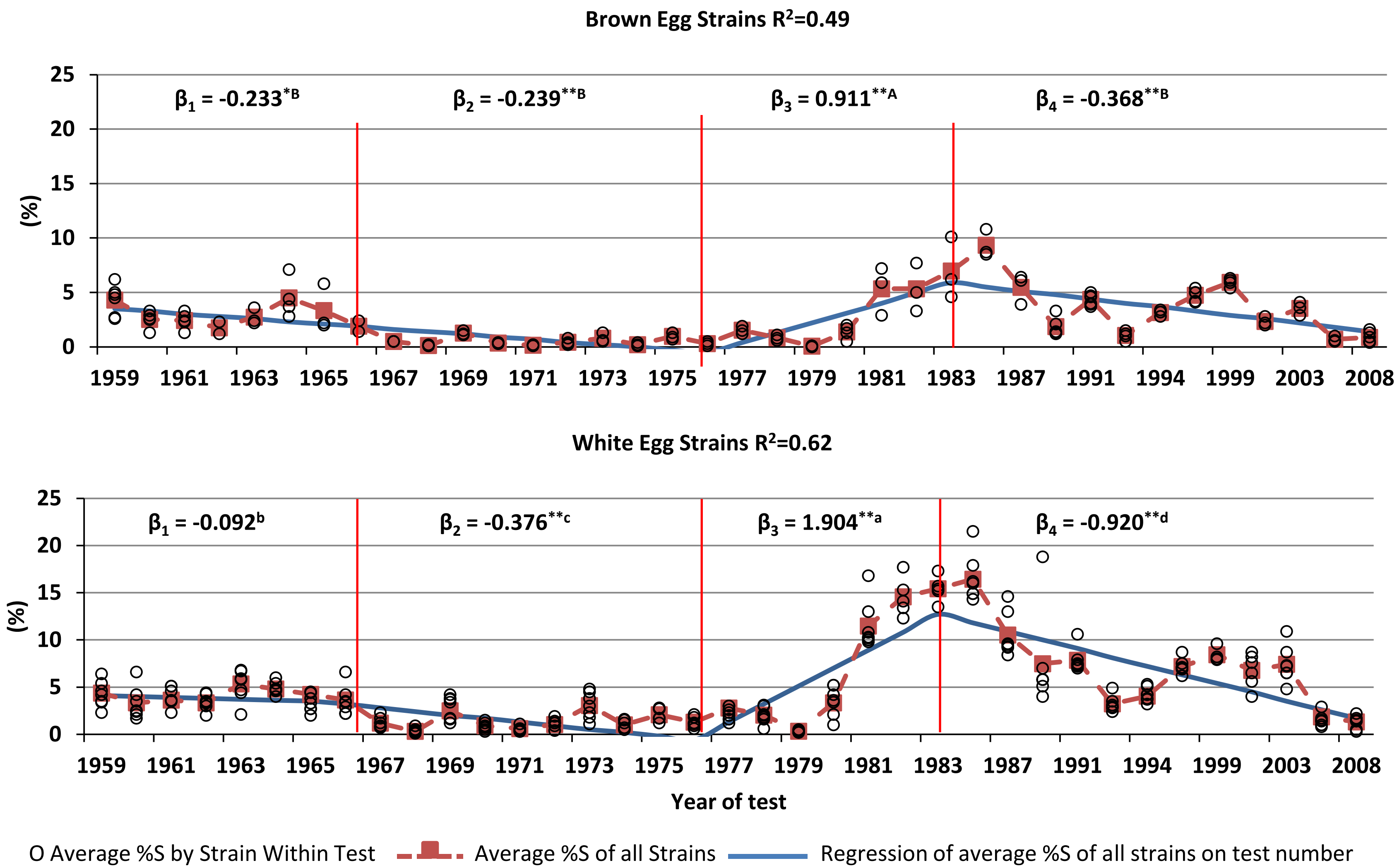


Figure 15. Percent Small Eggs (%S) by strain within test, and the regression of the average %S of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



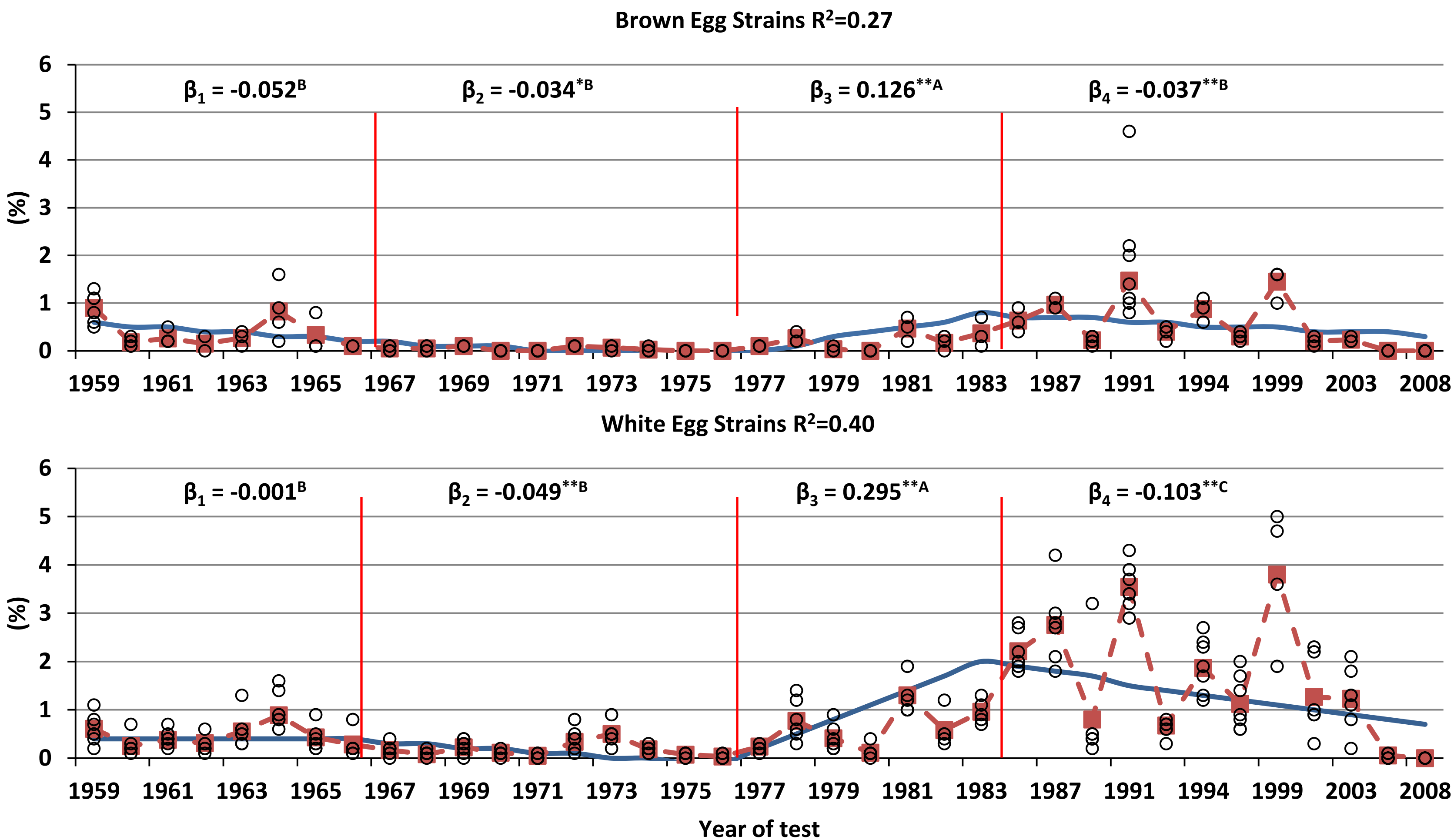
* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

abc Slopes with different superscripts are significantly different (P<0.05)

Figure 16. Percent Pee Wee Eggs (%PW) by strain within test, and the regression of the average %PW of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



O Average %PW by Strain Within Test — Average %PW of all Strains — Regression of average %PW of all strains on test number

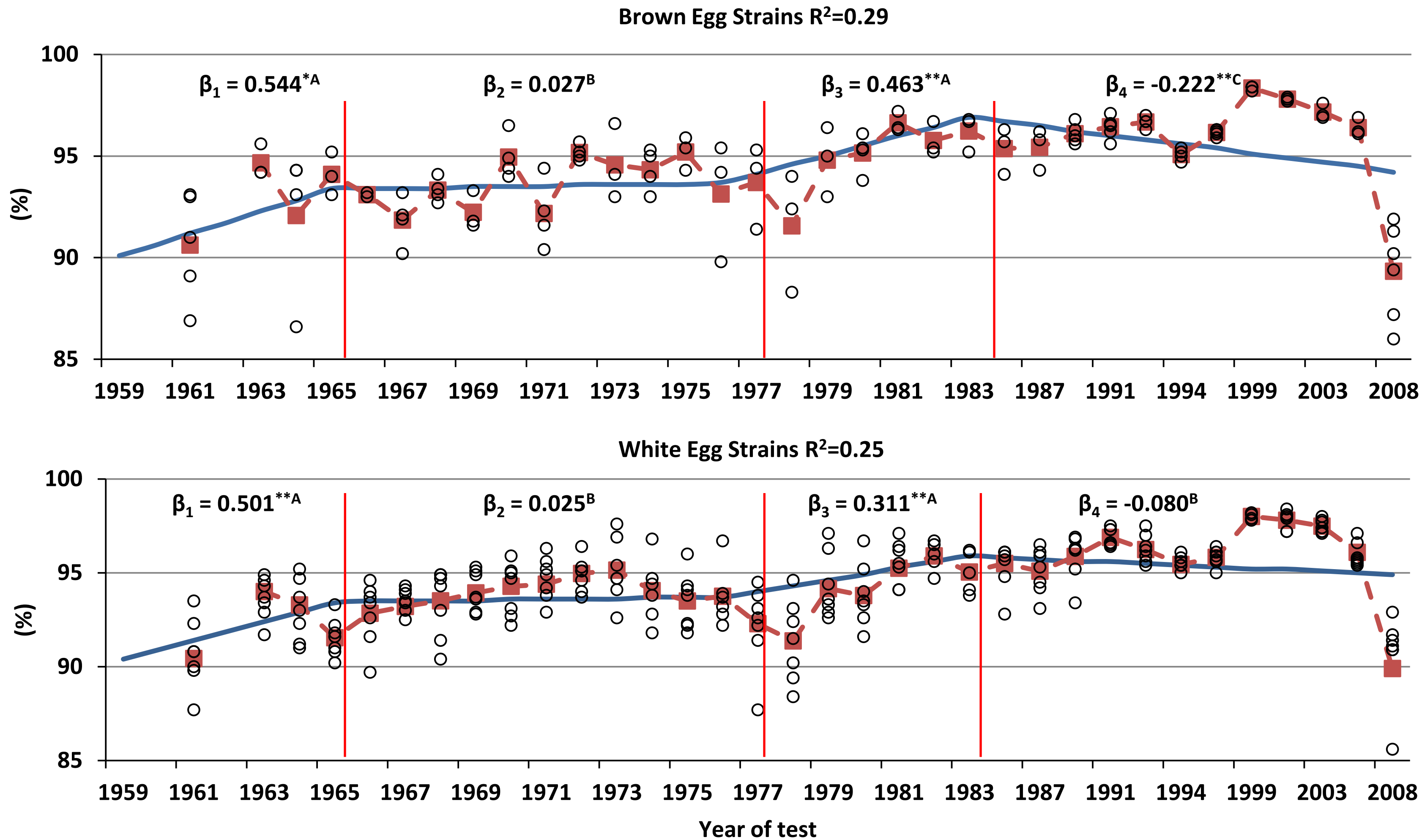
** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

USDA Egg Quality

Single Production Cycle

Figure 17. Percent USDA Grade A Eggs (%GA) by strain within test, and the regression of the average %GA of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



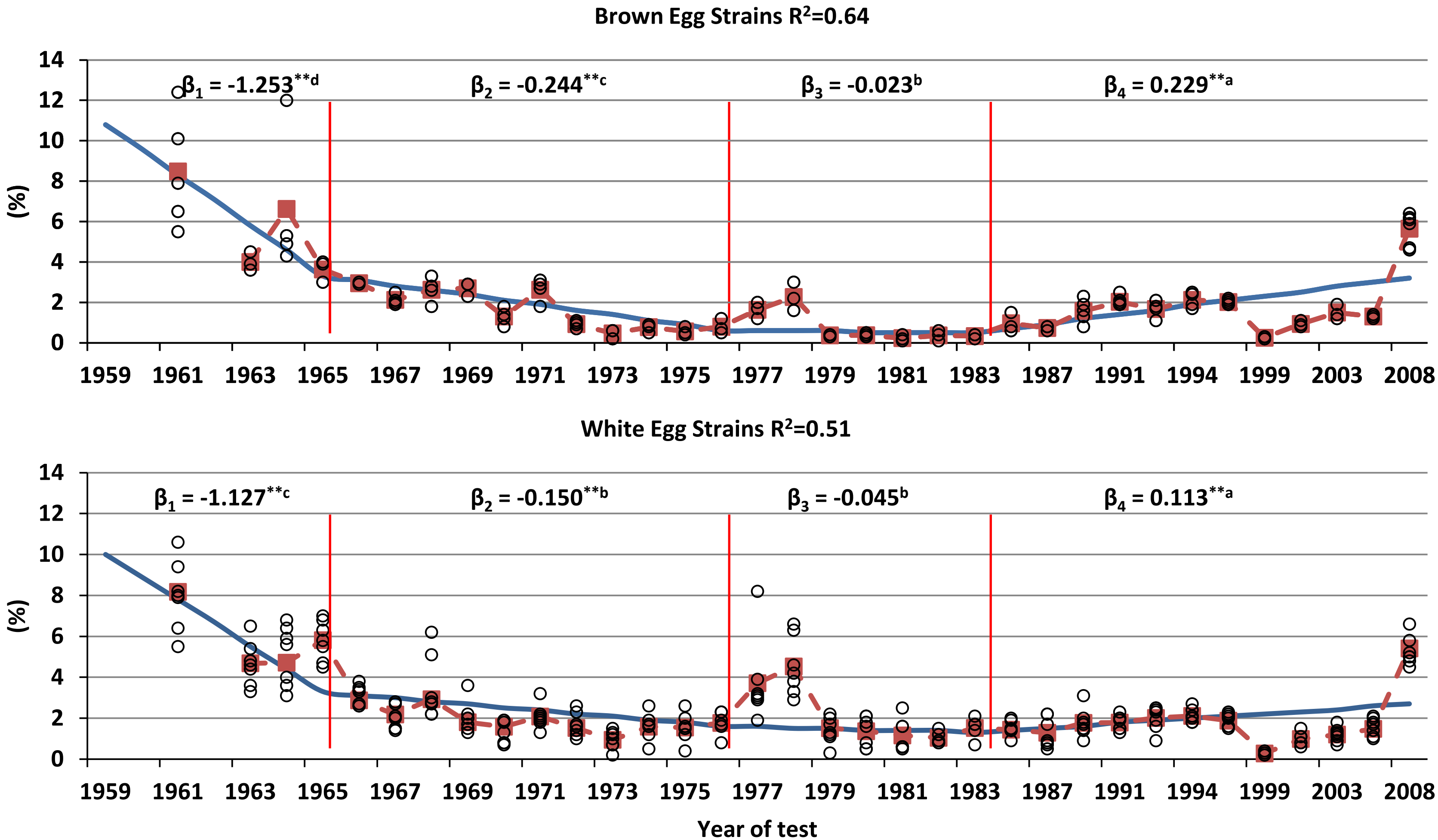
O Average %GA by Strain Within Test — Average %GA of all Strains — Regression of average %GA of all strains on test number

* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABCSlopes with different superscripts are significantly different (P<0.01)

Figure 18. Percent USDA Grade B Eggs (%GB) by strain within test, and the regression of the average %GB of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.

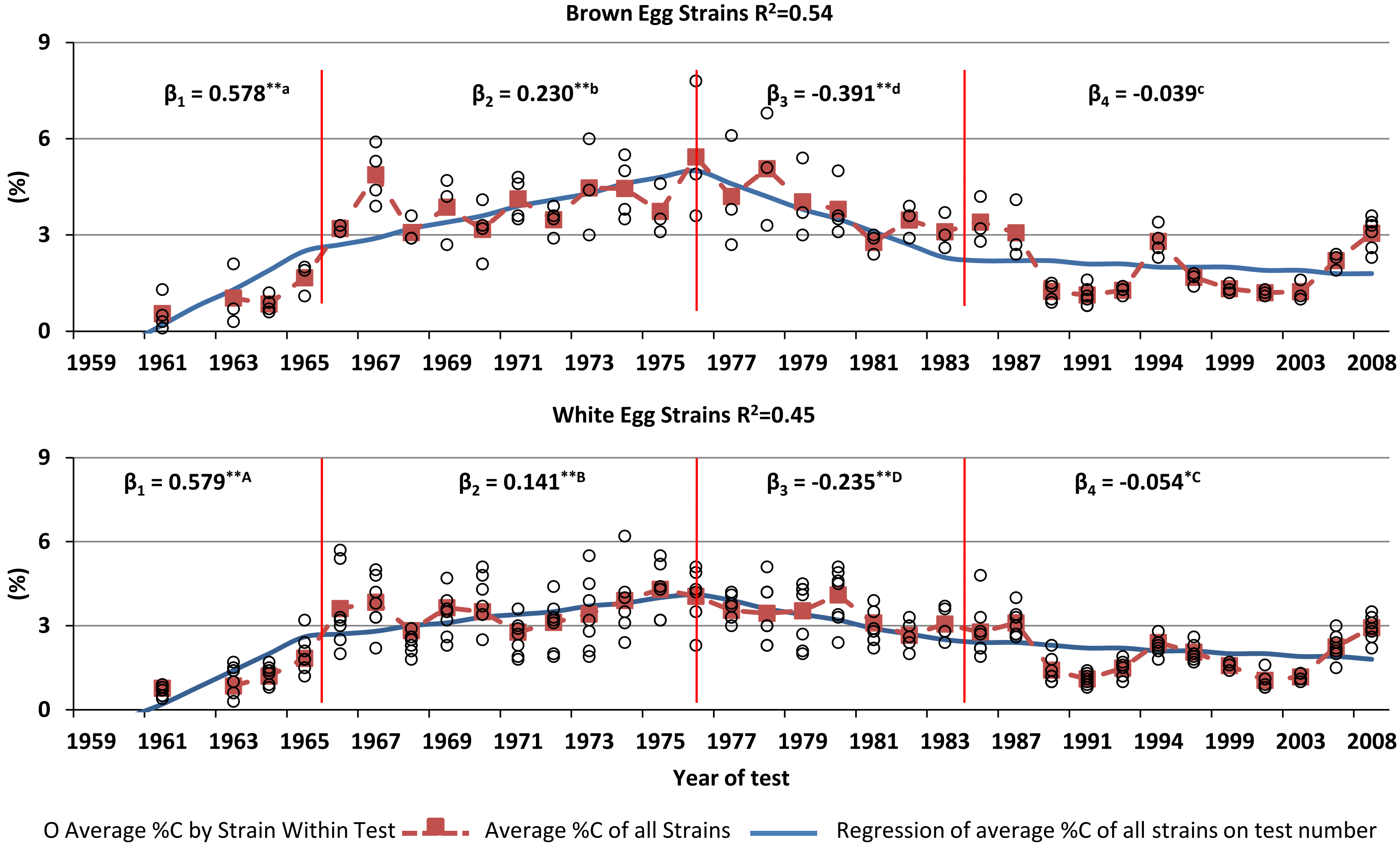


O Average %GB by Strain Within Test — Average %GB of all Strains — Regression of average %GB of all strains on test number

** Slope significantly different from 0 (P<0.01)

abcSlopes with different superscripts are significantly different (P<0.05)

Figure 19. Percent USDA Checked Eggs (%C) by strain within test, and the regression of the average %C of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



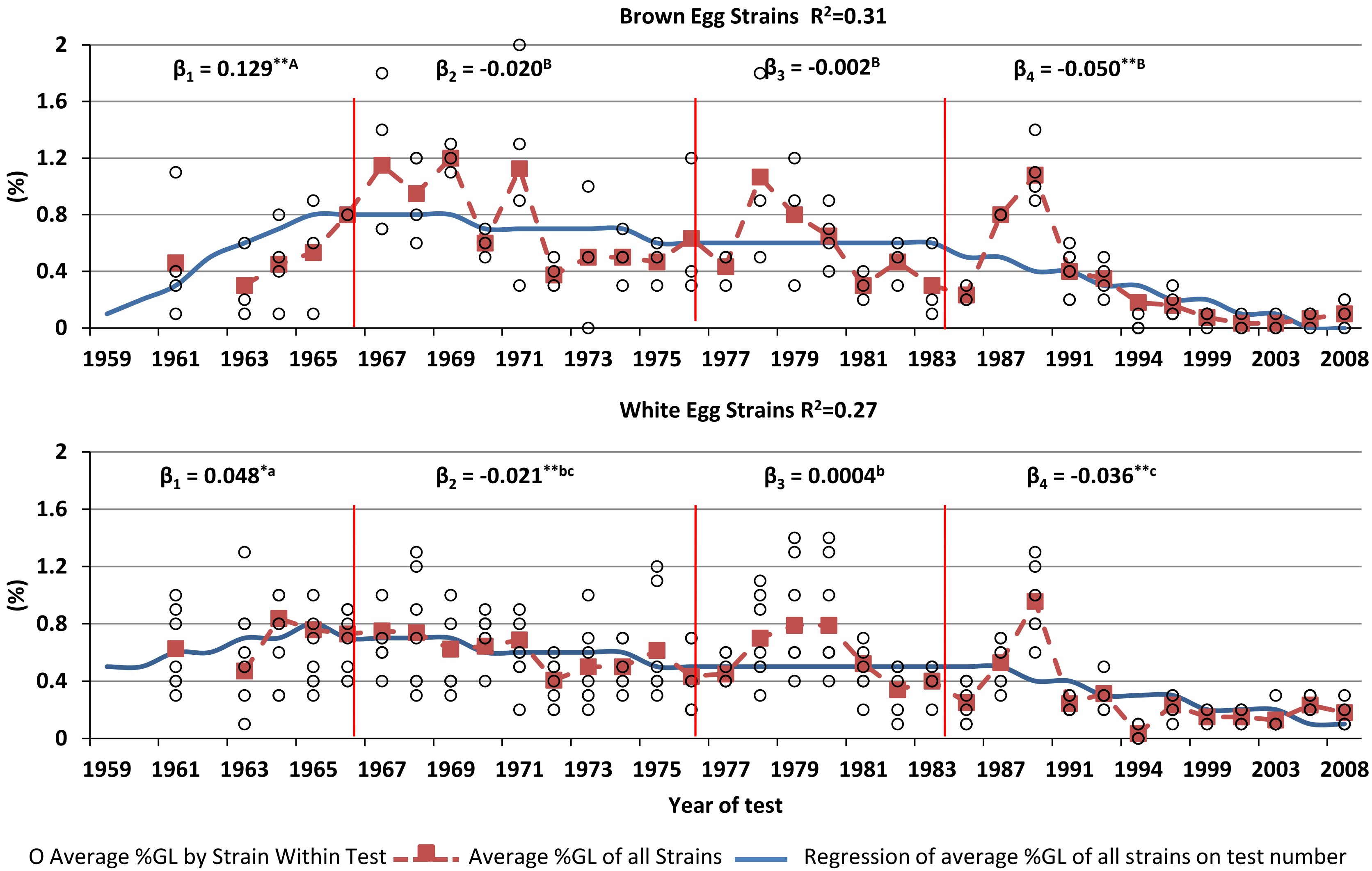
* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

abc Slopes with different superscripts are significantly different (P<0.05)

Figure 20. Percent USDA Grade Loss Eggs (%GL) by strain within test, and the regression of the average %GL of all strains on the test number within three sets of tests with similar testing environments, for the brown and white egg strains entered from 1958 through 2008 into the 1st through the 37th North Carolina layer tests.



* Slope significantly different from 0 (P<0.05)

** Slope significantly different from 0 (P<0.01)

ABC Slopes with different superscripts are significantly different (P<0.01)

abc Slopes with different superscripts are significantly different (P<0.05)

Post-molt
Egg Production Characteristics

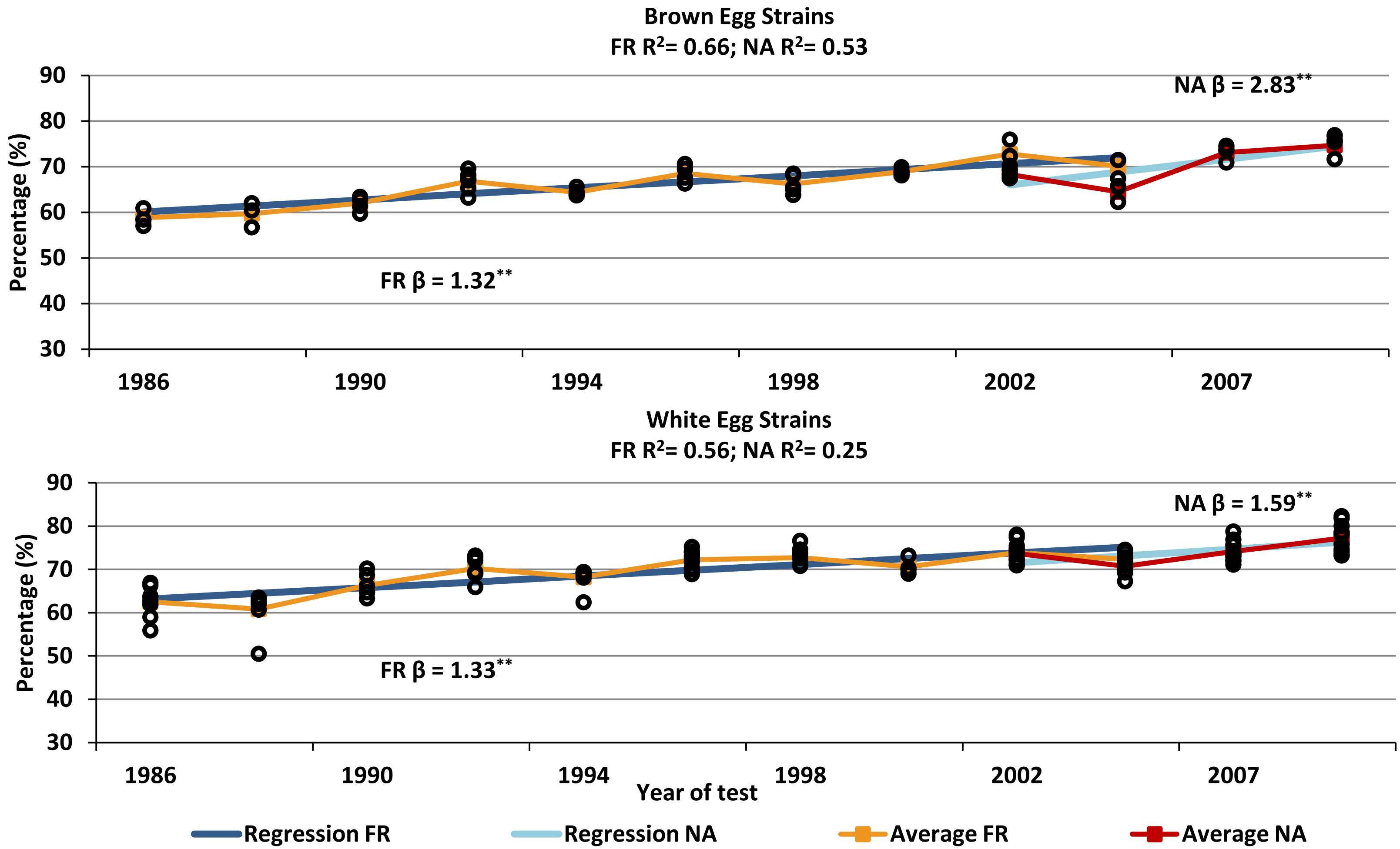
Second Production Cycle

Table 5. Production characteristics in post-molt hens for the brown and white egg strains entered into the 26th through the 37th North Carolina layer tests

NCLP&MT Test	Hen-Day Production	Hen-Housed Eggs	Feed Cons.	Feed Conv.
(Brown Egg Strains)	(%)	(eggs/hen)	(kg/100 hens)	(g egg/g feed)
1986-26th NCLP&MT	58.9[B]	139[b]	11.2[a]	0.288[B]
2009-37th NCLP&MT	67.9[A]	151[a]	12.1[b]	0.400[A]
Std Err	±1.3	±2	±0.2	±0.010
(White Egg Strains)				
1986-26th NCLP&MT	59.5[B]	153	9.5[B]	0.324[B]
2009-37th NCLP&MT	67.7[A]	148	12.0[A]	0.404[A]
Std Err	±1.5	±4	±0.2	±0.010

[ab]Superscripts different within column and strain are significant ($p<0.05$).
[AB]Superscripts different within column and strain are significant ($p<0.0001$).

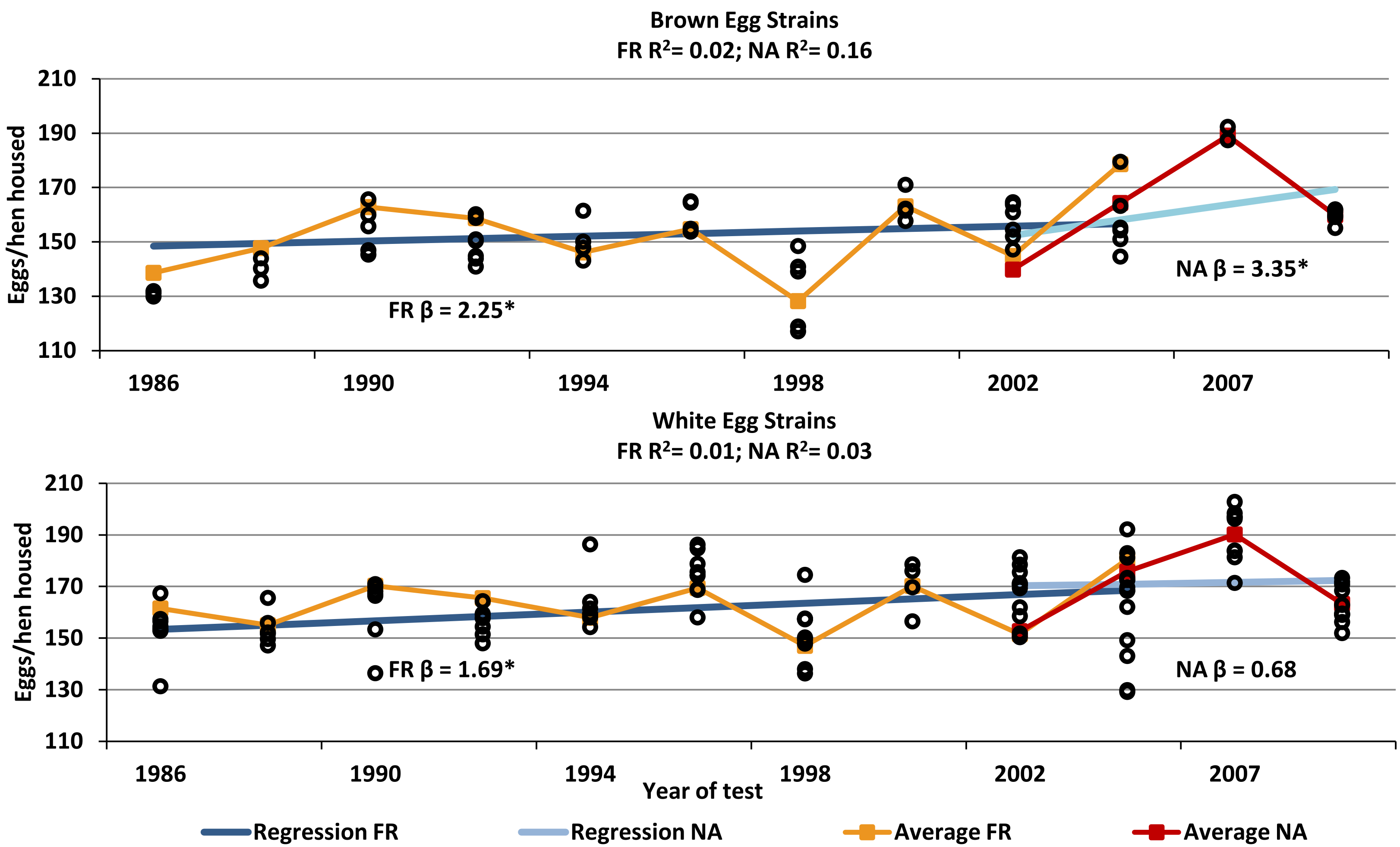
Figure 21. Post-molt Percent Hen-Day production (%PMHD) post-molt by strain within test, and the regression of the average %PMHD of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

**Slope significantly different from 0 (P<0.01)

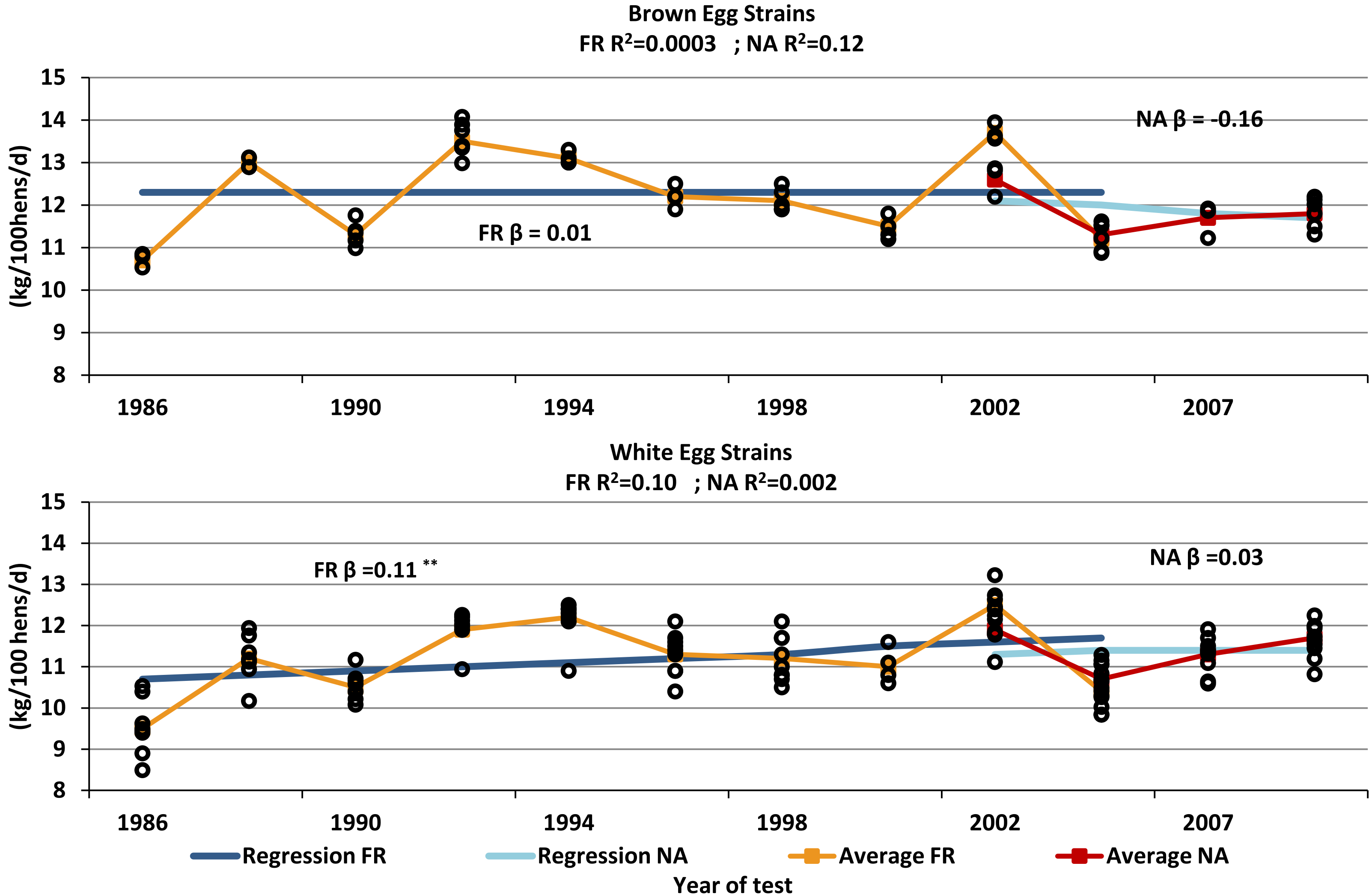
Figure 22. Post-molt Eggs per Hen-Housed (PMHH) by strain within test, and the regression of the average PMHH of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

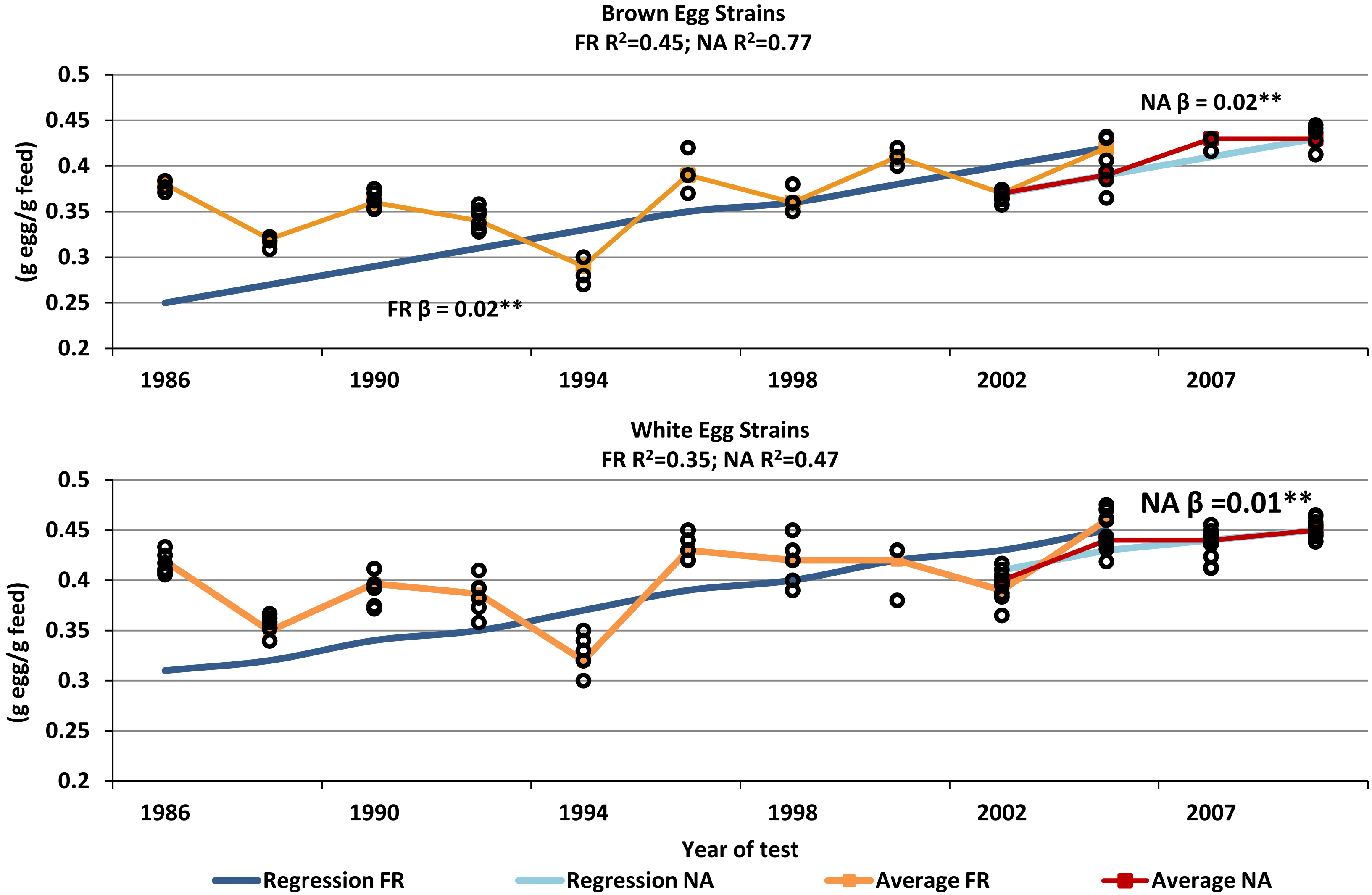
Figure 23. Post-molt Feed consumption per 100 hens (PMFC/100) by strain within test, and the regression of the average PMFC/100 of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

**Slope significantly different from 0 (P<0.01)

Figure 24. Post-molt feed conversion (PMFCV = g egg/g feed) by strain within test, and the regression of the average PMFCV of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

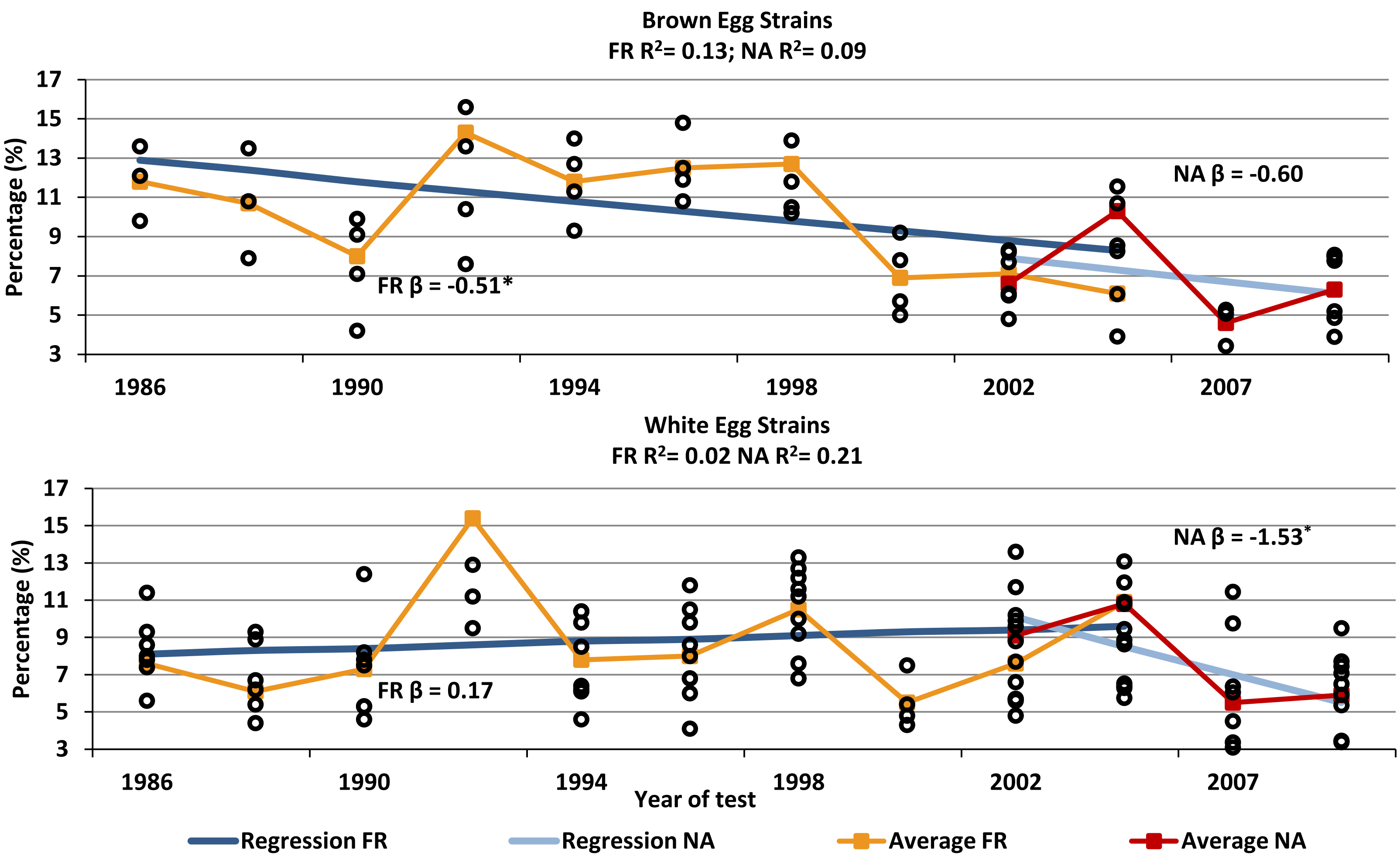
**Slope significantly different from 0 (P<0.01)

Table 6. Mortality, egg wt, and size distribution in post-molt hens for the brown and White egg strains entered into the 26th through the 37th North Carolina layer tests

NCLP&MT Test Year	Mortality	Egg wt	X Lg	Lg	Med	Sm
(Brown Egg Strains)	(%)	(g)	(%)	(%)	(%)	(%)
1986-26th NCLP&MT	11.8^{A}	68.8	90.3^{b}	8.4^{a}	1.0^{a}	0.2^{a}
2009-37th NCLP&MT	8.5^{B}	67.6	95.8^{a}	4.3^{b}	0.4^{b}	0.01^{b}
Std Err	±1.1	±0.5	±0.7	±0.7	±0.2	±0.04
(White Egg Strains)						
1986-26th NCLP&MT	7.6	63.7^{B}	68.4^{B}	22.4^{A}	3.7^{A}	0.8^{A}
2009-37th NCLP&MT	8.6	67.3^{A}	95.4^{A}	4.2^{B}	0.2^{B}	0.02^{B}
Std Err	±0.9	±0.3	±1.4	±1.1	±0.3	±0.06

^{ab}Superscripts different within column and strain are significant ($p<0.05$).
^{AB}Superscripts different within column and strain are significant ($p<0.0001$).

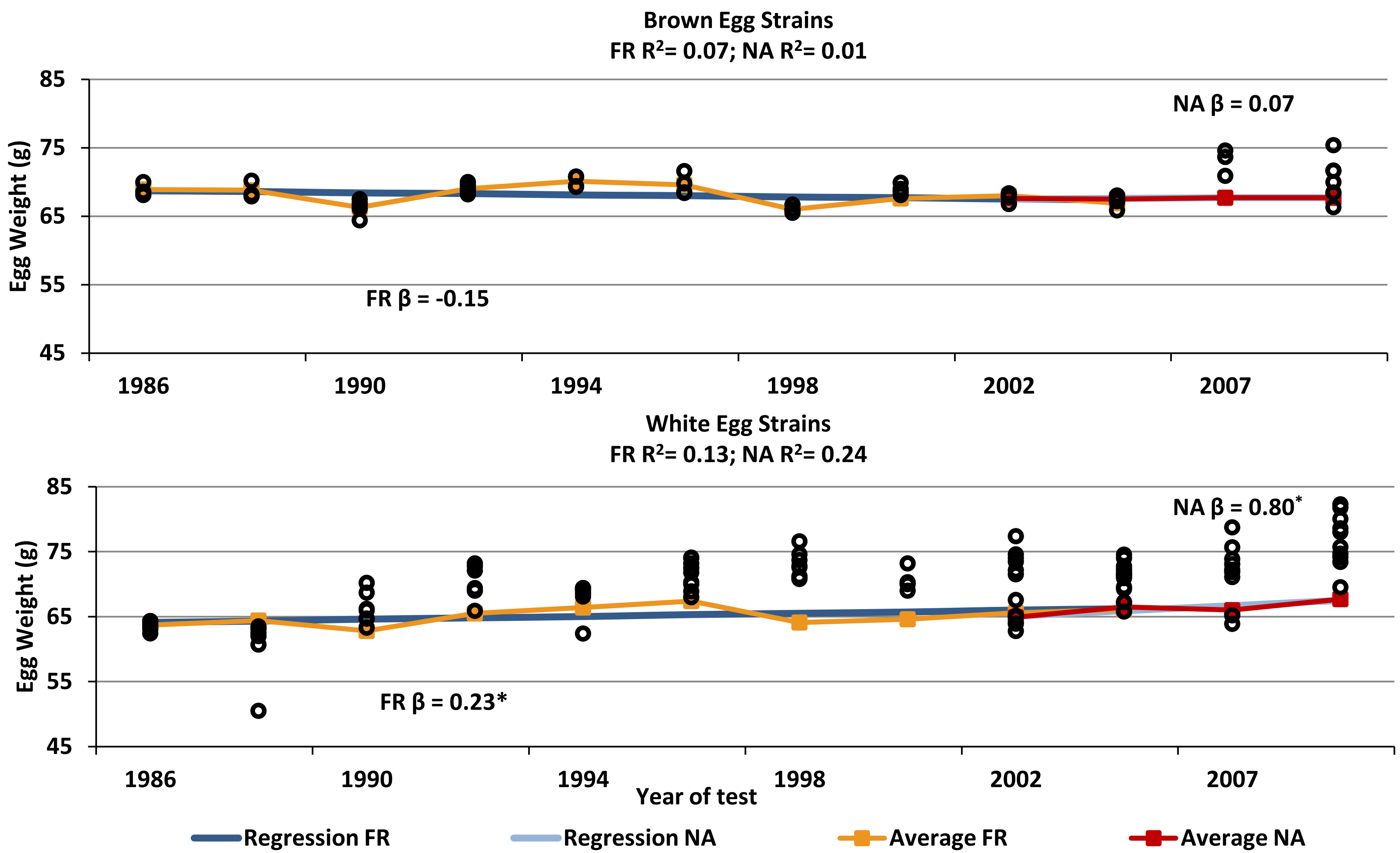
Figure 25. Post-molt Percent Mortality (PM%M) post-molt by strain within test, and the regression of the average PM%M of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

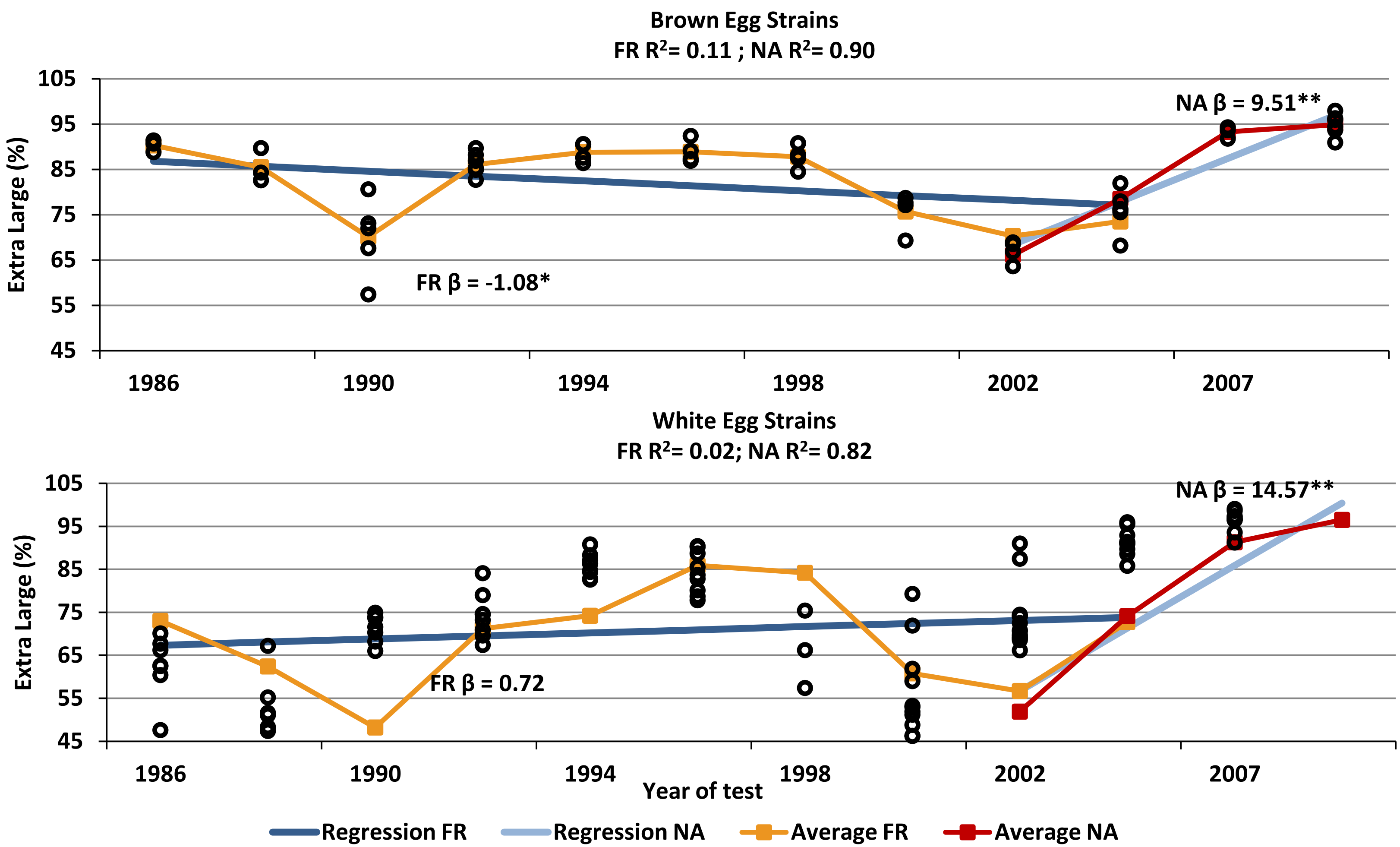
Figure 26. Post-molt Egg Weight (PMEWT) post-molt by strain within test, and the regression of the average PMEWT of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

Figure 27. Post-molt Percent Extra Large Eggs (PM%EL) by strain within test, and the regression of the average PM%EL of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.

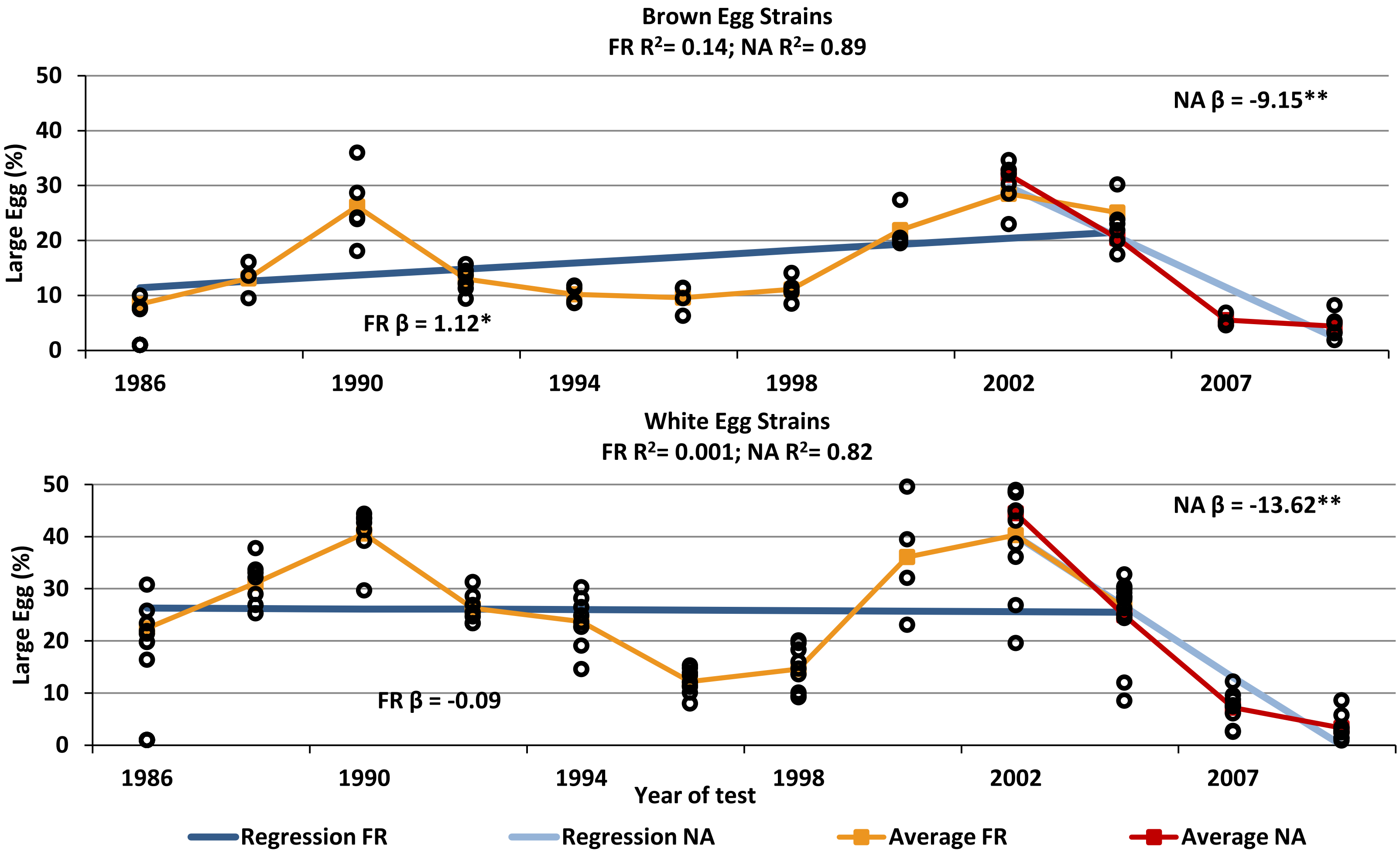


°Represents individual strain averages for the test

*Slope significantly different from 0 ($P<0.05$)

**Slope significantly different from 0 ($P<0.01$)

Figure 28. Post-molt Percent Large Eggs (PM%L) by strain within test, and the regression of the average PM%L of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.

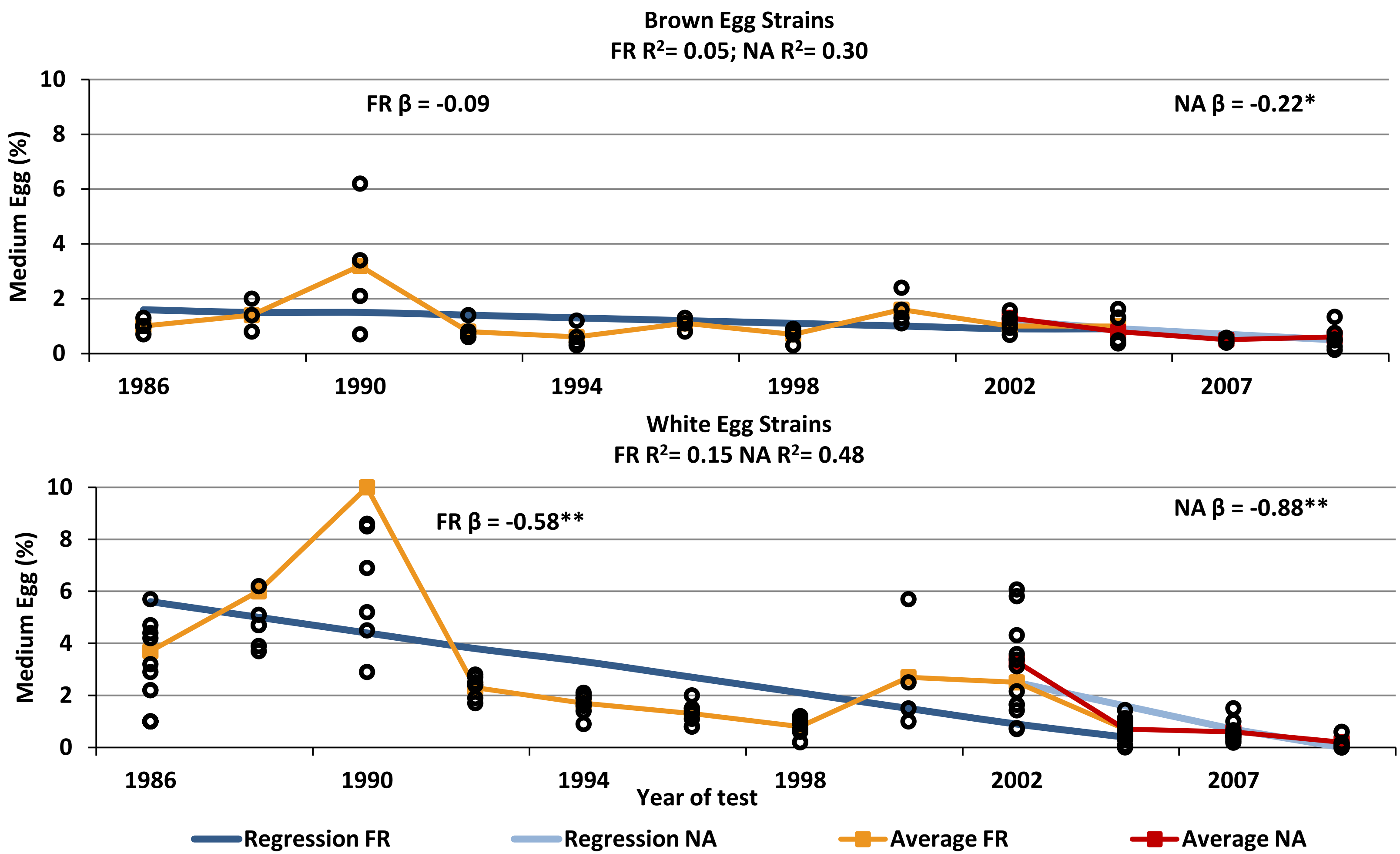


°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

**Slope significantly different from 0 (P<0.01)

Figure 29. Post-molt Percent Medium Eggs (PM%M) by strain within test, and the regression of the average PM%M of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.

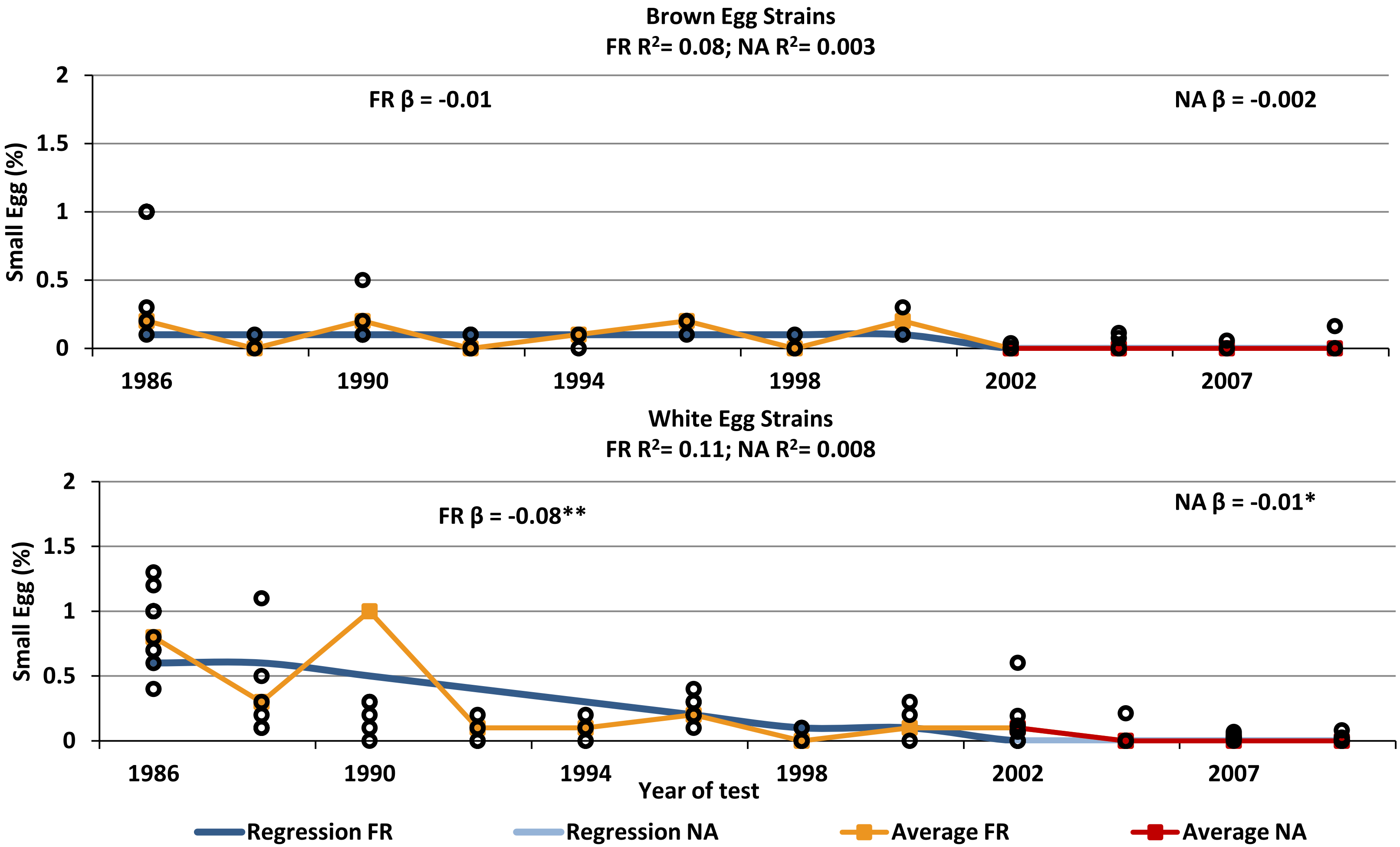


°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

**Slope significantly different from 0 (P<0.01)

Figure 30. Post-molt Percent Small Eggs (PM%S) by strain within test, and the regression of the average PM%S of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.

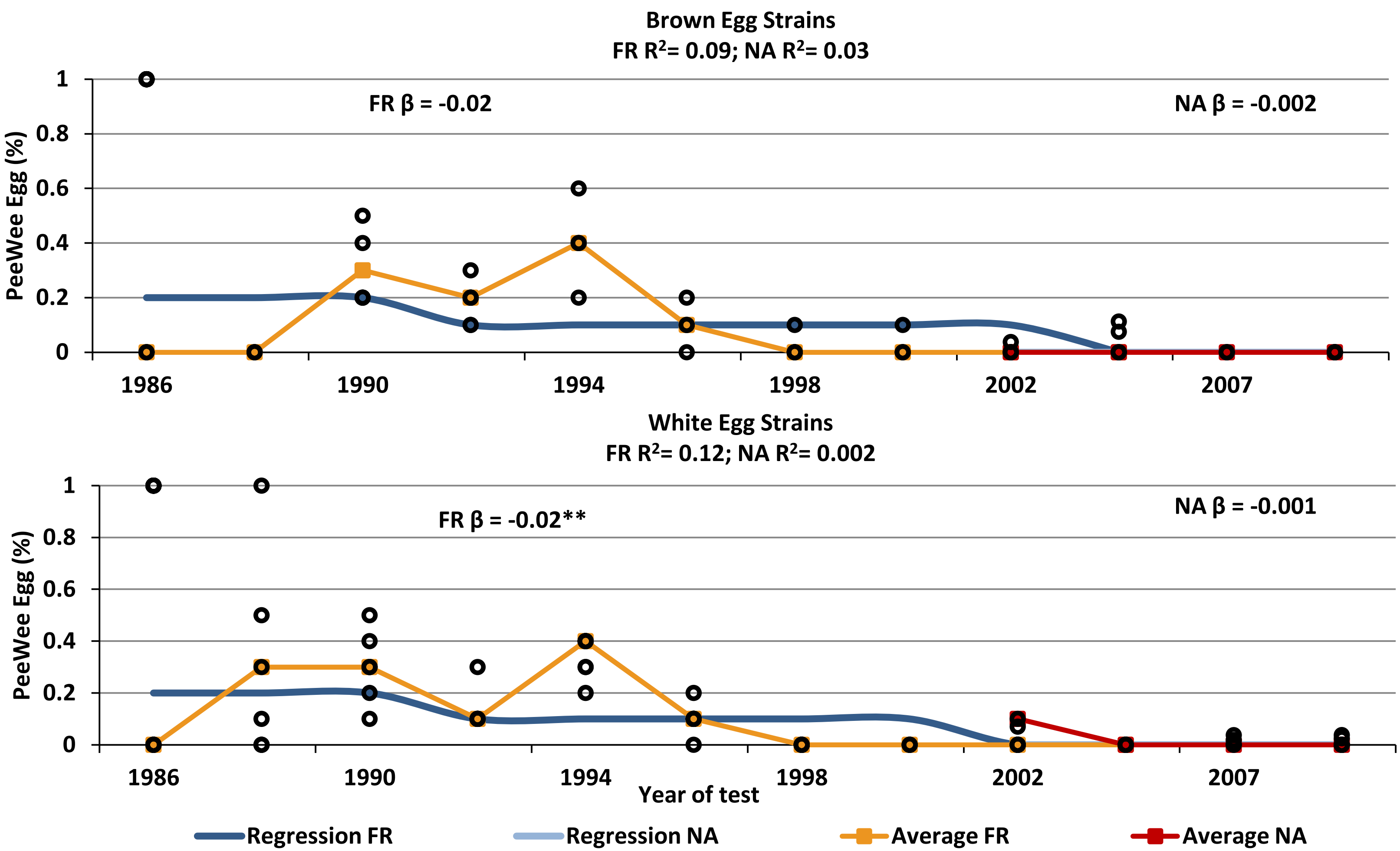


°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

**Slope significantly different from 0 (P<0.01)

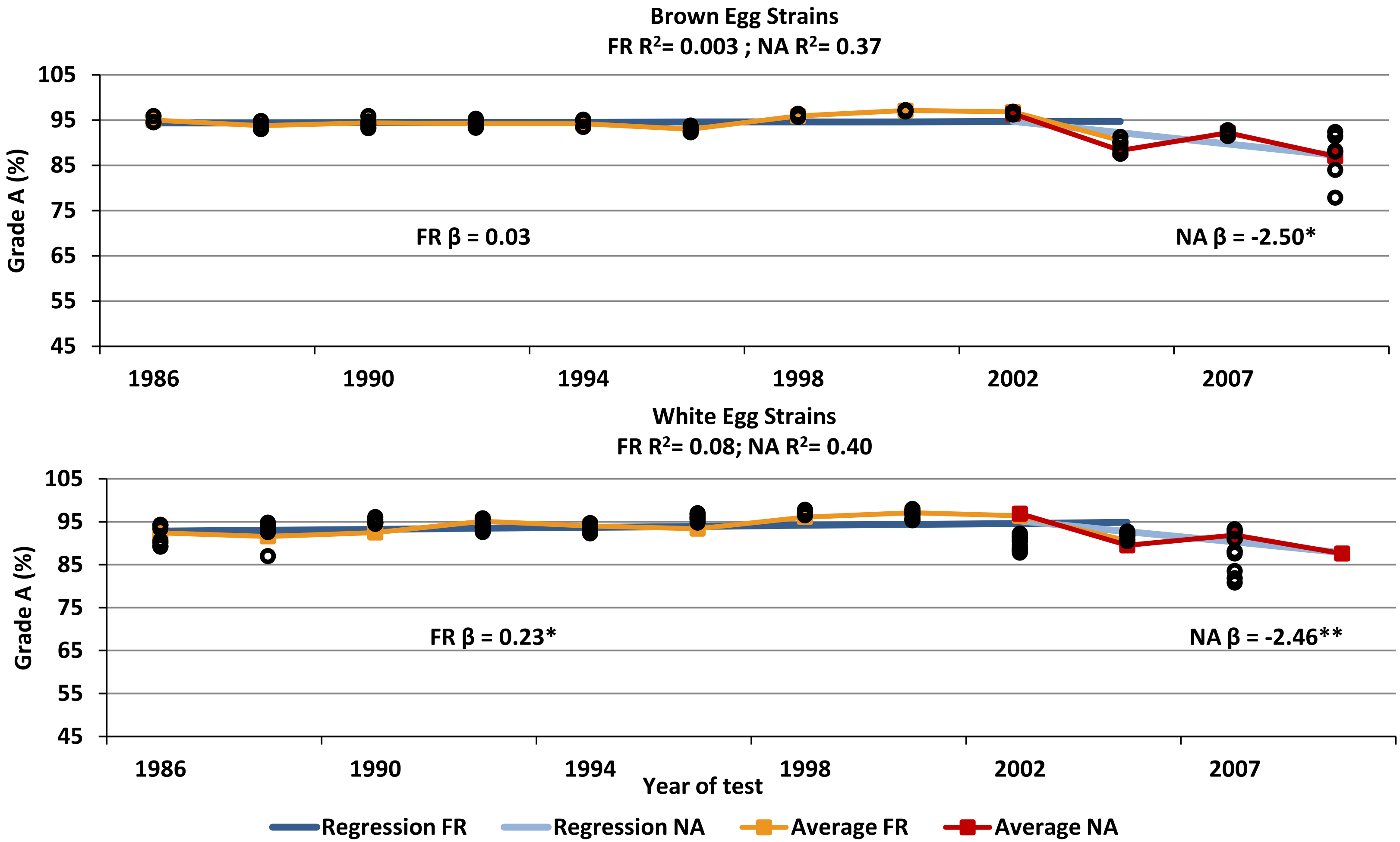
Figure 31. Post-molt Percent PeeWee Eggs (PM%PW) by strain within test, and the regression of the average PM%PW of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

**Slope significantly different from 0 (P<0.01)

Figure 32. Post-molt Percent USDA Grade A Eggs (PM%GA) by strain within test, and the regression of the average PM%GA of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.

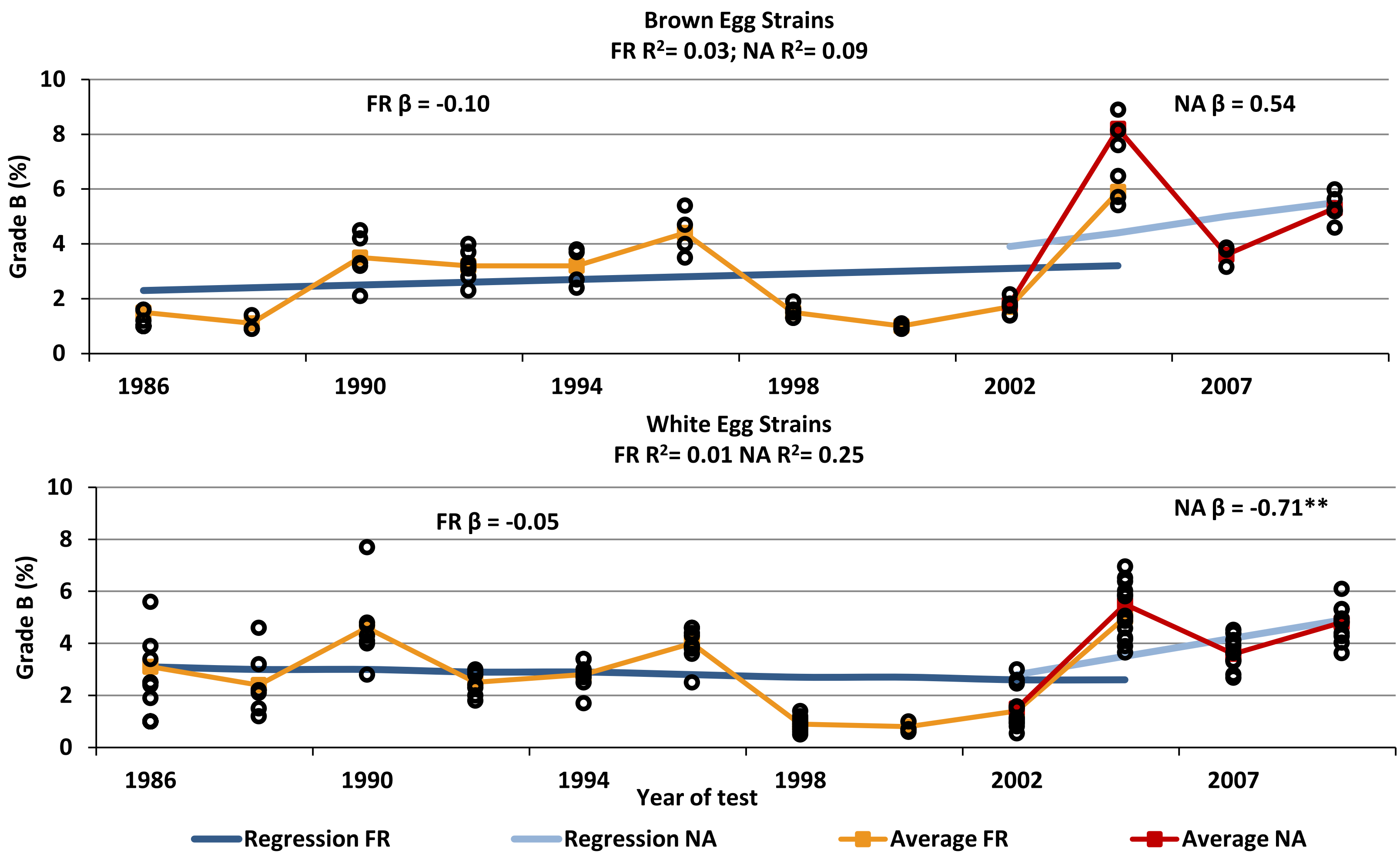


°Represents individual strain averages for the test

*Slope significantly different from 0 ($P<0.05$)

**Slope significantly different from 0 ($P<0.01$)

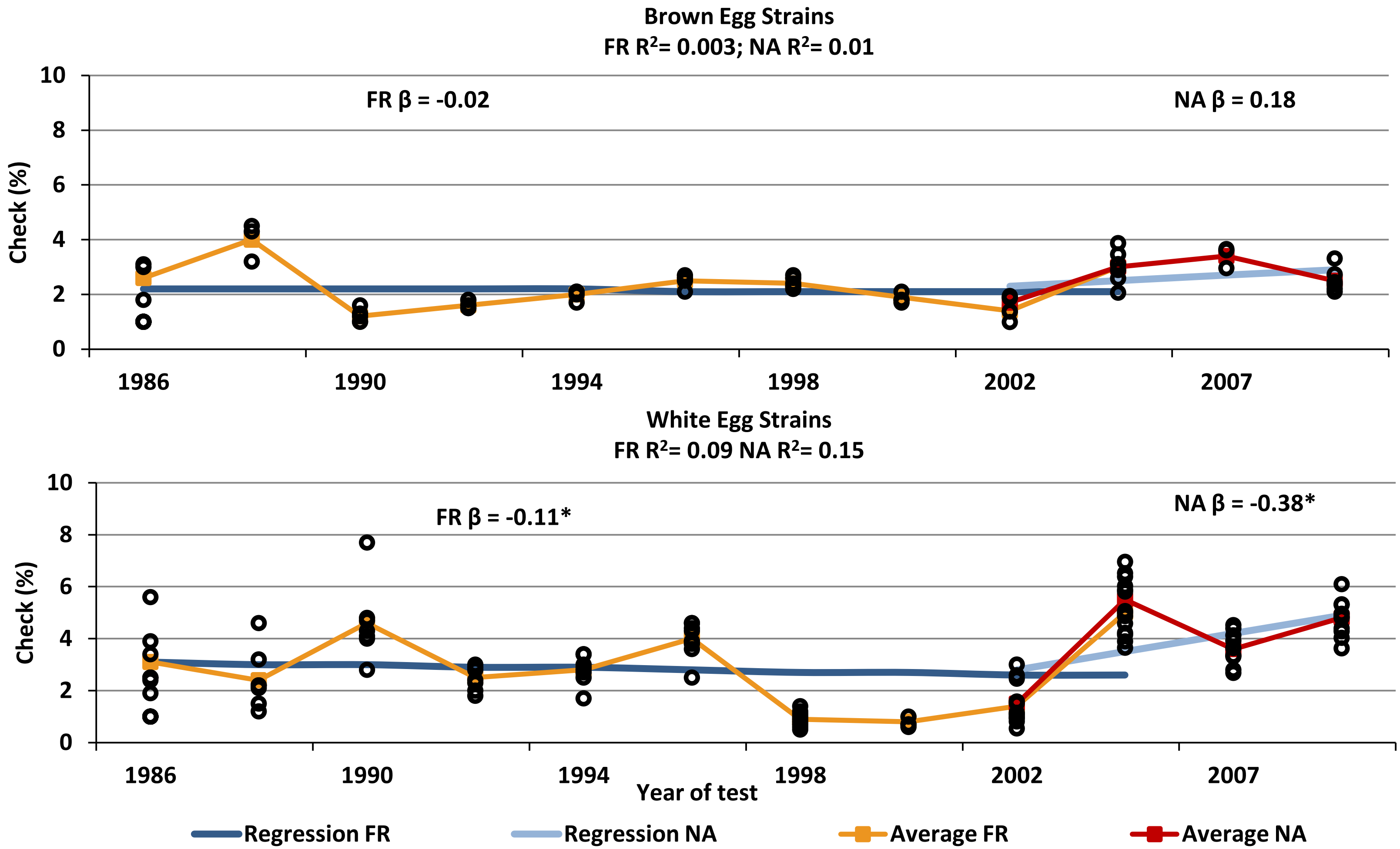
Figure 33. Post-molt Percent USDA Grade B Eggs (PM%GB) by strain within test, and the regression of the average PM%GB of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

**Slope significantly different from 0 (P<0.01)

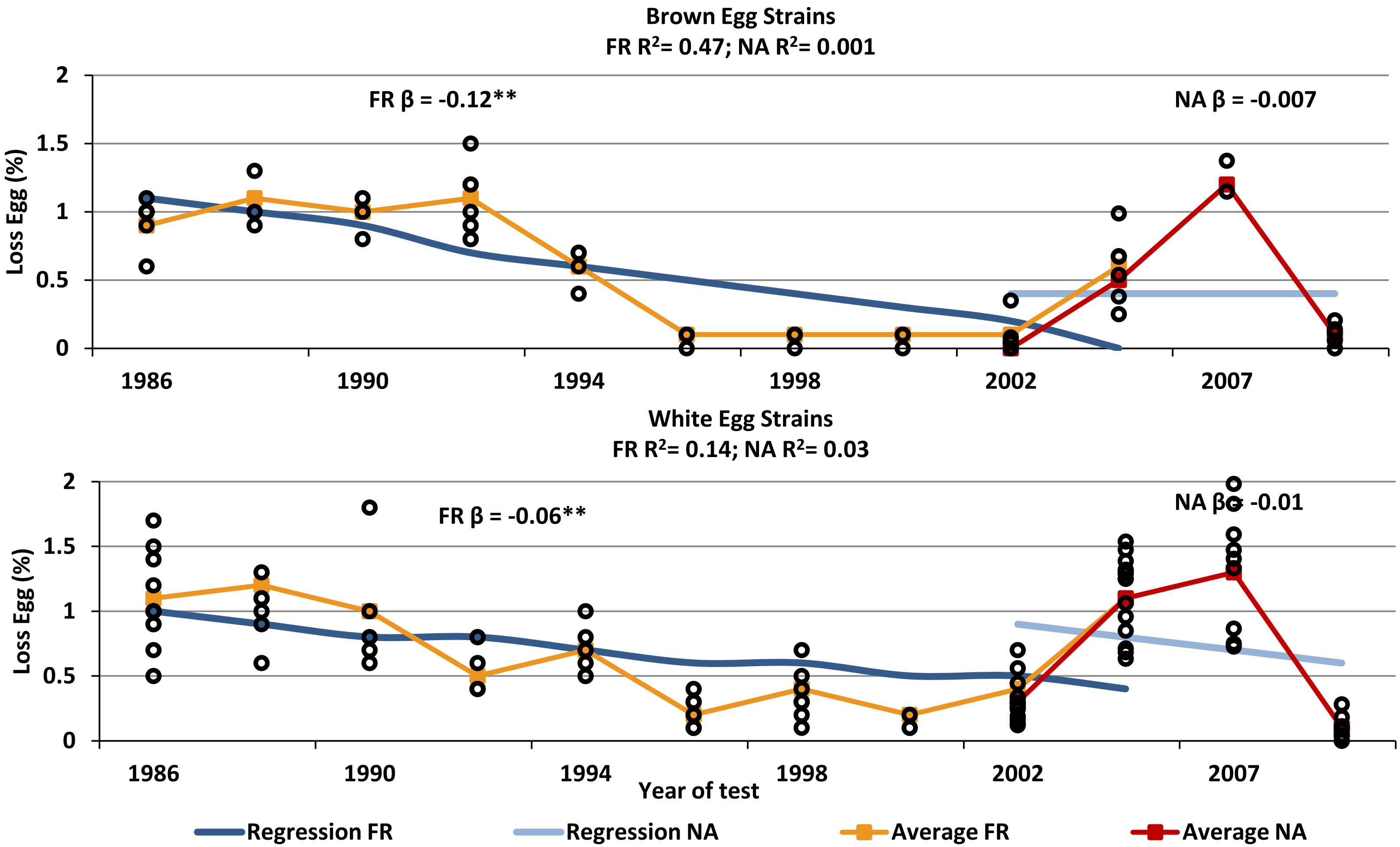
Figure 34. Post-molt Percent USDA Check Eggs (PM%C) by strain within test, and the regression of the average PM%C of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

*Slope significantly different from 0 (P<0.05)

Figure 35. Post-molt Percent USDA Grade Loss Eggs (PM%GL) by strain within test, and the regression of the average PM%GL of all strains on the test number within the feed removal (FR) and non-anorexic (NA) molt programs, for the brown and white egg strains included in the 26th through the 37th North Carolina layer tests.



°Represents individual strain averages for the test

**Slope significantly different from 0 (P<0.01)

References to the North Carolina Layer Performance and Management Test Historical Summary

Martin, G. A., 1959. North Carolina Random Sample Egg Laying Test: First year-Growing Report. Vol. 1, No. 1. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1960. North Carolina Random Sample Egg Laying Test: Final Report. Vol. 1, No. 2. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1960. North Carolina Random Sample Egg Laying Test: Second year-Growing Report. Vol. 2, No. 1. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1961. North Carolina Random Sample Egg Laying Test: Final Report. Vol. 2, No. 2. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1961. North Carolina Random Sample Egg Laying Test: Third year-Growing Report. Vol. 3, No. 1. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1962. North Carolina Random Sample Egg Laying Test: Final Report. Vol. 3, No. 2. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1962. North Carolina Random Sample Egg Laying Test: Fourth year-Growing Report. Vol. 4, No. 1. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1963. North Carolina Random Sample Egg Laying Test: Final Report. Vol. 4, No. 2. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1963. North Carolina Random Sample Egg Laying Test: Fifth year-Growing Report. Vol. 5, No. 1. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1964. North Carolina Random Sample Egg Laying Test: Final Report. Vol. 5, No. 2. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1964. North Carolina Random Sample Egg Laying Test: First year-Growing Report. Vol. 6, No. 1. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1965. North Carolina Random Sample Egg Laying Test: Final Report. Vol. 6, No. 2. North Carolina Department of Agriculture and North Carolina State College, School of Agriculture, Raleigh, NC.

Martin, G. A., 1965. Seventh North Carolina Random Sample Laying Test Growing Report. Vol. 7, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1966. Seventh North Carolina Random Sample Laying Test Final Report. Vol. 7, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1966. Eighth North Carolina Random Sample Laying Test Growing Report. Vol. 8, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1967. Eighth North Carolina Random Sample Laying Test Final Summary Report. Vol. 8, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1967. Ninth North Carolina Random Sample Laying Test Growing Report. Vol. 9, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1968. Ninth North Carolina Random Sample Laying Test Final Summary Report. Vol. 9, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1968. Tenth North Carolina Random Sample Laying Test Growing Report. Vol. 10, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1969. Tenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 10, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1969. Eleventh North Carolina Random Sample Laying Test Growing Report. Vol. 11, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1970. Eleventh North Carolina Random Sample Laying Test Final Summary Report. Vol. 11, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1970. Twelfth North Carolina Random Sample Laying Test Growing Report. Vol. 12, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1971. Twelfth North Carolina Random Sample Laying Test Final Summary Report. Vol. 12, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1971. Thirteenth North Carolina Random Sample Laying Test Growing Report. Vol. 13, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1972. Thirteenth North Carolina Random Sample Laying Test Final Summery Report. Vol. 13, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1972. Fourteenth North Carolina Random Sample Laying Test Growing Report. Vol. 14, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1973. Fourteenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 14, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1973. Fifteenth North Carolina Random Sample Laying Test Growing Report. Vol. 15, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1974. Fifteenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 15, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1974. Sixteenth North Carolina Random Sample Laying Test Growing Report. Vol. 16, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1975. Sixteenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 16, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1975. Seventeenth North Carolina Random Sample Laying Test Growing Report. Vol. 17, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1976. Seventeenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 17, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1976. Eighteenth North Carolina Random Sample Laying Test Growing Report. Vol. 18, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1977. Eighteenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 18, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1977. Nineteenth North Carolina Random Sample Laying Test Growing Report. Vol. 19, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1978. Nineteenth North Carolina Random Sample Laying Test Final Summary Report. Vol. 19, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1978. Twentieth North Carolina Random Sample Laying Test Growing Report. Vol. 20, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1979. Twentieth North Carolina Random Sample Laying Test Final Summary Report. Vol. 20, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1980. Twenty First North Carolina Random Sample Laying Test Final Summary Report. Vol. 21, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1980. Twenty Second North Carolina Random Sample Laying Test Growing Report. Vol. 22, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1982. Twenty Second North Carolina Random Sample Laying Test Final Summary Report. Vol. 22, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1981. Twenty Third North Carolina Random Sample Laying Test Growing Report. Vol. 23, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1983. Twenty Third North Carolina Random Sample Laying Test Fianal Summary Report. Vol. 23, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1982. Twenty Fourth North Carolina Layer Production and Management Test: Growing Report. Vol. 24, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1984. Twenty Fourth North Carolina Layer Production and Management Test: Final Summary Report. Vol. 24, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A., 1983. Twenty Fifth North Carolina Layer Performance and Management Test: Growing Report. Vol. 25, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Martin, G. A. and J.B. Carey, 1984. Twenty Fifth North Carolina Layer Performance and Management Test: Final Summary Report. Vol. 25, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1985. Growing Report for Twenty Sixth North Carolina Layer Performance and Management Test. Vol. 26, No. 1. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1986. Molting Report (439-490 Days) for the 26th North Carolina Layer Performance and Management Test:. Vol. 26, No. 2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1987. Final Report (140-728 Days) for 26th North Carolina Layer Performance and Management Test. Vol. 26, No. 3. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1987. Supplementary Data Booklet for Twenty Sixth North Carolina Layer Performance and Management Test. Vol. 26. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1987. Twenty Seventh North Carolina Layer Performance and Management Test Growing Report. Vol. 27, No. 1. August 1987. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1987. Twenty Seventh North Carolina Layer Performance and Management Test First Laying Cycle Report. Vol. 27, No. 2. November 1987. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1988. Twenty Seventh North Carolina Layer Performance and Management Test Final Report. Vol. 27, No. 3. May 1988. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1988. Twenty Seventh North Carolina Layer Performance and Management Test Supplementary Data Booklet. Vol. 27. August 1988. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carey, J. B., 1988. Impact Study Agriculturs and Natural Resources: Animal and Poultry Performance Testing Program: Random Sample Layer Test. May 1988. Agricultural Extension Service, North Carolina State University, Raleigh, NC.

Carey, J. B., 1989. Twenty Eighth North Carolina Layer Performance and Management Test Growing Report. Vol. 28, No. 1. January 1989. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Carter, T.A., 1990. Tewnty-Eighth North Carolina Layer Performance and Management Test: First Laying Cycle Report. Vol.28, No.2. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1991. 28th North Carolina Layer Performance and Management Test: Final Production Report. Vol. 28, No. 3. Agricultural Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1991. 29th North Carolina Layer Performance and Management Test: Hatch and Serology Results. Vol. 29, No. 1. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1991. Pullet Rearing Period Report of the Twenty Ninth North Carolina Layer Performance and Management Test. Vol. 29, No. 2. May 1991. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1991. 29th North Carolina Layer Performance and Management Test: Production Report for First Cycle. Vol. 29, No. 3. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1992. Final Report of the 29th North Carolina Layer Performance and Management Test: Production Report. Vol. 29, No. 4. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1992. 30th North Carolina Layer Performance and Management Test: Hatch and Serology Results. Vol. 30, No. 1. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1992. Pullet Rearing Period Report of the 30th North Carolina Layer Performance and Management Test. Vol. 30, No. 2. November 1992. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1993. First Cycle Report of the Thirtieth North Carolina Layer Performance and Management Test. Vol. 30, No. 3. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1994. Final Report of the 30th North Carolina Layer Performance and Management Test: Production Report. Vol. 30, No. 4. Agriculture Extension Service, North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1994. 31st North Carolina Layer Performance and Management Test: Hatch and Serology Results. Vol. 31, No. 1. North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1994. Pullet Rearing Period Report of the 31st North Carolina Layer Performance and Management Test. Vol. 31, No. 2. September 1994. North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1995. First Cycle Report of the Thirty First North Carolina Layer Performance and Management Test. Vol. 31, No. 3. North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1996. Final Report of the 31st North Carolina Layer Performance and Management Test: Production Report. Vol. 31, No. 4. May 1996. North Carolina Cooperative Extension Service and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1996. 32nd North Carolina Layer Performance and Management Test: Hatch and Serology Summary. Vol. 32, No. 1. January 1996. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1996. Report on Pullet Rearing Period 32nd North Carolina Layer Performance and Management Test. Vol. 32, No. 2. August 1996. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1997. First Cycle Report of the Thirty Second North Carolina Layer Performance and Management Test. Vol. 32, No.3. June 1997. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1998. Final Report of the Thirty Second North Carolina Layer performance and Management Test: Production Report. Vol. 32, No. 4. July 1998. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1998. 33rd North Carolina Layer Performance and Management Test: hatch and Serology Summary. Vol. 33, No. 1, October 1998. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 1999. Report on Pullet Rearing Period 33rd North Carolina Layer Performance and Management Test. Vol. 33, No. 2. February 1999. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2000. First Cycle Report of the Thirty Third North Carolina Layer Performance and Management Test. Vol. 33, No.3. February 2000. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2000. Final Report of the Thirty Third North Carolina Layer performance and Management Test: Production Report. Vol. 33, No. 4. October 2000. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2000. Hatch and Serology Report of the Thirty Fourth North Carolina Layer Performance and Management Test: Summary. Vol. 34, No. 1, November 2000. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2001. Report on Pullet Rearing Period: 34th North Carolina Layer Performance and Management Test. Vol. 34, No. 2, February 2001. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2002. First Cycle Report of the Thirty Fourth North Carolina Layer Performance and Management Test. Vol. 34, No.3. February 2002. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2002. Final Report of the Thirty Fourth North Carolina Layer performance and Management Test: Production Report. Vol. 34, No. 4. November 2002. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2003. Hatch and Serology Report of the Thirty Fifth North Carolina Layer Performance and Management Test: Summary. Vol. 35, No. 1, February 2003. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2003. Report on Pullet Rearing Period: 35th North Carolina Layer Performance and Management Test. Vol. 35, No. 2, May 2003. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2004. First Cycle Report of the Thirty Fifth North Carolina Layer Performance and Management Test. Vol. 35, No.3. July 2004. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2005. Final Report of the Thirty Fifth North Carolina Layer Performance and Management Test. Vol. 35, No.4. May 2005. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2005. Hatch and Serology Report of the Thirty Sixth North Carolina Layer Performance and anagement Test: Summary. Vol. 36, No. 1, June 2005. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2005. Report on Pullet Rearing Period: 36th North Carolina Layer Performance and Management Test. Vol. 36, No. 2, August 2005. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2006. First Cycle Report of the Thirty Sixth North Carolina Layer Performance and Management Test. Vol. 36, No.3. September 2006. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2007. Single Production Cycle Report of the Thirty Sixth North Carolina Layer Performance and Management Test. Vol. 36, No.4. February 2007. North Carolina Cooperative

Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2007. Final Report of the Thirty Sixth North Carolina Layer Performance and Management Test. Vol. 36, No.5.August 2007. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2007. Hatch and Serology Report of the Thirty Seventh North Carolina Layer Performance and Management Test: Summary. Vol. 37, No. 1, July 2007. . North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2007. Report on Pullet Rearing Period: 37th North Carolina Layer Performance and Management Test. Vol. 37, No. 2, December 2007. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2009. First Cycle Report of the Thirty Seventh North Carolina Layer Performance and Management Test. Vol. 37, No.3. January 2009. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2009. Single Production Cycle Report of the Thirty Seventh North Carolina Layer Performance and Management Test. Vol. 37, No.4. February 2009. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

Anderson, K. E., 2009. Final Report of the Thirty Seventh North Carolina Layer Performance and Management Test. Vol. 37, No.5.October, 2009. North Carolina Cooperative Extension Service, North Carolina State University and North Carolina Department of Agriculture, Raleigh, NC.

USDA-ARS. 1962. Report of Egg Production Tests: Records of Stocks Entered in Performance Tests in the United States and Canada for the Period 1961-62. USDA-ARS Publication: ARS 44-79-3, December 1962. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1963. 1963 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-4, December 1963. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1965. 1964 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-5, January 1965. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1966. 1965 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-6, January 1966. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1966. 1966 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-7, December 1966. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1968. 1967 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-8, January 1968. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1969. 1968 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-9, January 1969. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1970. 1969 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-10, January 1970. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1971. 1970 Report of Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS 44-79-11, January 1971. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1972. 1971 Report of Egg Production Tests: United States and Canada Random Sample Egg Production Tests. USDA-ARS Publication: ARS 44-79-12, March 1972. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1973. 1972 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS-NE-21, April 1973. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1974. 1973 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS-NE-21-1, February 1974. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1975. 1974 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS-NE-21-2, January 1975. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1976. 1975 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS-NE-21-3, March 1976. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1977. 1976 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS-NE-21-4, February 1977. United States Department of Agriculture-Agriculture Research Service.

USDA-ARS. 1978. 1977 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: ARS-NE-21-5, February 1978. United States Department of Agriculture-Agriculture Research Service.

USDA-SEA. 1979. 1978 Report of Random Sample Egg Production Tests: United States and Canada. USDA-ARS Publication: AGR 101, February 1979. United States Department of Agriculture-Science and Education Administration.

Flock, D.K., 2003. Commercial Breeding of Egg-type Chickens with Emphasis on Sustainability. Clyde Eby Memorial Lecture, North Carolina State University, Department of Poultry Science, May 1, 2003.

Dickerson, G. E. and F. B. Mather, 1976. Evidence Concerning Genetic Improvement in Commercial Stocks of Layers. Poultry Sci. 55:2327-2342.

USDA-AMS. 2000. USDA Egg-Grading Manual. Agricultural Handbook No. 75. USDA-AMS-Poultry Programs-STOP 0259, 1400 Independence Avenue, SW, Washington, DC 20250-0259 http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELDEV3004502