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CONDITION AND AGE STRUCTURE OF BIRD POPULATIONS ON THE MERSEY

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by

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EXECUTIVE SUMMARY

The condition and age structure of two species of wildfowl (Teal and Wigeon) and two species of wader (Redshank and Turnstone) were determined to ascertain whether the Mersey oil spill of August 1989 had any adverse effect on waterfowl using the estuary during winter 1989/90.

Wildfowl were studied using information gathered from birds shot by wildfowlers, which were weighed and measured by the British Association for Shooting and Conservation (BASC), and by the examination of birds caught at the Hale Duck Decoy for ringing purposes.

Waders were studied by the examination of mist-netted samples of birds at three sites around the Mersey by the Merseyside Ringing Group.

No birds were found to be oiled during the studies, which started in October 1989.

The proportions of juvenile birds to adults in the populations studied were within expected ranges, suggesting that there had been no effect on the age structure .

In general, condition of wildfowl was higher in winter 1989/90 than in previous years studied. The populations of Wigeon on the Mersey, Dee and Ribble had similar condition indices to those obtained from the rest of the UK, whereas the Teal populations of these three estuaries had consistently higher indices than populations throughout the rest of the UK.

Weights of Redshank and Turnstone on the Mersey in autumn 1989 were close to the expected values when compared both with data from other sites in previous years and with other sites in the same year.

This study suggests that the Mersey oil spill of August 1989 did not adversely effect the the condition or age structure of waterfowl populations using the estuary over the winter 1989/90.

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GENERAL INTRODUCTION

The Mersey oil spill of August 1989 could have affected the internationally important waterfowl populations of the Mersey in two ways: either through direct contamination of the birds themselves or by affecting their food supply. The latter effect would result in birds moving away to unaffected areas or in birds losing condition, making them more vulnerable to cold weather. This report aims to assess the extent, if any, to which waterfowl lost condition as a result of the oil spill and further to assess whether there was a change in the suitability of the estuary for birds by comparing the proportions of adults to juveniles.

The report is in two sections. The first assesses body condition in two species of wildfowl, primarily from information gained from the examination of birds shot by wildfowlers and subsequently collected by the British Association for Shooting and Conservation. The reliability of data obtained in this way was tested by a sample of birds caught at the Hale Duck Decoy.

The second section of this report considers the condition of waders caught on the Mersey by the Merseyside Ringing Group with samples of waders caught at other sites around Britain both in winter 1989/90 and in previous years.

Section 1 The Condition of Wildfowl on the Mersey and Surrounding Area

1.1 Introduction

This section examines the response of wildfowl, in terms of body condition, to the August 1989 oil spill. The comparison of the results from the Mersey with those nation-wide, both for that year and for previous years, would show whether wildfowl on the Mersey lost condition as a result of the oil spill. In addition, the participants in the Mersey survey provided information on any physical damage to wildfowl which may have resulted from oil pollution.

The British Association for Shooting and Conservation (BASC) is the national representative body for sporting shooting. Around 20% of members participate in coastal wildfowling with about 10% of members being regular wildfowlers. Since 1965, BASC, through their wildfowling members, have established a research network to study wildfowl age and sex ratios from duck wing examination. In 1986 the research was extended to include measurements of wing length and body weight which would provide information on body condition of wildfowl populations, particularly in relation to environmental stress such as prolonged severe weather.

Body weight has been shown to be a good indicator of condition in wildfowl (Owen & Cook, 1977). Body weight is related to the size of the bird, which in turn is related to its age and sex. Allowance for differences in size, however, must be made and the most closely related feature to body size is wing length (Owen & Cook, 1977). Wing length is used in conjunction with body weight to calculate a body condition index which can then be related to environmental pressures to monitor any changes in body condition which may occur.

1.2 Methods

The study concentrates on Wigeon and Teal since these are two of the most frequently taken species by wildfowlers and thus provide an adequate sample size for analysis. Although Mallard is probably the most frequent wildfowl species taken by wildfowlers, numbers are artificially reared and fed, and this confounds the body condition estimate of the wild population.

Wildfowl body measurements were collected as normal by wildfowling members from 1 September to 20 February for the winter 1989-90. In addition, clubs and individuals in the Mersey, Dee and Ribble estuaries were targeted to provide increased information from these areas for comparative purposes with the national survey.

The participants in the study were volunteers, either coastal wildfowlers, who are members of BASC, or nature reserve wardens who had access to the birds taken by wildfowlers. In addition, data collected on Teal caught at the Hale Duck Decoy were compared to that obtained from shot birds on the Mersey.

The survey volunteers were issued with an accurate Pesola spring balance for weighing the birds. They were also given a number of 'wing cards' on which they recorded certain information; species type, weight, place and date of shooting, name of participant and any other relevant observations such as oil damage. The participants were instructed in the use of the balances and precautions which ensure accurate weighing of birds. A wing was also removed from the dead bird to which the wing card with the above information was attached. The wings plus cards were sent to BASC headquarters where the wings were aged and sexed and the wing length measured according to the maximum flat length of the wing. This information was added to the wing card and finally transferred to a computer data base.

The body condition index was calculated by dividing the body weight by the wing length of each bird and the resulting index is therefore measured in g/mm. The results were then analysed using ANOVA and Tukey's alternate multiple comparison test with the SPSS statistical package.

The number of returns by species for the season 1989-90, where information on both wing length and body weight are available, is given in Table 1.1 and 1.2. The sample size from the Mersey itself is about 100 each for both Wigeon and Teal and 480 from the Ribble and Dee in the case of Wigeon and about 100 for Teal. A further sample of 20 Teal was collected on the Mersey at the Hale Duck Decoy.

1.3 Results

1.3.1 Oiled Birds

No reports of oiled birds were made by any participants in the study who were advised to note any such observations on the individual wing cards.

1.3.2 Comparison of Body Condition of Mersey Sample of Shot Teal with Mersey Sample of Duck Decoy Teal

The sample of Teal measurements were collected on the Mersey at the Hale Duck Decoy and was compared with the sample of shot Teal from the Mersey in order to determine whether there were any differences in the body condition of birds obtained from the two sampling methods. Most of the Teal data had been collected in September/October and so was compared with the shot sample for those months. (This was to control for normal seasonal fluctuations in condition whereby condition is lower in September and October than November, December or January.) There was no significant difference in body condition between the two samples overall or for the individual age-sex classes.

1.3.3 Age-Sex Ratio

The age-sex ratio did not vary significantly between the Mersey, Dee and Ribble populations and the UK as a whole in the body condition samples for either species. The results therefore appear to be generally unbiased with respect to age and sex (Table 1.3 and 1.4).

1.3.4 Wing Length

Neither species show a significant variation in wing length with month for any of the age-sex classes throughout the UK. There is also no significant variation in wing length for either species between each of the three study years for any age-sex class (Figures 1.1 and 1.2). There is a significant difference in wing length ($p < 0.01$) between each of the age-sex classes for both Wigeon and Teal (Figures 1.3 and 1.4). Adult males have the longest wing length followed by juvenile males then adult females and finally juvenile females.

With the exception of adult males there were no significant differences in wing length for Wigeon between any of the estuaries or the national averages. Adult male Wigeon wing lengths were significantly shorter on the Mersey in 1989-90 than any other group, $p<0.05$, (Figure 1.5).

For Teal the only significant difference in wing length was for juvenile females which were significantly shorter on the Mersey in 1989-90 than the Ribble for that year, the national average 1989-90 or the national average 1987-90, $p<0.05$, (Figure 1.6).

1.3.5 Body Condition and Age-Sex Class

The average body condition of each age-sex class for both Wigeon and Teal was calculated using data from 1987-90 (Figures 1.7 and 1.8).

Adult male Wigeon have a significantly higher condition index than any other age-sex class ($p<0.05$) and juvenile females have a significantly lower condition index than all other age-sex classes ($p<0.05$). Although there is a tendency for adult female Wigeon to have a higher condition index than immature males this is not significant.

Adult male Teal, like Wigeon, have a significantly higher condition index than the other age-sex classes but juvenile males also have a significantly higher index than juvenile females. Juvenile males tend to have a higher condition index than adult females but this is not significant. There is little difference between juvenile and adult female body condition in Teal.

1.3.6 Inter-Seasonal Variation

In general, condition indices were higher in 1989-90 than in the two previous years (Figures 1.9 and 1.10).

The Wigeon condition index for both adult males and juvenile females was higher in 1989-90 than 1988-89 ($p<0.05$) while the index for immature males is higher in 1989-90 than both previous years ($p<0.05$).

Adult male Teal have a significantly higher condition index in 1989-90 than both previous years ($p<0.05$), further, the condition index of juvenile males and juvenile females were higher in 1989-90 than 1988-89 ($p<0.05$).

1.3.7 Intra-seasonal Variation

Figures 1.11-1.14 show the variation in condition index over the winter months. Both show similar variations; September tends to be the month of lowest condition for all age-sex classes and condition peaks overall in December and January for Teal and November-December for Wigeon before tailing off again in February.

Wigeon adult females have a lower index in October than either of November, December or January ($p<0.05$) and adult males have a lower index in February than November or December ($p<0.05$). Juvenile males have significantly higher indices in November, December and January than either September or October, while juvenile females, although displaying similar trends to the other age-sex classes, display no significant differences between months.

Adult female Teal show a significantly lower condition in October than December ($p<0.05$) while adult males have a significantly lower condition index in September and October than December ($p<0.05$). The condition index for immature females is lower in September than either December or January ($p<0.05$) and juvenile males have significantly lower indexes in September, October and November than either December or January ($p<0.05$).

1.3.8 Body Condition in the Combined Study Areas of the Mersey, Dee and Ribble in Comparison to the National Averages

The condition indices for the combined study areas of the Mersey, Dee and Ribble estuaries for 1989-90 against the national average for that year (exclusive of Mersey data) and the national average over 1987-90 for Wigeon and Teal are given in Figures 1.15 and 1.16.

In Wigeon the combined Mersey data suggests a higher body condition index for all age-sex classes than the 1987-90 national average. However, these differences are significant only for juvenile males which have a higher index than both national averages ($p<0.01$) and juvenile females who have a higher index than the 1987-90 national average ($p<0.001$).

In the case of Teal all age-sex classes in the combined Mersey, Dee and Ribble areas show a higher index than either the 1989-90 or the 1987-90 national averages. This is significant in each case for all age-sex classes, except the index for juvenile females which is not significantly higher than the 1989-90 average ($p=0.06$).

1.3.9 Comparisons of Body Condition Between the Mersey, Dee and Ribble and National Averages

Examination of each of the three target estuaries with each other and with both the national average for 1989-90 and the average for 1987-90 was carried out for both species (Figure 1.17 and 1.18).

In general, Wigeon condition indices for the four age-sex classes were similar. However, adult female Wigeon have significantly higher indices on the Dee than the Ribble, Mersey, or the national average 1987-90 ($p<0.05$). For juvenile females, the index on the Ribble is significantly higher than the 1987-90 national average ($p<0.01$) whilst juvenile males on the Ribble and the Dee are significantly higher than the 1987-90 national average ($p<0.05$).

For Teal (Figure 1.18), the index for age-sex classes on the Mersey is generally higher than the Ribble, the Dee and both the national averages. Adult males and juvenile females on the Mersey have higher condition indices than the Dee or both national averages which is significant at the 5% level. Juvenile males have a higher index on the Mersey than either national average ($p<0.05$). The Dee and the Ribble seem to have similar indices to the national averages except for juvenile males on the Dee which have a significantly higher index than the 1987-90 average ($p<0.05$).

1.4 Discussion

The wing length results for both Wigeon and Teal appear to indicate distinct size bands for each of the age-sex classes. Adult males have the longest wing length followed by juvenile males, adult females and then juvenile females. The wing lengths between years and between estuaries seems to be quite consistent for both species except for two cases in 1989-90. Adult male Wigeon appear to have a significantly smaller wing length on the Mersey than either the Ribble, the Dee or the national average, while juvenile female Teal on the Mersey appear to have a smaller wing length than the Ribble in 1989/90. The similarity of the results between areas and years would otherwise seem to indicate unbiased sampling. The minor differences for Wigeon adult males and Teal juvenile females may be real but more studies would be required to examine this further.

The body condition index for both Wigeon and Teal also varies with age and sex. Adult males have a significantly higher index than the other age-sex classes in both species while juvenile female Wigeon have a significantly lower condition index than the other age-sex classes. Juvenile female Teal have a significantly lower index than juvenile males but a similar index to adult females. In Teal, juvenile males tend to have a higher index than adult females while Wigeon adult females tend to have a higher index than juvenile males, however neither result is statistically significant.

The three winters for which body condition data has been gathered have been mild winters with no extreme periods of severe weather or other environmental disturbance which would be likely to result in major changes in wildfowl body condition, with the possible exception of the oil spill. The winter data on body condition for the first two years of the study, 1986-88, is quite consistent over all age-sex classes for both species. The main difference is with the 1989-90 data where it can be seen that the body conditon indices are significantly higher for nearly all age-sex classes in both species. At present there is no information available which might explain this difference in terms of weather patterns or habitat quality between winters.

The variation in condition index within winters shows a similar pattern for each of the study years. Condition tends to be at its lowest in September and October rising through November, December and January before tailing off again in February. This is true for each of the age-sex classes. Peak condition appears to be reached by Wigeon in November-December and by Teal in December-January. These are consistent with the monthly pattern determined for mallard by Owen and Cook, (1977) and appear to follow the general pattern of many temperate Birds (eg Johnson, 1985, for waders, Newton, 1972, for Bullfinches).

In comparing the condition indexes for the combined Mersey, Dee and Ribble estuaries it appears that Wigeon show a higher condition index in the study areas, for adult females, adult males and juvenile females, than the national average for 1987-90 but a similar index for the 1989-90 average. (The latter average is exclusive of the Mersey data). Juvenile males show a significantly higher index in the study areas than either the 1987-90 or the 1989-90 national average. This would appear to indicate that across the study area as a whole there is little difference in body condition from the national figures of 1989-90 for the age-sex classes. The only difference is in the case of juvenile males where they actually appear to have a higher index in the study are than the national average.

The body condition indices for Teal in the combined study areas are higher than either the 1987-90 or the 1989-90 national averages for all age-sex classes. Teal in the study areas, therefore, appear to have a higher condition index than the national average.

Examination of the three study areas individually reveals that in the case of Wigeon there is no significant difference in the condition of the birds on the Mersey with either the Dee, the Ribble or the national average. There are some minor variations in the condition of adult females on the Dee which are higher than the national average, and juvenile females on the Ribble which also have a higher condition than the national average. However, there is no evidence to suggest any negative effect on the condition of Wigeon on the Mersey, Dee or Ribble compared either to the national average for that season or the national average taken for the period 1987-90.

For Teal, the condition index of the birds on the Mersey appears to be higher than the national averages, the Dee and the Ribble. Adult males and juvenile females have significantly higher indices on the Mersey than the Dee or the national averages and juvenile males have a significantly higher index on the Mersey than the national averages. Adult females show little difference in body condition between any of the study areas or the national averages. This data would seem to suggest that in general Teal on the Mersey have a higher body condition index than the national average. The results on Teal body condition from the Hale Duck Decoy are not significantly different from the Mersey results described here, which would seem to confirm the findings of this study.

These results therefore give no indication of any negative effect on the condition of Teal or Wigeon on the Mersey as a result of the August 1989 oil spillage.

From the results it is clear that body condition of wildfowl species varies significantly between age-sex classes and therefore any major changes in body condition resulting from environmental pressures may not affect individuals within a population equally. In Wigeon, adult males have the highest condition index and juvenile females the lowest and in Teal adult and juvenile males have higher indices than adult or juvenile females. The data therefore was analysed with respect to each age-sex class since any possible affects on body condition is likely to effect those age-sex classes with a lower condition more severely.

The patterns of wing lengths for both species was generally consistent for all study years and between study areas which would appear to indicate that the samples are representative in each case. This is also true with respect to the age-sex ratio which displayed no significant differences between any of the samples used in the analysis. Most of the variation then in the body condition indexes is due to variation in the body weights of the birds.

The body condition of Wigeon and Teal appeared to be greater in the season 1989-90 than the two previous winters which may be due to normal seasonal fluctuations, milder climatic conditions or differences in the habitat quality of the areas sampled over previous years. More seasonal data and complementary climatic information are required to examine these seasonal differences in greater detail.

Examination of each of the study areas of the Mersey, Dee and Ribble reveal a similar index to the national average for Wigeon and a higher than average index for Teal. Neither set of results indicate any loss of condition on the Mersey or surrounding areas for Wigeon or Teal as a result of the oil spill. The higher than average results on the Mersey for Teal may be a result of habitat quality in terms of better food quality and/or less human disturbance or some other environmental variable.

Further study of wildfowl populations in the Mersey area can examine inter-seasonal trends in body condition for that site and address any possible time-lag effects of the August 1989 oil spill. The availabilty of a data base on wildfowl condition for the Mersey and surrounding areas will also be useful in helping to assess the impact of environmental pressures in future.

SECTION 2

CONDITION AND AGE STRUCTURE OF WADERS

2.1 Introduction

Detailed studies of waders on British estuaries have been carried out for the past thirty years under the auspices of the B.T.O.'s ringing scheme. Large data banks of wader biometrics exist from a range of sites around Britain. These can be utilized when studies are required on waders under stress, for example during severe weather or after an oil spill.

The aim of this study was to catch, at predetermined sites, samples of waders wintering on the Mersey and, using the biometrics obtained, to assess their response in terms of body condition to the oil spill.

2.2 Methods

Birds were mist-netted on the Mersey at night by members of the Merseyside Ringing Group during the 1989/90 winter at three different sites:

1) New Brighton, Wirral, Merseyside.
2) Hale Duck Decoy, Widnes, Cheshire.
3) Oglet Bay, Widnes, Cheshire.

(See Figure 2.1)

The sites chosen were all in areas where most pollution occurred as a result of the spill. Each bird was ringed, the date and place of capture noted and several measurments taken. Where possible these included wing length, bill length, head and bill, tarsus and toe and weight, as well as details of their age sex and moult.

The patterns of weight change over the 1989/90 winter of both Redshank and Turnstone on the Mersey were established and compared with other estuaries, both in previous years and in the same winter. The three locations used for comparison (The Wash, North Wales and the Firth of Forth) were chosen for two reasons:

1. Their geographical separation gives a broad representation of wader weights throughout the country.

2. The availability of a large amount of ringing data over a number of years at these sites enables a good comparison to be made.

2.3 Results

The waders captured were obtained in the first half of the winter only. Strenuous attempts were made to catch birds during the latter half of the winter but the gale conditions that prevailed during much of January and February (especially around spring tides which are the most suitable for catching waders) meant that these were unsuccessful. Samples of two species, Redshank and Turnstone, were obtained which were large enough for data analysis.

Differences in body size between different populations were taken into account by plotting weight against wing length (Figures 2.2 & 2.3). Wing length is a good indicator of body size for all wader species. There was no significant difference between the wing lengths of adult and juvenile birds on the Mersey. Consequently the use of body weight alone was thought to be sufficient to reveal any effect the oil spill may have had in terms of body condition.

The variation in body weight throughout the season is given in figures 2.4 and 2.5 for Redshank and Turnstone respectively. Both figures show a general increase in mean weights as the winter progressed and follow the pattern observed on other estuaries around the country in previous years. Similarly, the weights of Turnstone captured on the Mersey fell well within the range of weights recorded at other sites during the 1989/90 winter (Figure 2.5). The weights of Redshank and Turnstone on the Mersey appear

The percentage of juveniles of both species studied was calculated and found to compare favourably with all three localities. Table 2.1 shows the percentage of juvenile Redshank on the Mersey in comparison to published sources.

2.4 Discussion

The term 'condition' has been used to describe the fitness of a bird to cope with its present or future needs. In assessing the condition of wildfowl two variables, weight and wing length, have been used to calculate a condition index for the species concerned. Changes in the condition index can thus, by definition, be due to changes in either weight or wing length. However, when variability of wing length is small, as described for the waders examined, the changes in condition index are almost entirely due to changes in weight. Hence, for the purposes of this study, weight alone was used as an indicator of any adverse effects the oil spill may have had on the waders using the Mersey estuary in the following months.

In the course of this study two species were examined in detail: Redshank and Turnstone. Generally speaking, waders show an increase in weight from the low post-breeding level to a mid-winter peak. Thereafter levels drop, showing a further rise prior to migration and the breeding season. This has been demonstrated in previous years both in Redshank (Davidson 1982) and in Turnstone (Johnson 1985).

The establishment normal patterns of weight change exhibited by birds utilizing an estuary is important in monitoring the effects of an incident, such as this oil spill, on the condition of the birds subsequently using the area. There are two hypotheses to explain the changes in weight exhibited by waders in the non-breeding season.

1. Changes in food abundance and availability.

2. Insurance against the possibility of harsh weather: Difference in weights between sites can be explained by differences in the severity of weather experienced by individual estuaries around the country. Birds at sites which usually experience harsher weather accumulate more fat as insurance.

In addition, these patterns of weight change have been shown to occur under conditions of constant, maximum food availability and abundance in some species, for example Dunlin (Clark 1983) and Turnstone (Whitfield 1985), and therefore may be subject to internal regulation.

Redshank have been documented as being particularly vulnerable to severe weather, often resulting in high levels of winter mortality (Goss-Custard et al. 1977, Baillie 1980, Clark 1982) and this has been suggested as the reason for the early build-up of reserves exhibited in this species (Johnson 1985). Hence Redshank may be expected to be one of the worst affected species should their feeding be impaired in some other way, for example as a result of this oil spill.

By contrast, Turnstone have been found to cope fairly well with harsh weather. Possible reasons for this include their unspecialized diet, highly specialized feeding technique and the absence of competition from many other species feeding on the same substrate. Adults and juveniles have been shown to accumulate similar levels of fat (Johnson 1985, Whitfield 1985) and neither sex is apparently differentially affected by a decrease in food abundance or availability. In addition, late winter fat loss has been shown to be due to regulation of fat levels rather than any differences in feeding conditions (Pienkowski et al.1979, Clark 1983). Consequently, Turnstone might be expected to cope better than Redshank with an impairment in their ability to feed.

Clearly the Redshank and Turnstone on the Mersey do not differ significantly from those wintering at other sites around the country in terms of weight, although insufficient data were available for Redshank captured on other estuaries during the 1989/90 winter for a comparison to be made. The weights of Redshank found freshly dead during the severe winter 1981/82 at Montrose Basin had a mean weight of only 109 ± 10 g. Birds caught on the Mersey were clearly nowhere near these low levels. Pienkowski et al. (1979) demonstrated that the mean mid-winter weights of Dunlin on different estuaries were inversely proportional to the mean mid-winter temperatures recorded at those estuaries (Figure 2.7). Consequently any differences between estuaries in the range of weights recorded (Figures 2.4-2.6) can be explained in these terms.

There was a higher proportion of juvenile Redshank than would have been expected from previous studies. MOSPAG Project 3A has shown that there was a substantial increase in the Redshank population on the Mersey in the winter 1989/90, following the general increase in numbers of this species throughout Britain during the 1980's. In a situation where the population is increasing, the proportion of juveniles would be expected to be high as adults are highly site-faithful. This strongly suggests that the age structure of Redshank on the Mersey was not affected by the August 1989 oil spill.

2.5 Conclusion

Comparison with previous studies has shown that the percentage of juveniles mist-netted on the Mersey compares favourably with percentages trapped at other sites around the country (Table 2.1). This indicates that all sections of the population were still present in good numbers and supports the findings of the MOSPAG 3C Report on the dead birds picked up after the spill that no particular section of the population was disproportionately affected. In addition, analysis of the weight data collected on the Mersey has revealed no differences between waders caught here and those caught at other locations around the country that could not be attributed to inter-estuarine diffences in weather conditions. Hence there is no indication that the condition of the species examined was affected by the August 1989 oil spill in terms of condition.

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Table 1.1

Wigeon Wing Returns for Season 1989-90

AREA	NUMBER OF RETURNS
Mersey Estuary	93
Ribble Estuary	364
Dee Estuary	73
Rest of UK	139
TOTAL	**669**

Table 1.2

Teal Wing Returns for Season 1989-90

AREA	NUMBER OF RETURNS
Mersey Estuary	97
Ribble Estuary	25
Dee Estuary	68
Rest of UK	220
TOTAL	**410**

Table 1.3

Wigeon Age-Sex Ratios

	Mersey, Dee, Ribble Number	(%)	Rest of UK Number	(%)
Juvenile Male	152	(28.7%)	30	(21.6%)
Juvenile Female	148	(28.0%)	39	(28.1%)
Adult Male	149	(28.2%)	48	(34.5%)
Adult Female	80	(15.0%)	22	(15.8%)
	529	(100%)	139	(100%)

Table 1.4

Teal Age-Sex Ratios

	Mersey, Dee, Ribble Number	(%)	Rest of UK Number	(%)
Juvenile Male	76	(41.8%)	70	(31.8%)
Juvenile Female	56	(30.8%)	96	(43.6%)
Adult Male	23	(12.6%)	22	(10.0%)
Adult Female	27	(14.8%)	32	(14.6%)
	182	(100%)	220	(100%)

Table 2.1 Percentages of juvenile Redshank caught over several winters at four sites around Britain compared with birds caught on the Mersey in the 1989/90 winter.

SITE	NO. CATCHES	METHOD	% JUVENILES
Firth of Forth	10	Cannon	16
The Wash	31	Mist/ Cannon	28
Anglesey	1	-	10
Merseyside	1	Cannon	7
Merseyside (This study)	5	Mist	22

Figure 1.1

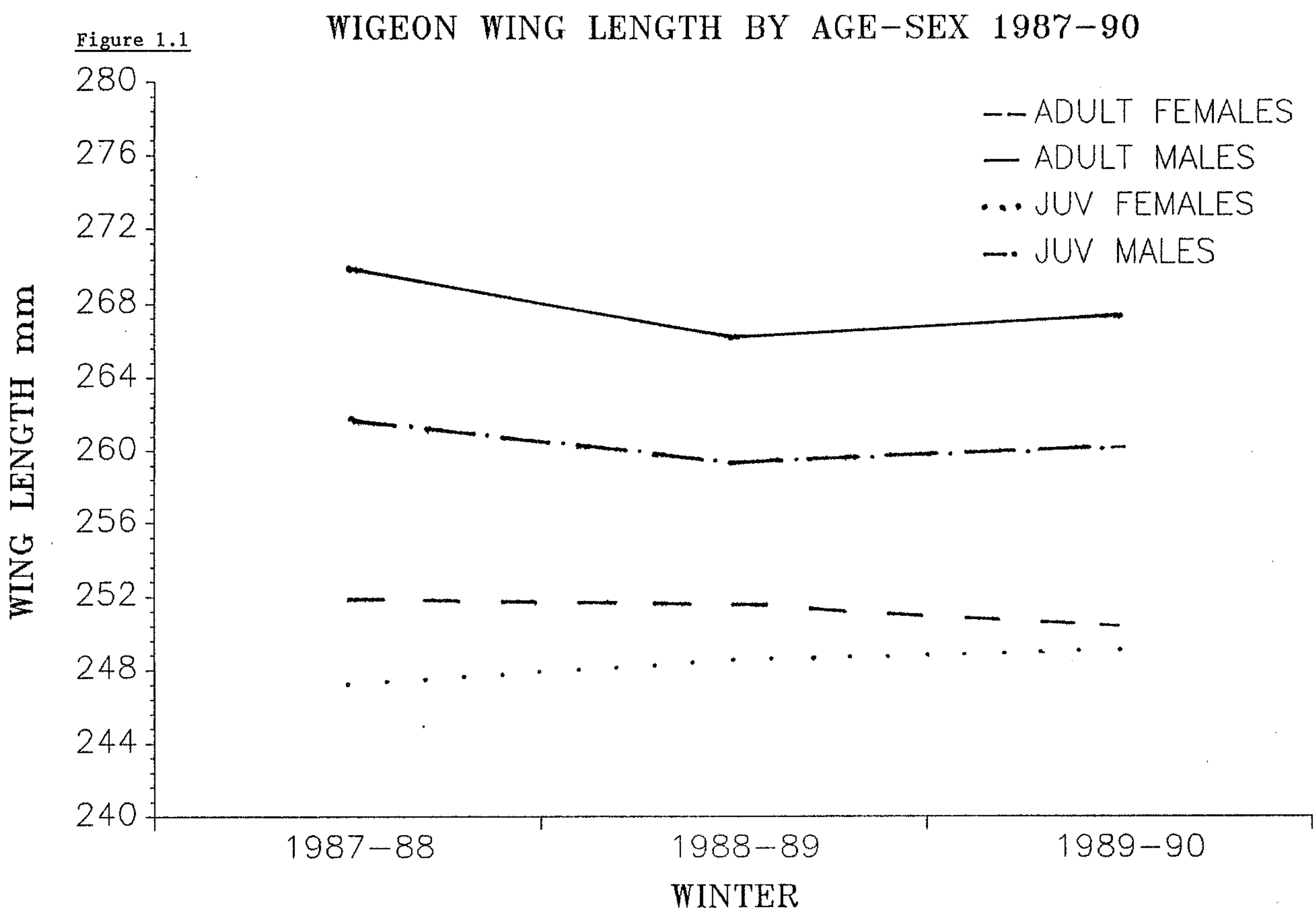

WIGEON WING LENGTH BY AGE-SEX 1987-90
ADULT FEMALES
ADULT MALES
JUV FEMALES
JUV MALES
WING LENGTH mm
280
276
272
268
264
260
256
252
248
244
240
1987-88
1988-89
1989-90
WINTER

Figure 1.2

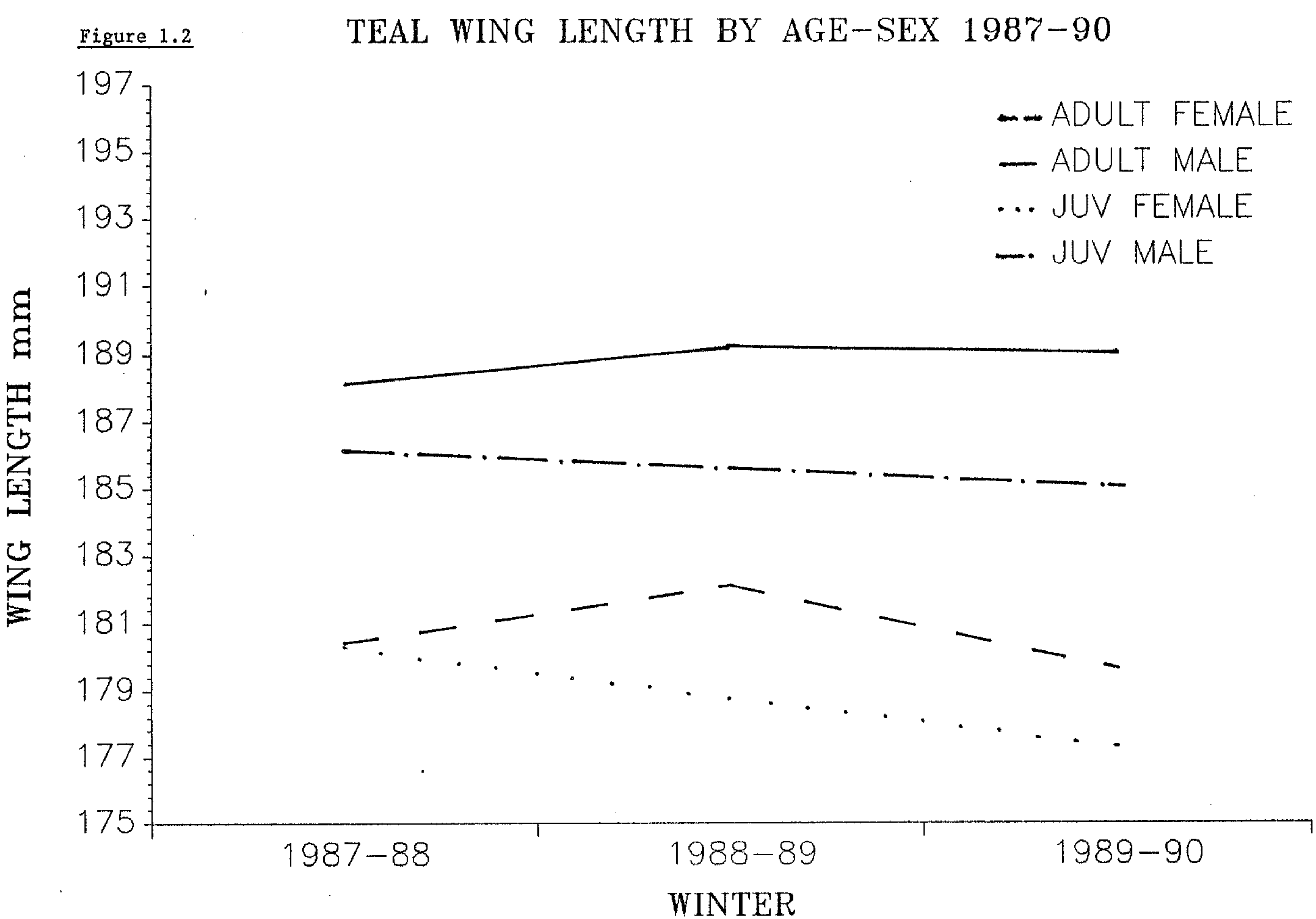

TEAL WING LENGTH BY AGE-SEX 1987-90
ADULT FEMALE
ADULT MALE
JUV FEMALE
JUV MALE
WING LENGTH mm
197
195
193
191
189
187
185
183
181
179
177
175
1987-88
1988-89
1989-90
WINTER

Figure 1.3

WIGEON WING LENGTH BY AGE-SEX CLASS
AVERAGED OVER 1987-90

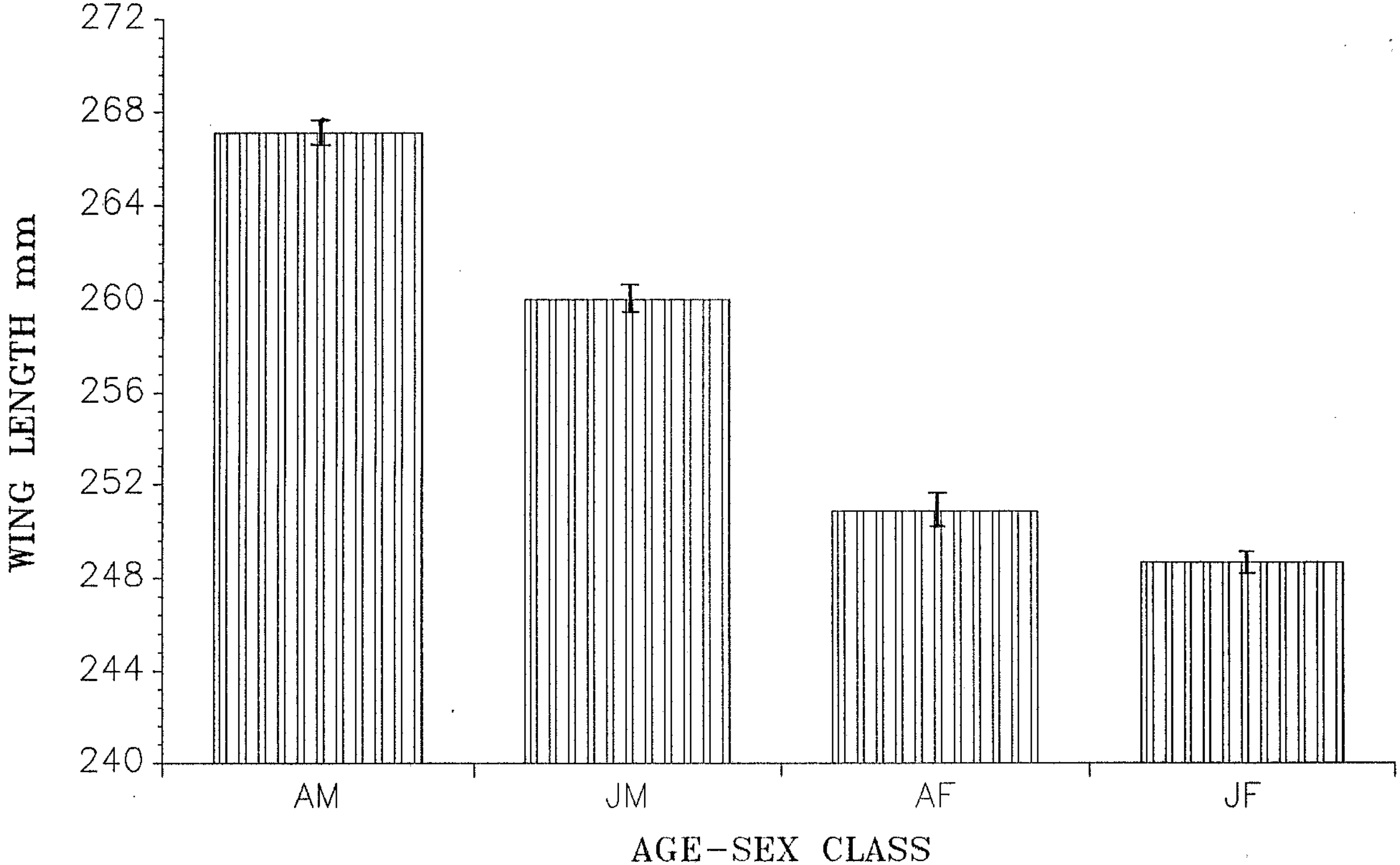


Figure 1.4

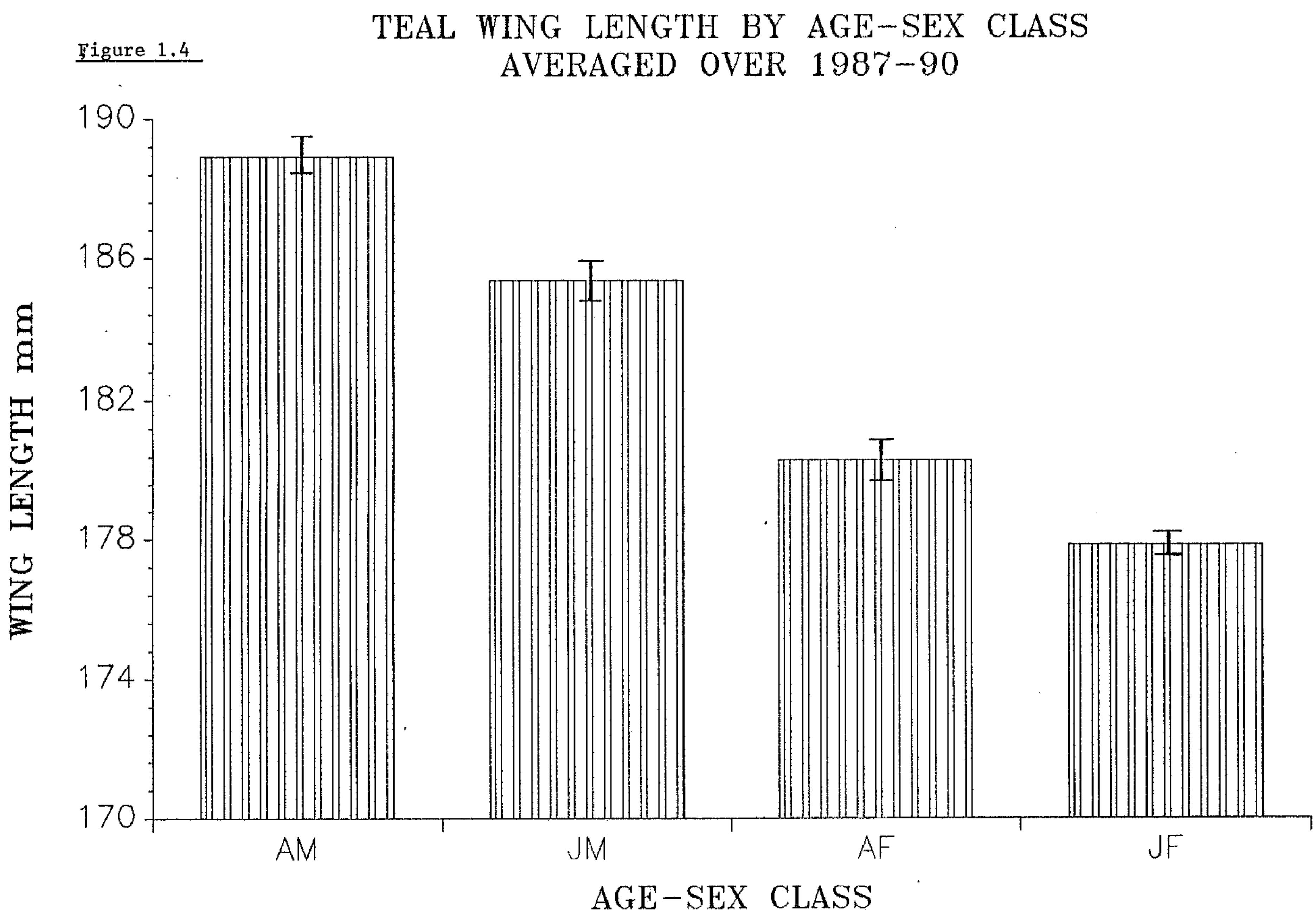

TEAL WING LENGTH BY AGE-SEX CLASS
AVERAGED OVER 1987-90
WING LENGTH mm
190
186
182
178
174
170
AM
JM
AF
JF
AGE-SEX CLASS

Figure 1.5

WIGEON WING LENGTHS ON THE MERSEY, DEE AND RIBBLE ESTUARIES BY AGE-SEX

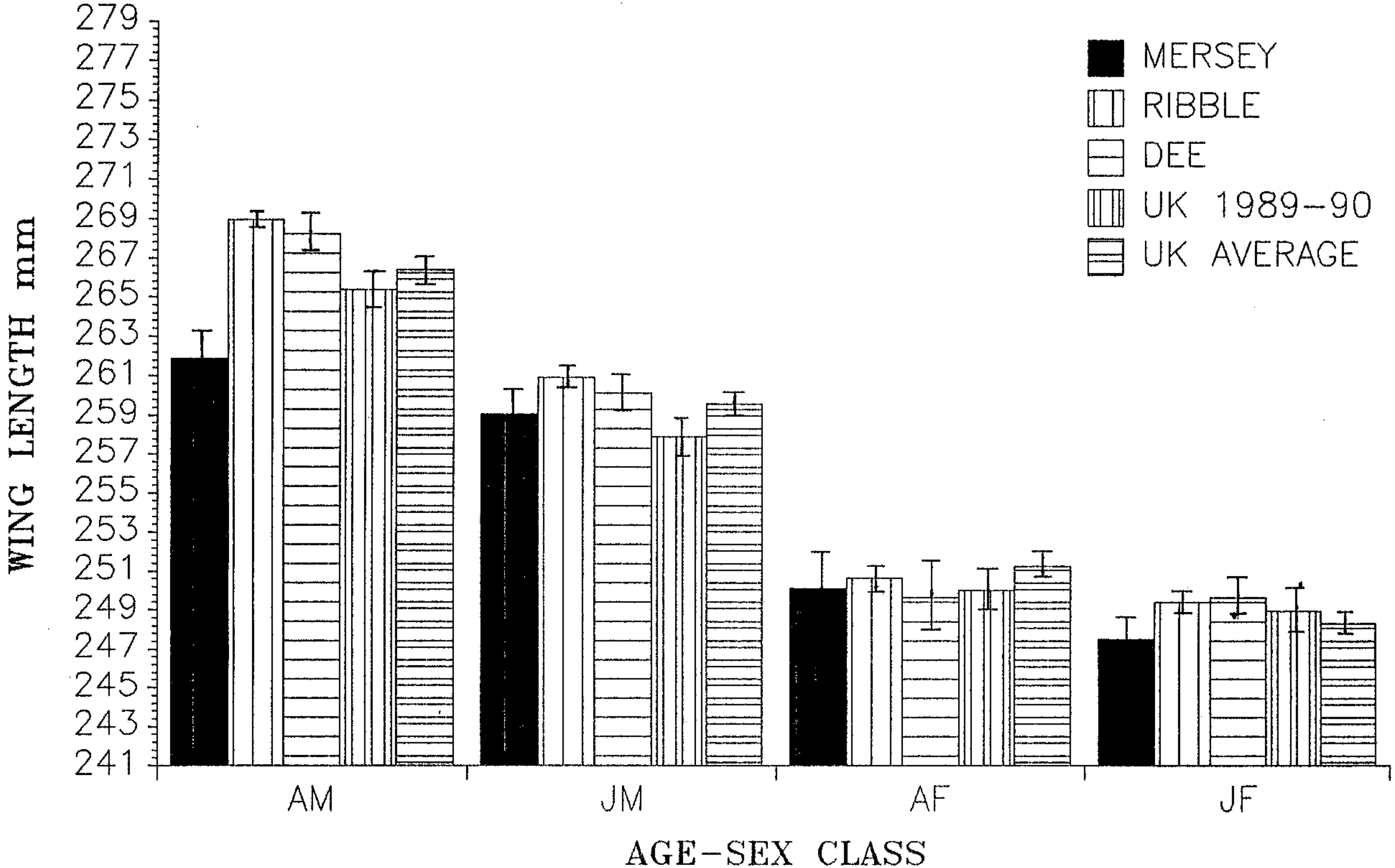


Figure 1.6

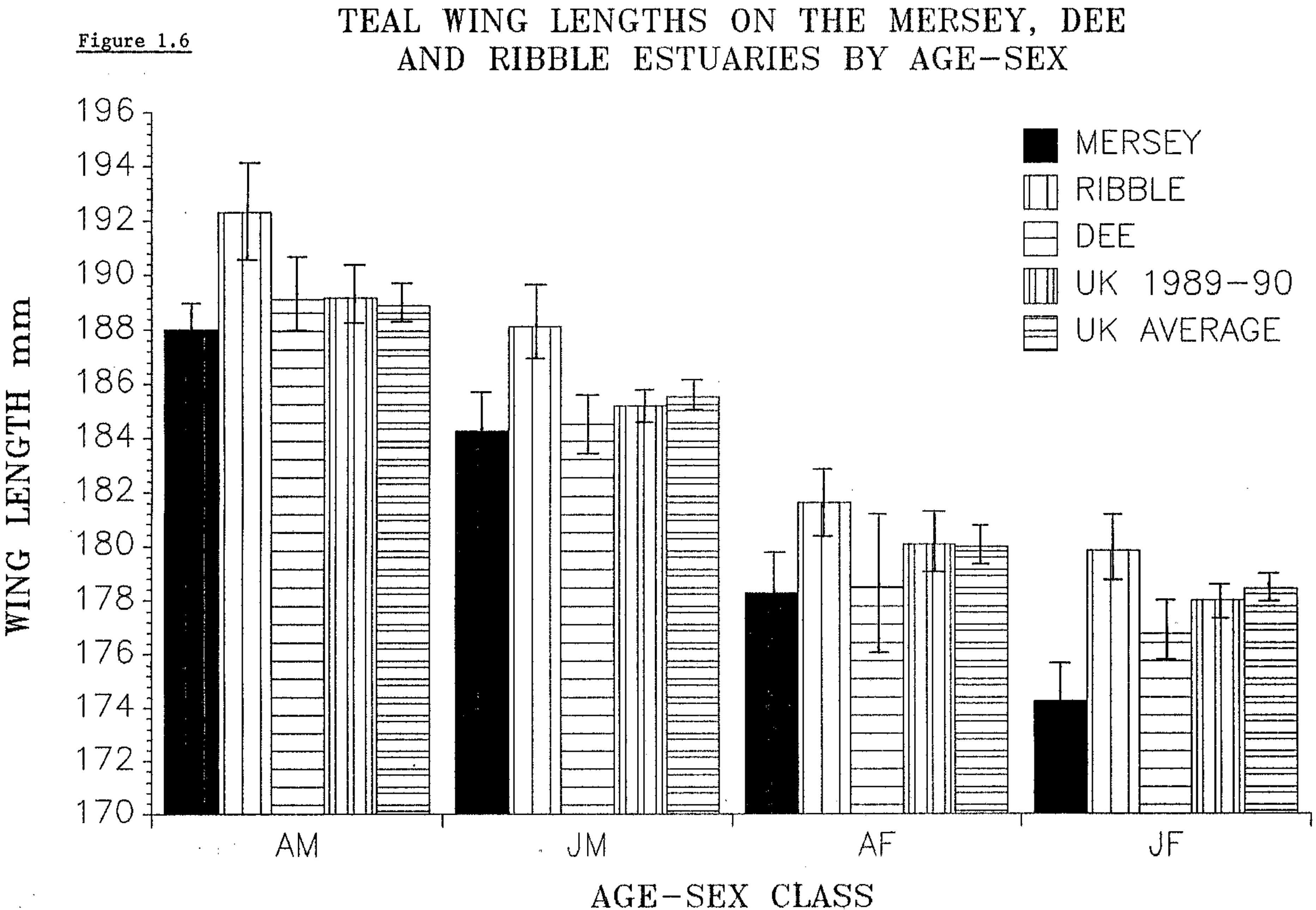

TEAL WING LENGTHS ON THE MERSEY, DEE
AND RIBBLE ESTUARIES BY AGE-SEX
WING LENGTH mm
196
194
192
190
188
186
184
182
180
178
176
174
172
170
MERSEY
RIBBLE
DEE
UK 1989-90
UK AVERAGE
AM
JM
AF
JF
AGE-SEX CLASS

Figure 1.7

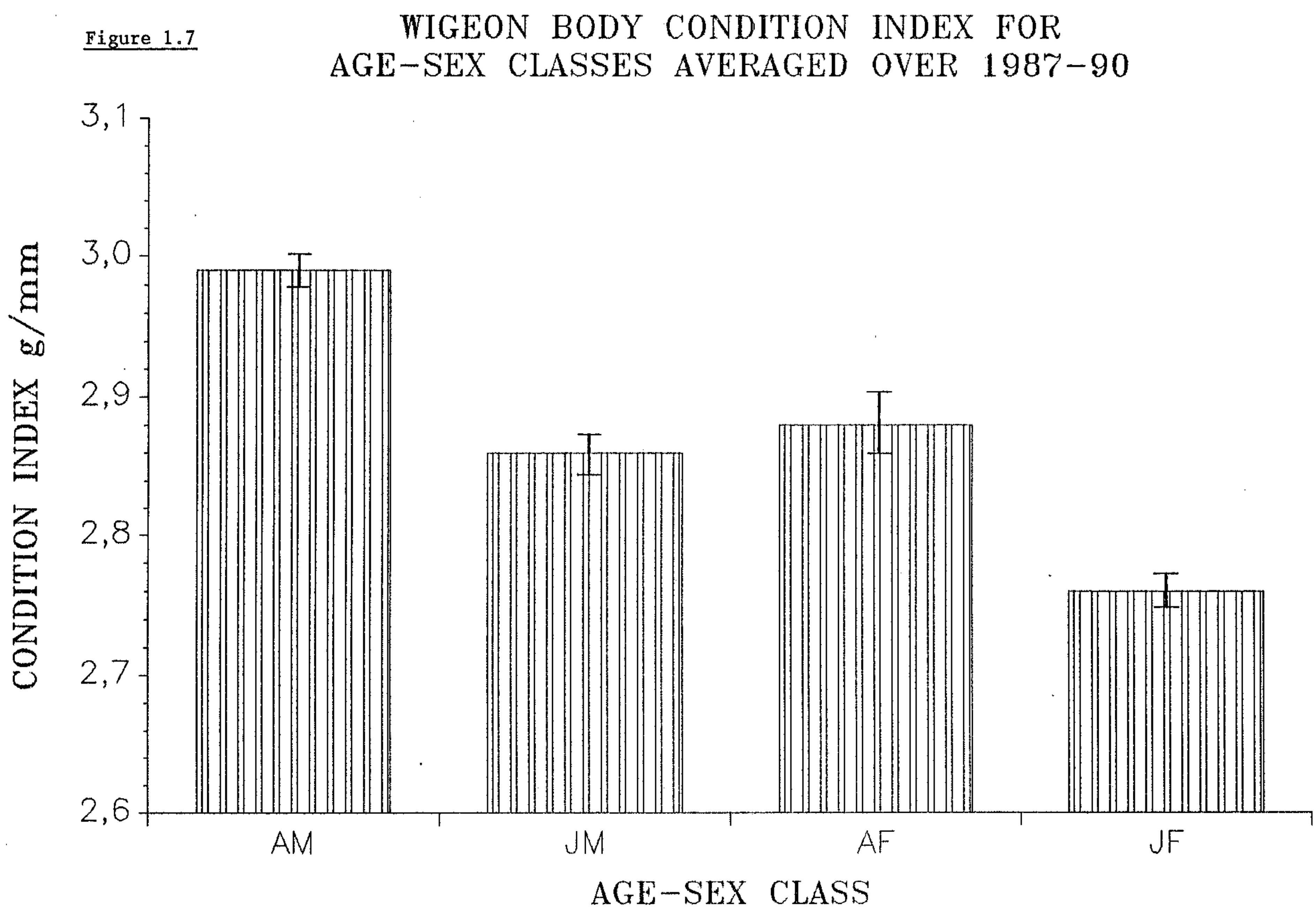

WIGEON BODY CONDITION INDEX FOR
AGE-SEX CLASSES AVERAGED OVER 1987-90
CONDITION INDEX g/mm
3,1
3,0
2,9
2,8
2,7
2,6
AM
JM
AF
JF
AGE-SEX CLASS

Figure 1.8

TEAL BODY CONDITION INDEX FOR AGE-SEX CLASSES AVERAGED OVER 1987-1990

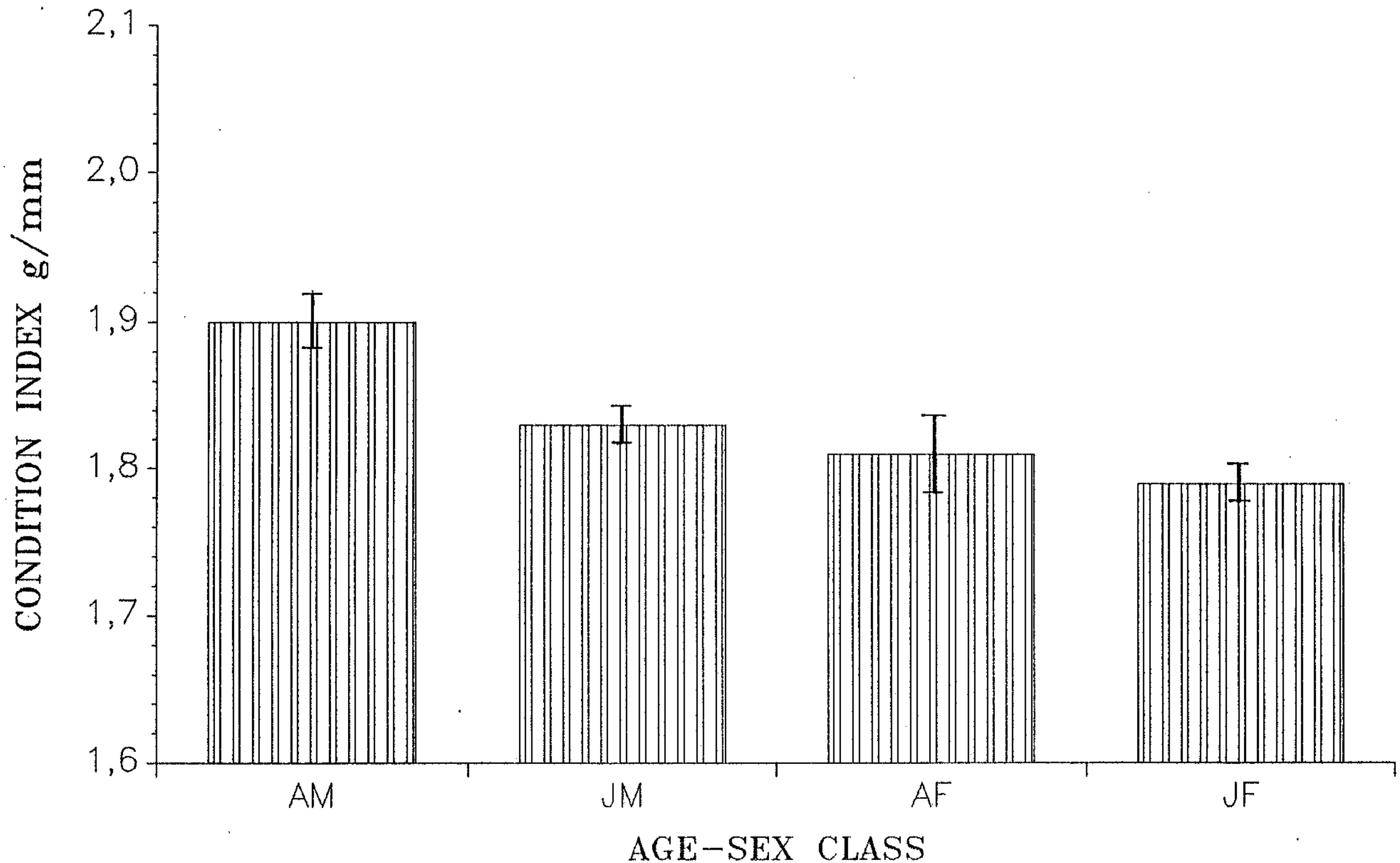


Figure 1.9

WIGEON BODY CONDITION INDEX FOR AGE-SEX CLASSES 1987-90

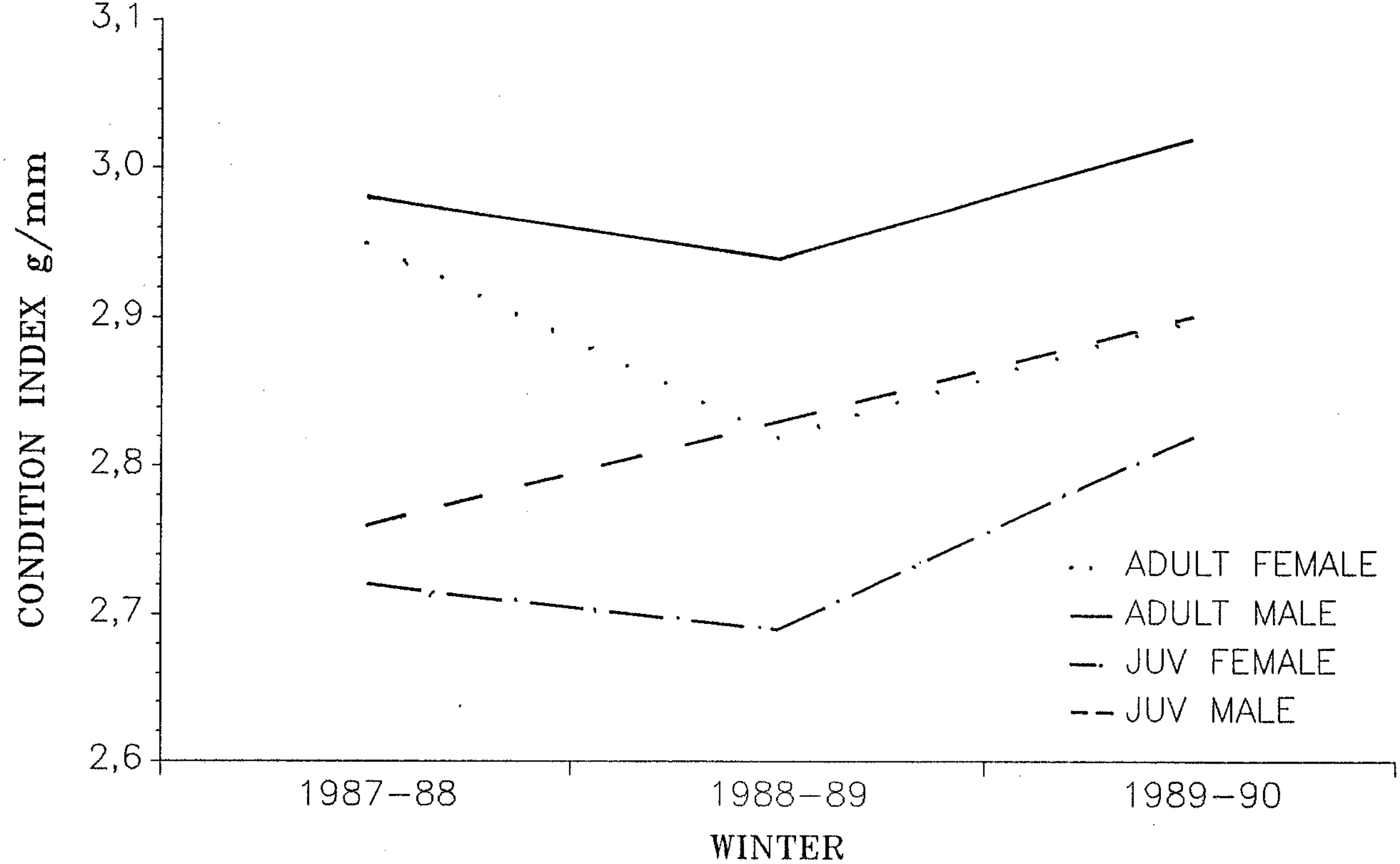


Figure 1.10

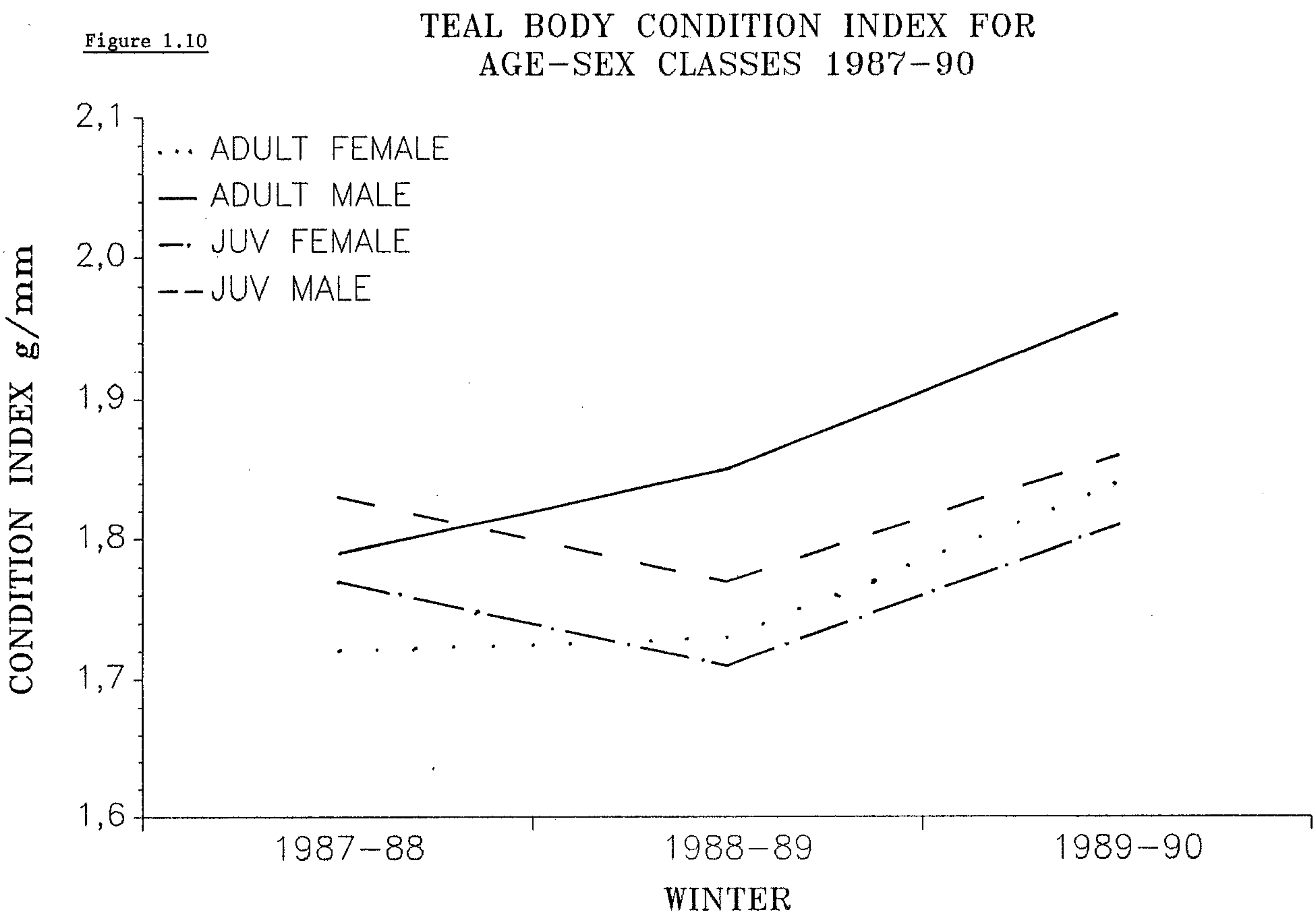

TEAL BODY CONDITION INDEX FOR
AGE-SEX CLASSES 1987-90
ADULT FEMALE
ADULT MALE
JUV FEMALE
JUV MALE
CONDITION INDEX g/mm
2,1
2,0
1,9
1,8
1,7
1,6
1987-88
1988-89
1989-90
WINTER

Figure 1.11

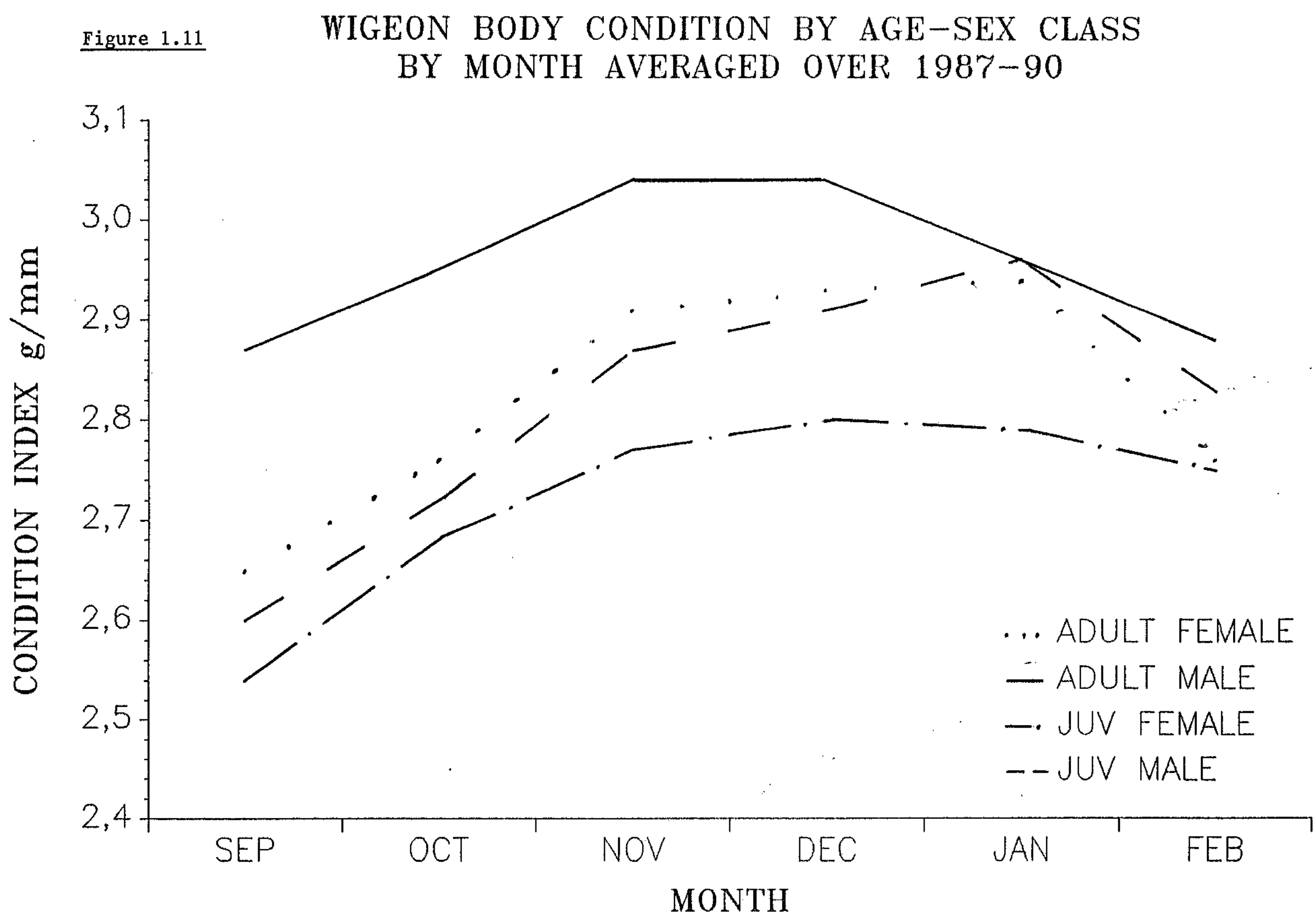

WIGEON BODY CONDITION BY AGE-SEX CLASS
BY MONTH AVERAGED OVER 1987-90
CONDITION INDEX g/mm
3,1
3,0
2,9
2,8
2,7
2,6
2,5
2,4
SEP
OCT
NOV
DEC
JAN
FEB
MONTH
ADULT FEMALE
ADULT MALE
JUV FEMALE
JUV MALE

Figure 1.12

WIGEON BODY CONDITION INDEX BY MONTH
AVERAGED OVER 1987–90

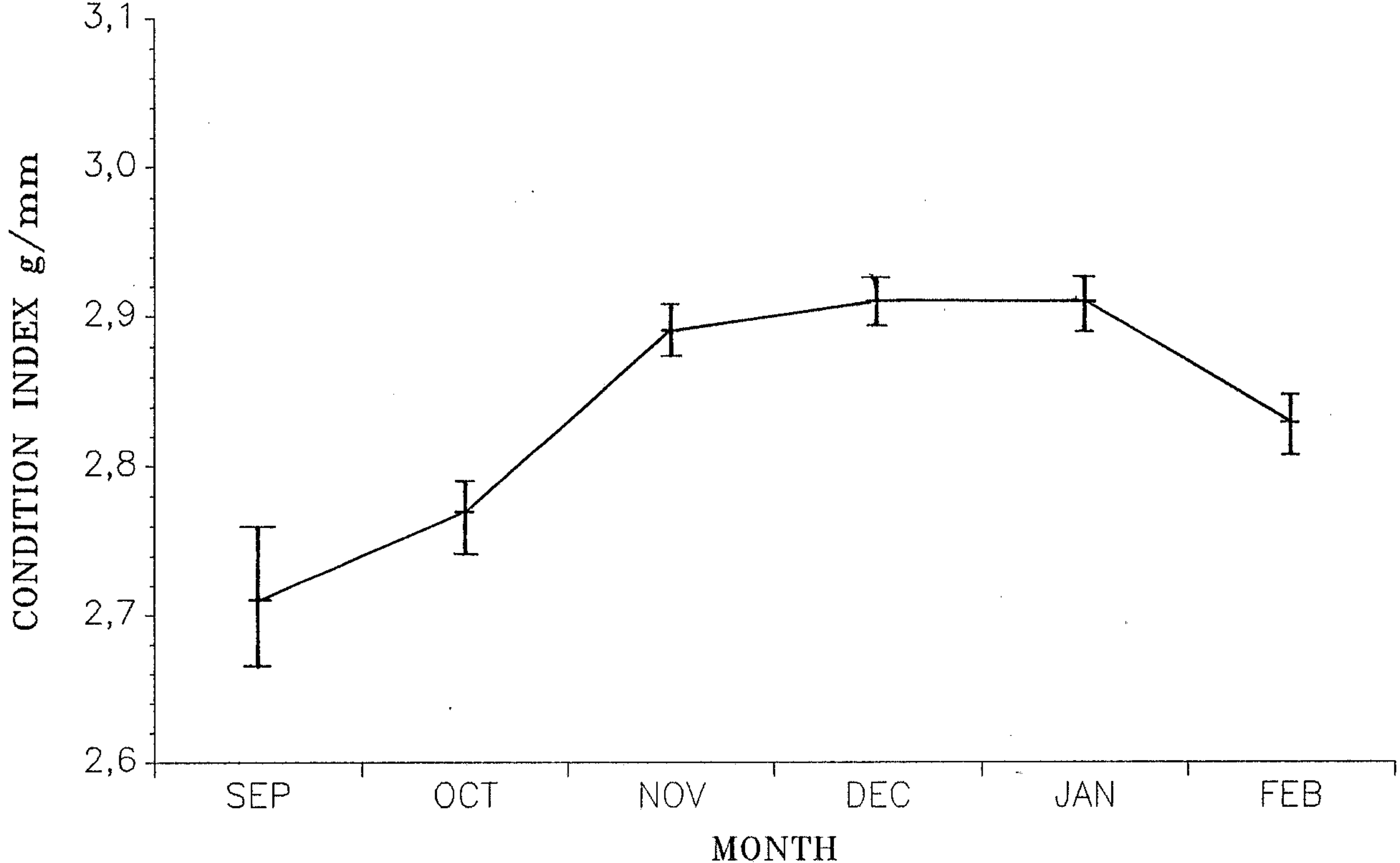


Figure 1.13

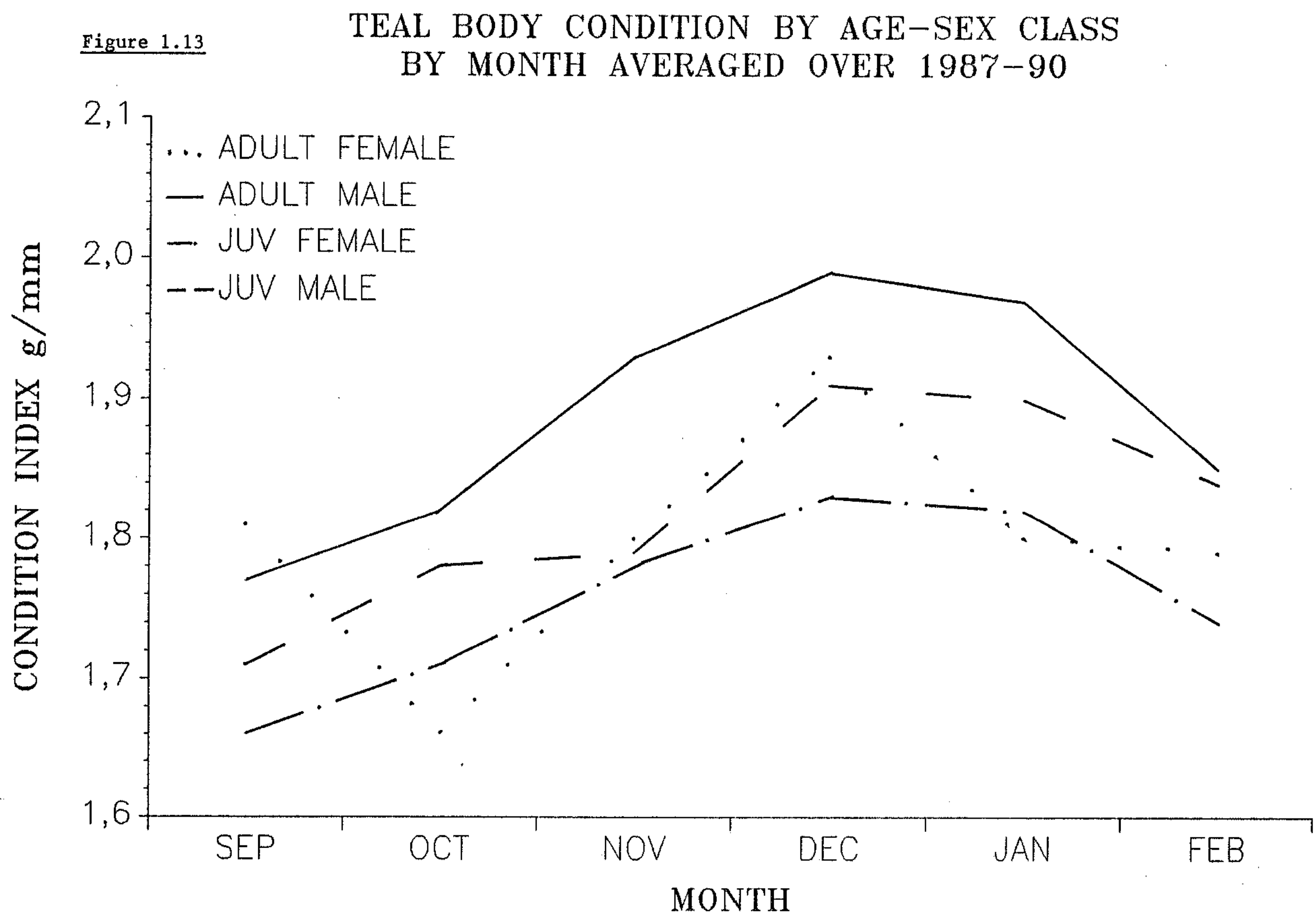

TEAL BODY CONDITION BY AGE-SEX CLASS
BY MONTH AVERAGED OVER 1987-90
ADULT FEMALE
ADULT MALE
JUV FEMALE
JUV MALE
2,1
2,0
1,9
1,8
1,7
1,6
CONDITION INDEX g/mm
SEP
OCT
NOV
DEC
JAN
FEB
MONTH

Figure 1.14

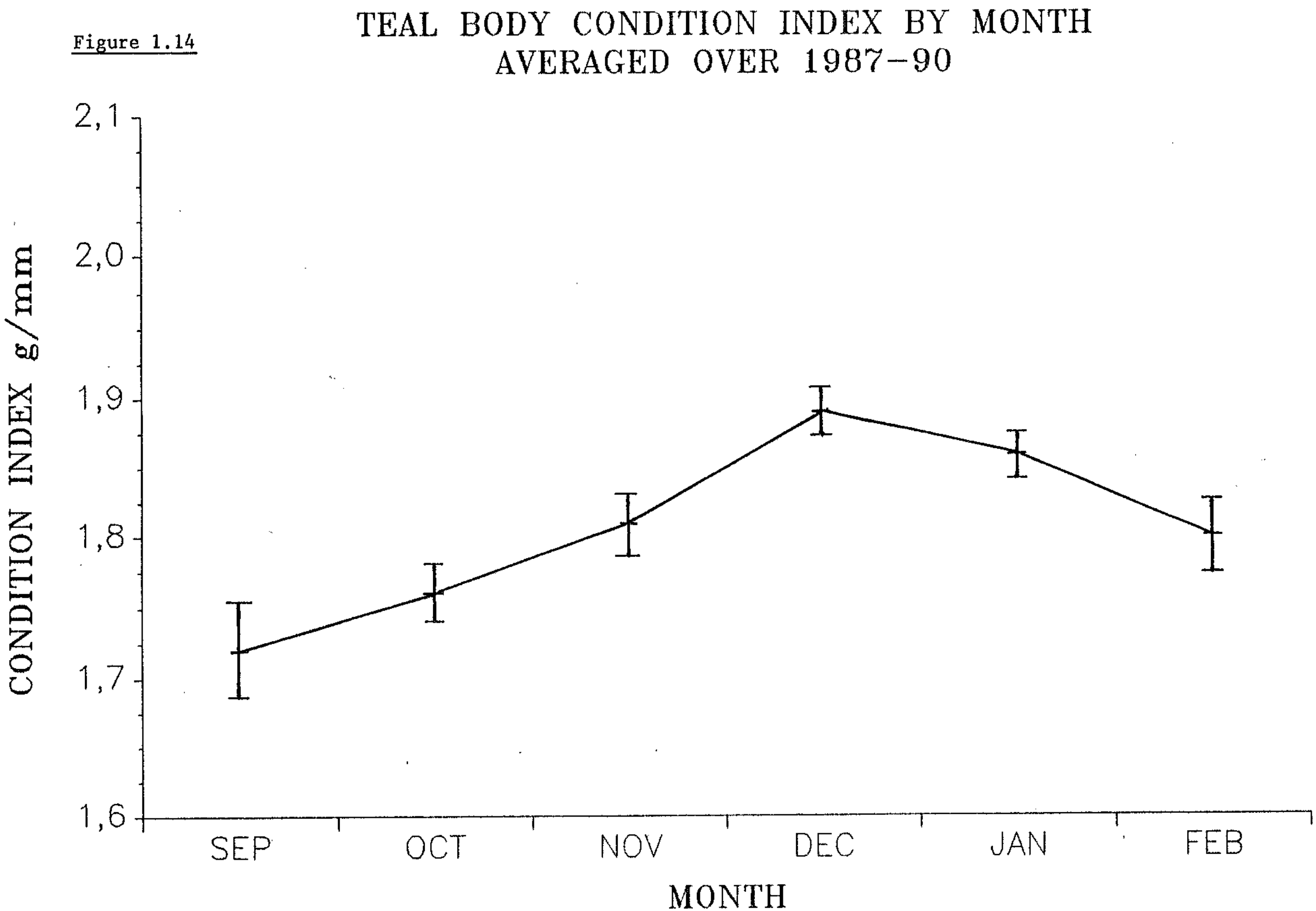

TEAL BODY CONDITION INDEX BY MONTH
AVERAGED OVER 1987–90
2,1
2,0
1,9
1,8
1,7
1,6
CONDITION INDEX g/mm
SEP
OCT
NOV
DEC
JAN
FEB
MONTH

Figure 1.15

COMPARISON OF WIGEON BODY CONDITION INDEX OF COMBINED MERSEY, DEE AND RIBBLE ESTUARIES WITH THE REST OF UK

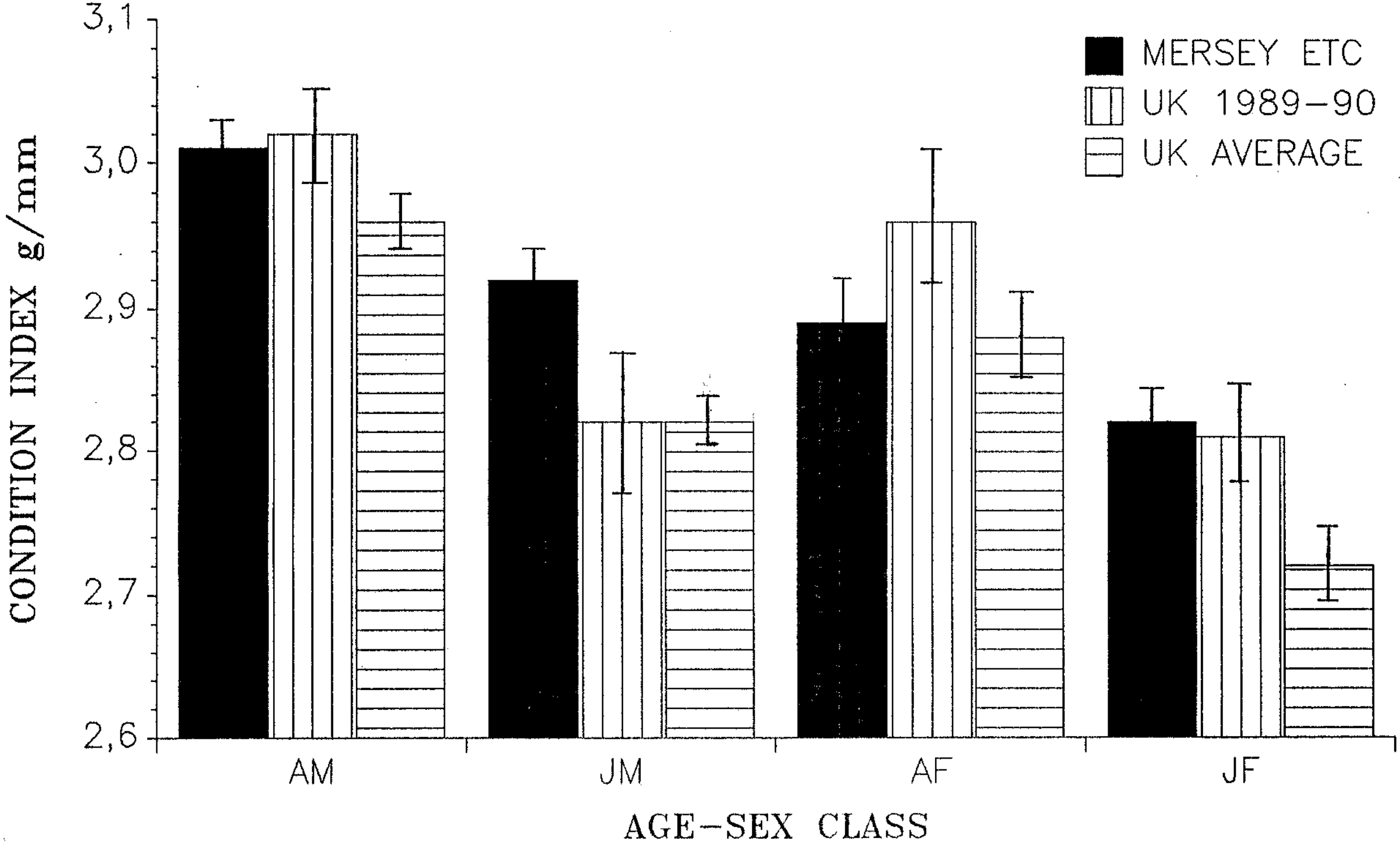


Figure 1.16

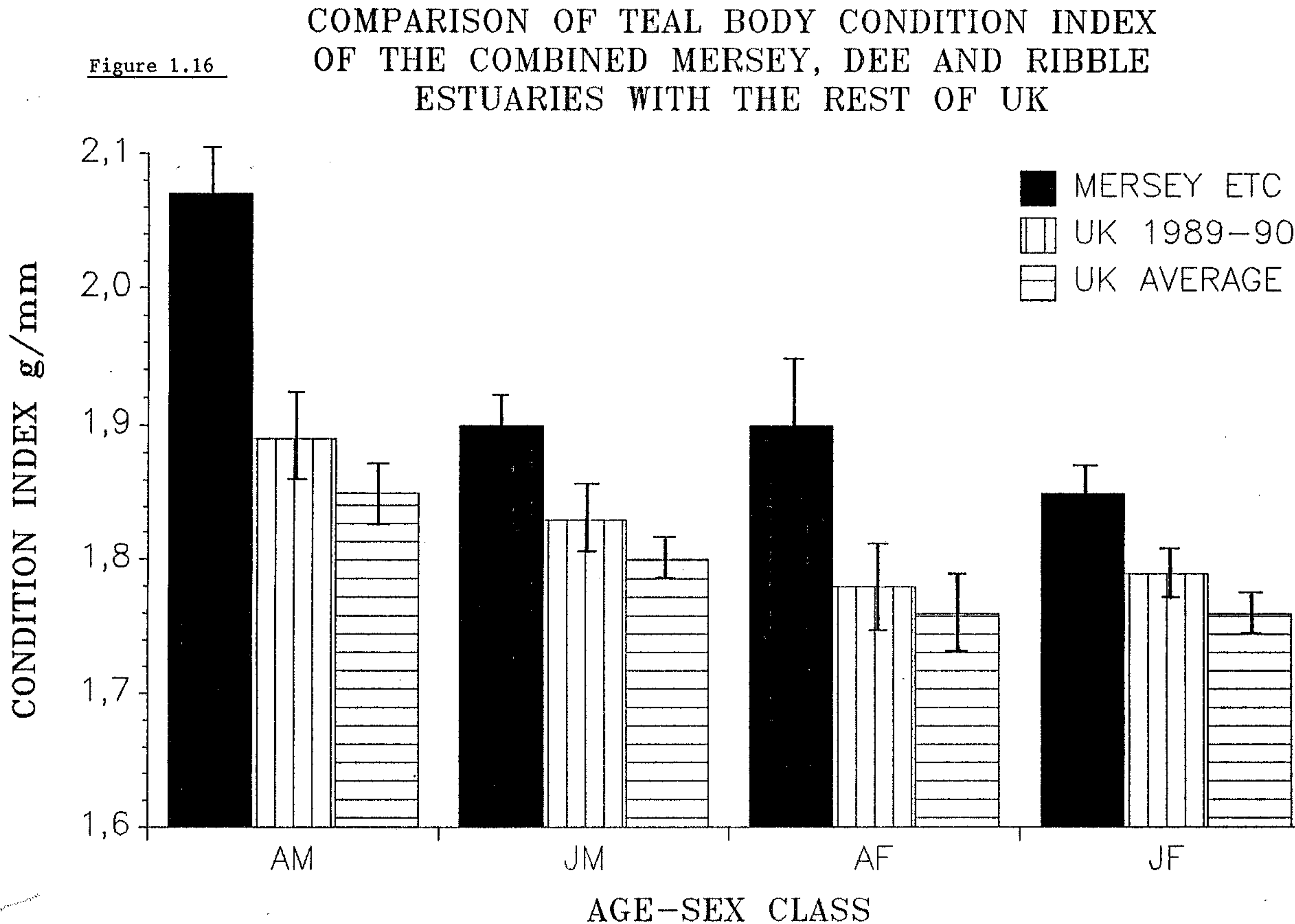

COMPARISON OF TEAL BODY CONDITION INDEX
OF THE COMBINED MERSEY, DEE AND RIBBLE
ESTUARIES WITH THE REST OF UK
MERSEY ETC
UK 1989-90
UK AVERAGE
CONDITION INDEX g/mm
2,1
2,0
1,9
1,8
1,7
1,6
AM
JM
AF
JF
AGE-SEX CLASS

Figure 1.17

COMPARISON OF WIGEON BODY CONDITION INDEX BY AGE-SEX CLASS BETWEEN MERSEY, DEE AND RIBBLE ESTUARIES AND REST OF UK

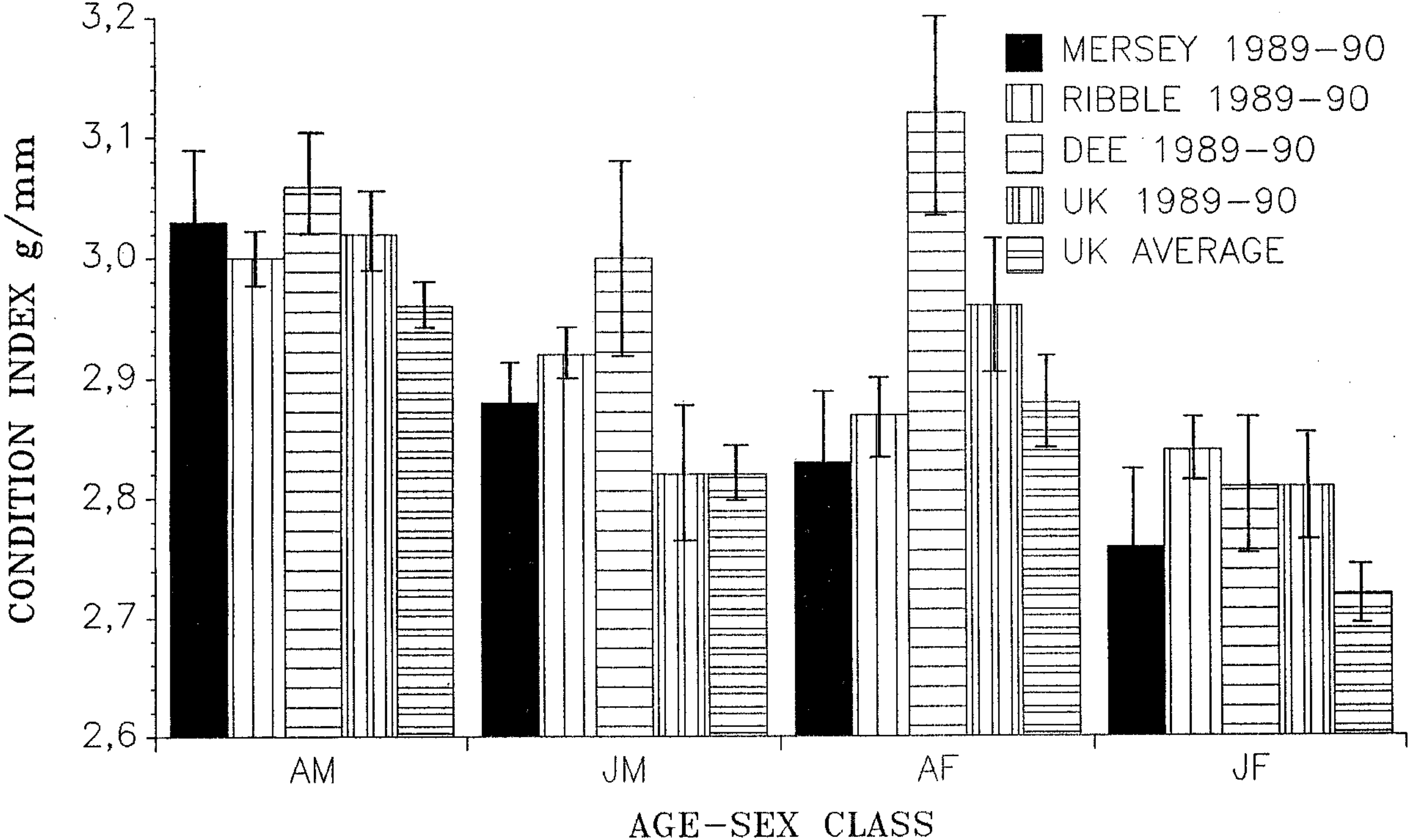
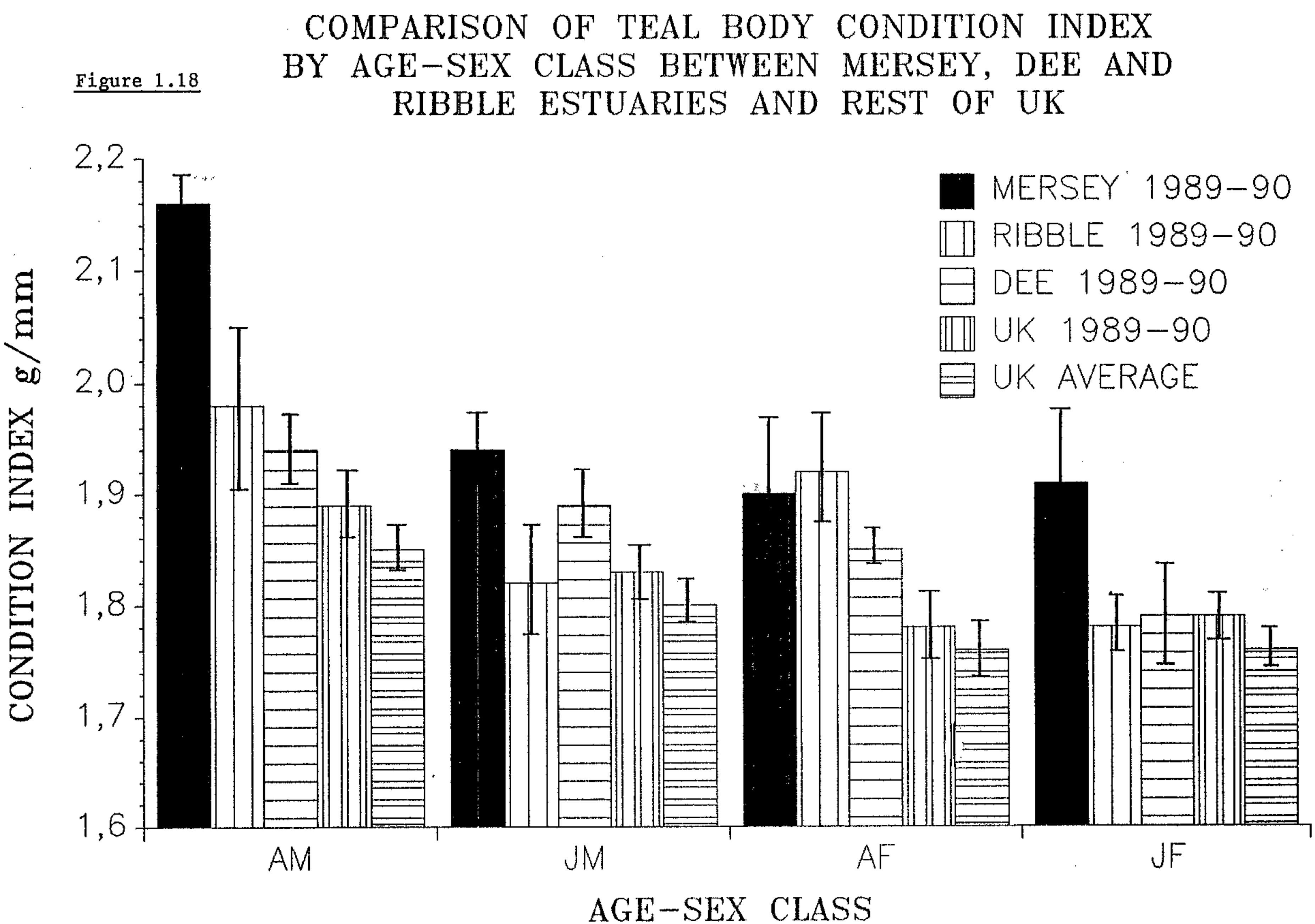


Figure 1.18


COMPARISON OF TEAL BODY CONDITION INDEX
BY AGE-SEX CLASS BETWEEN MERSEY, DEE AND
RIBBLE ESTUARIES AND REST OF UK
MERSEY 1989-90
RIBBLE 1989-90
DEE 1989-90
UK 1989-90
UK AVERAGE
CONDITION INDEX g/mm
2,2
2,1
2,0
1,9
1,8
1,7
1,6
AM
JM
AF
JF
AGE-SEX CLASS

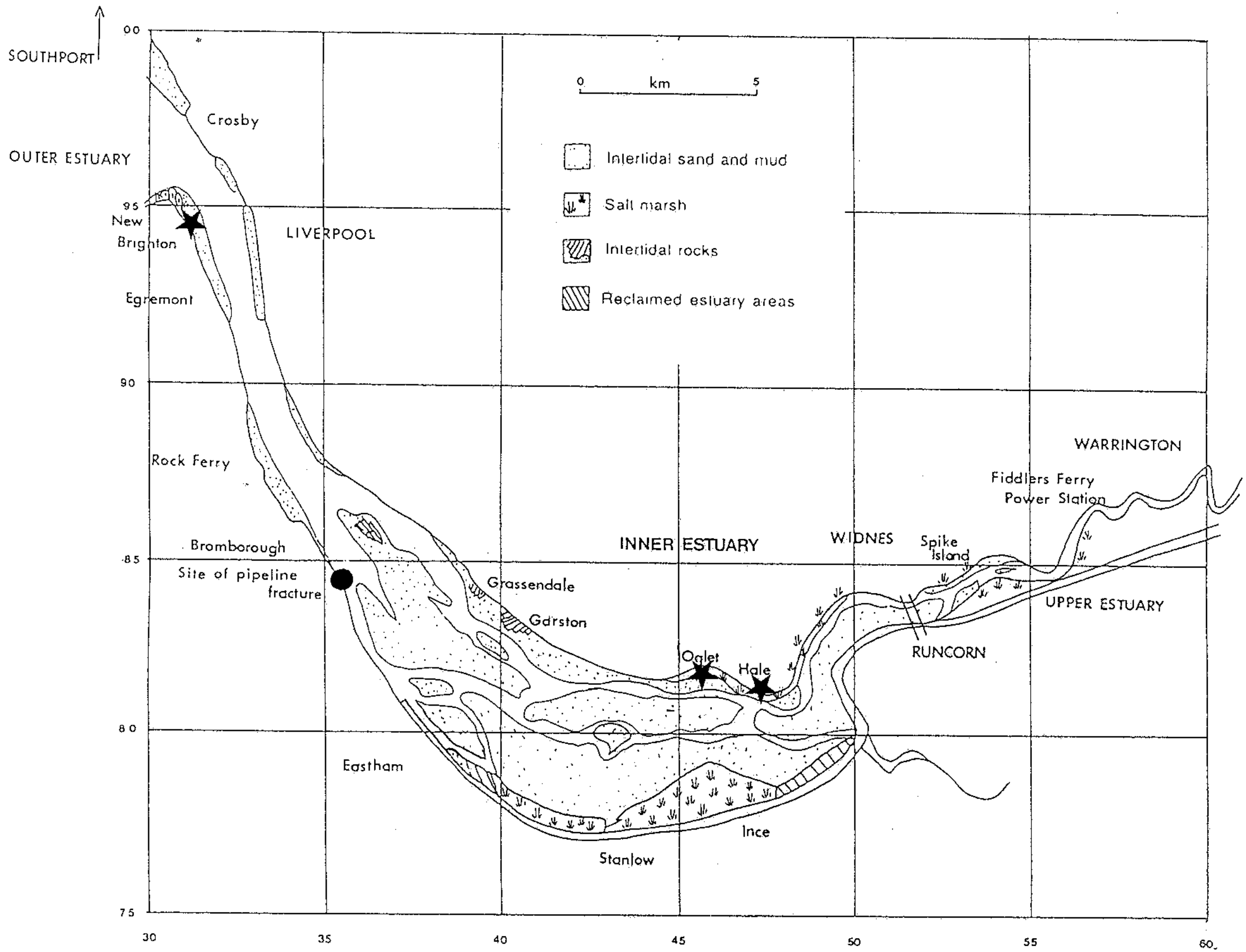


Figure 2.1 Map of the Mersey Estuary showing main habitat types. Cannon netting sites are marked

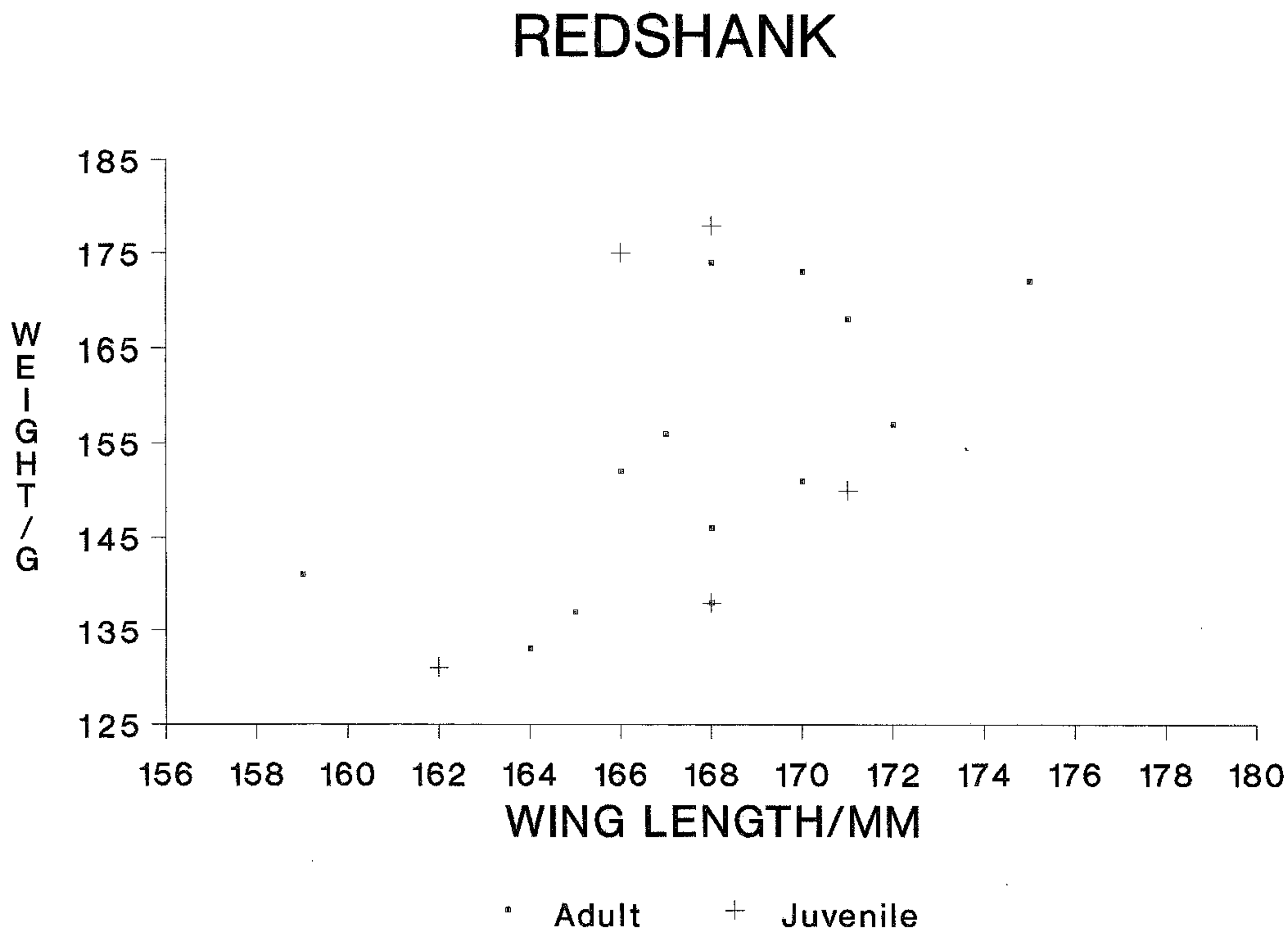


Figure 2.2 A comparison of weight with wing length for adult and juvenile Redshank caught on the Mersey during winter 1989/90.

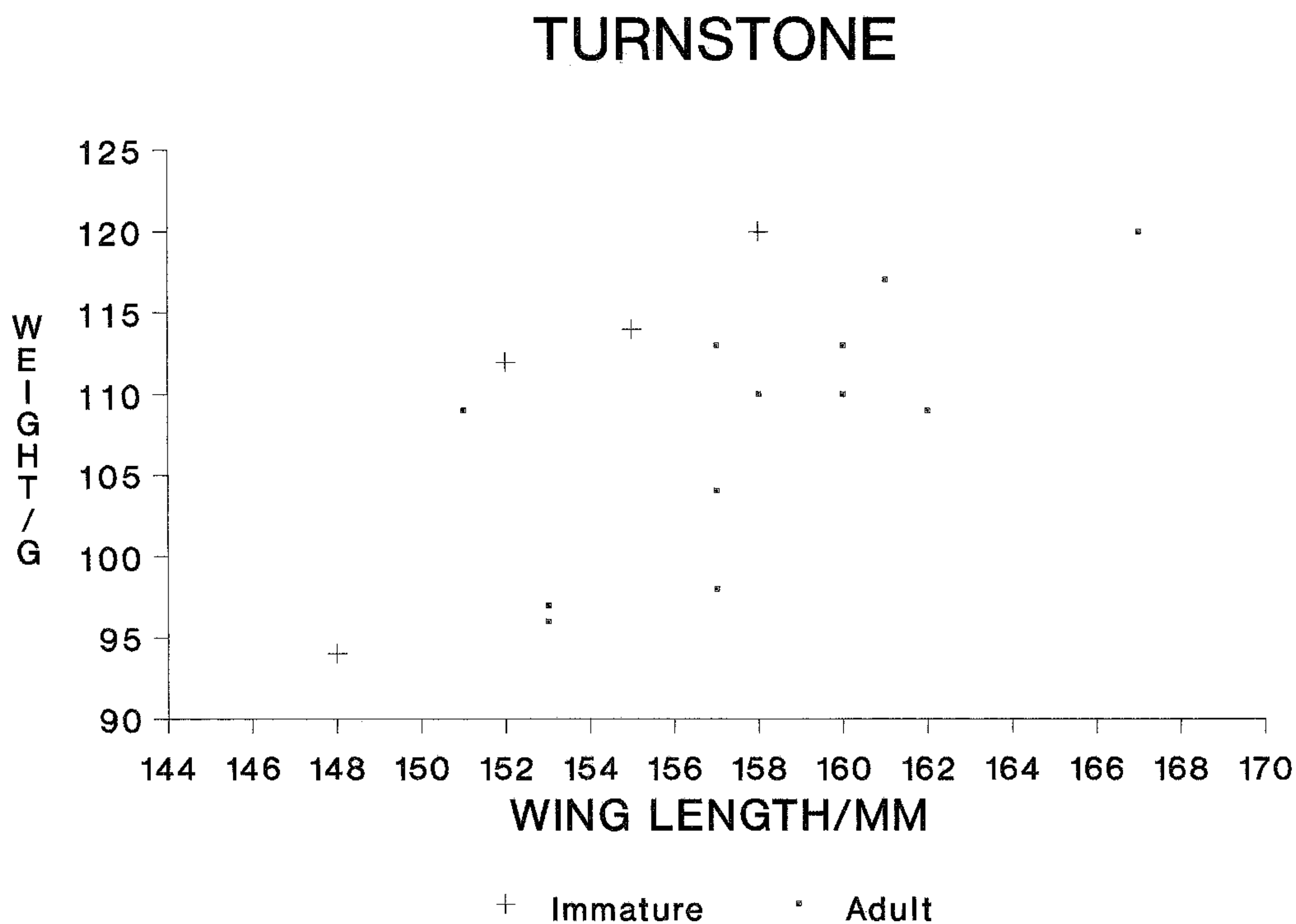


Figure 2.3 A comparison of weight with wing length for adult and juvenile Turnstone caught on the Mersey during winter 1989/90.

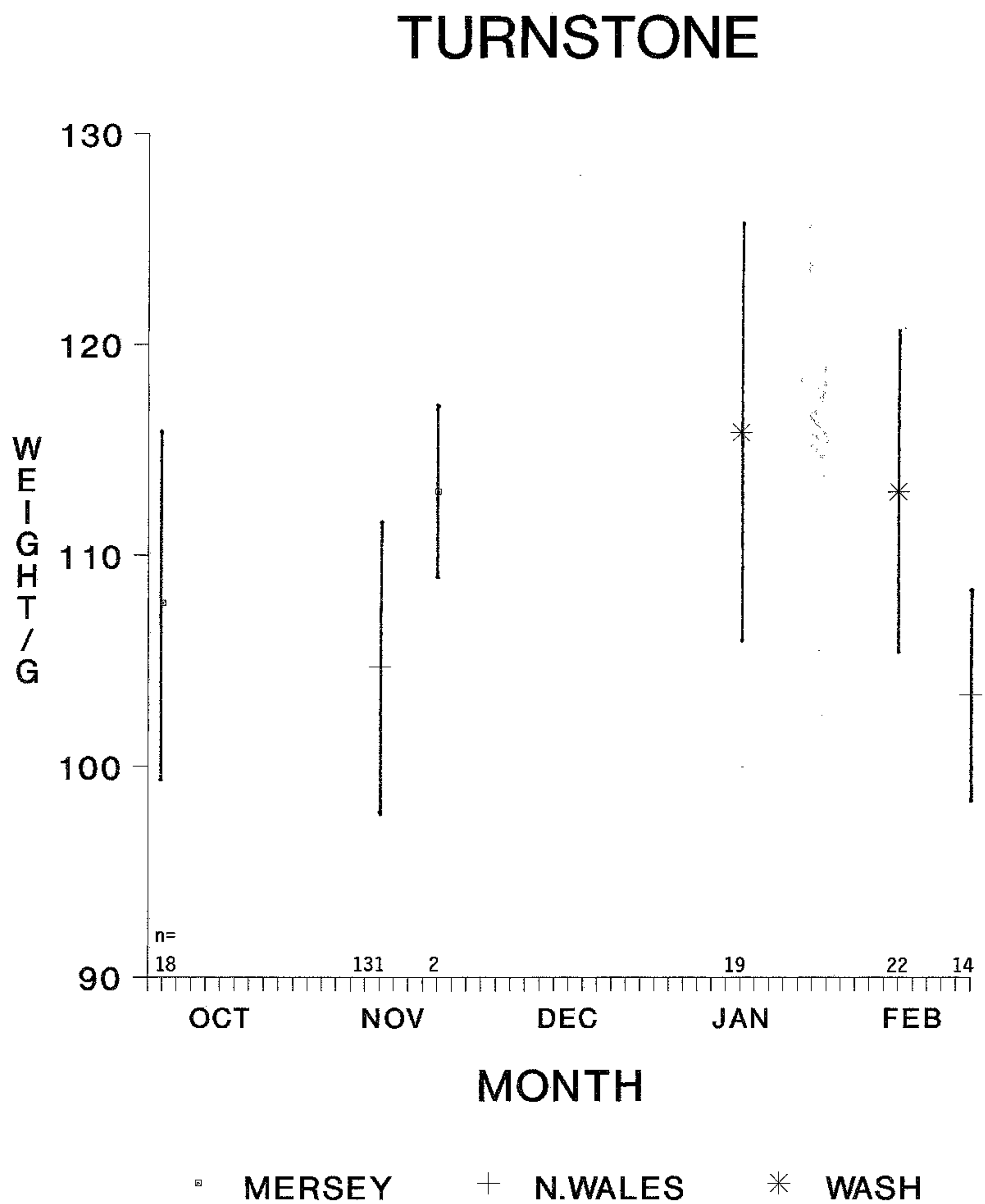


Figure 2.6 Mean weights of Turnstone at three sites around Britain at different times throughout the winter 1989/90.

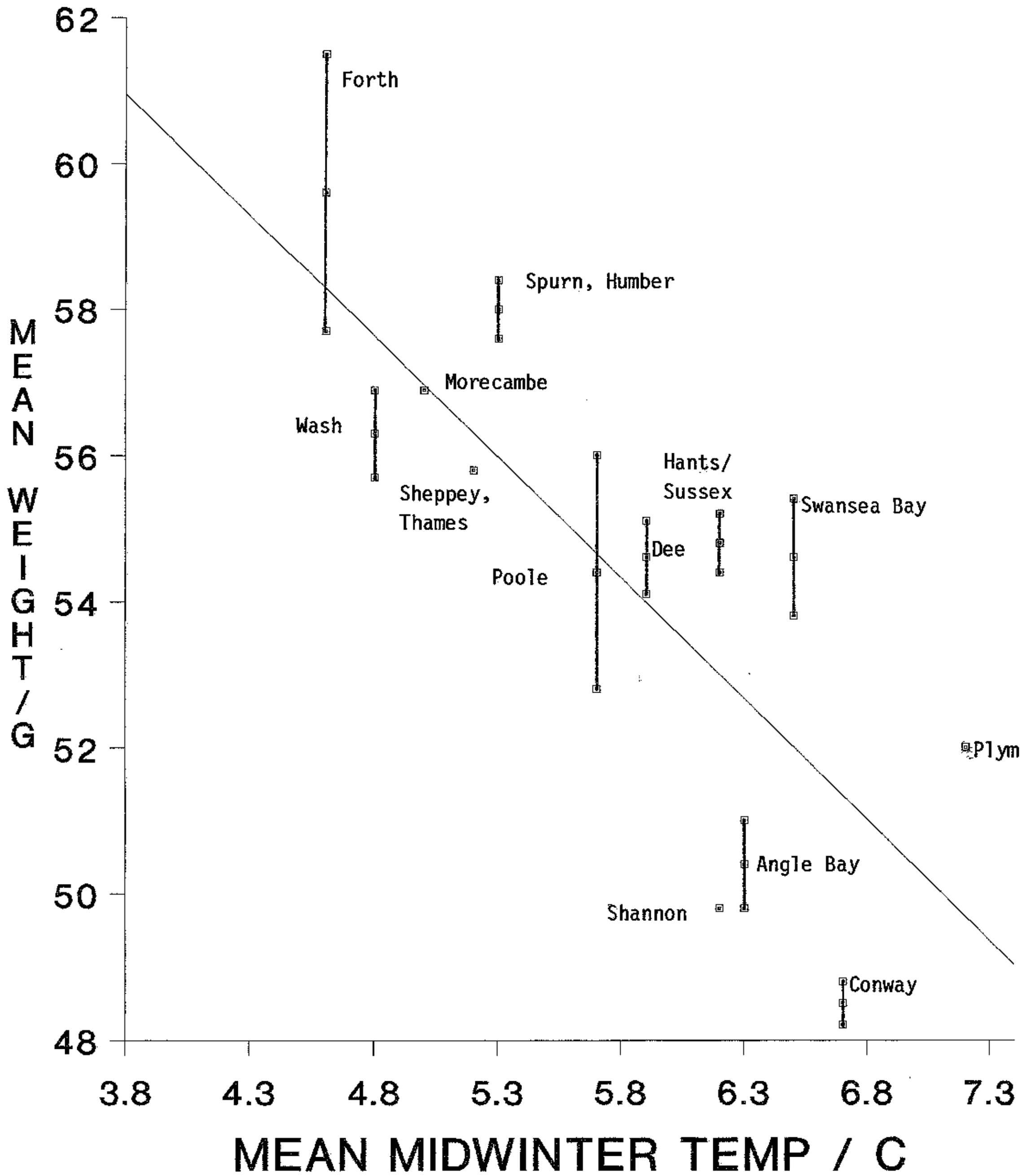


Figure 2.7 The relationship between mean December weight of adult Dunlin and mean December temperature at various coastal sites in Britain and Ireland (redrawn from Pienkowski et al 1979).