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Waders on Swansea Bay: past trends and present usage

by

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EXECUTIVE SUMMARY

This project was commissioned by the Countryside Council for Wales as a number of developments were proposed for the Swansea Bay area. This study assesses the distribution and changes in numbers of waders in Swansea Bay which is an essential background for considering the impact of these proposed developments. When the Blackpill SSSI was notified it had held internationally important numbers of Sanderling and nationally important numbers of Ringed Plover but in 1991 the site was nationally important only for Sanderling.

The project had three main objectives. The first was to compare changes in numbers of each wader species on Blackpill with national changes since 1969. This would reveal when any declines occurred and whether these declines followed national trends or were due to local changes within Swansea Bay, possibly related to increasing development and human disturbance of the area. This objective was achieved by a detailed analysis of data from the Birds of Estuaries Enquiry. Only three species showed any significant correlation with national trends; Oystercatcher, Dunlin and Sanderling. Species which have not shown any correlation with the national index and have shown a downward trend over the years include Knot, Bar-tailed Godwit and Redshank.

The second objective was to identify patterns of movement of birds around the tidal cycle at selected points within Swansea Bay, and the third objective was to assess the distribution of birds around the whole of Swansea Bay by means of low tide counts. However, it was found that the whole of Swansea Bay could be encompassed by all day study sites attaining the third objective in more detail than initially thought possible. As was already known from BoEE counts there were two main roost sites in Swansea Bay, the most important at Blackpill and the other at Crymlyn. Waders used these sites for up to third of the tidal cycle, dispersing from and returning to these sites around high tide. Apart from the roost sites, the three most important areas on Swansea Bay in terms of their usage by waders were: 1) the mussel beds on western Swansea Bay which were important feeding areas for Oystercatcher, Turnstone, Curlew and Redshank, 2) the sandy lower shore south of the Blackpill roost site, an important feeding area for Dunlin, Sanderling, Ringed Plover, Bar-tailed Godwits and Curlew and 3) much of the sandy shore below Crymlyn Burrows used by Dunlin, Sanderling, Oystercatcher and Curlew.

1. GENERAL INTRODUCTION

Swansea Bay stretches from Mumbles Head to Port Talbot and at low tide provides a strip of sand flats over 1 km wide, with small areas of mussel beds, rocks and seaweed. Apart from Crymlyn Burrows on the eastern end of Swansea Bay the whole shoreline is developed either by industry and docks in the centre or by a promenade from Swansea to Mumbles. There are two designated SSSI's within the bay, Blackpill and Crymlyn Burrows. At present Blackpill holds nationally important numbers of Sanderling but in the past was considered to hold internationally important numbers of Ringed Plover and Sanderling, as well as nationally important numbers of Grey Plover and Turnstone. In addition the Crymlyn Burrows SSSI holds small populations of wintering waders. There are a number of development proposals for the Swansea Bay area at the present time, as well as a number of human pressures such as disturbance. As a consequence, a study of the distribution and changes in the numbers of waders was considered as essential background information for considering the impact of these proposed developments.

The first objective of this project was to compare changes in numbers of waders on Blackpill to national trends since 1969 and the results of this analysis are presented in the first part of this report.

The second and third objectives of the project were to identify patterns of movement and distribution of the different wader species around Swansea Bay within the 1991-92 winter. The results of this are presented in the second part of this report.

2. BACKGROUND TO THE BoEE

After several barrage schemes were proposed on British estuaries in the mid 1960's, it soon became apparent that the knowledge of waders around Great Britain was fragmentary and that a survey of estuary birds, especially waders, was desirable. In the 1969-70 winter a pilot survey was set up and from its success the 'Birds of Estuaries Enquiry' (BoEE) was conceived in the following year.

The aims of the BoEE were threefold. Its main purpose was to document the species and numbers of birds using each of Britain's estuaries. Secondly, the annual counts could be used to monitor population levels throughout Britain. From these results it was possible to assess the conservation value of each estuary and allow comparisons between them. The third aim was to document seasonal population fluctuations which, when combined with ringing studies, could help explain the migration and local movements of birds. An example of the achievement of these three aims is represented in the first part of this report, which presents the BoEE data from Blackpill. It is not however within the scope of this report to explain the cause of any long term declines or increases of wader species at Blackpill, but to identify whether or not changes in the local population can be attributed to factors operating at a national scale.

3. METHODS

The BoEE monitors the distribution and numbers of waders and wildfowl on all UK estuaries (and some non-estuarine sites) by a series of synchronised monthly counts. Counts are performed by experienced local ornithologists who are familiar with their area and often participate in the BoEE for many years. Counts at most times are carried out around high tide when most birds are on regularly used roost sites. This fulfils the first aim of the BoEE, to estimate the numbers and species of birds using each of Britain's estuaries. It also allows data to be extracted for a particular site such as is done in this report for Blackpill on Swansea Bay. There are two main roost sites (Blackpill and Neath) within Swansea Bay and these are counted separately for the BoEE (Figure 3.1). Within this report the winter is referred to by the first year that it spans for example the winter spanning November 1969 to March 1970 inclusive is referred to as 1969. Autumn 1969 refers to data from July 1969 to October 1969 inclusive and spring 1970 refers to data from April 1970 to June 1970 inclusive.

Since the start of the BoEE Blackpill has received many additional counts to that obtained on the official BoEE date and historically it was the peak counts which were computerised, not the count made on the official BoEE date. In 1991 Blackpill was brought in line with the rest of the country and the count closest to an official BoEE date was computerised. Where this count has differed from the highest count during the winter months the highest winter count is given in the text. During the analysis of the BoEE data from Blackpill, it became apparent that data from the 1976 and 1978 winters were missing from the computerised database. These missing counts were obtained and used for the figures on peak winter, spring and autumn counts. However, there was insufficient time for them to be incorporated within the national database and hence they were not used for estimates of the national and international importance of Blackpill.

BoEE data are also used to calculate an annual national population index based upon counts made in January. This index charts the long term changes in national populations of waders and wildfowl in Britain (Kirby *et al.* 1991). The national indices from 1969 and 1991 were not used in this report, the first because it was a pilot year and the second was not available at the time of writing. By comparing the peak winter count at Blackpill with the national index for each year it is possible to identify the significance of a correlation between the two and hence the percentage of local changes which can be attributed to national trends.

To show how the seasonal pattern of waders varies BoEE data from the whole of Swansea Bay rather than only Blackpill was used. Unfortunately there is a gap in the data from the other main site, Neath, in the late 1970's and early 1980's. This was a period when the BoEE lacked funding for a full time national organiser, and resulted in a gap in the data set collected on some sites such as Neath. Seasonal variations for Swansea Bay could only be shown for the periods before and after this 'hiatus' in the BoEE counts.

BoEE counts are also used to assess national and international importance of individual estuaries for each species. Blackpill has qualified as being of national importance for several wader species and of international importance for one. If an estuary **regularly** holds 1% or more of Great Britain's national population of a certain species, it is held to be of national importance for that species, as defined by Kirby *et al.* 1991. To determine

whether an estuary **regularly** holds nationally important numbers of a particular species, the average winter peak count over the previous five winters is used rather than the peak winter count of each winter. Thus although an estuary may in occasional years hold numbers of a particular species which exceed 1% of the national population of that species, the estuary would not be considered to be of national importance unless the peak winter count over a five year period exceeded the 1% level.

The national population is used as a benchmark to calculate national importance levels. Periodically the national population is redefined. From 1969 to 1984 a national population was derived from counts made on estuaries during the period 1969-1975. By 1985 many species had shown a considerable increase in numbers and more comprehensive material was collected during the period 1980-85. This included the first survey of waders on the non-estuarine coasts of Britain, the Winter Shorebird Survey (Moser and Summers 1987), and further extensive counts of waders on estuaries. In 1985 Moser revised the population estimates of Great Britain and new qualifying levels for national importance were implemented (Moser 1987). These changes in national populations, together with changes in other countries, have also resulted in the international population levels being redefined.

4. RESULTS and DISCUSSION

4.1 Oystercatcher

Oystercatcher is one of the most numerous species in Swansea Bay, with peak numbers present in autumn and winter. Figure 4.1.1 shows that numbers were steady in the early 1970's at around 1000, but by the late 1970's numbers had increased to between 2000 and 3000. A natural increase at this time may have been enhanced by the cessation of the MAFF cull of Oystercatcher on selected estuaries, e.g. the Burry Inlet and Morecambe Bay, after the 1974 winter (Prater 1975). The population has remained between 2500 and 3000 since then (the low figure in 1991 is due to the change in BoEE analysis; if counts had been analysed in the same way as in previous years this figure would be 2980). The national index has shown a noticeable increase since 1969. Autumn numbers also increased in the mid 1970's and have fluctuated around 2000 since then (Figure 4.1.2). There was no definite trend in the spring population but numbers were often between 300 and 500 birds.

There has, however, been a change in the seasonal pattern of birds present in Swansea Bay. In recent years there has been a large increase in the number of Oystercatcher during the autumn passage compared with numbers in the early 1970's (Figure 4.1.3a). Numbers have consistently fallen from February to April as adult birds return to their territories on breeding grounds. It is thought that most of the Oystercatcher wintering on the west coast of Britain breed in Scotland, the Faeroes and Iceland. Those which remain on British estuaries between late May and early June are mainly immature birds. The recent trend in average monthly counts is more consistent with the broad west coast trend found by Prater (1981). Prater identified an increase in numbers in late July and through August, as post breeding adults and juveniles gather on the shore, a peak in September and a decrease in numbers by October as many of the juveniles migrate to France and Iberia. A similar seasonal timing to this pattern has been found on other Welsh estuaries, such as the Cleddau (Pr_s-Jones 1989) and the Burry Inlet (Pr_s-Jones *et al.* 1989).

Further decreases during the winter may occur as birds move on to fields adjacent to the coast. Numbers at Blackpill are sometimes lower during the high tide period as birds are feeding and roosting on nearby playing fields when the BoEE counts are carried out.

There is a significant correlation between changes in the national population index and changes in the numbers of Oystercatcher recorded at Blackpill ($y=1.11 + 0.974x$), with 45% of local changes accounted for by national trends (Figure 4.1.3b). This suggests that the main reason for the increase in Swansea Bay is the increase in the wintering population and not a change in the suitability of the area for Oystercatcher. Oystercatcher have not reached levels of national importance at Blackpill but have remained near 0.8% of the national population since 1979 (Figure 4.1.4). The qualifying level for Oystercatcher only changed slightly in 1985 from 3000 to 2800, so the trends are comparable either side of this year.

4.2 Ringed Plover

Numbers of Ringed Plover at Blackpill have generally remained between 200 and 300 (Figure 4.2.1). 1969 was a notable exception to this with around 700 birds recorded. Although

numbers were slightly lower than 200 between 1987 and 1989 this may only be a temporary decline as numbers recovered from around 100 in 1983 to nearly 300 in the following three years. Added to this the highest number recorded last winter outwith the BoEE count dates was 258. The birds which winter in Britain are primarily local breeders although augmented by birds which breed from the Netherlands to southern Sweden and Germany (Prater 1981). The national index has shown an overall increase in numbers over the span of the BoEE.

The number of Ringed Plover present during autumn has shown an overall decrease since 1980 (Figure 4.2.2). Autumn passage in Britain is strongest in the west largely due to concentrations on the Severn, Dee and Morecambe Bay (Prater 1981). This is reflected in the increased numbers at Blackpill during autumn as birds which breed in Iceland, Greenland and Scandinavia pass through to winter elsewhere in Britain or further south to the African coasts (Prater 1976). Although numbers have been somewhat variable during spring they have remained below 100 with the exception of spring 1970 (Figure 4.2.2).

As in other parts of Britain the peak numbers on Swansea Bay occur in August and September (Figure 4.2.3a). Numbers generally decline over the winter to a March/April low coincidental with a return to breeding territories. The path for spring migration appears to be extremely narrow for the southwest (Prater 1981) and, although spring migrants were in evidence between 1969-1971, they usually miss Swansea Bay.

There is no correlation between the changes in population which occur at Blackpill and those which occur nationally (Figure 4.2.3b).

Figure 4.2.4 shows that Blackpill held a nationally important number of Ringed Plover up to the reassessment of national populations in 1985. Since then it has been fluctuating just below or above the qualifying level of 1%. As shown by the peak winter counts (Figure 4.2.1) this is not due to a real decline in the numbers of Ringed Plover at Blackpill but to a reassessment of the national population. The BTO/WSG Winter Shorebird Count revealed surprisingly high numbers of Ringed Plover on open coastal habitats not previously covered in the BoEE, particularly in Scotland and N. Ireland (Salmon and Moser 1985) and the qualifying level for national importance was recalculated from 120 to 230.

Estimates of W. European populations have improved over the years. This has led to an increase in the estimated Ringed Plover population and a readjustment of the qualifying levels for international importance, from 250 1969-75, to 400 1975-80 and since 1980 set at 1,000 (Prater 1981). A detailed analysis of the BoEE data from Blackpill has shown that the number of Ringed Plover at this site have not reached the qualifying levels for international importance since the start of the BoEE.

In summary, although the changes in numbers of Ringed Plover present at Blackpill have not shown any correlation with the national index neither have they shown a distinct decline in any season. Swansea Bay has been used as a staging post by birds on autumn passage. The fact that Blackpill did not qualify as a site of national importance between 1989 and 1991 is largely due to the reassessment of national populations in 1985 and cannot yet be said to be due to a decline in numbers.

4.3 Grey Plover

Peak wintering populations of Grey Plover on Swansea Bay were greater between 1976 and 1986 than at other times (Figure 4.3.1). This corresponds with a general increase which occurred nationally over this period. However, for three years after this period, numbers dropped to levels similar to those recorded in the 1970's, in marked contrast to the steeply rising national index in 1987 and 1988. Numbers of Grey Plover also rose on other Welsh estuaries up to 1986 with low numbers in 1987 (Pr_s-Jones *et al.* 1989, Pr_s-Jones 1989). The Cleddau showed a resurgence in its wintering population in 1988 and to some extent this has also occurred in Swansea Bay in the past two winters (the peak winter count of Grey Plover last winter including unofficial BoEE count dates was 114).

Figure 4.3.2 shows that numbers were generally very much lower during the autumn and spring compared to the winter months. There were signs of slightly higher numbers during the spring months in the mid 1980's. Autumn peaks generally averaged around 20 Grey Plover, with occasional influxes of around 100 birds. As seen in Figure 4.3.3a, Grey Plover have shown a similar seasonal pattern over the years. Wintering birds start to arrive on Swansea Bay from September onwards, numbers peak in January and most birds have left for the arctic tundra by May. This pattern is typical of estuaries in the southwest of Britain (Prater 1981).

Although the local Grey Plover population at Blackpill generally followed the national trend up to 1986 the correlation between the two rates of change in each year was not found to be significant (Figure 4.3.3b).

As mentioned above numbers of Grey Plover at Blackpill were highest in the late 1970's and early 1980's and it was over this period that Blackpill qualified as a site of national importance for this species (Figure 4.3.4). After 1985 the qualifying level for Grey Plover was changed from 100 to 210 due to the increase in the national population. This meant that even in 1985 when levels had been high for the preceding five years numbers at Blackpill no longer reached 1% of the revised national population estimate. Last winter's low level is exaggerated by the change in BoEE analysis.

In summary, numbers of Grey Plover were highest at Blackpill between 1979 and 1986 and have not qualified for national importance since 1985. The site has not significantly followed national trends and is mainly used by Grey Plover during the winter months.

4.4 Knot

The numbers of Knot recorded at Blackpill have shown a decline over the years of the BoEE which is not matched by trends in the national index (Figure 4.4.1). Up to 1977 over 200 birds were consistently observed with peaks of around 400 in 1970 and 1976. Since 1979 the highest figure recorded was 181 in 1981. Last winter was particularly poor with only three birds recorded on a BoEE count and a maximum of 9 observed all winter. Throughout the BoEE, numbers of Knot recorded at Blackpill have not approached the qualifying level for national importance which is now set at 2,200. There does not appear to be any significant trend in the numbers of birds present in the autumn (Figure 4.4.2). Numbers were very high on autumn passage in 1969, although this was not the

case on other nearby estuaries (Prater 1972). High spring counts were recorded in the first three years of the BoEE, but an exceptional peak of 308 was recorded in 1984.

During the early 1970's Knot began to arrive on Swansea Bay from August onwards and peaked in January with, over the years, a decreasing number of birds remaining until spring (Figure 4.4.3a). In recent years there have been too few Knot on Swansea Bay to display any seasonal trend. There is no correlation between the changes in numbers of Knot recorded at Blackpill and changes in the national population.

4.5 Sanderling

Peak numbers occur in winter at Blackpill with autumn numbers being, generally, slightly lower and still fewer birds are present in spring. Numbers of Sanderling wintering on Swansea Bay have varied over the period of the BoEE. From 1969-1976 the population was steady with around 200 birds present, but since then levels have fluctuated between 200-400 (Figure 4.5.1). The low figure in 1991 is due to the change in BoEE analysis; if counts had been analysed in the same way as in previous years this figure would be 454, the second highest number of Sanderling recorded at Blackpill since monitoring began. Before the early 1980's, the national indices were highly variable but since then the national population levels seem to have stabilised.

Figure 4.5.2 shows that between the early 1970's and mid 1980's, numbers of Sanderling were regularly between 200 and 400 during autumn passage and 150 and 250 during spring passage. The population levels have not always been this consistent, as illustrated by the very high numbers in the first two years of monitoring and the highly variable figures in recent years.

Up to the mid 1970's, there was a pronounced autumn passage of Sanderling with high numbers passing through Swansea Bay between August and October (Figure 4.5.3a). However, this contrasts with the overall pattern observed during these months in southwest estuaries as a whole (Prater 1981) which show little or no increase during the autumn months. In recent years, this autumn passage has been represented by only a slight increase in numbers in October. The wintering population has continued to be fairly stable between November and March. Evidence for a decline in the spring passage in Swansea Bay is somewhat exaggerated for this species due to the very high numbers which occurred between 1969-1971 and the very low numbers which occurred between 1988-91. However, from Figures 4.5.1 and 4.5.2, it can be seen that numbers at Blackpill are usually lower during the spring than in winter.

There is a significant but weak correlation between the changes in numbers of Sanderling recorded at Blackpill and those recorded nationally ($y=0.569+0.888x$) (Figure 4.5.3b). Only 18% of the local changes can be explained by changes in the national index.

Blackpill has consistently qualified as a site of national importance for Sanderling since the start of the BoEE (Figure 4.5.4). The site held around 2% of the national population until the early 1980's when, with the increased numbers present (Figure 4.5.1), Blackpill held between 3.5% and 4.5% of the national population. The Winter Shorebird survey in 1985 revealed that, although 80% of the waders found were on estuaries, there was a marked difference in the importance in estuarine and non-estuarine sites for each species (Moser

1987). This was particularly evident for Sanderling with 67% being counted on non-estuarine sites. As the January population indices had shown no increases, the higher population estimate must have been due to birds present on non estuarine sites which were previously unsurveyed. After the reassessment of the national populations in 1985, Blackpill returned to holding around 2% of the national population. There appears to have been a slight decline in the importance of Blackpill since 1985. However, the high numbers of Sanderling recorded during this winter, outside the BoEE, indicate that this decrease may be levelling out. Comparison with this year's national index will be necessary to clarify this point.

4.6 Dunlin

Peak numbers of Dunlin occur at Blackpill in winter. Numbers of Dunlin recorded at Blackpill have increased from the start of the BoEE to a peak in the mid 1970's (Figure 4.6.1). Thereafter numbers have remained fairly stable, between 1500 and 2750 (the low figure in 1991 is due to the change in BoEE analysis, if the counts had been analysed in the same way as in previous years this figure would be 1500). The national indices have followed a broadly similar trend to this until recent years when there has been an upturn in the national population.

Autumn counts have shown a very similar trend to the winter counts over the years, with peaks in the mid 1970's and lower, more steady levels preceding and following this peak. This trend was not so obvious in the spring counts which were generally lower. Numbers in the autumn and spring are very much lower than in the winter, with no signs of Swansea Bay being used as a staging post through migrations (Figure 4.6.2).

Figure 4.6.3a shows there has been a consistent seasonal pattern over the years. Dunlin start to arrive at the site between October and November, then slowly build up to a peak in January or February. Only a few hundred birds are present on Swansea Bay between April and July. These are most likely to be of the *schinzii* and *arctica* races on passage from Africa to Iceland and Greenland. This pattern is typical of most estuaries in southwest Britain (Prater 1981). The majority of wintering Dunlin in Great Britain are of the race *alpina* which breed in Scandinavia and Russia. In April, birds migrate eastwards to moult at the Wash or the Waddensea before completing their annual cycle by returning to their breeding grounds.

There is a significant correlation between changes in the national population index and changes in the peak winter count of Dunlin at Blackpill ($y=1.8+0.812x$), with 34% of local changes accounted for by national trends (Figure 4.6.3b).

Dunlin have never reached levels of national importance on Swansea Bay, the highest level being in 1978 when numbers were just below 0.7% of the national population, but since then they have regularly been between 0.4% and 0.5% (Figure 4.6.4).

4.7 Bar-tailed Godwit

Numbers of Bar-tailed Godwit at Blackpill during winter and autumn were at their highest and most stable up to the late 1970's, since when they have generally been lower and more variable (Figure 4.7.1 and 4.7.2), with the exception of the two high counts in the last two

autumns. Although the national population was also variable in the 1980's the national index showed increased levels at this time (Figure 4.7.1). Numbers recorded in the spring are variable but generally lower than winter and autumn. The winter population at Blackpill is not of national importance, for which the qualifying level is now set at 610 birds.

In the early 1970's when numbers were at their highest godwits started to arrive on Swansea Bay for the winter from August onwards (Figure 4.7.3a). The timing of peak numbers varied, only lasting for one or two months in the 1969-71 average but for much longer, from December and March, in the 1972-74 average. In both of these sets of years most birds had departed by April. The seasonal pattern from 1988-91 was very different with the highest numbers being recorded in the autumn and dropping to a winter low by November.

The correlation between changes in the number of Bar-tailed Godwit at Blackpill and changes in national trends is not statistically significant (Figure 4.7.3.b). Although the number of Bar-tailed Godwit at Blackpill has never been of national importance (Figure 4.7.4), the importance of this species at Blackpill has shown a steady decline over the years.

4.8 Curlew

Peak numbers of Curlew occur at Blackpill in autumn and winter. Numbers of Curlew recorded at Blackpill have remained very stable over the years with around 150-200 birds present (Figure 4.8.1). The highest BoEE count of Curlew recorded at Blackpill was 229 in 1976. The national index has varied over the years but this may be due to factors such as the movement of inland birds on to estuaries during cold weather. If, however, the peak winter count is examined, as opposed to one count in January, this variability is reduced and shows that Curlew numbers on all British sites are stable. Sites in southwest Britain are generally less variable than in the rest of Britain, suggesting that they are at ceiling densities or 'carrying capacity' (Clark 1989).

Autumn counts at Blackpill have also been stable over the years, with numbers comparable to those found in winter but very low numbers were present in spring (Figure 4.8.2) during which counts are also more variable. From BoEE counts of the whole of Swansea Bay (Figure 4.8.3a) it can be seen that there was been an autumn passage up to the mid 1970's which must have been due to birds counted at Neath. The pattern and timing of this passage has been variable over the years and was absent in recent years. With such a large gap in the data it is difficult to say whether there has been a gradual or sudden decline in autumn numbers but it will be interesting to see whether future counts at Neath show a return of Curlew in autumn passage to Swansea Bay.

There is not a significant correlation between changes in the peak winter counts at Blackpill and the national index (Figure 4.8.3b) but, as mentioned above, there is likely to be a higher degree of variability in an index derived from the January count than from peak winter counts. This will be exaggerated in species such as Curlew which also use non estuarine habitats.

The number of Curlew at Blackpill have remained substantially lower than the qualifying level for international importance, which is 910.

In summary, numbers of Curlew at Blackpill have remained very stable over the years with comparable numbers present in winter and autumn. Nearly all Curlew have left the bay by April. Although local trends at Blackpill do not follow the national index this is not unusual for a species which also uses inland areas during the winter and other southwest estuaries have also shown stable numbers.

4.9 Redshank

Numbers of Redshank at Blackpill have declined since the mid 1980's (Figure 4.9.1). From 1969-1985 nearly all the counts were between about 160 and 300, with the highest counts in 1975 and 1976. Since 1985 numbers have gradually declined to 120 (1991 count of 120 outwith the BoEE count dates). This is not consistent with the apparent increase suggested by the national index at this time.

Since 1983, there has been a decline in the numbers of Redshank present at Blackpill in the autumn (Figure 4.9.2). The spring counts have been variable over the years but have been at their lowest in the last four winters. Numbers of Redshank at Blackpill have never reached the qualifying levels for international importance which are now set at 750 wintering birds or 1,200 on passage.

Up to the mid 1970's there was an increase in numbers of Redshank on Swansea Bay during the autumn months with a gradual decline in numbers over the winter (Figure 4.9.3a). However in recent years there has been no autumn passage with Redshank only arriving after September, reaching peak numbers in January and departing by April. There was no correlation between changes in numbers of Redshank at Blackpill and changes in the national populations (Figure 4.9.3b).

4.10 Turnstone

Numbers of Turnstone at Blackpill have generally fluctuated between 200 and 300 since 1973 (Figure 4.10.1). The highest levels recorded were from 1984-1986 before returning to the 200-300 level. Last winter, however, numbers were the lowest recorded at Blackpill since the start of the BoEE. Even including counts outwith the official BoEE count date, the peak winter count at Blackpill was only 77. It was thought that Turnstone may been using an alternative roost site. A preliminary search was carried out over three consecutive high tides in January along the rocky shore around the Mumbles Head. One roost site was located on the steps of the lifeboat pier with 120 birds recorded last winter. Turnstone have apparently been roosting there for many years, but numbers have not previously been recorded (Lifeboat warden pers. comm.). The birds observed at Blackpill were probably included in this count and Turnstone have probably used both sites in the past but did not favour Blackpill last winter. The reason for this is not clear but factors such as disturbance or a change in the habitat of the roost site may cause such movements. Small numbers (around 10 birds) of Turnstone were occasionally observed roosting on the dock side of the western breakwater adjacent to area 45 (Marina), but time did not allow for regular counts of this roost.

The number of Turnstone present in autumn and spring has varied over the years, with the highest numbers recorded in the 1980's (Figure 4.10.2). Autumn counts have been very low in recent years. The very high number in spring 1985 may be due to a late departure of the large wintering population that year.

There has been a similar seasonal pattern of Turnstone numbers on Swansea Bay over the years (Figure 4.10.3a), with the highest number of Turnstone present over the winter months. The exact timing of the start of the winter build up of numbers and the timing of the winter peak however has varied.

There was no correlation between changes in the peak winter counts at Blackpill and changes in the national index (Figure 4.10.3b), and other more local factors may be more important in controlling variation in numbers.

The number of Turnstone at Blackpill qualified for national importance between 1982 and 1984 (Figure 4.10.4). Turnstone was the third most abundant species on non-estuarine coasts during the 1984-85 Winter Shorebird Count, with more than three-quarters of the population wintering in Britain being found outside estuaries (Moser 1987). The results of this survey increased the size of the Turnstone population wintering in Britain by 80% and caused the qualifying level for national importance to be raised from 250 to 450 in 1985. This meant that although numbers at Blackpill were higher in the five year periods up to 1985 and 1986 compared to the 1982 and 1983 periods Blackpill no longer qualified as a site of national importance for Turnstone. Levels were quite stable for four years following the reassessment when the five year average would have included the high counts in the mid 1980's but have fallen since then.

In summary, even taking into account the birds roosting elsewhere on Swansea Bay, ie the lifeboat slipway, the numbers of Turnstone recorded in the 1991-92 winter (around 120) were very much lower than the 200-300 regularly recorded. The population should however be carefully monitored in the next few years to see if the markedly low number recorded in 1991 is the start of a more permanent decline.

ALL DAY MOVEMENTS AND DISTRIBUTIONS

5. BACKGROUND

BoEE counts provide a lot of valuable information such as described in the first section of this report. However, they do not reflect which parts of the intertidal areas are the most important for feeding waders or where birds move throughout the tidal cycle. Birds do not always feed in the areas closest to their roost site. As a result of disturbance or habitat changes, birds may be forced to move their roost sites. This can result in birds moving very long distances between roosting and feeding sites. At the present time the evaluation of an estuarine site for birds is, for the most part, based on the numbers of birds recorded at roost sites but feeding areas should also be considered.

The length of time that waders and wildfowl need to feed per tidal cycle varies according to the time of year and the species involved (Goss-Custard *et al.* 1977). Smaller species of wader e.g. Dunlin and Sanderling, need to feed for longer periods during each tidal cycle than larger species, e.g. Curlew and Oystercatcher. During very harsh weather it becomes critical for birds to feed at every available opportunity in order to survive (Goss-Custard 1977) and concentrated numbers of birds may be found continuing to feed on less favoured feeding areas when others are covered. Not only do birds have to increase their food intake in harsh weather but this is often difficult because of factors such as shorter daylight hours, depressed invertebrate activity or heavy rain and strong winds which hinder feeding. It is therefore very important to identify and conserve the feeding areas of waders as well as the roost sites. With this in mind the patterns of distribution, usage and movement of waders on Swansea Bay, from the Mumbles to the River Neath, were determined during the 1991-92 winter.

6. METHODS and ANALYSIS

Swansea Bay was divided in to four study sites which could be monitored hourly throughout the tidal cycle. The original aim was to only cover the areas within Swansea Bay considered most likely to be of major importance by all day counts and to cover the remainder on a much lower intensity by low tide counts. However, it was possible to cover virtually the whole of the study area by all day counts providing a much more detailed picture than expected. This was done at the expense of a small area below the Queen's Docks which was not visible from observation points and to cover this area would have involved reducing the number of all day counts.

The four all day study sites were named Mumbles, Blackpill, Marina and Crymlyn for reference. These were in turn divided into intertidal areas for ease of counting. These were distinguished by easily recognisable features either by changes in substrate, wooden posts, outfall pipes or by obvious sight lines e.g. permanent buoys, breakwaters. Thus the four study sites were divided into 60 intertidal count areas (Figures 6.1 and 6.2). A basic description of the substrate types on each of the 60 count area is given in Table 6.1.

Each study site was observed over spring and neap tides between November and March. Each intertidal count area was counted once an hour throughout the period of daylight giving, once counts were amalgamated, information throughout the tidal cycle. Roosting and feeding birds were recorded separately. Little time was lost during the fieldwork due to heavy rain or very strong winds, but visibility was affected on sunny days due to the aspect of the bay and the low angle of the sun in winter.

Several observation points were used on each study site to ensure the best possible counts, these are illustrated on Figures 6.1 and 6.2. At low water, especially on spring tides, it was difficult to count birds on the outer reaches of the most extensive mudflats on the Blackpill and Crymlyn sites. However, supplementary counts were carried out near low water on the Blackpill site by I. Fernandez and the results were very similar to those found on the all day counts, confirming their accuracy.

Counts were carried out irrespective of varying levels of disturbance e.g. by dogs, walkers, beach cleaning or bait digging. The following section therefore represents accurate distribution patterns of how, on average, birds use Swansea Bay with the existing levels of disturbance.

Data were analysed for each species on each site at which an average peak of 5 or more birds occurred at any time interval. For each species, the all day usage was calculated for each area using the following equation:

All day usage (average number of bird hours per tidal cycle) = $\sum_{A=+5}^{A=\_6} (BxC)\,1$

where:
A = hours from low tide
B = Average number of birds feeding at time A when area is exposed
C = Proportion of counts when count area is exposed at time A

The average number of bird hours feeding and roosting on each count area was calculated separately for each species and plotted on maps of the study sites.

7. RESULTS and DISCUSSION

7.1 Oystercatcher

There are two main roost sites in Swansea Bay, at Blackpill and Crymlyn, both of which may hold about 1500 Oystercatcher. Numbers at Blackpill fall quickly from two to three hours after high tide. At this time, mussel beds on the Marina and Mumbles sites are uncovering and the numbers of Oystercatcher increase on these sites as birds disperse from the Blackpill roost site to feed (Figure 7.1.1a-d). The highest numbers of feeding birds are found on the Marina site (around 900). Numbers at Crymlyn decline gradually towards low tide. Small flocks of Oystercatcher were observed flying westwards from Crymlyn throughout the falling tide to feed on areas between the Marina and Mumbles. When the visibility was good, Oystercatcher were also observed feeding at low tide on the rocky shore below the Queen's Dock.

On the rising tide, the numbers gradually increase at Blackpill and Crymlyn as birds are pushed off the other sites. The numbers of birds which roost at Crymlyn would appear to be highly variable but this may be a product of disturbance on one of the counts. As the number, of this relatively obvious species, counted on the four sites at low tide is substantially lower than the roost counts, it is likely that some of these birds may travel to other suitable intertidal areas or feed in areas not visible from the observation points. Both of these factors may be important in explaining this discrepancy.

Figures 7.1.2 and 7.1.3 show that Oystercatcher can be found feeding on virtually all parts of Swansea Bay. The shoreline on some of the intertidal areas of Blackpill (areas 19, 21 and 23), along the edge of the river Neath (area 48) and the mussel beds at Mumbles (areas 7, 14 and 15) are of similar importance; but the highest numbers of bird hours spent feeding are on the relatively small areas of mussel bed on the Marina site (areas 31, 32, 37, 41 and 43). Figures 7.1.4 and 7.1.5 show that the main roost sites are on areas 22 (Blackpill) and 48 (Crymlyn). Observations showed that as the rising tide covered the mussel beds approximately 200 birds from the Marina site would start to collect and roost on areas 30 and 31 (Marina), about three hours after low tide, before moving on to the main roost site at Blackpill. Oystercatcher were also found to start roosting as soon as their feeding areas were covered on the Exe (Goss-Custard *et al.* 1983). About 800 birds collected on areas 23 and 24 (Blackpill) to roost or wash in the river channels before being pushed onto the higher shore (area 22) by the rising tide. As the tide fell birds again moved on to areas 23 and 24 before starting to feed. The pattern was similar at Crymlyn with roosting Oystercatcher gradually dispersing from area 48 onto nearby areas (49, 56 and 50) as the tide dropped and starting to roost on these areas and area 59 before high tide.

In summary, the most important feeding areas are on mussel beds, especially near the Marina, and the lower tidal levels, while important roosts are at Blackpill and Crymlyn.

7.2 Ringed Plover

From Figure 7.2.1 it can be seen that very few Ringed Plover were observed on Swansea Bay during all day counts. However, the number of Ringed Plover which roosted within the survey area was highly variable, as shown by the high error bar near high tide at Blackpill. This was confirmed by the numerous high tide counts carried out over the winter at this site by R.J. Howells. Ringed Plover are very cryptic and can therefore can be difficult to locate at low tide (Spearpoint *et al*. 1988). The upper shore of Blackpill was the main feeding and roosting site with smaller numbers on the upper shore at Marina over high tide and a very small number using a wide area of the Crymlyn site throughout the tidal cycle Figures 7.2.1-7.2.5.

7.3 Grey Plover

Grey Plover were only observed on three of the all day count sites with the highest numbers at Blackpill and Crymlyn (Figure 7.3.1). Regular high tide counts at Blackpill showed numbers here to be highly variable from day to day. Very few were observed at Blackpill on all day counts, and the pattern over the tidal cycle may be different when high numbers are roosting at Blackpill. Grey Plover were very difficult to locate and probably underestimated at low water due to their loose flock dispersion, often slow feeding movement and their cryptic coloration when feeding on mussel beds. Grey Plover which were located were mostly found to be feeding on the southern half of the Blackpill site and the western half of the Crymlyn site (Figures 7.3.2 and 7.3.3), and roosted mainly on areas 22 and 23 (Blackpill) and along the upper shore at Crymlyn (Figures 7.3.4 and 7.3.5)

7.4 Knot

As mentioned in section 4.4 very few Knot were observed on Swansea Bay in the 1991-92 winter, with a maximum of 9 birds observed roosting at Blackpill.

7.5 Sanderling

Around 200-250 Sanderling were using Swansea Bay during the 1991-92 winter. This number of birds was observed at both Blackpill and Crymlyn and it is thought that the same flock was using both sites. Blackpill was the main roost site at high tide (Figure 7.5.1b). Numbers decreased after high tide, as some birds moved to form a sub-roost near the Marina before moving on to feed on the Crymlyn site about three hours before low tide (Figure 7.5.1). Numbers at Crymlyn continued to build up towards high tide before moving back to Blackpill. Sanderling were not recorded as roosting at Crymlyn during the all day counts and do not occur regularly at Crymlyn on BoEE high tide counts; certainly in lower numbers than at Blackpill. The number of Sanderling feeding at Blackpill and Crymlyn at low tide may have been underestimated due to the poorer visibility over the long distances of mudflat especially in bright sunlight and on spring tides. Birds which concentrate at Blackpill on the rising tide continue to feed until high tide. Whether or not Sanderling were feeding on the roost site at or just after high tide varied.

As shown by Figures 7.5.2-7.5.5 the roost site at Blackpill was also the most important feeding

area with, as mentioned above, large numbers of birds there for at least a third of the tidal cycle. Observations showed that Sanderling moved off this area once others were exposed, and as shown by Figures 7.5.3 and 7.5.4, the next most important feeding areas were at Crymlyn with other birds widely spread along the shoreline of the Blackpill and Marina sites. A flock of 125 Sanderling were observed feeding along the strand line on area 25 on one occasion when the beach had not been cleaned. This was at a time when other areas of mudflat were exposed and available for feeding. The outer edge of the Crymlyn site was not visible due to the sand bank in area 53 but it may be of importance to feeding Sanderling as small flocks were observed flying over this bank, from the seaward side, on the rising tide to feed on the Crymlyn intertidal areas. Figures 7.5.4 and 7.5.5 show the positions of the main roost site at Blackpill, the post high tide sub-roost at Marina and a pre high tide sub-roost at Crymlyn.

In summary, there is one main roost site at Blackpill but Sanderling spread over much of Swansea Bay to feed and use different areas at different states of the tide.

7.6 Dunlin

The main roost site for Dunlin on Swansea Bay is at Blackpill, with a smaller proportion at Crymlyn. On some occasions Dunlin sometimes continued to feed during part of the high tide period at Blackpill. This was dependent on the exact height of the high tide. On the falling tide, most Dunlin are distributed on the Blackpill and Mumbles sites. Numbers at Mumbles peaked just after low tide when they were at their lowest on the Blackpill site. Numbers at Crymlyn were reasonably stable with 200-300 birds remaining to feed throughout the tidal cycle and up to a hundred moving east on to the Marina site about two hours after high tide (Figure 7.6.1a-d). This pattern was reversed about two hours after low tide with birds from Mumbles gradually moving back to Blackpill and from the Marina to Crymlyn. Without marked birds, it is not possible to say to what extent Dunlin from the two roost sites are independent.

Figures 7.6.2 and 7.6.3 show the most important feeding areas to be on the lower shore, with Dunlin spreading along the whole of the shoreline south of area 24 (Blackpill) and the outer edges of Crymlyn (area 60). The upper shore at Blackpill (area 22) is an important feeding area, as well as being the most important roost site (Figure 7.6.4), since the high numbers of Dunlin which are concentrated there over the high tide period may continue to feed. Although of less importance, many other areas were also used for feeding. Figure 7.6.5 shows the main roost at Crymlyn to be within area 48, but Dunlin sometimes started to roost on the adjacent area before being pushed onto the higher shore by the rising tide.

In summary, the most important roost sites are within the Blackpill and Crymlyn sites and the most important feeding areas are on the lower shore south of the roost site at Blackpill and, to a lesser extent, on the outer edges of the Crymlyn site. The main roost site for Dunlin in Swansea Bay is at Blackpill, with a smaller proportion at Crymlyn. On the falling tide, most Dunlin are distributed on the Blackpill and Mumbles sites. Numbers at Mumbles peaked just after low tide when they were at their lowest on the Blackpill site. Numbers at Crymlyn were reasonably stable with 200-300 birds remaining to feed throughout the tidal cycle and up to a hundred moving east on to the Marina site about two hours after high tide.

7.7 Bar-tailed Godwit

The most important feeding areas for Bar-tailed Godwits were along the shoreline of the Blackpill and Marina sites. Birds started to disperse from the roost site at Blackpill an hour after high tide and were at their full dispersion for four hours spanning the low tide period (Figures 7.7.1-7.7.5).

Numbers on the Crymlyn site were highest when birds were roosting there just before and after high tide.

7.8 Curlew

Curlew are catholic in their use of Swansea Bay, feeding on all four sites (Figure 7.8.1). As with the majority of species, the main roost site is at Blackpill. Although no Curlew were recorded as remaining to roost at Crymlyn over high tide during the all day counts, small numbers have been recorded as roosting there on BoEE counts (Figure 7.8.1d). Numbers decline on the Blackpill site during the falling tide with birds dispersing on to all four sites to feed. The exact timing of this movement varies between sites. Between 20 and 40 remain on the Blackpill site throughout the tidal cycle (Figures 7.8.1.a-c).

Numbers start to build up on the Crymlyn site immediately after high tide and continue to rise throughout the tidal cycle. However, it is only over the low tide period that a high percentage of these birds are feeding. An increasing number of Curlew start to roost just after low tide and the site is used as a sub roost until two hours before high tide when birds fly westwards to roost at Blackpill. There is a coinciding increase in the number of birds at Blackpill around this time.

Around 25 birds move to feed on the Mumbles site about three hours after high tide, once the lower areas are exposed. Some of these birds start to roost at Mumbles in the hour before returning to Blackpill. Approximately 15 Curlew feed on the Marina site over the low tide period.

Some Curlew were observed feeding on the playing fields near Blackpill over high tide and flying on to the mudflats on the falling tide.

Figures 7.8.2 and 7.8.3 show that Curlew were feeding on virtually all the intertidal areas on Swansea Bay but the most important areas were the mussel beds, the middle and lower shore south of the Blackpill roost site (area 22) and the central areas of Crymlyn. Figures 7.8.4 and 7.8.5 show that Curlew roosted on many areas in addition to the main roost site, although these were of less importance. As shown in Figure 7.8.1, not all Curlew will feed throughout the low water period and some obviously roost on feeding areas before the rising tide pushes them off.

In summary, Curlew roost at Blackpill at high tide but by low tide have dispersed to feed over the whole of Swansea Bay, although they show a preference for mussel beds and sandy areas south of the roost site.

7.9 Redshank

The majority of Redshank used only two of the all day sites, Mumbles and Blackpill, with on average less than five birds present on the Marina site. Birds roosted at Blackpill over high tide and then numbers declined on this site as some birds moved away to feed on the rocky shore and mussel beds on the Mumbles and the Marina (Figures 7.9.1-7.9.3). The Redshank which remained on the Blackpill site were often feeding or roosting within the river channels in area 24. The numbers of Redshank feeding on mussel beds at low tide may well have been under-estimated due to their dull coloration and habit of moving through pools and depressions in the mussel beds, where they were less visible.

7.10 Turnstone

From Figure 7.10.1 it can be seen that Mumbles and the Marina are the main feeding sites for Turnstone and that they were only observed on the Blackpill site close to high tide when other sites were covered (Figure 7.10.1). Turnstone flew on to the Mumbles site, either from Blackpill or from the steps of the lifeboat pier, and started to feed on the upper areas near the sea wall (areas 11 and 17) as soon as they were uncovered. As the tide fell they moved on to the outer mussel beds, which were the most important feeding areas, and remained there until these areas were once more covered about four hours after low tide (Figures 7.10.1-7.10.3). When Turnstone were present on the Blackpill site they fed and roosted in the stony areas between the groynes and on the old sea wall on area 20. Most Turnstone were observed on the Marina site just after high tide either feeding on one of the first mussel beds to be exposed (area 31) or on the rocky area at the base of the breakwater (area 45).

As with all waders the feeding distribution of Turnstone is closely associated with the distribution of its prey items. Two of the Turnstone prey items are *Littorina* and *Gammarus* which live on or under rocks, stones and seaweeds. The Turnstone distribution on Swansea Bay is therefore restricted to the distribution of these habitats.

8. OVERALL CONCLUSIONS

Numbers of only three species at Blackpill have been significantly correlated with national trends since 1969 - Oystercatcher, Dunlin and Sanderling. Even for these species, national trends do not explain all the changes at Blackpill and other factors must also play a part, especially for Sanderling for which only 18% of changes can be explained by national trends. Numbers of Dunlin and Oystercatcher at Blackpill had increased to stable levels by the mid or late 1970's respectively but have not followed the national index in recent years and Swansea Bay may have reached its carrying capacity for these species. The main reason that Blackpill is no longer a site of international importance for Sanderling is due to a change in the qualifying level and not to any dramatic decline in numbers.

Numbers of Curlew and Redshank at Blackpill have remained fairly stable over the years. However, the national index for species such as Curlew and Redshank which use inland fields in mild weather may vary more than the actual population. This is because the national index is based on one count in January which is strongly influenced by the weather.

Numbers of Knot at Blackpill have shown a steady decline over the years which is not true of the national trends. However, it is unlikely that any estuary would show a very high correlation with the national index of this species due to the substantial winter movements of Knot between estuaries (Stanley 1971) leading to great variation between counts (Warbrick et al 1991).

The reasons why local populations of Turnstone, Ringed Plover, Grey Plover and Bar-tailed Godwit do not follow national trends are less clear. The small populations of these species presently at Blackpill can be relatively more variable than are larger populations. These fluctuations in small populations may obscure long-term trends which are more likely to be clear at sites where the species occurs in larger numbers.

Since 1973, the only species that has consistently been of national importance at Blackpill has been Sanderling. The Sanderling population at Blackpill was at its highest in the early 1980's when it reached 3-5% of the national population estimate but now composes around 2% of the national population since reassessment of the national population estimate in 1985.

At certain times Blackpill has also been a nationally important site for Ringed Plover (1973-88), Grey Plover (1979-84) and Turnstone (1982-84) and internationally important for Sanderling (1974-1987).

Numbers of Ringed Plover and Sanderling at Blackpill ceased to be of international importance when the western European populations were reassessed and higher qualifying levels set. Ringed Plover numbers have remained stable at Blackpill and this species is only no longer of national importance due to improved estimates of the population levels in 1985 and hence a reassessment of the qualifying level.

Grey Plovers are no longer of national importance at Blackpill due to both the reassessment of the qualifying levels after the dramatic increase in the national population, and a decline in numbers at Blackpill.

Turnstone only qualified for national importance during three years prior to the reassessment, when the five year average included years when numbers were at their highest. The importance of Blackpill started to decline in 1988 when fewer of the peak years were included in the five year average. Since then lower numbers have been using the bay and the Turnstone which remained preferred another roost site not counted in the BoEE.

Figures 8.1 and 8.2 show the most important areas for all wader species combined, feeding and roosting. The highest number of birds hours were spent on the two roost sites at Blackpill and Neath, where large numbers of waders concentrated for three to four hours over high tide. On the falling tide birds would disperse from the roost sites to feed on other parts of the bay. The next most important areas were where birds were feeding. The majority of Sanderling, Ringed Plover, Dunlin and Grey Plover fed on the sandy outer shore south of the Blackpill roost and the eastern and western parts of the Crymlyn site. Oystercatcher, Curlew and Redshank fed on the above sandy areas as well as on the mussel beds at Mumbles and Marina, but Turnstone restricted themselves to the areas of rocks and mussel beds.

There was some interchange between the eastern and western parts of Swansea Bay at certain times of the tidal cycle, especially by some Oystercatcher, Curlew and Sanderling.

10. RECOMMENDATIONS FOR FURTHER WORK

1.At present only the peak winter counts are computerised for Blackpill. If all the counts carried at Blackpill since 1969 were computerised it would be possible to gain a much clearer picture of the average number of birds present at Blackpill. This would also be a valuable test case for BoEE studies in general. For example, a study of variability between counts and the influence of weather on the number of birds present would be valuable. On many BoEE sites it would be difficult to assess the effects of bad weather on the number of birds present, as the quality of the count is often itself affected by the poor conditions. However, as the roost site at Blackpill is very close to observation points it is not affected by this.

2.From the all day studies, a very clear picture of the movements of birds around Swansea Bay can be obtained without the need to dye-mark birds. Further counts would probably fill in any gaps left by only one winter survey as well as providing the opportunity to compare usage between years. Dye-marking birds would only be recommended if proposed developments made it important to assess the amount of interchange between Blackpill and Crymlyn.

3.This study has provided a clear baseline understanding of the use of Swansea Bay by waders, but more detailed studies would be desirable for any specific developments.

4.It is difficult to assess the necessity for more general work from this report, but in any management plan it would be essential to understand the human impacts on the whole estuarine food chain e.g. disturbance by walkers, dogs and windsurfers, beach cleaning, bait digging, changing ground water levels and salinity, and changes in sediment distribution due to barrage construction on the River Tawe.

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AREA NO.	SUBSTRATE DESCRIPTION	AREA NO.	SUBSTRATE DESCRIPTION
1	Rocks & algae	31	Rocks, seaweed & mussel beds
2	Rocks & algae	32	Rocks, seaweed & mussel beds
3	Sand	33	Rocks, seaweed & mussel beds
4	Sand	34	Sand
5	Sand	35	Sand
6	Sand	36	Sand
7	Rocks, seaweed & mussel beds	37	Rocks, seaweed & mussel beds
8	Rocks & seaweed	38	Sand
9	Sand & rocks	39	Sand
10	Rocks & seaweed	40	Sand
11	Rocks & seaweed	41	Rocks, seaweed & mussel beds
12	Sand	42	Sand
13	Rocks, seaweed & mussel beds	43	Rocks, seaweed & mussel beds
14	Rocks, seaweed & mussel beds	44	Sand
15	Rocks, seaweed & mussel beds	45	Rocks & seaweed
16	Rocks & seaweed	46	Sand & breakwater
17	Rocks & algae	47	Sand & breakwater
18	Sand	48	Sand
19	Sand	49	Sand
20	Sand & pebbles	50	Sand & small channel
21	Sand	51	Sand
22	Sand & *Spartina*	52	Sand & pools
23	Sand	53	Sand bank
24	Sand & river channels	54	Sand
25	Sand	55	Sand
26	Sand	56	Sand & small channel
27	Sand	57	Sand
28	Sand	58	Sand & pools
29	Sand	59	Sand
30	Sand	60	Sand

Table 6.1 Description of substrate types on each count area within the study sites.

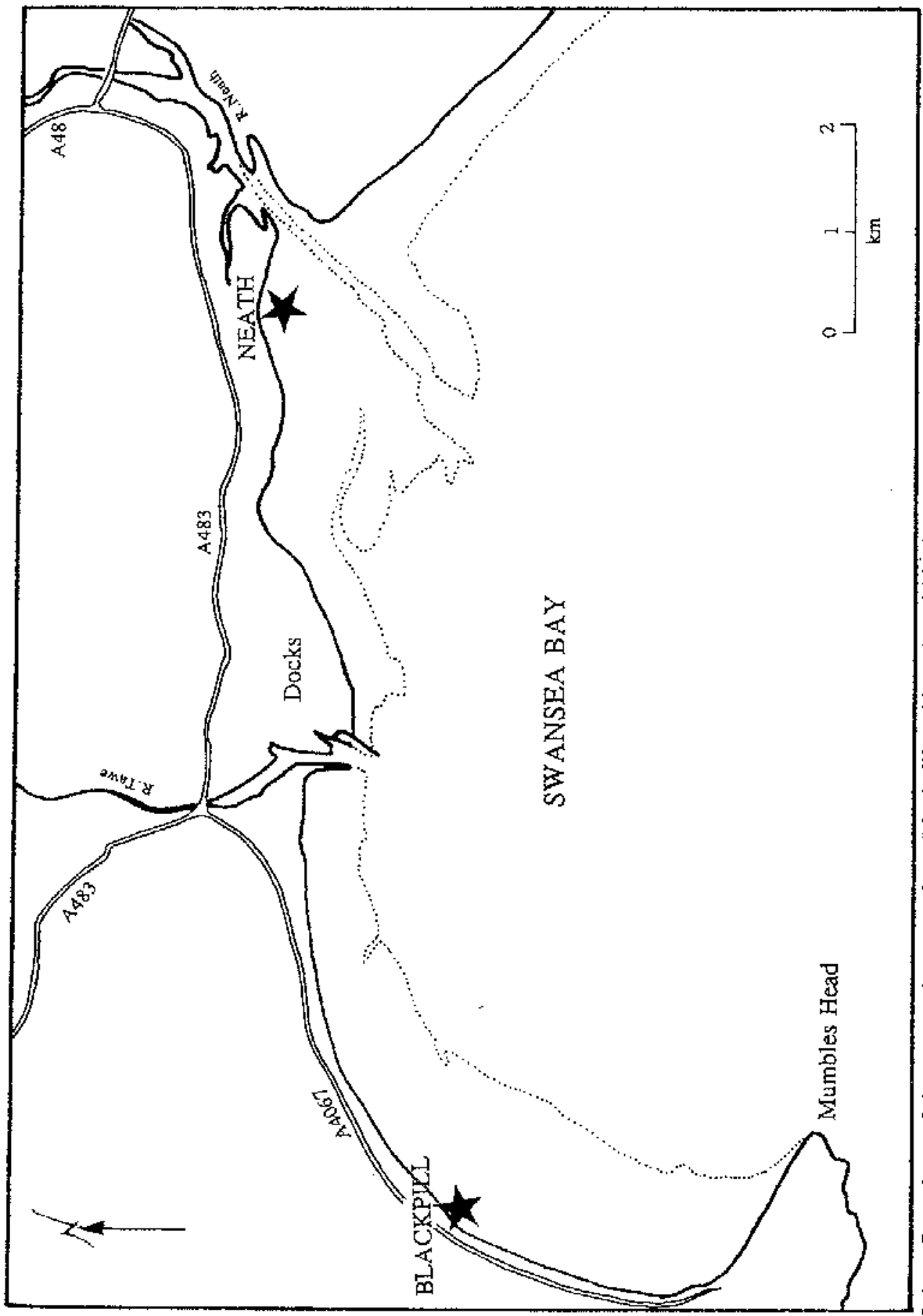


Figure 3.1 Locations of the two main roost sites (Blackpill and Neath) within Swansea Bay.

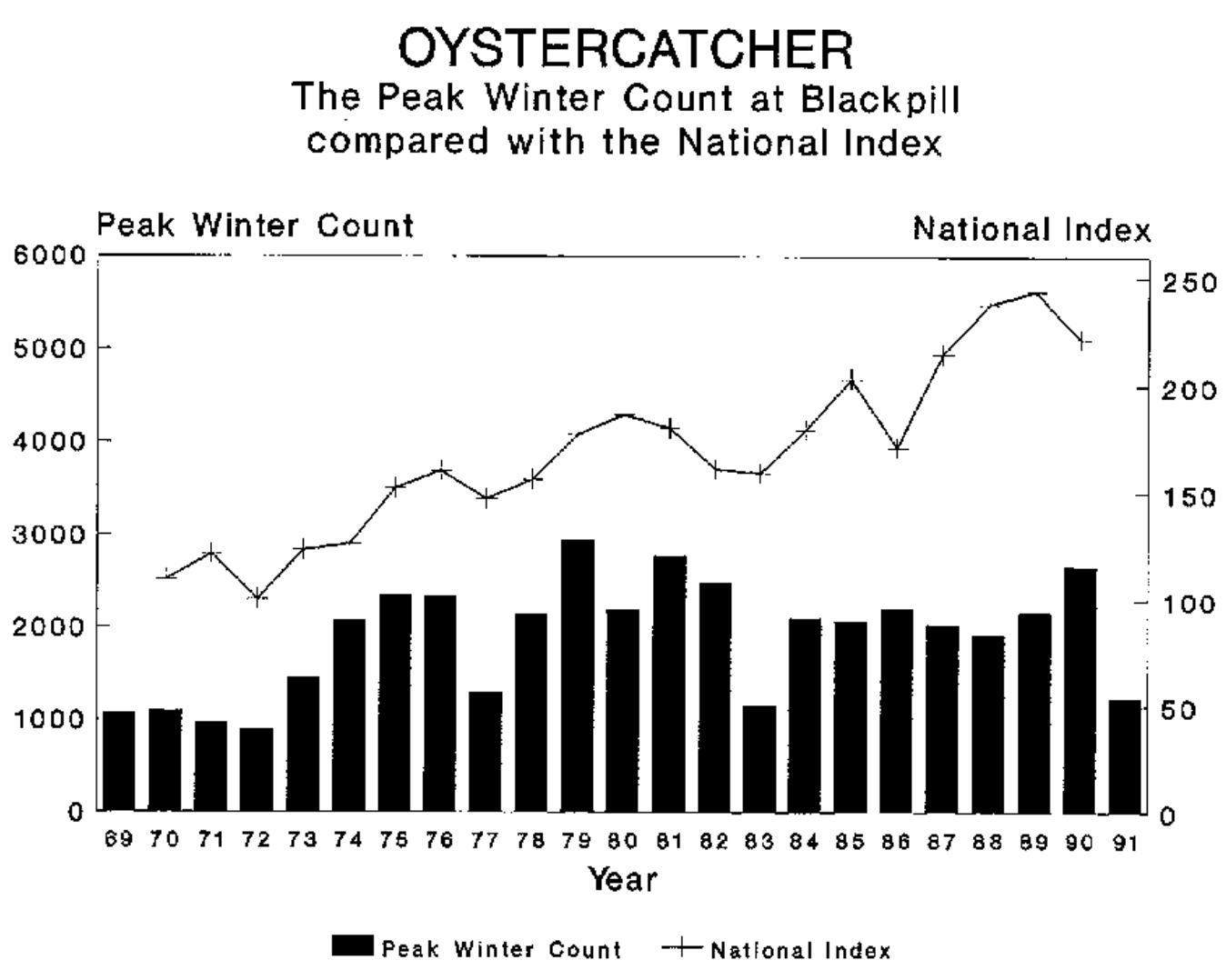


Figure 4.1.1 The Peak Winter Counts of Oystercatcher at Blackpill and the National Indices between 1969 and 1991.

OYSTERCATCHER

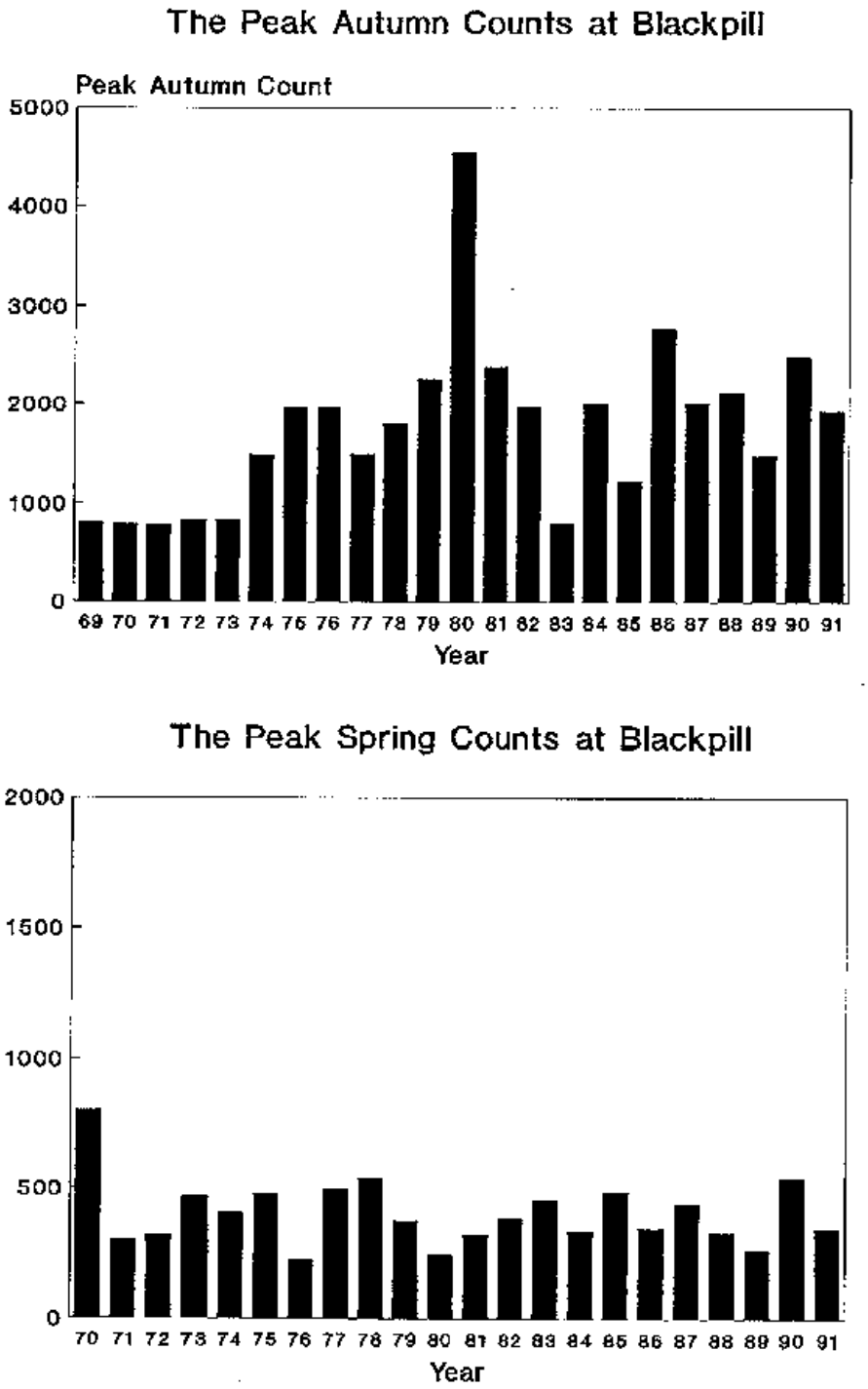


Figure 4.1.2 The Peak Autumn and Spring Counts of Oystercatcher at Blackpill between 1969 and 1991.

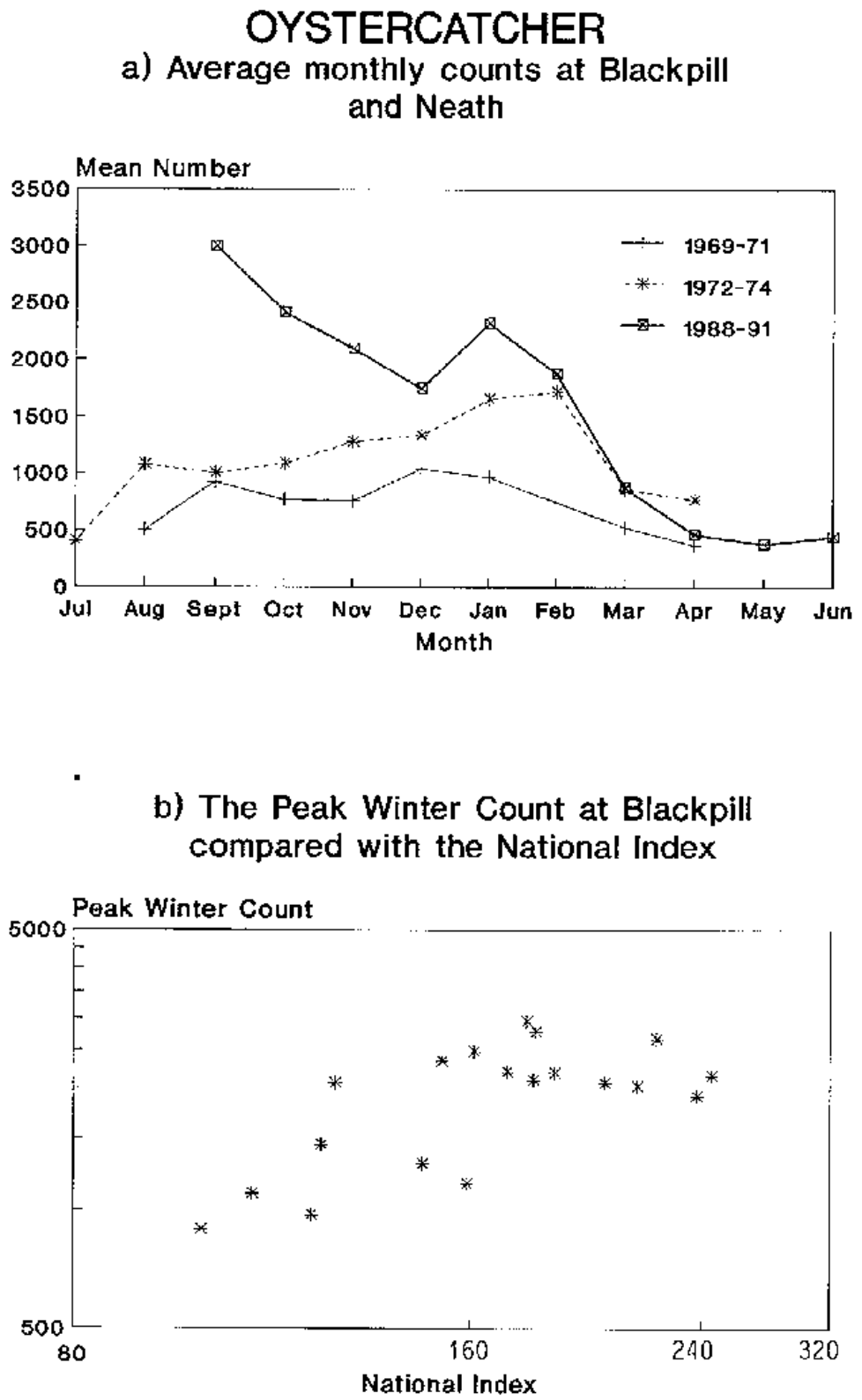


Figure 4.1.3 Variations in the occurrence of Oystercatcher in Swansea Bay in relation to a) season and b) the national index.

OYSTERCATCHER
The Importance of Blackpill

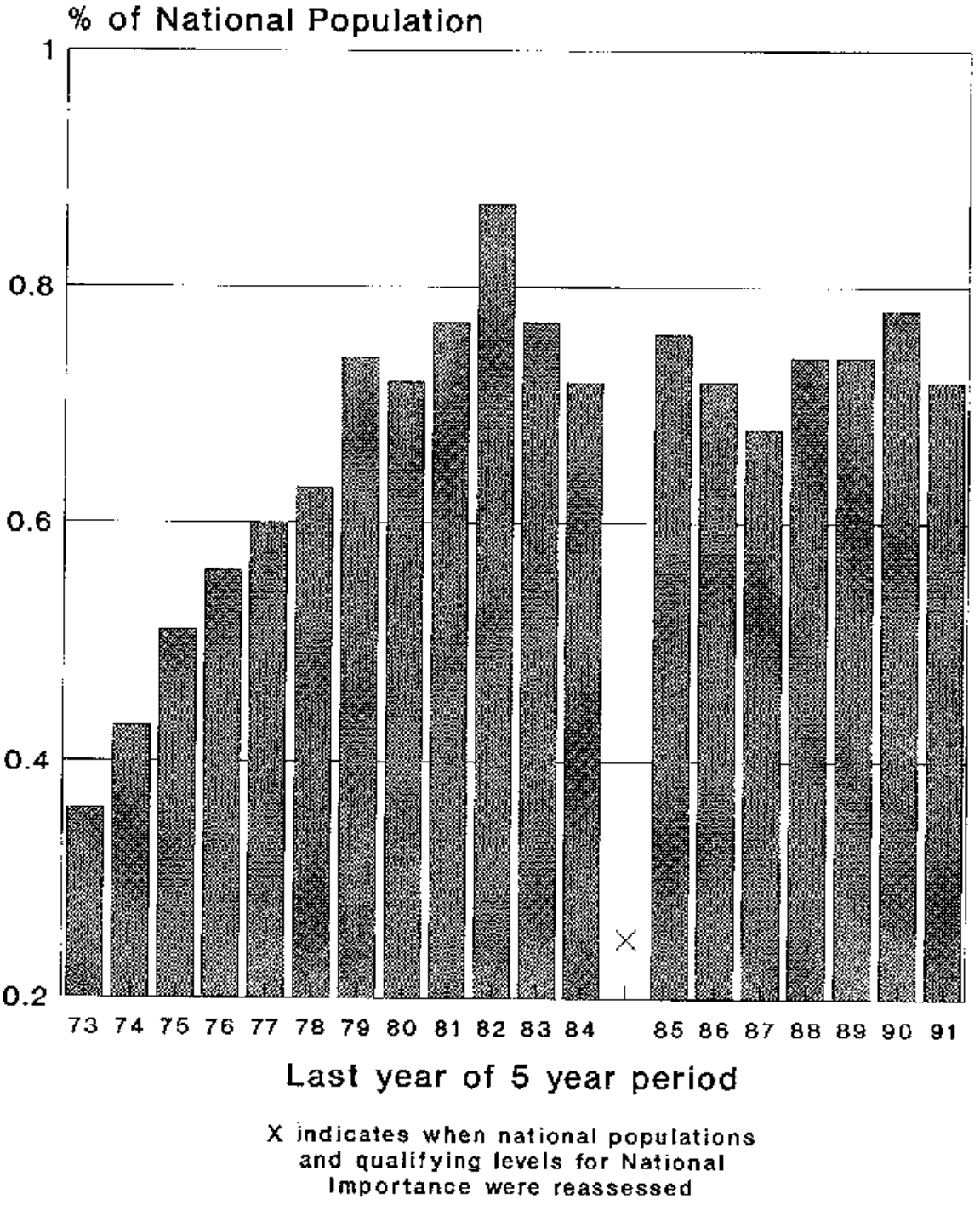


Figure 4.1.4 Variations in the National Importance of Blackpill for Oystercatcher between 1973 and 1991.

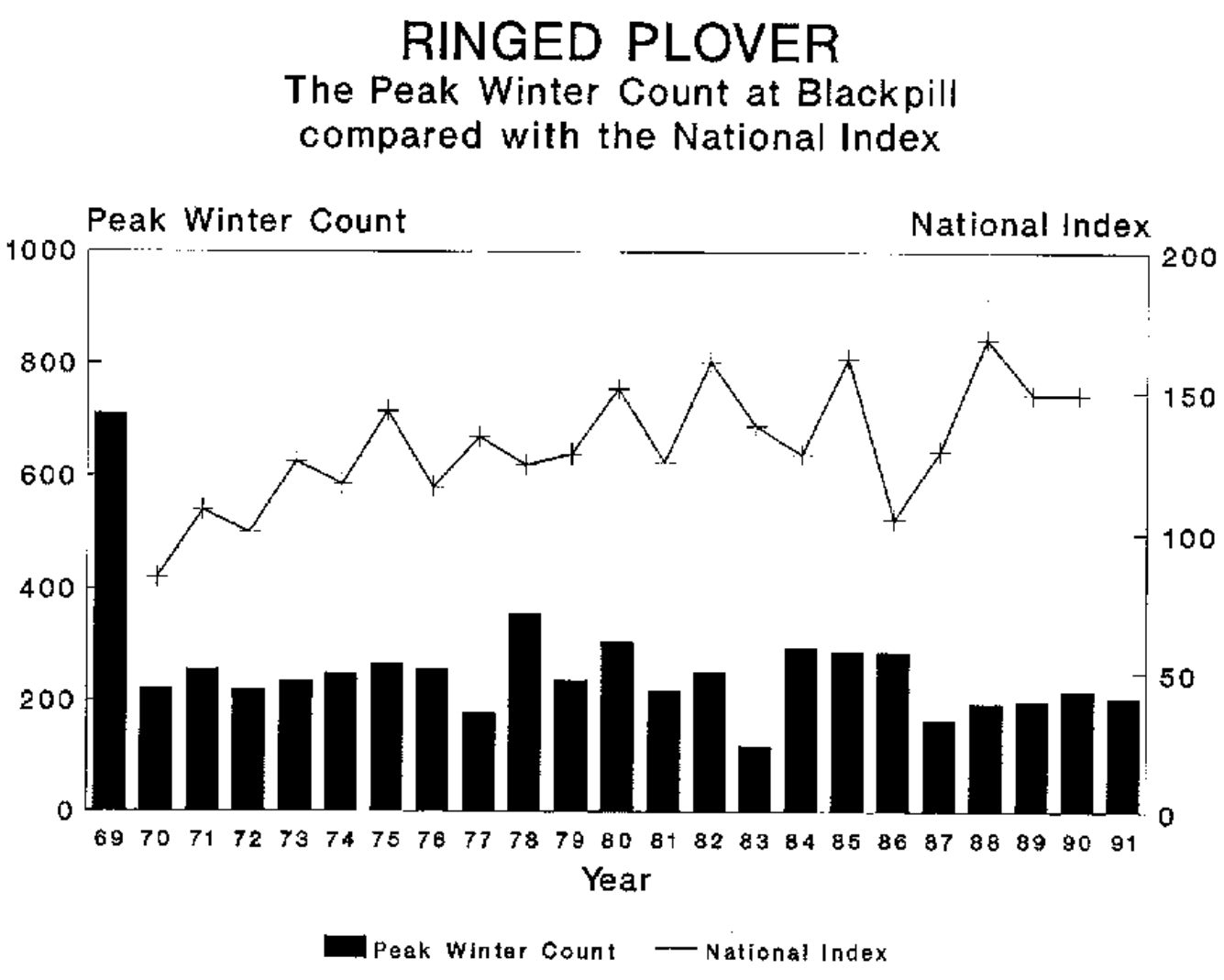


Figure 4.2.1 The Peak Winter Counts of Ringed Plover at Blackpill and the National Indices between 1969 and 1991.

RINGED PLOVER

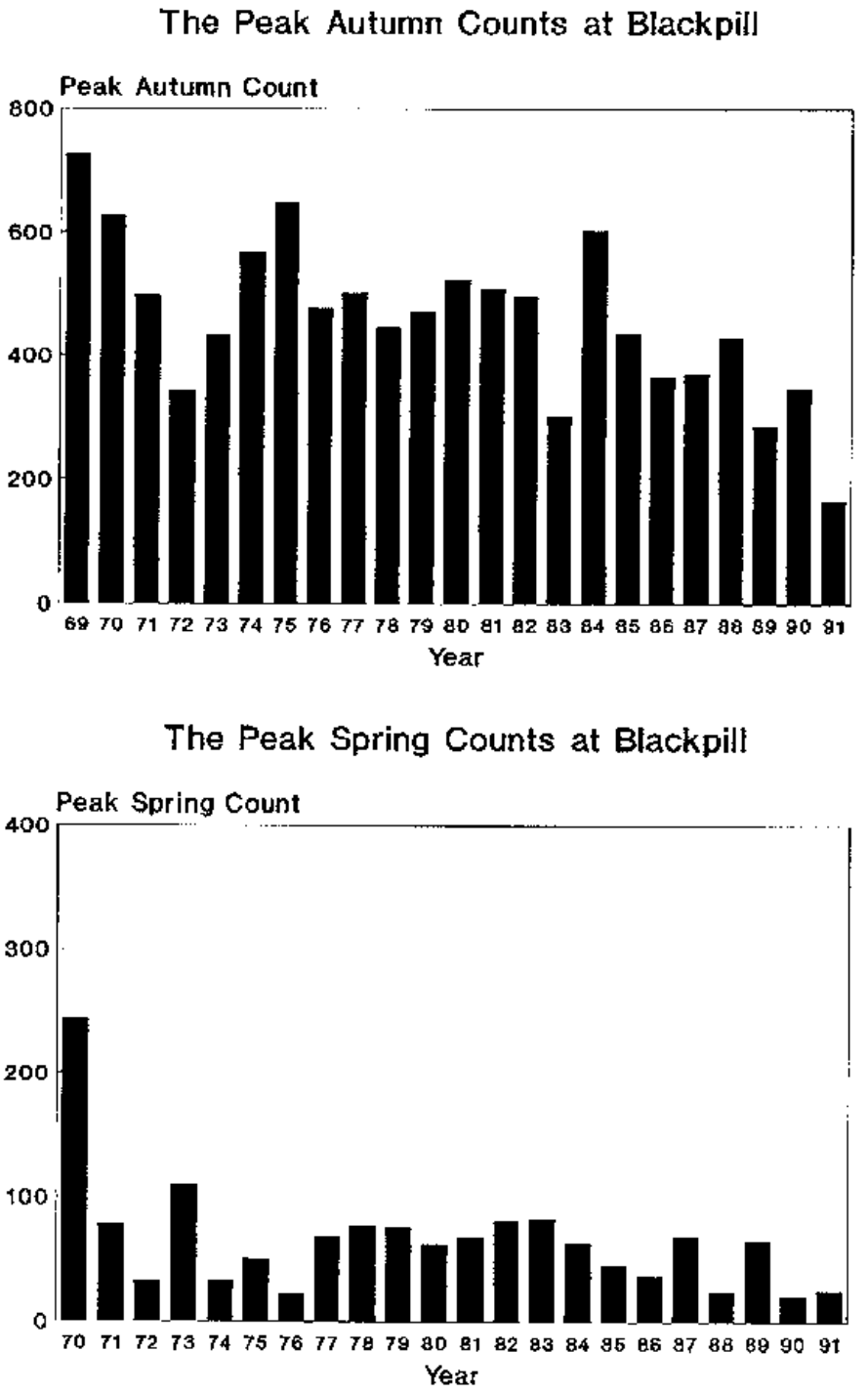


Figure 4.2.2 The Peak Autumn and Spring Counts of Ringed Plover at Blackpill between 1969 and 1991.

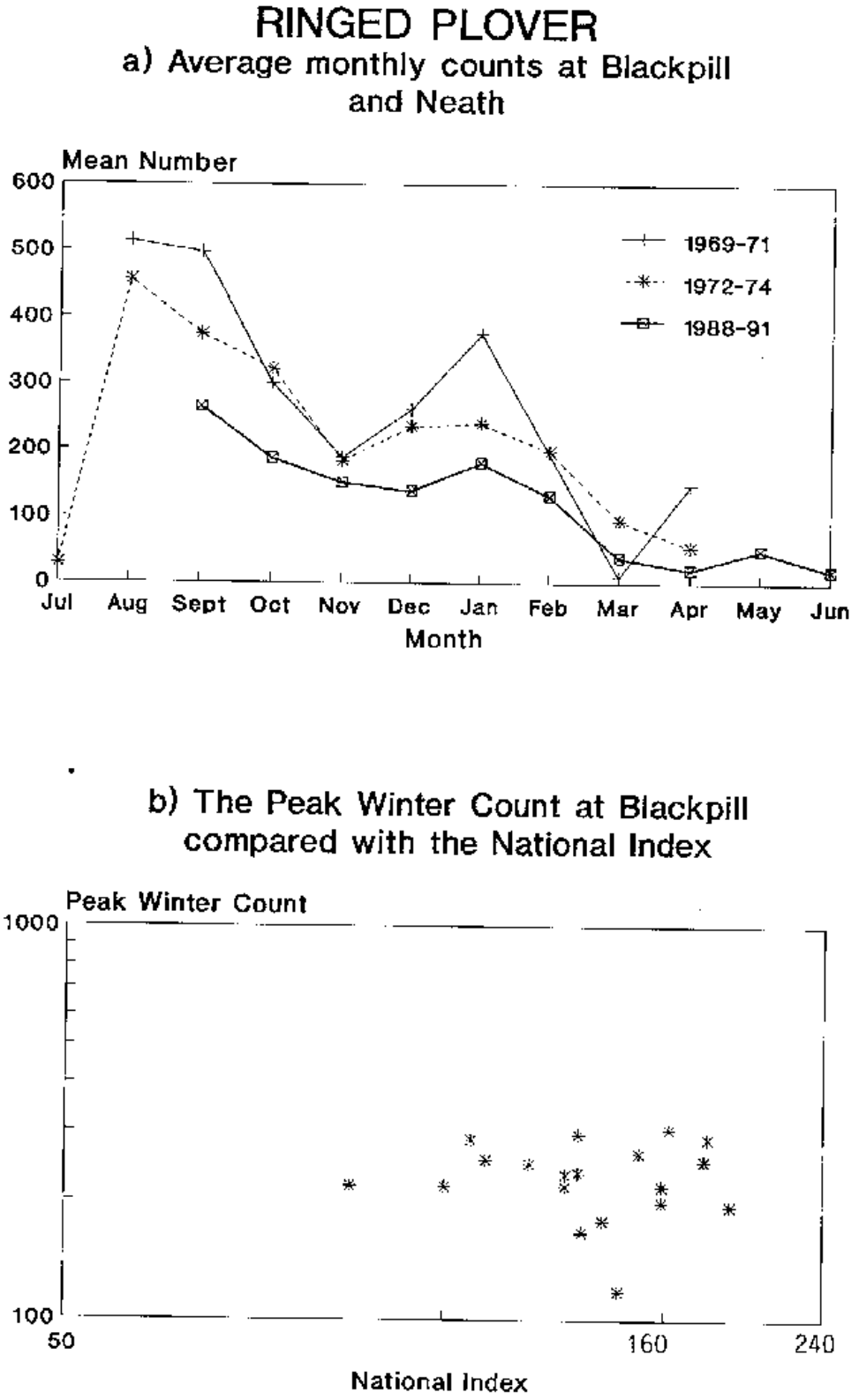


Figure 4.2.3 Variations in the occurrence of Ringed Plover in Swansea Bay in relation to a) season and b) the national index.

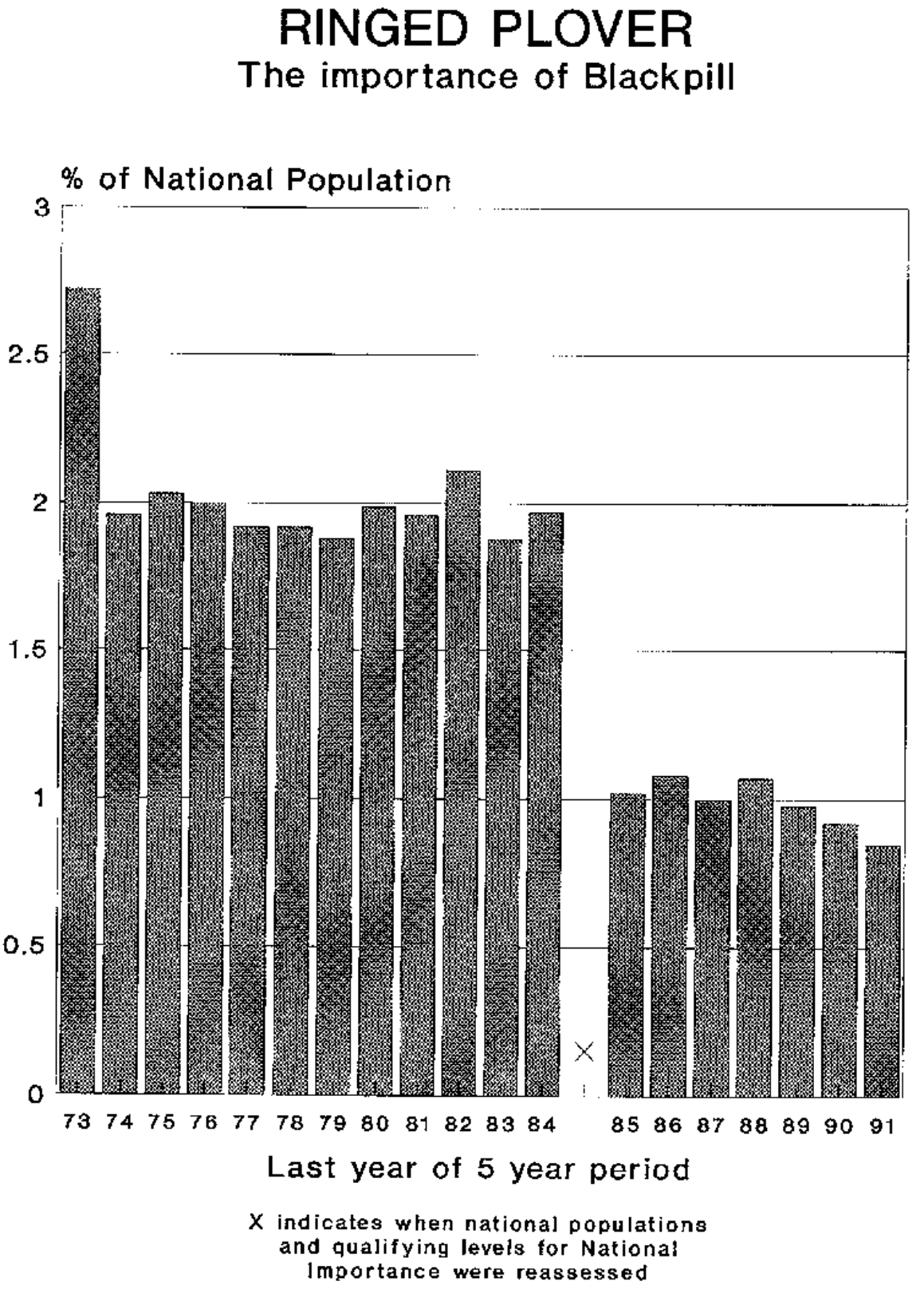


Figure 4.2.4 Variations in the National Importance of Blackpill for Ringed Plover between 1973 and 1991.

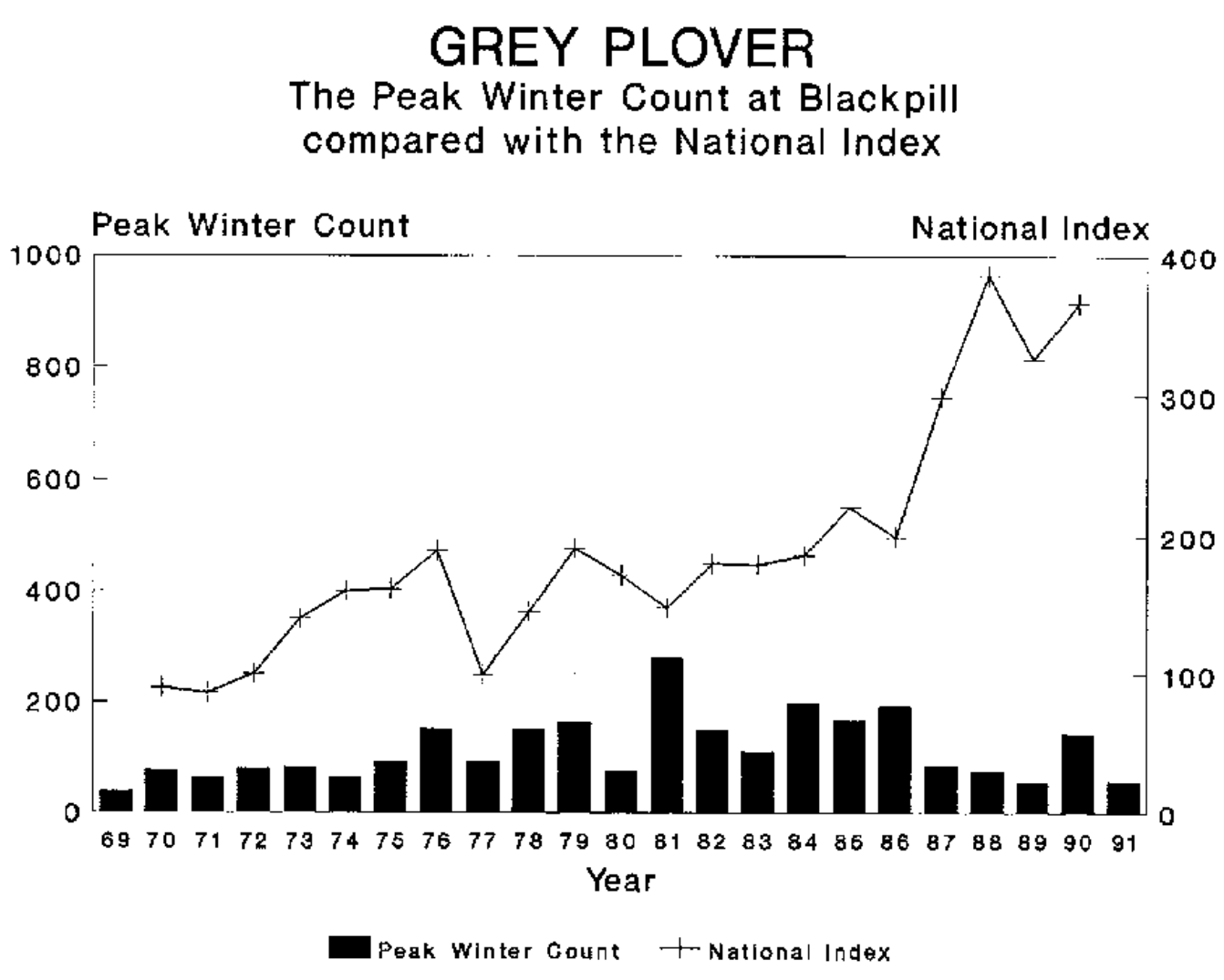


Figure 4.3.1 The Peak Winter Counts of Grey Plover at Blackpill and the National Indices between 1969 and 1991.

GREY PLOVER

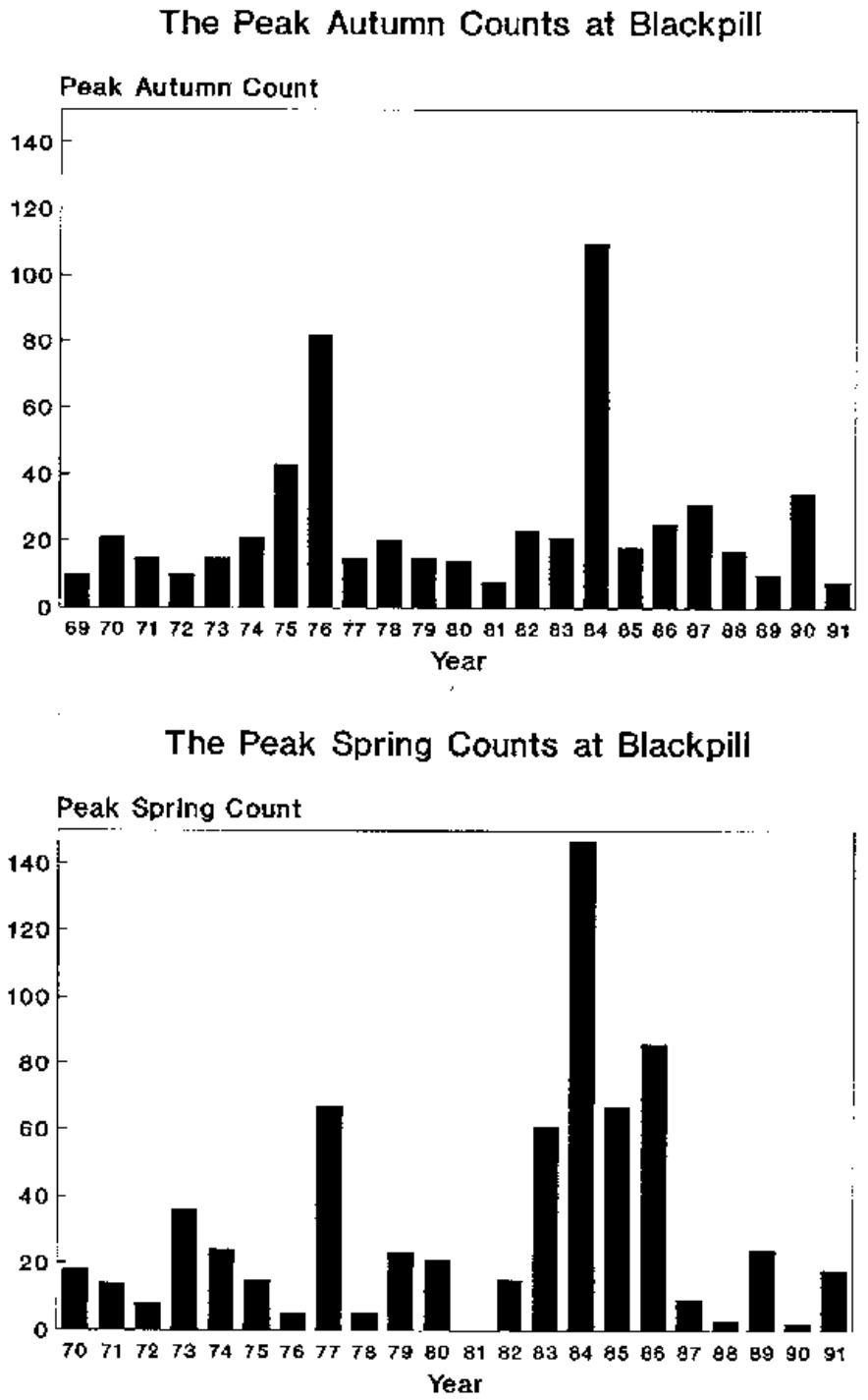


Figure 4.3.2 The Peak Autumn and Spring Counts of Grey Plover at Blackpill between 1969 and 1991.

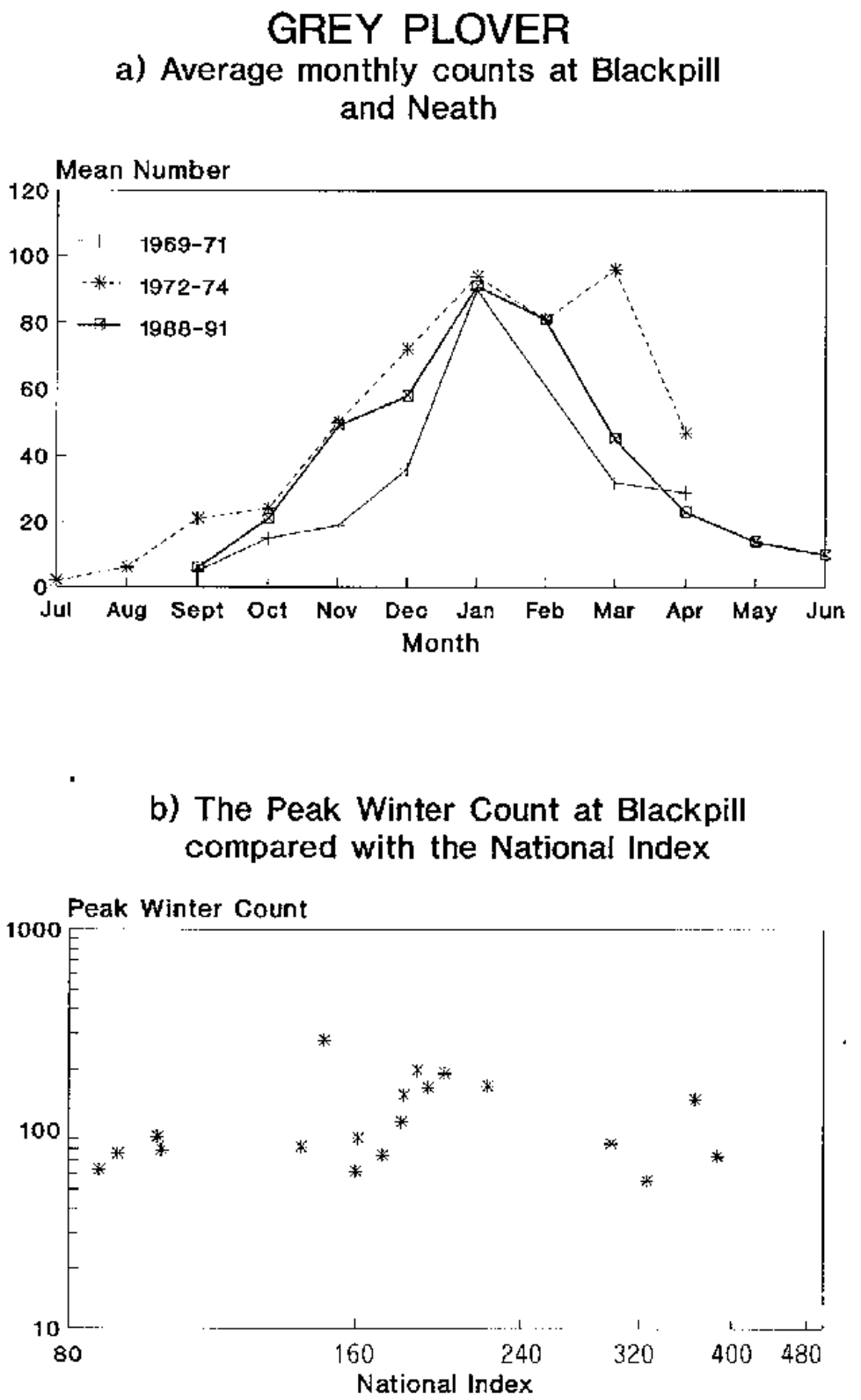


Figure 4.3.3 Variations in the occurrence of Grey Plover in Swansea Bay in relation to a) season and b) the national index.

GREY PLOVER
The importance of Blackpill

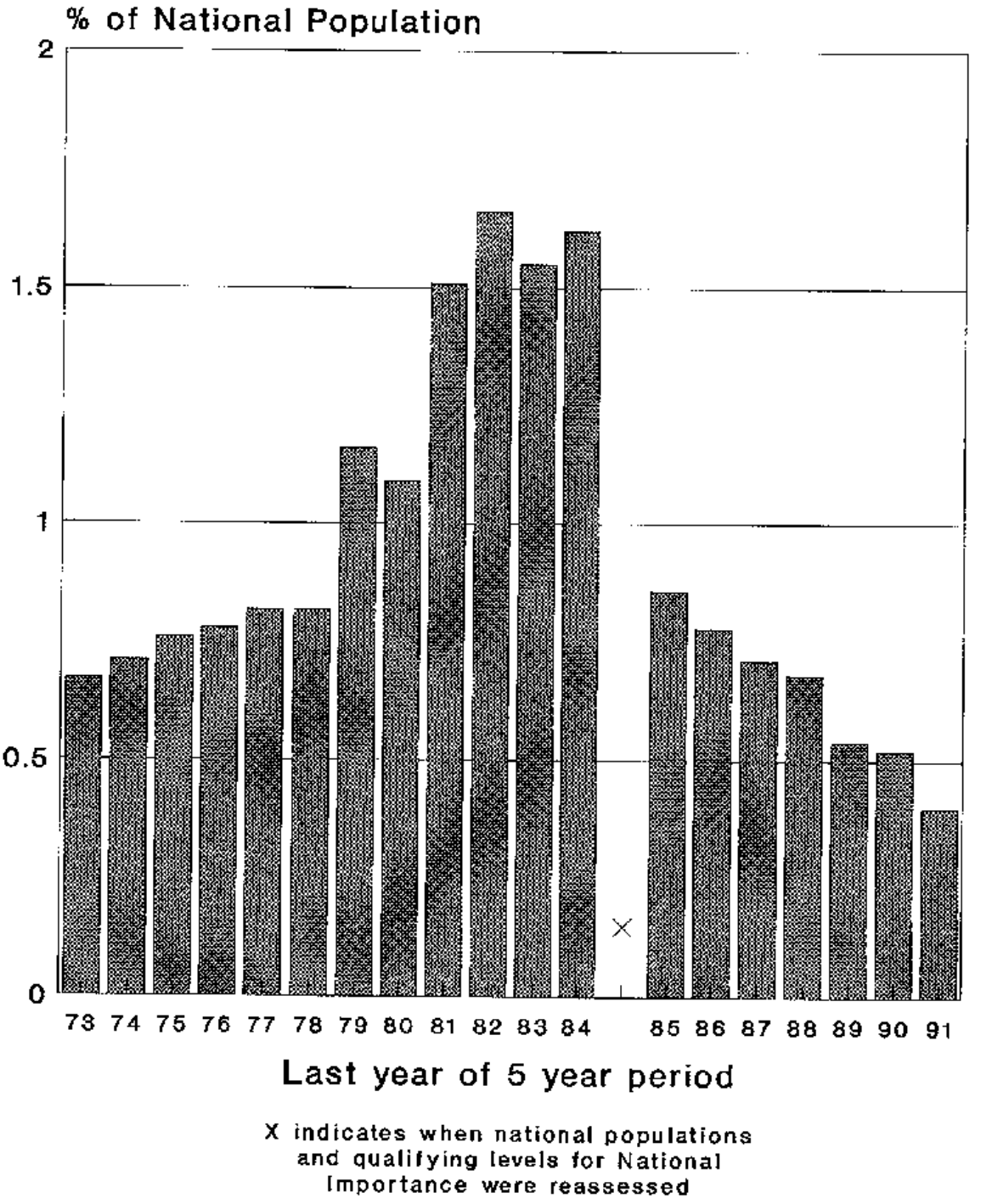


Figure 4.3.4 Variations in the National Importance of Blackpill for Grey Plover between 1973 and 1991.

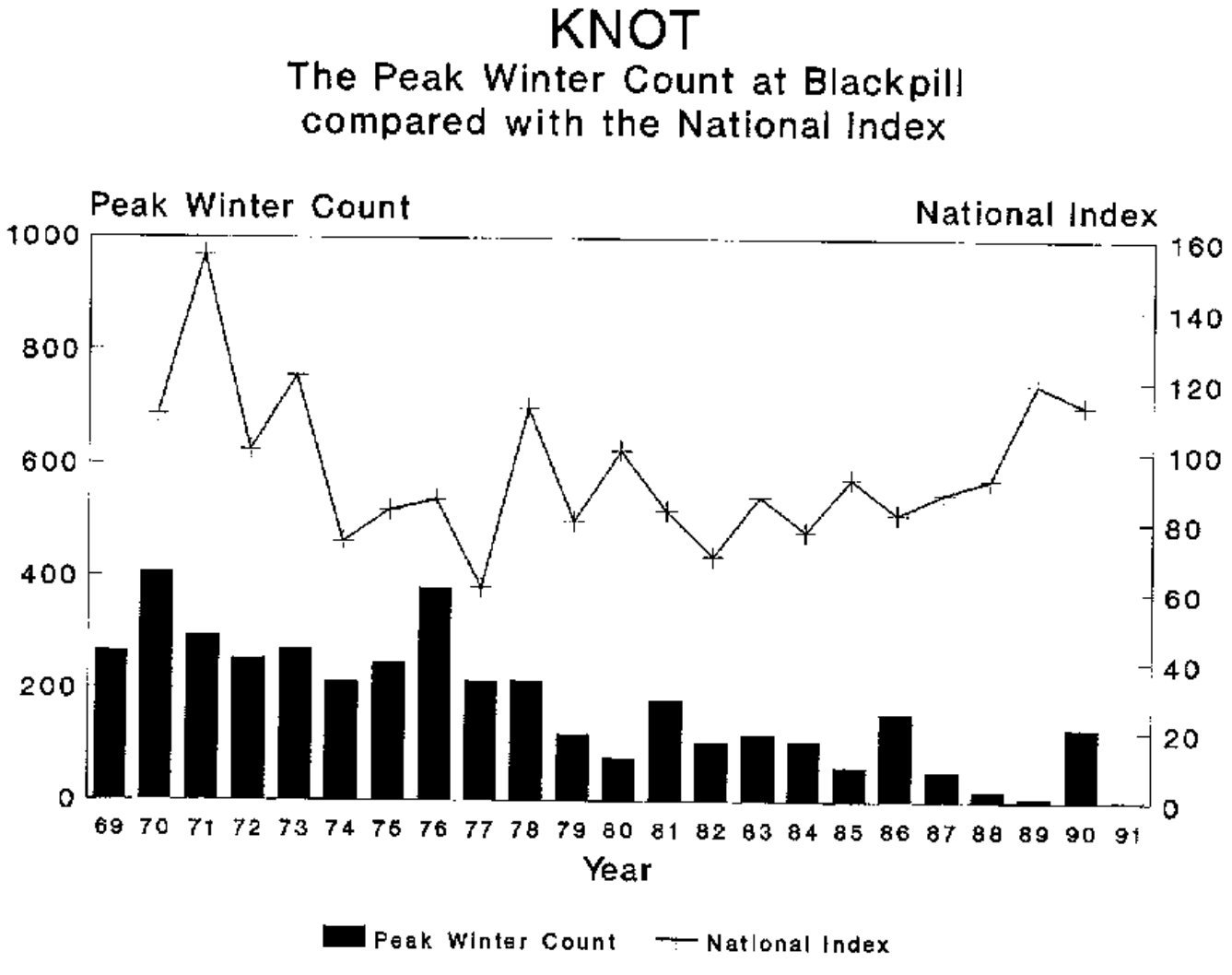


Figure 4.4.1 The Peak Winter Counts of Knot at Blackpill and the National Indices between 1969 and 1991.

KNOT

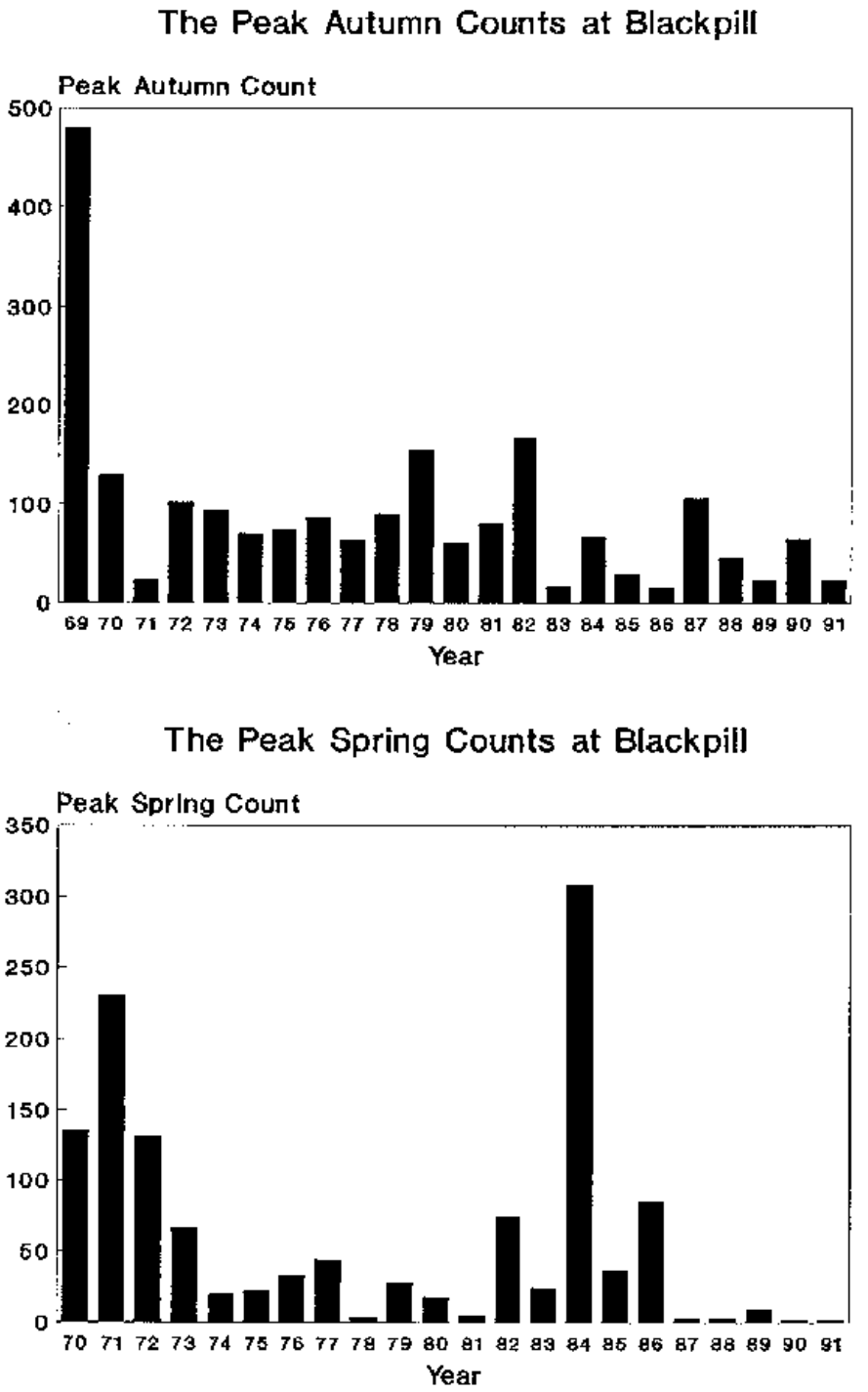


Figure 4.4.2 The Peak Autumn and Spring Counts of Knot at Blackpill between 1969 and 1991.

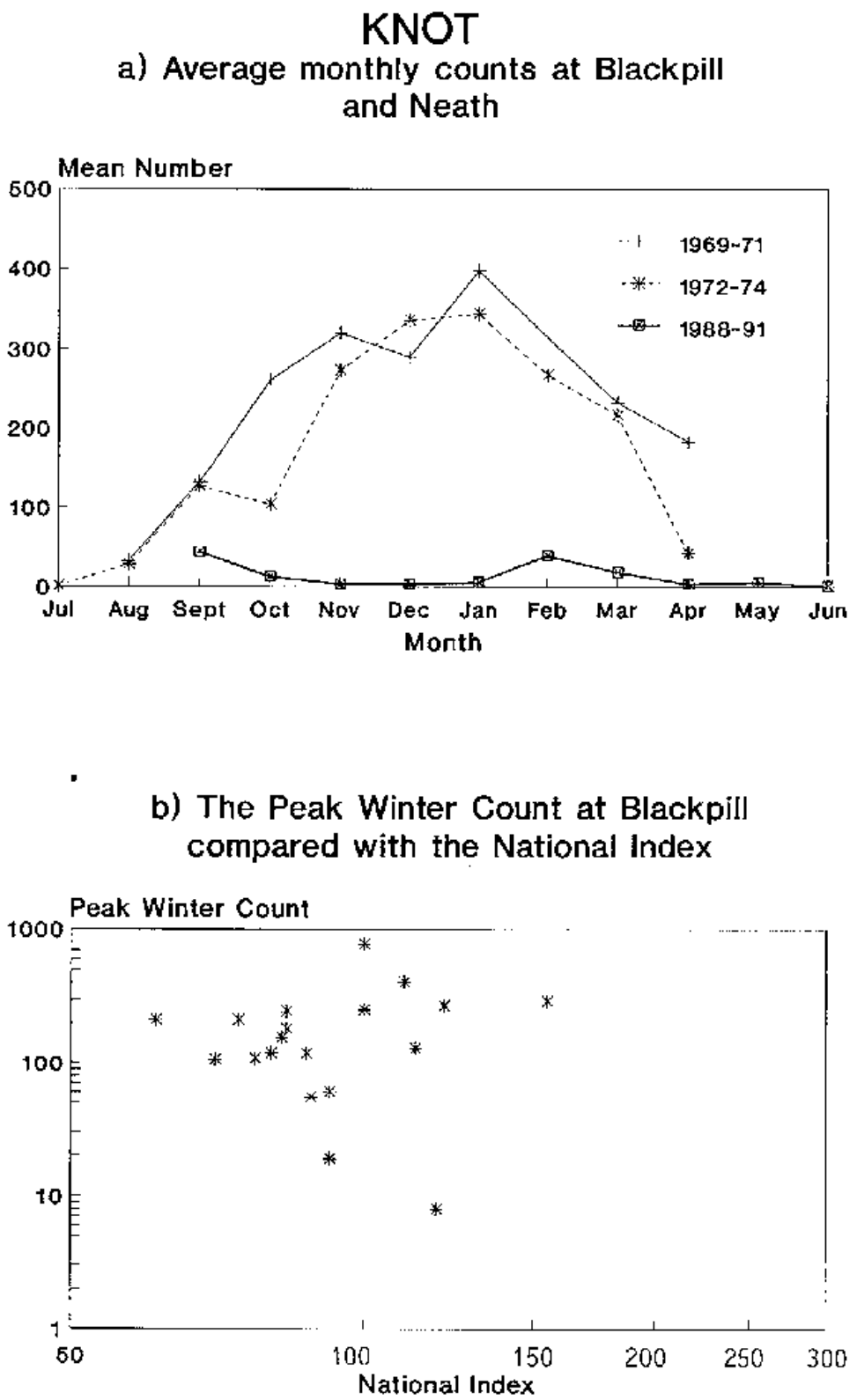


Figure 4.4.3 Variations in the occurrence of Knot in Swansea Bay in relation to a) season and b) the national index.

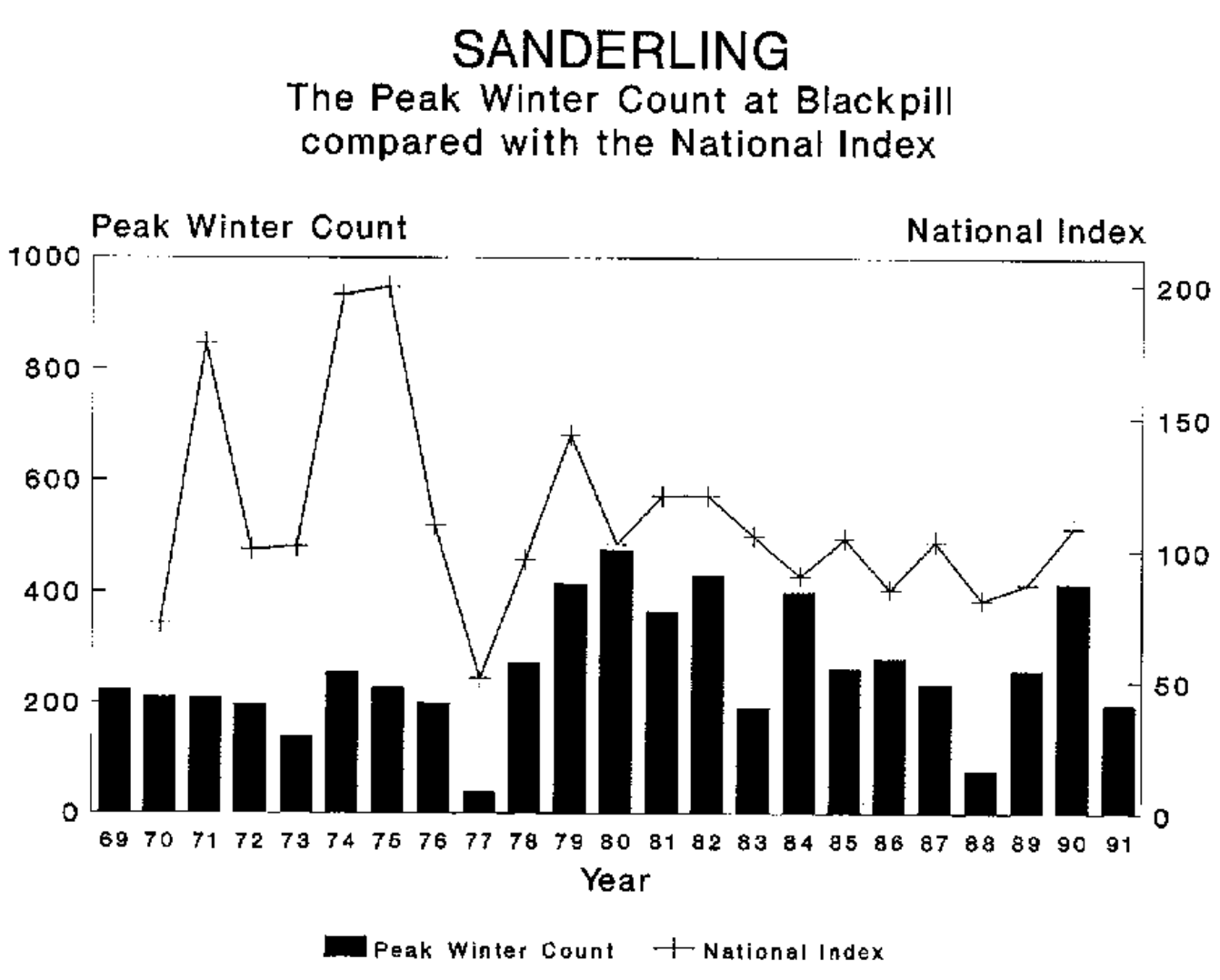
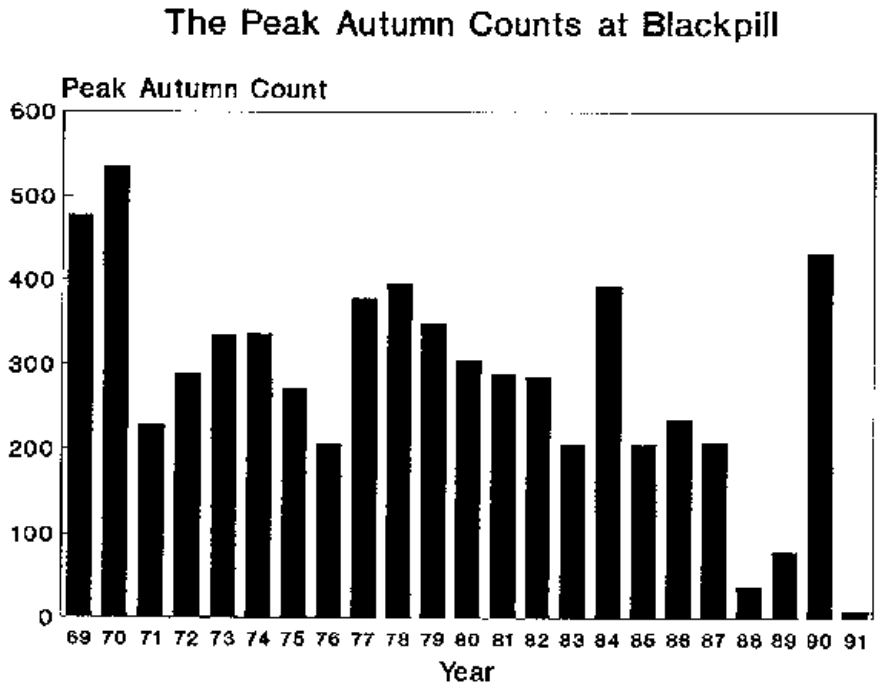


Figure 4.5.1 The Peak Winter Counts of Sanderling at Blackpill and the National Indices between 1969 and 1991.

SANDERLING



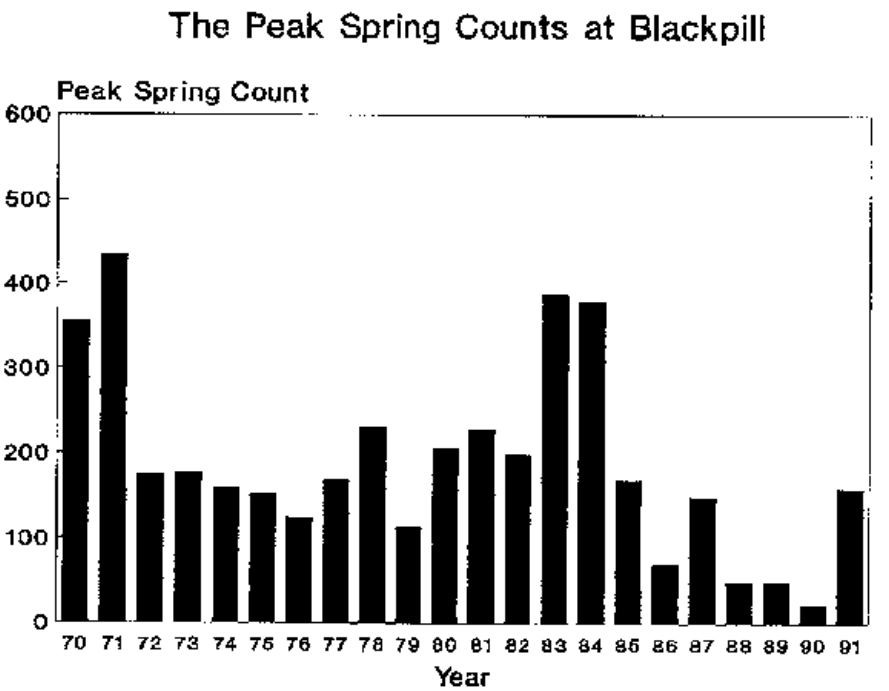


Figure 4.5.2 The Peak Autumn and Spring Counts of Sanderling at Blackpill between 1969 and 1991.

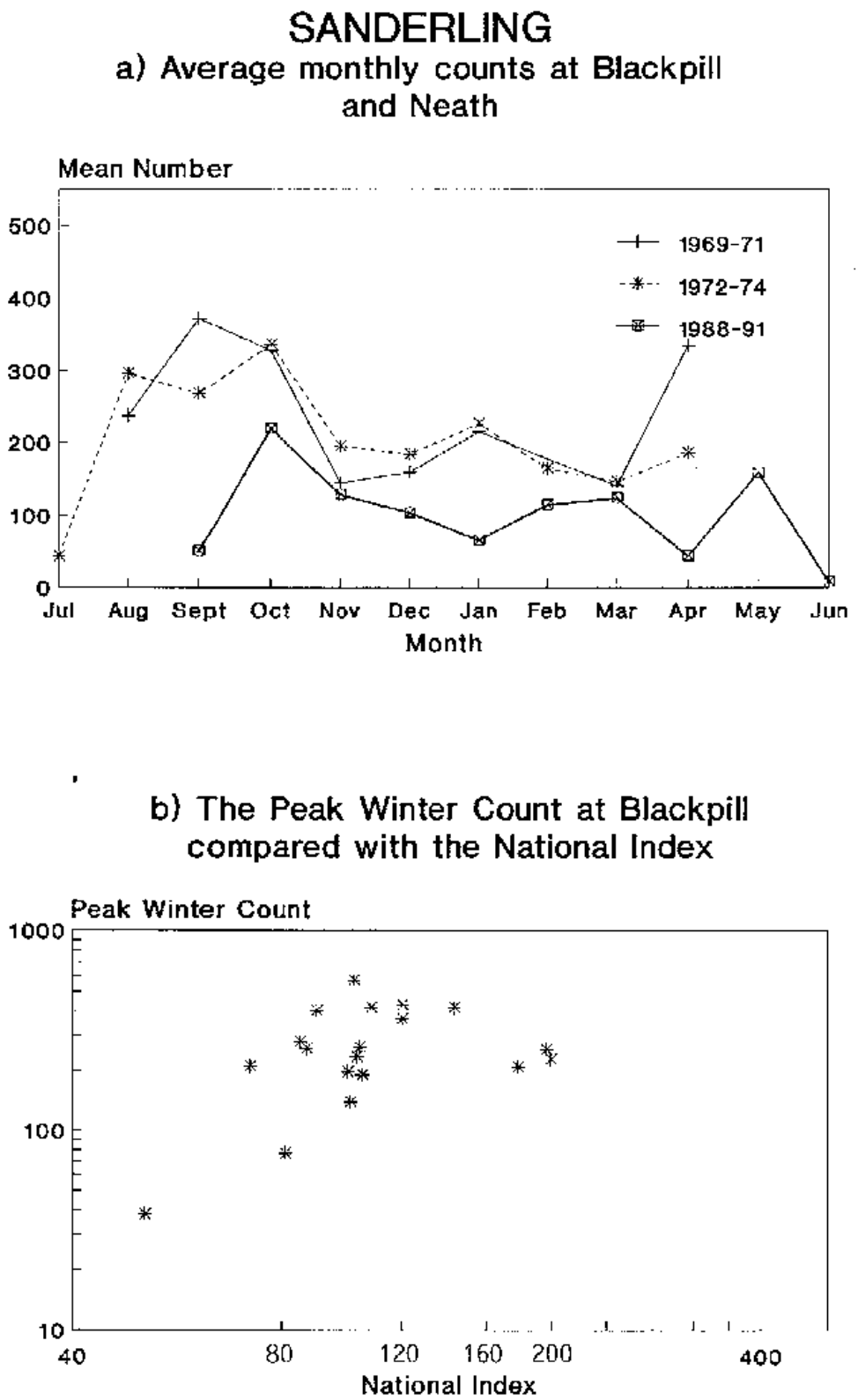


Figure 4.5.3 Variations in the occurrence of Sanderling in Swansea Bay in relation to a) season and b) the national index.

SANDERLING
The importance of Blackpill

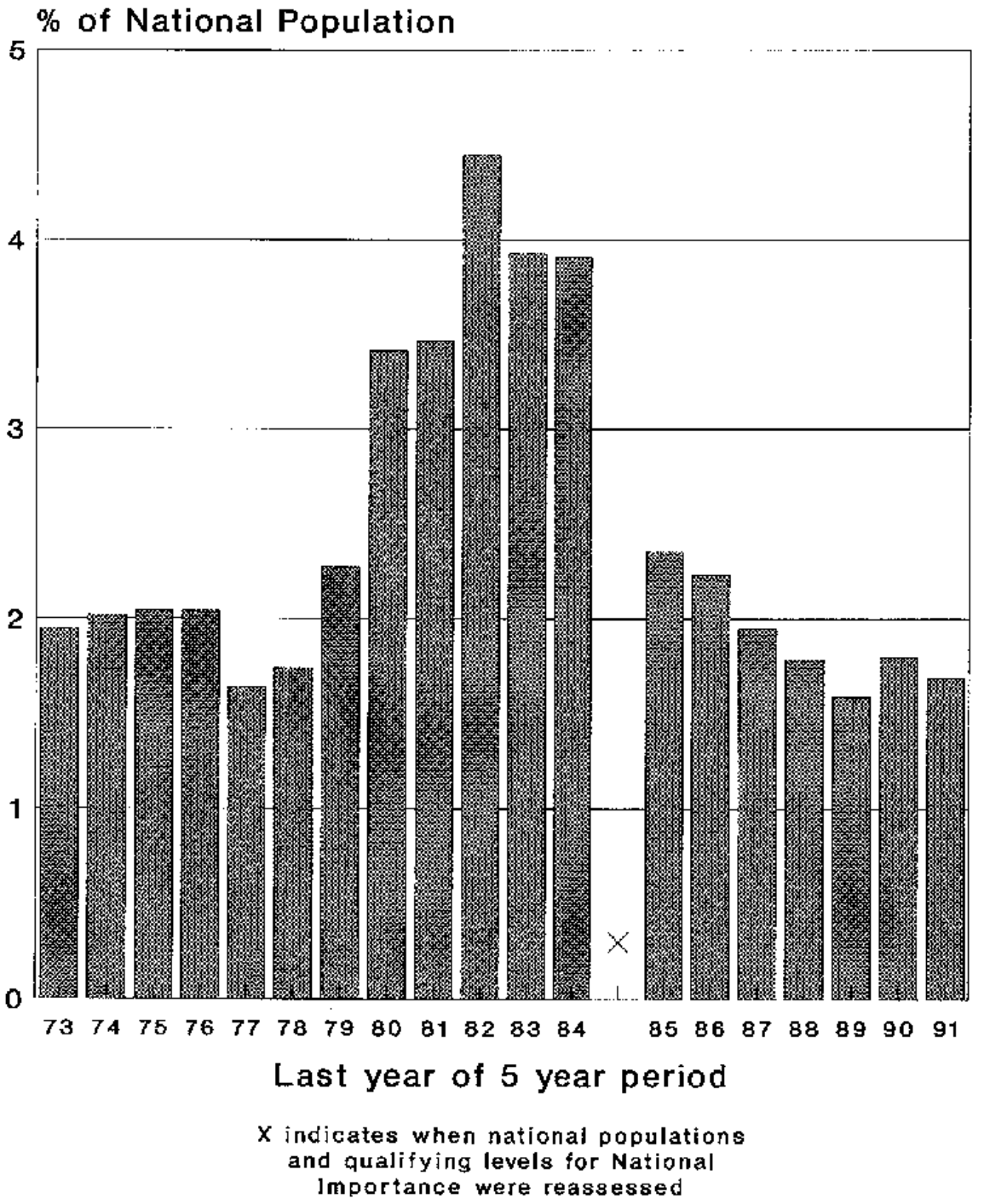


Figure 4.5.4 Variations in the National Importance of Blackpill for Sanderling between 1973 and 1991.

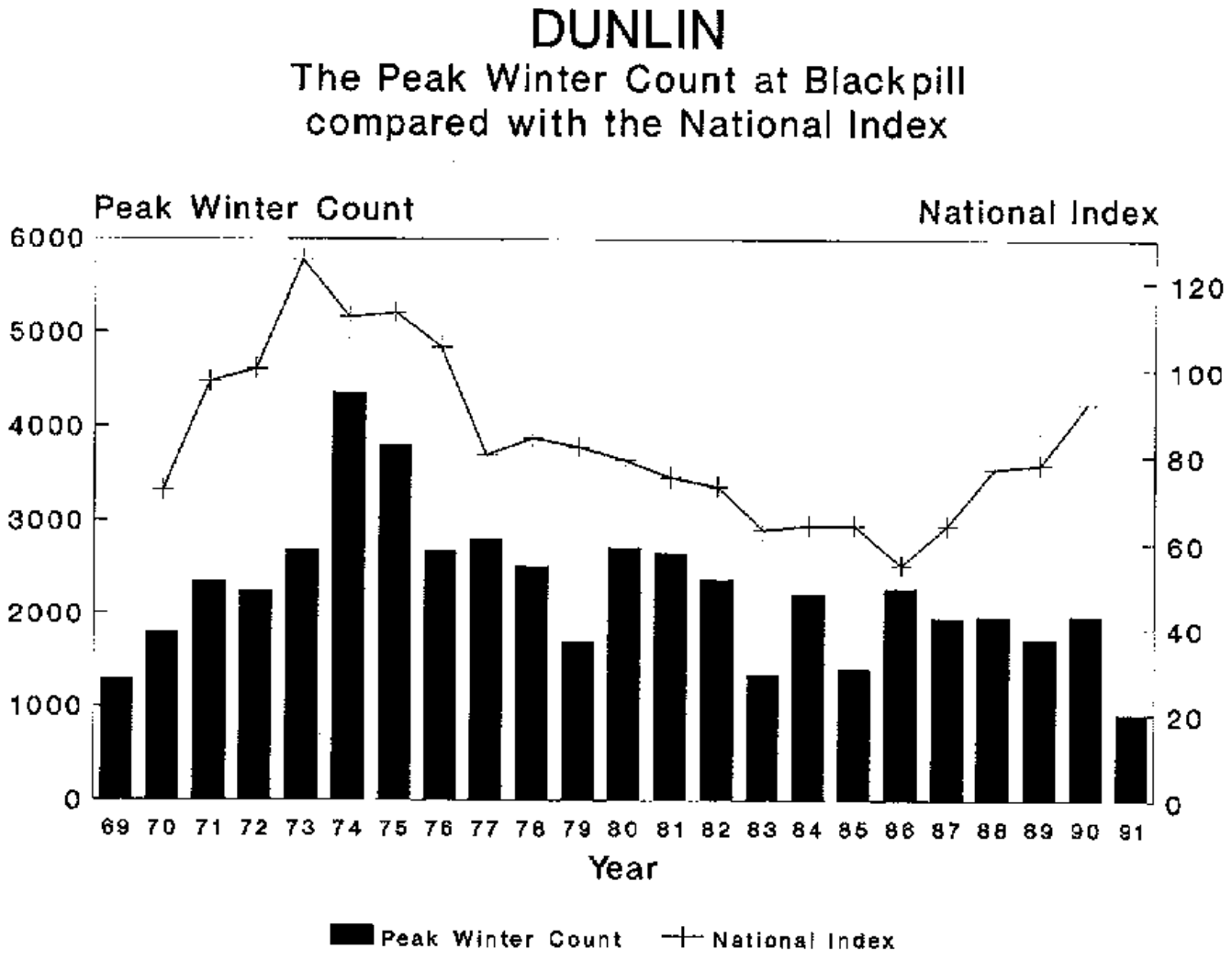
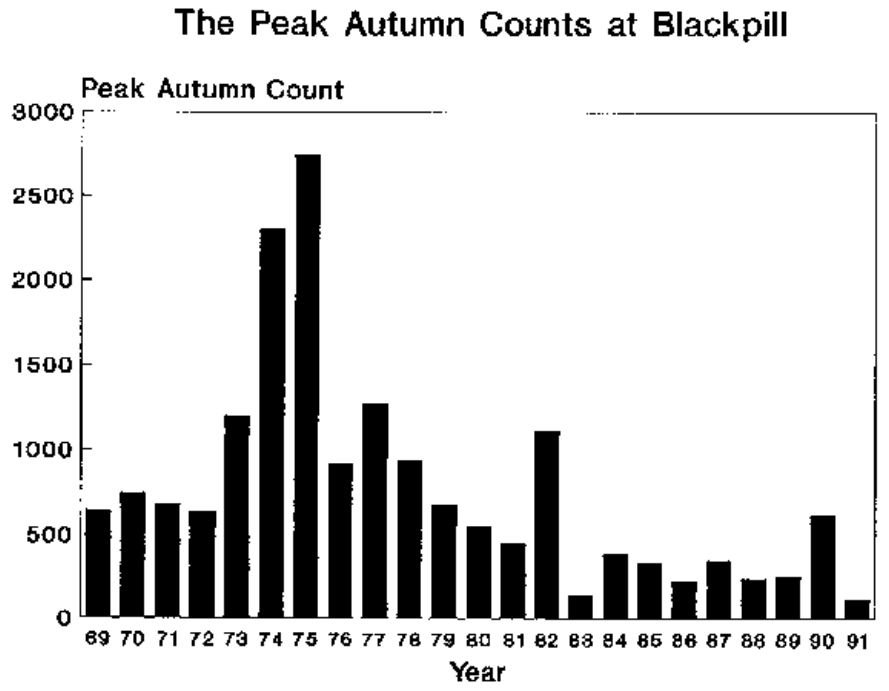


Figure 4.6.1 The Peak Winter Counts of Dunlin at Blackpill and the National Indices between 1969 and 1991.

DUNLIN



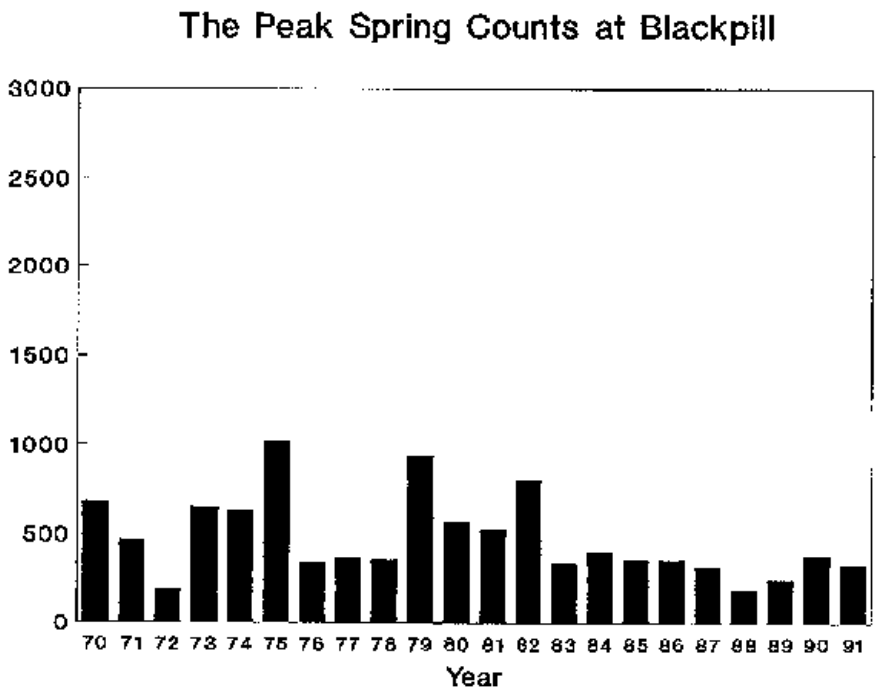


Figure 4.6.2 The Peak Autumn and Spring Counts of Dunlin at Blackpill between 1969 and 1991.

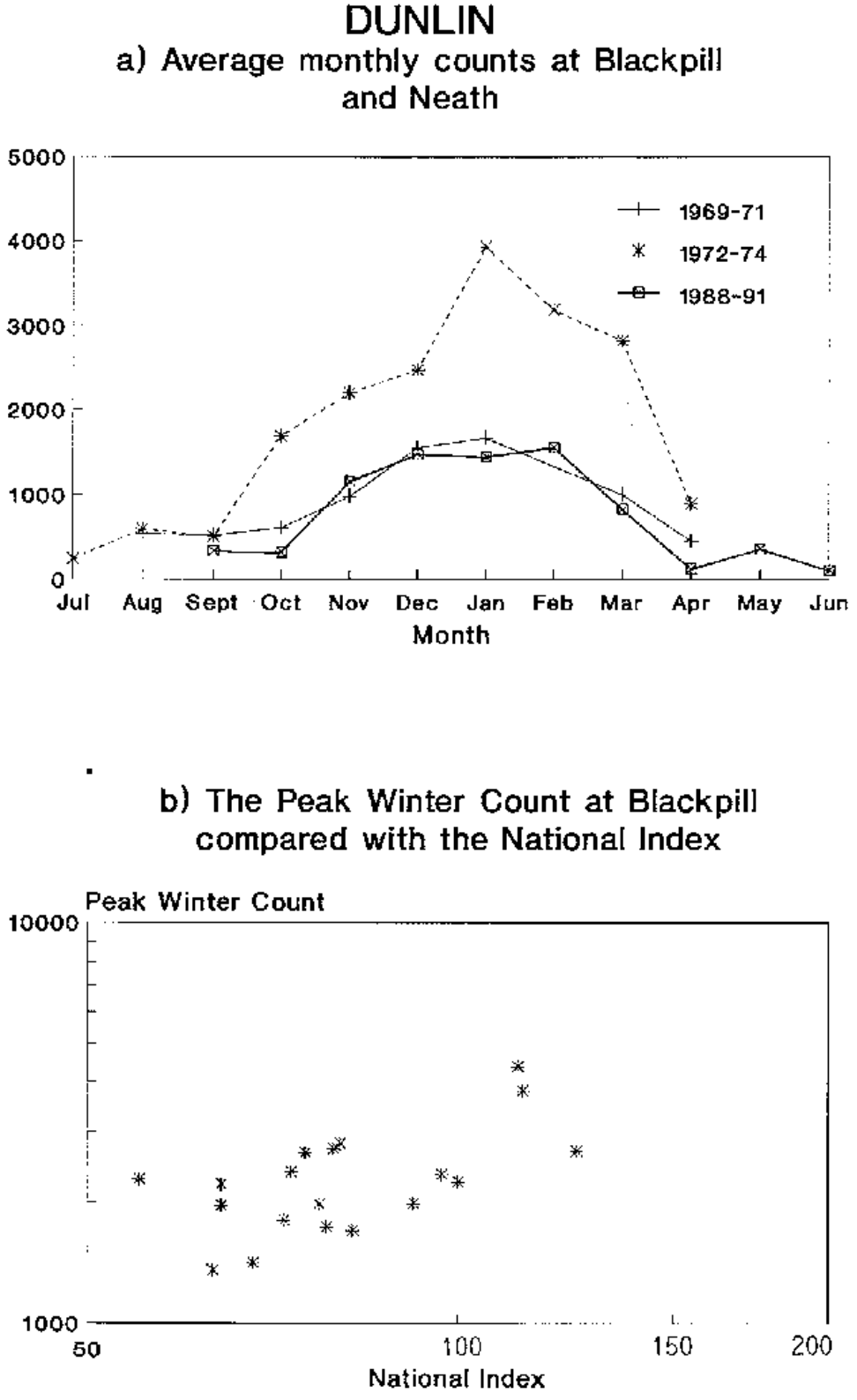


Figure 4.6.3 Variations in the occurrence of Dunlin in Swansea Bay in relation to a) season and b) the national index.

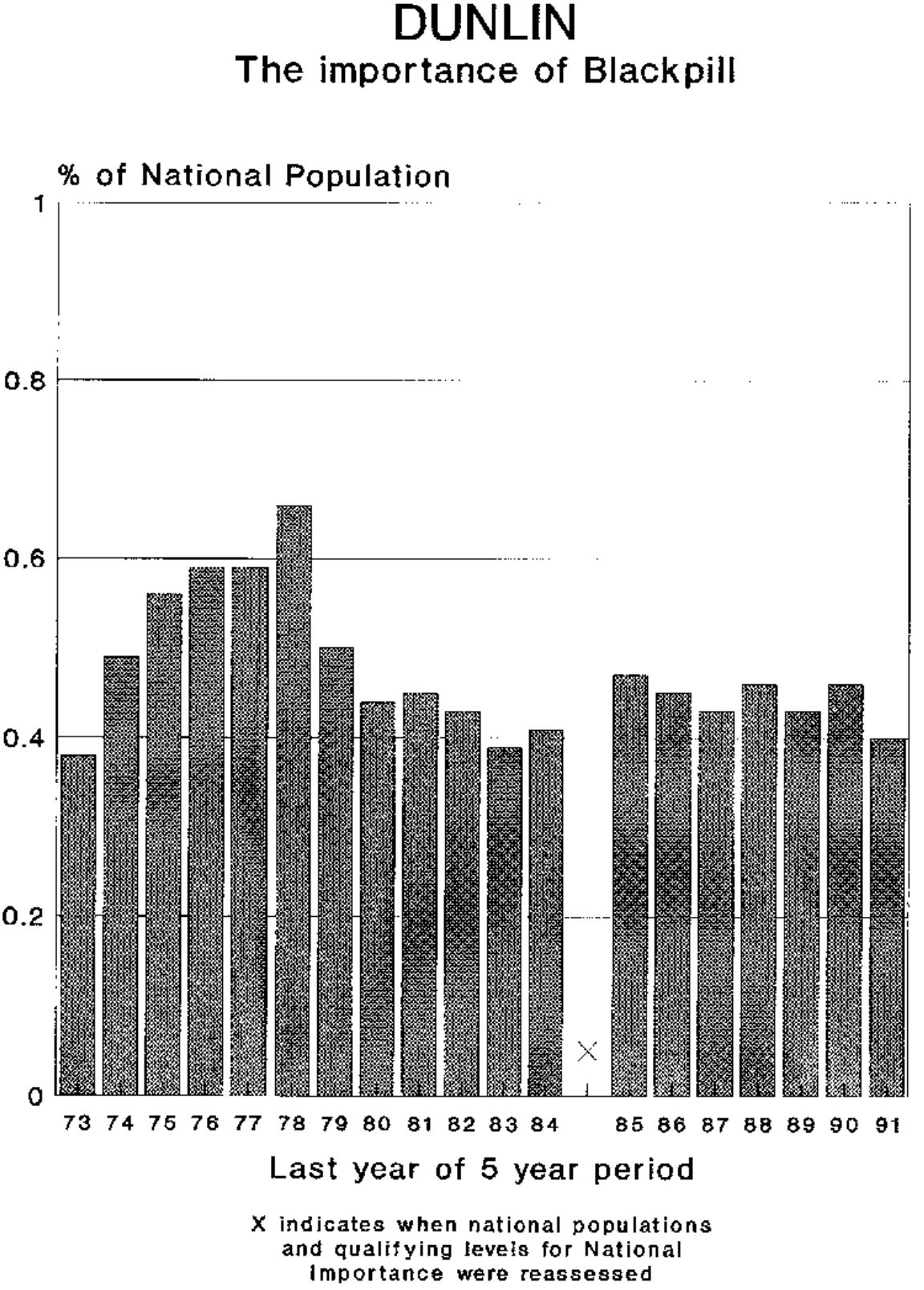


Figure 4.6.4 Variations in the National Importance of Blackpill for Dunlin between 1973 and 1991.

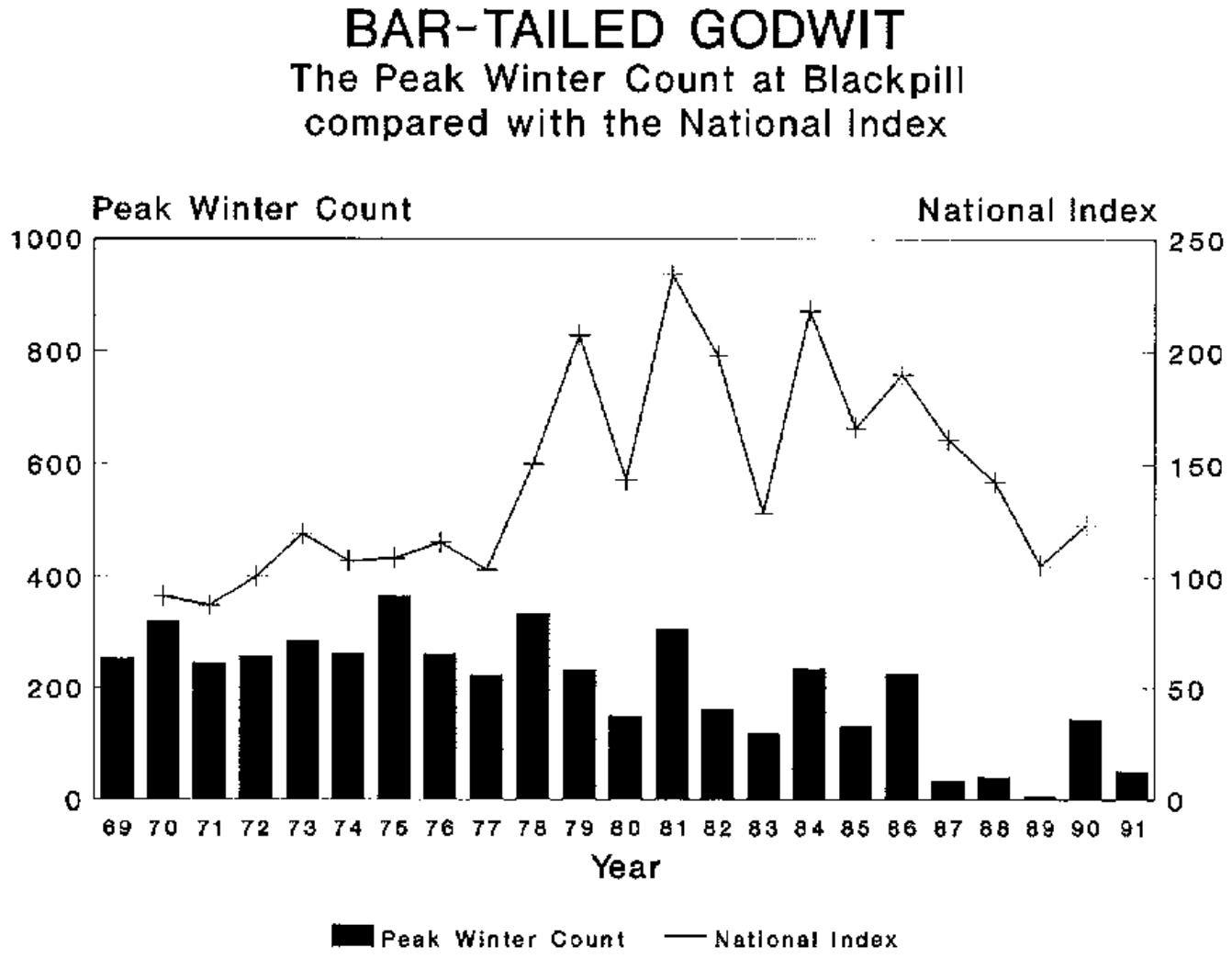
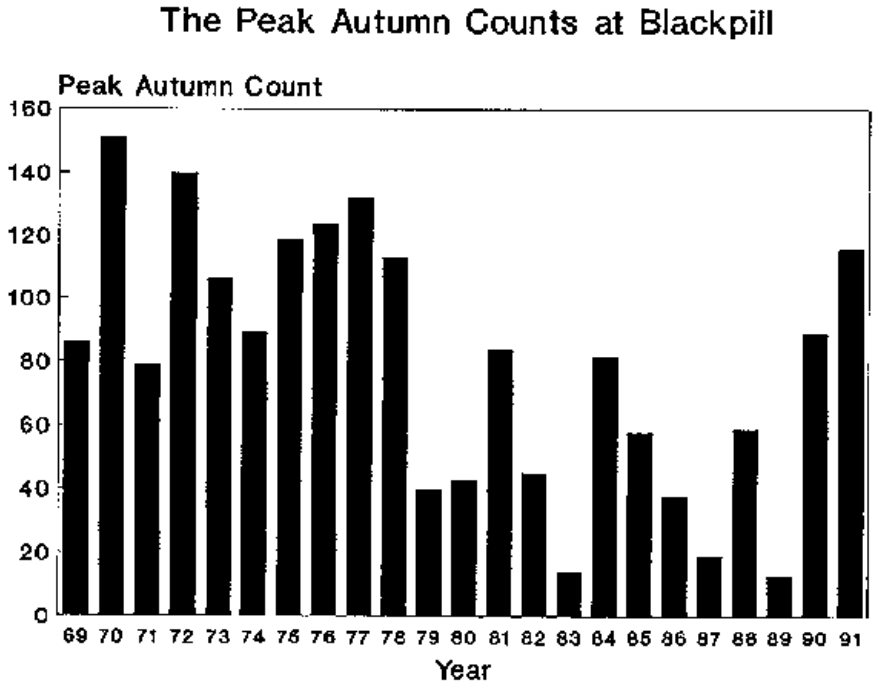


Figure 4.7.1 The Peak Winter Counts of Bar-Tailed Godwit at Blackpill and the National Indices between 1969 and 1991.

BAR-TAILED GODWIT



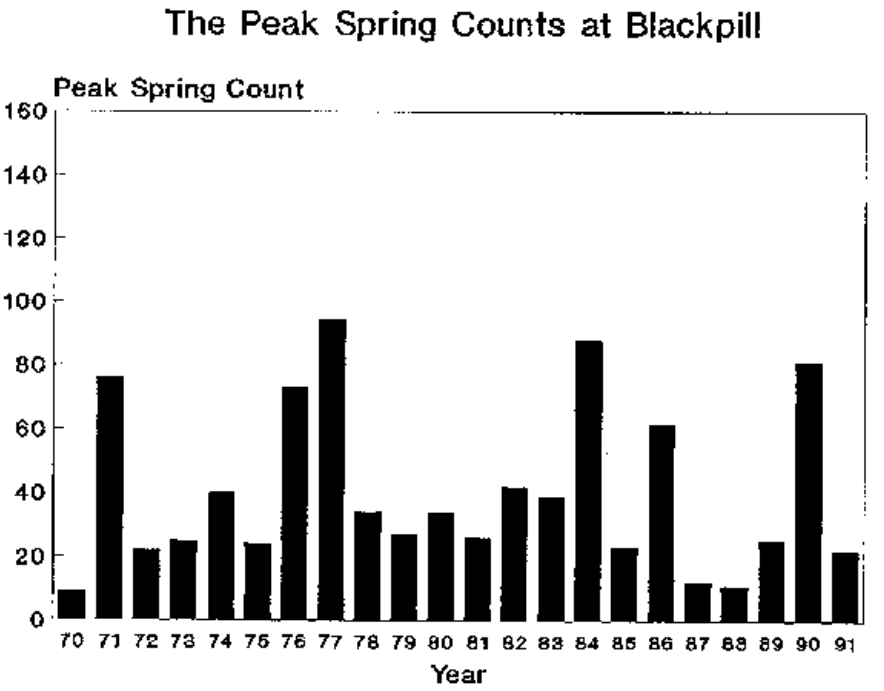


Figure 4.7.2 The Peak Autumn and Spring Counts of Bar-Tailed Godwit at Blackpill between 1969 and 1991.

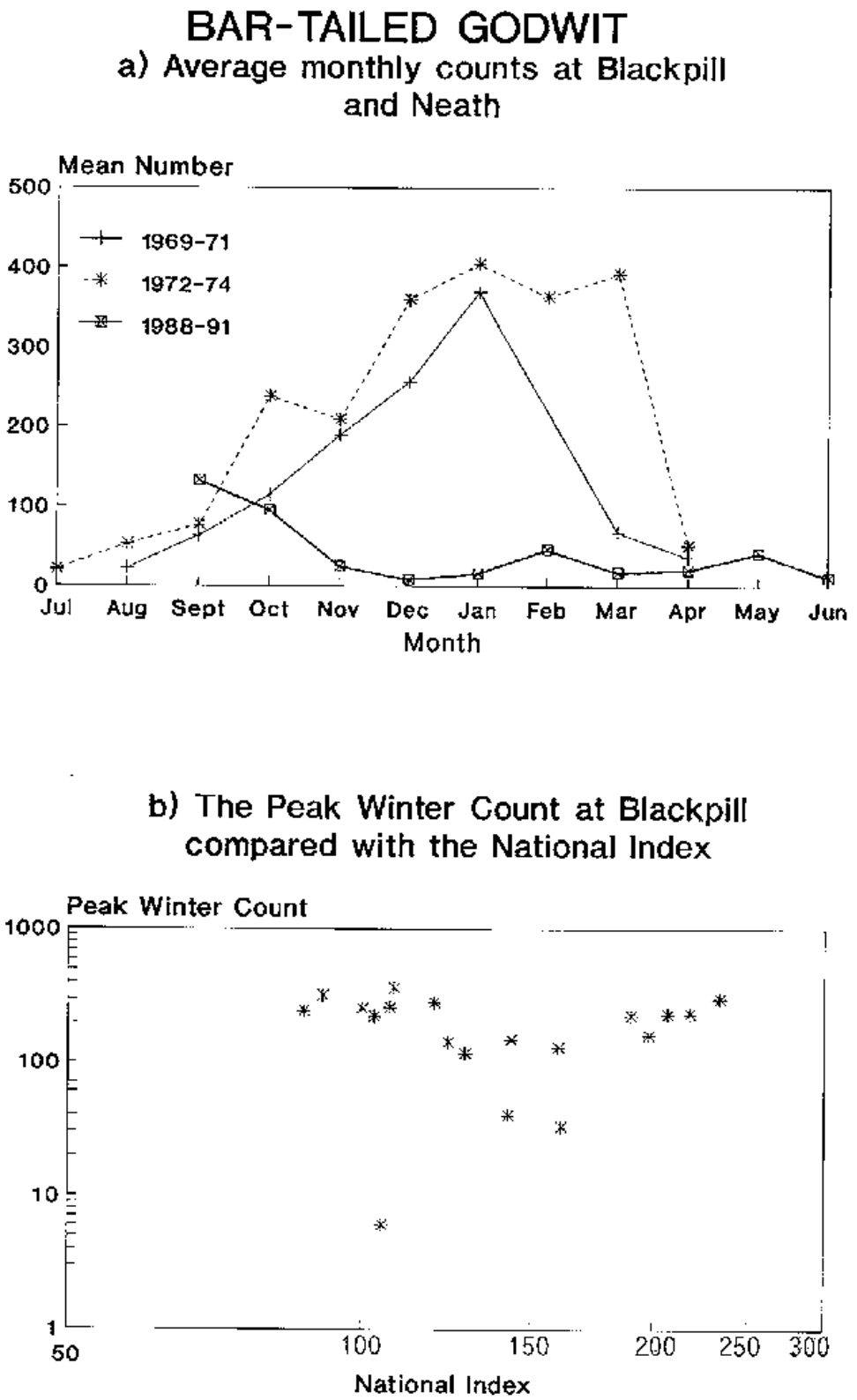


Figure 4.7.3 Variations in the occurrence of Bar-Tailed Godwit in Swansea Bay in relation to a) season and b) the national index.

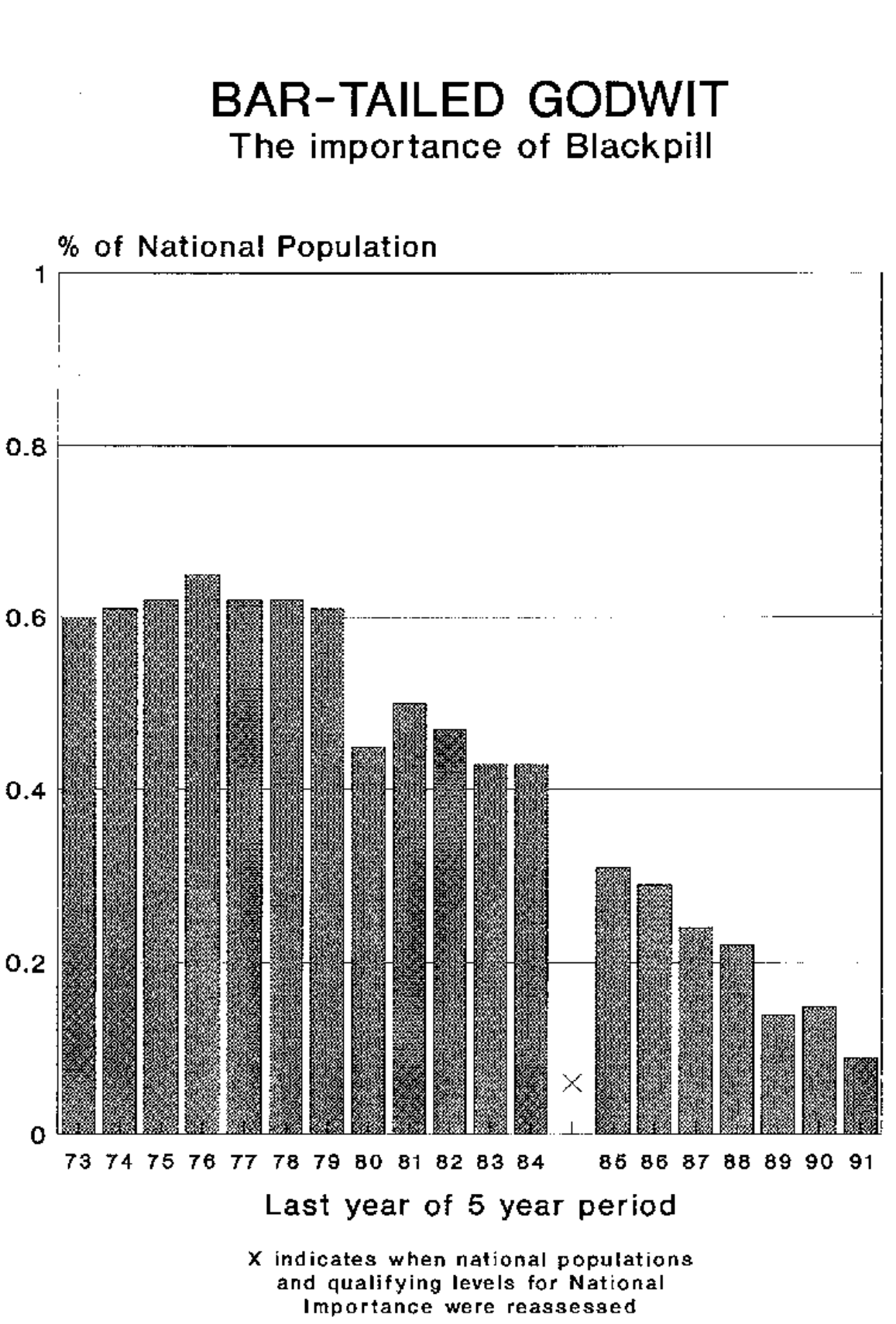


Figure 4.7.4 Variations in the National Importance of Blackpill for Bar-Tailed Godwit between 1973 anbd 1991

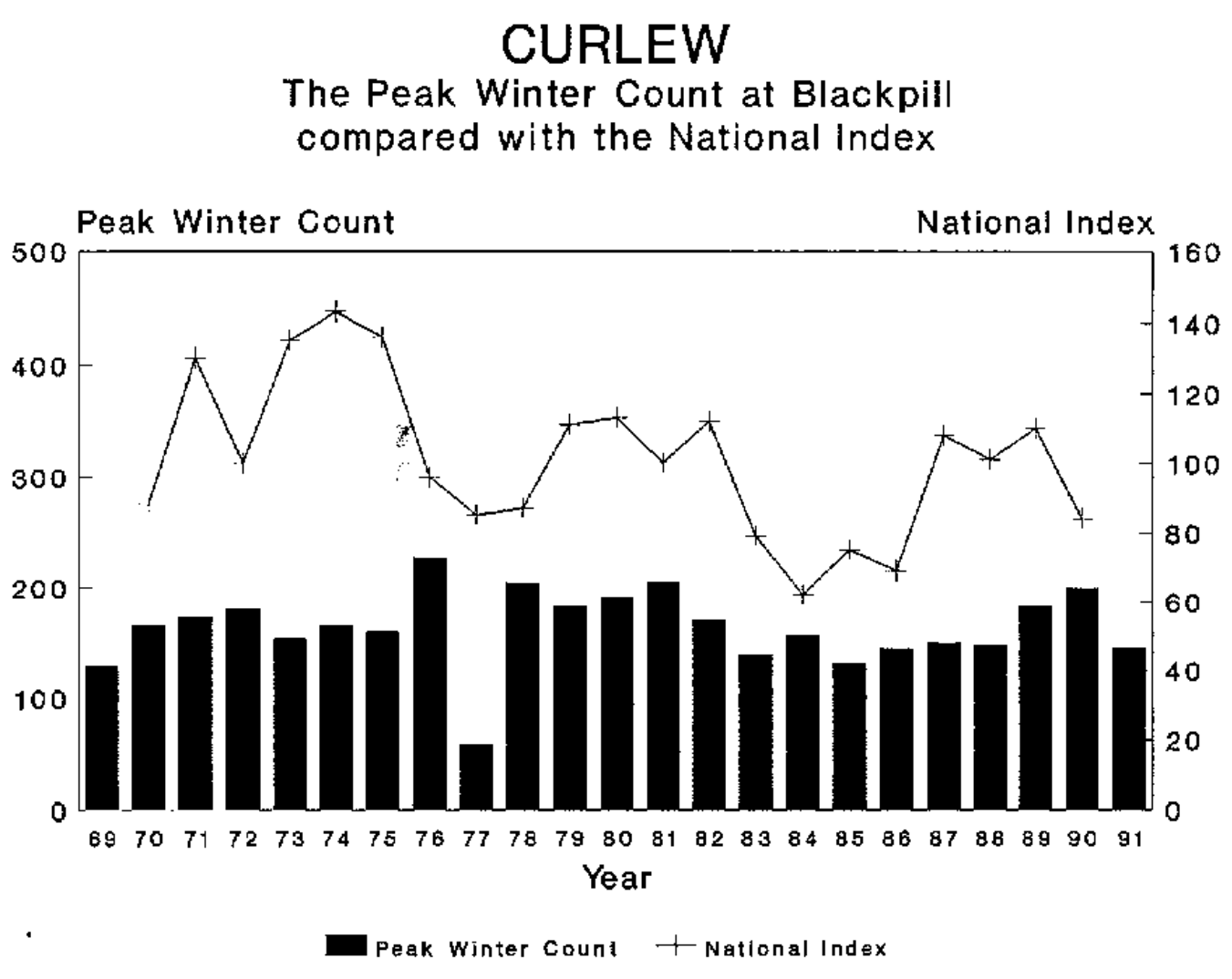
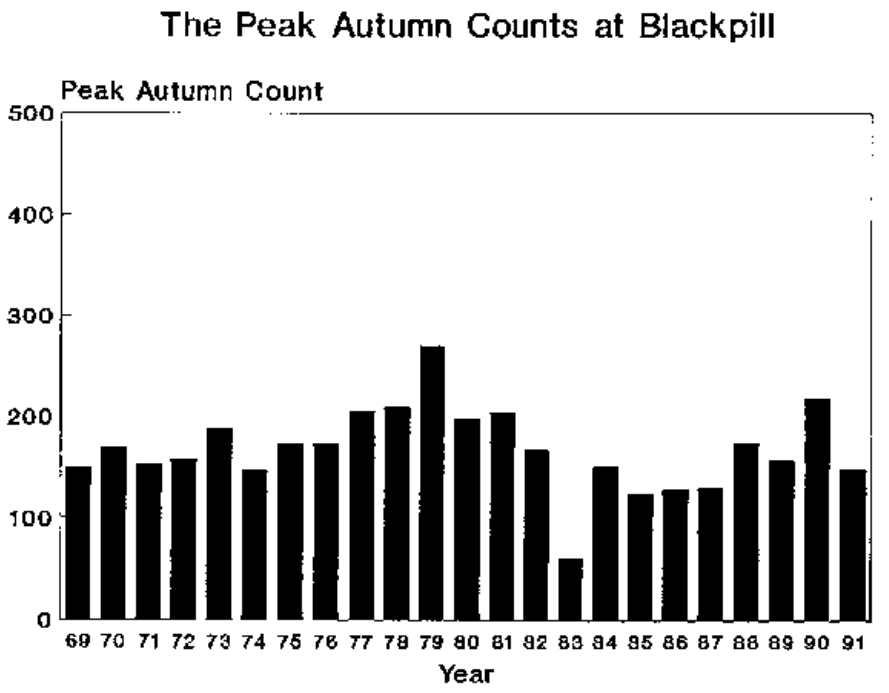


Figure 4.8.1 The Peak Winter Counts of Curlew at Blackpill and the National Indices between 1969 and 1991.

CURLEW



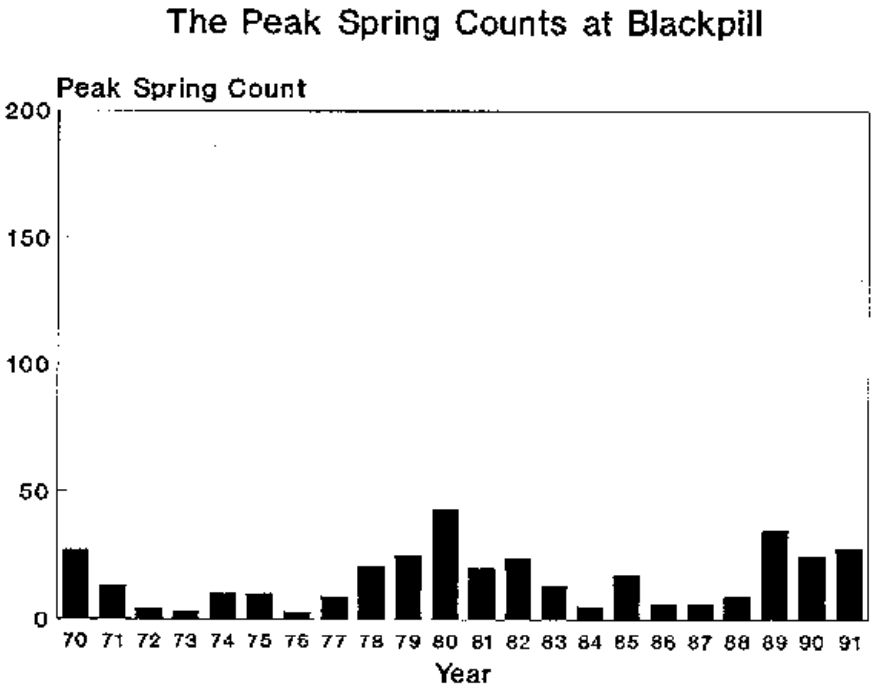


Figure 4.8.2 The Peak Autumn and Spring Counts of Curlew at Blackpill between 1969 and 1991.

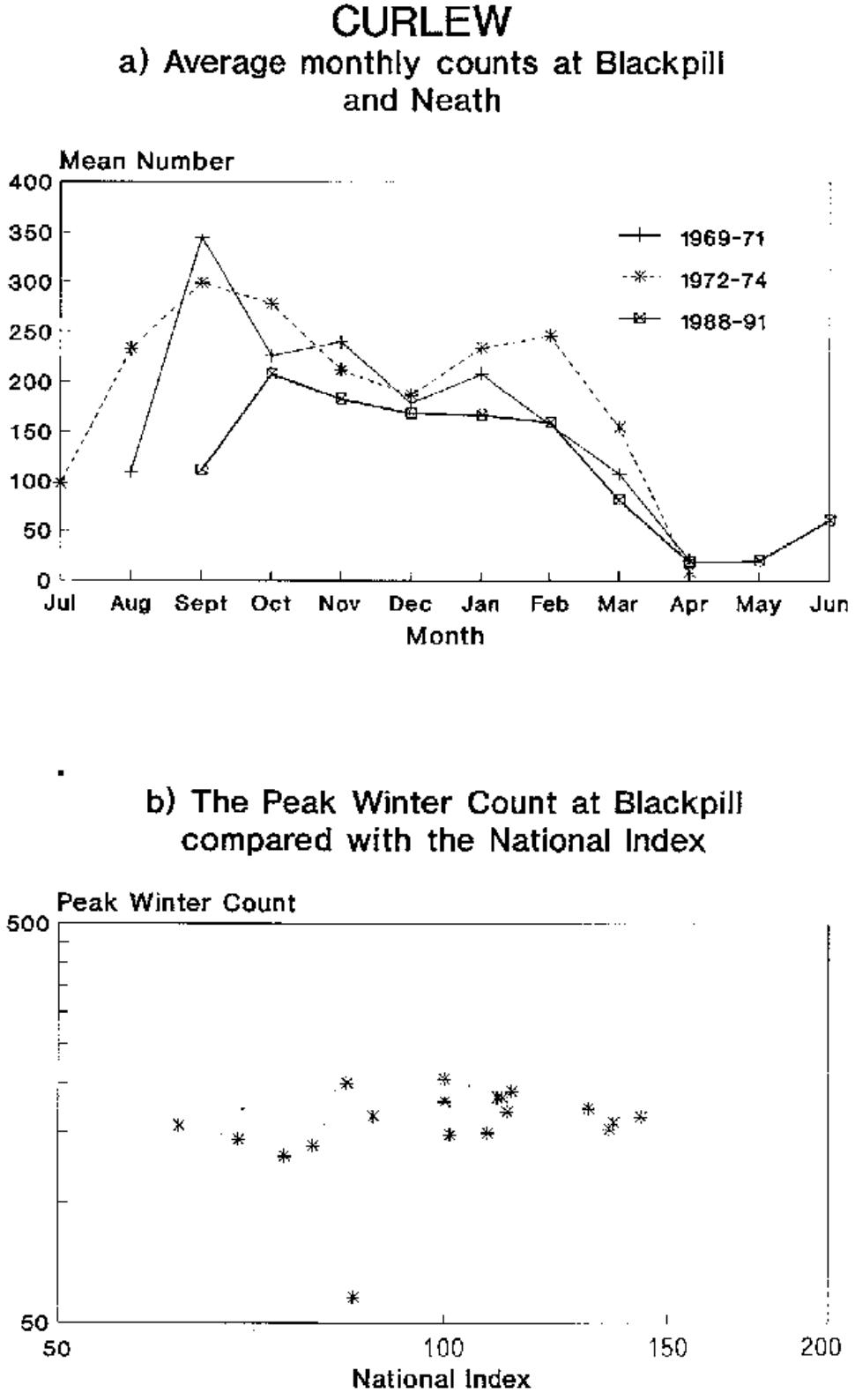


Figure 4.8.3 Variations in the occurrence of Curlew in Swansea Bay in relation to a) season and b) the national index.

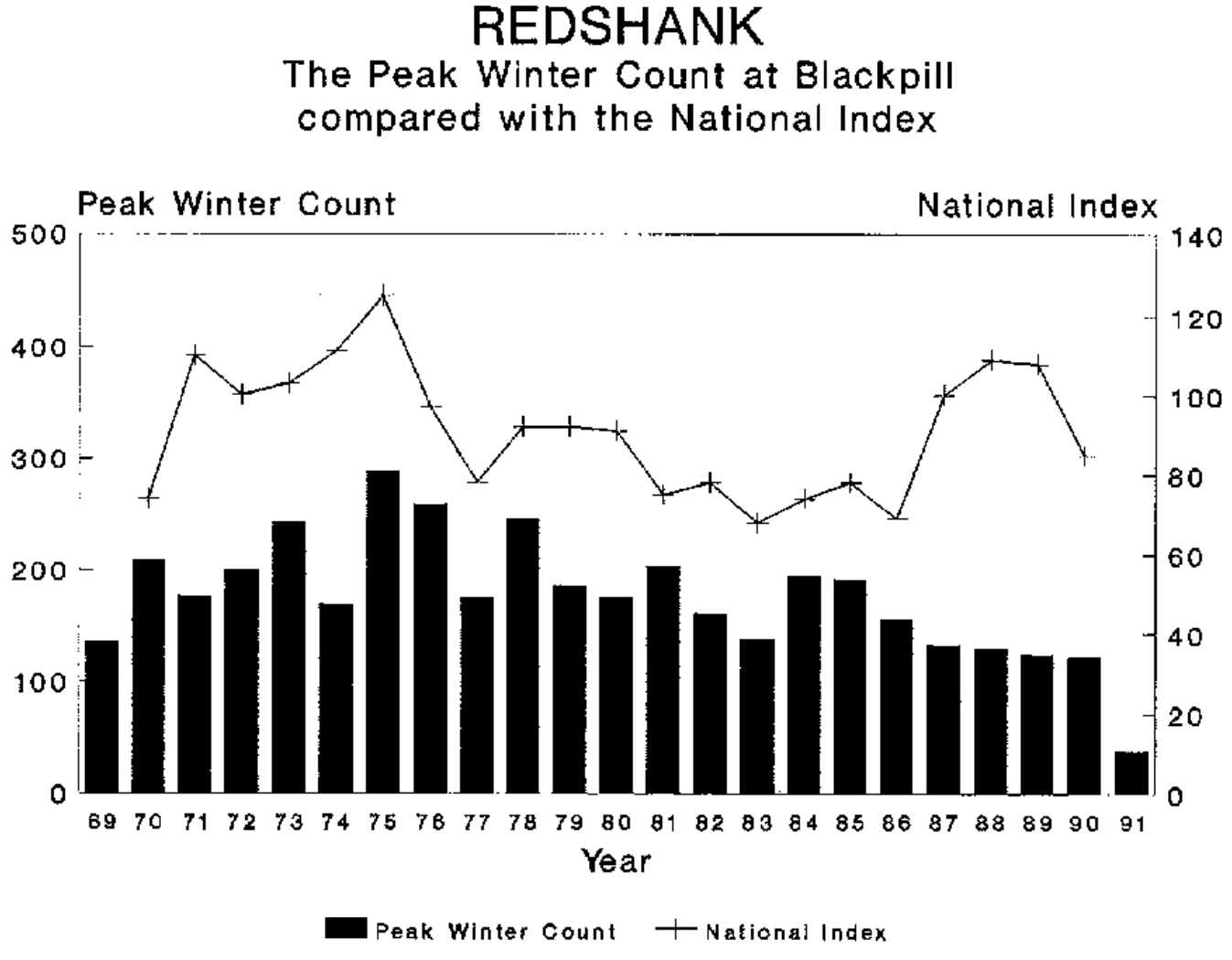


Figure 4.9.1 The Peak Winter Counts of Redshank at Blackpill and the National Indices between 1969 and 1991.

REDSHANK

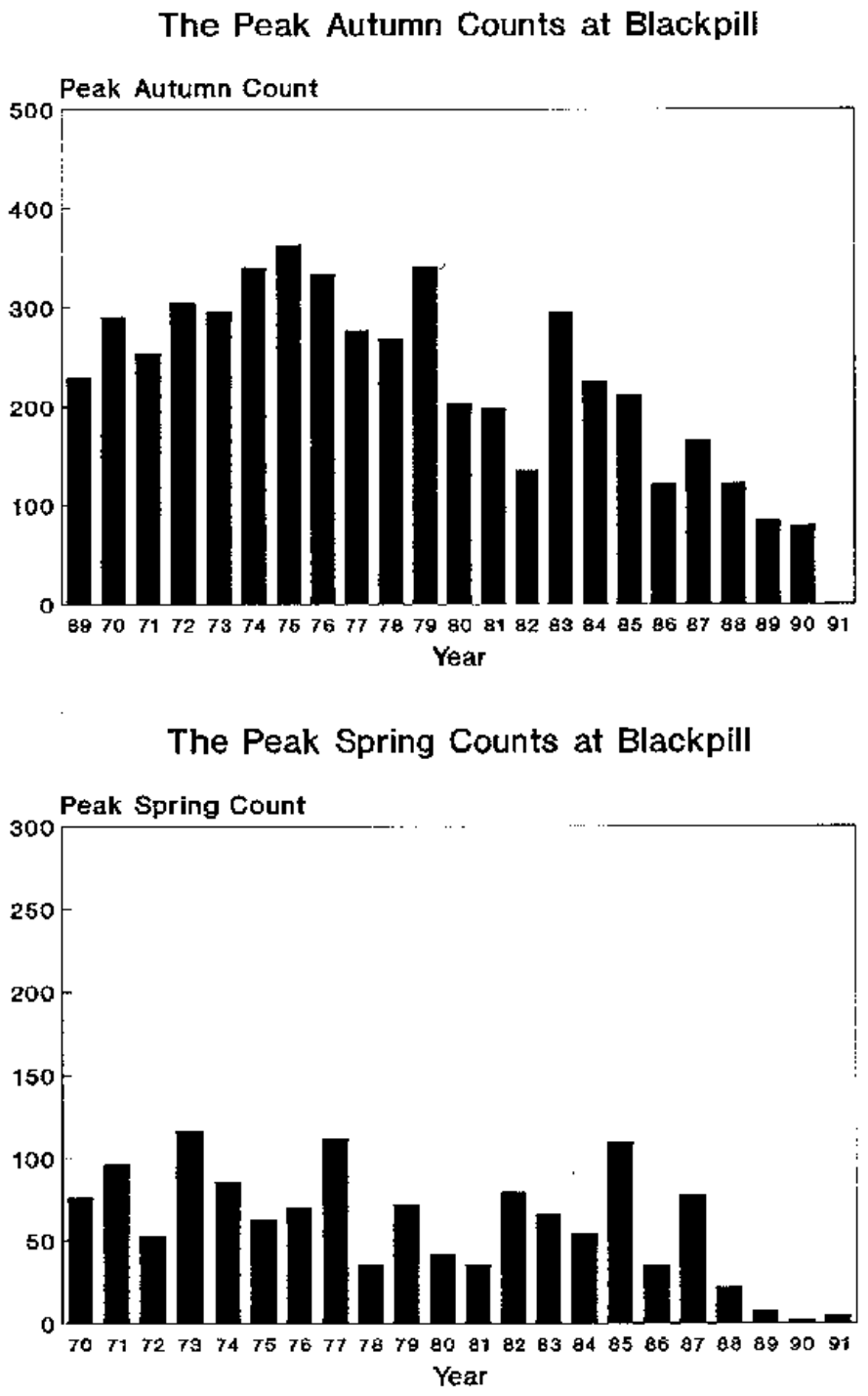


Figure 4.9.2 The Peak Autumn and Spring Counts of Redshank at Blackpill between 1969 and 1991.

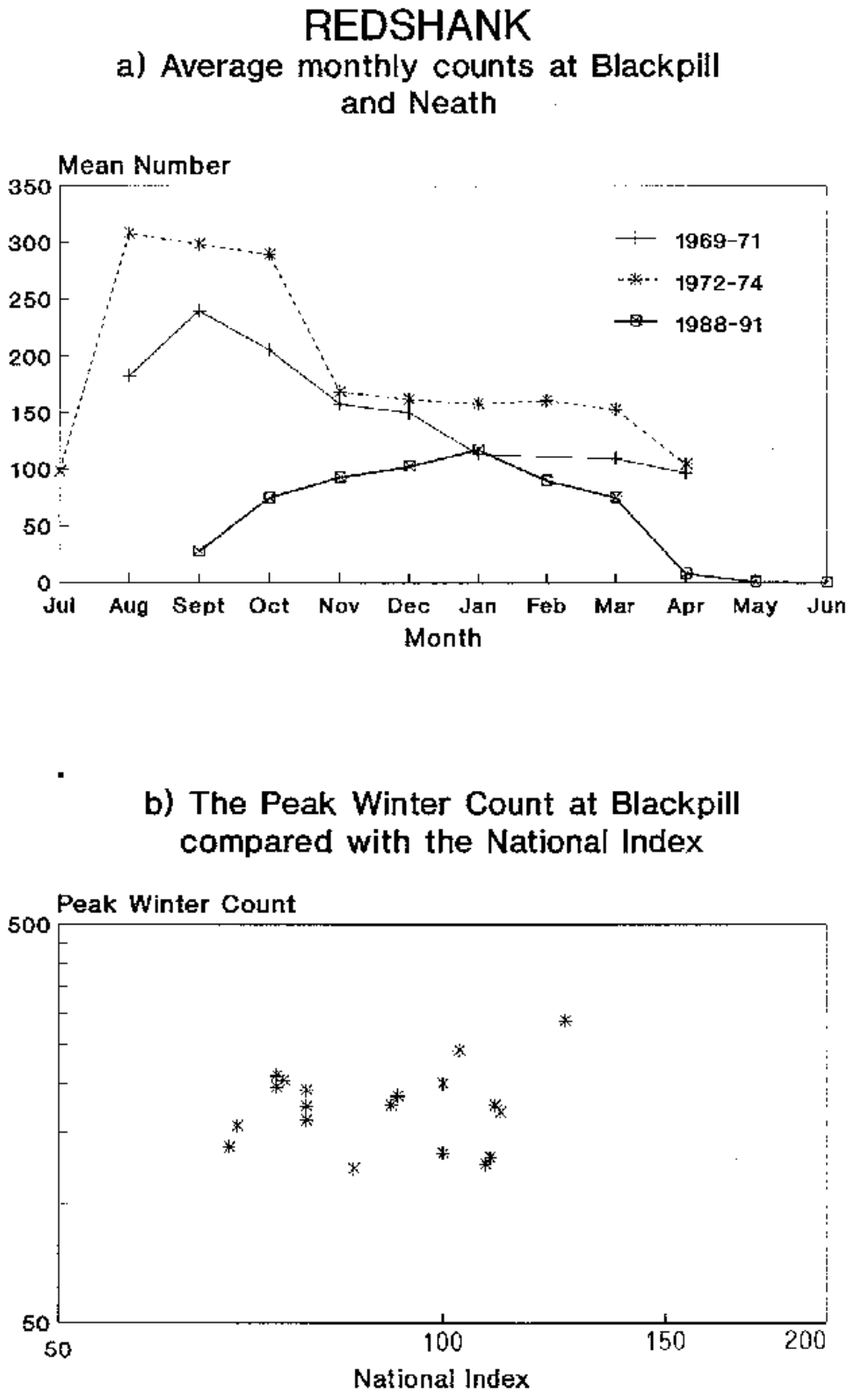


Figure 4.9.3 Variations in the occurrence of Redshank in Swansea Bay in relation to a) season and b) the national index.

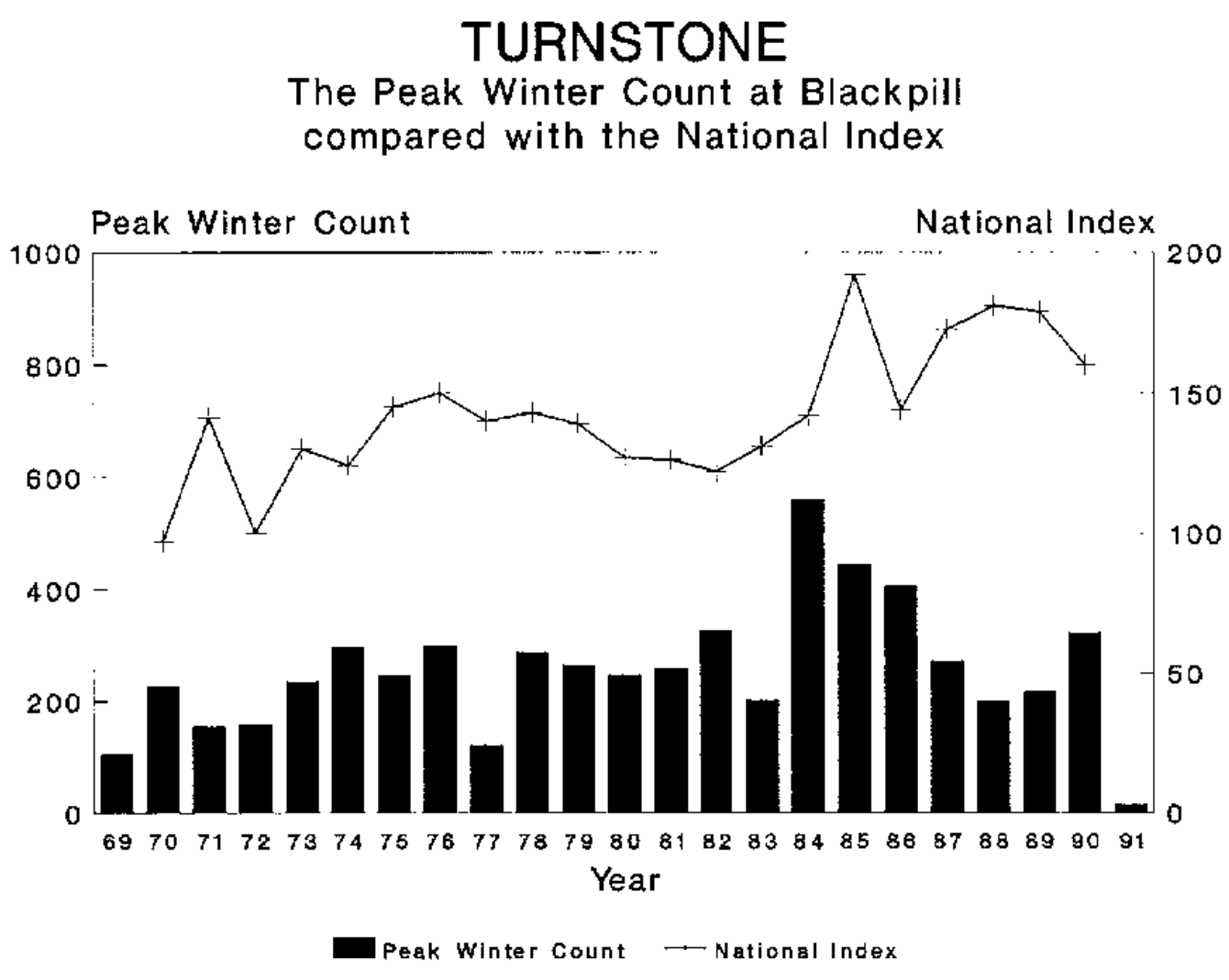
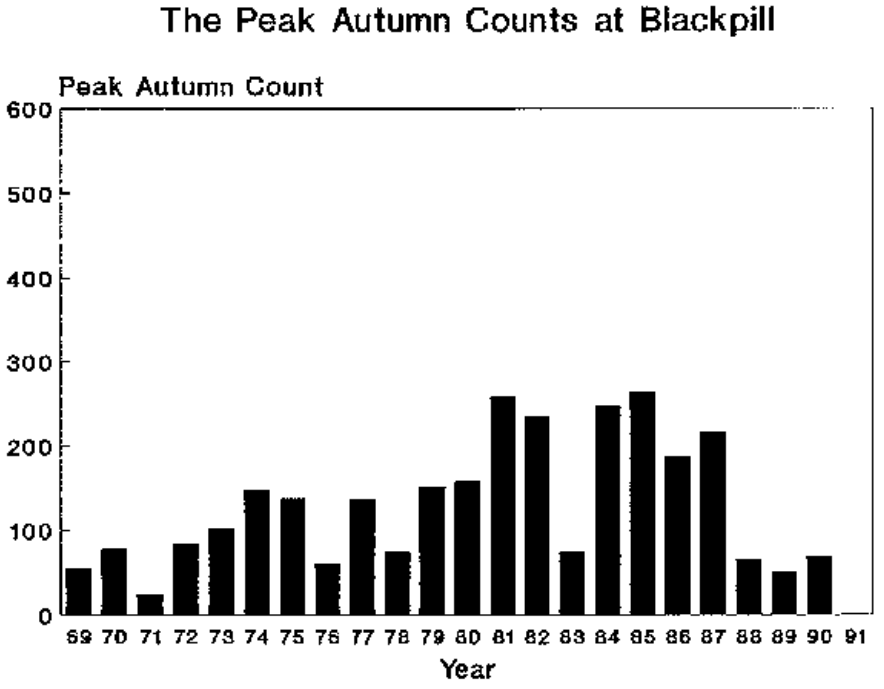


Figure 4.10.1 The Peak Winter Counts of Turnstone at Blackpill and the National Indices between 1969 and 1991.

TURNSTONE



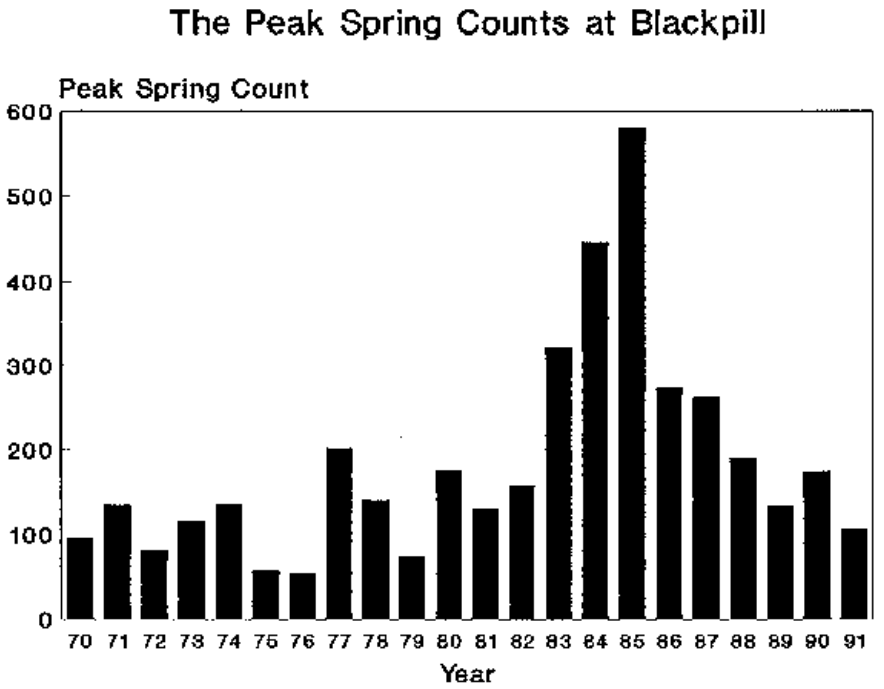


Figure 4.10.2 The Peak Autumn and Spring Counts of Turnstone at Blackpill between 1969 and 1991.

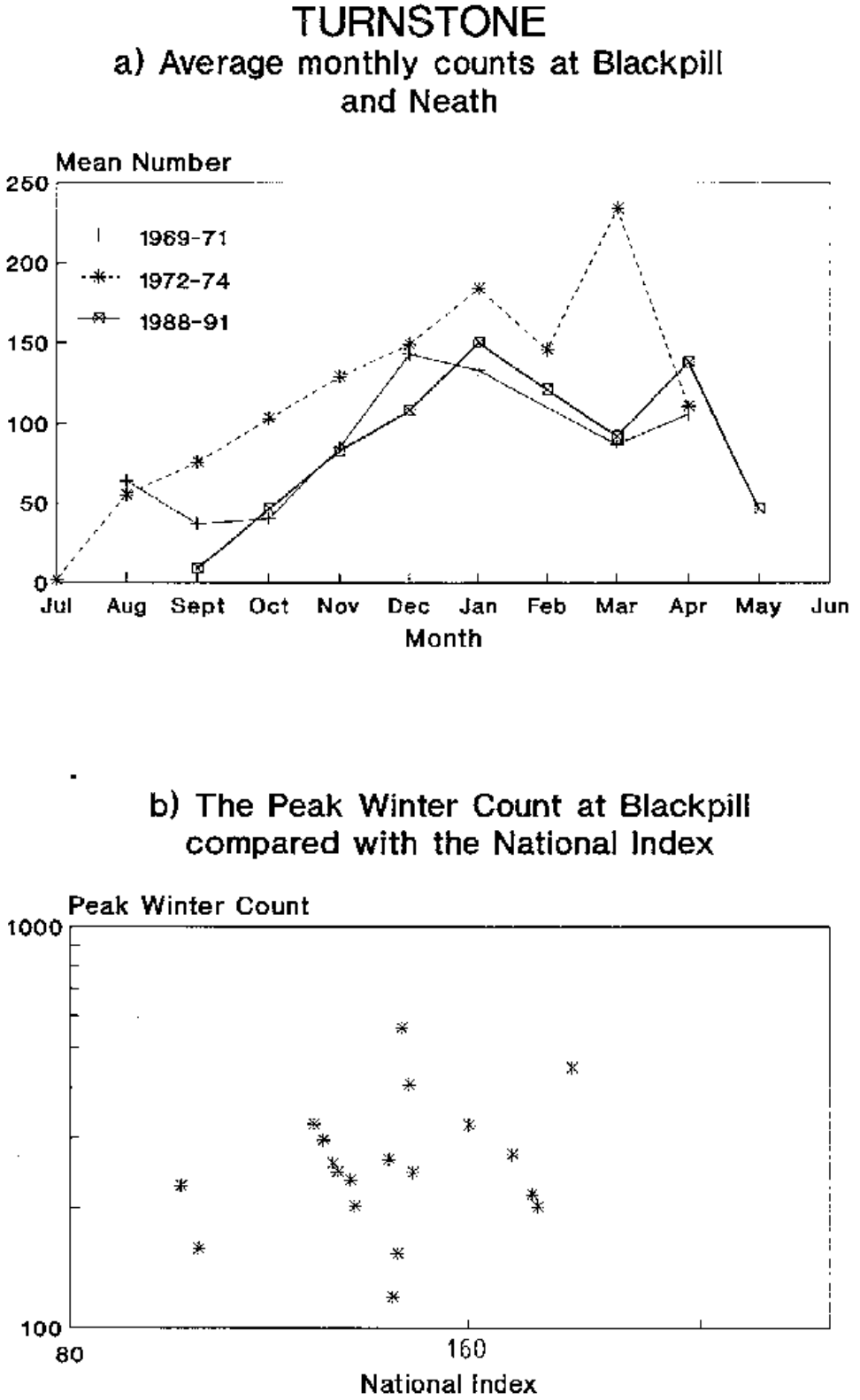


Figure 4.10.3 Variations in the occurrence of Turnstone in Swansea Bay in relation to a) season and b) the national index.

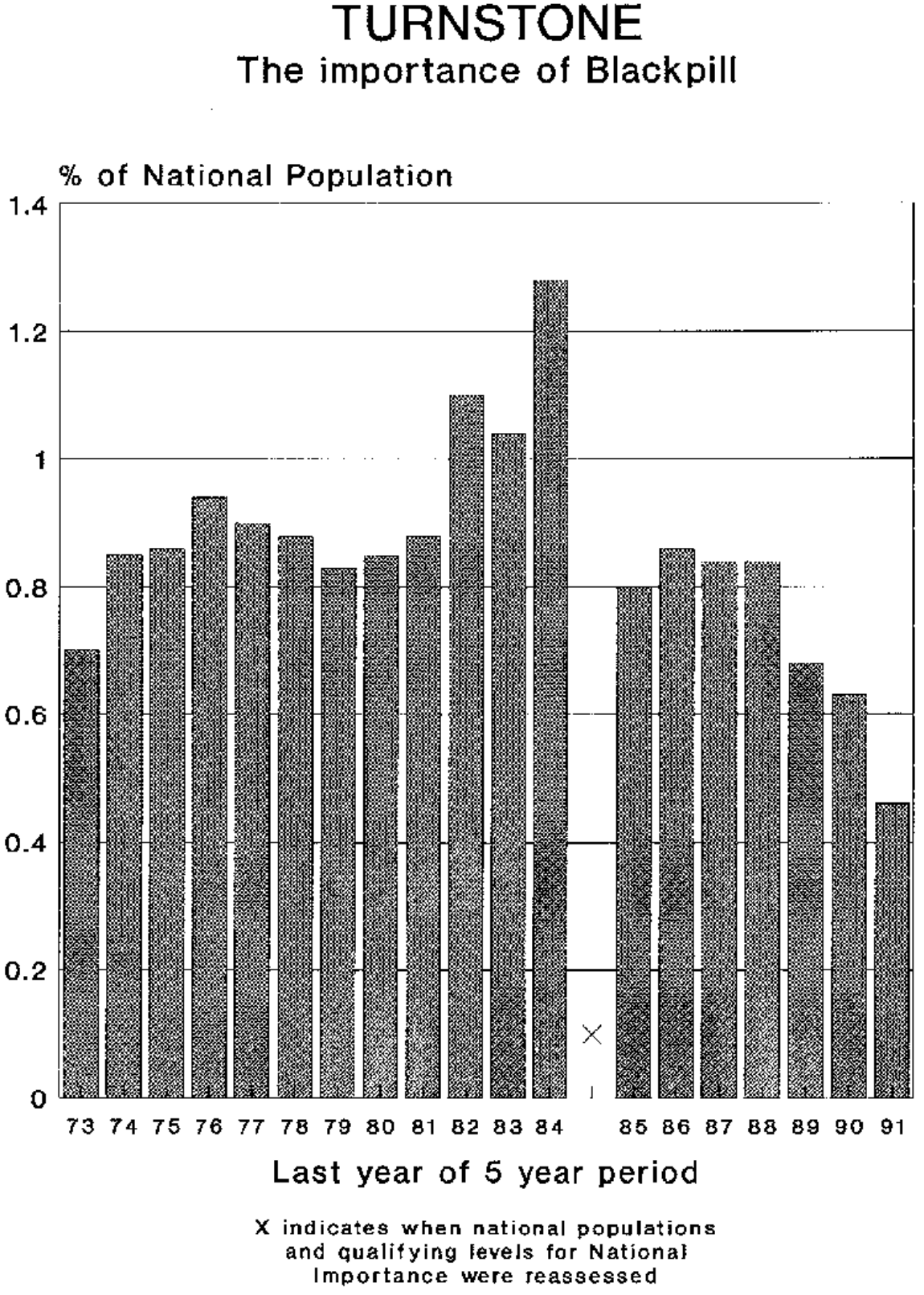


Figure 4.10.4 Variations in the National Importance of Blackpill for Turnstone between 1973 and 1991.

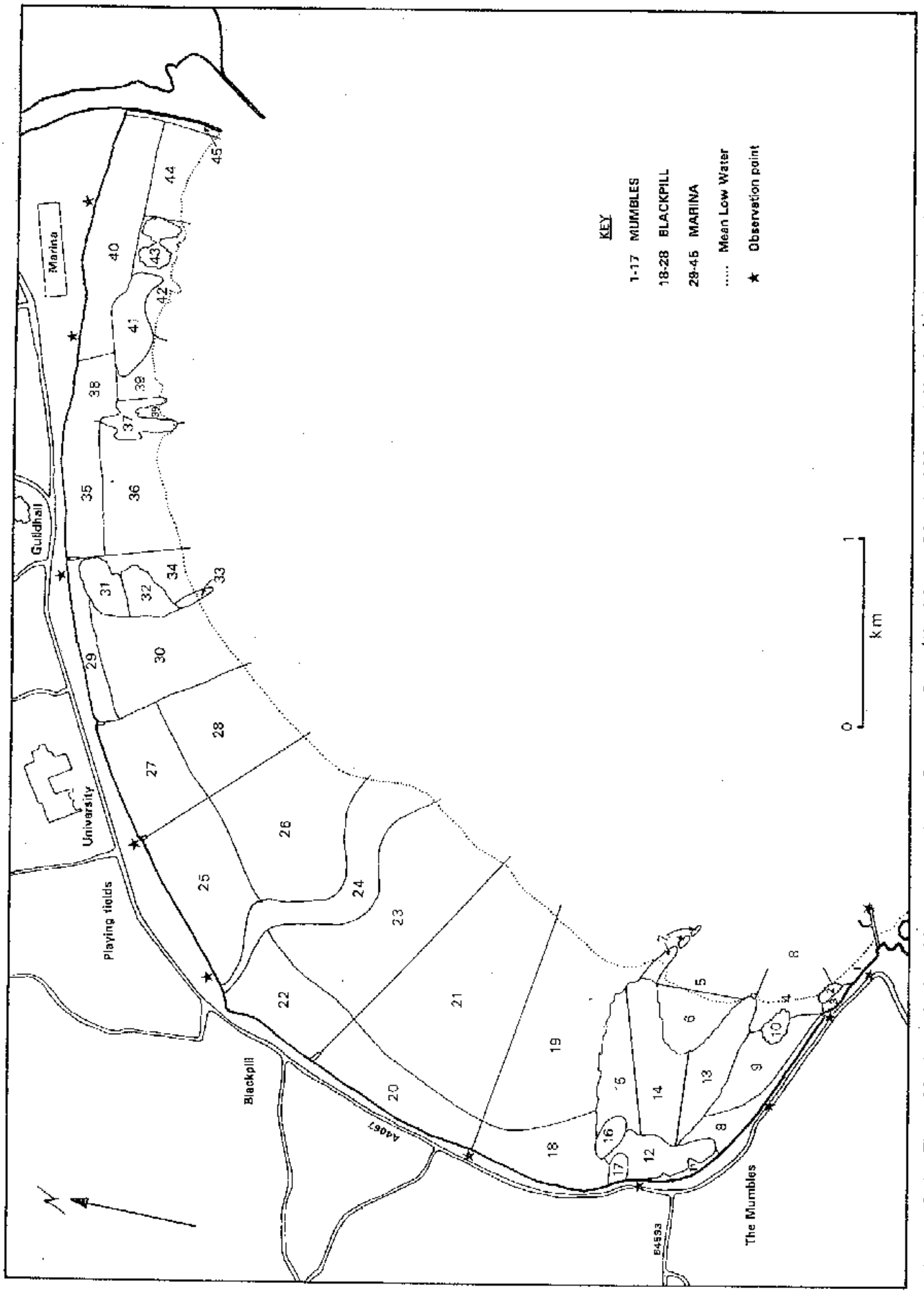


Figure 6.1 The all day study sites on western Swansea Bay (Mumbles, Blackpill and Marina) with their constituent count areas.

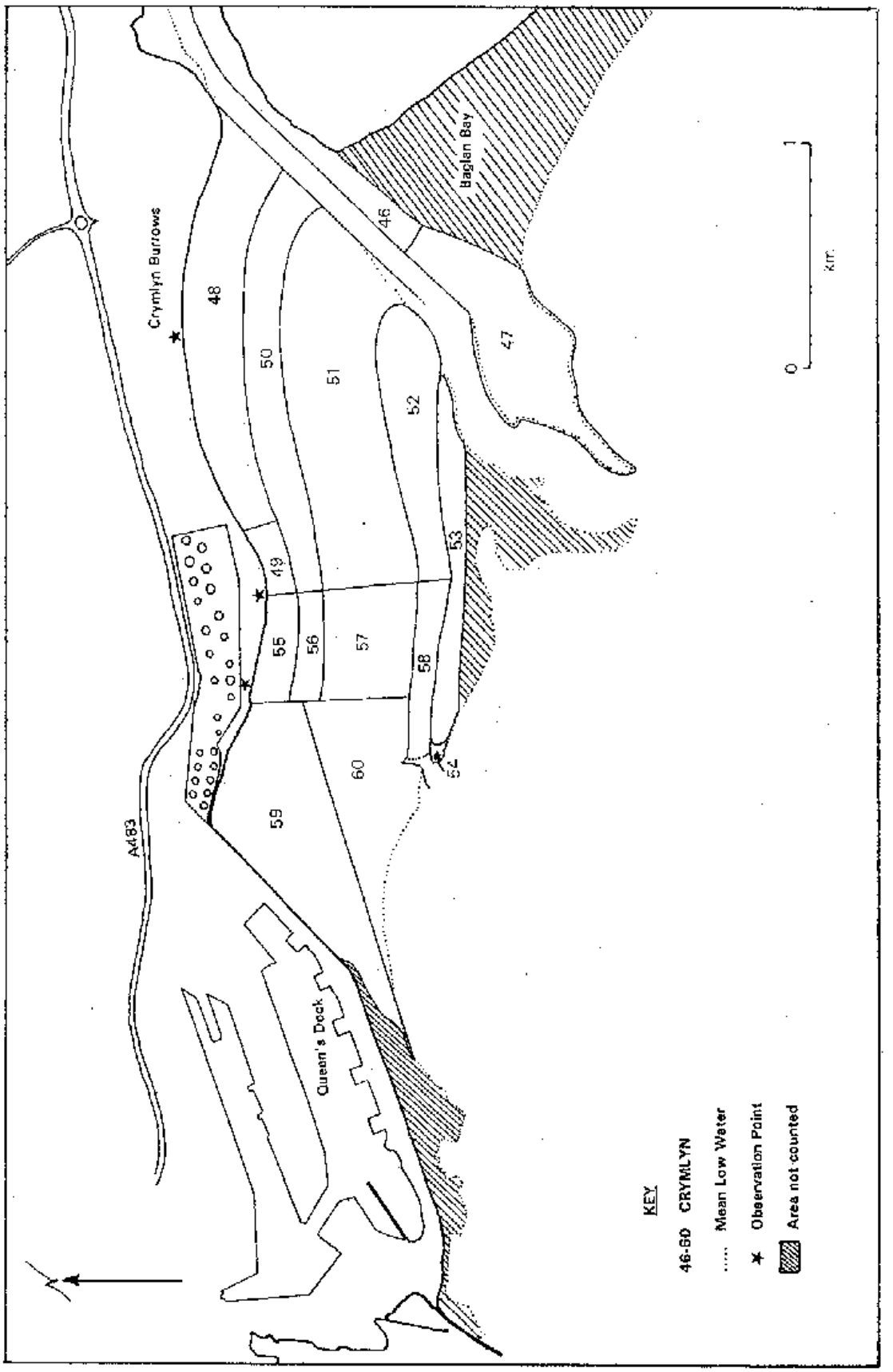


Figure 6.2 The all day study site on eastern Swansea Bay (Crymlyn) with its constituent count areas.

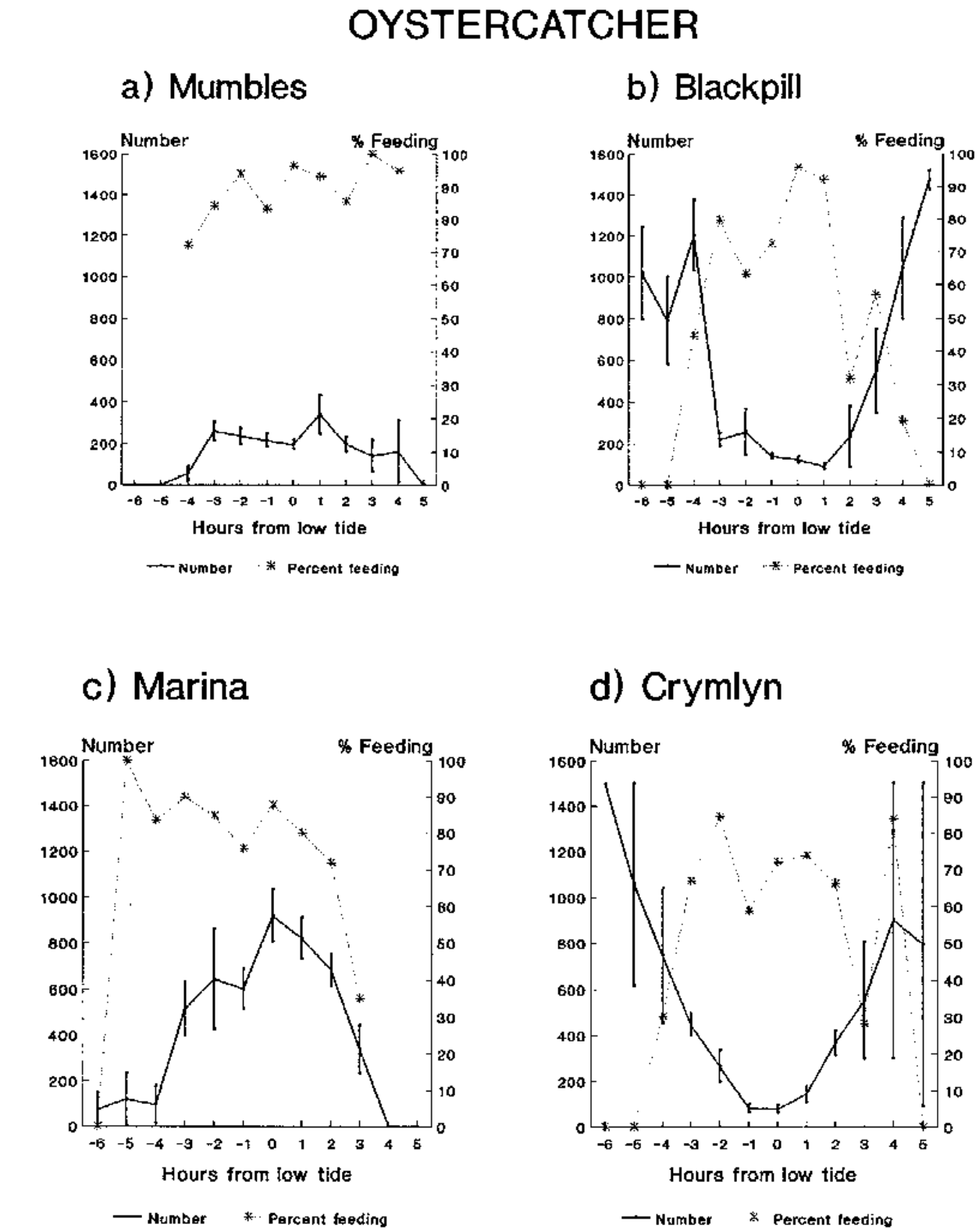


Figure 7.1.1 The average number of Oystercatcher present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

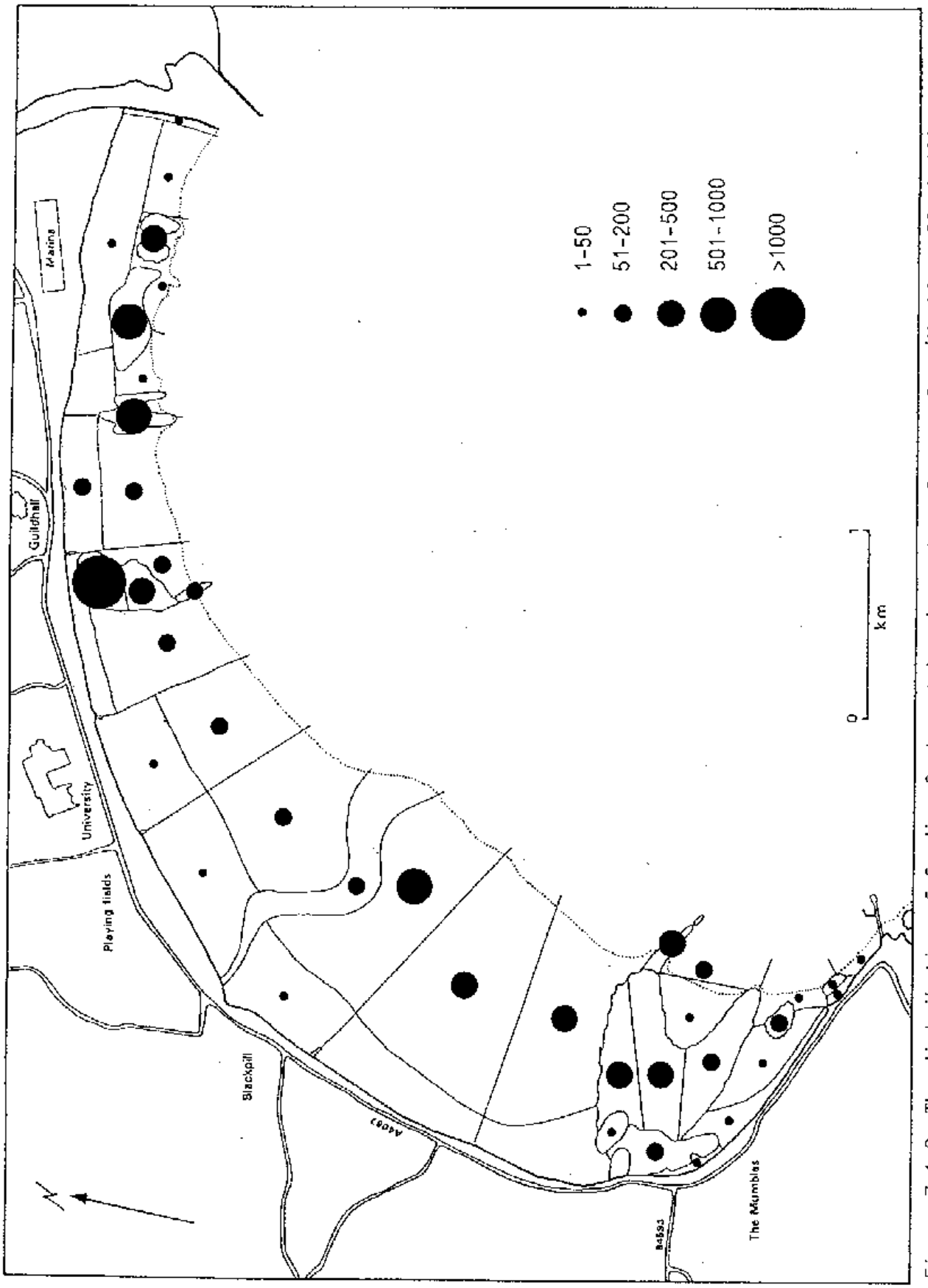


Figure 7.1.2 The distribution of feeding Oystercatcher in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

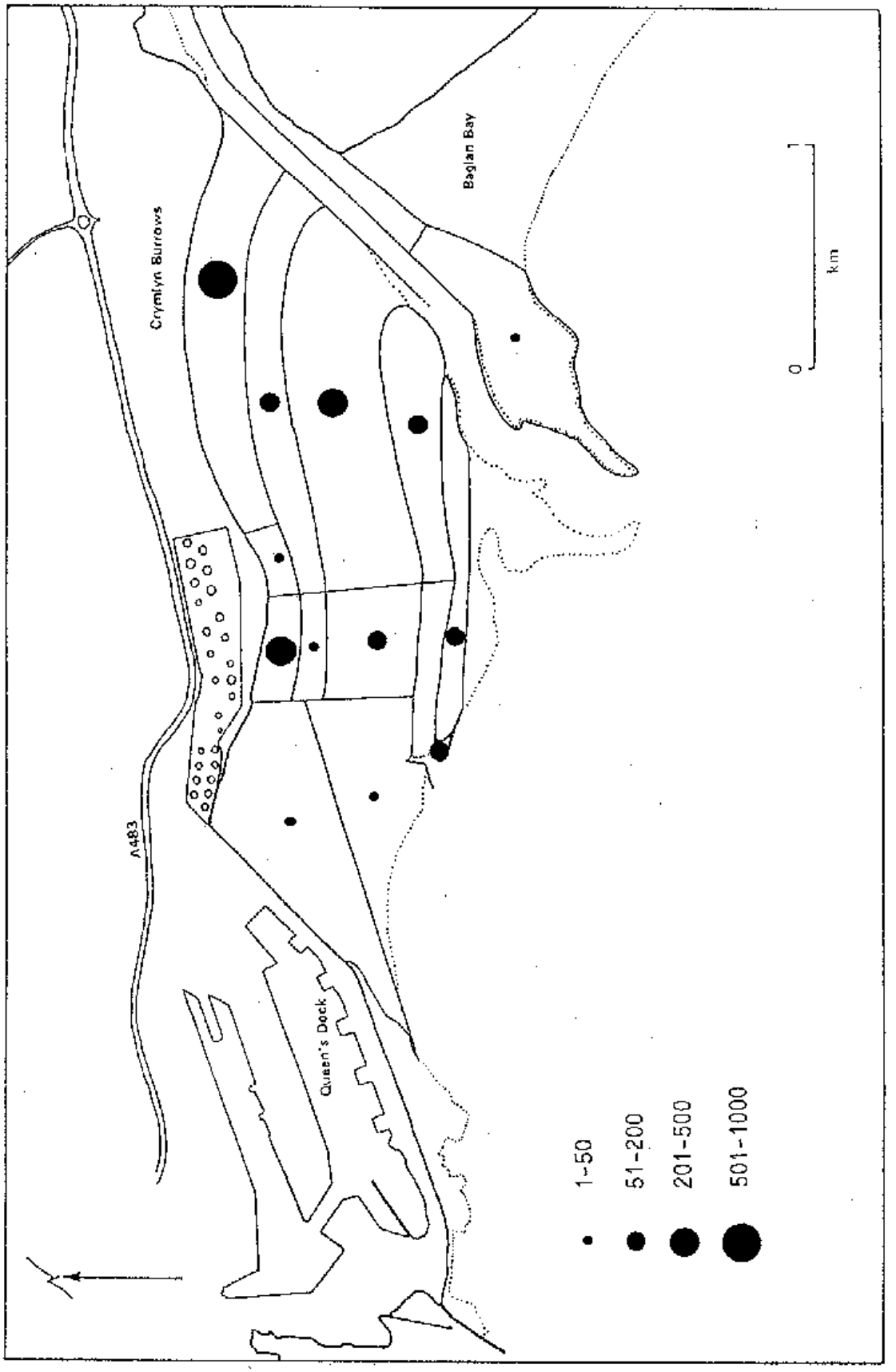


Figure 7.1.3 The distribution of feeding Oystercatcher in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

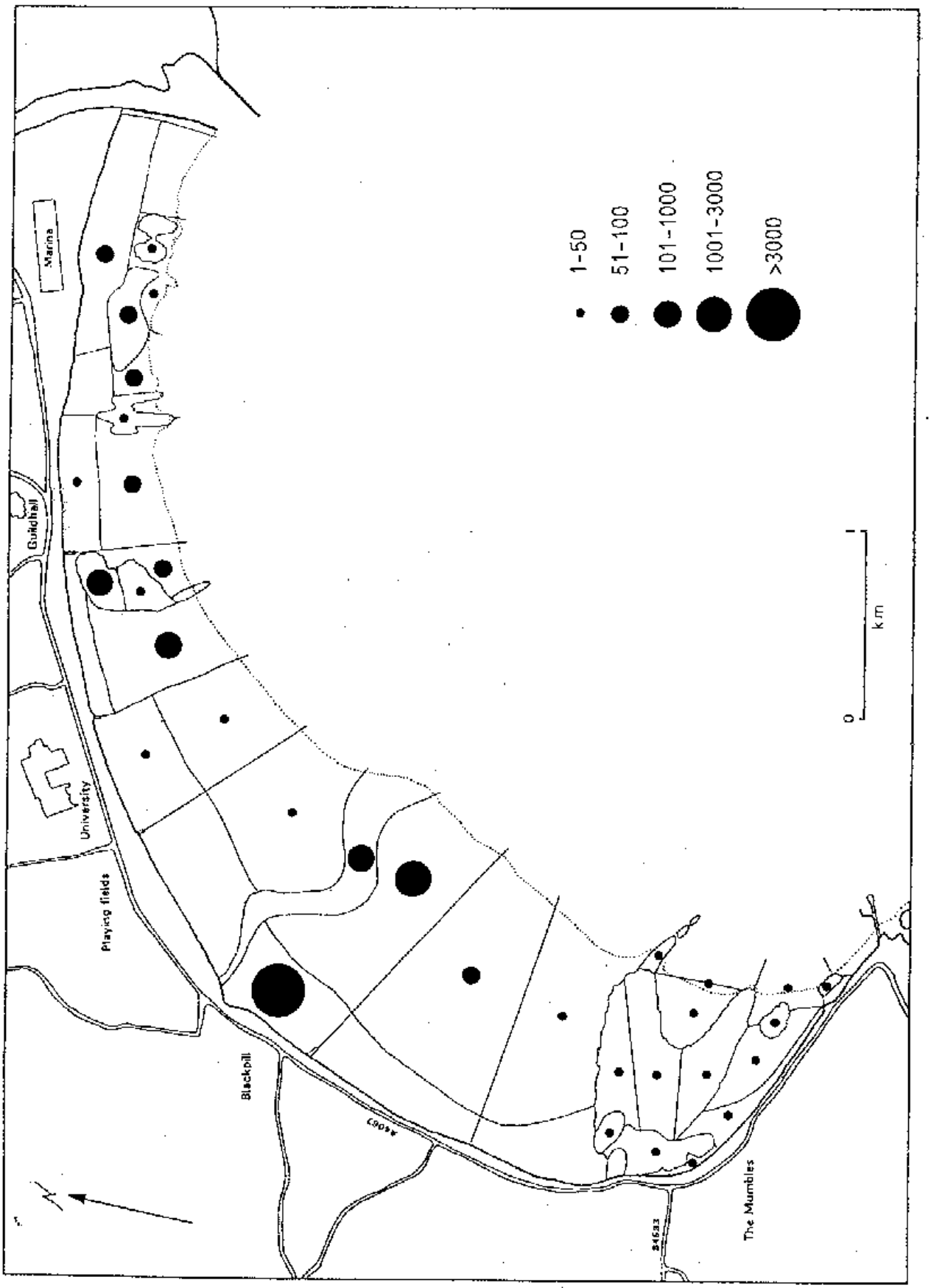


Figure 7.1.4 The distribution of roosting Oystercatcher in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

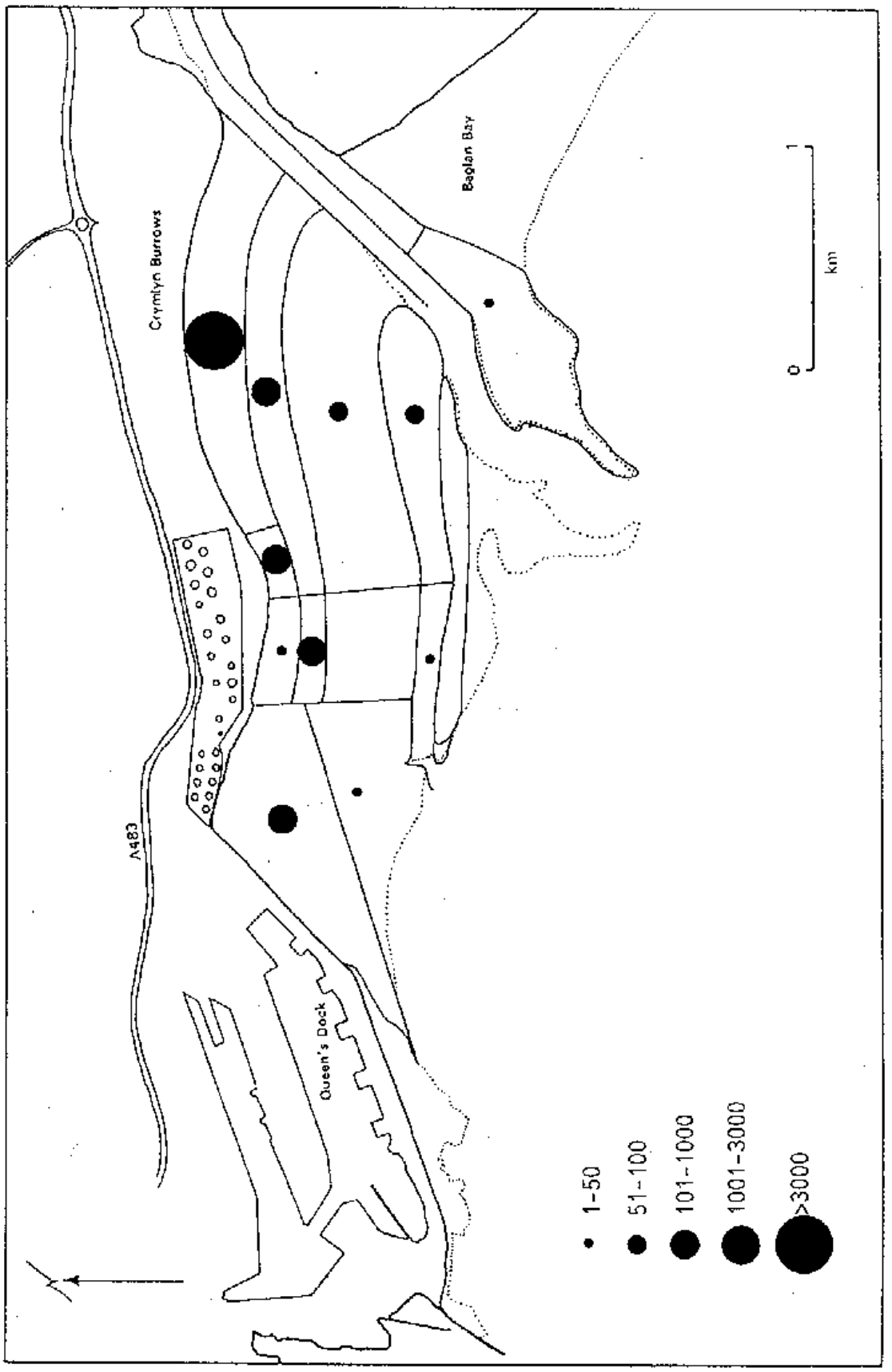


Figure 7.1.5 The distribution of roosting Oystercatcher in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

RINGED PLOVER

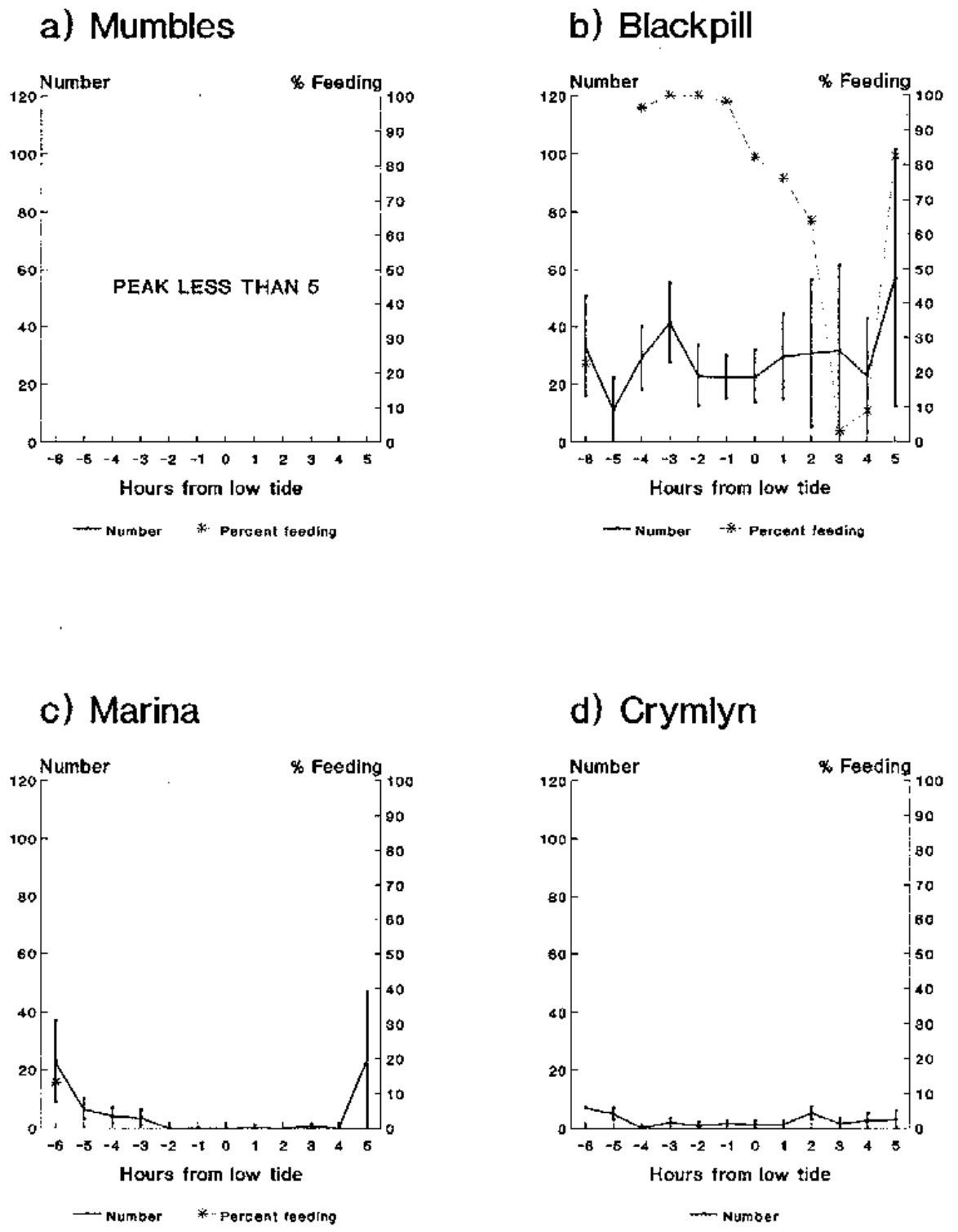


Figure 7.2.1 The average number of Ringed Plover present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

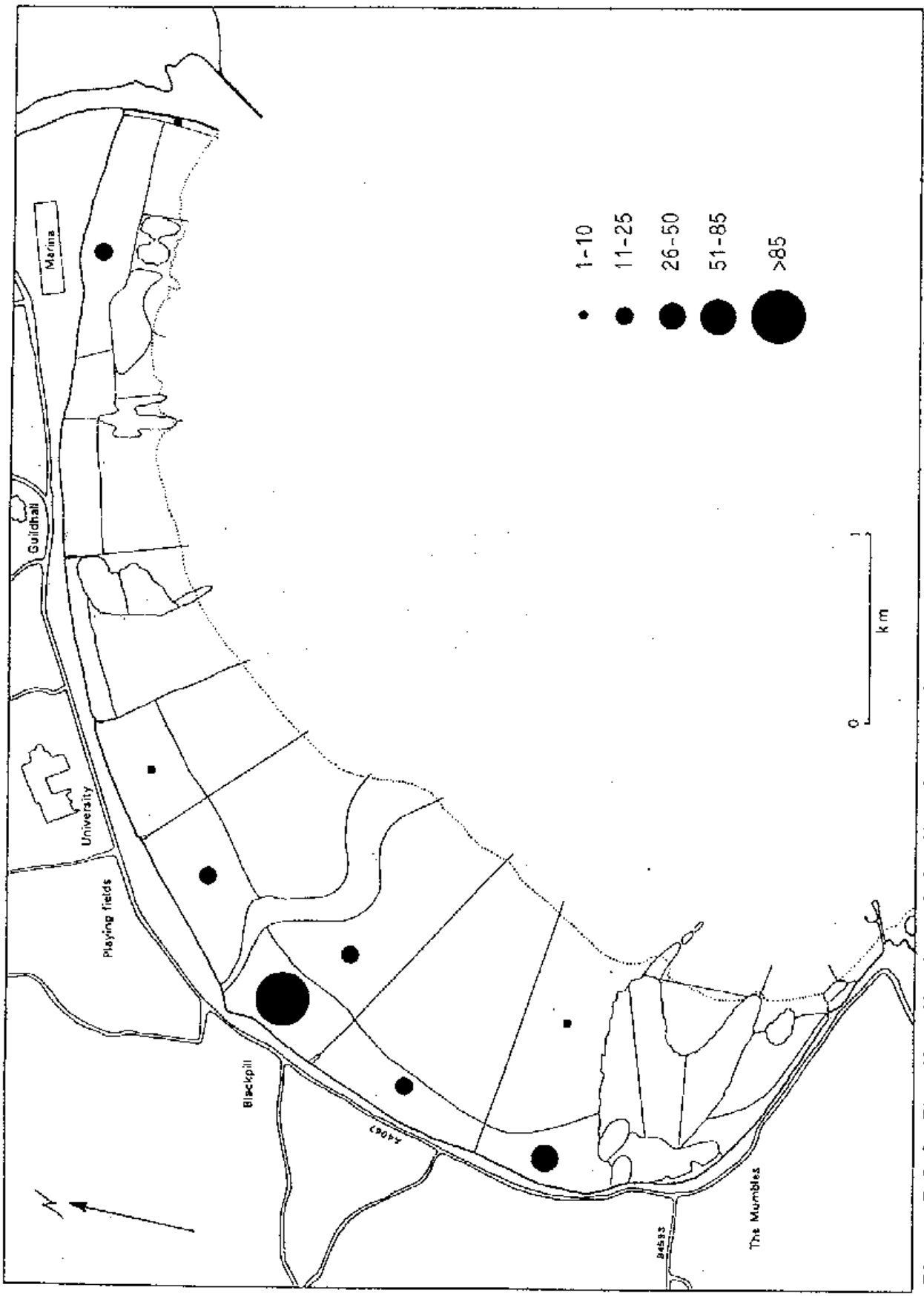


Figure 7.2.2 The distribution of feeding Ringed Plover in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

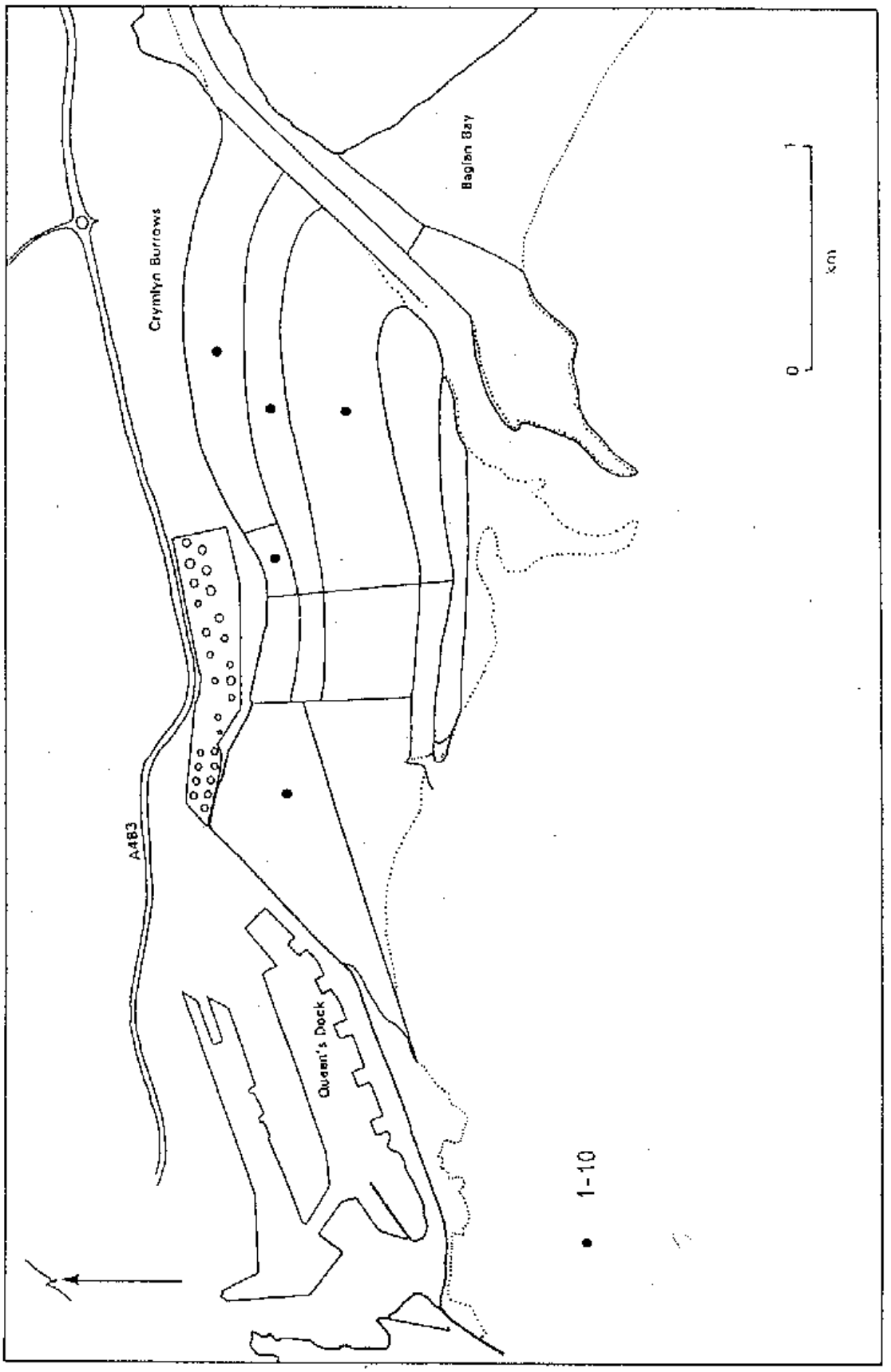


Figure 7.2.3 The distribution of feeding Ringed Plover in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

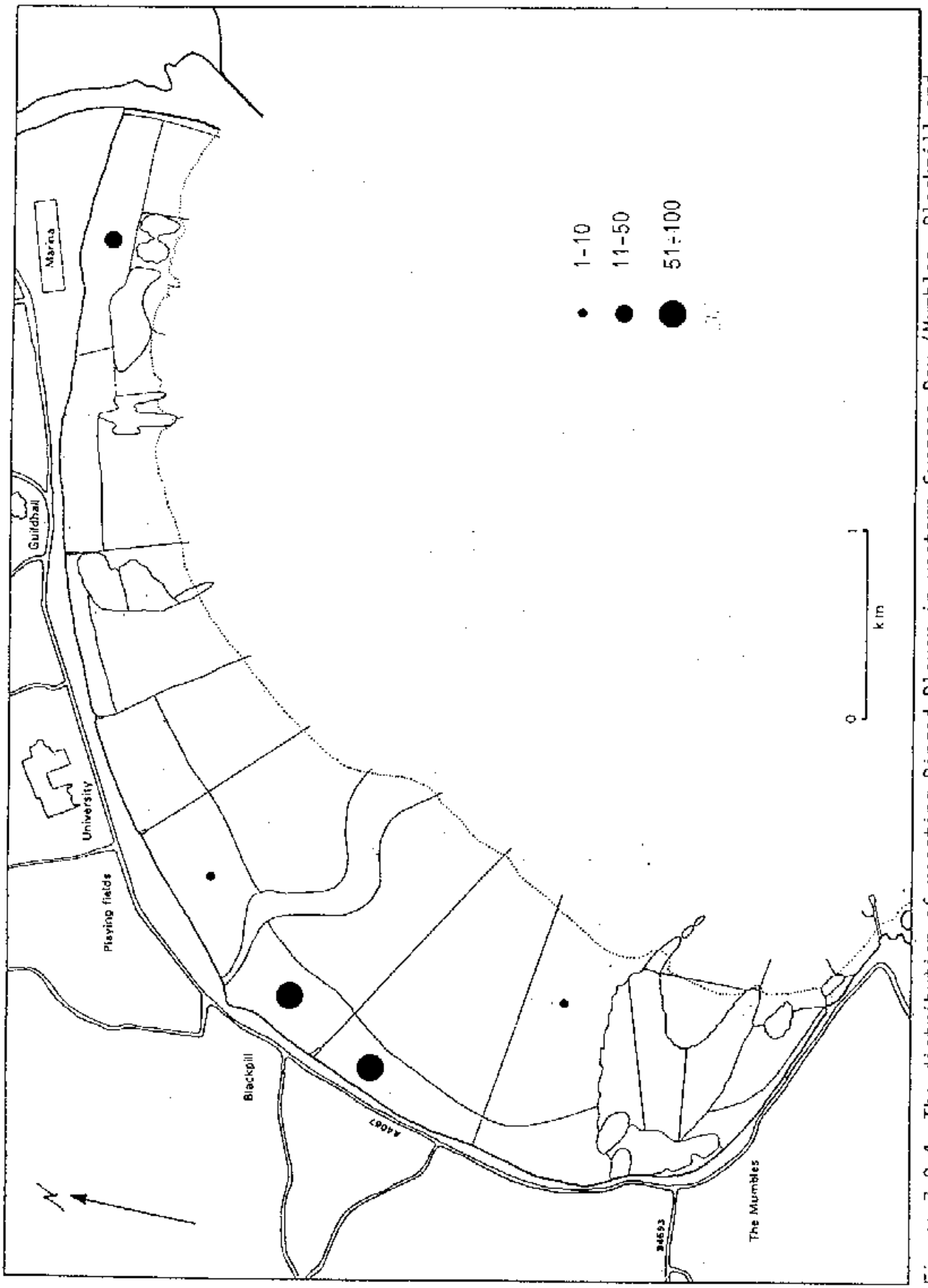


Figure 7.2.4 The distribution of roosting Ringed Plover in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

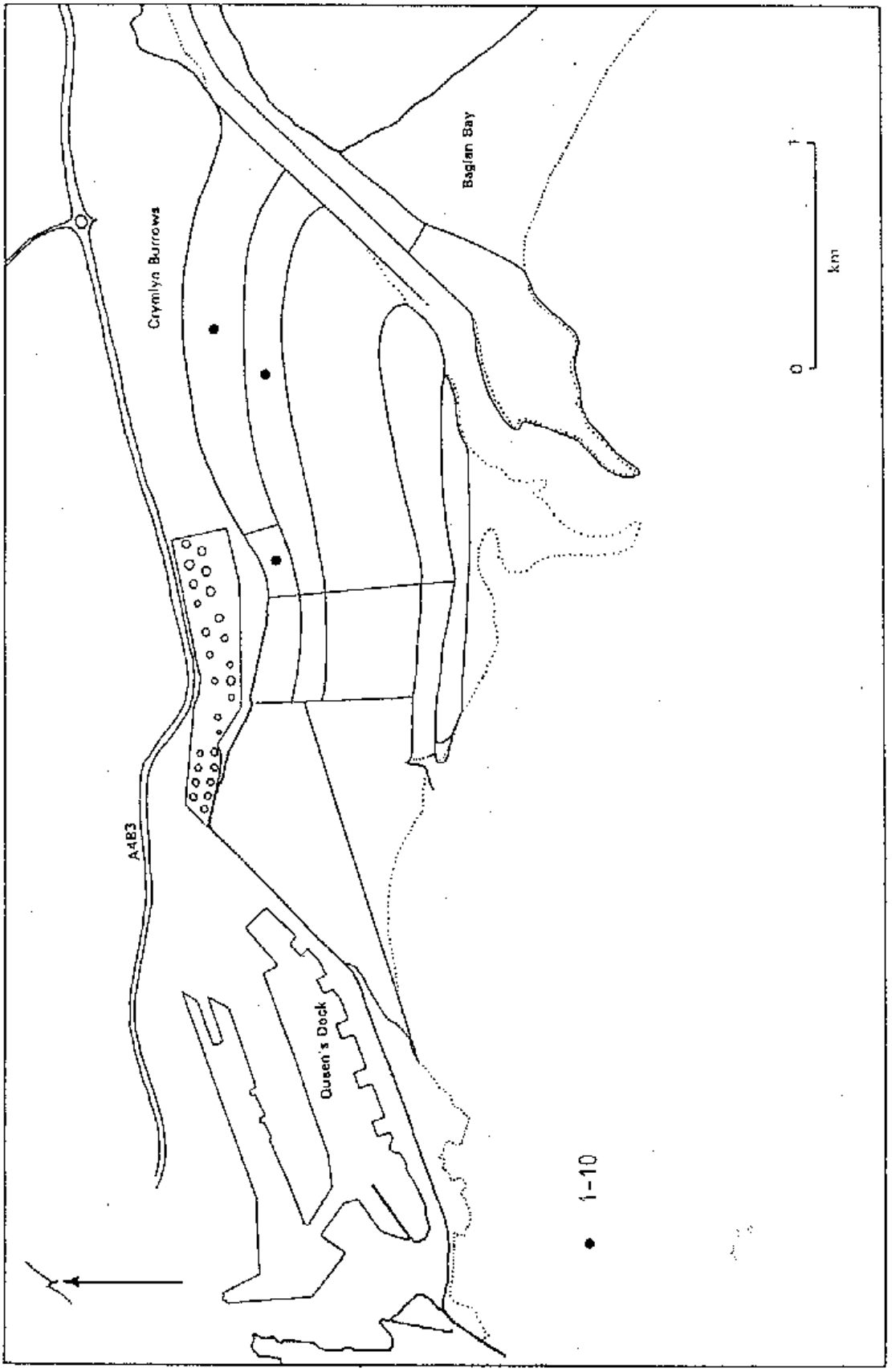


Figure 7.2.5 The distribution of roosting Ringed Plover in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

GREY PLOVER

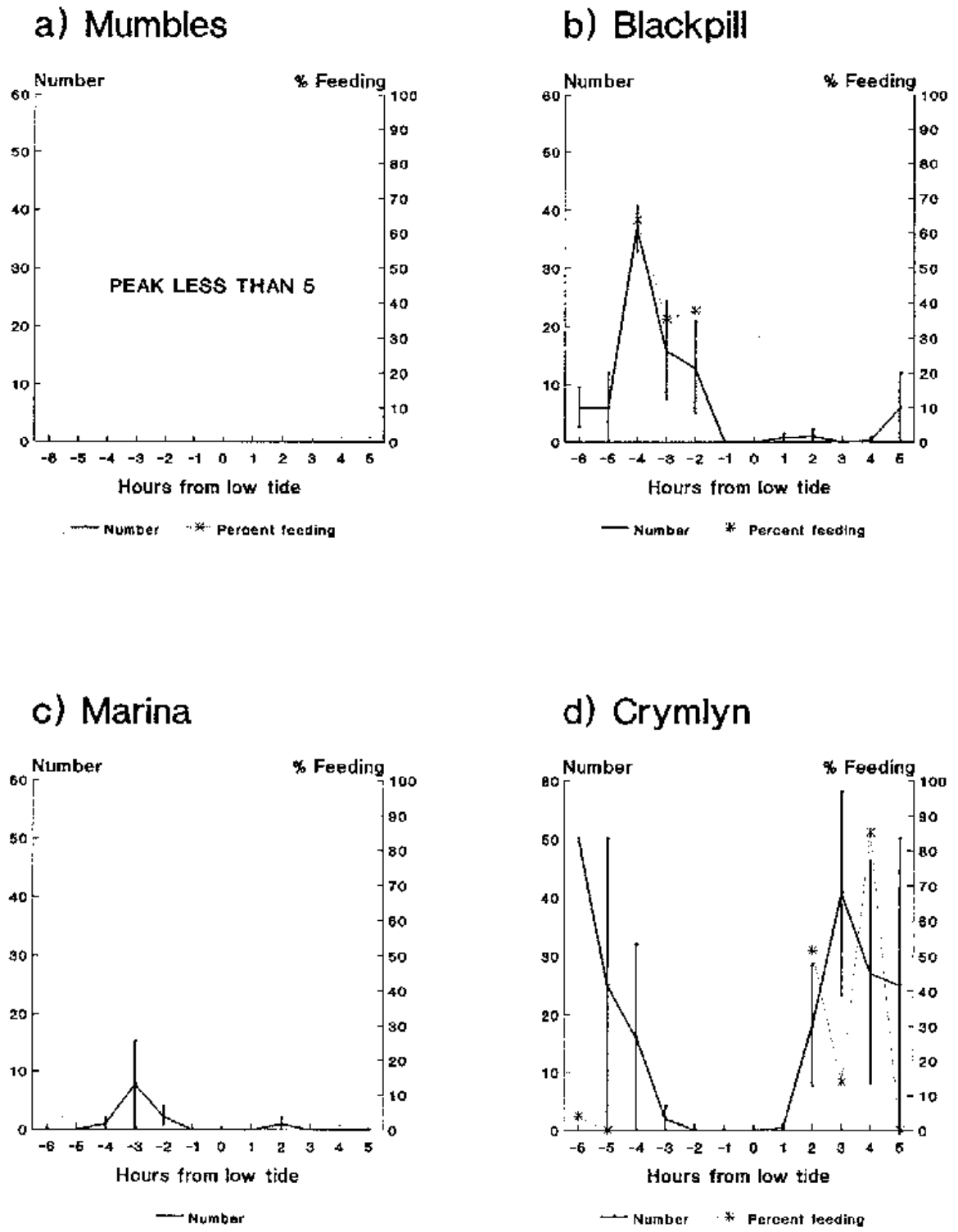


Figure 7.3.1 The average number of Grey Plover present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

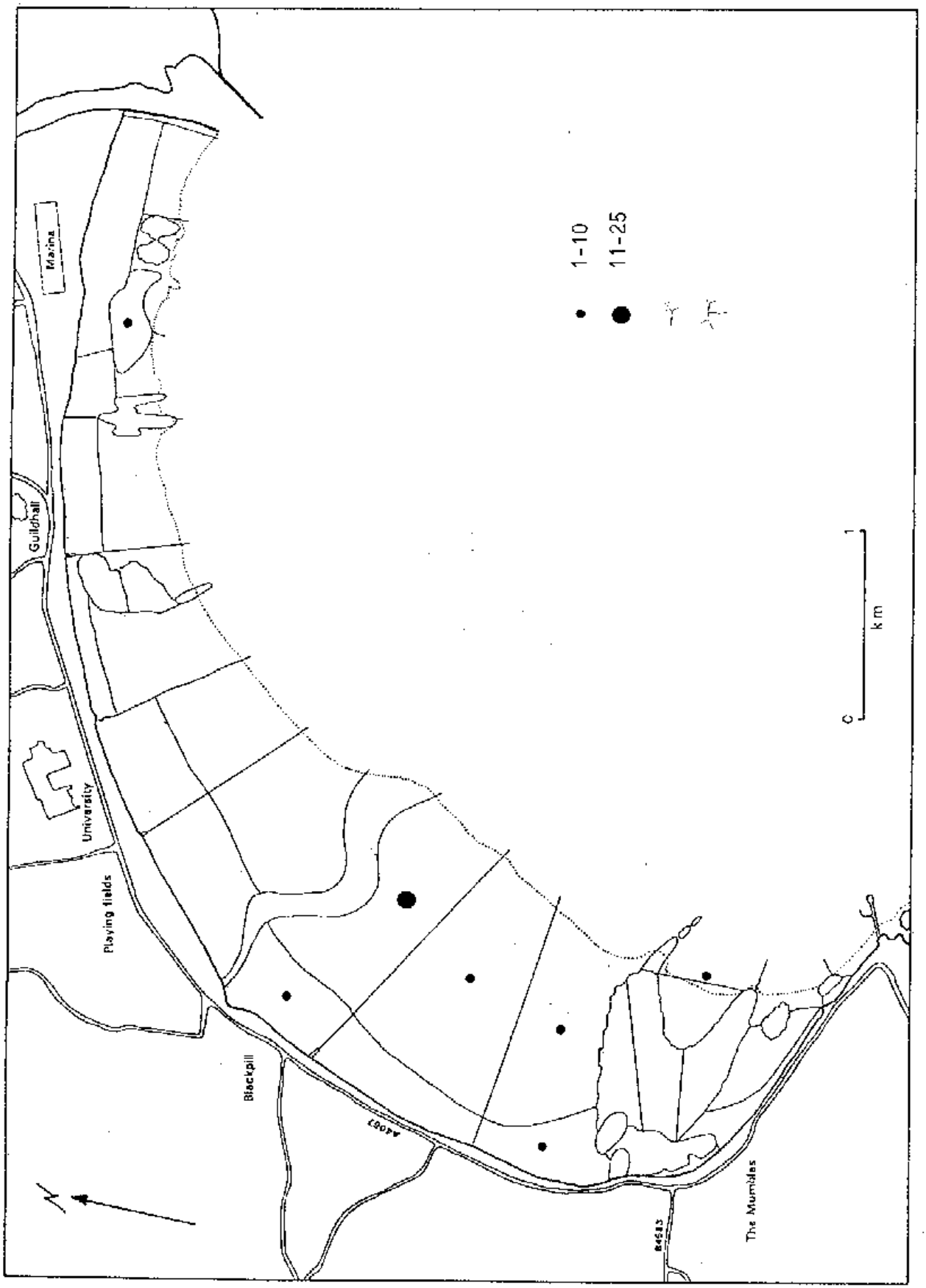


Figure 7.3.2 The distribution of feeding Grey Plover in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

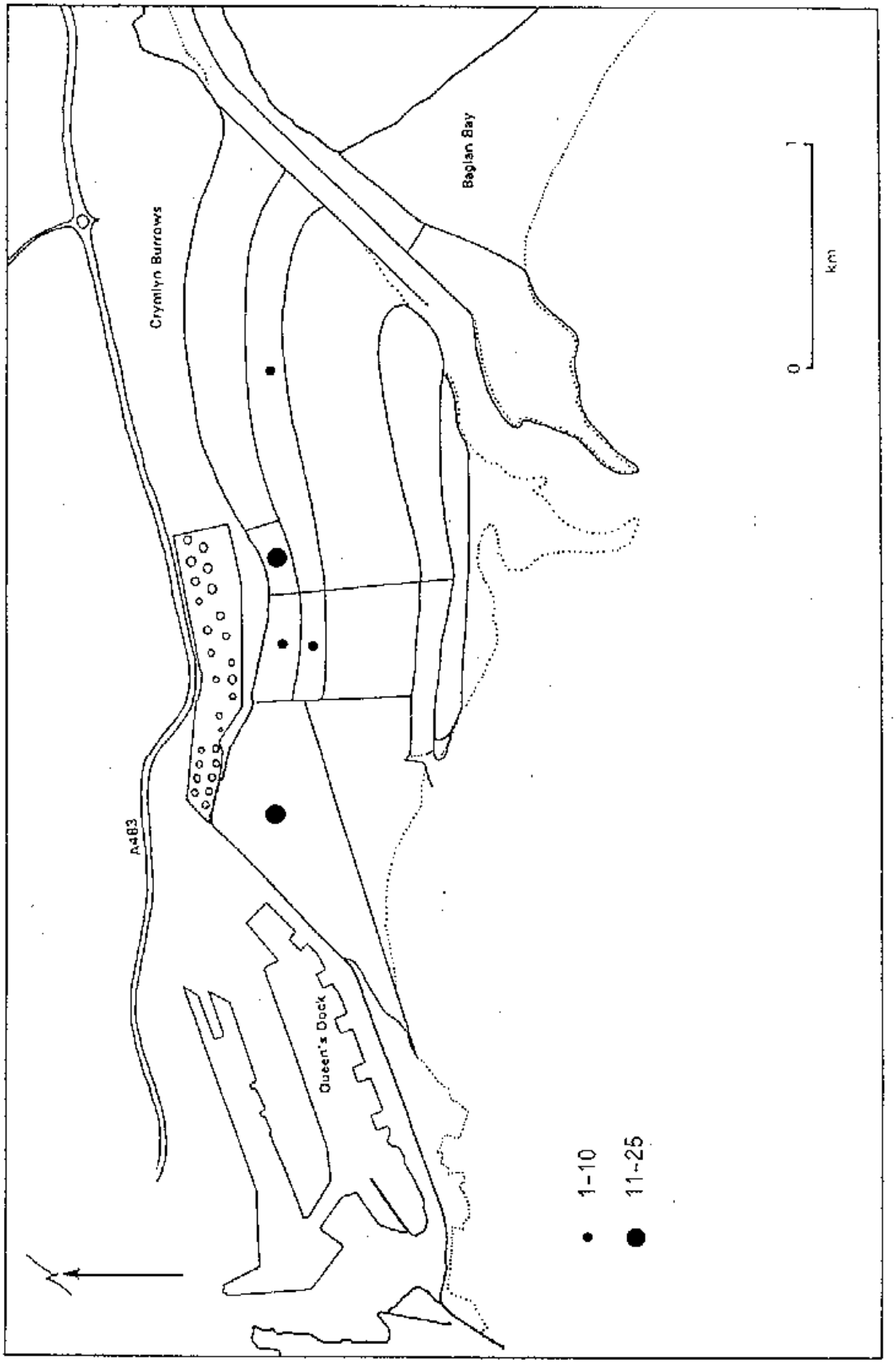


Figure 7.3.3 The distribution of feeding Grey Plover in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

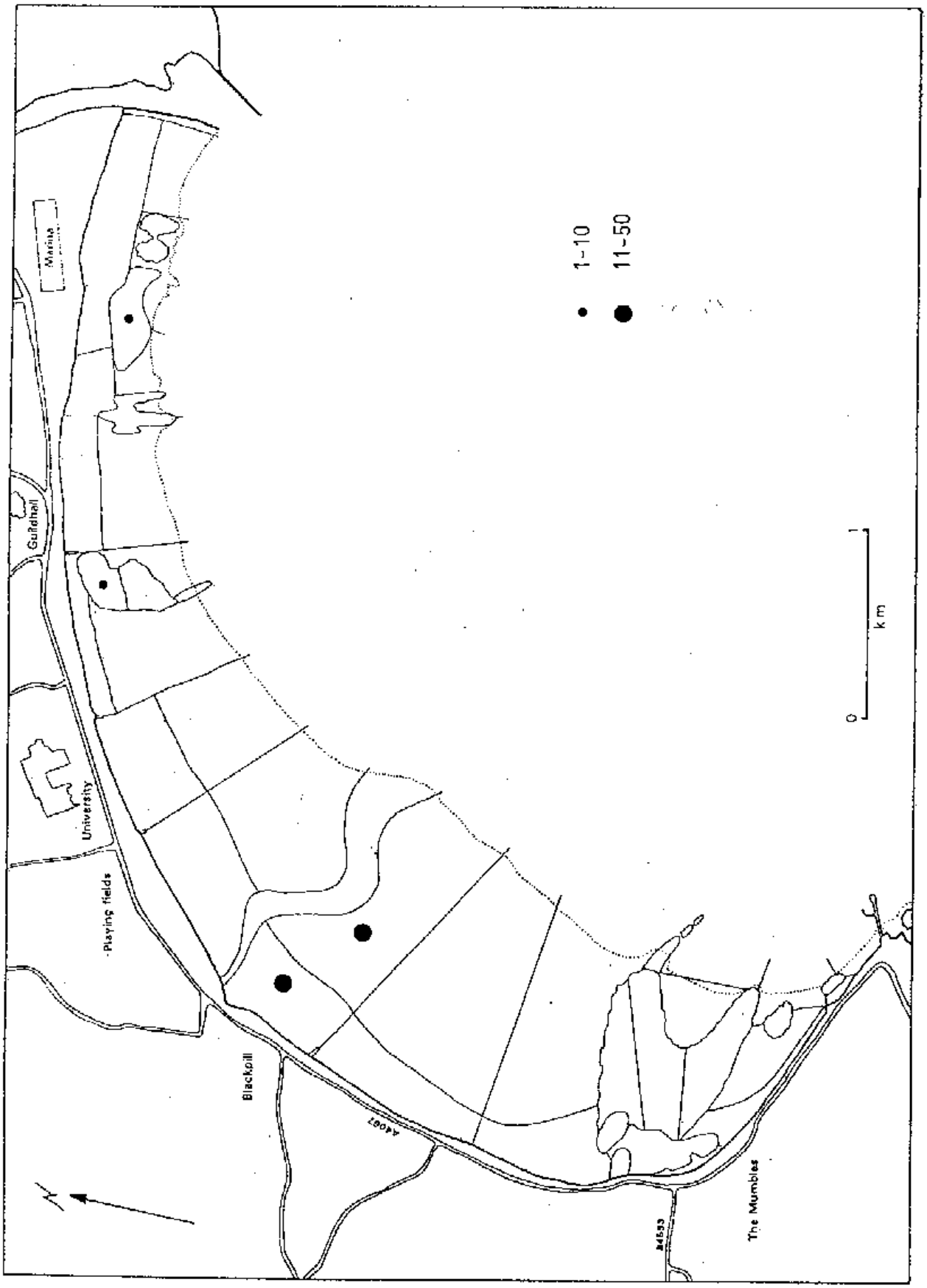


Figure 7.3.4 The distribution of roosting Grey Plover in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

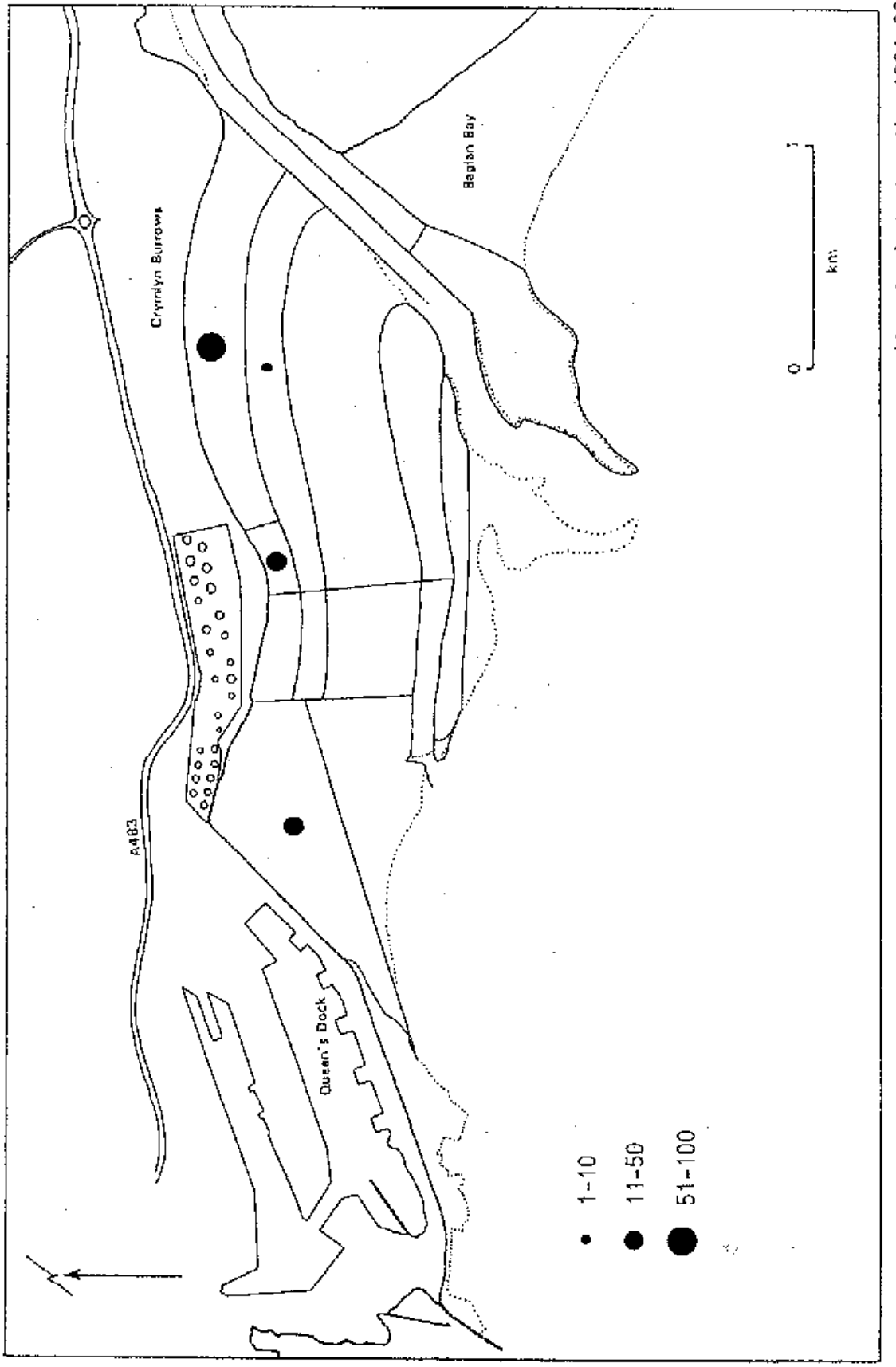


Figure 7.3.5 The distribution of roosting Grey Plover in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

SANDERLING

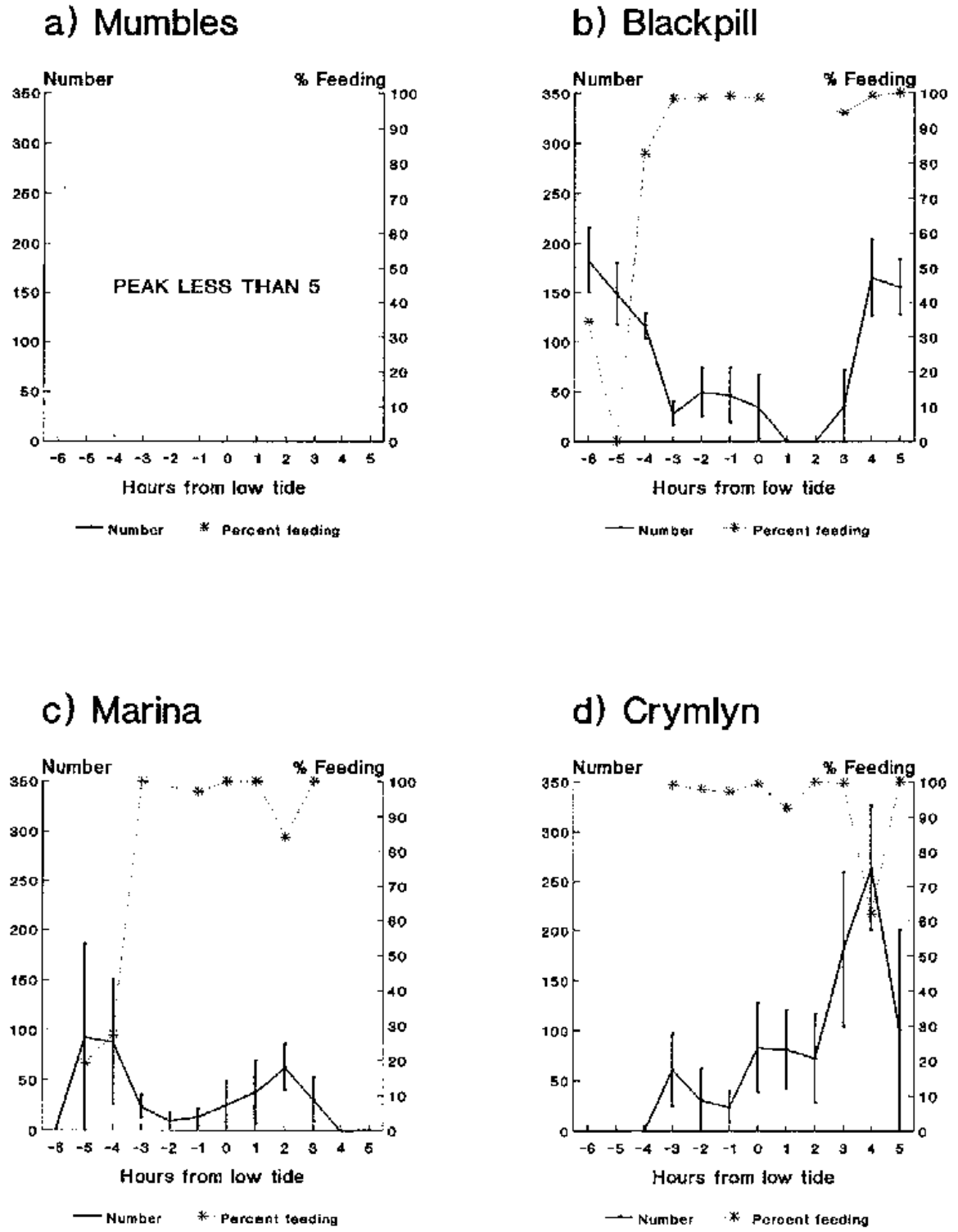


Figure 7.5.1 The average number of Sanderling present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

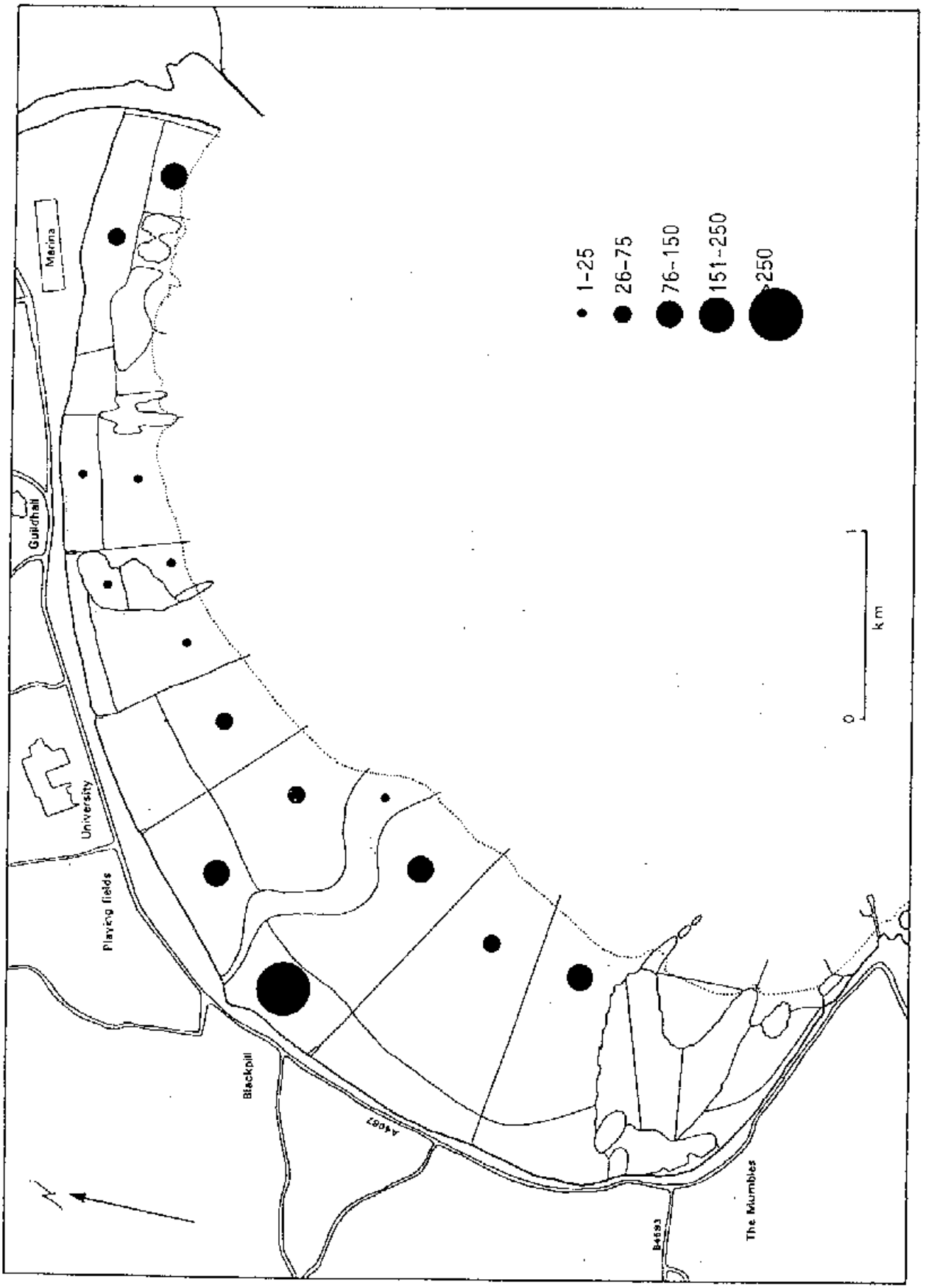


Figure 7.5.2 The distribution of feeding Sanderling in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

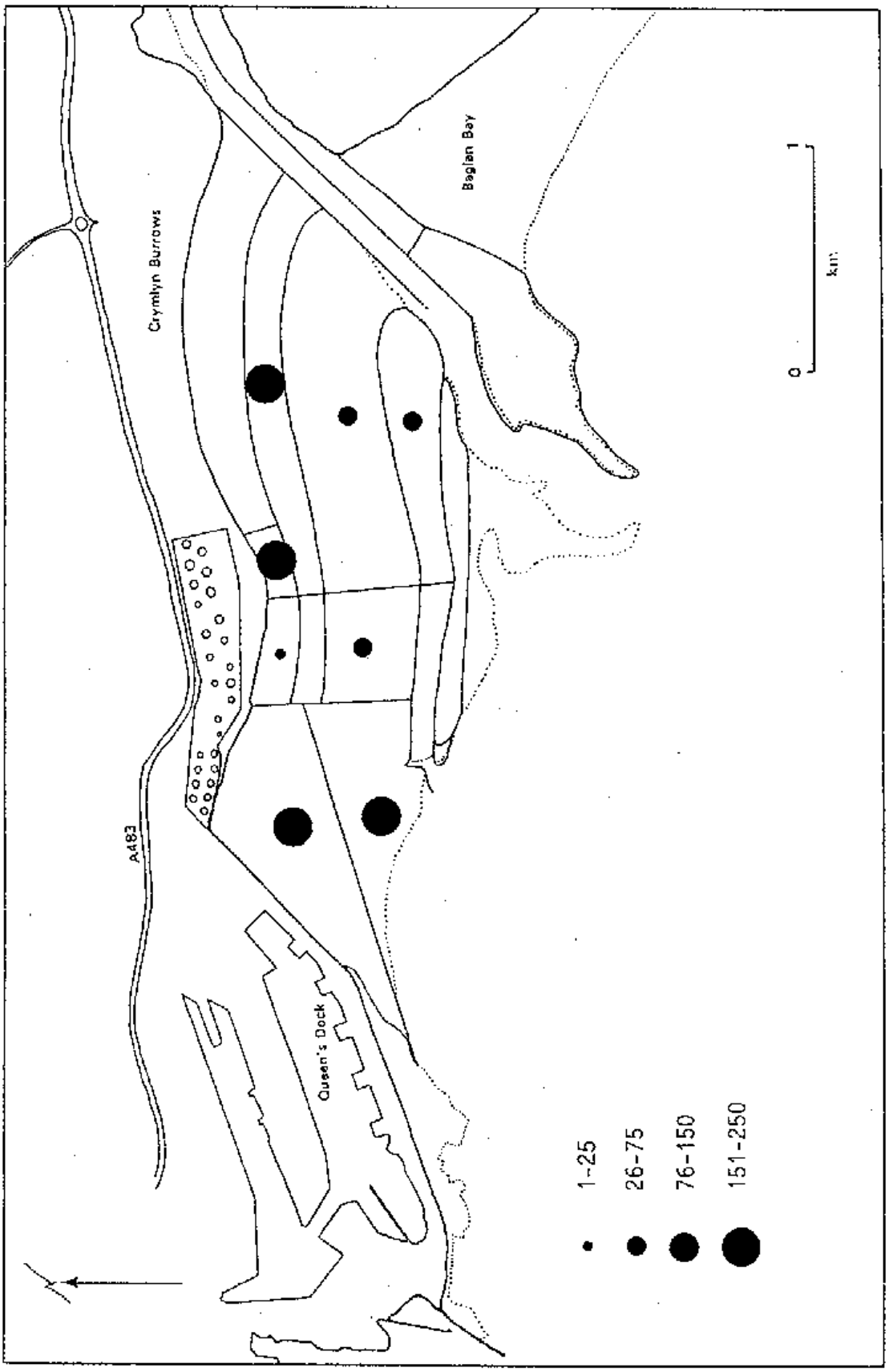


Figure 7.5.3 The distribution of feeding Sanderling in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

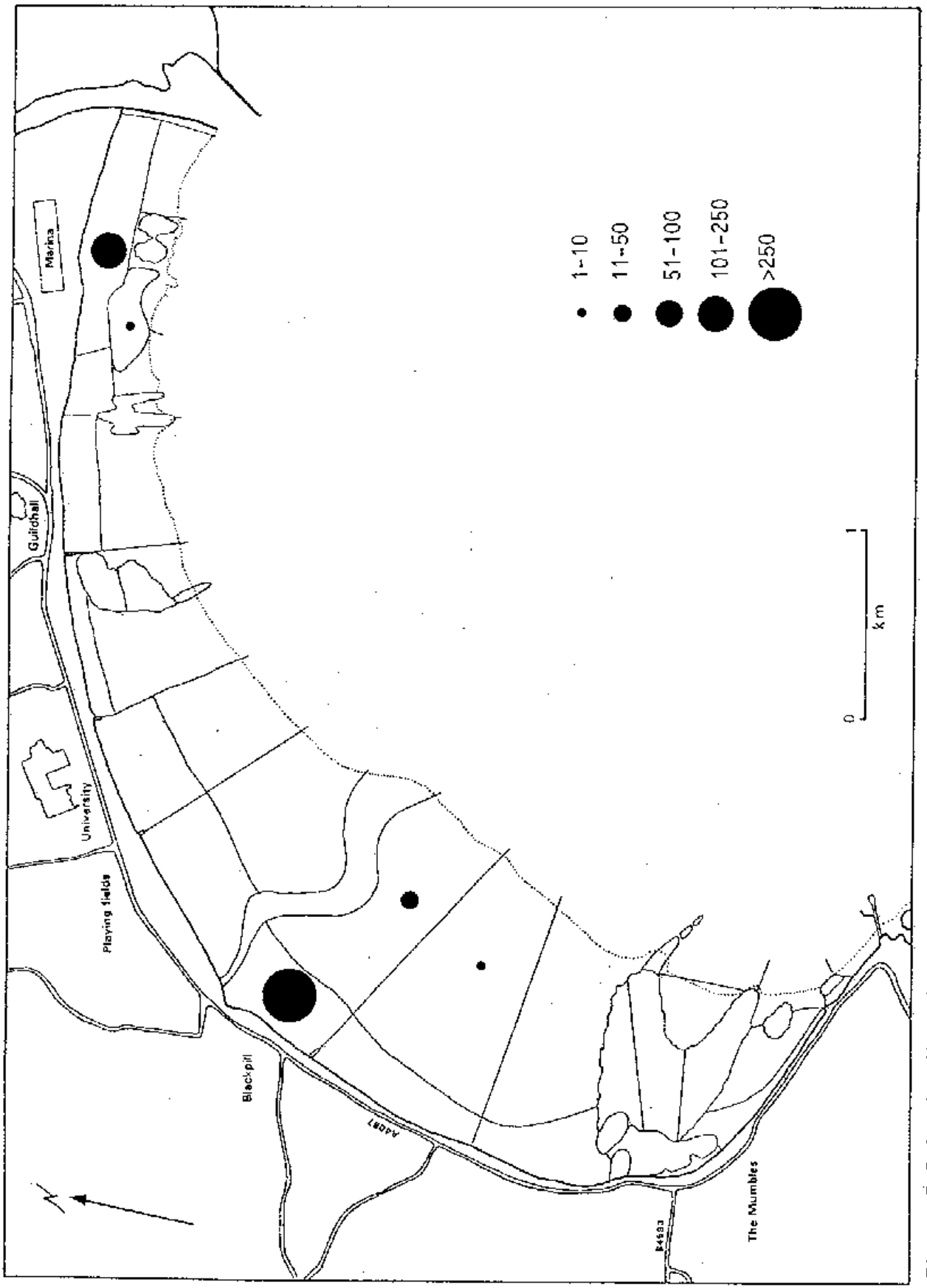


Figure 7.5.4 The distribution of roosting Sanderling in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

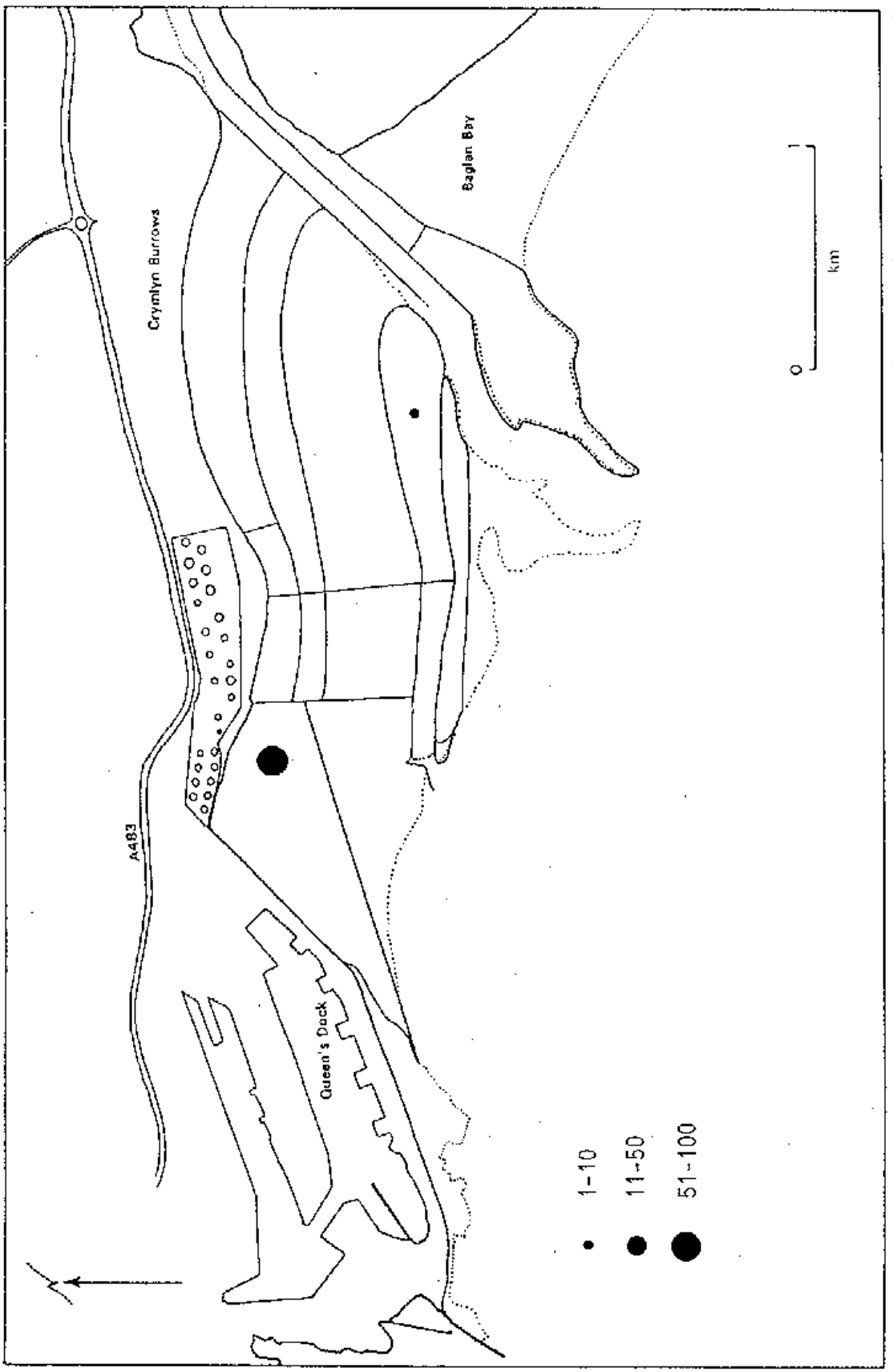


Figure 7.5.5 The distribution of roosting Sanderling in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

DUNLIN

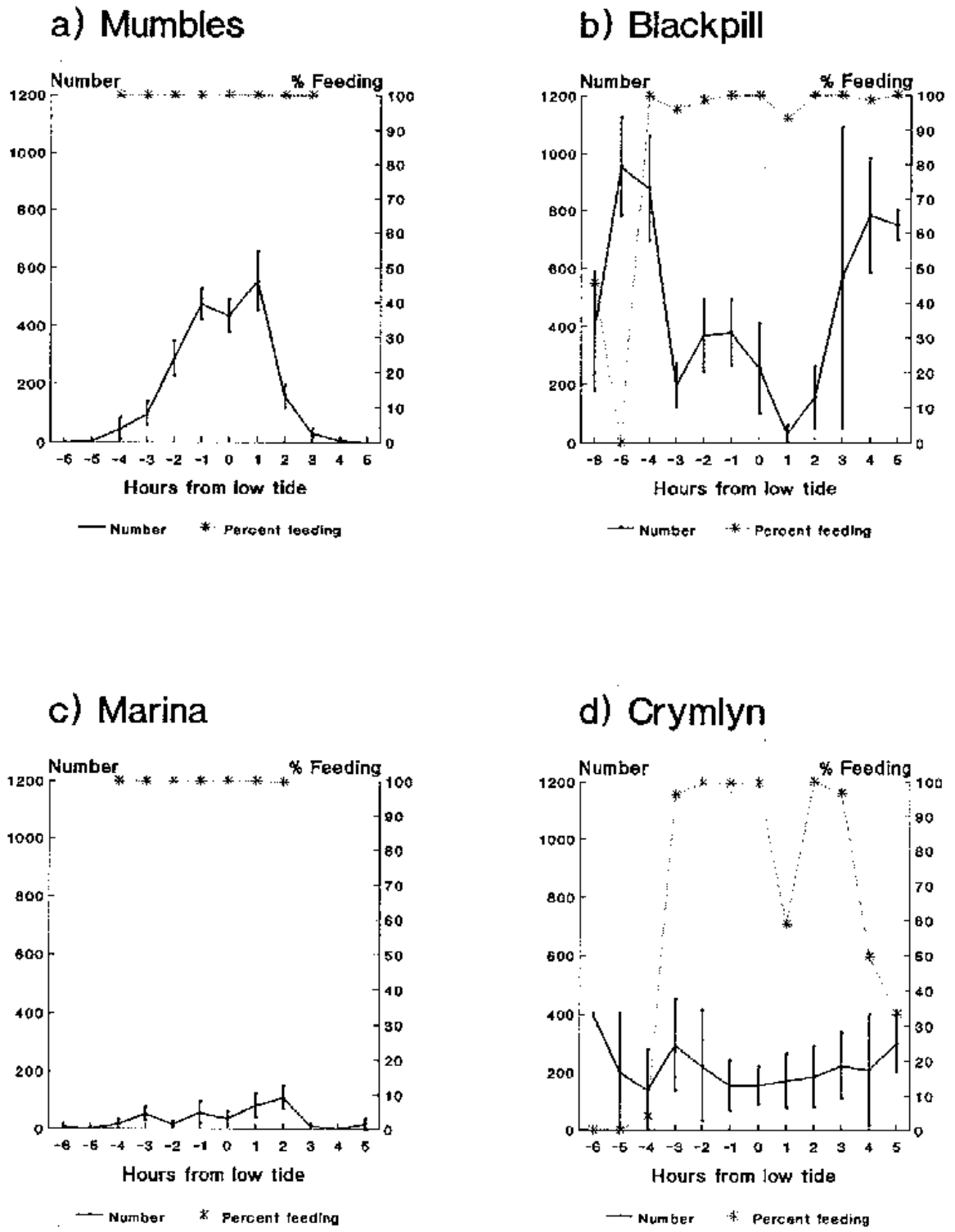


Figure 7.6.1 The average number of Dunlin present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

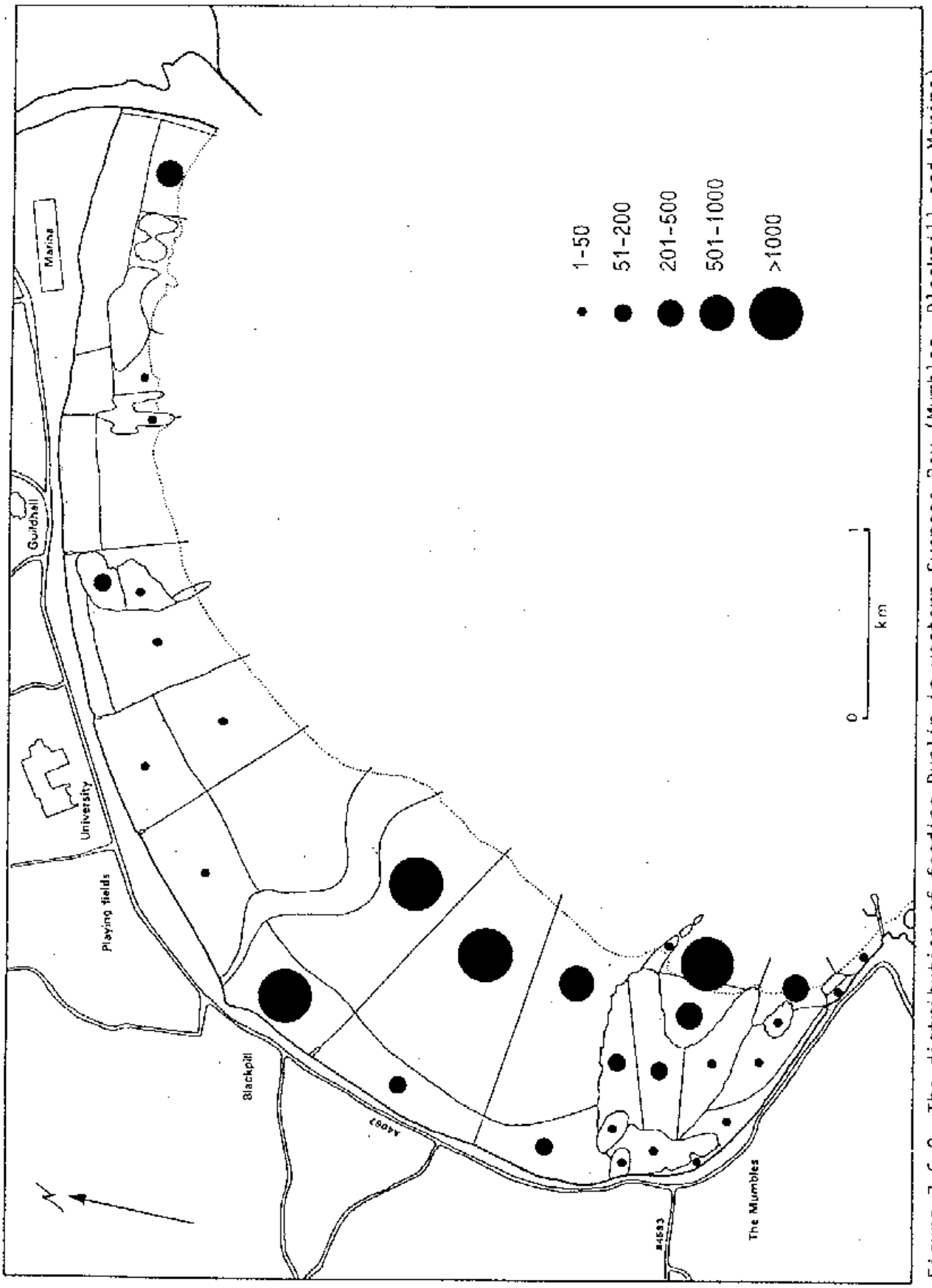


Figure 7.6.2 The distribution of feeding Dunlin in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

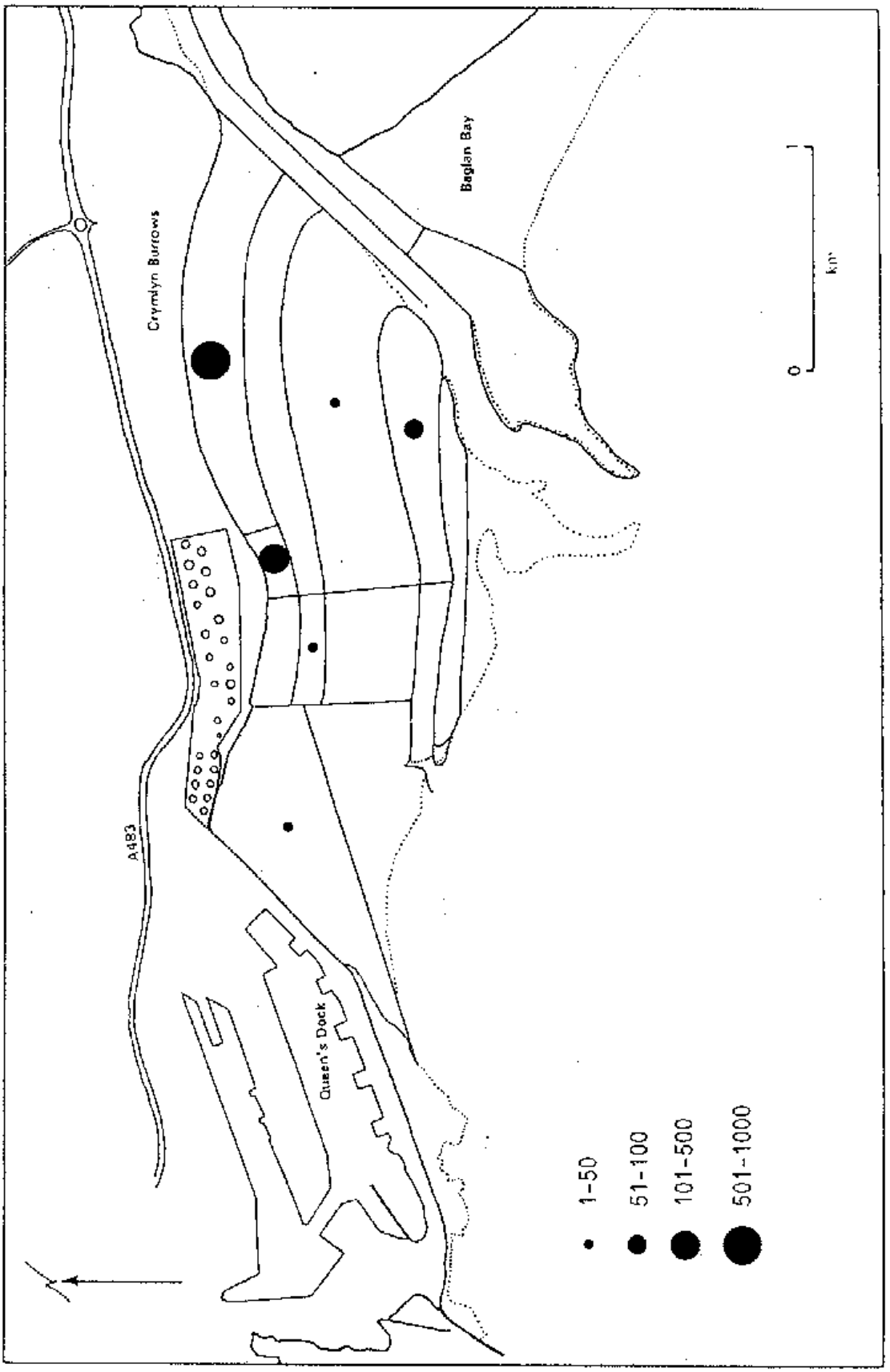


Figure 7.6.3 The distribution of feeding Dunlin in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

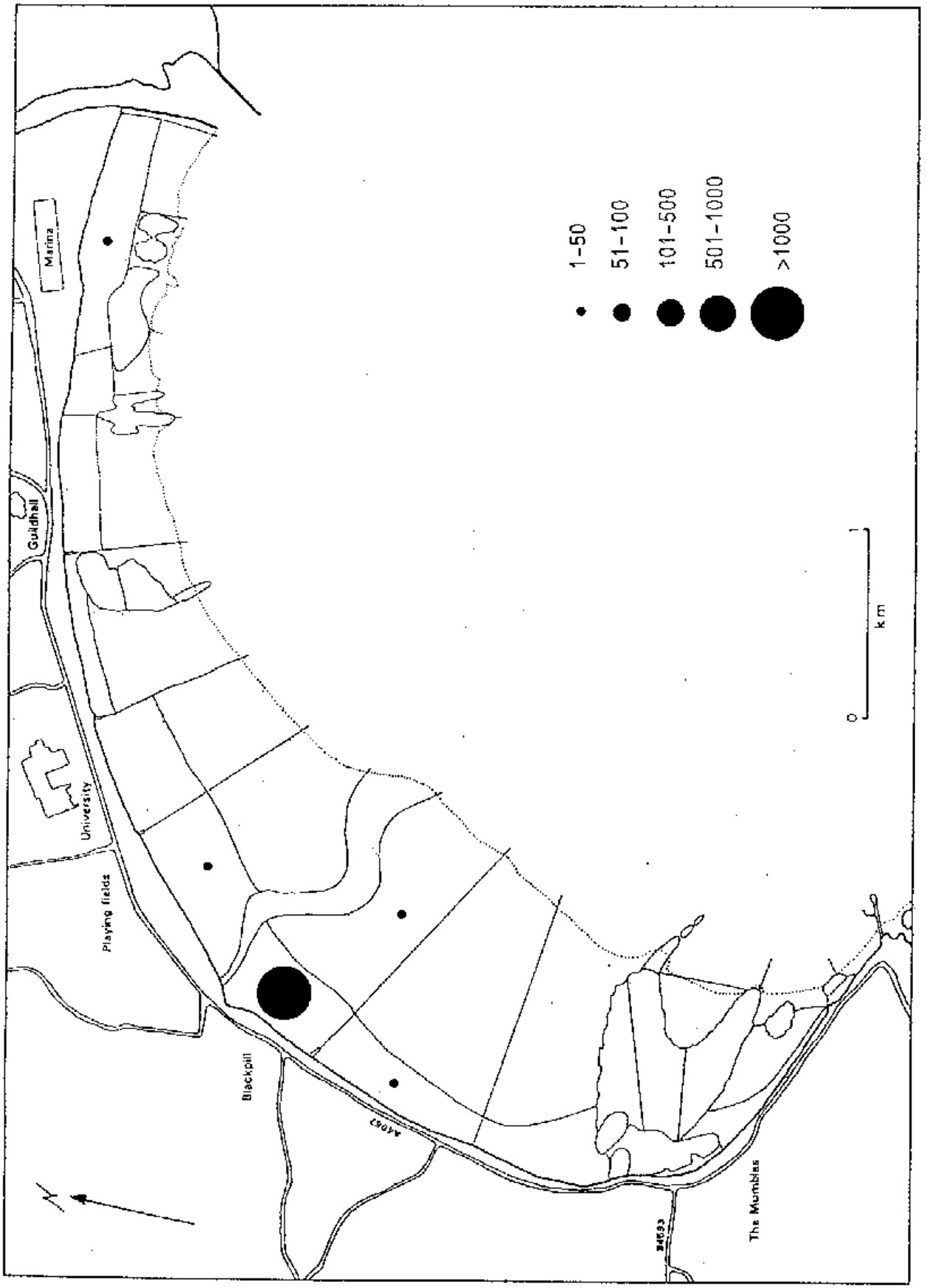


Figure 7.6.4 The distribution of roosting Dunlin in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

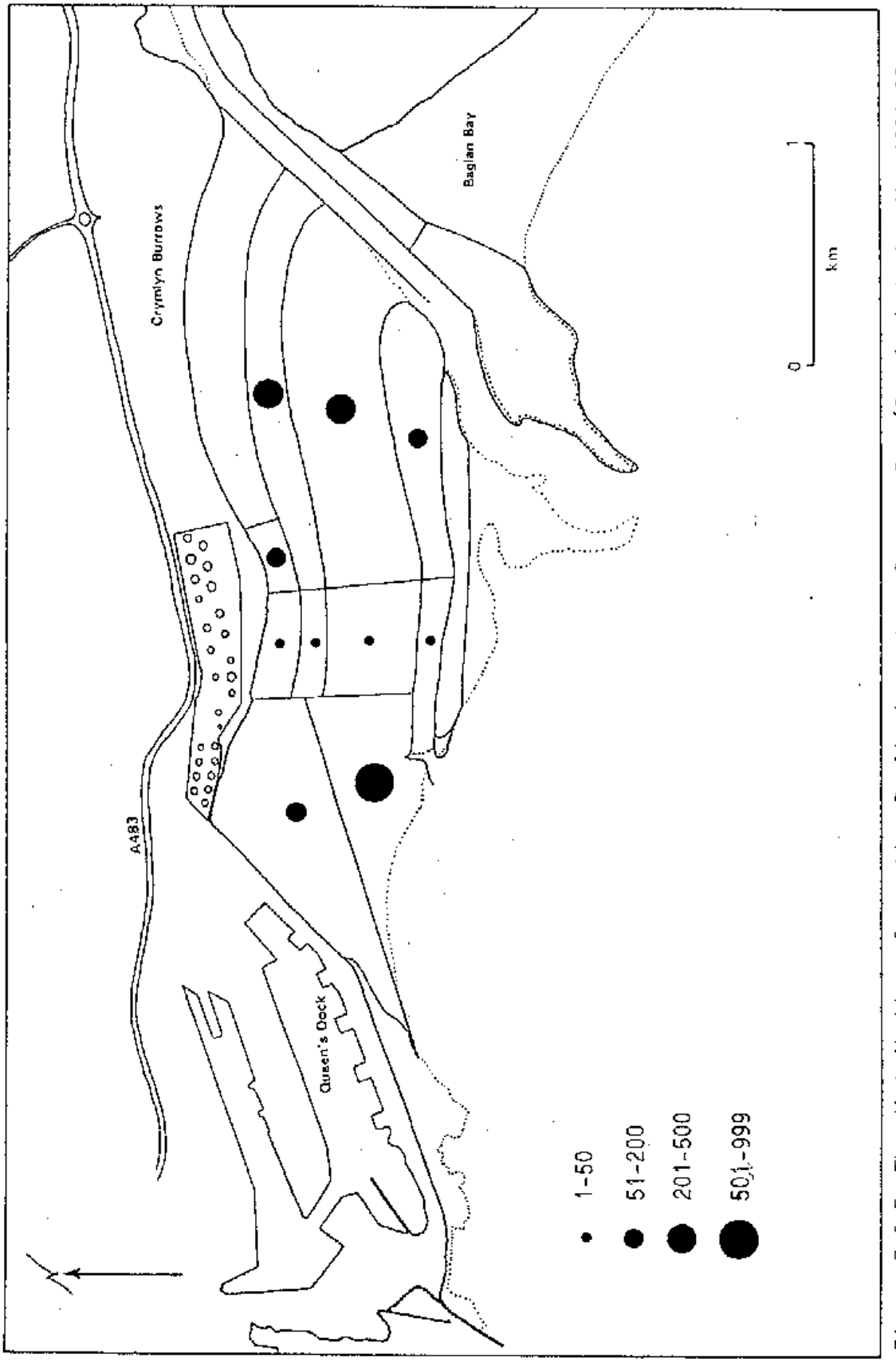


Figure 7.6.5 The distribution of roosting Dunlin in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

BAR-TAILED GODWIT

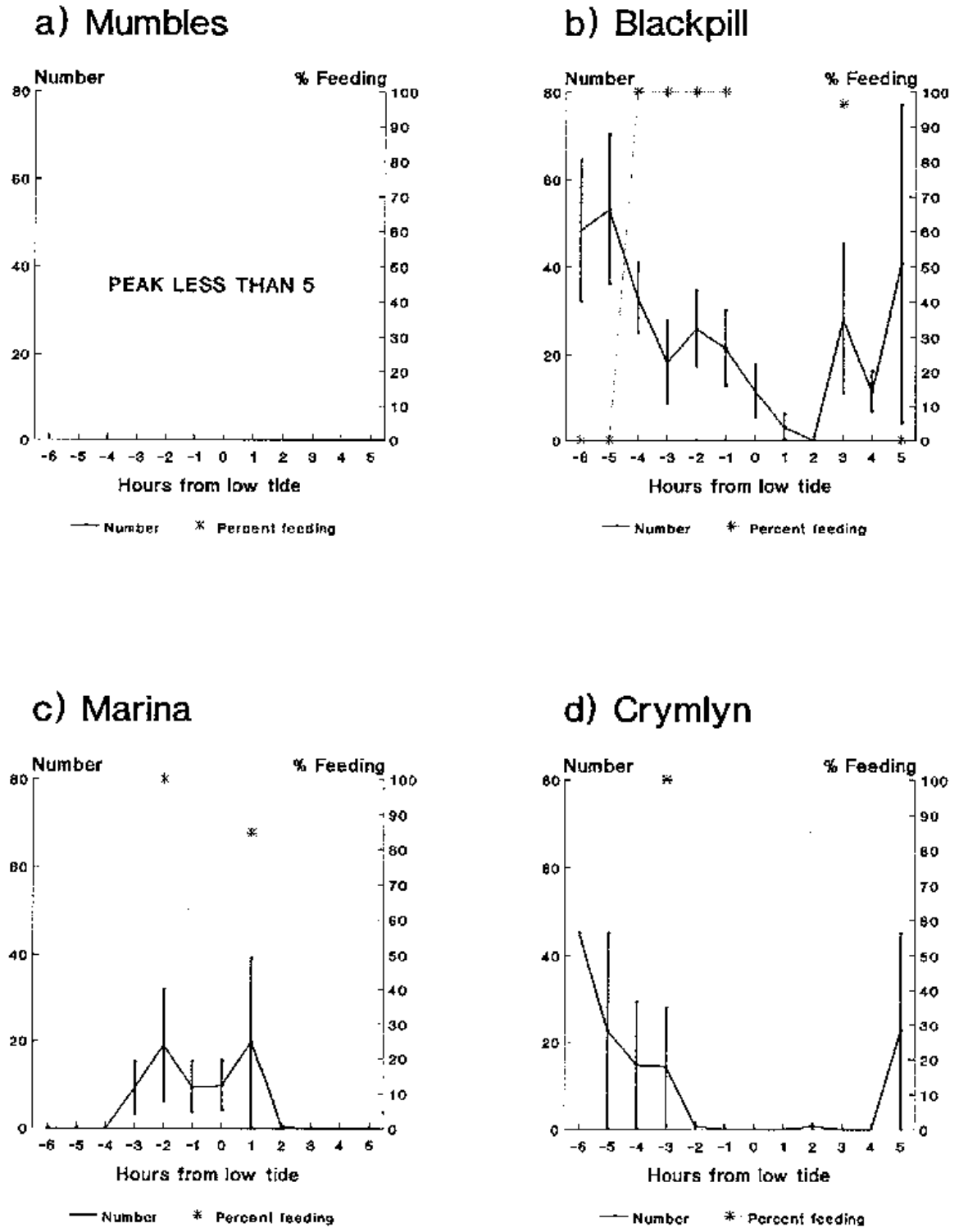


Figure 7.7.1 The average number of Bar-Tailed Godwit present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

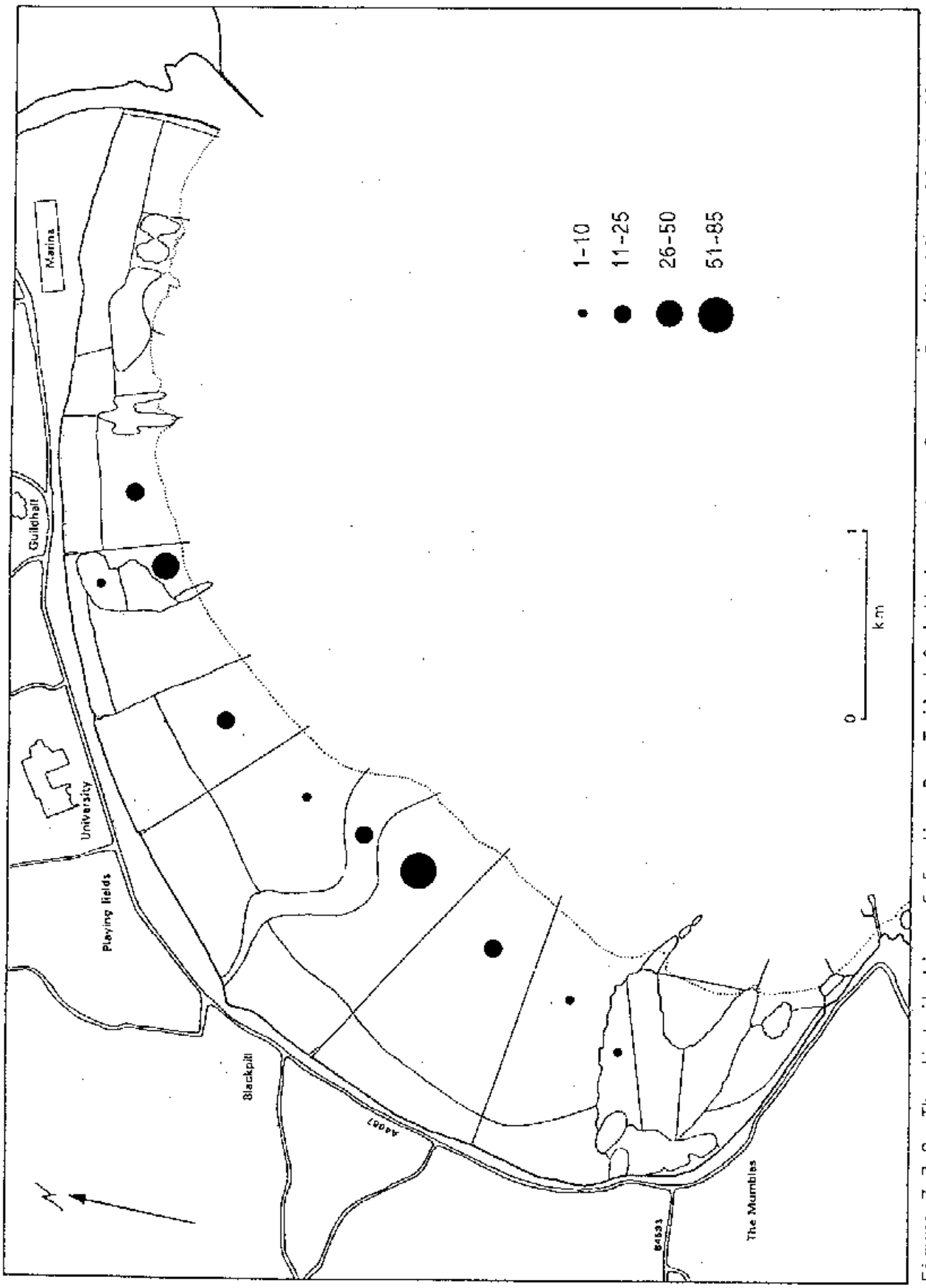


Figure 7.7.2 The distribution of feeding Bar-Tailed Godwit in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

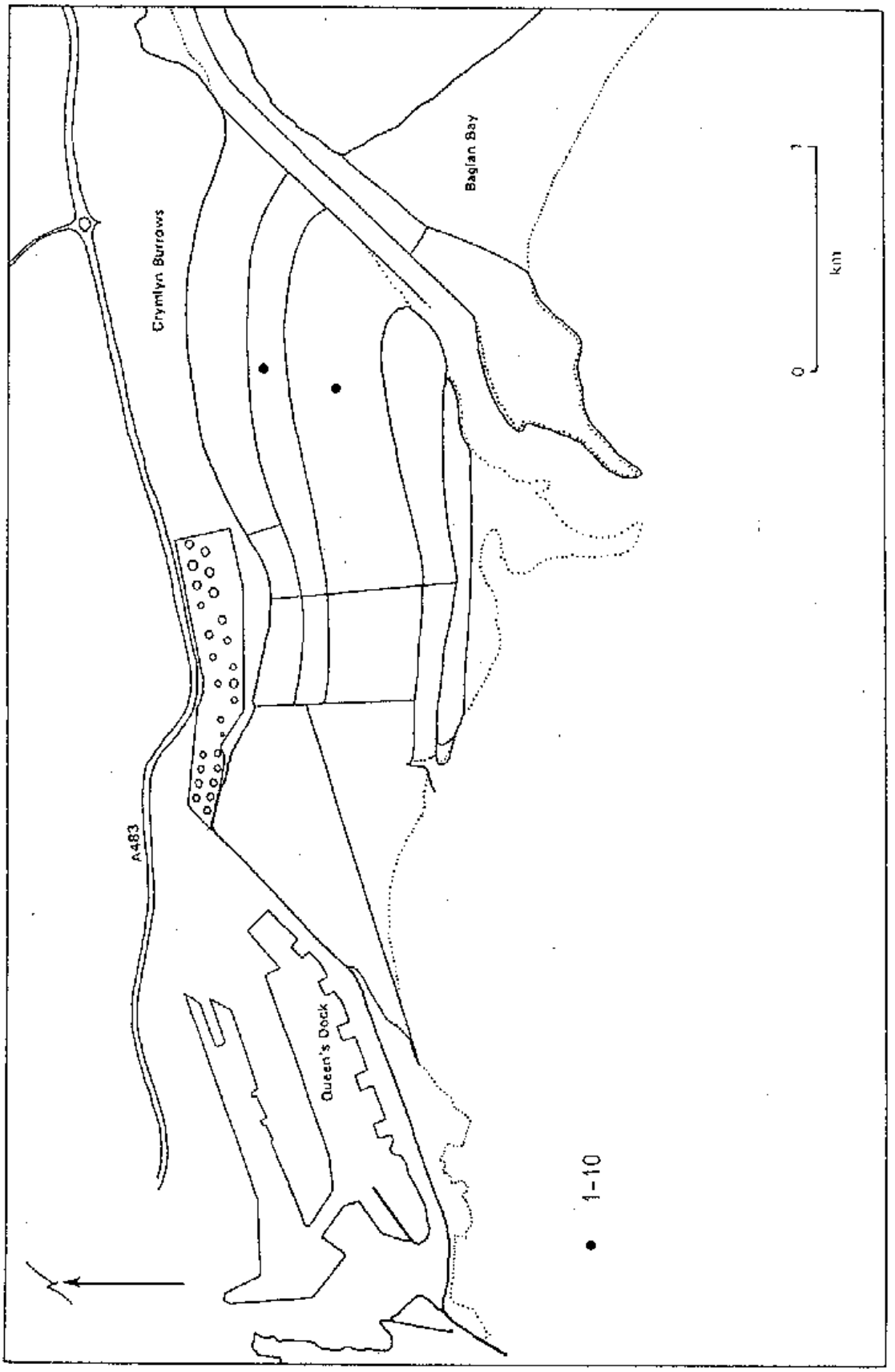


Figure 7.7.3 The distribution of feeding Bar-Tailed Godwit in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

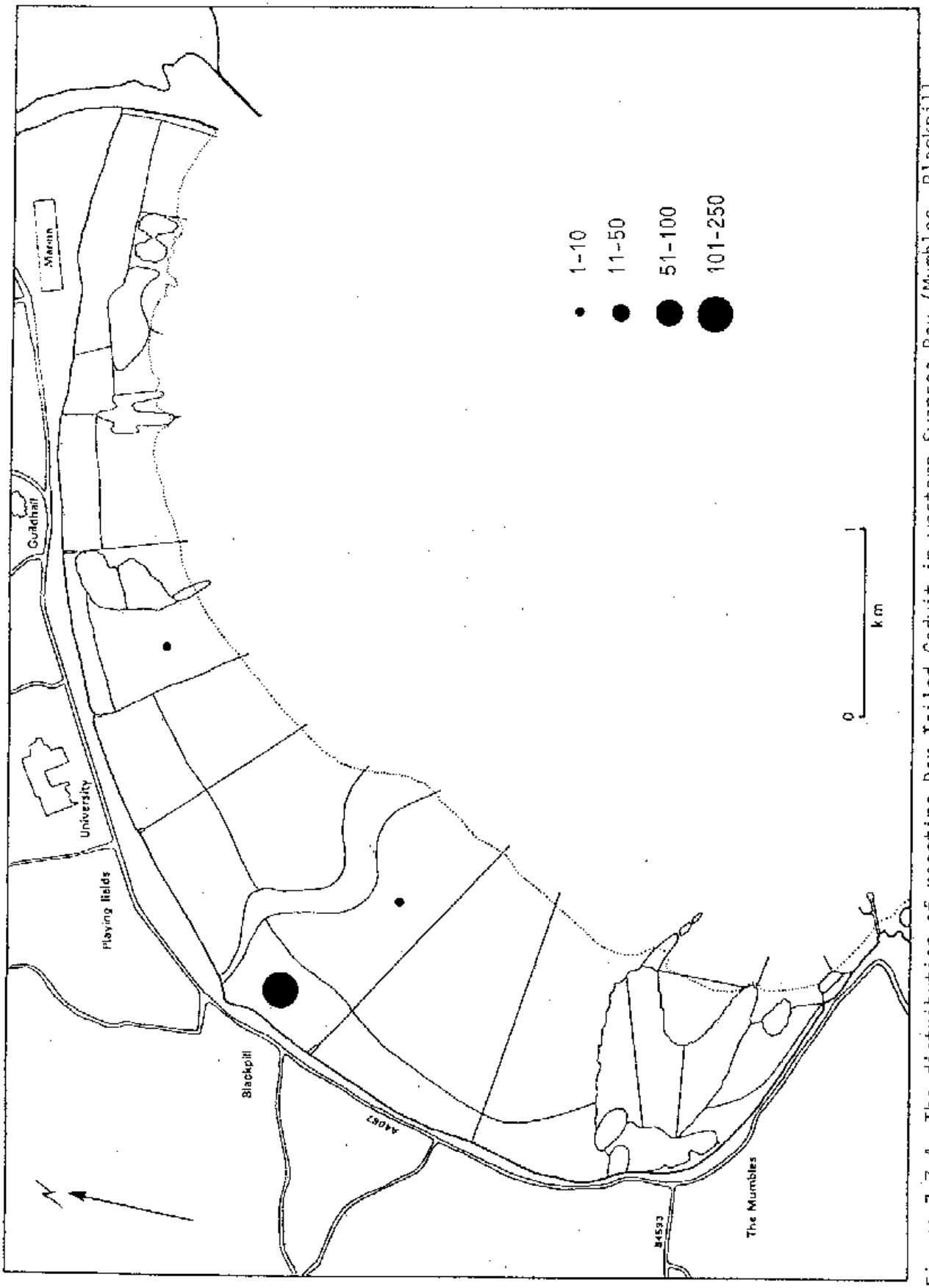


Figure 7.7.4 The distribution of roosting Bar-tailed Godwit in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

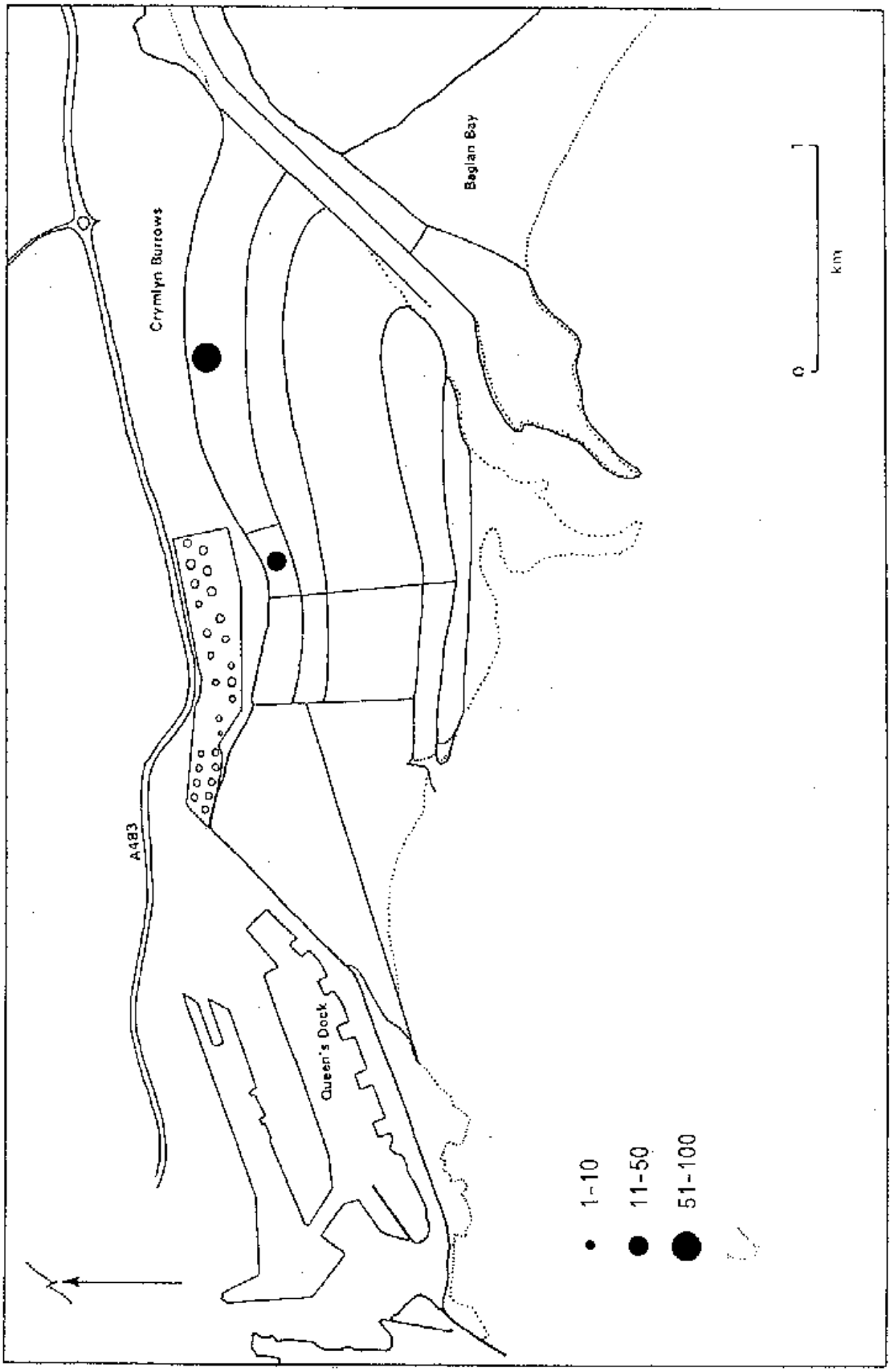


Figure 7.7.5 The distribution of roosting Bar-Tailed Godwit in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

CURLEW

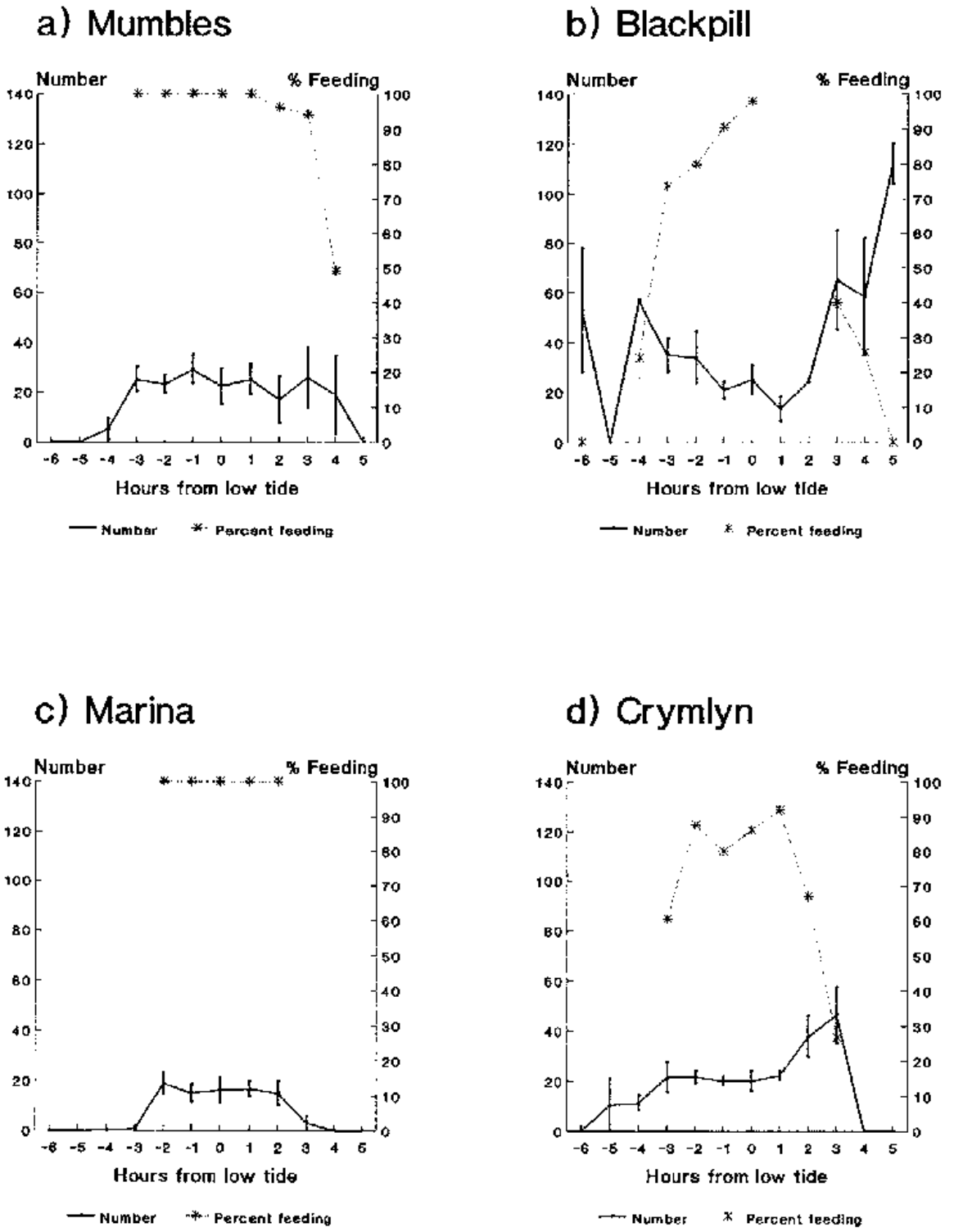


Figure 7.8.1 The average number of Curlew present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

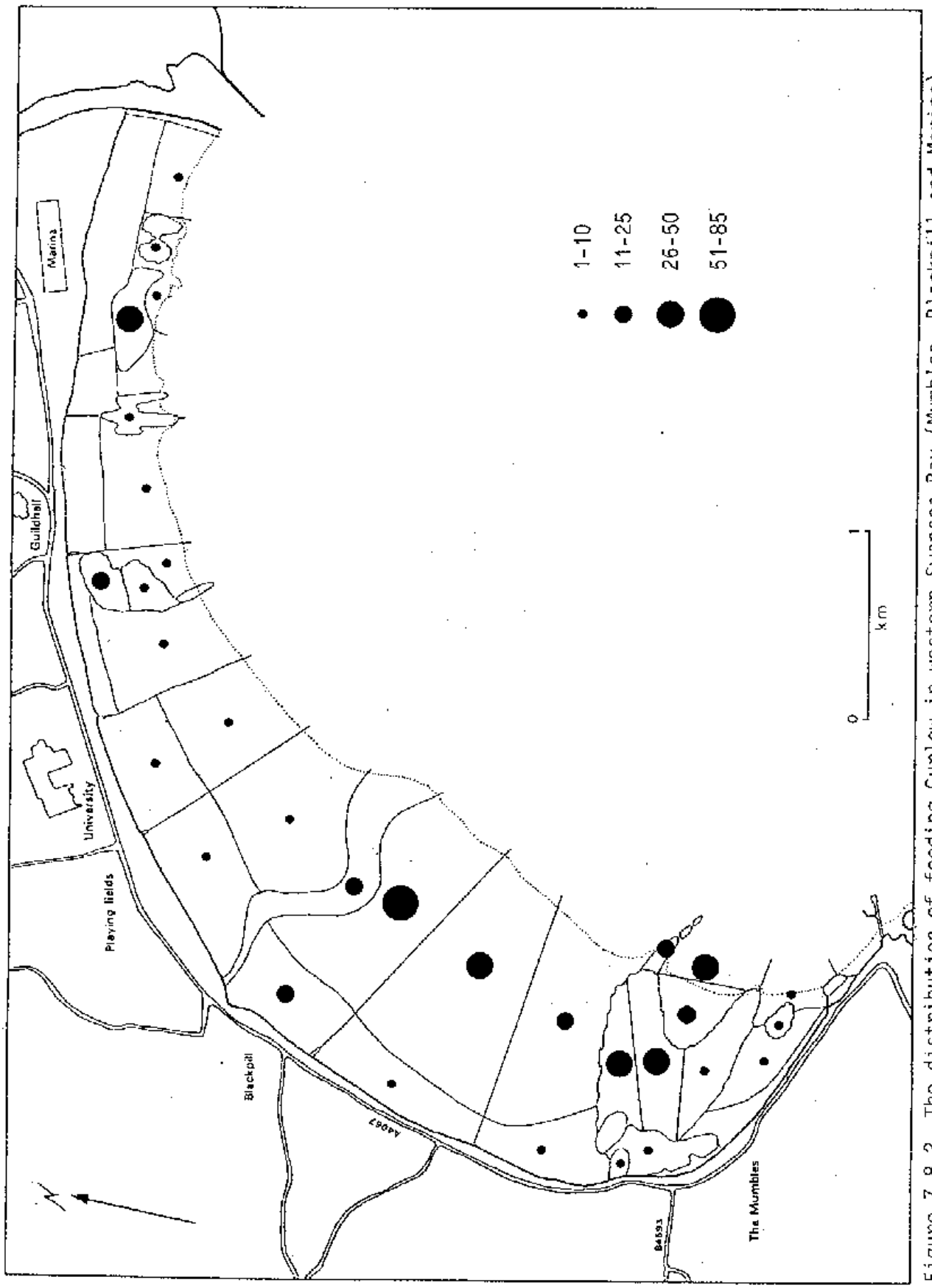


Figure 7.8.2 The distribution of feeding Curlew in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

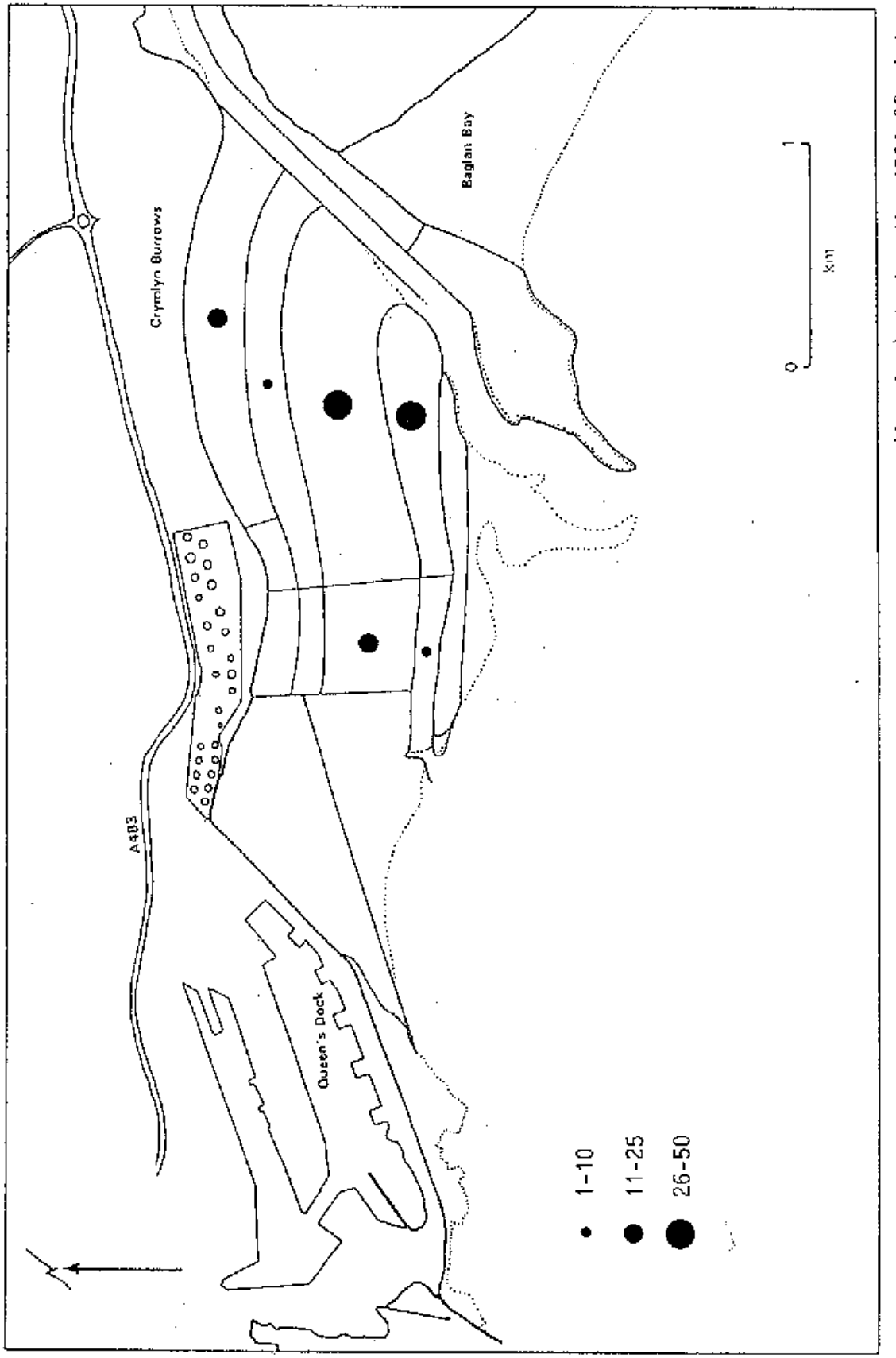


Figure 7.8.3 The distribution of feeding Curlew in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

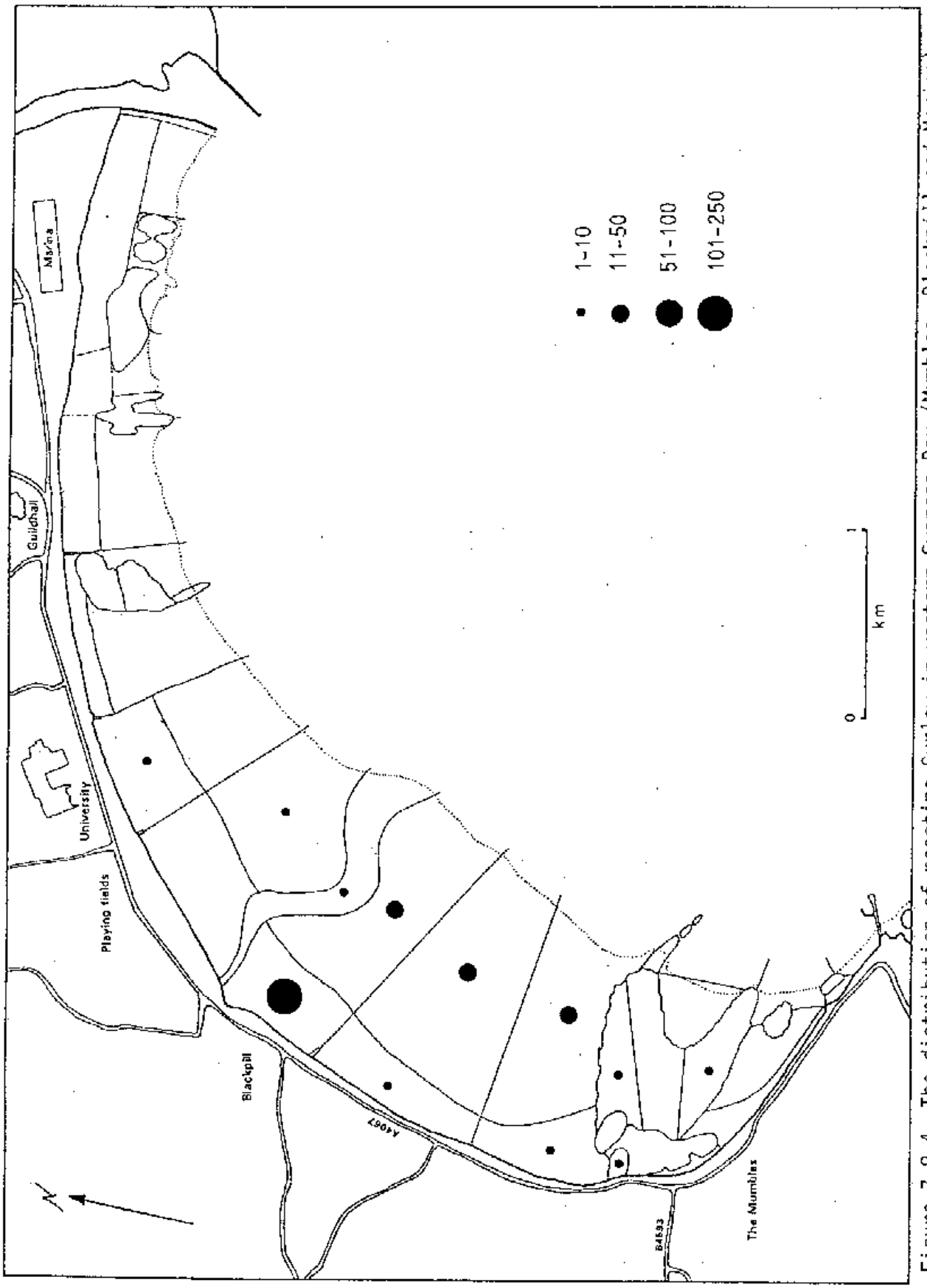


Figure 7.8.4 The distribution of roosting Curlew in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

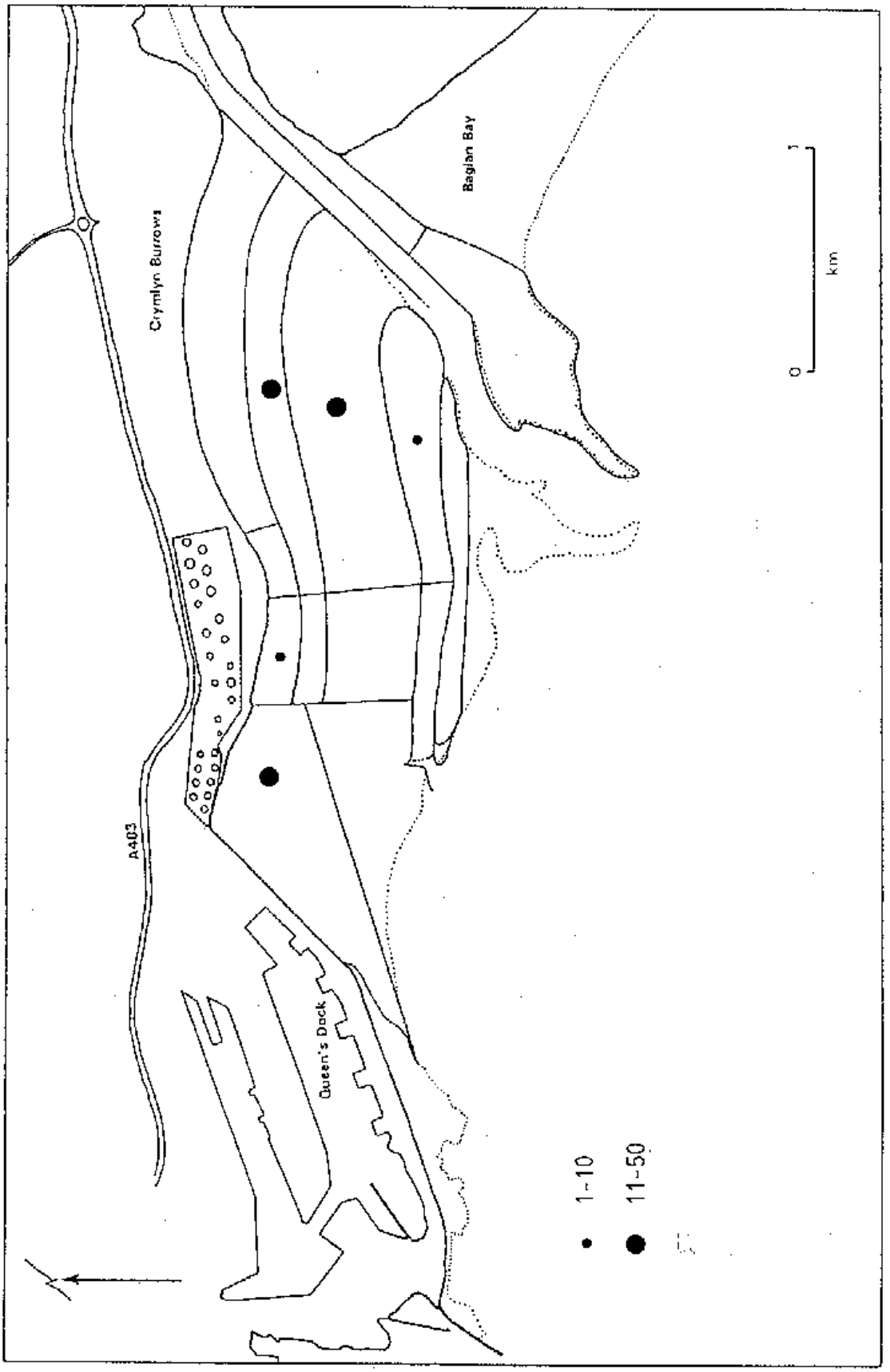
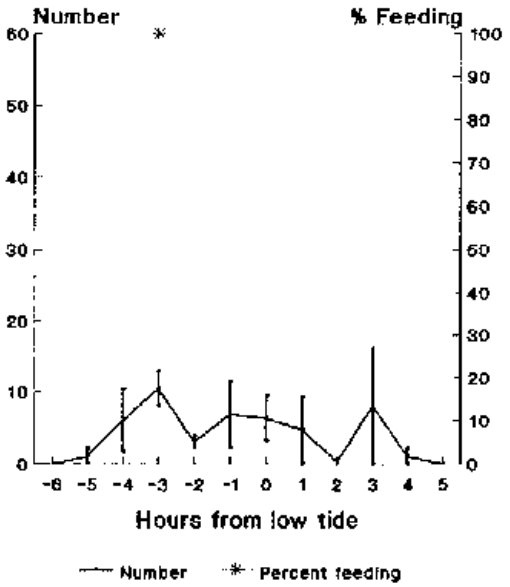


Figure 7.8.5 The distribution of roosting Curlew in eastern Swansea Bay (Crymlyn) during the 1991-92 winter assessed from all day observations. The average number of birds per tidal cycle is plotted for each area.

REDSHANK

a) Mumbles



b) Blackpill

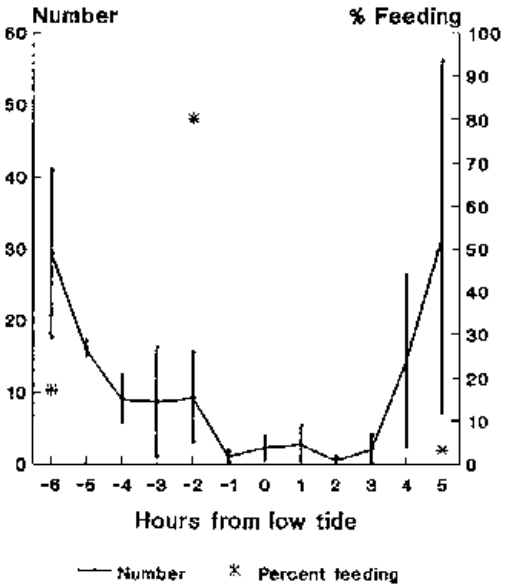


Figure 7.9.1 The average number of Redshank present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

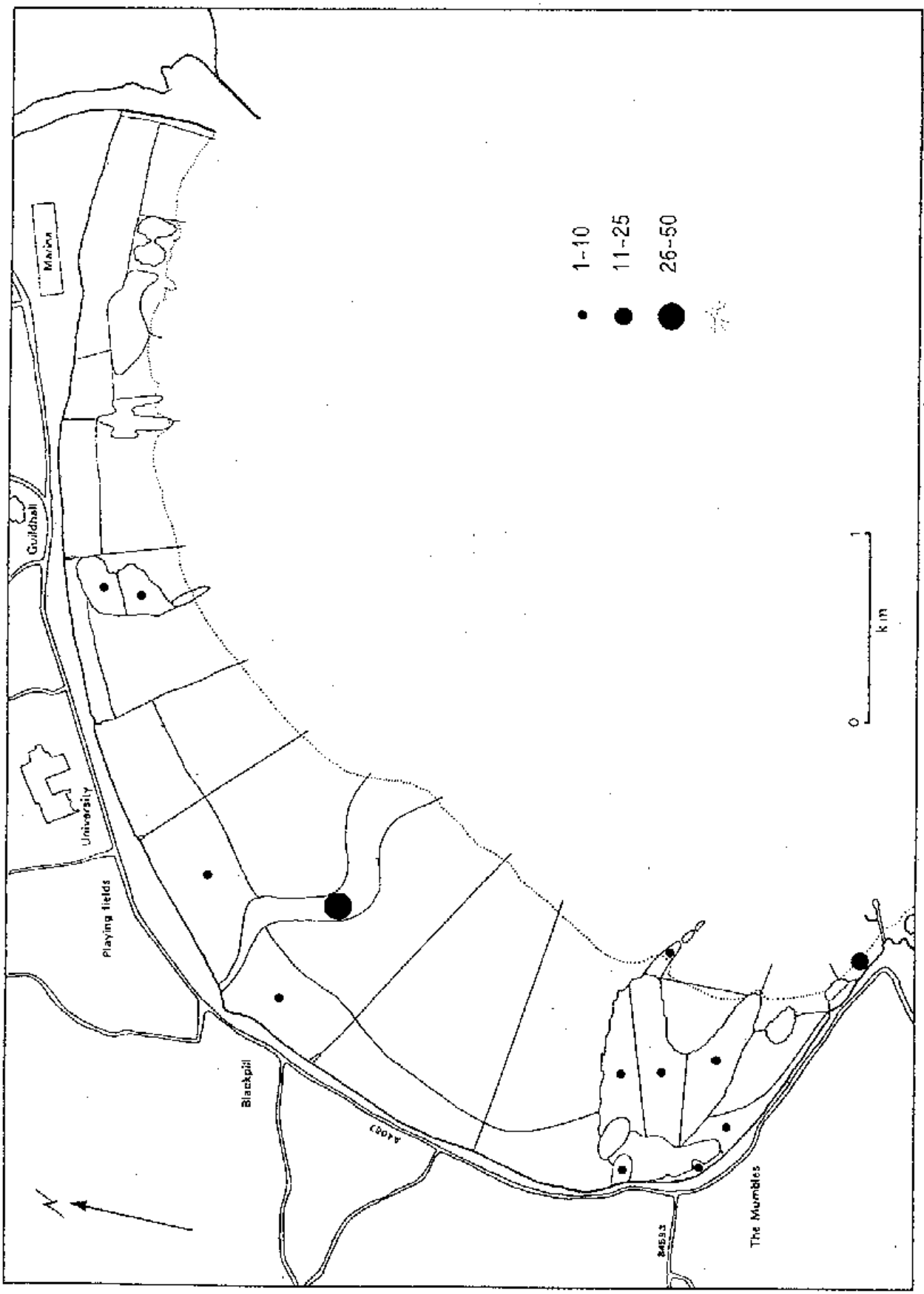


Figure 7.9.2 The distribution of feeding Redshank in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

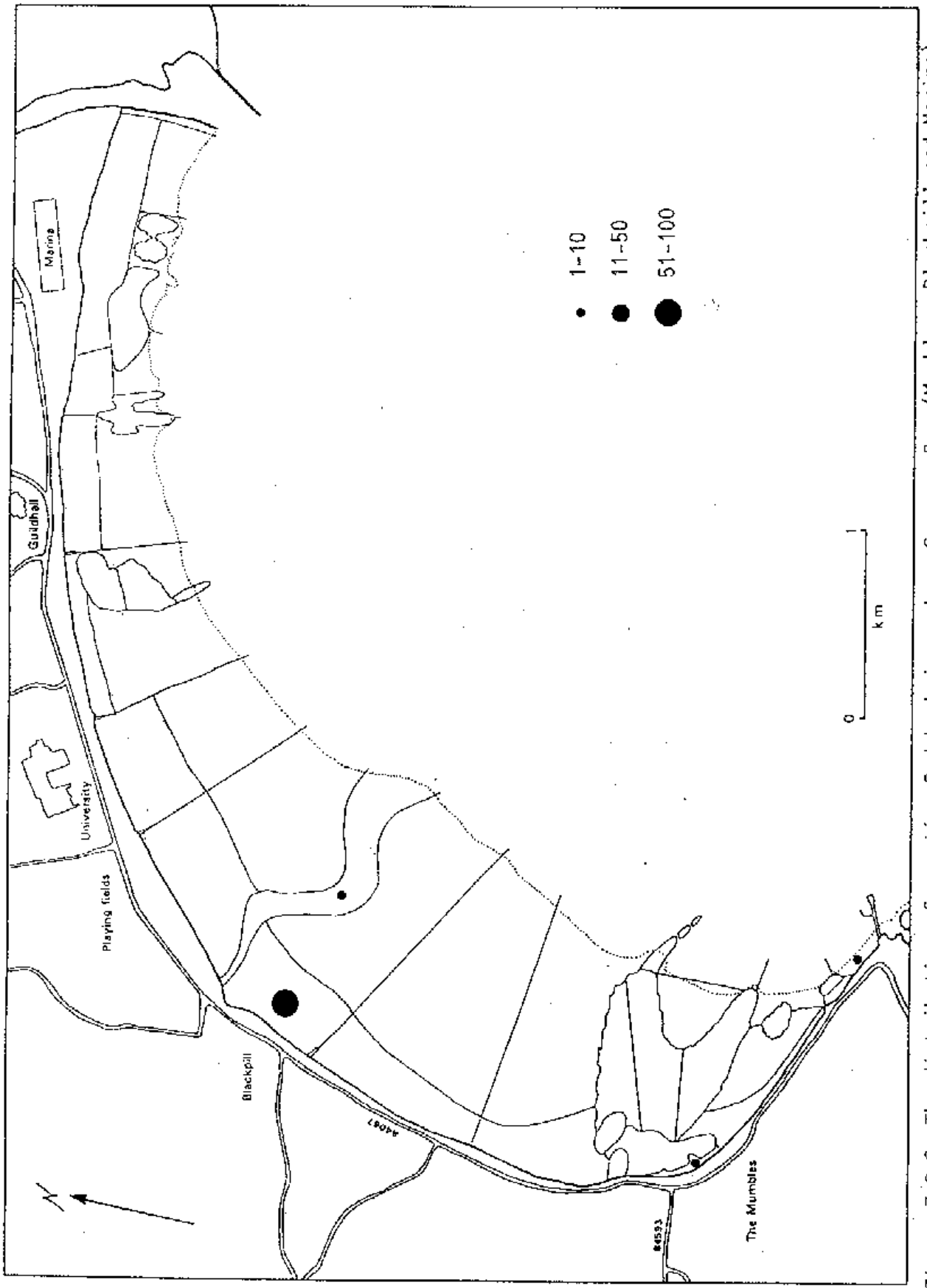


Figure 7.9.3 The distribution of roosting Redshank in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

TURNSTONE

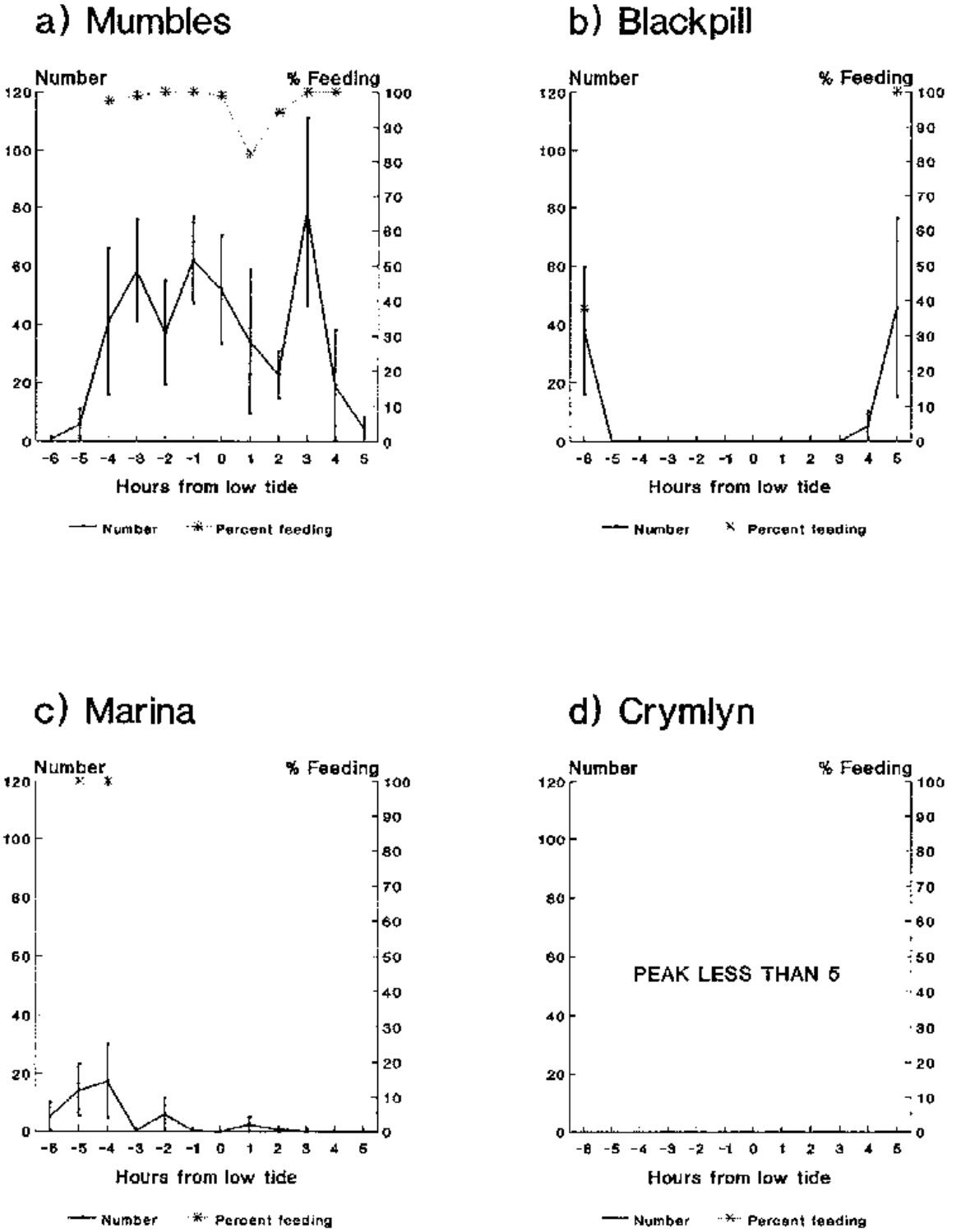


Figure 7.10.1 The average number of Turnstone present and the percentage feeding in each study site throughout the tidal cycle. The percentage feeding is only plotted when more than 50 birds were counted in total throughout the winter.

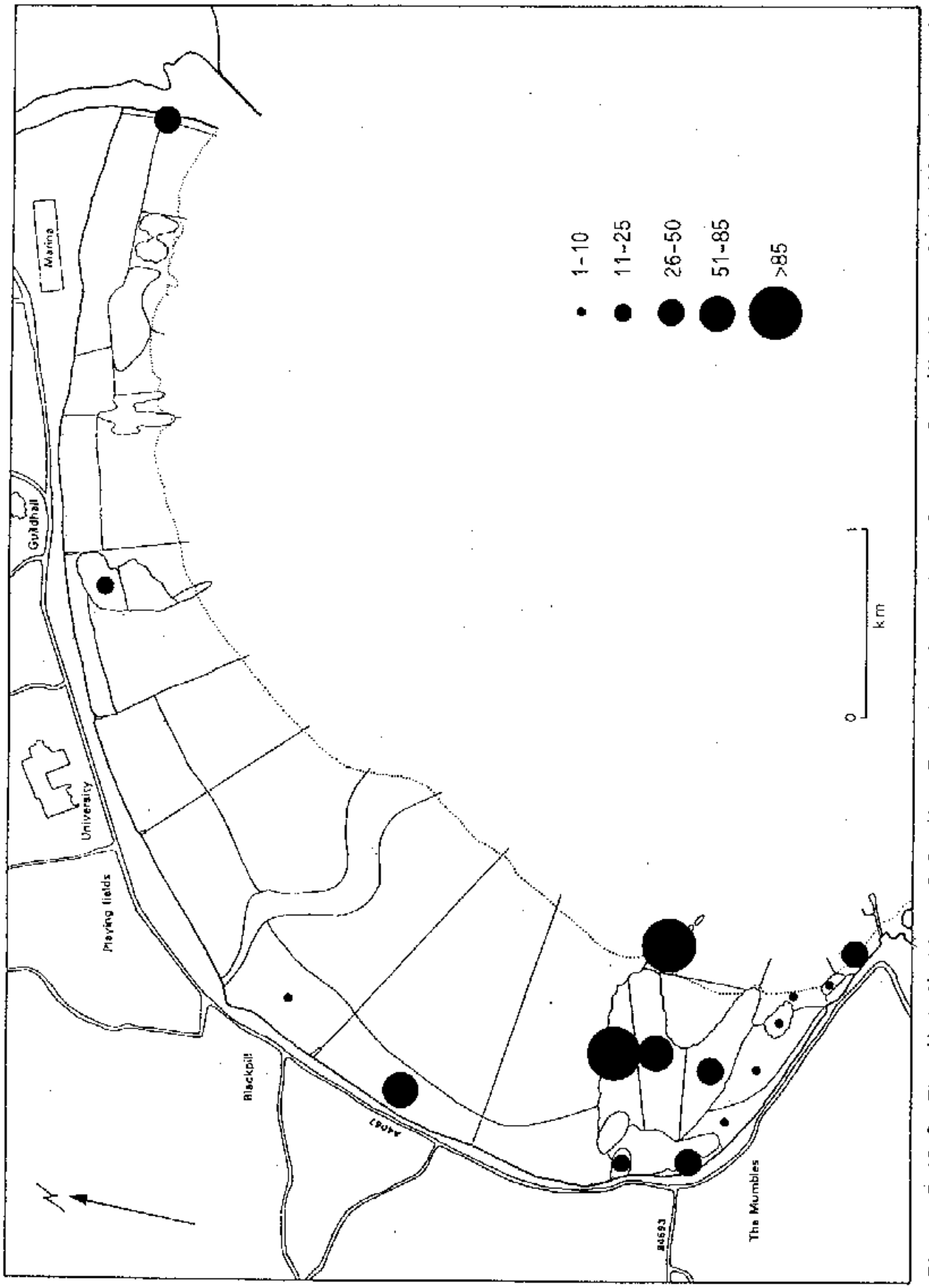


Figure 7.10.2 The distribution of feeding Turnstone in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991-92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

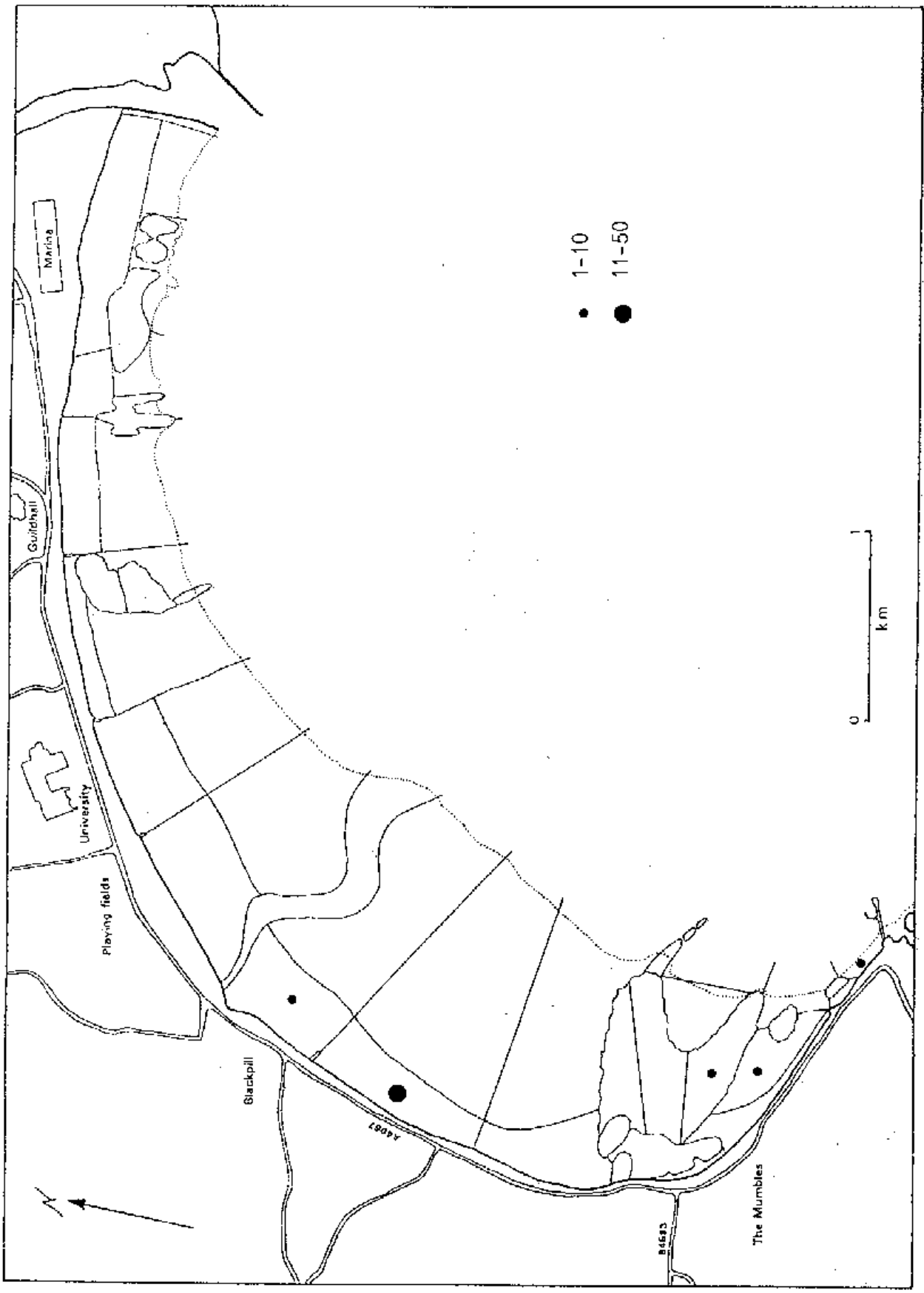


Figure 7.10.3 The distribution of roosting Turnstone in western Swansea Bay (Mumbles, Blackpill and Marina) during the 1991/92 winter assessed from all day observations. The average number of bird hours per tidal cycle is plotted for each area.

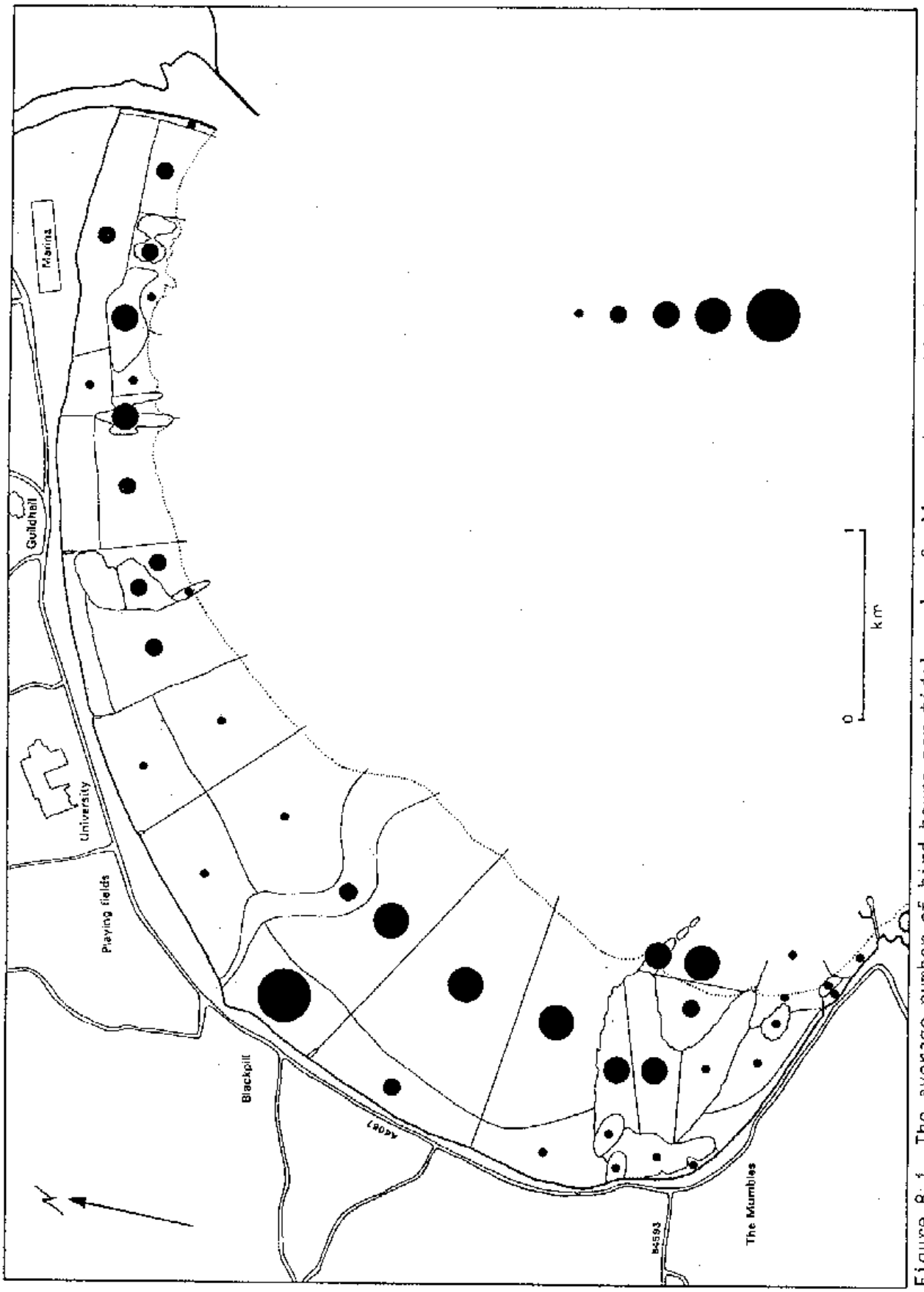


Figure 8.1 The average number of bird hours per tidal cycle of all species combined on western Swansea Bay (Mumbles, Blackpill and Marina).

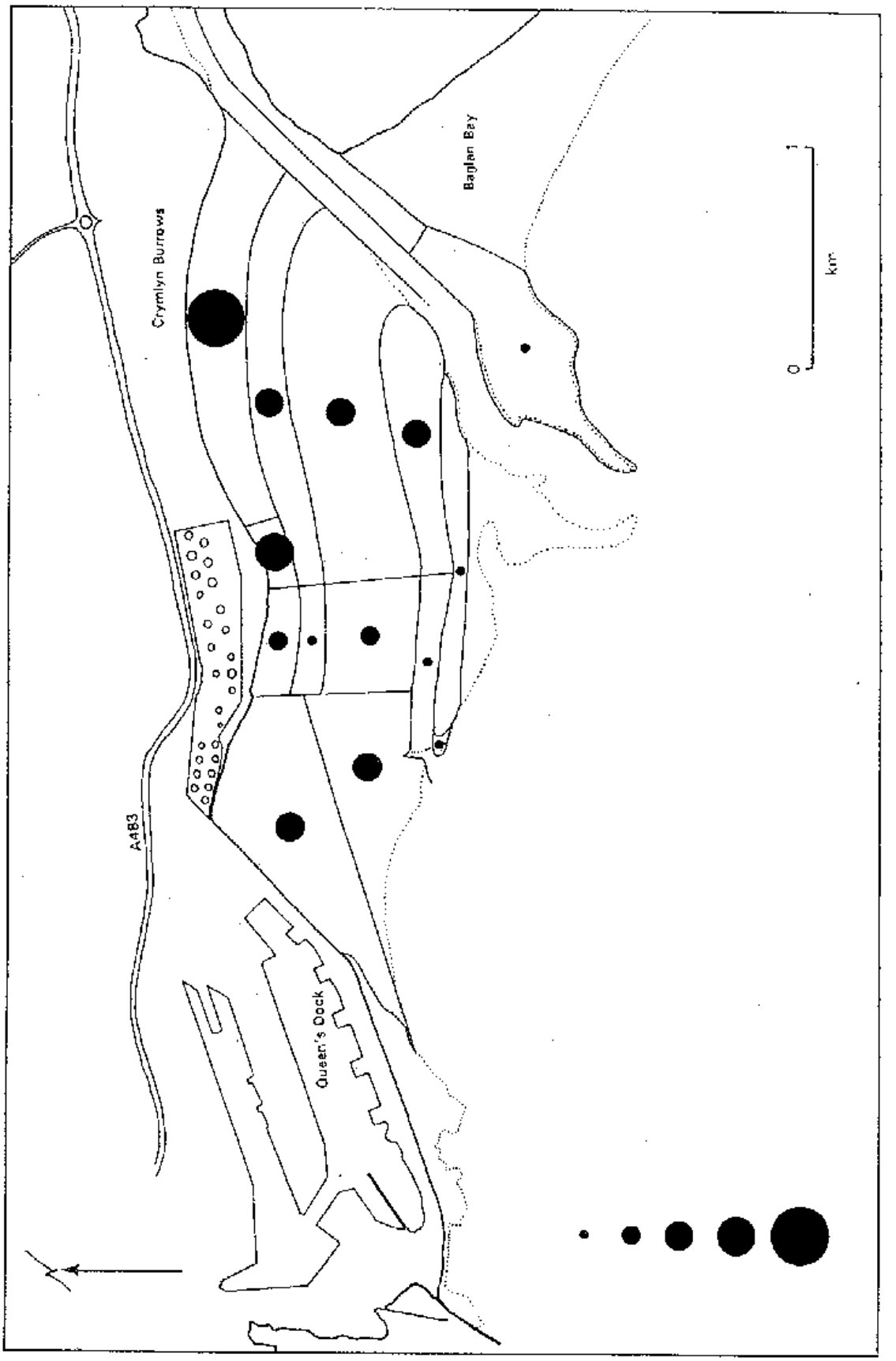


Figure 8.2 The average number of bird hours per tidal cycle of all species combined on eastern Swansea Bay (Crymlyn).