**BTO Research Report No. 336**

# Marine Monitoring Project: Ground and Aerial Monitoring Protocols for In Shore Special Protection Areas

# Common Scoter Surveys in Carmarthen Bay During the Winter of 2002-03

# Prosiect Monitro Morol: Protocoliau Monitro Ar Y Ddaear Ac O'r Awyr Ar Gyfer Ardaloedd Gwarchodaeth Arbennig Ger Y Glannau

# Arolygon o fôr-hwyaid duon ym Mae Caerfyrddin yn ystod gaeaf 2002-03

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## Executive Summary


- During the winter of 2002-03, a series of ground and aerial counts of Common Scoters *Melanitta nigra* was undertaken in Carmarthen Bay, south Wales, to maintain an existing monitoring programme and to investigate methodological and interpretative issues arising from counts.

- Ground-based monitoring counts from three vantage points were carried out on four days. Further ground-based counts to investigate methodological issues were carried out on another eight days. Eight aerial surveys of the bay were undertaken, four each using two separate methods, hereafter described as the 'census-method' (transects flown at an average altitude of 152 m and at a separation distance of 1 km, designed to record all of the birds in the bay) and the 'distance-method' (transects flown at an average altitude of 76 m and at a separation distance of 2 km, designed to account for missed birds using distance sampling protocols).

**Ground Counts: Monitoring**

- The numbers of Common Scoters recorded during the four ground-based monitoring counts were 16,203 (29/11/02), 23,288 (23/1/03), 19,925 (6/3/03) and 5,678 (31/3/03). The last count was substantially lower both as a result of less suitable survey conditions and birds having left the bay by this date.

- Ground counts did not cover the whole of the bay and it is likely that the true peak numbers present in the bay were substantially higher than the peak ground count of 23,288 (itself the highest count in the bay since the *Sea Empress* oil spill of 1996).

**Ground Counts: Methodological Studies**

- Ground-based counts were undertaken to investigate the effect of thoroughness on the numbers of scoters counted. The numbers depended very strongly on the time taken by the counter and counts from Carmarthen Bay count stations should take at least an hour, otherwise birds are likely to be overlooked.

- Ground-based counts were undertaken to investigate the effect of the tide on the apparent distribution of scoters, but detected no clear effect.

- A simultaneous count by two observers suggested that inter-observer variability was potentially high, although it was not possible to test this rigorously. However, other data suggested that intra-observer variation in counting was low.

- Anecdotal observations collected during the study confirmed that counts should only be attempted with a light swell at most and that strong sun-glare and other conditions of poor visibility should be avoided. The heavier the swell or poorer the visibility, the longer the time allowed for the count should be.

## Aerial Surveys

- The numbers of Common Scoters recorded during the census-method aerial surveys were 8,835 (4/1/03), 10,309 (5/1/03), 7,956 (15/3/03) and 7,572 (16/3/03). To allow for a non-visible area underneath the plane, these counts could be scaled up to estimates of 10,779, 12,577, 9,706 and 9,238, respectively.

- The estimates derived from the distance-method aerial surveys (with 95% confidence intervals) were 19,909 (10,803-36,390) on 1/12/02, 15,417 (7,840-30,317) on 4/1/03, 13,337 (7,846-22,672) on 15/3/03 and 9,819 (6,071-15,881) on 16/3/03. It is proposed that a refined distance analysis will be carried out in the future.

- Ground observations confirmed that the aerial survey plane flushed those scoters from areas close to the shore. Moreover, the effect was prolonged with birds not returning two hours later. More than half of the scoters noted during the aerial surveys were detected in flight as opposed to on the surface of the sea. The proportion in flight was higher for the distance-method flights than the census-method flights, perhaps due to the lower altitude of the former.

- A trainee aerial surveyor recorded substantially fewer scoters than the more experienced surveyors, although this was in part due to more restricted visibility from his seat. However, the relative distribution of scoters recorded by the trainee was similar to that by the other observers.

- One of the suggested advantages of the distance-method over the census-method is that the latter is more likely to involve double-counting of birds between transects. However, the results suggested that far from inflating the estimate the census-method actually suggested fewer birds than the distance-method. The underlying assumption that the census-method records all birds to a distance of 500 m would thus seem to be questionable.

- Neither aerial survey method accounts for scoters diving upon the approach of the plane. This would appear to be a natural response for a sea-duck encountering a perceived threat and some birds at least must surely be missed in this manner by aerial surveys. Additionally, neither method accounts for birds which fly well in advance of the arrival of the plane. This is known to occur and is likely to be the single largest problem in combining ground and aerial counts to derive an overall estimate for the bay. It was not possible to use the aerial counts to describe the decline in detectability by ground counts over distance due to this issue.

## Conclusions

- None of the methods, in isolation or in combination, has yet been able to provide a reliable estimate of the true number of Common Scoters using Carmarthen Bay. Provisional targets for assessing Favourable Conservation Status are proposed but further information is required before these targets can be considered reliable.

- Draft Procedural Guidelines and Standard Operating Procedures are presented.

- An outline of further work to be carried out during the winter of 2003-04 is presented.

## Crynodeb Gweithredol

- Yn ystod gaeaf 2002-03, gwnaethpwyd cyfres o gyfrifon ar y ddaear ac o'r awyr o'r fôr-hwyaden ddu *Melanitta nigra* ym Mae Caerfyrddin, yn ne Cymru, er mwyn cynnal rhaglen fonitro sydd eisoes wedi'i sefydlu ac er mwyn ymchwilio materion methodolegol a deongliadol yn codi o'r cyfrifon.

- Cafodd cyfrifon monitro o'r ddaear eu gwneud o dri man ffafriol am bedwar o ddiwrnodau. Cafodd cyfrifon pellach o'r ddaear eu gwneud am wyth o ddiwrnodau eraill er mwyn ymchwilio materion methodolegol. Gwnaethpwyd wyth arolwg o'r bae o'r awyr, pedwar yr un yn defnyddio dau ddull ar wahân, fydd o hyn allan yn cael ei ddisgrifio fel y 'dull-cyfrifiad' (trawsluniau yn cael eu hedfan o uchder o 152m ar gyfartaledd ac o bellter ymwahanu o 1 cilomedr, wedi'i lunio i gofnodi'r holl adar yn y bae) a'r 'dull-pellter' (trawsluniau yn cael eu hedfan o uchder o 76m ar gyfartaledd ac o bellter ymwahanu o 2 cilometr, wedi'u llunio i roi cyfrif am yr adar nad oedd wedi'u cofnodi gan ddefnyddio protocolau samplu pellter).

### *Cyfrifon o'r Ddaear: Monitro*

- Dyma'r niferoedd o fôr-hwyaid duon gafodd eu cofnodi yn ystod y pedwar cyfrif monitro o'r ddaear : 16,203 (29/11/02), 23,288 (23/1/03), 19,925 (6/3/03) a 5,678 (31/3/03). Roedd y cyfrif olaf yn llawer is oherwydd amgylchiadau arolwg llai ffafriol ac oherwydd fod adar wedi gadael y bae erbyn y dyddiad yma.

- Nid oedd y cyfrifon o'r ddaear yn amgylchynu'r bae cyfan ac mae'n debygol fod y niferodd uchaf gwirioneddol oedd yn bresennol yn y bae yn llawer uwch na'r cyfrif uchaf o'r ddaear o 23,288 (oedd ynddo'i hun y cyfrif uchaf yn y bae er i'r *Sea Empress* ollwng olew i'r bae yn 1996).

### *Cyfrifon o'r Ddaear: Astudiaethau Methodolegol*

- Cafodd cyfrifon o'r ddaear eu gwneud er mwyn ymchwilio i effaith trylwyredd ar y niferoedd o fôr-hwyaid duon gafodd eu cyfrif. Roedd y niferoedd yn dibynnu'n helaeth iawn ar yr amser roedd y sawl oedd yn cyfrif yn ei gymryd a dylai cyfrifon o orsafoedd cyfrif Bae Caerfyrddin gymryd o leiaf awr neu fel arall mae'n debygol na fyddai rhai adar yn cael eu gweld.

- Cafodd cyfrifon o'r llawr eu gwneud i ymchwilio i effaith y llanw ar ddosbarthiad ymddangosol môr-hwyaid duon, ond ni welwyd fod y llanw yn cael effaith pendant.
- Roedd cyfrifon gafodd eu gwneud yr un pryd gan ddau wyliwr yn awgrymu fod posibl i'r amrywioldeb rhwng gwylwyr fod yn uchel, er nad oedd yn bosibl profi hyn yn haearnaidd. Roedd data arall yn awgrymu, fodd bynnag, mai isel oedd yr amrywioldeb rhwng gwylwyr wrth gyfrif.

- Roedd arsylwadau anecdotaidd gafodd eu casglu yn ystod yr astudiaeth yn cadarnhau mai dim ond pan fo ymchwydd ysgafn ar y mwyaf yn y tonnau y dylid ceisio gwneud cyfrif ac na ddylid gwneud cyfrif pan fo disgleirdeb yr haul yn gryf neu amgylchiadau eraill yn ei gwneud hi'n anodd gwled. Po fwyaf ymchwydd y tonnau neu anoddaf yw hi i weld, mwyaf yn y byd o amser ddylid ei ganiatau ar gyfer y cyfrif.

**Arolygon o'r Awyr**

- Dyma niferoedd y môr-hwyaid duon gafodd eu cofnodi yn ystod yr arolygon o'r awyr oedd yn defnyddio'r dull cyfrifiad : 8,835 (4/1/03), 10,309 (5/1/03), 7,956 (15/3/03) a 7,572 (16/3/03). Er mwyn rhoi cyfrif am yr ardal o dan yr awyren lle na ellir gweld dim, gellid codi'r cyfrifon yma i amcangyfrifon o 10,779, 12,577, 9,706 a 9,238 yn y drefn yna.

- Dyma'r amcangyfrifon a gafwyd o'r arolygon o'r awyr oedd yn defnyddio'r dull pellter (gyda 95% o bellterau hyder) : 19,909 (10,803-36,390) ar 1/12/02, 15,417 (7,840-30,317) ar 4/1/03, 13,337 (7,846-22,672) ar 5/3/03 a 9,819 (6,071-15,881) ar 16/3/03. Bwriedir gwneud dadansoddiad pellter mwy manwl yn y dyfodol.

- Roedd arsylwadau o'r ddaear yn cadarnhau fod awyren yr arolwg o'r awyr yn cyfwynebu'r môr-hwyaid duon oedd o ardaloedd agos at y lan. Ar ben hynny, roedd yr effaith wedi'i ymestyn gan nad oedd adar wedi dychwelyd ddwy awr yn ddiweddarach. Roedd dros hanner y môr-hwyaid duon gafodd eu cofnodi yn ystod yr arolygon o'r awyr wedi'u gweld wrth iddynt hedfan yn hytrach nag ar wyneb y môr. Roedd y gyfran oedd yn hedfan yn uwch ar gyfer yr hediad dull pellter na'r hediad dull cyfrifiad, o bosibl oherwydd fod y dull cyntaf yn cael ei wneud o lai o uchder.

- Bu i un oedd yn gwneud arolwg o dan hyfforddiant gofnodi llawer llai o fôr-hwyaid duon na'r rhai oedd yn fwy profiadol ar wneud arolwg er fod hyn i raddau oherwydd nad oedd yn gweld cyn belled o'i sedd. Roedd dosbarthiad cymharol y môr-hwyaid duon gafodd eu cofnodi gan y sawl oedd yn gwneud yr arolwg dan hyfforddiant yn debyg i'r rhai a gofnodwyd gan y gwylwyr eraill.

- Awgrymwyd mai un o fanteision y dull pellter dros y dull cyfrifiad yw fod yr olaf yn fwy tebygol o gyfrif yr adar ddwywaith rhwng trawsluniau. Roedd y canlyniadau yn awgrymu, fodd bynnag, fod y dull cyfrifiad, yn hytrach na chwyddo'r amcangyfrif, mewn gwirionedd yn awgrymu llai o adar na'r dull pellter. Mae'n ymddangos felly fod angen cwestiynu'r rhagdybiaeth sylfaenol fod y dull cyfrifiad yn cofnodi'r holl adar hyd at bellter o 500m .

- Nid yw'r un o'r dulliau arolwg o'r awyr yn rhoi cyfrif am y môr-hwyaid duon sy'n deifio pan fo awyren yn dynesu. Byddai hyn yn cael ei weld fel ymateb naturiol i fôr-hwyaden wyneb yn wyneb â bygythiad gweledig ac mae'n rhaid fod rhai adar o leiaf yn cael eu colli fel hyn gan arolygon o'r awyr. Ar ben hyn, nid yw'r un o'r dulliau yn rhoi cyfrif am adar sy'n hedfan ymhell cyn i'r awyren gyrraedd. Gwyddir fod hyn yn digwydd ac mae'n debygol mai dyma'r broblem unigol fwyaf wrth gyfuno cyfrifon o'r ddaear ac o'r awyr er mwyn cael amcangyfrif cyffredinol ar gyfer y bae. Oherwydd yr anhawster yma, nid oedd yn bosibl defnyddio'r cyfrifon o'r awyr i ddisgrifio'r dirywiad mewn datgeladwyedd gan gyfrifon o'r ddaear dros bellter.

**Canlyniadau**

- Nid oes yr un o'r dulliau, ar eu pennau eu hunain nac ychwaith o'u cyfuno, hyd yma wedi gallu darparu amcangyfrif dibynadwy o'r niferoedd gwirioneddol o fôr-hwyaid duon sydd yn defnyddio Bae Caerfyrddin. Mae targedau dros dro ar gyfer asesu

Statws Cadwraeth Ffafriol yn cael eu hargymell ond mae angen mwy o wybodaeth cyn y gellir ystyried y targedau hyn yn rhai dibynadwy.

- Cyflwynir Cyfarwyddiadau Trefniadol a Dulliau Gweithredu Safonol.

- Cyflwynir amlinelliad o waith pellach sydd i'w wneud yn ystod gaeaf 2003-2004.

# 1 INTRODUCTION

## 1.1 Common Scoters and Carmarthen Bay

The Common Scoter *Melanitta nigra* is a priority species in the UK Biodiversity Action Plan. Recent aerial surveys have confirmed Carmarthen Bay to be one of the most important wintering grounds in the UK and this has led to the bay qualifying for classification as the UK's first marine Special Protection Area (SPA), through regularly supporting more than 1% of the biogeographic population. Such a classification results in an obligation to Europe to monitor the "favourable conservation status" of the SPA.

A component of this monitoring is the enumeration either of an absolute population size of Common Scoter or, from sampling, obtaining a reliable estimate or index of this population. However, there remains uncertainty about both the most accurate and most cost-effective methods for monitoring inshore sea ducks. Ground-based surveys are relatively inexpensive, but suffer from limitations on the distance from the shore over which birds can be counted, the technical difficulty of assigning birds to distances from the land and the uncertainty over variation in survey efficiency with weather conditions. In addition, there are only a limited number of suitable vantage points around Carmarthen Bay. Aerial survey (Komdeur *et al.* 1992) is relatively expensive, but suffers less from the aforementioned limitations. It is also possible to cover the whole bay much more rapidly. There is, however, a pay-off between the desire to count all birds and so gain an absolute population estimate and the amount of disturbance this causes to scoters, which potentially results in double-counting or missed birds. Recent experience in Denmark suggests that lower flights and more widely spaced transects, designed to account for the distance over which scoter fly in response to disturbance from the survey plane, result in a more accurately mapped and counted distribution of a sample of the population. However, this introduces the problem of extrapolation from the sample to the actual population.

The purpose of this project is to maintain a programme of monitoring of Common Scoters at Carmarthen Bay but also to develop the methodology and interpretation of the fieldwork further, in order to lead to generic Procedural Guidelines and site-specific Standard Operating Procedures for the monitoring of the species.

## 1.2 Previous Monitoring

Information on the use of Carmarthen Bay by Common Scoters was relatively sketchy until recent years. Stewart (1996) summarised the historical records, finding little information before the 1970s except that "large numbers" were already clearly recognised. More detailed counts in the 1970s included a peak of 25,000 recorded from a boat between Pendine and Rhossili in March 1974, although the level of precision of this count was not stated. Most other counts in the 1970s, including all of a series of aerial counts made between 1975 and 1977, recorded totals of less than 10,000 scoters. Stewart found no records between 1978 and 1992, after which time more frequent counts were listed, although often only from parts of the bay. A peak count for the early 1990s of 17,650 scoters was recorded for the whole bay on 21/12/94.

Interest in the scoters of Carmarthen Bay was greatly increased following the *Sea Empress* oil spill in February 1996 at the mouth of Milford Haven nearby and a great deal of monitoring was carried out immediately after the spill and has continued each year since then to the present. Stewart *et al.* (1997) summarised counts made between February 1996 and March

1997. It was thought that at least 15,000 birds had been present prior to the spill, whereas no counts exceeded 5,000 birds the following winter. Most of the counts were land-based; the aerial counts that were undertaken typically recorded fewer birds although were able to plot the overall distribution of the species more effectively. Cranswick *et al.* (1998) reported upon counts made between April 1997 and March 1998. Land-based counts in the 1997-98 winter peaked at just over 3,200 birds although modified aerial counts found higher numbers than the previous winter. A comparison of ground and aerial counts led to an estimate of a peak 1997-98 count of 6,420 Common Scoter. During the winters of 1998-99, 1999-2000 and 2000-01, further counts were carried out by Lucy Smith as part of PhD studies for the University of Swansea and CCW (unpubl. data).

During 2001-02, further ground and aerial counts were carried out as part of an all-Wales study into Common Scoter numbers and distribution (WWT 2003). Seven ground-based counts were made, peaking at 20,078 Common Scoters in February 2002. Additionally, three aerial counts were made, for the first time using a distance-sampling approach to surveying the bay, although half of the data for one of the flights were lost following the theft of equipment from a car. With the change in methods, the actual counts made (up to 12,724 birds) were not comparable with those gathered in previous years. However, analysis of the data (using two slightly different methods) provided estimates of up to 18,578 birds (although with wide confidence limits).

## 1.3 Objectives

The key objectives of the current project were as follows:

1. Maintain a monitoring programme of ground-based counts.

2. Assess the factors affecting the precision and accuracy of ground-based counts, including weather conditions, tidal state and observer effects.

3. Maintain a monitoring programme of aerial counts.

4. Assess the relative merits of two different aerial survey techniques.

5. Investigate whether ground-based counts consistently provide an appropriate index of overall numbers of scoters.

6. Investigate whether a distance function can be derived using aerial counts to describe the decline in detectability by ground counts over distance

7. Evaluate all extant data to provide possible expressions of targets for scoter numbers and create a draft protocol for how assessments of Favourable Conservation Status should be made.

8. Produce generalised *Procedural Guidelines* for ground-based and aerial assessments of Common Scoter numbers.

9. Produce site-specific *Standard Operating Procedures* for making ground-based and aerial counts of Common Scoters at Carmarthen Bay.

# 2 METHODS

## 2.1 Overall Approach

To address the objectives set out in Section 1.3 above, a programme of ground-based and aerial survey events was planned. As anticipated, the programme had to be modified to deal with the eventualities of the weather and plane availability. Ideal conditions for both ground and air counts would be a flat sea (to avoid birds being lost being waves), no glare on the surface (i.e. cloud cover) and no precipitation (which can reduce visibility). Several planned days of both ground and aerial counts had to be called off at the last minute. However, a total of 20 survey events was achieved, as set out in Table 2.1.

The personnel involved in each survey are also listed, as observer effects are clearly a major consideration when looking at this type of survey. As such, the observers are frequently identified throughout the report, as follows: LS = Lucy Smith, RS = Richard Schofield, NF = Nigel Fairney and SH = Steve Holloway.

It should be noted that, throughout the report, the state of the tide is often referred to. To ensure a standard approach, a tidal prediction package was used to produce standard high and low tide times for Tenby; tides elsewhere in Carmarthen Bay are generally within 15 minutes of the times at Tenby.

## 2.2 Methods for Individual Surveys

### 2.2.1 Ground-based monitoring counts

The methodology followed for the ground-based monitoring counts was the same as that used since the winter of 1998-99. Continuity was further ensured by the fact that the same observer (LS) carried out the counts.

Counts were made on four dates (29th November 2002, 23rd January 2003, 6th March 2003 and 31st March 2003), selected by LS as being those likely to provide good viewing conditions. Counts were carried out from three count stations along the coast, *i.e.* Pembrey sand dunes (241500, 199190 – 9 m ASL), Dolwen Point near Pendine (223310, 207840 – 25 m ASL) and Merrifields, Amroth (217900, 207350 – 48 m ASL). In some previous seasons, a fourth station at Kitchen Corner, Rhossili, has been used. This area was favoured by the birds following the *Sea Empress* oil spill, but it appears that birds have largely ceased to use the area as the effect of the oil spill on other parts of the bay has lessened through time. During the 2002-03 season, all available information (confirmed by aerial surveys) suggested that numbers of birds present off Rhossili were relatively insignificant in comparison with the whole bay population and thus effort was concentrated at the other three count stations.

At each site and on each date, the time of count, weather (wind speed, wind direction, precipitation, cloud cover), sea-state and any disturbance was recorded. Full sea scans were then carried out using a telescope (20-60x zoom magnification, 80 mm objective). For each bird or flock, the number of birds, their bearing and their distance were recorded. To check the distance estimations a graticule was used which had previously been fixed in lens and used on a life-size duck model positioned at various known distances from the observer. The graticule was then used occasionally throughout fieldwork to check that distance estimations were reasonable. Bearings were taken using a protractor disc centred on the tripod holding

the telescope. Recorded bearings were compared with the bearing of a known landmark to enable conversion into actual bearings. Data were recorded in a notebook in the field and transferred to MS Excel after the count. Further analyses were carried out within Excel and using ArcView GIS.

### 2.2.2 Ground-based methodological studies

A series of further detailed ground-based counts were undertaken from the single count station at Dolwen Point, Pendine. These were designed to address a number of questions and indeed, each day's survey was not necessarily confined to addressing one individual question. For convenience, the counts are described in three groups below.

#### 2.2.2.1 Two-observer counts

On 5th January 2003, both LS and RS made simultaneous ground-based counts of the numbers of Common Scoters visible from the Pendine count station. RS simply recorded a total figure whilst LS used her method of recording birds to distance and bearing, as described in 2.2.1. As a result, the count made by RS took somewhat less time than that of LS, although it was in no way rushed. The other main difference between the observers was that the telescope used by RS was a 30x wide-angle lens compared to the 20-60x zoom used by LS.

On 6th March 2003, LS carried out a monitoring count from Pendine (as well as the other two stations) whilst NF was also at Pendine carrying out a series of counts designed to assess the effect of thoroughness (see 2.2.2.2). Count numbers six through eight of NF overlapped with those made by LS at the same count station.

#### 2.2.2.2 'Thoroughness' studies

A series of counts was designed to test the effect of the degree of thoroughness with which a count was carried out. On four dates from the Pendine count station, NF attempted to count all Common Scoters in view but allowing himself search times of varying duration. Details of the weather and sea-state were also recorded, along with anecdotal observations on the behaviour of the birds. NF used a telescope with a 20-60 zoom magnification and 85 mm objective lens. On the first two of these dates, the count regime was that in each hour, three sets of five-minute counts, two sets of ten-minute counts and one 20-minute count would be carried out. Having carried out these first two days of counts at this level, it was decided that these durations were too short to make an adequate assessment of numbers and the count regime was changed. For the last two dates, the count regime was that in each two hour period, two 20-minute counts, one 40-minute count and one 80-minute count would be carried out.

#### 2.2.2.3 'Tidal' studies

A further series of counts was designed to assess the degree to which tide-related differences in scoter distribution could be assessed from ground-based counts. On three dates from the Pendine count station, NF made four two-hour counts of all Common Scoters visible, this time assessing the distance and bearing of all flocks recorded in a similar manner to that used by LS for her monitoring counts. NF did not have a graticule, however, and based his distance estimations upon buoys of known

distance pointed out to him by LS. Additionally, NF recorded total counts within a five degree sector, rather than assigning every flock an individual bearing. As on the other dates, weather and sea-state were also recorded, as were anecdotal observations concerning the behaviour of the birds.

### 2.2.3 Aerial census-method counts

Four aerial surveys of Carmarthen Bay were undertaken using the technique hereafter described as the 'census-method'. The aim of this method was to attempt to survey the entire area of the bay and to be able to view every individual bird. The bay was surveyed using rectangular cells of 2 km x 1 km for the majority of the area and 1 km squares in the south-easterly section, off Rhossili. This was because the lower density of birds off Rhossili enabled a more detailed recording of the distribution. The plane (a Partenavia PN68) was flown at an altitude of 152 m (500 ft) at a speed of approximately 185 $kmh^{-1}$ (51 $ms^{-1}$), although varying somewhat depending on the strength and direction of the wind. A pair of observers (RS to port and LS to starboard in each case) looked out of windows on either side and recorded all birds to a distance of 500 m from the transect line. A navigator, equipped with GPS, assisted the pilot and notified the observers when they were entering the next recording cell. Observations were recorded onto a dictaphone and the birds were recording as either sitting, flying or flushing; in the latter two cases the direction of travel was also recorded. Other species noted during the flights were also noted, as was the presence of sandbanks.

On the latter two flights, SH accompanied the count team in a training capacity. The intention was to introduce a new observer to the unfamiliar environment of counting from a plane and to teach the techniques used. SH occupied a seat on the starboard side of the plane, directly behind LS. Unfortunately, the visibility from this seat was somewhat reduced but the exercise was certainly still valuable.

To allow comparability with previous years, the census-method flights were conducted along transects alternating east to west then west to east, starting in the north of the bay and continuing southwards, with each transect 1,000 m south of the previous one. The northernmost transect was flown along the Ordnance Survey national grid northing 207000 and the southernmost along northing 189000, whilst the west and east limits of the survey area were bounded by the eastings 212000 and 240000 respectively. The precise cells covered on each flight varied slightly around the edge of the bay, depending upon conditions upon the day; the extent of each flight can be seen in Figures 3.7 to 3.10.

The data were transcribed from dictaphones to standard paper recording forms, then were analysed using MS Excel and ArcView GIS.

### 2.2.4 Aerial distance-method counts

Four aerial surveys of Carmarthen Bay were undertaken using the more recently developed 'distance-method' (Kahlert *et al.* 2000). This method is based on distance sampling protocols (Buckland *et al.* 2001). Because the ability to detect a bird decreases with increasing distance from the observer, any counts constitute only a proportion of the total number of birds present in the survey area. If the distance from the observer to the bird is recorded, however, a correction factor may be incorporated. The level of correction may differ according to the flock size, weather conditions / sea-state, observer and behaviour of the birds.

The same plane as for the census-method flights was used but for the distance-method the altitude was 76 m (250 ft). The speed of the plane was again approximately 185 $kmh^{-1}$ (51 $ms^{-1}$). The position of the flight was recorded using a Garmin 12XL GPS which was set to record the position of the plane every five seconds (although there were some problems during the first and second flights). The transect lines (see Figure 3.13 for an example flight track) alternated from north to south then south to north, running from east to west and each transect being located 2,000 m west of the previous one. The approximate line of travel was along eastings of the Ordnance Survey national grid; the first transect was south along easting 243000. The start and end times of each transect were recorded.

North-south transects were favoured as they were approximately perpendicular to the major environmental gradient, *i.e.* the depth of water. This is important as it removes a potential source of bias between the two sides of the plane (*i.e.* if scoter distribution is partly dependent upon water depth, as seems likely, then by flying parallel to the depth contour the observer on one side of the plane would be likely to record different numbers of birds to the observer on the other side).

The same observers (RS and LS along with SH as a trainee on the latter two flights) were seated in the same positions as for the census-method flights and dictaphones were again used to record observations. However, for the distance-method flights each observation of a flock was recorded as a time, size of flock and distance band, along with species and behaviour (simply as sitting or flying / flushing, with the direction of flight seldom recorded owing to the greater demands on the observers). For this winter of counts, four distance bands were used: Band A = 44-162 m ($60^0$-$25^0$ below the horizontal); Band B = 162-282 m ($25^0$-$15^0$); Band C = 282-426 m ($15^0$-$10^0$); Band D = 426-1000 m ($10^0$-$4.23^0$). There was a 'dead-zone' below the plane where observations could not be made, which extended out from the transect line to a distance of 44 m. The limits of each band were determined using a clinometer which enabled the measurement of predetermined angles below the horizontal.

The data were transcribed from the dictaphones onto standard paper recording forms and from there into MS Excel. The GPS track was output as an ASCII text file of northing, easting and time. Most of the data analysis and preparation was carried out using Excel. For example, the GPS track was used to derive a estimated position of the plane during every second of the flight (assuming a constant speed in a straight line from one recorded point to the next) and then these positions were assigned to the count data to enable plotting in ArcView GIS.

# 3 RESULTS

## 3.1 Ground-Based Counts

### 3.1.1 Ground-based monitoring counts

The three count stations were visited by LS on each of four dates, selected by the observer as being those likely to provide good viewing conditions. However, it should be noted that on 31st March 2003, conditions were less suitable. On this date, all sites experienced haze and, combined with the sea state and particularly strong glare over a 10 degree arc at Pendine, counts are likely to have been affected more strongly than on the other three dates.

The counts made on the four dates, along with the associated count conditions, are summarised in Table 3.1, whilst the distributions of Common Scoters recorded by these counts are mapped in Figures 3.1 to 3.4, both as graduated symbols showing flock size at a given position and bearing and as dot density maps where the counts have been assigned to the same recording cells used for the census-method aerial surveys.

### 3.1.2 Ground-based methodological studies

The different methodological questions posed by this study were assessed by a variety of surveys which are described below in three groups for convenience. However, as discussed in Section 4, some questions (e.g. intra-observer variation) were investigated by use of data from more than one of these groups.

#### 3.1.2.1 Two-observer counts

On the morning of 5th January 2003 (tide falling from high), LS and RS each made a simultaneous ground-based count of the number of Common Scoters visible from the Pendine count station. The wind during the count was south-easterly 1-2, cloud cover was 1/8 and the sea surface was described as having small waves but no 'white horses'.

The totals differed markedly, with 3,740 birds counted by RS compared to 6,318 birds counted by LS. LS carried out her count in the same manner as her ground-based monitoring counts, *i.e.* by recording flocks to bearing and distance. The distribution of birds recorded by Lucy is shown as Figure 3.5. RS also made a careful count but, not recording distance and bearing, his count took about half the time.

During the afternoon of 6th March 2003, the monitoring count by LS from Pendine overlapped with the 6th to 8th hours of thoroughness counts (see 3.1.2.2 below) being carried out by NF. The former recorded a total of 7,434 birds over approximately two hours. The counts carried out by NF varied with duration. Five-minute counts over these three counts averaged 754 birds, ten-minute counts averaged 1,586 birds and 20-minute counts averaged 2,858 birds.

#### 3.1.2.2 'Thoroughness' studies

Counts of varying durations were carried out on 14th February 2003, 6th March 2003, 13th March 2003 and 17th March 2003. All counts were made by NF from the Pendine

count station and aimed to provide an estimate of the numbers of Common Scoters visible on the sea. On the first two dates, count durations of five minutes, ten minutes and 20 minutes were made, whilst on the latter two dates, count durations were extended to 20 minutes, 40 minutes and 80 minutes. The counts and associated conditions are summarised in Tables 3.2 to 3.5. Further observations pertaining to the counts were recorded by NF and are as follows:

*14th February 2003 (Table 3.2)*

Counts began at 0745 on a falling tide with low tide at 1036. Counts continued until 1545, ending before high tide which was at 1642.

The majority of birds were loafing with small groups of males displaying and squabbling. Feeding activity was difficult to ascertain due to distance, especially since it was difficult to determine whether a bird had dived or just disappeared due to the swell. The strong, low sun made observation very difficult. Haze and glare combined such that making out individuals or groups was difficult. The time scales (five, ten and 20 minutes) did not allow sufficient time to observe birds that may have been lost in even the lightest swell. This was clearer as the time scale increased, when (for example) what may have appeared to be only 20 birds in a scope width became 40 as a group emerged from the trough in a swell.

Relatively little in the way of movements of the scoter was noted, with about 200 flying east during the third hour along with three Velvet Scoters *Melanitta fusca*.

From the fifth hour, as the sun approached due south where most of the scoter were grouped, counting became very difficult and at times near-impossible. During the last three hours, several counts could not be made ('n.c.' in Table 3.2) as a result of extreme sun glare affecting prolonged counts and increasing the need to rest between counts. The conditions could be described as almost a 'white-out', made worse by low tide and glare / reflection from the beach below the count point.

*6th March 2003 (Table 3.3)*

Counts began at 0825, shortly after high tide which was at 0754. Counts continued past low tide at 1412 until 1655.

Feeding activity was difficult to ascertain due to the distance of the scoter from the watchpoint and the effects of swell. The number of birds counted did not seem to be affected by the rising and falling tide, as they appeared to stay faithful to an area of the sea across which they occupied a band, more than 2 km off the watchpoint. The apparent decrease in numbers later in the day seemed more likely to be due to the increased swell and the difficultly that created with 'losing' birds in that swell, with a limited time period for each scope width count. Indeed, it was the shorter duration counts which decreased to the greater extent.

During the fourth and fifth hours there were low-flying RAF sorties over Pembrey, with live missile tests and bomb dropping. There were associated large movements of scoters: 1,800 flew west at 1145, 1,500 flew east at 1215, 1,000 flew west at 1315 and 1,100 flew east at 1325. The counts tabulated do not include these flying flocks.

Following this time most birds appeared to be loafing and small movements noted were never of more than 15 birds. Squabbling groups of males were commonly observed.

*13th March 2003 (Table 3.4)*

Counts began at 0830 shortly after low tide at 0730. High tide was at 1348 and the counts continued until 1630.

This was the first of the days during which the count duration was increased, as the five and ten minute counts had been found to be too rushed and estimation (to the point of guesswork) had to play a large part if the count was to be completed within the time scale. Even at 20 minutes the effect of swell on the number of scoters visible was great, and counts varied greatly for each scope-width dependent on whether the scoters came onto the crest of the swell whilst observing the patch of sea. For example, one scope width could produce 30 scoter at one glance, with a return to the same area showing 130.

Throughout the day, the main impression was of loafing birds, again with squabbling groups of males commonly noted. During the second set of counts, strong sun glare particularly affected the 40 and 80 minute counts, where the 'white-out' was directly over the main body of scoter. By the third set of counts, the main body of scoter was now very distant, but numbers had apparently increased as the flock drifted around on the high tide. Sun 'glare' was less of an issue, but the increased wind speed had increased the swell, particularly as the wind direction was against the incoming tide and drift.

*17th March 2003 (Table 3.5)*

Low tide was at 1148 and high tide at 1748.

Again, the general pattern was of loafing birds with squabbling groups of males. Although strong glare affected portions of the count, flat sea conditions allowed for easier counting and fewer scoter were lost to swell. The scoter were again dispersed, mostly along a band 1.5-2.5 km off the watchpoint across the bay although during the third set of counts the rising tide brought the scoter closer inshore (no more than 500 m in places).

#### 3.1.2.3 'Tidal' studies

Three further days of ground counts were also undertaken by NF from the Pendine count station, on 12th, 14th and 15th March 2003, with the principal aim being to examine the effect of the tidal state on the numbers of birds noted and their distribution.

The counts and associated conditions are summarised in Tables 3.6, 3.7 and 3.8, whilst the distributions of the Common Scoters recorded during these counts are shown in Figure 3.6. Further observations pertaining to the counts were recorded by NF, as follows:

*12th March 2003 (Table 3.6)*

Counts began at 0725, following low tide at 0548. High tide was at 1200 and counts continued until 1615 (the next low tide being at 1824).

The distance of the scoters made activity difficult to assess. The birds appeared to be loafing, although feeding could well have been occurring. However, even light swell caused the birds to appear and then disappear very easily. NF wondered whether these birds were diving or just being lost to the swell and considered that the latter was most likely in the vast majority of cases. Only occasionally could feeding activity clearly be seen. Small, tight groups (10-25) of scoters squabbling were common and when seen at closer range (1 km), these clearly involved groups of males chasing off rival males. The majority of flight activity occurred after such 'bouts' when a small number of males would fly away to join other groups. Invariably one or two females was amongst these groups and was the object of their attention, but again this could only clearly be seen at ranges below 1 km.

*14th March 2003 (Table 3.7)*

Counts began at 0825 with low tide at 0906. High tide was at 1518 and counts continued until 1655.

Most scoters appeared to be loafing but, as noted on 12th March, activity was difficult to monitor due to the distance and conditions. There were particular problems with sun glare, at its worst during the third count. Otherwise, comments from 12th March also applied.

*15th March 2003 (Table 3.8)*

Counts began at 0815 with low tide at 1012. Counts continued until 1635, just after high tide at 1618.

Glare was again a major problem, reducing visibility on all counts. Birds were again apparently mostly loafing but, as always, actual behaviour was very difficult to monitor in the conditions.

The aerial survey plane passed over the observation point at 1235, resulting in scoter numbers halving on the following count as the bulk of the flock moved too far out to sea to count. Some birds returned but the majority remained well out throughout the rest of the survey period.

## 3.2 Aerial Counts

### 3.2.1 Aerial census-method counts

Four census-method survey flights were flown to count Common Scoters in Carmarthen Bay, on pairs of consecutive dates, *i.e.* 4th and 5th January 2003 and 15th and 16th March 2003. In all flights, counts were carried out by RS and LS, although in the latter pair of flights they were joined by SH in a training capacity.

The total counts made are summarised in Table 3.9, whilst the distributions of Common Scoters recorded are shown in Figures 3.7 to 3.12. As the latter show, the two March flights were not carried out quite so far south as those in January, given that all information suggested relatively few birds present in this area.

The observers noted whether scoters were recorded on the sea or in flight (flushed by the plane in the majority of cases), as well as the direction of flight. Scoters most often flew in a direction away from the plane. The proportions of birds in flight and the direction of flight is summarised in Table 3.10.

Finally, small numbers of other species were also recorded during the flights, the totals of which are summarised in Table 3.11.

### 3.2.2 Aerial distance-method counts

Four distance-method flights were flown to survey Common Scoters along transects in Carmarthen Bay. The counts were carried out on 1st December 2002, 4th January 2003 and 15th and 16th March 2003. For all flights, counts were carried out by RS and LS, although in the latter pair of flights they were joined by SH in a training capacity. During the distance-method flight on 15th March, SH did not complete a recording form but simply "acclimatised" to the experience of aerial surveying. On the 16th March, SH did record counts but these were very much lower than those gathered by RS and LS and were not used in further analyses.

The counts are summarised in Table 3.12 and the data are further broken down into transects and recording bands in Tables 3.13 to 3.16. Table 3.17 summarises the recorded behaviour of the Common Scoters noted during the flights. Unlike with the census-method aerial surveys, the direction of flushing away from the plane was not consistently recorded, given the greater complexity of the distance-method recording. Table 3.18 summarises the other species recorded during the flight. Figure 3.13 shows the flight path recorded by GPS on 15/3/03, which was essentially the same route followed each time (despite problems with the GPS recording during the first two flights).

Although recording distribution was not the primary aim of the distance-method flights, the distribution of Common Scoters recorded on these flights is depicted in Figures 3.14 to 3.17. It should be noted that, during the first two flights, there were problems with the GPS used by the recording team to record their position every five seconds (and thus to translate bird observations, which were recorded to a time, into positions with eastings and northings). However, the GPS used by the pilot and navigator to fly the plane along the predetermined route was operational and the start and end times of each transect were recorded. Therefore, it was possible to derive approximate, but fairly accurate, positions for the observed clusters of scoters, as mapped in Figures 3.14 and 3.15, by assuming the same flight path as was flown on 15/3/03.

The data collected during these flights were analysed using the distance sampling software Distance 4. The analysis is described in further detail in Appendix 1 and the results are set out in Table 3.19.

# 4 DISCUSSION

The findings of the survey work carried out during the 2002-03 winter are discussed below in terms of the objectives listed previously in Section 1.3.

## 4.1 Maintenance of a Monitoring Programme of Ground-Based Counts

A programme of ground-based counts was maintained with four full counts carried out in a consistent manner with the methodology used in previous seasons. The totals recorded are summarised in Table 3.1.

The final count of the season, on 31st March 2003, produced notably lower numbers than the other three counts. There were two reasons for this. Firstly, the observer considered the viewing conditions to be suboptimal and a combination of sea-state, haze and glare meant that birds were much more likely to be missed. Secondly, however, the late date meant that it was quite possible that many birds had left the bay to return to their breeding grounds.

At the time of writing, the historical data were not all available, notably those from the winters of 1998-99 to 2000-01. As such, it was not possible to discuss the counts made during 2002-03 in their full context. From the information available, however, it appears that the January 2003 count of 23,288 Common Scoters may have been the highest at Carmarthen Bay (or indeed anywhere in the UK) in recent years and the highest there ever apart from the (presumably somewhat approximate) 25,000 in March 1974.

Upon plotting the ground counts using the recorded distance and bearing measurements, a simple visual comparison with the distribution recorded by aerial surveys suggests that the area over which the ground counts were carried out constitutes only a small part of the distribution of Common Scoters at the site. It is almost certain, therefore, that the true numbers of Common Scoters present in Carmarthen Bay are substantially higher than currently realised. This issue is discussed further in Section 4.7 below.

It is recommended that the ground-based monitoring counts should be continued. They appear to document a level of scoter occupancy not apparent from aerial surveys. Until this discrepancy is resolved the ground-based counts should be continued, particularly during the mid-winter months of November through February. One important point is that most recent counts have all been carried out by a single observer (LS). If there were to be any change of observer in the future then it would be important that the new observer should follow the same protocols carefully, especially with regard to the discussion below in Section 4.2.4 on the effect of thoroughness.

## 4.2 Assessment of the Factors Affecting the Precision and Accuracy of Ground-Based Counts

### 4.2.1 Weather

Broad weather conditions were recorded during all ground-based counts, including wind speed and direction, cloud cover and glare, precipitation and visibility. Additionally, the state of the sea-surface was also described. However, although this information can be examined with regard to explaining influences on counts, in reality most counts were made on days where conditions were reasonably favourable. Experienced counters recognise that if sea-

state is too rough or visibility too poor then it is effectively pointless attempting to make a count. Most of the following discussion is based on anecdotal observations and a visual inspection of the count conditions; there are too few data to allow for a formal analysis.

#### 4.2.1.1 Wind and sea-state

Generally, wind speed and direction were probably not so important by themselves compared to the effect they had on sea-state. Clearly, however, sea-state can also be affected by factors more remote from the survey area itself. Sea-state is one of the most critical factors affecting ground-based counts. The greater the amplitude of the waves, the more likely a flock on the surface will be overlooked from the shore due to its being in a trough. In general, counts should be carried out on days of low wind speeds and this is more critical if the wind is from the south.

Although LS recorded conditions during the monitoring counts, her records were not particularly suited for this question as she was only making one count per station per date. The monitoring counts were carried out with winds from a variety of directions. Most wind speeds were below force 2 although occasionally up to force 5.

During the paired counts undertaken by RS and LS on 5/1/03 from Pendine, even a wind recorded as SE 1-2 was thought to have contributed to lower counts by RS than by LS, as with a lower powered telescope, he evidently missed many birds behind wavetops.

During the thoroughness studies, NF recorded multiple counts along with wind speed and direction. Anecdotally, NF recognised the critical effect of sea-state on his ability to count the birds present and even a light swell readily hid birds from view on less thorough counts. A consideration of the counts on 6/3/03 shows a interesting pattern. On this date, the first two hours of counts were recorded as taking place with westerly winds of 10 mph and a light swell. However, the third to eighth hours of counts had westerly winds of 15 mph with an increasing swell and ‘white horses’ on the wave tops. Average counts were higher during the first two hours than during the following six hours. However, this decrease was most apparent for the less thorough counts, as set out in Table 4.1. This result is hardly surprising. With any count, scoter flocks can be hidden within troughs. The likelihood of the observer noting the flock is dependent upon both the number and size of the waves and the time taken to observe a particular area of sea.

During the further counts carried out by NF to look at the influence of the tide, the wind and sea-state was again recorded. However, with these counts more time was available (two hours per count) and as expected, sea-state became less significant in comparison to glare.

In summary, the sea-state is a very important factor when making ground-based counts of scoter. However, it becomes less important if more time is available to carry out the count. It has to be stated, however, that all of the counts for this study were in conditions chosen to be suitable for survey work and no counts were made with a wind of more than 20 mph. Above this level, one would expect even rougher seas to become an even more serious impediment.

#### 4.2.1.2 Visibility, glare, cloud cover and precipitation

As well as the sea-state, the other major weather-related factor affecting the ground-based counts was overall visibility which was a combination of glare, cloud cover and haze. Precipitation would also affect visibility, but it was not possible to assess the effect of precipitation on the counts, as none fell on any of the dates on which they were carried out. However, it can be surmised that precipitation would affect counts mostly through a general reduction in the distance over which scoter can be seen. Other factors would be effects on optical equipment and, particularly in heavy precipitation, a reduction in thoroughness on the part of an observer.

Strong sun glare was a serious problem on some counts although the effect was strongest in a limited part of the sea, *i.e.* that in line with the sun from the observer. Wherever possible, count stations and times should be situated with this fact in mind. The effects of glare were considered particularly pronounced during the monitoring count on 31/3/03 when the numbers of birds recorded were relatively low. However, the true extent of this was difficult to judge as the late date in the season meant that many scoters may have left the area anyway.

As with sea-state, the effects of strong glare were greatest during shorter duration counts. The effects were particularly severe during the thoroughness counts carried out by NF on 14/2/03 when he experienced near 'white-out' conditions and was even left feeling rather unwell for a time. Again, increasing the time available to carry out the count should reduce any such problems, allowing the counter time to rest their eyes.

### 4.2.2 Disturbance

Disturbance can affect bird-counts in a number of ways, although a real impact on bird populations is usually extremely difficult to demonstrate (Hill *et al.* 1997). Surveys of the type discussed in this study can only really assess immediate disturbance effects, *i.e.* those witnessed at the time. In reality, disturbance events occurring before the survey period may also have a major effect on the numbers of birds present.

During all ground-based counts in this study, disturbance was looked for and recorded when seen. In the event, however, very little disturbance was noted. A number of boats were noted from time to time but no effects were recorded. The only recorded effects of disturbance were from aircraft, both military and the aerial survey plane used for this study.

The military use parts of Carmarthen Bay for training flights and weapons practice. This was most apparent during the survey on 6/3/03 when such activity was noted to cause large flocks of scoter to fly past the Pendine watchpoint. However, the effects seemed to be local and short-lived in nature. More of a problem was the effect of the aerial survey plane on 15/3/03 which passed over NF shortly before his third count. He noted that about half of the birds visible flew further out to sea and his count numbers were affected accordingly. Notably, during the fourth count of the day, two hours later, these birds had apparently not returned. It is recommended, therefore, that if ground and aerial counts are to made on the same day, the ground counts should be undertaken shortly before the survey plane covers the same area.

### 4.2.3 Tidal patterns

NF carried out three days of counts specifically designed to concentrate on assessing the degree to which the birds moved around on the tide. All observations were made from the Pendine count station. Figure 4.1 shows the overall distribution of all scoter observations during these days, with a clearly favoured general area from north-west to south-east. As the tide progressed, different stages of the tidal cycle were covered and the individual counts shown in Figure 3.6 could be grouped by approximate stage in the tidal cycle (low, rising (split into two), high and falling (split into two)). These grouped distributions are shown in Figure 4.2.

From a visual inspection, it is difficult to see any clear pattern from these plots. There is no clear evidence of a tidal movement but if anything, birds appear to be further offshore as the tide rises. To some extent, the overall pattern has been affected by the southwards movement of many birds on 15/3/03 after being flushed by the aerial survey plane.

It is quite possible that patterns of movement may be diurnal rather than (or as well as) tidal in nature. This would be better picked up by having observations better spaced throughout the month, with different tidal states occurring at different times of day. It is hoped that once the full historical dataset becomes available a wider investigation of this issue will be possible.

### 4.2.4 Thoroughness

One of the clearest findings of the study has been the major effect that the degree of thoroughness has on the numbers of scoters counted. Through a series of timed counts of varying duration carried out by NF from Pendine the effect of thoroughness could be seen clearly. Figure 4.3 shows the count totals made from Pendine throughout the winter, grouped by duration of count. Clearly there is a great deal of variation within each duration grouping, which is linked to count conditions (sea-state and visibility), intra-observer variation and the actual numbers present on different dates. However, the increase in total counted with increasing duration of count is very clear.

The fitted logarithmic trend line indicates a levelling-off in counts with increasing duration, although it suggests that increasing the duration of counts above 80 minutes may continue to provide higher counts. Most of the monitoring counts carried out for this study and in previous years by LS have taken approximately two hours per count station. Figure 4.3 suggests that this is probably a sensible period to count over, but anything less than one hour should probably be regarded as a undercount unless associated with perfect counting conditions.

### 4.2.5 Intra-observer variation

Intra-observer variability was investigated by considering the repeated sets of ‘thoroughness’ counts carried out by NF. On the first two of the four dates allocated to these counts, NF carried out sets of 3 x 5 minute counts and 2 x 10 minute counts, whilst on the last two dates sets of 2 x 20 minute counts were undertaken. Counts clearly varied over the course of a day, due to factors such as sea-state, glare and overall movement of birds. However, the counts can be considered within their own ‘sets’ to investigate intra-observer variation, making the assumption that during each set of counts, the true number of birds visible did not alter.

For each set of 5 minute, 10 minute and 20 minute counts, the mean was calculated. The percentage difference of each count from its 'set mean' was then calculated. The results are plotted in Figure 4.4. Overall, in 58% of cases the count was within 5% of its 'set mean' and in 87% of cases counts were within 10% of the 'set mean'. The maximum percentage difference from a 'set mean' was 16%. There was relatively little difference in intra-observer variation between different durations of counts.

These results suggest that, for NF at least, intra-observer variation was relatively low and that ground-based counts should be considered to be relatively precise. However, it would be of interest to investigate this matter further in two ways. Firstly, a longer series of repeated counts could be carried out, perhaps 5 x 10 minute counts per hour for a whole day. Secondly, it would be interesting to look at the intra-observer variation for other observers to see how this varies. If possible, observers with a range of levels of experience would be used to assess how experience affects precision.

### 4.2.6 Inter-observer variation

Inter-observer variation in making ground counts of scoters was addressed on two occasions.

On 5th January 2003, both LS and RS made simultaneous ground-based counts of the numbers of Common Scoters visible from the Pendine count station, although using slightly differing methods and, probably more significantly, different optical equipment. The level of discrepancy was great, with LS recording about 70% more birds than RS. There were considered to be a number of reasons why the discrepancy between the counts was so great. LS carried out her count in the same manner as her ground-based monitoring counts, *i.e.* by recording flocks to bearing and distance. Whilst RS also made a careful count he was not recording distance and bearing and thus his count took about half the time. The discrepancy therefore could be partly related to the effects of thoroughness described above in Section 4.2.4. Additionally, the optical equipment used by the two observers varied. RS used a telescope with 30x wide-angle lens whilst LS used a 20-60x zoom lens. This was considered by the counters to be a major factor in explaining the difference in counts. Finally, whilst RS is a very experienced observer, LS has a great deal more specific experience in carrying out ground-based counts from this particular site.

During the afternoon of 6th March 2003, the monitoring count by LS from Pendine overlapped with the 6th to 8th hours of thoroughness counts being carried out by NF. The former recorded a total of 7,434 birds over approximately two hours. The counts carried out by NF varied with duration. Five-minute counts over these three counts averaged 754 birds, ten-minute counts averaged 1,586 birds and 20-minute counts averaged 2,858 birds. In this case, the difference between observers is confounded by the effects of thoroughness.

Further work should be carried out to look into this issue, including at least one day with at least three observers using identical optical equipment from the same site. This could be combined with the further work suggested above for further investigation of intra-observer variation.

## 4.3 Maintenance of a Monitoring Programme of Aerial Counts

A programme of eight flights was carried out during the 2002-03 winter, using two different count techniques. Given the dates of these counts, for monitoring purposes three aerial monitoring "events" can be considered to have occurred, in early December 2002, early January 2003 and mid March 2003. The results of the aerial monitoring events can be summarised as follows.

*Early December 2002*

A total of 11,004 Common Scoter was recorded during a distance-method flight on 1/12/02, which resulted in an estimate of 19,909 birds (95% CI = 10,803-36,690). The single flight located scoters spread over a wide area. The densest concentration was located well offshore, at least 7 km away from any of the ground stations. A second main cluster was situated closer to shore between Amroth and Pendine. Only small numbers were found off Pembrey.

*Early January 2003*

A total of 5,408 Common Scoter was recorded during a distance-method flight on 4/1/03, which resulted in an estimate of 15,417 birds (95% CI = 7,840-30,317). Two census-method flights were carried out, on 4/1/03 and 5/1/03, during which totals of 8,835 and 10,309 were recorded respectively. Birds were again scarce inshore off Pembrey but were widespread further west. However, most of the birds were well offshore, with few closer than 3 km and some major concentrations as far as 9 km offshore.

*Mid March 2003*

Totals of 9,690 and 5,984 Common Scoter were recorded during distance-method flights on 15/3/03 and 16/3/03 respectively, which resulted in estimates of 13,337 (95% CI = 7,846-22,672) and 9,819 (95% CI = 6,071-15,881) birds respectively. Two census-method flights were carried out, on 15/3/03 and 16/3/03, during which totals of 7,956 and 7,572 were recorded respectively. The scoters were grouped into two broad areas. The densest concentrations were found between 2 km and 5 km off Pembrey Sands, although substantial numbers were dispersed up to 8 km offshore. The other group was found between about 2 km and 5 km off Amroth and Pendine, in an area about 10 km from east to west. These two groupings were separated by a gap of about 4 km where relatively few scoters were located.

At the time of writing, the historical data were not all available, notably those from the winters of 1998-99 to 2000-01. As such, it was not possible to discuss the totals from the aerial counts made during 2002-03 in their full context. The totals and derived estimates were not dissimilar to those recorded by distance method flights in the winter of 2001-02 (following either the methods used by Webb *et al.* 2003 or WWT 2003) Additionally, the broad overall distribution of the scoters was also similar to that seen in previous years. The distribution varied between months but averaged across the winter the birds could be found throughout a band approximately 5 km wide running from the north-west of the bay off Amroth and Saundersfoot to the east off Pembrey Sands. The Rhossili area, to the west of the Gower Peninsula, again supported few birds, further supporting the theory that this is a suboptimal area used only following the *Sea Empress* oil spill because the favoured areas became unavailable. Additionally, very few scoters were located in the north-east of the bay at the outflow of the three rivers.

One point of note is that whilst the existence of a 'dead-zone' (*i.e.* a band of sea below the survey plane that cannot be observed from windows on the side of the plane) is a well-recognised issue for the analysis of data from distance-method flights, there is also an equivalent 'dead-zone' for the census-method flights. As the plane is at twice the height during a census-method flight, the zone is twice as wide, *i.e.* 88 m either side of the transect line. The census-method takes as an assumption that the whole sea-area is covered by the observers. However, the dead-zone means that about 18% of the sea is not being viewed and census-method counts should perhaps be increased by a factor of 1.22 (to totals of 10,779, 12,577, 9,706 and 9,238 for the four counts in their respective date order). On the other hand, it could be argued that many of the scoters that are in this zone will in fact flush to one side or the other and thus be observed anyway. Whether or not this correction factor is used is probably not too important, as it seems likely that even making this correction the resulting estimate is still far too low, as discussed below in Sections 4.4 and 4.5. The relative distribution is of greater interest.

During the flights, the behaviour of the scoters was recorded, although only in the broadest of detail, as to have concentrated upon behaviour would have compromised the primary aim of making counts. All that could really be investigated was the reaction of the scoters to the plane. During the distance-method counts, the great concentration required of the counters meant that only division of birds into sitting, flying and flushing was possible. For the census method flights, the direction of travel of flying birds was usually also recorded. The distinction between 'flying' and 'flushing' birds is not straightforward as it is not possible to say for certain that a flock of scoters in flight have not been influenced by the approach of the plane. As a result, it is perhaps safest simply to consider whether birds are recorded on the water or in flight.

Overall, during distance-method flights, 71% of birds were noted in flight, compared to 59% in flight during the census-method flights. This difference could perhaps be due to the fact that the distance-method flights were at a lower altitude, causing greater disturbance to the birds. However, it was strongly influenced by the final distance-method survey on 16/3/03 when over 96% of birds were recorded in flight. It is possible that by the time of this flight, which was the fourth covering the bay in two days, the birds had become increasingly 'spooked' by the plane, although other studies have suggested that in some circumstances, birds may become accustomed to disturbance factors over time (*e.g.* Fitzpatrick & Bouchez 1998, Triplet *et al.* 1998).

An obvious question is whether the detectability function for birds in the air differs from that for birds on the sea. It seems intuitively likely that they would be different although it is not clear in what manner: distant birds are likely to be more visible in flight than on the surface but, conversely, birds are perhaps more likely to be in flight nearer the transect due to the effect of the plane. A preliminary attempt was made to separate flying and sitting birds within the distance analysis but, perhaps surprisingly, it appeared that the split added little to the model. It is envisaged that a more refined method of the distance analysis will be undertaken in the future, incorporating such factors as bird behaviour and observer differences.

As part of the study, as well as to increase the base of available observers for aerial surveys, a BTO staff member, Steve Holloway, (a highly experienced field observer but with no prior aerial survey experience) joined the four flights made over the weekend of 15-16/3/03, having been fully briefed on the techniques to be used. For each flight, SH occupied a seat behind LS and made observations to starboard of the plane. However, the visibility afforded

to him by this seat was less than that of the two principal surveyors; the window was of inferior quality and viewing outside the plane was obstructed by a wing-strut. As expected, the counts made by SH were substantially lower than those of LS; 31% and 37% of her totals for the two census method counts and 19% of her second distance method count (the first distance method count was primarily used by SH to acclimatise to the overall experience of aerial survey). However, it was difficult to assess the extent to which these lower count totals were due to counter experience *vs* the less optimal viewing conditions. It is likely both had an impact however and these surveys confirmed that counts from a new aerial surveyor should be treated as undercounts for at least the first four flights. Interestingly, however, the relative distribution of Common Scoters recorded by SH for the two census method counts (Figures 3.11 and 3.12) are similar to those recorded by the other two observers (Figures 3.9 and 3.10 respectively). This implies that relative inexperience of aerial surveyors may not be such a problem if the main aim of a flight is to record a broad distribution rather than come up with a population estimate.

For future monitoring purposes, it is essential that some aerial surveys at least are continued, as there are areas of the bay which are too far offshore to survey from the land. The issue of the combination of ground and aerial counts means that further comparative data will be crucial although, as discussed below in Section 4.6, the precise method of combining the results of these two methods is still open to question. It will be especially important to ensure that ground and air counts are as close in time as possible. Additionally, the effect of the survey plane upon the scoters requires more detailed examination, including the extent to which the plane "herds" the scoters across the bay in front of it, as discussed in Section 4.6. Transects for both census and distance flights should ideally be flown in a random order. If this is prohibitively impractical, then at least the order of the transects should be reversed on consecutive flights. It is also important to continue to train new aerial observers, not only to increase the pool of potential fieldworkers for this type of work but also to investigate the extent to which relative patterns of distribution can be described by relatively inexperienced observers.

## 4.4 Assessment of the Relative Merits of Two Different Aerial Survey Techniques

Aerial surveys of Common Scoters in Carmarthen Bay have been flown using two quite separate methods, both during 2002-03 and during several years prior to that (*i.e.* distance-method during 2001-02 and census-method before that). It will be valuable to consider all of the historical data from both methods. However, the data from 2002-03 are the most suitable for comparing the two methods, being the closest matches temporally.

The principal reason for introducing the distance-method was to try to improve upon estimates of numbers of scoters in the bay, as it was felt that the census-method involved too great a risk of double-counting birds as they were flushed from one cell to another. With the distance-method, the distance between transects was increased thus lessening the chance of double-counting. Additionally, the distance-method allows the calculation of confidence intervals on the estimates.

The aerial surveys carried out during 2002-03 allow for four sensible comparisons to be made, *i.e.* three pairs of surveys on 4/1/03, 15/3/03 and 16/3/03 and a further comparison of the 4/1/03 distance-method flight with the 5/1/03 census-method flight. The results of these surveys are summarised in Table 4.2. Overall, the estimates from all of these aerial surveys were relatively consistent, within a range of 9,000 to 16,000 birds (although the point

estimate from the additional non-paired distance-method count on 1/12/02 was almost 20,000 birds).

For the pair of flights on 4/1/03, the adjusted census total was within the confidence limits of the distance-method estimate, although 30% lower than the point estimate. The adjusted census-method total from the 5/1/03 was closer to the point estimate but still 18% lower. On 15/3/03, the adjusted census total was again within the distance-method estimate confidence limits (although the non-adjusted census total was only just within these limits) and again the census estimate was lower than the distance point estimate, by 27%. Finally, the estimates from the pair of counts made on 16/3/03 were in closer agreement, with the census-method adjusted total only 6% lower than the distance-method estimate.

Within these comparisons, some interesting observations arise. Firstly, consider the actual count made during distance-method flights (*i.e.* before analysis to produce an estimate). As these counts are made during a survey designed with the expectation that birds will be missed, it would be expected that these counts would always be substantially lower than those from the census-method counts (which attempt to record all birds). This occurred in three cases but the distance-method survey on 15/3/03 actually recorded more birds than on the census-method survey the same day. This implies that either the distance-method count was an overcount (*e.g.* an observer over-estimated the number of scoters in one or more flocks) or that the census-method count was an undercount.

As mentioned above, one of the principal justifications for using the distance-method is that the census-method is likely to lead to double-counting. Therefore, one would expect there to be a tendency for the census-method to lead to higher estimates than the distance-method. However, this was clearly not the case; in all four comparisons the census-method estimate, even after adjusting for a 'dead-zone' under the plane, was lower than the point estimate from the distance-method survey. It is hard to argue, therefore, that double-counting of flocks during census-method flights is a major problem.

It seems likely that the census-method also undercounts bird numbers. One reason for this is probably the underlying assumption that counters record all birds out to a distance of 500 m from the transect line. The distance-method results suggest, though, that this assumption is incorrect. For the distance-method flights undertaken during 2002-03, three of the four distance bands were within the 500 m zone and counts were clearly not distributed evenly amongst these bands (see Tables 3.13 to 3.16). However, it should be remembered that the two aerial survey methods were undertaken with the plane at different heights.

Although they give higher estimates and follow a more scientifically rigorous methodology, the distance-method estimates are also far from ideal, in that the bootstrapped 95% confidence intervals they provide around the estimates are very wide. This makes it more difficult to have faith in the point estimate. These wide confidence intervals are largely as a result of a high degree of clumping in the distribution of scoters in the bay. For example, for the distance-method survey on 16/3/03 a total of 176 observations of scoter 'clusters' was made, totalling 5,984 birds. However, over half of these birds were present in just two clusters (of 2,200 and 1,100 birds respectively). Given this level of concentration into a few principal concentrations, the accuracy of the counting of these flocks is of great importance. It is well-known that even the most experienced counters (and LS and RS are undoubtedly highly experienced in this type of fieldwork) can have difficulty in counting larger flocks under the demanding conditions of being in a fast-moving plane, particularly when of uneven

density (*i.e.* denser in the centre and more dispersed to the edge). Photographs of the principal clusters encountered during a flight could be advantageous if it were possible to obtain them without undermining the counting effort.

From the aerial surveys during 2002-03 it has been possible to compare the two methods and further fieldwork would strengthen this comparison. If similar results are obtained, this could allow an approximate scaling factor to be applied to past counts to convert results from one aerial survey method to the other. However, it is not possible to say which of these two methods is better at estimating the true number of birds present in the bay, since the true number is not known to begin with. It remains to be proven whether estimates derived from either aerial method are suitable to describe the true numbers of scoters using the bay. The ground-based monitoring counts undertaken over the 2002-03 winter, whilst not ideally synchronised with the aerial count dates, suggest that the aerial counts record lower numbers overall than the ground-based counts. Given the limits of visibility of the ground-based counts (*i.e.* mostly within 4 km of the land), the discrepancy is likely to be larger as there appear to be large parts of the known occupied range which are not covered by the ground counts. This issue is explored further below in Sections 4.5 to 4.7.

## 4.5 Investigation of Whether Ground-Based Counts Consistently Provide an Appropriate Index of Overall Numbers of Scoters

Both aerial counts and ground-based counts can be used to describe the numbers of scoters in Carmarthen Bay but both have their limitations. As such, neither can be considered to provide a definitive answer to the number of scoters in the bay. Ground-based counts cannot survey birds that are too far away from the shore. Aerial counts by the census-method are limited by the risk of double-counting but probably also, as discussed above in Section 4.4, by the invalid assumption that birds can be completely surveyed to a distance of 500 m from the transect line. Aerial counts by the distance-method attempt to account for the risk of double-counting but, in Carmarthen Bay in 2002-03 at least, the confidence limits around the resulting estimates are very wide.

Even a very cursory visual comparison of the results from the ground and aerial counts strongly suggests that many birds are missed from the air compared to those counted from the ground, which agrees with past survey work at the site (Stewart *et al*. 1997, Cranswick *et al.* 1998). There are two plausible reasons which this should be so. Firstly, neither aerial survey method accounts for birds which fly well in advance of the arrival of the plane. This is known to occur, both from observations by NF during this study and also in previous winters by LS. Secondly, neither of the two aerial survey methods accounts for scoters diving underwater upon the approach of the plane. This would appear to be a natural response for a sea-duck encountering a perceived threat and some birds at least must surely have been missed in this manner.

The question of whether ground-based counts can consistently provide an appropriate index of overall numbers of scoters is thus not straightforward to address, as the true number present is not known. It could be argued that it is unnecessary to record the true number of birds present so long as one knows what proportion of the whole is being covered by the ground-based counts. For example, if the area known to be visible from the ground count stations can be assumed always to hold a given proportion of the birds, then an appropriate index can indeed be provided. To look closer into this type of assumption it would be

valuable to make use of the full historical dataset of both ground-based and aerial counts. However, some conclusions can be drawn from just the counts undertaken in 2002-03.

Whatever the accuracy of the counts and estimates derived from the aerial surveys, the relative distribution is broadly similar throughout all counts, on a band from north-west to south-east, agreeing with the general pattern found during other recent winters. However, within this band, the relative distribution can vary considerably. For example, during the two January census-method counts (Figures 3.7 and 3.8), the bulk of the scoter flock was concentrated in the north-western quarter of the bay, along with a substantial flock in the middle of the bay at least 7 km offshore. However, during the two March counts (Figures 3.9 and 3.10) the centre of distribution had shifted eastwards with the largest flock centred about 3 km offshore. Therefore, one could not say that the ground counts represented a constant proportion of the overall number of birds in the bay.

As a result, individual ground-based counts should perhaps not be used as an index of total population size. However, it is possible that, given access to the full historical dataset one might be able to make an assumption that if four counts were made each winter, say, then the peak count each winter could be assumed to represent a similar proportion of the true number present. It would be useful to test this once the full dataset is available.

Alternatively, the ground-based counts could be used in conjunction with aerial counts. The latter could provide a relative distribution map to scale up the ground-based counts from the limited area of the bay visible from land to the overall occupied area. A key requirement to providing overall estimates of numbers (as discussed in Section 4.7), therefore, is to know quite precisely the area that is being monitored from the land, as discussed below in Section 4.6.

## 4.6 Investigation of Whether a Distance Function Can Be Derived Using Aerial Counts to Describe the Decline in Detectability by Ground Counts Over Distance

The likelihood of detecting an offshore flock of scoters from a land-based observation station is related to the distance of the flock from the observer and the size of the flock (larger flocks are likely to be detectable over greater distances than smaller ones). Additionally, count-related factors such as sea-state and visibility are also important. In order to interpret ground counts of scoters correctly, it is necessary to develop a distance function to describe detectability. This should also enable counts to be scaled up across the whole of Carmarthen Bay by comparison with aerial counts. The determination of the distance function would be a relatively straightforward matter if the scoters were distributed evenly across the bay. However, this is clearly not the case, as can be seen from both the survey work described in this report and that carried out in previous years. A different approach is thus required. It was initially envisaged that the distance function could be determined by comparing the aerial survey data with the ground count data. Although this approach has proved unsuccessful, as discussed below, it is useful to consider the theory behind it.

Carmarthen Bay is divided into recording cells for the purposes of the aerial census flights. For most of the bay these were 2 x 1 km in size. The south-eastern part of the bay was divided into 1 x 1 km cells, although relatively few birds were recorded here and this area can be largely discounted for the current purpose. The ground counts were recorded to distance and bearing from the three vantage points, enabling plotting of flocks to eastings and northings. Following this, flocks were assigned to the aerial census recording cells (by use of

ArcView GIS software). Additionally, the distance from the centre of each cell to the nearest ground station was also calculated.

Ideally, one would assume that the distribution was constant between the two surveys and that both ground and air counts recorded the same number of birds close to shore but that ground counts declined relative to air counts solely with increasing distance. A graph of (ground / air) *vs* distance could then be plotted and the shape of the resulting curve would describe the distance function. A refinement of this method would be to plot separate curves for different sized scoter flocks (perhaps 1-10, 11-100, 101-1000, 1001+) as one would expect detection of small flocks to drop off more rapidly than for large flocks. A further modification would be necessary if, as observed in this study, the overall numbers of birds seen from the air were lower than those counted from land. In this case, one could scale up the aerial counts proportionately and then plot (ground / scaled air) *vs* distance instead. The resulting curve would again be suitable for determination of a distance function.

However, an attempt to use this approach on the data collected for this project was unsuccessful. The reason was that in the nearest cells to the shore, where the ground count would be assumed to be the most accurate, very few birds were recorded by the aerial counts. Although synchronicity between ground and air counts could not be achieved, a comparison of the mean distribution between ground and aerial census counts (Figure 4.5) shows that the ground counts reported very much higher numbers of birds close to the shore than were recorded by the aerial census method counts. The discrepancy is striking; as an example, from the first entire recording cell south of the Pendine vantage point, a mean of 2,666 Common Scoters was recorded during ground-based counts compared to zero from aerial census counts. It is clearly unrealistic to attempt to scale up such aerial counts. Therefore, the underlying assumption of the approach is violated, *i.e.* that the actual distribution of the birds was constant between the two surveys.

It has to be concluded that it is not feasible to rigorously determine a distance function in this manner. However, it is important to discover why such a discrepancy exists. The possibilities are:

1. There was a real, inherent difference in distribution on the dates of the ground and aerial counts. As the counts could not be synchronised it is not possible to discount this entirely. However, given that analysis has been attempted using data averaged over four winter counts for both methods it seems highly unlikely that this level of discrepancy can be explained entirely in this manner. One possible difference would be if all counts of one method had been at a different state of the tide to all of those by another method. However, examination of the times and tides of the counts shows that each method was carried out over a similar spread of tidal situations. Additionally, visual examination of the maps of distribution by the aerial census-method (Figures 3.7 to 3.10) is instructive. These two pairs of counts on successive dates were carried out at different states of the tide (*i.e.* around high tide for 4/1/03 and 15/3/03 and around low tide for 5/1/03 and 16/3/03). Whilst small differences can be described for the high and low tide distributions there is no large-scale redistribution in the parts of the bay closest to the shore.

2. The distances assigned to flocks during the ground counts were incorrect. If the distance values recorded by LS were lower than they should have been then the aerial and ground counts would suggest more similar distributions. Judging distance over

open water is particularly difficult and it would seem quite possible that some distances were not assigned correctly. However, the method used by the observer had been developed in a rigorous manner. LS felt that if errors did occur then they would be more likely to operate in the opposite direction, *i.e.* it was felt that distances might be over-estimated. Additionally, if there were problems within the distance estimations, these would be more likely for the greater distances, whereas the greatest discrepancy between ground and air counts appears to be closer to the shore. It is not likely, therefore, that this would explain the discrepancy entirely. It should be noted, however, that if this explanation was shown to be correct and distances were being underestimated then this would have further implications as the count zones from the Amroth and Pendine vantage points would overlap and flocks would then be double-counted.

3. The difference in distribution is due to birds moving in response to the approach of the plane. LS felt that this was the most likely explanation and the observations of NF on 15/3/03 back this up, when he noted a redistribution out to sea of the scoter flocks off Pendine following the pass of the survey plane. It was also thought that this explained the discrepancy of the distributions noted off Pembrey in the east of the bay, where birds were noted relatively close to shore during ground counts but were located further offshore during aerial counts. LS felt that during the distance-method flights, with north-south transects moving progressively from east to west, it was likely that scoters were 'herded' across the bay in front of the plane.

It seems most likely that the third explanation is the most plausible. This has serious implications for the determination of a distance function and thus for the consequent estimation of the overall numbers of scoters within the bay. An exploratory approach to such an estimation resulted in estimates of up to 150,000 scoters which seems highly unlikely, given that no other counts have ever approached this range.

A much coarser-scale approach was also tried. In this case, it was assumed that all birds seen from the ground within a distance of 4 km from the vantage points were equivalent to all of the birds recorded from the air within a distance of the vantage points. Scaling the ground counts upwards accordingly then resulted in an estimate of about 35,000 scoters which seems more reasonable. However, it is felt that there is still far too much uncertainty surrounding the counts to rely upon such an estimate yet.

Further investigation of the determination of a distance function would be possible using further data, both past and future. In the future, more observer effort to look into the response of the birds to the plane would be useful. Secondly, it would seem highly sensible to try to vary the flight path of the plane to a greater degree. Transects could either be flown in a random order or else paired flights could be carried out where the order of transects was reversed between flights. This latter would enable the possibility of scoter 'herding' to be investigated; it would be interesting to see if the scoter flocks could be herded closer and closer to the shore where the numbers and the birds' reactions would be more visible from the land. Finally, the level of synchronicity between ground and aerial counts should be improved if possible. Ideally, ground counts from all three vantage points should be carried out simultaneously and immediately followed by aerial survey, with the ground observers recording the reaction of birds to the plane.

## 4.7 Evaluation of All Extant Data to Provide Possible Targets for Scoter Numbers and Creation of a Draft Protocol for How Assessments of Favourable Conservation Status Should be Made

Can a target be derived for the numbers of Common Scoters in Carmarthen Bay which would enable an assessment of Favourable Conservation Status to be made? As has been discussed above, whilst there are a number of ways of arriving at scoter numbers for the site none are ideal and all have associated problems. Similarly, it is not yet possible to produce a reliable index of the population. The most rigorously derived estimates are those from the distance-method flights. However, the width of the confidence intervals around these estimates means that they would not be very suitable for detecting change in the numbers using the site. Measures of change in waterbird populations in the UK are becoming standardised around the WeBS Alerts system (Austin *et al.* 2003). This system uses smoothed index values to assess change over three time periods (five, ten and 25 years). Any declines fire an 'alert' if greater than 25% (a medium alert) or 50% (a high alert) over a given time period. Formal application of the Alerts system to the Carmarthen Bay dataset would currently be inappropriate as an appropriate index has not yet been derived. However, the three time periods (when enough data become available) and the two levels of decline should be adhered to in discussion of change for the purposes of standardisation.

A more detailed examination of the full set of historical data, once available, will help with providing targets and assessing Favourable Conservation Status. Based largely on 2002-03 data, however, the following suggestions can be made:

**Option A – Ground counts only**

Given an adequate degree of thoroughness and good count conditions, these provide good minimum estimates. Ground counts are also relatively inexpensive and straightforward to carry out. However, they are not suited to monitoring the whole site. Given that the relative distribution of the scoters within the bay varies through the winter it is not straightforward to use an individual ground count to index the total population. However, it is possible that given a series of ground counts over a winter, taking the peak count for the winter might provide a reasonably reliable measure of occupancy. Further data would be needed to look into this further.

*Examination of the recent counts available suggests that peak ground counts over a winter in the order of 20,000 birds should be a reasonable expectation. Using peaks published in Pollitt* et al. *2003, WWT 2003 and this study, the five-year peak mean for the period 1998-99 to 2002-03 is 20,541. Until further notice, it is suggested that if a minimum of four ground counts over the course of a winter fail to produce a peak total of 15,000 Common Scoters, this should be considered a provisional medium alert. Likewise, if a minimum of four ground counts over the course of a winter fail to produce a peak total of 10,000 Common Scoters, this should be considered a provisional high alert.*

**Option B – Aerial census-method only**

This is a reasonably straightforward way of covering the whole bay, although is clearly organisationally more difficult than ground counts (requiring more staff and a plane). This does not appear to be a good method for assessing the overall numbers, as numbers recorded are much lower than those recorded by ground counts. This is probably due to a) birds flying

well in advance of the plane and b) birds diving upon the approach of the plane. However, it is possible that the relative numbers recorded per flight could be as effective an indexing tool as the ground counts although past data would be useful to assess this question. The totals counted by this method during the present study were relatively consistent, averaging 8,668 Common Scoters. During similar aerial census-method flights (although with different routes used) in the winters following the *Sea Empress* oil spill, the peak and average totals were, respectively, 4,500 and 2,382 in the 1996-97 winter and 4,953 and 3,020 in the 1997-98 winter, although totals were somewhat more variable between flights.

*From the recent counts available, it appears that a peak winter count by the aerial census-method of over 10,000 birds should be considered a reasonable expectation. Until further notice, it is suggested that if a minimum of four aerial census-method counts over the course of a winter fail to produce a peak total of 7,500 Common Scoters, this should be considered a provisional medium alert. Likewise, if a minimum of four aerial census-method counts over the course of a winter fail to produce a peak total of 5,000 Common Scoters, this should be considered a provisional high alert.*

**Option C – Aerial distance-method only**

This is a rigorous and repeatable method and so provides what are arguably the best estimates for between-year comparisons. However, the width of the confidence intervals arising from the analyses are such that it would be difficult to identify a real decline of 25% or even 50%.

*Until further notice and dependent on further analyses, it is not recommended that aerial distance-method counts should be used to assess Favourable Conservation Status of Common Scoters at Carmarthen Bay.*

**Option D – Combination of ground and air counts**

As discussed in Section 4.6, it would be ideal if aerial counts could be used to scale up ground counts to derive an overall estimate of Common Scoters within Carmarthen Bay. Although this has been unsuccessful so far, the broad principle would appear to be sensible and it should be possible to develop a modification of Option A which involves a degree of checking of the overall distribution by aerial survey.

*The provisional recommendations for Option A should be followed, except that aerial census flights should be carried out to detect any broad-scale changes in distribution which could explain changes in numbers.*

## 4.8 Procedural Guidelines and Standard Operating Procedures

Procedural Guidelines (PGs) and Standard Operating Procedures (SOPs) are designed to ensure consistent monitoring approaches between sites (PGs) and over time at an individual site (SOPs). It was envisaged that PGs and SOPs would be produced for both ground and aerial counts, the SOPs specific to Carmarthen Bay. However, given that not all historical data and reports (especially LS's Ph.D. thesis) were available at the time of writing and given that it was not clear which method of aerial survey should be recommended, these PGs and SOPs will be completed in a future report.

However, a draft PG and SOP for ground counts of Common Scoters have been produced for comment and as a template for future work. These are included as Appendices 2 and 3 respectively.

# 5 RECOMMENDATIONS FOR FUTURE WORK

This report has identified a number of areas where further work would be beneficial.

***Ground-based monitoring counts***

It is clearly important that a programme of dedicated ground-based counts are maintained for monitoring purposes. They appear to document consistently higher numbers than do aerial surveys and far higher numbers than would be recorded by casual observations of the bay. For consistency, the same three count stations (Amroth, Pendine and Pembrey) should be used, with consideration given to observing from Rhossili at least once during the winter and more frequently if aerial surveys show there to be reasonable numbers of birds in this part of the bay. At least four counts should be carried out during the period October to March.

***Ground-based methodological studies***

This study has looked into various methodological aspects of ground-based scoter counts. Further work into these aspects would be beneficial, although to a varying degree.

The observations recorded during this study have confirmed the importance of good visibility and as calm a sea as possible for carrying out scoter counts. Further anecdotal observations would be of interest but there seems little to be gained from a formal study of different weather variables. If the conditions are poor, then counts simply are not carried out anyway and the dates chosen for the counts are thus by default suitable within a fairly narrow window of conditions.

Disturbance has not been a major issue to date with scoter counts at Carmarthen Bay and there is no pressing reason for a more detailed investigation into most types of disturbance, although anecdotal observations should continue to be recorded. However, it is most important to look more closely into the reaction of the scoters to the survey plane in order to learn more about the way the estimates from the ground and air counts can be combined.

The effect of the tide on the distribution and numbers of scoters counted from the ground requires further investigation and this issue would benefit both from further days of observation but also having survey dates selected in such a way so that each broad tidal state occurs at different times of the day (although, as always, pre-selection of dates can be hampered by unsuitable weather at the time).

The effect of thoroughness on the number of scoters counted has been well-documented by this study and it is unnecessary to collect the same data again. However, it might be worth further investigation of the effect of thoroughness towards the longer end of the time spectrum, *e.g.* between one and two hours per count.

This study made limited comparisons between counts made by different observers. Further work should be carried out to look into this issue, including at least one day with at least three observers using identical optical equipment from the same site. Additionally, this study suggested that, for NF at least, intra-observer variation was relatively low and that ground-based counts should be considered to be relatively precise. However, it would be of interest to investigate this matter further in two ways. Firstly, a longer series of repeated counts could be carried out, perhaps 5 x 10 minute counts per hour for a whole day. Secondly, it would be

interesting to look at the intra-observer variation for other observers to see how this varies. It should be possible to design fieldwork in such a way as to combine the study of intra- and inter-observer variation during the same day. If possible, an assessment of the level of experience of the different observers could be introduced, to look into how experience affects count precision.

### *Aerial counts*

It is suggested that the comparison of the two methods of aerial survey would benefit from additional flights by both methods. Further analytical work into the incorporation of observer effects and bird behaviour effects on the distance analysis should be undertaken. However, of greater interest is the comparison of aerial and ground counts to derive, if not a population estimate for the bay, then at least a reliable and repeatable index of the numbers present. Of course, it is easy to describe the manner in which counts can be improved but less straightforward to incorporate these improvements, given the logistical difficulties of combining the required observers, plane and suitable weather. However, where possible, the following should be attempted.

Firstly, ground and aerial counts should be synchronised as closely as possible. However, the ground count should take place first, before any possible disturbing effects of the survey plane. Ideally, one would have a synchronised count from all ground stations using a team of observers. Immediately following this, an aerial census method count should take place. It would be of interest to fly east-west transects (for historical comparability) but from south to north, thus potentially herding birds towards the shore. During this flight, the ground-based counters should remain at their stations and prioritise recording the effect of the plane on the birds in their survey area, recording observed movements precisely to time and, so far as possible, to direction and distance of movement. Attention should be paid to the possibility of birds diving. If the weather allows, the counts (ground and air) should be repeated the following day but this time the order of the transects should be reversed, *i.e.* from north to south. The difference between the distribution recorded and the behaviour noted should be instructive in interpreting the combination of the ground and aerial counts.

It is also important to continue to train new aerial observers, not only to increase the pool of potential fieldworkers for this type of work but also to investigate the extent to which relative patterns of distribution can be described by relatively inexperienced observers.

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| Date | Type of survey | Surveyors |
|---|---|---|
| 29/11/2002 | Ground - monitoring | LS |
| 01/12/2002 | Aerial - distance | LS, RS |
| 04/01/2003 | Aerial - distance | LS, RS |
| 04/01/2003 | Aerial - census | LS, RS |
| 05/01/2003 | Ground - methodological - two observers | LS, RS |
| 05/01/2003 | Aerial - census | LS, RS |
| 23/01/2003 | Ground - monitoring | LS |
| 14/02/2003 | Ground - methodological - thoroughness | NF |
| 06/03/2003 | Ground - methodological - thoroughness | NF |
| 06/03/2003 | Ground - monitoring | LS |
| 12/03/2003 | Ground - methodological - tidal | NF |
| 13/03/2003 | Ground - methodological - thoroughness | NF |
| 14/03/2003 | Ground - methodological - tidal | NF |
| 15/03/2003 | Ground - methodological - tidal | NF |
| 15/03/2003 | Aerial - distance | LS, RS, SH |
| 15/03/2003 | Aerial - census | LS, RS, SH |
| 16/03/2003 | Aerial - distance | LS, RS, SH |
| 16/03/2003 | Aerial - census | LS, RS, SH |
| 17/03/2003 | Ground - methodological - thoroughness | NF |
| 31/03/2003 | Ground - monitoring | LS |

**Table 2.1** Summary of fieldwork carried out in Carmarthen Bay during the 2002-03 winter

| Date & tides | Station | Start time | Count | Approx tidal state | Wind (mph) | Cloud | Sea state | Potential disturbance noted |
|---|---|---|---|---|---|---|---|---|
| 29/11/2002 (low 0718, high 1336) | Amroth | 0900 | 6663 | Rising from low | NW 5 | 2/8 | Small waves, no white horses | None |
| | Pendine | 1100 | 8942 | Rising to high | NW 2 | 1/8 | Small waves, no white horses | Three canoes 500m offshore |
| | Pembrey | 1400 | 598 | Falling from high | WNW 2 | 1/8 | Small waves, some white horses | None |
| | Total | | **16203** | | | | | |
| 23/01/2003 (high 0930, low 1554) | Pendine | 0945 | 15159 | Falling from high | NW 2 | 1/8 | Small ripples, no white horses | None |
| | Amroth | 1230 | 6246 | Falling to low | NW 2 | 1/8 | Small ripples, no white horses | None |
| | Pembrey | 1530 | 1883 | Low | NW 2 | 3/8 | Small waves, no white horses | None |
| | Total | | **23288** | | | | | |
| 06/03/2003 (high 0754, low 1412) | Pembrey | 0910 | 7071 | Falling from high | SW 0 | 1/8 | Small waves, no white horses | None |
| | Amroth | 1200 | 5420 | Falling to low | SW 10 | 5/8 | Small waves, no white horses | Two boats within 4 km |
| | Pendine | 1415 | 7434 | Rising from low | SW 20 | 2/8 | Small waves, occ.white horses | None |
| | Total | | **19925** | | | | | |
| 31/03/2003 (high 0630, low 1248) | Amroth | 1030 | 3201 | Falling to low | SE 5 | 1/8 | Small to medium waves, some white horses | None |
| | Pendine | 1230 | 1973 | Low | SW 10 | 1/8 | Small to medium waves, some white horses | None |
| | Pembrey | 1500 | 504 | Rising from low | SE 5 | 1/8 | Small to medium waves, some white horses | None |
| | Total | | **5678** | | | | | |

**Table 3.1** Ground-based monitoring counts of Common Scoters at Carmarthen Bay during the 2002-03 winter.

| Count | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Start time | 0745 | 0845 | 0945 | 1045 | 1145 | 1245 | 1345 | 1445 |
| Precipitation | None | None | None | None | None | None | None | None |
| Wind speed (mph) | 5 | 5 | 5 | 5 | 5-10 | 5-10 | 10 | 10 |
| Wind direction | NNE | NNE | NNE | NNE | NE | NE | NE | NE |
| Cloud cover | 2/8 | 2/8 | 2/8 | 1/8 | 0/8 | 0/8 | 0/8 | 0/8 |
| Visibility | 4 km | 4 km | 4 km | 4 km | 4 km | 4 km | 4 km | 4 km |
| Sea state | Light swell | Light swell | Light swell | Light swell | Light swell | Light swell | Light swell | Light swell |
| Disturbance | None | None | None | None | None | None | None | None |
| 5 min (1) | 874 | 945 | 712 | 939 | 627 | n.c. | n.c. | n.c. |
| 5 min (2) | 796 | 897 | 859 | 821 | 534 | n.c. | n.c. | n.c. |
| 5 min (3) | 832 | 902 | 958 | 970 | 725 | 638 | 748 | n.c. |
| 10 min (1) | 986 | 1167 | 1562 | 1327 | 1029 | 955 | 863 | 1087 |
| 10 min (2) | 1024 | 1390 | 1483 | 1322 | 937 | n.c. | n.c. | 1235 |
| 20 min | 1384 | 1567 | 1782 | 1584 | 1425 | 1026 | 1157 | 1369 |

**Table 3.2** Counts and associated conditions during ‘thoroughness’ counts on 14/2/03.

| Count | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Start time | 0825 | 0925 | 1025 | 1125 | 1225 | 1355 | 1455 | 1555 |
| Precipitation | None | None | None | None | None | None | None | None |
| Wind speed (mph) | 10 | 10 | 15 | 15 | 15 | 15 | 15 | 15 |
| Wind direction | W | W | W | W | W | W | W | W |
| Cloud cover | 0/8 | 3/8 | 3/8 | 3/8 | 3/8 | 3/8 | 3/8 | 3/8 |
| Visibility | 6 km | 6 km | 6 km | 6 km | 6 km | 6 km | 6 km | 6 km |
| Sea state | Light swell | Light swell | White horses | White horses | White horses | White horses | White horses | White horses |
| Disturbance | None | None | None | See notes | See notes | None | None | None |
| 5 min (1) | 1723 | 1242 | 1347 | 819 | 723 | 926 | 832 | 688 |
| 5 min (2) | 1685 | 1310 | 1202 | 1112 | 654 | 846 | 743 | 601 |
| 5 min (3) | 1791 | 1139 | 1289 | 1011 | 839 | 894 | 632 | 627 |
| 10 min (1) | 2343 | 1663 | 2316 | 1839 | 1846 | 1682 | 1563 | 1466 |
| 10 min (2) | 2208 | 1781 | 1916 | 1632 | 1846 | 1770 | 1483 | 1549 |
| 20 min | 3258 | 2621 | 3015 | 2431 | 2628 | 2783 | 2830 | 2960 |

**Table 3.3** Counts and associated conditions during ‘thoroughness’ counts on 6/3/03

| Count | 1 | 2 | 3 |
|---|---|---|---|
| Start time | 0830 | 1115 | 1400 |
| Precipitation | None | None | None |
| Wind speed (mph) | 10 | 15 | 15 |
| Wind direction | ENE | ENE | ENE |
| Cloud cover | 1/8 | 0/8 | 1/8 |
| Visibility | Worm's Head | Worm's Head | Worm's Head |
| Sea state | Light swell | White horses | White horses |
| Disturbance | None | None | None |
| 20 min (1) | 1348 | 1566 | 2018 |
| 20 min (2) | 1686 | 1471 | 1702 |
| 40 min | 2356 | 2015 | 2839 |
| 80 min | 3411 | 2630 | 3907 |

**Table 3.4** Counts and associated conditions during 'thoroughness' counts on 13/3/03.

| Count | 1 | 2 | 3 |
|---|---|---|---|
| Start time | Not reported | Not reported | Not reported |
| Precipitation | None | None | None |
| Wind speed (mph) | 5 | 5 | 10 |
| Wind direction | E | E | E |
| Cloud cover | 0/8 | 0/8 | 0/8 |
| Visibility | 4 km (hazy) | 4 km | 4 km |
| Sea state | Slight swell | Slight swell | Slight swell |
| Disturbance | None | None | None |
| 20 min (1) | 2380 | 1965 | 2651 |
| 20 min (2) | 2634 | 2106 | 2367 |
| 40 min | 4340 | 4002 | 2839 |
| 80 min | 5650 | 4991 | 5955 |

**Table 3.5** Counts and associated conditions during 'thoroughness' counts on 17/3/03.

| Count | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Start time | 0725 | 0935 | 1145 | 1415 |
| Precipitation | None | None | None | None |
| Wind speed (mph) | 15 | 15 | 15-20 | 15 |
| Wind direction | NNE | NNE | NE | NE |
| Cloud cover | 2/8 | 1/8 | 0/8 | 0/8 |
| Visibility | Worm's Head | Worm's Head | Worm's Head | Worm's Head |
| Sea state | Light swell | Light swell | Swell increasing | Light swell |
| Disturbance | None | None | None | None |
| Common Scoter total | 5309 | 4302 | 4027 | 1597 |

**Table 3.6** Common Scoter totals and associated conditions during 'tidal' counts from Pendine on 12/3/03.

| Count | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Start time | 0825 | 1035 | 1245 | 1455 |
| Precipitation | None | None | None | None |
| Wind speed (mph) | 5 | 5 | 10 | 10 |
| Wind direction | SE | SE | SE | SE |
| Cloud cover | 0/8 | 0/8 | 0/8 | 0/8 |
| Visibility | 3 km | 3 km | 2 km | 3 km |
| Sea state | Light swell, mod chop | Light swell, mod chop | Incr swell, chop/surf | Incr swell, chop/surf |
| Disturbance | None | None | None | None |
| Common Scoter total | 3076 | 2330 | 759 | 3400 |

**Table 3.7** Common Scoter totals and associated conditions during 'tidal' counts from Pendine on 14/3/03.

| Count | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Start time | 0815 | 1015 | 1245 | 1435 |
| Precipitation | None | None | None | None |
| Wind speed (mph) | 5 | 5 | 10 | 10 |
| Wind direction | E | E | E | E |
| Cloud cover | 2/8 | 1/8 | 0/8 | 0/8 |
| Visibility | 3 km | 3 km | 3 km | 3 km |
| Sea state | Light swell, mod chop | Light swell, mod chop | Incr swell, chop/surf | Incr swell, chop/surf |
| Disturbance | None | None | Survey plane | None |
| Common Scoter total | 3003 | 2769 | 1255 | 1198 |

**Table 3.8** Common Scoter totals and associated conditions during 'tidal' counts from Pendine on 15/3/03.

| Date | Start | End | Tide (approx) | RS (Port) | LS (S'b) | SH (S'b) | Total LS+RS |
|---|---|---|---|---|---|---|---|
| 04/01/2003 | 1033 | 1314 | Rising to high | 5860 | 2975 | n.a. | 8835 |
| 05/01/2003 | 1246 | 1540 | Low | 5724 | 4585 | n.a. | 10309 |
| 15/03/2003 | 1432 | 1710 | High | 4979 | 2977 | 1088 | 7956 |
| 16/03/2003 | 1008 | 1219 | Low | 4140 | 3432 | 1047 | 7572 |

**Table 3.9** Totals of Common Scoters recorded on census-method aerial surveys.

| Date | On sea | In flight | | | | | | | | Overall total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | North | East | South | West | NE | SE | Unspec. | Total flight | |
| 04/01/2003 | 4171 | 3643 | 205 | 0 | 0 | 816 | 0 | 0 | 4664 | 8835 |
| 05/01/2003 | 4854 | 3470 | 1122 | 0 | 0 | 13 | 850 | 0 | 5455 | 10309 |
| 15/03/2003 | 2478 | 2089 | 27 | 3346 | 0 | 0 | 0 | 16 | 5478 | 7956 |
| 16/03/2003 | 2575 | 2123 | 7 | 1959 | 5 | 0 | 0 | 903 | 4997 | 7572 |

**Table 3.10** Behaviour and direction of flight of Common Scoters detected during the census-method aerial surveys. The figures tabulated are the combined totals from LS and RS.

| Date | 04/01/03 | 05/01/03 | 15/03/03 | 16/03/03 |
|---|---|---|---|---|
| Red-throated Diver Gavia stellata | 0 | 0 | 3 | 2 |
| Great Northern Diver Gavia immer | 0 | 0 | 0 | 1 |
| Unidentified Diver Gavia sp. | 0 | 2 | 0 | 1 |
| Cormorant Phalacrocorax carbo | 0 | 0 | 6 | 2 |
| Eider Somateria mollissima | 0 | 0 | 2 | 0 |
| Long-tailed Duck Clangula hyemalis | 0 | 0 | 0 | 2 |
| Velvet Scoter Melanitta fusca | 0 | 1 | 0 | 9 |
| Red-breasted Merganser Mergus serrator | 0 | 0 | 4 | 0 |
| Unidentified Auk Alcidae sp. | 0 | 0 | 12 | 0 |
| Unidentified Seal Phocidae sp. | 1 | 0 | 1 | 1 |
| Porpoise Phocoena phocoena | 0 | 0 | 0 | 1 |

**Table 3.11** Other species recorded during the census-method flights. Totals are the sum of those recorded by LS and RS. Gulls were not recorded.

| Date | Start | End | Tide (approx) | RS (Port) | LS (S'b) | SH (S'b) | Total LS+RS |
|---|---|---|---|---|---|---|---|
| 01/12/2003 | 1130 | 1338 | Rising | 5947 | 5057 | n.a. | 11004 |
| 04/01/2003 | 1350 | 1545 | Rising from low | 2695 | 2713 | n.a. | 5408 |
| 15/03/2003 | 1123 | 1311 | Rising | 7288 | 2402 | n.a. | 9690 |
| 16/03/2003 | 1319 | 1513 | Rising | 4085 | 1899 | 360 | 5984 |

**Table 3.12** Totals of Common Scoters recorded on distance-method aerial surveys.

| Transect | Length (m) | LS | | | | RS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| 1 | 4230 | | | | | | | | |
| 2 | 4290 | | 1 | | | 1 | | | |
| 3 | 13900 | 74 | 63 | 22 | | 1 | 5 | | |
| 4 | 14970 | 23 | 87 | | | 2 | 45 | | |
| 5 | 18700 | 15 | 14 | 4 | | 7 | 5 | | |
| 6 | 14430 | 19 | 10 | | | 3 | 9 | | |
| 7 | 15550 | 25 | 23 | 14 | | | | | |
| 8 | 11380 | 1845 | 756 | 600 | | 2211 | 2007 | | |
| 9 | 12420 | 1 | 28 | 100 | | 7 | 601 | | |
| 10 | 10750 | 12 | 12 | | | | 5 | | |
| 11 | 12560 | 7 | 199 | | | 66 | 5 | | |
| 12 | 12013 | 406 | 430 | 130 | | | 879 | 40 | |
| 13 | 12720 | 4 | 83 | 50 | | 21 | 26 | | |
| 14 | 10950 | | | | | | 1 | | |
| 15 | 11510 | | | | | | | | |
| Total | 180373 | 2431 | 1706 | 920 | 0 | 2319 | 3588 | 40 | 0 |

**Table 3.13** Distance-method aerial counts of Common Scoters, by transect and distance band, on 1/12/02.

| Transect | Length (m) | LS | | | | RS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| 1 | 4230 | | | | | | | | |
| 2 | 4270 | | | | | | | | |
| 3 | 13100 | | 1 | | | 5 | | | |
| 4 | 14940 | | 6 | | | | | | |
| 5 | 17850 | 12 | 8 | | | | | | |
| 6 | 14300 | 302 | 50 | | | 78 | | | |
| 7 | 14900 | 25 | | 20 | 2 | 3 | | | |
| 8 | 11190 | 45 | 23 | 30 | 50 | 200 | 500 | | |
| 9 | 11960 | 537 | 540 | 220 | | 473 | 400 | 150 | |
| 10 | 10740 | 20 | 39 | 20 | | | 6 | | |
| 11 | 11830 | 7 | 12 | 16 | | 41 | | | |
| 12 | 12162 | 184 | 76 | 232 | 60 | 354 | 60 | | |
| 13 | 12240 | 52 | 80 | 30 | | 405 | 20 | | |
| 14 | 11020 | | 14 | | | | | | |
| 15 | 11200 | | | | | | | | |
| Total | 175933 | 1184 | 849 | 568 | 112 | 1559 | 986 | 150 | 0 |

**Table 3.14** Distance-method aerial counts of Common Scoters, by transect and distance band, on 4/1/03.

| Transect | Length (m) | LS | | | | RS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| 1 | 4350 | | | | | | | | |
| 2 | 4500 | | | | | | | | |
| 3 | 13670 | | | | | 9 | | | |
| 4 | 14700 | 192 | 185 | 87 | | | 3755 | | |
| 5 | 18380 | 256 | 149 | 66 | | | 2813 | | |
| 6 | 14110 | 23 | 51 | 26 | | 25 | 19 | 12 | |
| 7 | 15240 | 62 | 7 | 12 | | 4 | 16 | 15 | |
| 8 | 10950 | 1 | 15 | 4 | | 2 | | | |
| 9 | 12110 | | | 5 | | | | | |
| 10 | 11090 | 47 | 57 | 87 | 45 | 40 | 187 | | |
| 11 | 12080 | 135 | 269 | 166 | 204 | 48 | 133 | 7 | |
| 12 | 11713 | 28 | 15 | 22 | | 9 | 112 | | |
| 13 | 12470 | 19 | 32 | 67 | 35 | 48 | 31 | | |
| 14 | 10560 | 5 | | 28 | | 3 | | | |
| 15 | 11030 | | | | | | | | |
| Total | 176953 | 768 | 780 | 570 | 284 | 188 | 7066 | 34 | 0 |

**Table 3.15** Distance-method aerial counts of Common Scoters, by transect and distance band, on 15/3/03.

| Transect | Length (m) | LS | | | | RS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| 1 | 4260 | | | | | | | | |
| 2 | 4500 | | | | | | | | |
| 3 | 13738 | | | | | 6 | | | |
| 4 | 14650 | 125 | 121 | 1 | | | 1108 | | |
| 5 | 18270 | 197 | 63 | 23 | | | 2233 | 6 | |
| 6 | 14040 | 34 | 45 | 16 | | 12 | 11 | | |
| 7 | 15240 | 88 | 46 | 30 | | 15 | 70 | 46 | |
| 8 | 10970 | | 4 | | | | | | |
| 9 | 12160 | 7 | 2 | 3 | | 7 | 6 | 12 | |
| 10 | 11110 | 95 | 89 | | | 2 | 8 | 240 | |
| 11 | 12110 | 87 | 179 | 263 | 110 | 10 | 212 | | |
| 12 | 11510 | 48 | 41 | 7 | | 17 | 15 | 4 | |
| 13 | 12740 | 10 | 20 | 95 | 10 | 25 | 14 | | |
| 14 | 10810 | | 27 | 13 | | | 6 | | |
| 15 | 10970 | | | | | | | | |
| Total | 177078 | 691 | 637 | 451 | 120 | 94 | 3683 | 308 | 0 |

**Table 3.16** Distance-method aerial counts of Common Scoters, by transect and distance band, on 16/3/03.

| Behaviour | 01/12/2002 | 04/01/2003 | 15/03/2003 | 16/03/2003 | Total | % |
|---|---|---|---|---|---|---|
| Flushing | 7073 | 3271 | 5383 | 5146 | 20873 | 65 |
| Flying | 1249 | 19 | 2 | 620 | 1890 | 6 |
| Sitting | 2682 | 2043 | 3986 | 208 | 8919 | 28 |
| Not recorded | | 75 | 319 | 10 | 404 | 1 |
| Total | 11004 | 5408 | 9690 | 5984 | 32086 | |

**Table 3.17** Behaviour of Common Scoters detected during the distance-method aerial surveys. Totals are the combined totals from LS and RS.

| Species | 01/12/2002 | 04/01/2003 | 15/03/2003 | 16/03/2003 |
|---|---|---|---|---|
| Red-throated Diver Gavia stellata | 2 | 12 | 2 | 4 |
| Diver sp. Gavia sp. | 3 | 11 | 4 | 5 |
| Fulmar Fulmarus glacialis | 3 | 1 | 2 | |
| Gannet Morus bassanus | | 2 | | |
| Cormorant Phalacrocorax carbo | 9 | 2 | 21 | 40 |
| Shag Phalacrocorax aristotelis | | | 2 | 1 |
| Cormorant sp. Phalacrocorax sp. | | | 2 | |
| Eider Somateria mollissima | | | 2 | |
| Velvet Scoter Melanitta fusca | 1 | | 2 | 7 |
| Red-breasted Merganser Mergus serrator | 3 | | 1 | |
| Kestrel Falco tinnunculus | | | 1 | |
| Oystercatcher Haematopus ostralegus | 2 | | 25 | |
| Wader sp. Charadrii sp. | 162 | | | |
| Black-headed Gull Larus ridibundus | | 16 | | |
| Common Gull Larus canus | | 19 | | |
| Lesser Black-backed Gull Larus fuscus | 1 | 1 | | |
| Herring Gull Larus argentatus | 17 | 34 | | |
| Great Black-backed Gull Larus marinus | | 4 | | |
| Kittiwake Rissa tridactyla | 59 | 17 | | |
| Gull sp. Laridae sp. | 21 | 363 | | |
| Guillemot Uria aalge | 8 | | 5 | |
| Auk sp. Alcidae sp. | 82 | 33 | 32 | 34 |
| Grey Seal Halichoerus grypus | 1 | | | |
| Seal sp. Phocidae sp. | | | 1 | 1 |
| Porpoise Phocoena phocoena | 2 | 6 | 1 | 4 |
| Dolphin sp. Delphinidae sp. | | | | 1 |

**Table 3.18** Other species recorded during the distance-method flights. Totals are the sum of those recorded by LS and RS. Note that recording of gulls was discontinued part-way through the second count as it was proving a distraction from surveying the Common Scoters.

| Date | DS | E(s) | D | N |
|---|---|---|---|---|
| 01/12/2003 | 1.416 (0.954-2.102) | 38.97 (23.78-63.86) | 55.19 (29.99-101.70) | **19909** (10803-36690) |
| 04/01/2003 | 1.074 (0.613-1.880) | 40.81 (26.69-62.40) | 43.82 (22.28-86.16) | **15417** (7840-30317) |
| 15/03/2003 | 1.829 (1.160-2.887) | 20.60 (15.23-27.86) | 37.69 (22.17-64.06) | **13337** (7846-22672) |
| 16/03/2003 | 1.788 (1.189-2.688) | 15.51 (11.70-20.55) | 27.73 (17.14-44.84) | **9819** (6071-15881) |

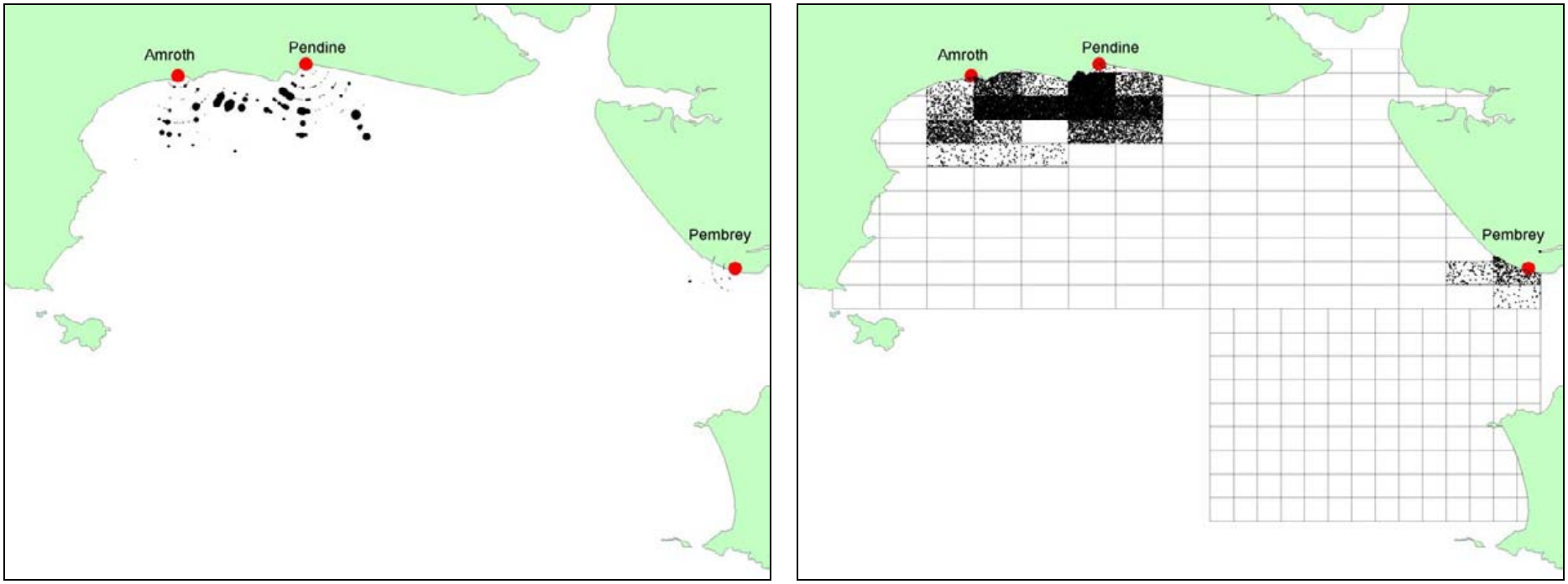
**Table 3.19** Analysis of distance-method aerial survey counts: estimated cluster density DS, cluster size E(s), density of individuals D and total numbers N (with bootstrapped 95% confidence intervals) for each survey of the whole of Carmarthen Bay.

| | Hours 1-2 | Hours 3-8 | % decline with less favourable conditions |
|---|---|---|---|
| | Wind 10 mph Light swell | Wind 15 mph Increasing swell | |
| Average 5-min count | 1482 | 877 | 41% |
| Average 10-min count | 1999 | 1742 | 13% |
| Average 20-min count | 2940 | 2775 | 6% |

**Table 4.1** Average five-minute, ten-minute and 20-minute counts of Common Scoter from Pendine, with hours 1-2 and hours 3-8 grouped.

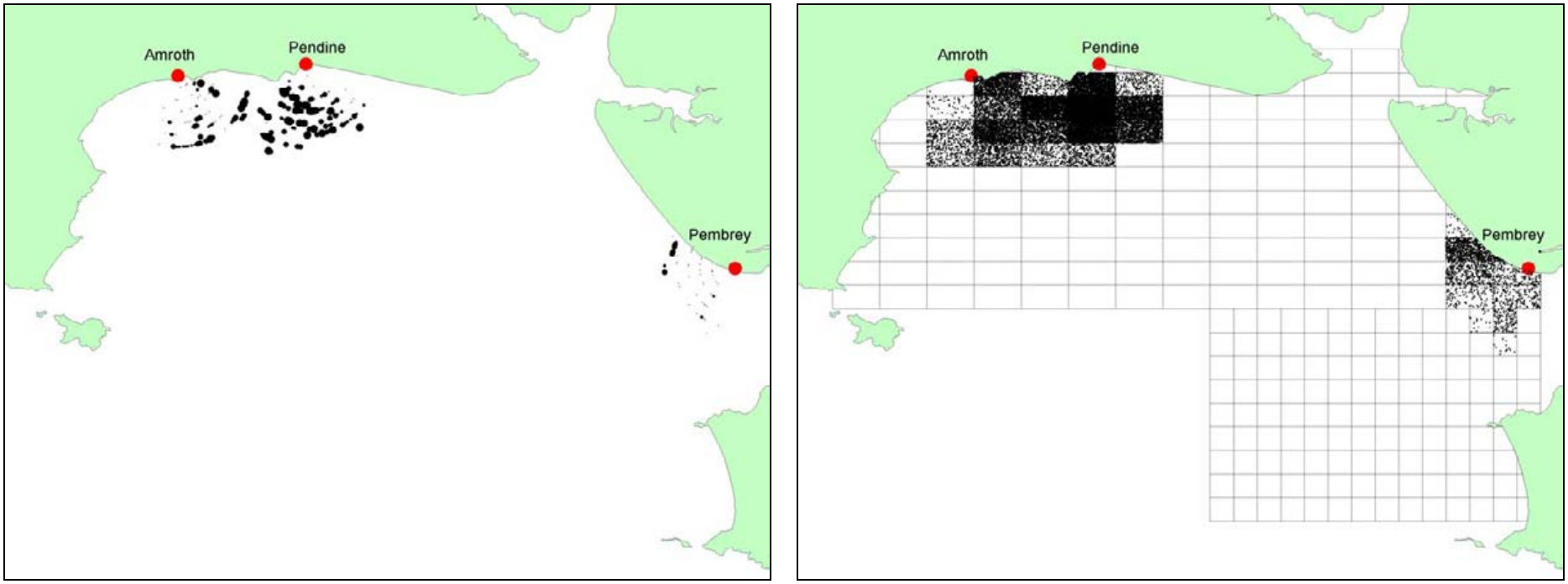
| Surveys | | Distance-method results | | | Census-method results | |
|---|---|---|---|---|---|---|
| Distance | Census | Count | Point estimate | 95% Confidence Intervals | Count | Adjusted estimate |
| 04/01/2003 | 04/01/2003 | 5408 | 15417 | 7840-30317 | 8835 | 10779 |
| 04/01/2003 | 05/01/2003 | 5408 | 15417 | 7840-30317 | 10309 | 12577 |
| 15/03/2003 | 15/03/2003 | 9690 | 13337 | 7846-22672 | 7956 | 9706 |
| 16/03/2003 | 16/03/2003 | 5984 | 9819 | 6071-15881 | 7572 | 9238 |

**Table 4.2** Comparison of results from aerial surveys during the 2002-03 winter. The adjusted estimates for the census-method count are to allow for a 'dead-zone' underneath the survey plane as discussed in Section 4.3.



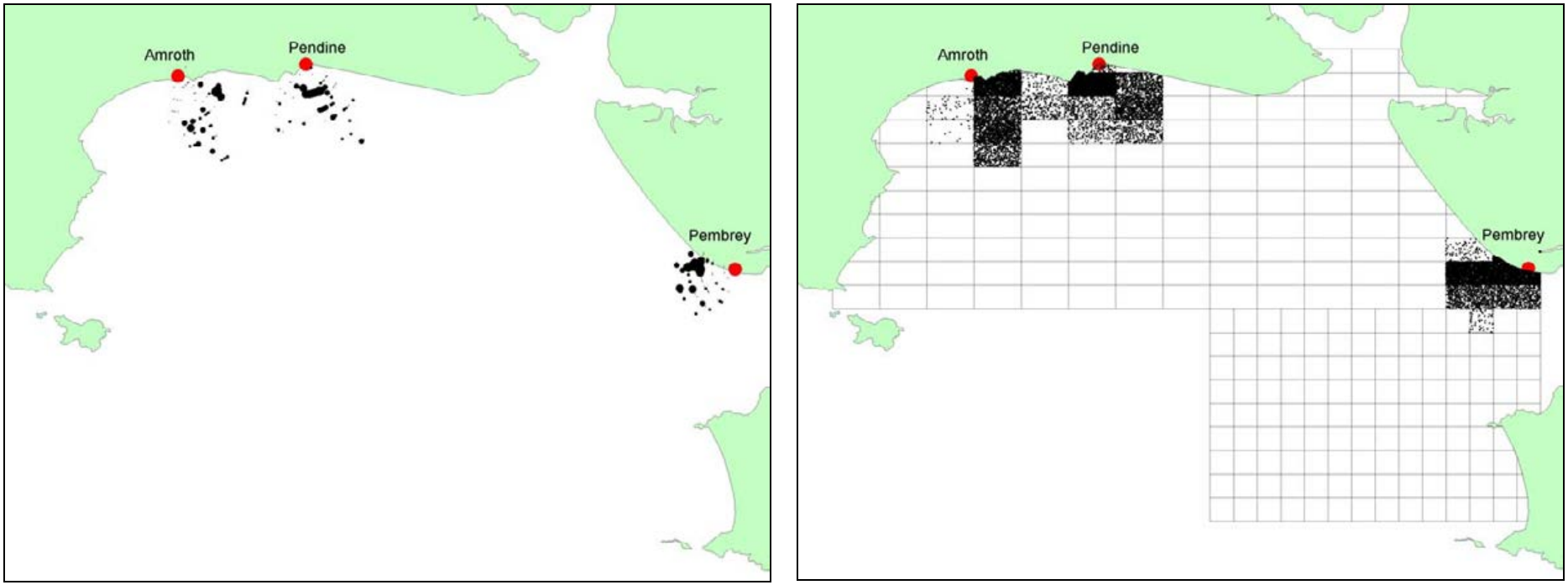

i) ii)

**Figure 3.1** Distribution of Common Scoters recorded during ground-based monitoring counts on 29/11/02, depicted as i) graduated symbols at measured bearing and distance and ii) dot-density maps of counts assigned to aerial census-method cells.



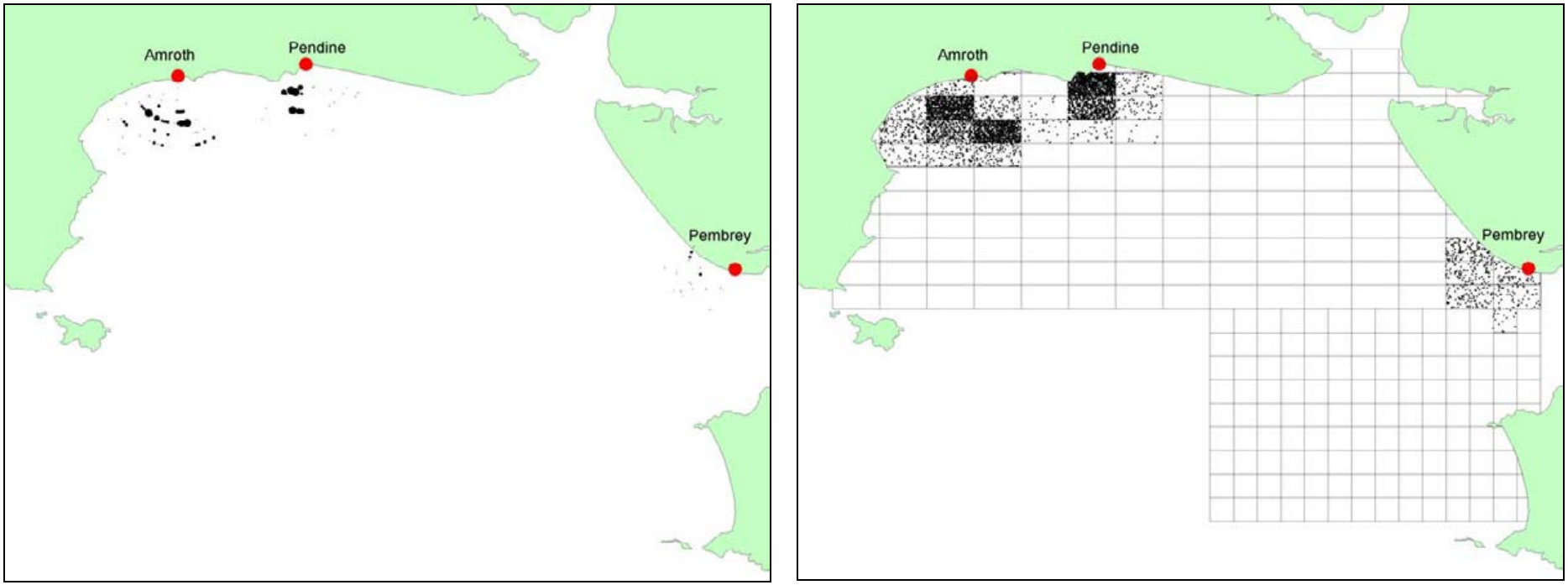

i) ii)

**Figure 3.2** Distribution of Common Scoters recorded during ground-based monitoring counts on 23/01/03, depicted as i) graduated symbols at measured bearing and distance and ii) dot-density maps of counts assigned to aerial census-method cells.



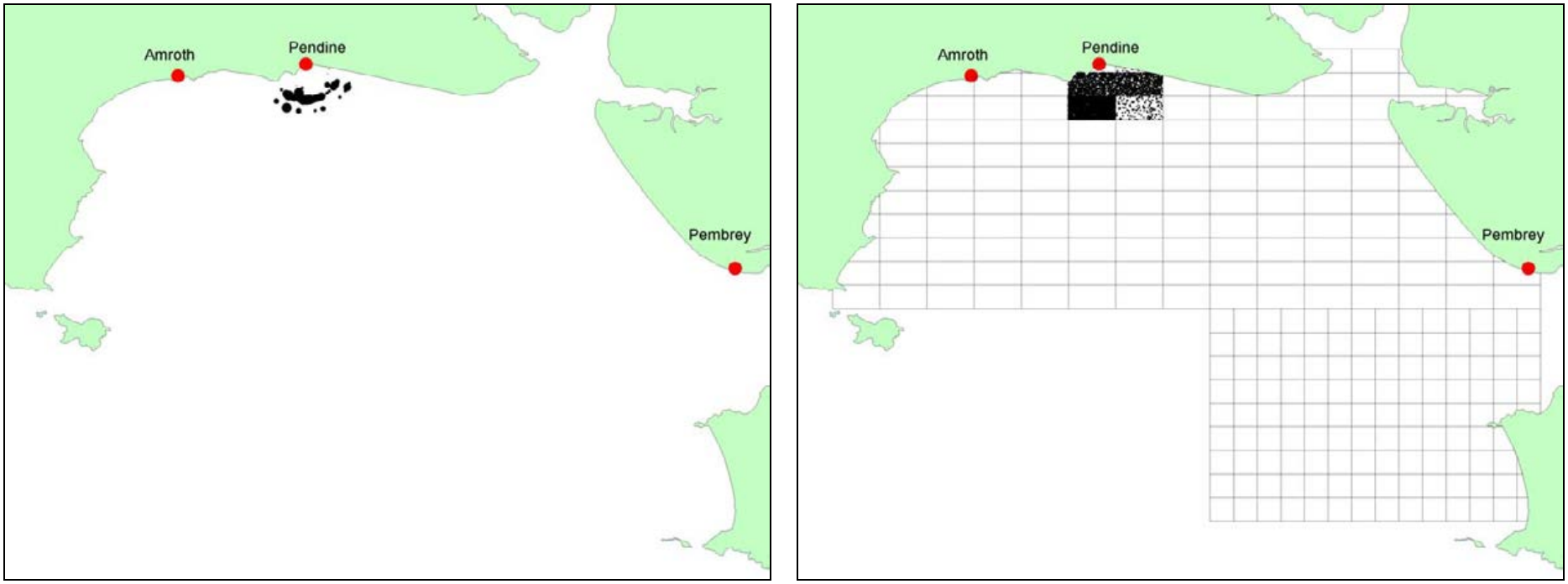

i) ii)

**Figure 3.3** Distribution of Common Scoters recorded during ground-based monitoring counts on 6/3/03, depicted as i) graduated symbols at measured bearing and distance and ii) dot-density maps of counts assigned to aerial census-method cells.




i) ii)

**Figure 3.4** Distribution of Common Scoters recorded during ground-based monitoring counts on 31/3/03, depicted as i) graduated symbols at measured bearing and distance and ii) dot-density maps of counts assigned to aerial census-method cells.




i) ii)

**Figure 3.5** Distribution of Common Scoters recorded during ground-based monitoring counts on 5/1/03 (Pendine station only), depicted as i) graduated symbols at measured bearing and distance and ii) dot-density maps of counts assigned to aerial census-method cells.

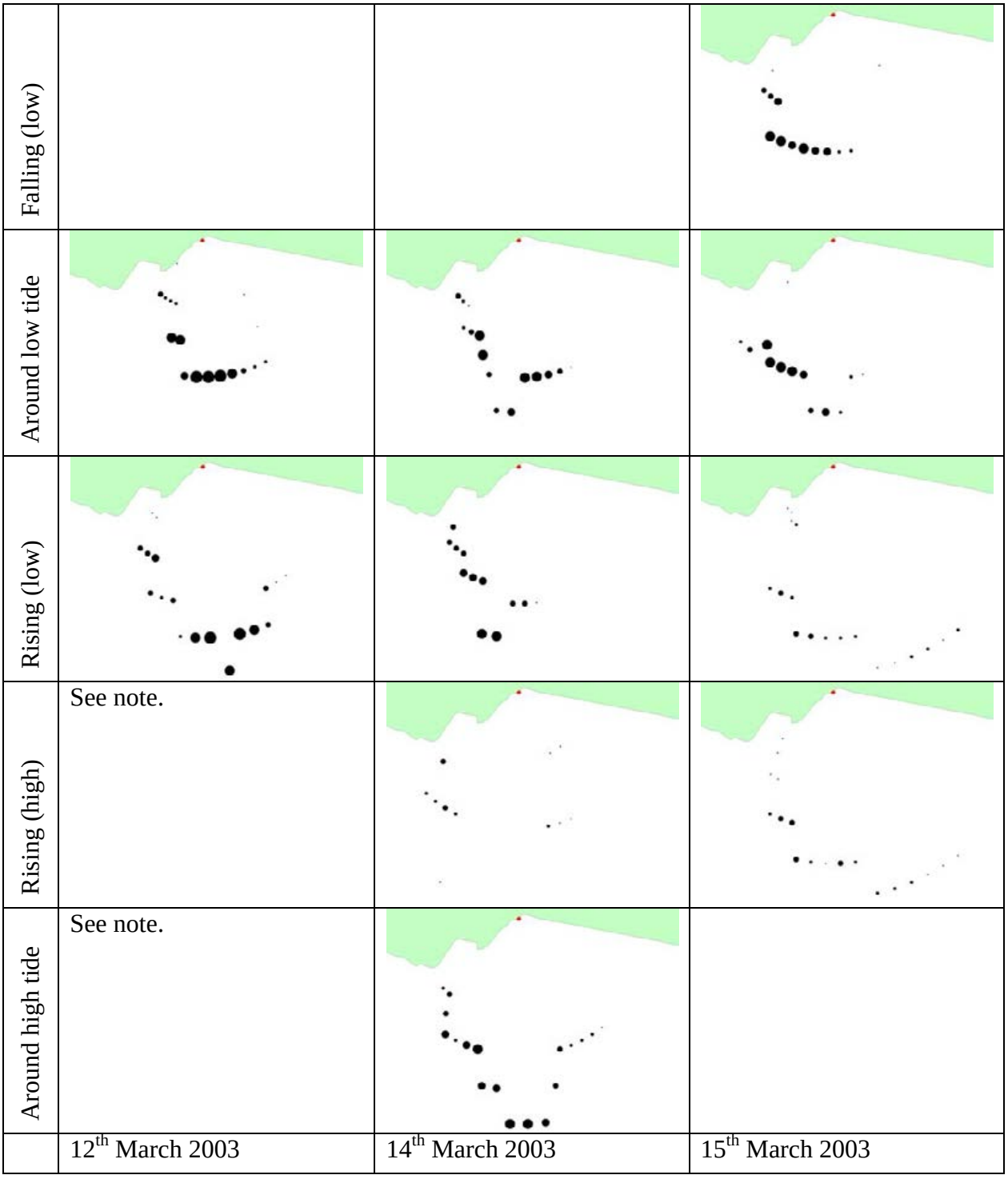
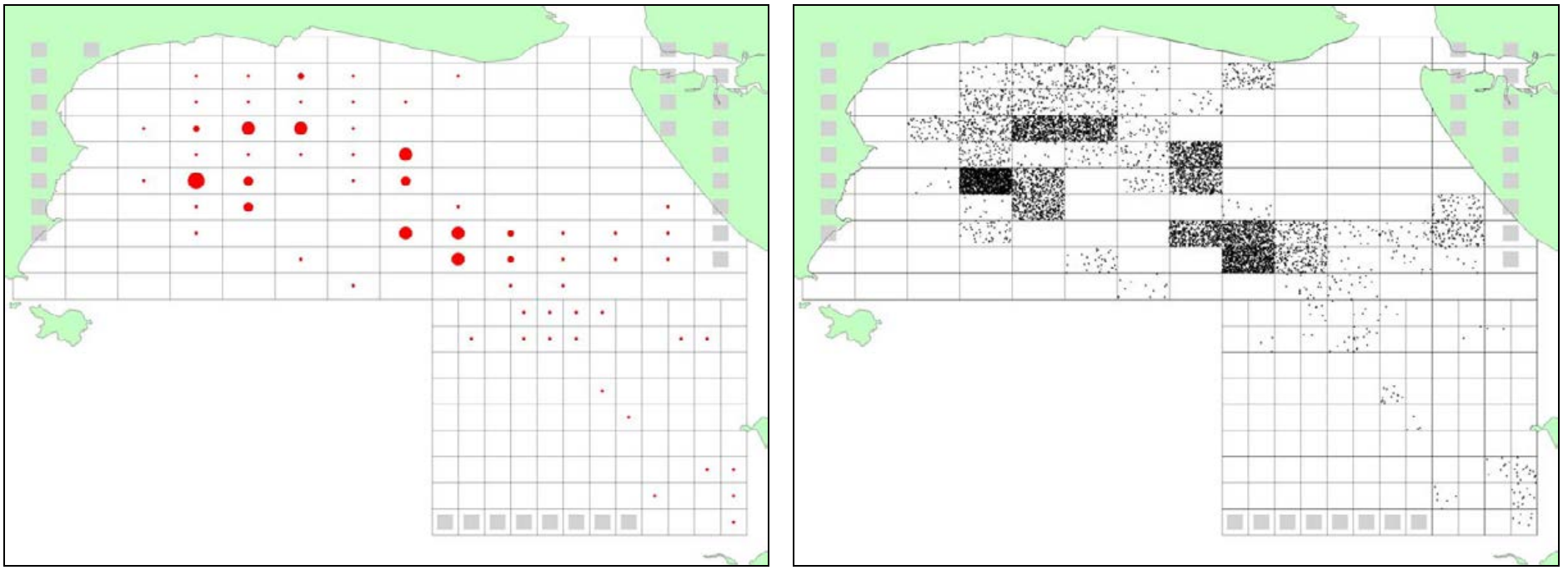
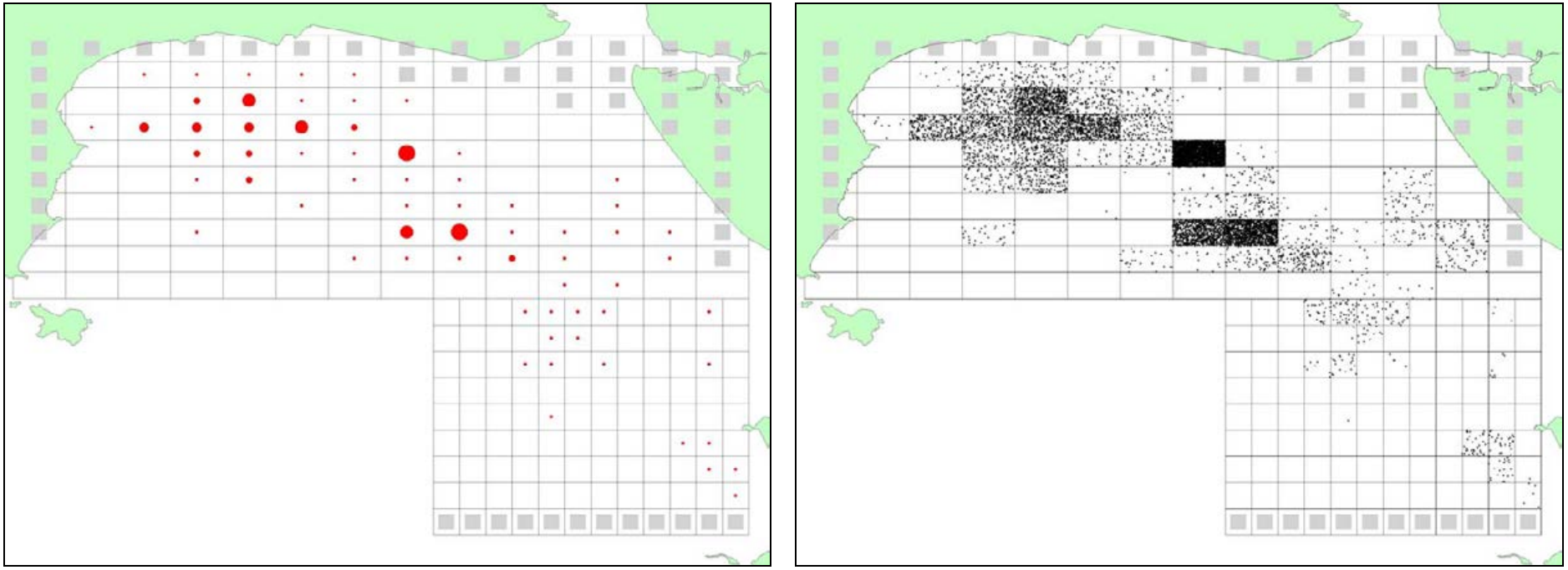



**Figure 3.6** Distribution of Common Scoters recorded from the Pendine watchpoint on three dates in March 2003, shown as graduated dots plotted to bearing and distance. Plots have been grouped such that each row of the above 'table' represents an approximate tidal state. Note that data have yet to be fully incorporated for two counts on 12/3/03.



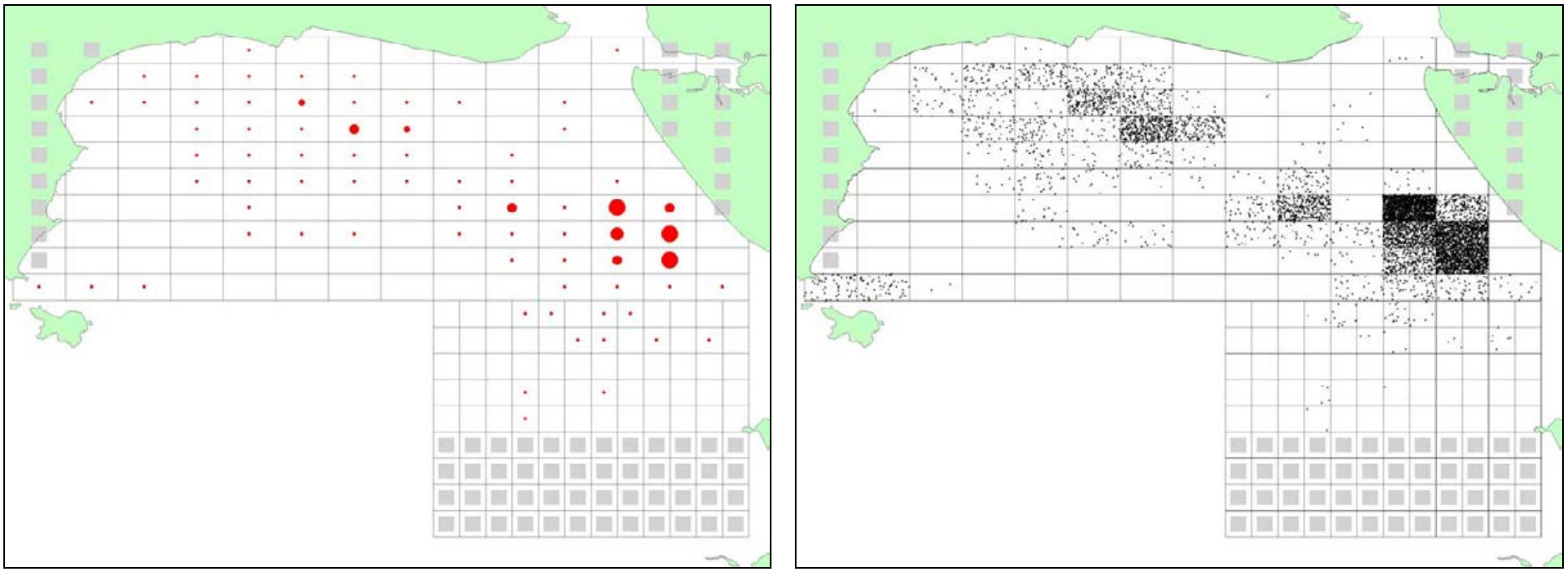
i) ii)

**Figure 3.7** Distribution of Common Scoters recorded during aerial census-method counts on 4/1/03. Counts are those of RS and LS combined, depicted as i) graduated symbols centred in each counted grid cell and ii) dot-density maps of counts within grid cells. Grey squares denote non-counted cells.



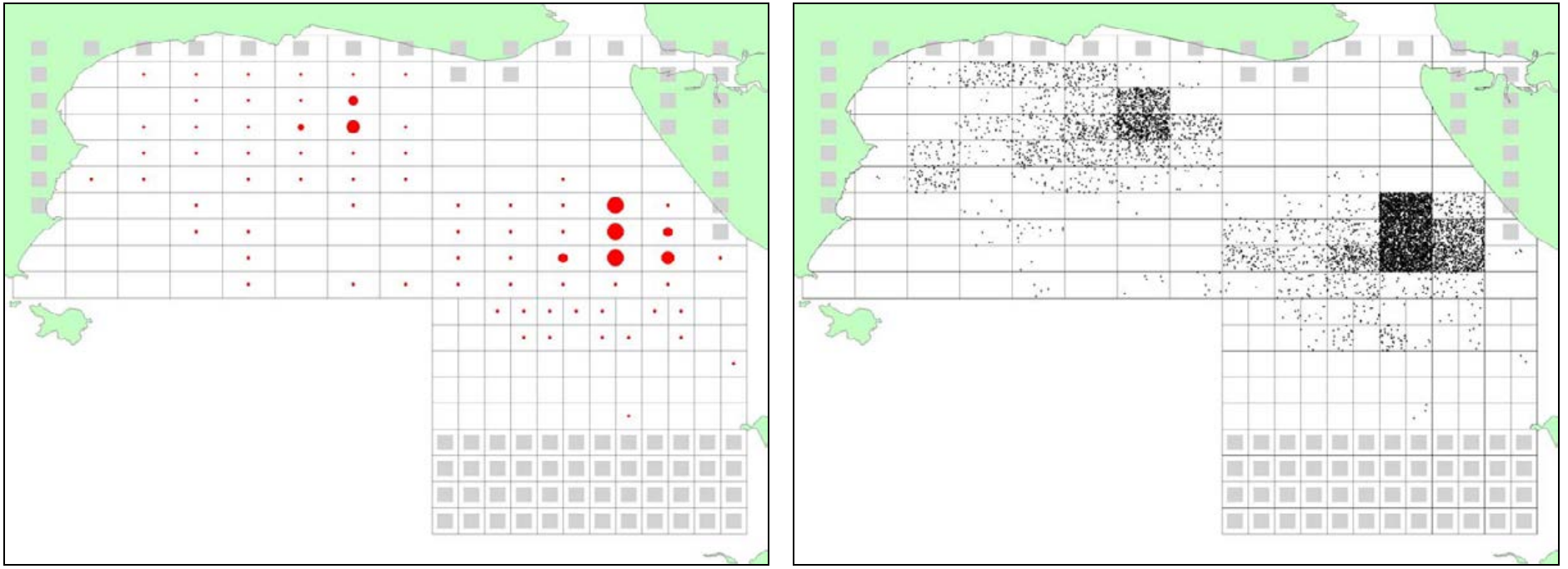
i) ii)

**Figure 3.8** Distribution of Common Scoters recorded during aerial census-method counts on 5/1/03. Counts are those of RS and LS combined, depicted as i) graduated symbols centred in each counted grid cell and ii) dot-density maps of counts within grid cells. Grey squares denote non-counted cells.



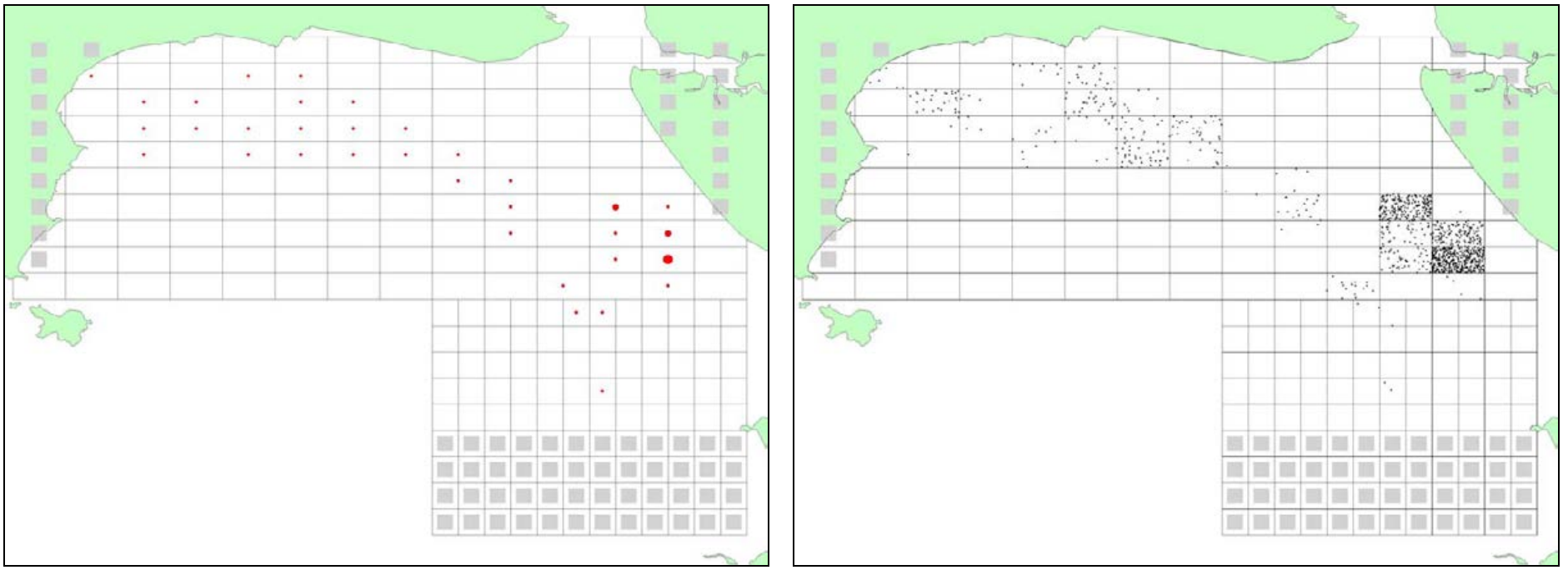
i) ii)

**Figure 3.9** Distribution of Common Scoters recorded during aerial census-method counts on 15/3/03. Counts are those of RS and LS combined, depicted as i) graduated symbols centred in each counted grid cell and ii) dot-density maps of counts within grid cells. Grey squares denote non-counted cells.



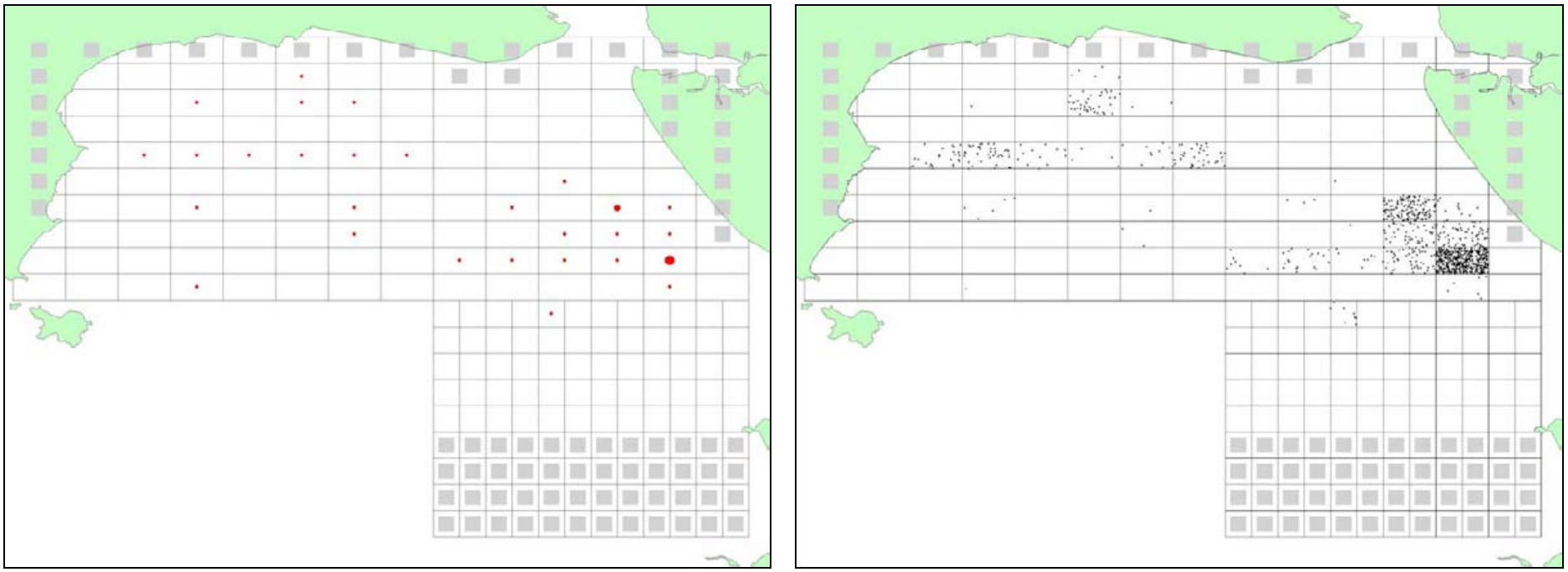
i) ii)

**Figure 3.10** Distribution of Common Scoters recorded during aerial census-method counts on 16/3/03. Counts are those of RS and LS combined, depicted as i) graduated symbols centred in each counted grid cell and ii) dot-density maps of counts within grid cells. Grey squares denote non-counted cells.



i) ii)

**Figure 3.11** Distribution of Common Scoters recorded during aerial census-method counts on 15/3/03. Counts are those of SH who was undertaking the count in a training capacity, depicted as i) graduated symbols centred in each counted grid cell and ii) dot-density maps of counts within grid cells. Grey squares denote non-counted cells.



i) ii)

**Figure 3.12** Distribution of Common Scoters recorded during aerial census-method counts on 16/3/03. Counts are those of SH who was undertaking the count in a training capacity, depicted as i) graduated symbols centred in each counted grid cell and ii) dot-density maps of counts within grid cells. Grey squares denote non-counted cells.

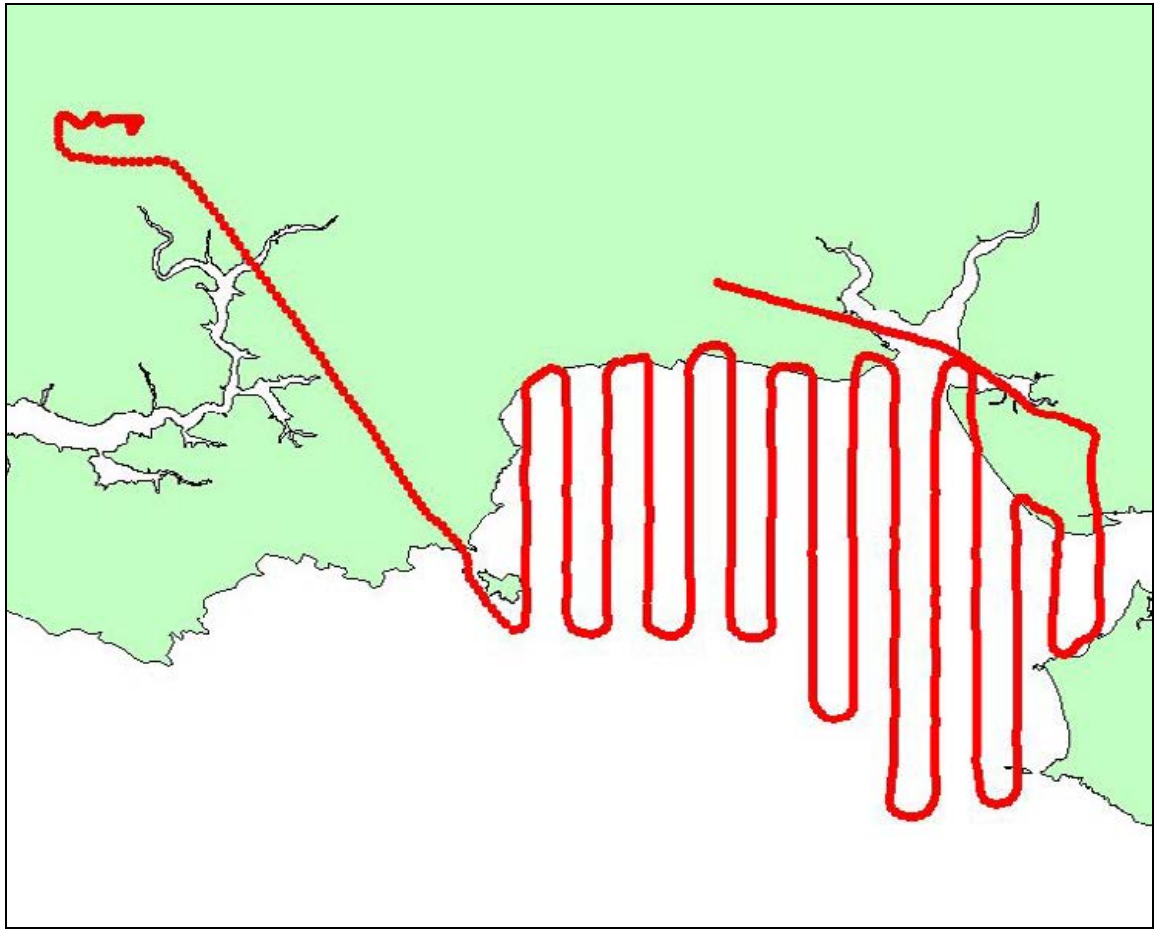


**Figure 3.13** Flight path taken during distance-method aerial survey on 15/3/03, as recorded by GPS. The bay was surveyed from east to west.

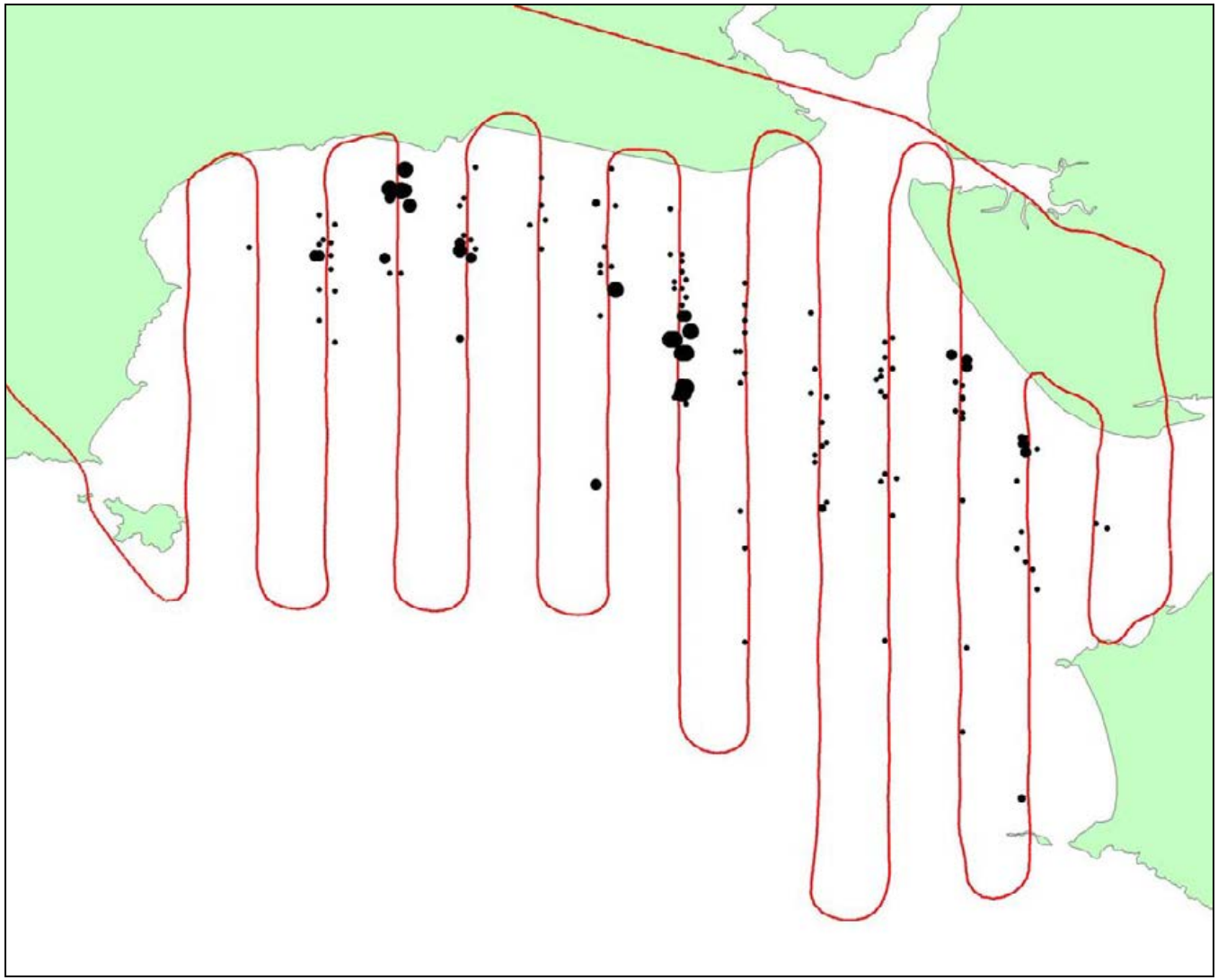


**Figure 3.14** Position of Common Scoter flocks recorded during distance-method aerial survey on 1/12/02. Note that due to problems with the GPS, positions are approximate and based on the track flown on 15/3/03 (flight line shown).

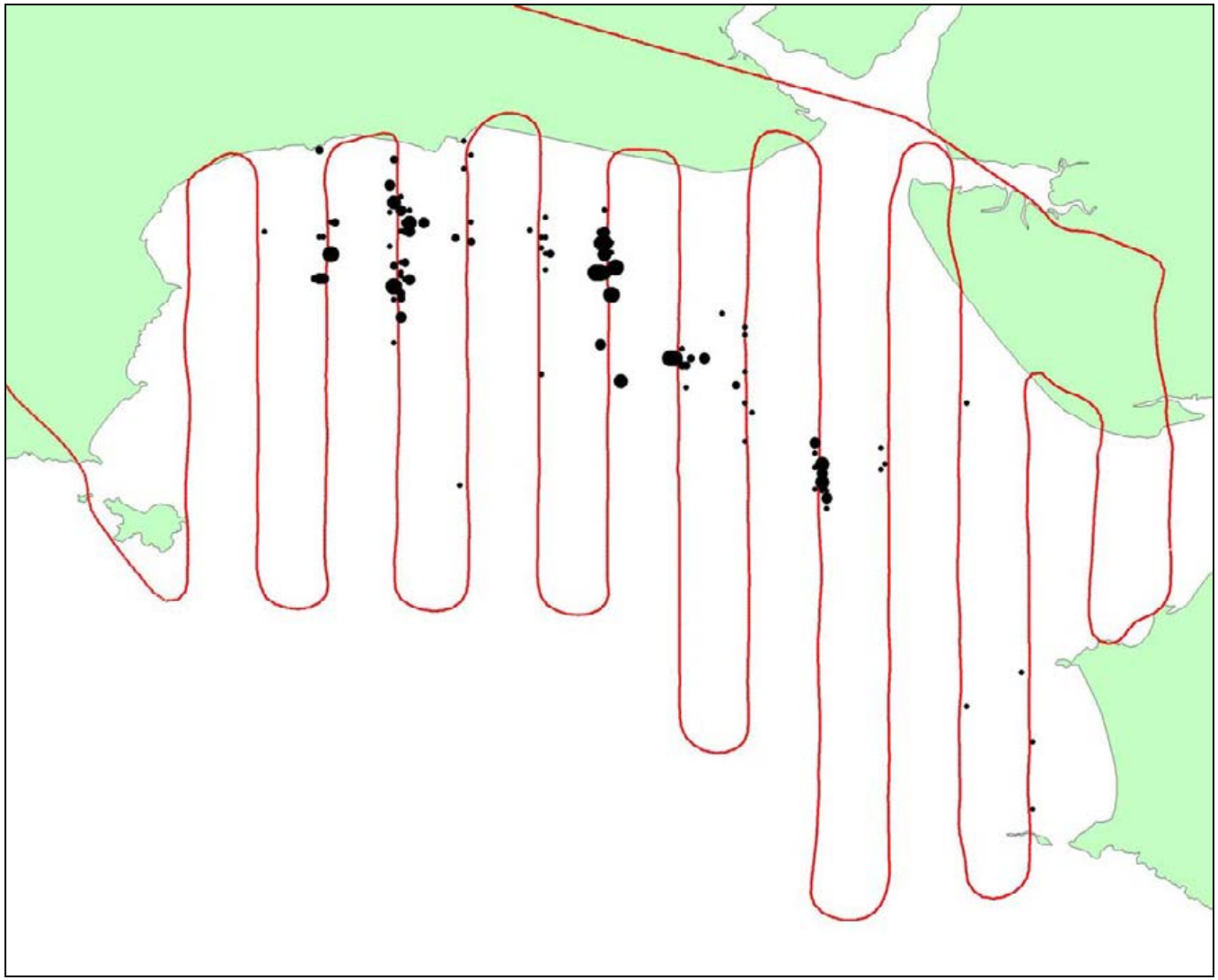


**Figure 3.15** Position of Common Scoter flocks recorded during distance-method aerial survey on 4/1/03. Note that due to problems with the GPS, positions are approximate and based on the track flown on 15/3/03 (flight line shown).

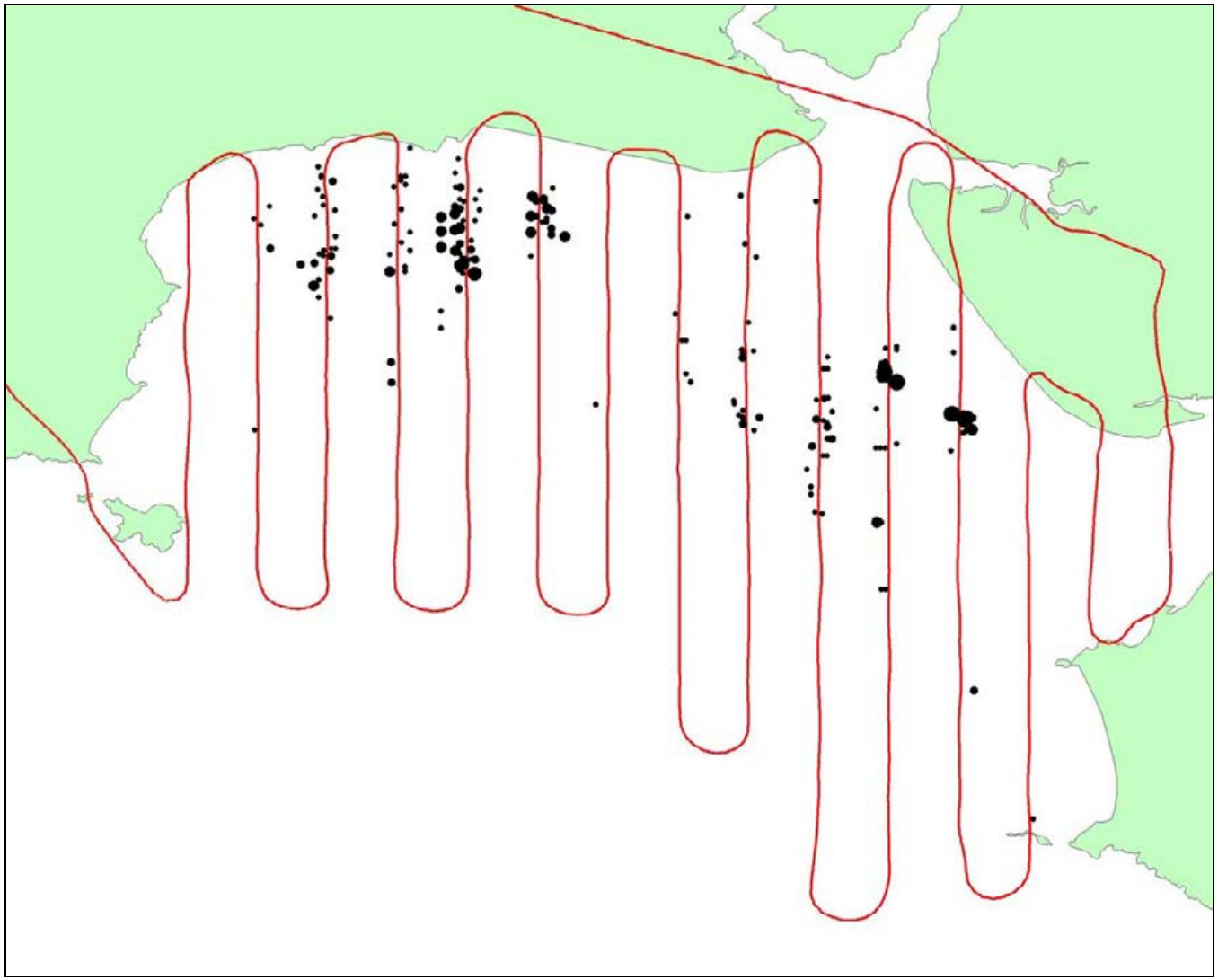


**Figure 3.16** Position of Common Scoter flocks recorded during distance-method aerial survey on 15/3/03, with flight line shown.

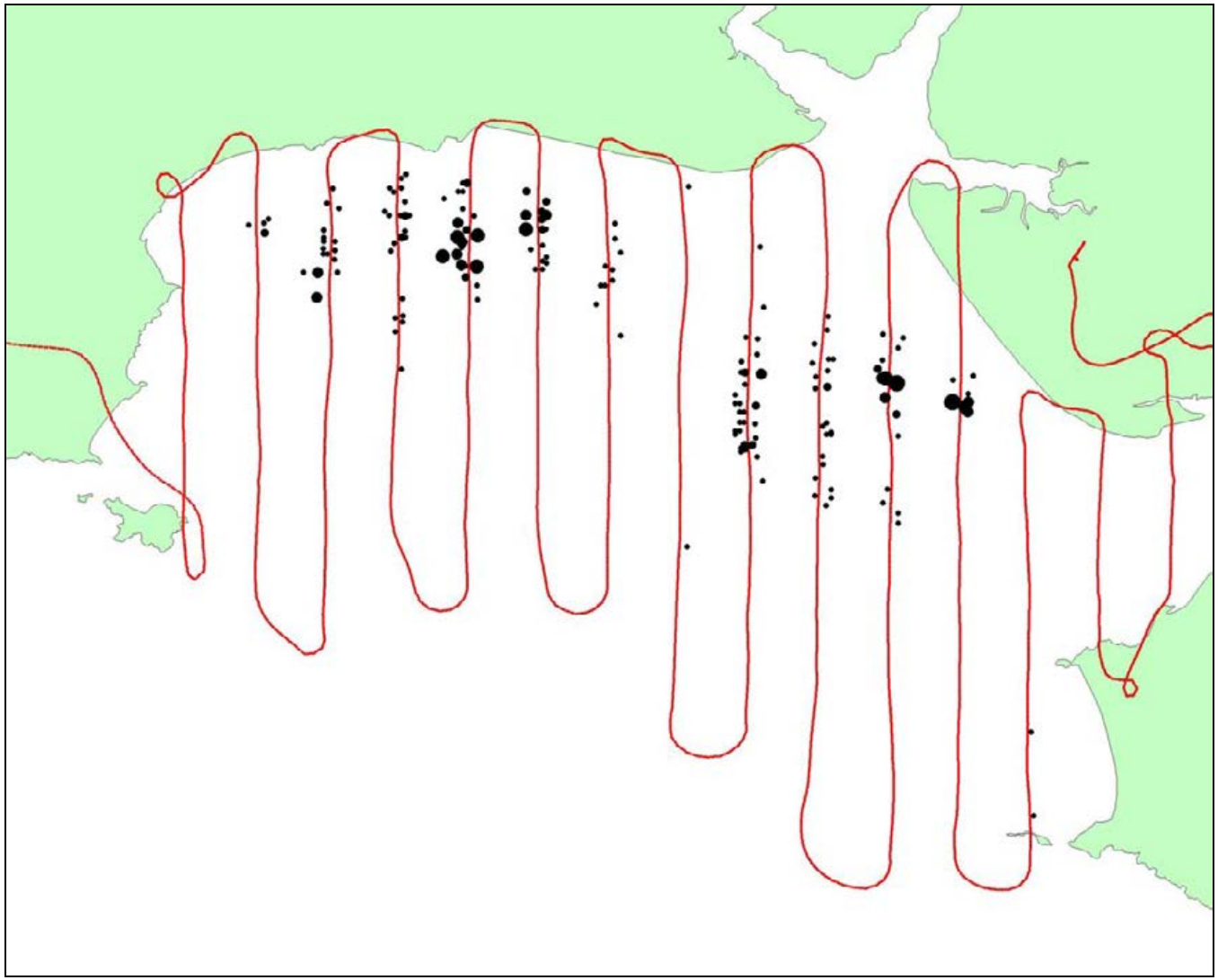


**Figure 3.17** Position of Common Scoter flocks recorded during distance-method aerial survey on 16/3/03, with flight line shown.

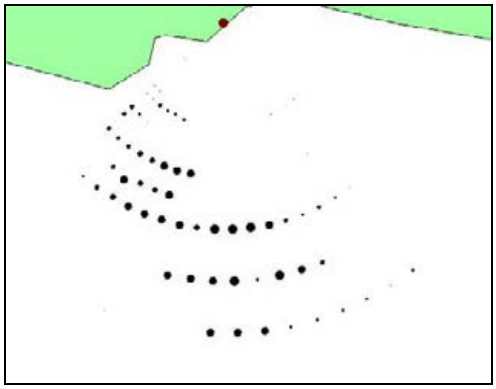


**Figure 4.1** Combined distribution of Common Scoters off Pendine on 12th, 14th and 15th March 2003, four two-hourly counts per day being made.

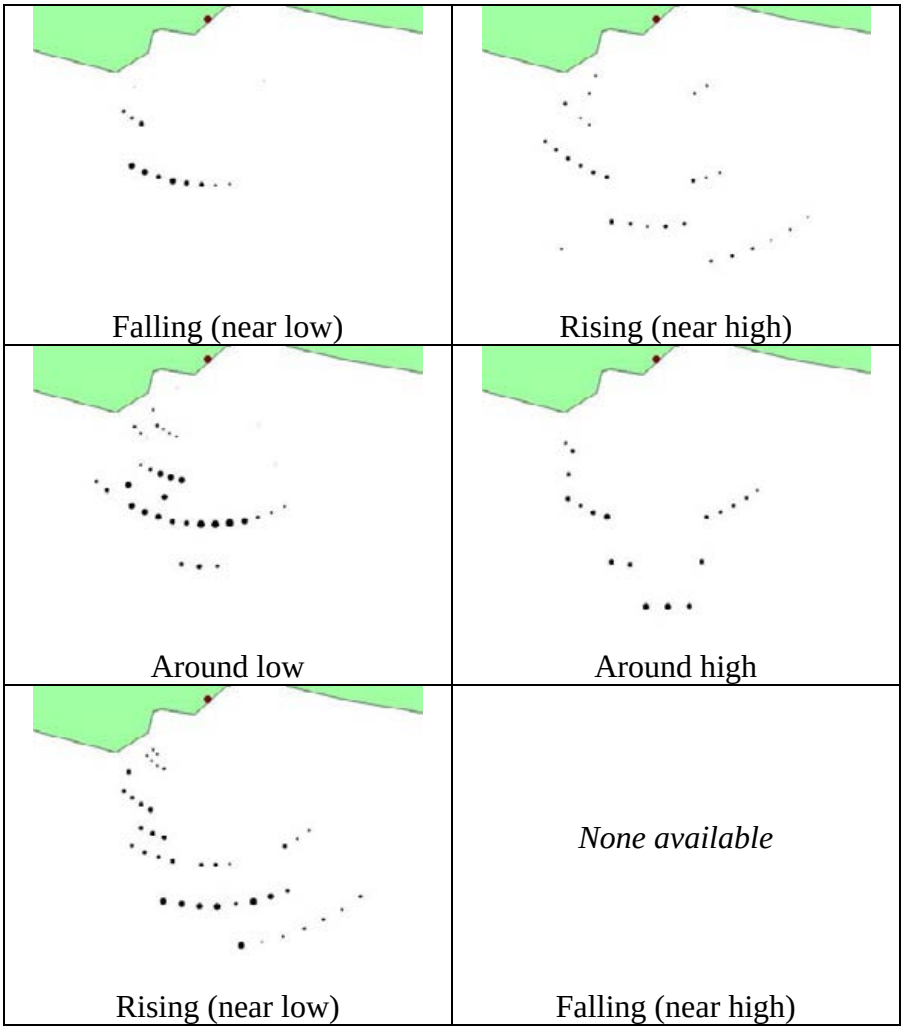



**Figure 4.2** Grouped distribution patterns of Common Scoters off Pendine at different stages of the tidal cycle. Note that no observations were made on a tide falling from high.

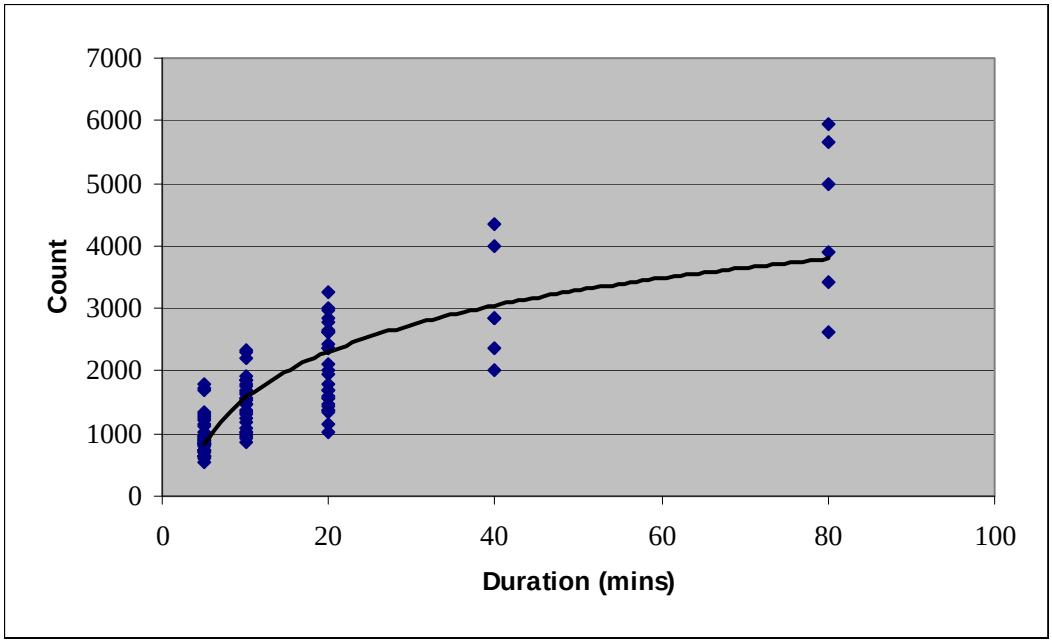



**Figure 4.3** Variation in counts made by NF from Pendine with duration of count.

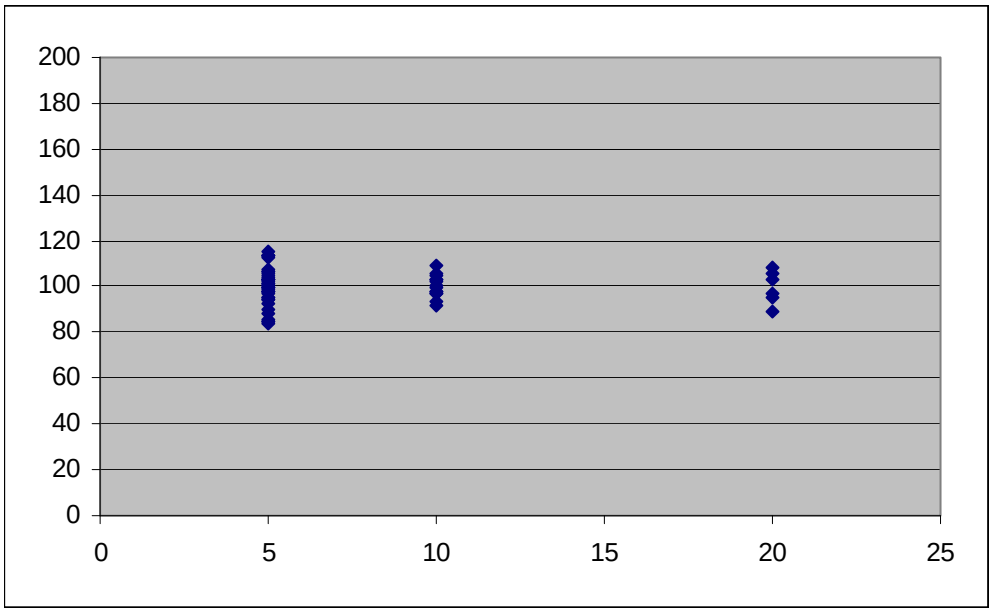



**Figure 4.4** Intra-observer percentage variation in counts made by NF from Pendine, by duration of count (mins).

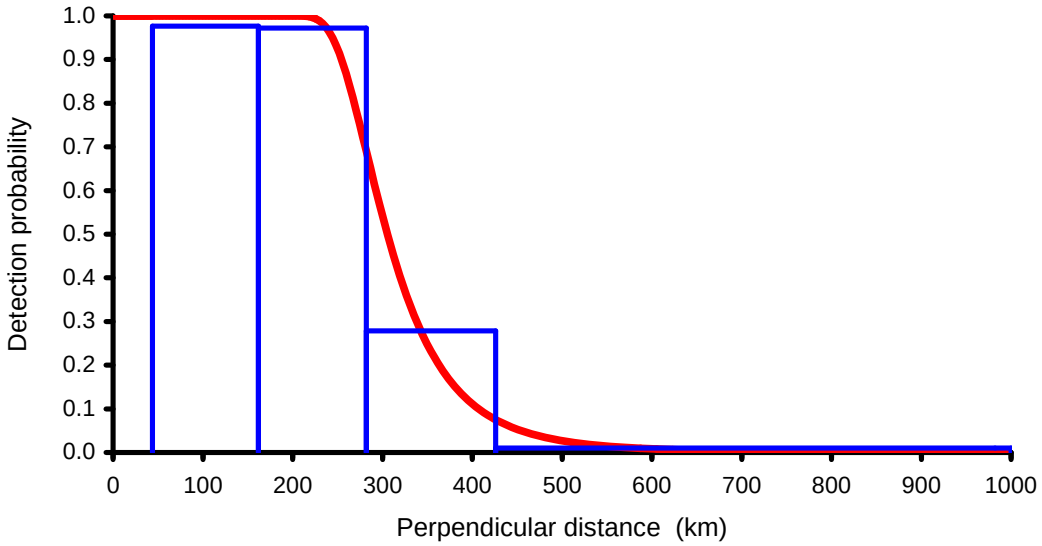
**Figure 4.5** Mean ground (above) and aerial census (below) distributions of Common Scoters at Carmarthen Bay during the 2002-03 winter. One dot represents one averaged bird.

## APPENDIX 1 ANALYSIS OF DISTANCE-METHOD AERIAL SURVEY DATA

In this study, Common Scoter were encountered in flocks, where the detection of an individual within a flock could not be considered independent of the detection of other individuals within that flock. For this reason we modelled detectability of individual flocks (referred to as clusters).

Exploratory analysis of the data using the package DISTANCE 4 suggested that fitting separate detection functions to each survey visit resulted in little gain in model fit and reduction in precision in the resulting estimates compared with a global detection function applied to counts from each survey visit (see figure below). This makes the assumption that detectability of scoter was the same across visits (just absolute numbers differ). Probability detection functions based on hazard rate models gave the best fit of the model to the data (determined by minimum AIC[1] and goodness-of-fit). To take into account variation in detection of cluster size we regressed observed cluster size against distance to estimate the average population cluster size (as the expected value at distance of 0). This approach is intended to reduce bias if there is a tendency for smaller clusters to be missed more than large clusters at large distances from the track line. Variance was estimated empirically. Although there was some difference in detectability between observers, the reduction in precision that would result from treating observers as different strata was not justified.

Further refinements of the distance analysis part of this project are planned for the future, including improved assessment of the effects of observer, the differences between sitting and flying birds and the length of transect.



## APPENDIX 2 DRAFT PROCEDURAL GUIDELINE FOR GROUND COUNTS

**Note:**
The following Procedural Guideline is a first draft, as not all past data and reports were available. In particular, the Ph.D. thesis of Lucy Smith should be an important source for the guideline.

Additionally, the Procedural Guideline is currently restricted to the recording of scoter numbers only and not to recording the position of flocks. The evidence from this report so far suggests that there is little to be gained in recording the position of flocks as the resulting distribution cannot be combined with the aerial distribution. The only useful distance measure is one of overall visibility. In the future, however, the guideline might be modified if positional information was considered useful.

### Procedural Guideline for Making Ground-Based Assessments of Numbers of Offshore Common Scoter Flocks

*Andy Musgrove [also Lucy Smith in time?]*

#### Background

Outside the breeding season, most Common Scoter *Melanitta nigra* concentrate in flocks in shallow offshore areas. This Procedural Guideline recommends a technique to be used to assess Common Scoter numbers by ground-based observers (as opposed to aerial survey) and is based largely upon experience gained from surveying birds at Carmarthen Bay in south-west Wales. The method is straightforward but its interpretation is less so, being highly dependent upon both site-specific factors (*e.g.* vantage points and distance offshore of flocks) and count-specific factors (*e.g.* weather conditions). The method will provide minimum estimates of the numbers of birds present but will seldom be able to provide a reliable estimate of total numbers.

Advantages

- Relatively straightforward and in many instances requires little specialist knowledge (although this is dependent upon the occurrence or otherwise of other species in the same area).
- Relatively inexpensive.
- Does not require specialised equipment.

Disadvantages

- Can be used over only a limited range.
- Highly dependent upon weather conditions.
- Relatively time-consuming (in comparison to aerial survey).
- Requires a careful and thorough observer.
- May be less straightforward at locations where other similar species occur.

#### Purpose

The principal output of the method is a count of Common Scoters over a given area on a given date. This count (or a series thereof) can then be compared against pre-determined threshold values to monitor the condition of the area in question. The count obtained,

however, must be considered carefully in relation to site-specific and count-specific factors when comparing against threshold values before firm conclusions can be drawn.

Additional information could also be collected by making slight modifications of the method. The distribution of Common Scoters over the surveyed area could also be recorded with an extra investment of effort if it was deemed useful. Also, other offshore waterbird species could be surveyed at the same time. In some situations, bird behaviour and sex ratios could also be recorded, although these are even more strongly limited by site-specific and count-specific factors.

## Logistics

### *Equipment*

A telescope with a zoom eyepiece, typically of 20-60 times magnification with at least a 60 mm objective lens. The telescope must be mounted on a sturdy tripod.

A map and compass to determine accurately both the location of the vantage point and the extent of the surveyed area.

Suitable recording media. A pre-prepared form is the most suitable to ensure that all relevant supplementary information is recorded but in wet weather a dictaphone may be more suitable (although counts should be transferred to paper as soon as possible afterwards, to avoid uncertainty).

Warm and waterproof clothing, suitable for an observer working from a fixed, exposed position for about two hours at a time.

Suitable health and safety equipment, such as a mobile phone with relevant contact numbers (*e.g.* local coastguard and police), emergency rations, *etc*.

### *Personnel / time*

The number of staff required depends upon the size and nature of the particular site and the perceived necessity of avoiding double-counting. For example, it may be more critical to have multiple observers carrying out simultaneous counts from different vantage points at a highly disturbed site than at a relatively undisturbed site where distribution may alter much less over the course of a day. The work should be planned taking into account any prior knowledge of daily movements of scoters. Some organisations or situations may require paired observers for safety purposes and this should be considered at an early stage.

The method does not call for observers with highly-specialised identification skills, although the level of experience required is dependent upon the site and at least some basic ornithological background would be valuable. No formal qualification would be required and good eyesight and a degree of stamina are more valuable, along with thoroughness and attention to detail.

The preferred time of year for sampling is dependent upon the site, depending on both the occupancy by the species and the requirement for the survey (*e.g.* if investigating a seasonal disturbance factor). Common Scoters do occur in UK waters throughout the year but overall the highest numbers are in the winter. Existing datasets for the site in question should be

investigated in advance of the survey to determine what is already known about occupancy patterns.

## Method

### *Pre-survey considerations*

The target area should be clearly defined. Vantage points covering as much of the site as possible should be selected, although care should be taken to avoid double-counting through overlapping zones. Vantage points should be as high as possible to increase visibility. Ideally, vantage points should also be readily accessible, reducing the walk-in time. Where possible, vantage points should also be in sheltered situations; a more comfortable counter will produce a more thorough count which is very important.

Survey dates should be selected in advance but may vary at short notice. If the sea-state has any more than a slight swell or if visibility is hampered through haze, fog or precipitation, postponing the survey until a day with more suitable conditions should be considered. The time of day, where possible, should be selected to minimise the extent to which observations need to be made in line with the sun.

### *Survey methods*

Upon arrival at the vantage point, record the date, observer, equipment being used and start time. Weather conditions (wind speed and direction, cloud cover, precipitation and sea-state) should be recorded before the count and at the end of the count, along with any clear changes throughout. An assessment of the range of visibility should also be recorded.

Having positioned the telescope, a preliminary scan should be made to determine any broad patterns of occurrence. Then start at one end of the survey zone, using the telescope at a low magnification. It is critical that the sea is scanned very slowly, particularly when the sea-state is less than ideal. If there is the possibility of poor visibility (*e.g.* fog or precipitation approaching) it may be worth speeding up the count to cover the whole area in time but the fact that this was done should be carefully recorded. If a quick count is carried out and the visibility remains satisfactory then the observer should attempt to repeat more slowly.

Observe each area of sea for at least a minute to check for those birds which are under water. When birds are encountered a higher magnification should be used as necessary. A flock should be observed for at least a minute to check both for birds behind waves and birds diving. The observer should not necessarily expect to see all of the birds in a flock at the same moment as with a swell this is unlikely to occur. Instead, a combined impression of the numbers present should be arrived at after watching the flock for a period. It should be noted that birds will drift if watched for too long, however.

If large flocks (more than 100) are encountered, particular care should be taken not to rush to a total. Be careful about counting in blocks (*e.g.* count ten, then mental images of sets of ten or even sets of 100). If doing so then recall that flock density will not be uniform throughout, but generally tends to be densest towards the centre of the flock. If possible, practice beforehand estimating flocks from photographs or using a computer package which generating random flocks.

A count of each flock should be recorded separately. Whilst it may not be considered critical to assign birds to a particular position, it may be useful to record each flock to a compass

bearing as a check in case of accidental knocking of the tripod during the count, to ensure that the count can be resumed from a known point. This would be most useful in areas of higher density.

The target species is an all-dark duck and, within the UK at least, at its main sites it is usually the dominant species with relatively little scope for confusion. The related Velvet Scoter *Melanitta fusca* is difficult to distinguish within flocks of swimming Common Scoters. However, at most UK sites (including all Welsh sites), Velvet Scoters are scarce and likely to be so heavily outnumbered by Common Scoters that they will not affect the results in any significant manner. Only in Scotland (especially from the Firth of Forth to the Moray Forth) are Velvet Scoters likely to be an significant issue. The presence of substantial numbers of Velvet Scoters would become apparent to an observer carrying out an intensive survey of a site as the species is very apparent in flight or when flapping its wings on the surface, revealing white secondary feathers (not shown by Common Scoters). The other main possible source of confusion would be Eider *Somateria mollissima* and perhaps transient flocks of dabbling ducks *Anas* which can sometimes rest offshore, particularly on migration.

At the end of the count, the time and the weather conditions should again be recorded. If the time is available then the observer should consider carrying out repeat counts.

**Data Analysis**

The level of data analysis required is very much dependent upon the nature of the site and survey. At the simplest level, counts from all vantage points are summed and a total is produced for the site. Depending upon the selection of vantage points, the synchronicity of multiple counts and the degree of movement of flocks observed, it may be necessary to take account of potential double-counting. When required, it is useful for the counters themselves to be involved in this, ideally as soon after the survey as possible.

If multiple repeated counts have been made by a single observer then, unless there is a good reason otherwise, the maximum count should be taken. This is because the nature of the environment involved means that it is always far more likely that birds will be missed than that additional birds will be introduced into the count total. The level of variation amongst repeats, however, should be kept under review and if particularly variable then a modification of the site-specific procedures should be considered.

The interpretation of whether or how the ground count can be used to estimate the true number of scoters present depends greatly upon the other resources available and this subject is discussed in detail in Musgrove *et al.* (2003). As a bare minimum, an assessment should be made at the time of the count of the distance over which scoters are thought to be visible on the day. This may be by reference to objects of known distance, such as buoys or other landmarks, but it may be necessary to estimate the distance by comparing the perceived size of the most distant scoter with an object visible on the land which can be positioned on a map. It is important that this assessment is available, however approximate.

**Accuracy Testing**

Accuracy can be tested by making repeat counts using the same observer or by carrying out counts, ideally simultaneously, using more than one observer. Counts should also be considered with regard to the sea-state, visibility and duration of count.

**QA/QC**
Quality assurance and standardisation of methodology would be assured by ensuring that the same vantage points, count zones and approximate count dates were repeated between years. Consistency of optical equipment would be important. Where possible, the same observer should be used but if this is not possible the level of thoroughness (*i.e.* the duration of the count) should be the same over time. Acceptable weather conditions should be adhered to throughout.

**Data Products**
The method described in this guideline generates numbers of scoters only. Modifications of the method to record distribution would result in positional data which could be mapped or analysed using GIS.

**Cost & Time**
The main cost involved is that of staff time. Travel time and expenses (and perhaps overnight accommodation) should be taken into account. Consideration should also be given to potential standby costs, *i.e.* having planned to carry out a survey but then postponing at the last moment due to weather. Equipment costs are largely restricted to those for the telescope, tripod and compass.

**Health & Safety**
All standard procedures set out by CCW or other involved organisations and / or landowners should be followed. Particular attention should be paid to the following issues:

Have suitable warm and waterproof clothing. Vantage points may be exposed and suitable footwear should also be used if vantage points are accessed along paths with hazardous terrain. Observers should not walk out onto intertidal substrates. In remote areas, a survival blanket, whistle, first aid kit, torch and emergency rations should also be carried along with mobile phone with relevant contact details. Always make it clear with someone else where you are going and when you should be expected back and instruct this person to notify the emergency services if you do not return as expected. Some coastal areas are used as military firing ranges and in such cases make sure you are aware of the times the ranges will be active.

**References**
*This report plus that planned for next year*

*Ph.D. thesis or other reports by LS.*

Cranswick, P.A., Stewart, B., Bullock, I., Haycock, R. & Hughes, B. 1998. *Common Scoter* Melanitta nigra *monitoring in Carmarthen Bay following the* Sea Empress *oil spill: April 1997 to March 1998*. WWT Wetlands Advisory Service report to CCW, Contract No. FC 73-02-53A, Slimbridge, 25 pp.

## APPENDIX 3 DRAFT STANDARD OPERATING PROCEDURE FOR GROUND COUNTS AT CARMARTHEN BAY.

**Note:**
The following Standard Operating Procedure is a first draft, as not all past data and reports were available. In particular, the Ph.D. thesis of Lucy Smith should be an important source for the Standard Operating Procedure.

Additionally, the Standard Operating Procedure is currently restricted to the recording of scoter numbers only and not to recording the position of flocks. The evidence from this report so far suggests that there is little to be gained in recording the position of flocks as the resulting distribution cannot be combined with the aerial distribution. The only useful distance measure is one of overall visibility. In the future, however, the Standard Operating Procedure might be modified if positional information was considered useful.

### Standard Operating Procedure for Making Ground-Based Assessments of Numbers of Offshore Common Scoter Flocks in Carmarthen Bay

*Andy Musgrove [also Lucy Smith in time?]*

**General**
This Standard Operating Procedure should be read in conjunction with the associated Procedural Guideline. Only site-specific issues are covered below.

**Background**
Carmarthen Bay is perhaps the most important single site for wintering Common Scoters in Britain and Ireland. As is typical for the species, however, the true numbers present at any time are difficult to ascertain. Ground counts have certainly exceeded 20,000 birds on a number of occasions and, given that only a part of the bay can be surveyed from the land the true number is thought to be considerably higher. However, much lower counts were recorded following the *Sea Empress* oil spill of February 1996.

The distribution of Common Scoters within the bay varies, but overall birds can be found throughout a band approximately 5 km wide running from the north-west of the bay off Amroth and Saundersfoot to the east off Pembrey Sands. During the period following the *Sea Empress* oil spill the south-east of the bay (Rhossili Bay) was used by the birds to a greater extent.

Whilst not covering the whole of Carmarthen Bay, ground-based counts of the scoters are relatively straightforward to carry out and can provide a good assessment of the numbers of birds present.

**Purpose**
The purpose of the method described is to record counts of Common Scoters at Carmarthen Bay over the course of a winter for the purposes of comparison with totals from previous winters. Comparison with national and international threshold values can also be made.

The method could be modified to record the distribution of Common Scoters seen from the land. Additionally, other inshore species could also be noted, although at Carmarthen Bay

there are seldom large numbers of other sea-duck present, except for a small flock of Eider at Whiteford Sands at the mouth of the Burry Inlet (which are probably well monitored by standard WeBS Core Counts at the site). Recording of behaviour and sex ratios of Common Scoters at Carmarthen Bay is not likely to be easy, due to the distance of most of the birds from the shore.

## Logistics

### *Equipment*
As detailed in Procedural Guideline.

### *Personnel / time*
Ground counts of Common Scoter at Carmarthen Bay have traditionally been carried out by a single observer over the course of a day, with three or four vantage points visited consecutively. It is thought that the degree of movement between sites is relatively small over the course of an average day. Clearly, however, the option exists to carry out counts concurrently from all vantage points, if the observers were available to do so. The added value of synchronicity could, however, be outweighed by the differences in survey technique used by individual observers (despite efforts to standardise). Similarly, if sufficient resources were available then consideration should be given to carrying out simultaneous counts from vantage points by multiple observers. Given that there are few sea-duck other than Common Scoters within Carmarthen Bay, the observers would not be required to possess highly-developed identification skills.

Common Scoters can be seen in Carmarthen Bay throughout the year but post-breeding arrivals occur first in August and then again later in the autumn. The largest numbers appear to be present from November to March, although birds start to leave the site later in March and numbers are typically low from April. Ideally, the numbers in the bay would be monitored throughout the year. However, for an assessment of peak numbers the minimum requirement would be four counts during the period November to March.

## Method

### *Pre-survey considerations*
The four vantage points to be used for consistency are:

Pembrey sand dunes (241500, 199190 – 9 m ASL)
Dolwen Point near Pendine (223310, 207840 – 25 m ASL)
Merrifields, Amroth (217900, 207350 – 48 m ASL)
Kitchen Corner, Rhossili (240350, 187500 – 50 m ASL)

The Rhossili vantage point should be visited at least once during the winter. However, as mentioned above, this area is generally not used by large numbers of birds and survey efforts should be concentrated at the other three vantage points.

In general, the count zones visible from the vantage points can be assumed to be mutually exclusive. However, if count conditions are absolutely ideal then there may be a danger of double-counting between Pendine and Amroth, at ranges of more than 3.5 km to the south-east of the latter.
*[I would like LS to comment upon this.]*

*[I think more detailed access directions provided by LS would also be useful here]*

Carmarthen Bay is used by the military for training purposes during weekdays, which can cause movements of scoters from one part of the bay to another. It would be sensible to select count dates when it was known no training exercises would occur, such as at weekends.

Counts should only take place if visibility exceeds 4 km and the sea-swell is light. Southerly winds in particular should be avoided, along with any winds greater than 20 mph. Days with clear skies and bright sunshine should also be avoided.

***Survey methods***
As detailed in the Procedural Guideline.

**Data Analysis**
As detailed in the Procedural Guideline. However, it should be noted here that ground counts at Carmarthen Bay are known to underestimate the numbers of birds present as the range over which counts can be made appears to be only a part of the total occupied range recorded by aerial survey. Further discussion of this issue can be found in Musgrove *et al.* 2003.

**Accuracy Testing**
As detailed in the Procedural Guideline.

**QA/QC**
As detailed in the Procedural Guideline.

**Data Products**
As detailed in the Procedural Guideline.

**Cost & Time**
The minimum cost for a winter's fieldwork would be for four days of observer time, plus travel and expenses as required. In addition, one or two days of standby time would be a sensible provision to account for weather-related problems at short notice. Time should also be made available for data transfer from recording form to spreadsheet (one day) and analysis and reporting (time dependent upon the level of detail and supplementary information required). If a telescope, tripod and compass are not available then these need to be budgeted for (up to £1000).

**Health & Safety**
As detailed in the Procedural Guideline.
*[LS may be able to add further specific comments]*.

**References**
As detailed in the Procedural Guideline.