



Migration patterns of two populations of Twite *Carduelis flavirostris* in Britain

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Following a recent large decline in range and numbers, the Twite *Carduelis flavirostris* is a red-listed bird of conservation concern. An understanding of the species' movements between wintering and breeding areas is essential to underpin effective conservation. The migration patterns of two populations of Twite were examined: those breeding in the South Pennines and those wintering on the west coast of Lancashire and Cumbria. This was achieved by carrying out an intensive colour-ringing study on the two populations between 2003 and 2005. Birds breeding in the South Pennines wintered predominantly on the east and southeast coasts of England. However, a small number migrated to the west coast of England. Furthermore, large flocks of predominantly South Pennines-bred individuals overwintered in the South Pennines. From the single previous recovery, northwest-coast birds were also thought to originate from the South Pennines. However, resightings from this study suggest that these birds breed primarily on the west-coast islands of Scotland, with smaller numbers breeding on the Scottish mainland. Some interaction occurred between northwest-coast and South Pennines birds, with several birds ringed on the northwest coast found wintering during the same or subsequent year on the coast of Lincolnshire. Two birds ringed in the South Pennines were found breeding elsewhere in subsequent years: one in Scotland and one in Wales. This study has shown that, despite a small amount of cross-dispersal, these two populations have entirely different wintering and breeding grounds, and should be treated discretely for the purposes of future conservation management plans.

The Twite, *Carduelis flavirostris*, has a disjunct world distribution, with one population in northwestern Europe and the other in central and southwestern Asia (Newton 1972). In Britain, the Twite (of the endemic race *pipilans*) is listed as a Red Data species due to a recent large decline and range contraction, particularly evident in England and Wales (Gibbons *et al* 1996, Brown & Grice 2005). The breeding population is estimated at 10,000 pairs (Langston *et al* 2006), with the majority of birds found in Scotland and the remainder principally in England but with a few small colonies in Wales.

Few Twites have been ringed in Britain, so the species' migration routes are poorly understood. Birds ringed in the South Pennines have been recovered or resighted along the southeast coast of England in the winter, principally at sites from Lincolnshire to Kent (Brown & Atkinson 2002, Brown & Grice 2005). The Wash appears to be a particularly important wintering area for this population (Davies 1988, Atkinson 1998). Small numbers of South Pennines birds have also been

recovered on the coast of the Low Countries bordering the North Sea (particularly in northeastern France, Belgium and southwestern Netherlands) and at least seven ringed in this area have been recaptured on the southeast coast of England (Brown & Atkinson 2002).

Conversely, Scottish-breeding Twites are thought to be more sedentary, wintering on coastal farmland close to their breeding grounds (Clark & Sellers 1997, 1999). Of the small number of Scottish recoveries summarised in the BTO Migration Atlas, half consisted of movements of less than 20 km (Brown & Atkinson 2002). Of the remainder, a few birds were found to move between southwest Scotland and Northern Ireland and there was some evidence of a limited interchange of birds between Orkney and Shetland and between Caithness and the northeastern isles of Scotland (Clark & Sellers 1998).

Very little is known of the origin or movements of birds wintering on the northwest coast of England, principally in Lancashire and Cumbria. A single recovery of a South Pennines bird on the Ribble Estuary in March has led to speculation that some of these birds are of South Pennines origin (Brown & Atkinson 2002).

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In an effort to improve our understanding of the migration patterns of British Twite, a comprehensive colour-ringing programme was undertaken, involving two of the main populations in England. The first was those that breed in the South Pennines. These are considered the most important breeding population in England (Brown *et al* 1995, Batty *et al* 1999), and an understanding of their migration patterns and the identity of their key wintering sites was identified as a priority in local Biodiversity Action Plans (Anon 2001). The second population consisted of birds that winter on the west coast of Lancashire and Cumbria, as these have been poorly studied.

METHODS

Study area

The colour-ringing study focused on birds found in northern England: those breeding in the South Pennines Site of Special Scientific Interest (covering an area approximately 250 km² centred on 53°70'N 2°05'W) and those wintering on the northwest coast. In the breeding grounds, birds were captured at two baited feeding stations, one in Lancashire (grid reference SD8931) and one in Yorkshire (SD9619). Twite were also ringed as nestlings at nine different breeding colonies located within the South Pennines. On the wintering grounds, birds were caught on feeding stations at Heysham (on Morecambe Bay, SD3960) and the Ribble Estuary National Nature Reserve (SD3921) in Lancashire, and on both sides of the Duddon Estuary (SD2077 and SD1880) in Cumbria.

Additional small catches were also made at two known southeast-coast wintering sites: Donna Nook (grid reference TF4499) in Lincolnshire and Walberswick NNR (TM4973) in Suffolk.

Colour-ringing scheme

At all of these locations Twite were either trapped using whoosh nets and mist nets at sites baited with nyjer *Guizotia abyssinica* seed, or were ringed as nestlings. All trapping took place between winter 2002/03 and 2005/06. On west-coast wintering grounds, trapping was undertaken between October and April. In the South Pennines, trapping was carried out during August to April, while between May and July only nestlings were ringed. The majority of birds trapped in whoosh nets were given cohort combinations, which consisted of two colour rings (either solid or striped) signifying time period of capture (either August–December or January–July) and site of capture on the left leg and a metal BTO ring on the right. However, all nestlings and some

birds caught with whoosh nets were given individual combinations, which consisted of two colour rings on the left leg and a third colour ring above or below the metal ring on the right. Considerable efforts were made to make as many resightings of colour-ringed birds as possible during the winter by the authors and local birdwatchers. This project was heavily publicised to generate as much coverage of the wintering grounds as possible.

RESULTS

Over the course of the project 2,763 individuals were colour ringed. Of these, 529 were given individual colour combinations and the remainder cohort combinations. Table 1 summarises the ringing effort.

South Pennines Twite

Winter migration

The vast majority of colour-ringed Twite from the South Pennines were resighted on the east and southeast coast of England. Of 259 birds resighted at wintering sites (each site a distinct geographical location with one or more colour-ringed birds) outside the South Pennines, 250 (96.5%) were from sites between Flamborough, Yorkshire, and Pegwell Bay, Kent.

Twites from the South Pennines were reported wintering at 25 sites in seven counties (Fig 1a; Table 2). All but two of these sites were coastal, with one being inland in Cambridgeshire (70.6 km from the coast) and the other in north Lincolnshire (42.7 km from the coast). The mean distance (\pm SE) moved by wintering Twite to the east and southeast coast was 222.6 ± 4.4 km (range 98–363 km).

Repeat sightings of individually colour-ringed individuals allowed us to examine winter site fidelity. Of six birds resighted in subsequent winters on the east coast, all were resighted at the same site as the previous winter, indicating the possible importance of winter site fidelity in this species. Of 15 individuals with at least one week between resightings, 12 were resighted at the same site and six stayed in the same site for over two months. However, the remaining three individuals moved large distances over the course of the winter period. Two were initially resighted in a flock at Walberswick, Suffolk, on 19 November 2004. They were subsequently resighted, eight and 16 days later, 163 km north at Donna Nook in Lincolnshire. By the beginning of February, one of these birds was back at Walberswick, before being resighted back on the South Pennines breeding grounds at the end of April. A similar scenario was recorded in the winter of 2005/06, with a

Table 1. Totals of Twite colour-ringed during 2002–05 in the South Pennines and at English west-coast wintering sites. Brackets adjacent to the totals indicate number of individual ring combinations used.

Site	2002	2003	2004	2005	Total	
SOUTH PENNINES						
Lancashire Feeding Station	-	546	247	167	960	(56)
Yorkshire Feeding Station	-	335	176	232	743	(117)
South Pennines Nestlings	-	152	165	25	342	(342)
WINTER : WEST COAST						
Morecambe Bay	13	298	113	42	466	
Duddon Estuary	-	-	84	127	211	
Ribble Estuary NNR	-	-	37	-	37	
WINTER : EAST COAST						
Donna Nook	-	-	2	-	2	
Walberswick NNR	-	-	2	-	2	(2)

bird resighted at Walberswick on 11 November and again at Donna Nook on 20 November.

Twenty-one birds ringed as nestlings were resighted on the east and southeast coast in the winter. Of these, 12 were first-winter birds, seven were second-winter birds (*ie* ringed in 2003 as a nestling and resighted in the winter of 2004/05) and two were third-winter birds. Birds from different colonies were distributed

throughout most coastal wintering sites (Table 2) with no indication that nestlings from certain colonies preferentially wintered at specific sites. There were insufficient data to undertake analyses of age or sex differences between coastal sites.

There were nine records of South Pennines colour-ringed birds on the west coast, representing 3.5% of all coastal winter resightings (Fig 1a, Table 1). Of particular

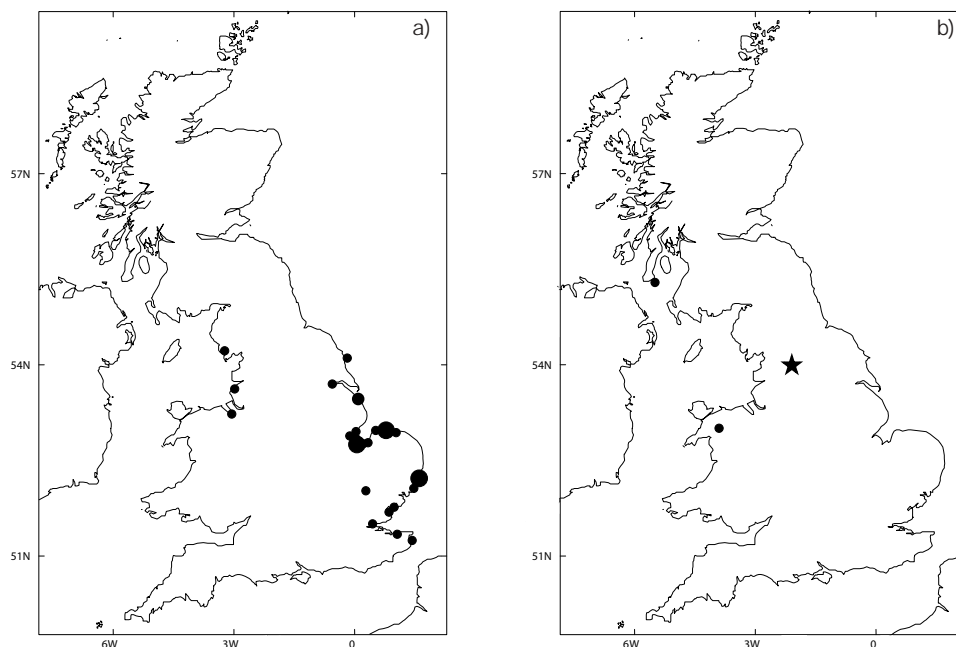


Figure 1. Recoveries of Twite ringed in the South Pennines (star). (a) Winter recoveries. Small circles indicate sites with fewer than ten resightings of colour-ringed birds. Four sites with more than ten colour-ringed birds are represented by large circles. (b) Summer recoveries. Star indicates main breeding area of South Pennines birds (100+ resightings). Small circles indicate two resightings of South Pennines birds outside the main breeding area.

Table 2. Locations of all winter resightings (earliest sighting 14 October, latest 25 March) of Twite ringed in the South Pennines over three winter periods. Resightings of birds ringed as nestlings are included in year totals and are also displayed separately. Sightings of more than ten colour-ringed birds at a site are displayed in bold. It is important to note that these totals represent minimum numbers, as cohort combinations were recorded as separate birds at any given site only if two of the same cohort were physically seen together.

Site	Grid ref	Distance (in km) from S Pennines	Number of South Pennines colour-ringed birds recorded			Total South Pennines nestlings
			2003/04	2004/05	2005 (to 02/06)	
SOUTH & EAST						
EAST RIDING OF YORKSHIRE						
Flamborough	TA221714	138	0	1	0	0
LINCOLNSHIRE						
Island Farm, N Lincs	SE865207	98	1	0	0	0
Donna Nook	TF441993	153	15	23	18	6
Freiston Shore – Kirton Marsh	TF411435	169	8	4	0	0
Frampton Marsh	TF365384	173	1	4	7	1
Holbeach Marsh	TF410340	180	0	20	0	3
NORFOLK						
Holkham Gap	TF898457	210	4	0	0	0
Brancaster	TF771451	194	2	3	1	1
Titchwell RSPB	TF756448	199	13	2	0	0
Thornham	TF726444	200	0	16	12	5
Gore Point – Holme NNR	TF708451	200	6	0	0	0
Ongar Hill	TF585250	199	0	2	0	0
Terrington Marsh	TF494268	191	0	4	0	0
CAMBRIDGESHIRE						
Fowlmere	TL413452	240	1	0	0	0
SUFFOLK						
Hen Reedbeds	TM475767	300	0	3	0	0
Walberswick NNR –						
Dunwich Pools	TM495738	297	29	21	6	4
ESSEX						
Hamford Water	TM240295	303	0	0	5	0
mouth of the River Blackwater	TL998113	297	1	0	0	0
Canvey Island	TQ821845	299	2	0	0	0
Bradwell-on-Sea	TL989083	306	0	3	0	0
Mersea Island	TM036162	303	1	7	1	0
Potton Island	TQ950910	316	0	1	0	0
KENT						
Oare Marshes	TR002655	339	1	0	0	0
Pegwell Bay	TR343625	363	0	1	0	0
		TOTAL	85	115	50	20
NORTH & WEST						
LANCASHIRE						
Ribble Marshes NNR	SD3921	57	0	3	0	0
Heysham	SD3960	55	0	0	1	0
Brockholes Quarry	SD5830	31	0	1	0	0
River Lune	SD5870	49	0	0	2	0
CUMBRIA						
Askam-in-Furness	SD2077	87	0	1	0	0
WALES						
Flint Castle, Clwyd	SJ247736	88	0	1	0	1
		TOTAL	0	6	3	1

interest was a bird ringed as a nestling in the South Pennines and resighted on 12 February 2005 at Flint Castle on the northern Welsh coast. No birds from the South Pennines ringed in the current study were recorded in continental Europe.

Overwintering in the South Pennines

Over the winter period (November–February), small flocks of Twite were recorded in the South Pennines study area. These winter flocks averaged between 47.9 ± 2.9 ($n = 12$, range 31–61) birds in December and 35.9 ± 5.3 ($n = 18$, range 3–80) in February. The majority of these birds had been colour-ringed, and all colour-ringed birds were of South Pennines origin, comprising Lancashire- and Yorkshire-ringed individuals, as well as birds ringed as nestlings. On average, 71.4% of birds in these wintering flocks were colour-ringed ($n = 46$, range 16.7–97.3%), with a maximum count of 72 colour-ringed individuals in a flock of 74. In total, 15 birds ringed as nestlings were resighted over the three winters in the South Pennines.

Colour-ringed birds from the South Pennines were also found at one other winter location within the study area. Deer Hill Reservoir (SE073117) held a maximum of 17 individuals over the two winters, comprising birds ringed at both feeding stations in the post-breeding season and several nestlings from nests in the study area. This site is only 26.7 km from the Lancashire ringing site and 13.3 km from the Yorkshire site. Interestingly, one bird was resighted wintering at Deer Hill Reservoir until the end of January, when it then moved 137 km southeast to the Lincolnshire coast for the rest of the winter period.

South Pennines-ringed birds breeding outside the Pennines

Two South Pennines birds were recorded breeding outside the South Pennines study area (Fig 1b). A bird ringed on 26 July 2003 was resighted in a family party on Sanda in Scotland (276 km from the South Pennines) on 27 July 2004. A second bird, ringed in the post-breeding season of 2004 was resighted on the lower slopes of Snowdon in Wales (146 km from the South Pennines) on 30 July 2005. As both of these resightings occurred towards the end of the breeding season, but before long-distance movements occur in post-breeding flocks, we assume that these birds were breeding locally.

Twite wintering on the northwest coast of England

Northwest coast winter movements

On the northwest coast, wintering flocks were located on the saltmarshes of both Morecambe Bay (from

Heysham southwards to the River Wyre) and the Ribble Estuary NNR in Lancashire, as well as at Walney Bird Observatory, Askam-in-Furness and Borwick Rails in Cumbria. A further wintering flock was reported from Flint Castle in Wales.

Of 199 birds ringed at Heysham in the winter of 2002/03, 29 (14.6%) were retrapped at Heysham the following year, indicating a degree of fidelity to this wintering area. The same pattern was evident in the following two winters, with 29 (9.2%) of 318 (running total) retrapped in 2004/05 (16 from winter 2002/03 and 13 from winter 2003/04) and 47 (11.0%) of 424 in the winter of 2005/06. Birds ringed at Heysham were also resighted in the same and subsequent winters at other localities in the Morecambe Bay area and were regularly seen in the saltmarshes from Heysham south to the mouth of the River Wyre (up to 14.6 km from the ringing site).

As well as regular movements within the Morecambe Bay area, some interchange was also recorded between Heysham and the Cumbrian ringing sites (Fig 2a). Heysham-ringed birds were retrapped in the same or subsequent winters at Borwick Rails and Askam-in-Furness (27.7 km and 25.7 km northwest of the Heysham ringing site, respectively) and larger numbers of Heysham birds were resighted at these sites in the winter of 2005/06. No birds ringed at Cumbrian sites were retrapped at Heysham. Finally, a bird ringed on the Ribble Estuary NNR in February 2005 was caught the following winter at Heysham.

Three birds ringed at Heysham in the winters of 2002 and 2003 were resighted 211 km east at Donna Nook, Lincolnshire (Fig 2a; Table 3). This represented a long-distance movement of a small proportion of colour-ringed birds from the northwest coast to east coast wintering sites. For two of these birds, resightings were made one and two winters after ringing. However, the remaining bird was ringed at Heysham (with a cohort colour-ring combination – it could have been ringed from October 2004 onwards) and then resighted in Lincolnshire on 3 December in the same winter, indicating a long-distance within-winter movement.

Origin of northwest-coast wintering flocks

Despite widespread publicity to local birdwatchers and considerable effort by the authors to resight colour-ringed birds in the South Pennines, no northwest-coast-ringed birds were recorded breeding there. Six birds ringed on the northwestern wintering grounds were resighted during the breeding season (between April and July) at five islands off the west coast of Scotland; Sanda, Oronsay, Staffa, Eigg and South Uist (Fig 2b; Table 3). There was also a single resighting of a bird on

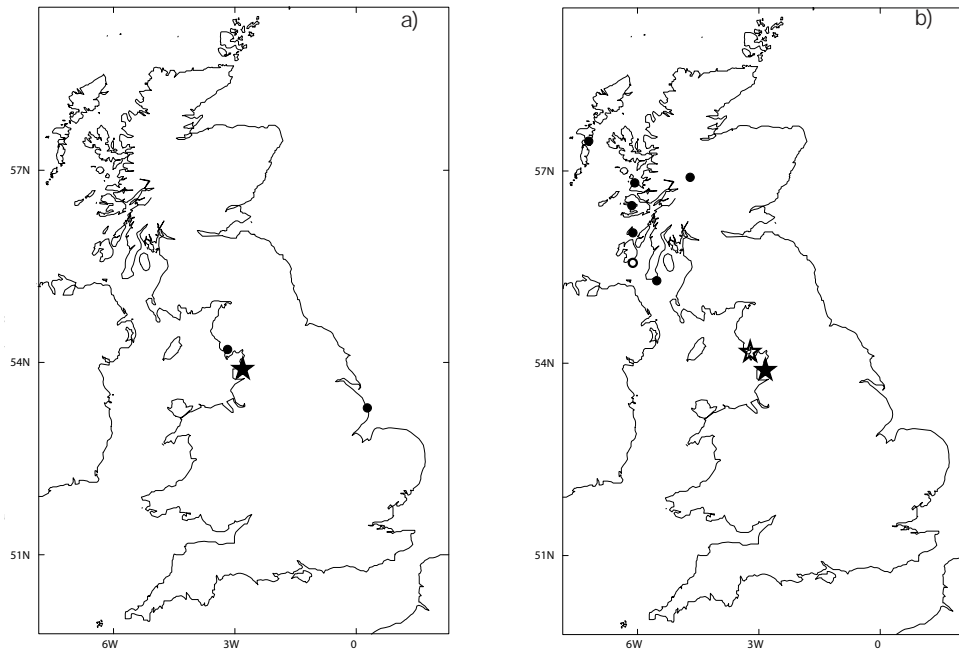


Figure 2. Recoveries of Twite ringed in the main wintering area of Morecambe Bay. (a) Winter recoveries. Filled star indicates main wintering area (100+ resightings). Small circles represent resightings of Morecambe Bay birds outside the main wintering area. (b) Summer recoveries of Twite ringed in Morecambe Bay (filled star) and Cumbria (open star). Small filled circles indicate birds ringed in Morecambe Bay. Small open circle indicates the recovery of a bird ringed in Cumbria.

7 August 2005 in a family party on Chno Dearg in the Scottish Highlands and a bird killed by a cat on 29 October 2004 at Carsaig Tayvallich in Strathclyde. Furthermore, three birds were caught at Heysham that had been ringed on Sanda during the breeding season. One of these birds was retrapped in two successive winters, indicating winter site fidelity. The only resighting of a breeding bird ringed in the winter on the Cumbrian coast came from Islay. This complements the migration patterns of Heysham birds. As with Heysham, one bird ringed in the breeding season at Sanda was caught at Askam, Cumbria, in the winter. These movements represent an average migration distance of 266.8 ± 25.9 km (range 220–451 km) from wintering site to breeding grounds. There were no resightings of birds ringed at the Ribble Estuary NNR in the subsequent breeding season.

DISCUSSION

Our colour-ringing study clearly indicates that the majority of Twites breeding in the South Pennines move southeastwards to winter along the east and southeast coast of England, from north Lincolnshire to Kent. Apart from two inland sightings, wintering birds in

the east and southeast were entirely coastal, with the saltmarshes of Lincolnshire, Norfolk and Suffolk of particular importance. This finding supports previous accounts of the significance of this area as a favoured wintering destination and of saltmarshes as a preferred wintering habitat for this population (Brown & Atkinson 1996, 2002, Atkinson 1998). Despite the large numbers of birds colour-ringed during this study and the assistance of observers at known near-continental European wintering sites, there were no reports of South Pennines birds from across the North Sea. Clearly, this may reflect the current migration patterns or may be due to lower observer effort across a potentially vast wintering area.

Many individuals appeared to show a high degree of site fidelity to their stretch of coastline in the winter. Atkinson (1998) found similar patterns of site fidelity, although his study also showed some localised movement between adjacent sites. The long-distance movements recorded by two individuals in this study appear to be exceptions, although they demonstrate that Twite are capable of large movements within the winter season. This might allow them flexibility in response to changing or widely-spaced food resources.

Sizeable flocks of Twite also overwintered in the South Pennines. All known colour-ringed individuals resighted

Table 3. Long-distance movements of Twite ringed or controlled at northwest coast wintering sites.

County	Site	Grid ref	Distance (km) from ringing site	Number of colour-ring resightings
WINTER				
Ringed in Heysham				
LINCOLNSHIRE	Donna Nook	TF4499	211	3
Ringed on Sanda, Mull of Kintyre				
LANCASHIRE	Heysham	SD3960	220	2
CUMBRIA	Askam-in-Furness	SD2077	194	2
SUMMER				
Ringed in Heysham				
SOUTHWEST SCOTLAND	Isle of Eigg, Inner Hebrides	NM4687	378	1
	Isle of Staffa, Inner Hebrides	NM3235	343	1
	Bornish, South Uist, Outer Hebrides	NF7229	451	1
	Oronsay, Inner Hebrides	NR3588	306	1
	Sanda Island, Mull of Kintyre	NR7204	220	2
SCOTTISH HIGHLANDS	Chno Dearg, near Loch Treig	NN3676	331	1
Ringed at Askam-in-Furness				
SOUTHWEST SCOTLAND	Islay	NR3444	275	1

in these flocks were of South Pennines origin. Towards the end of the migration period (late October and early November), small influxes of unringed birds were also noted. While their origins are as yet unknown, they could be South Pennines birds, birds moving in from the west coast or birds originating from more northerly upland breeding sites. Small wintering flocks in the South Pennines have been recorded historically (Nuttall 1972, Lack 1986, Brown & Grice 2005). The recent provision of supplemental feed may have served to increase the numbers of birds remaining in the area over winter, as wintering flocks of Twite were recorded rarely, if at all, in the areas around the feeding stations until feeding began (P Grice, pers comm). These feeding stations may therefore be encouraging larger wintering flocks than is normal in the South Pennines. Alternatively, they may simply be providing a focal point for several smaller, previously mobile wintering flocks, thus making them easier to locate and record.

The origin of wintering northwest-coast flocks has long been the subject of speculation, with the only ring recovery suggesting that they could be of South Pennines origin. However, despite a distance of only 54.5 km to the closest South Pennines breeding colonies, no northwest-coast birds were recorded breeding there. This study clearly indicates that significant numbers of Twite wintering on the northwest coast are of Scottish origin, predominantly from the west-coast islands. The two resightings of birds from the Scottish mainland also

suggest that at least some birds wintering in Morecambe Bay may come from breeding grounds further inland in Scotland. The larger number of resightings from the islands as opposed to the mainland could reflect a bias in sighting effort during the breeding season, so the lower number of resightings from inland areas should be treated with caution. Twites breeding on the northwest coast of Scotland were previously thought to be static populations with predominantly local winter migration and only a limited movement between areas in northern Scotland and northern Ireland (Clark & Sellers 1997). The present findings reveal a significant and previously unknown long-distance winter migration of at least some of these birds to the Lancashire and Cumbrian coasts.

Despite the fact that the northwest-coast wintering population and the South Pennines breeding population appeared to be largely discrete, there was a degree of cross-dispersal between the two groups. Small numbers of South Pennines birds were resighted in the winter on the northwest coast. Three birds ringed on the northwest coast were subsequently resighted wintering on the east coast with one bird moving from west to east in the same winter. This intermixing was not limited to winter migration, as South Pennines-ringed individuals were confirmed to be breeding in western Scotland and Wales, with the Scottish bird (being originally ringed in July, long before winter migration movements commence) almost certainly hatched in the

South Pennines. In the case of the South Pennines population, this cross-dispersal shows that small numbers of these birds move in the opposite direction to the normal migration routes and overwinter on the northwest coast. A South Pennines bird ringed as a nestling and resighted on the northern Welsh coast in winter suggests that at least some of these individuals are first-year birds. There they join wintering flocks of Scottish- or Welsh-bred birds and some subsequently join these flocks on the return migration back to Scottish and Welsh breeding grounds. As there have been no recoveries of Heysham-ringed birds breeding in the South Pennines, the reasons behind the movement of a small number of these birds to the east coast in the winter is not yet clear.

These findings have some important conservation implications. We have demonstrated that there is a degree of cross-dispersal between these populations which, although it appears to be on a small scale, could have important ramifications for some small breeding populations, such as those in Wales. As Twites are declining in the South Pennines, there are likely to be fewer individuals available to recruit to already critically small and fragmented colonies elsewhere. Notwithstanding this small element of cross-dispersal, each population is probably best considered discrete for the purposes of conservation. Appropriate conservation measures must address the factors affecting populations in the South Pennines, which may be entirely different from those facing birds breeding in the west coast islands of Scotland. Furthermore, each of these populations predominantly utilises different wintering grounds on either side of the British coast. These areas of saltmarsh represent a declining and increasingly fragmented habitat (Atkinson 1998), of immense nature conservation value in their own right. Formal measures which seek to protect any specific breeding population of Twite must also identify and take action on the appropriate wintering grounds.

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