

Numbers and distribution of wintering divers, grebes and seaducks in the Moray Firth, Scotland, 1998/99–2003/04

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Abstract

Numbers of divers, grebes and seaducks were counted in the Moray Firth during six consecutive winters between 1998/99 and 2003/04, and compared with earlier surveys. Common Scoter *Melanitta nigra*, Long-tailed Duck *Clangula hyemalis* and Eider *Somateria mollissima* were the most abundant species, accounting for over 70% of all birds counted. When maximum winter numbers during the study period were compared with published data for earlier years, declines in numbers were apparent for Goosander *Mergus merganser*, Long-tailed Duck and Eider since the early 1980s, and for Red-breasted Merganser *M. serrator* since the late 1980s. Counts of Goldeneye *Bucephala clangula* have increased since the early 1980s and those of Scaup, Common Scoter and Velvet Scoter *M. fusca* since the late 1980s. There were considerable changes in the distribution of several species within the Moray Firth, probably in response to changes in the food supply attributed to improvements to sewage and distillery discharges and to associated declines in fish and Blue Mussel *Mytilus edulis* populations. The Moray Firth supports internationally important numbers of two species (Great Northern Diver *Gavia immer* and Slavonian Grebe *Podiceps auritus*) and is nationally important for 10 other diver, grebe and seaduck species. The area supports the largest numbers of wintering Long-tailed Duck and the second largest numbers of Great Northern Diver, Red-throated Diver *G. stellata*, Slavonian Grebe, Common Scoter, Velvet Scoter and Goldeneye in Britain.

Key words: survey, seabirds, Scoter, Long-tailed Duck, Eider, Goosander, Red-breasted Merganser, Red-throated Diver, Scaup, Goldeneye.

The Moray Firth, in northern Scotland, is recognised as an important site for wintering divers, grebes and seaducks (Prater 1981). Comprehensive surveys of their numbers and distribution started during winter 1977/78 in response to threats of oil pollution and industrial developments (Mudge & Allen 1980). Surveys were carried out in most winters until 1994/95 (Barrett & Barrett 1985a,b; Campbell *et al.* 1986; Aspinall & Dennis 1988; Evans 1998). However, after 14 consecutive winter surveys, no counts were made in 1995/96 and 1996/97. Surveys resumed in winter 1998/99 and have continued to date.

This paper presents the results of the winter surveys in the Moray Firth between 1998/99 and 2003/04 and makes

comparisons with the previous surveys. The abundance and distribution of divers, grebes and seaducks is discussed and the international and national importance of the area is reassessed.

Study Area and Methods

The study area comprised the estuaries (firths) and coastal waters between Helmsdale (58°07'N, 3°38'W) in the north and Spey Bay in the east (57°40'N, 3°50'W) (Fig. 1). The study area was divided into 11 sections: Helmsdale–Strathsteven), Outer Dornoch Firth, Inner Dornoch Firth, East Ross coast, Cromarty Firth, Beaully/Inverness Firths, Riff Bank, Nairn/Culbin Bars, Burghead Bay, Burghead/Lossiemouth, Spey Bay.

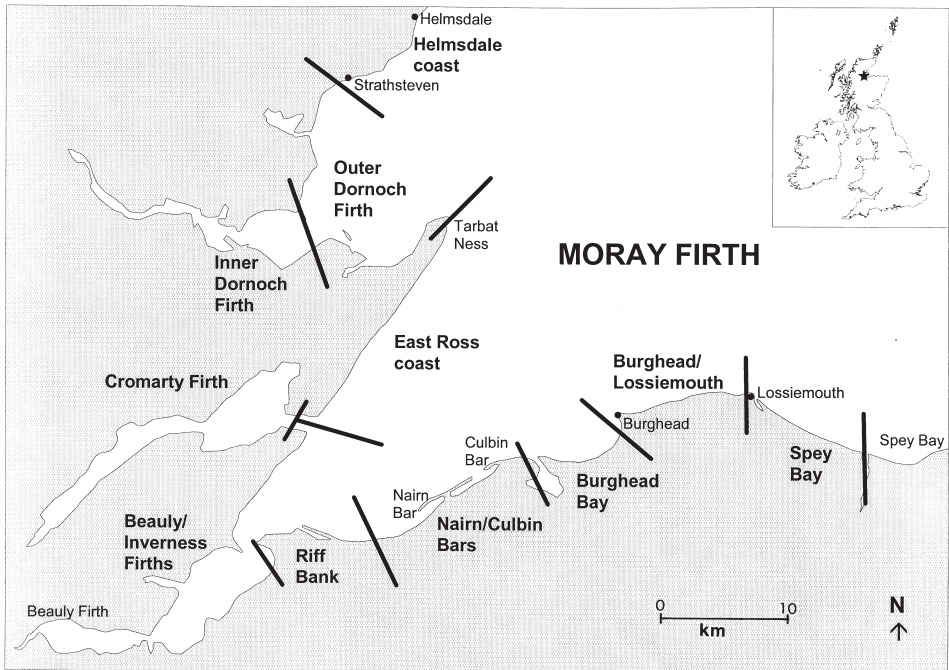


Figure 1. The study area in the Moray Firth. Divisions between the areas are marked with thick lines.

Burghead/Lossiemouth and Spey Bay. In the text, Sutherland refers to the Helmsdale coast, the Outer Dornoch Firth and the Inner Dornoch Firth; East Ross refers to East Ross coast and the Cromarty Firth; Morayshire refers to all sections between Nairn/Culbin Bars and Spey Bay. In Fig. 3 some sections were combined to show the distribution patterns in the Moray Firth as a whole. The same divisions were used while establishing the international and national importance of the sites for the birds.

The surveys were made once a month in November, December and January between winters 1998/99 and 2003/04. Birds were counted from 112 standard count points that were established in winter 1977/78 (Evans 1998). The number of points varied between the sections. Each section was counted within a day and, wherever possible, adjacent sections were counted on the same or consecutive days. Some of the species monitored occurred well offshore and were difficult to count. Efforts were therefore made to count them when the sea was calm and visibility good. Each month, counts were generally made in the northern sections first and the eastern sections last. These counts were not part of the national Wetland Bird Survey Programme (WeBs) conducted in the Moray Firth in winter.

To establish the national and international importance of the area for a particular species, the highest count for each winter in the most recent six winters (1998/99–2003/04) was averaged and compared with the national and international criteria. A site was considered to be of international importance for a particular species if it regularly supported at least 1% of the

total population of that species (Wetlands International 2002). Similarly, a site was considered to be of national importance if it regularly supported at least 1% of the British population (Kershaw & Cranswick 2003).

Results

Numbers

Divers (loons)

Three species of divers were recorded: Red-throated Diver *Gavia stellata*, Great Northern Diver *G. immer* and Black-throated Diver *G. arctica*. Red-throated Diver was the most abundant, with the average winter numbers varying between 57 (in 1999/2000) and 147 (in 1998/99) (Table 1).

Counts peaked in November for all species, except in 1998/99 and 1999/2000 when highest numbers were recorded in December (Fig. 2). In November, the maximum counts were: 185 for Red-throated Diver, 113 for Great Northern Diver and 43 for Black-throated Diver (Fig. 2).

All species showed a similar distribution, with the Outer Dornoch Firth being the most important section (Fig. 3). The composite area comprising Nairn/Culbin Bars and Burghead Bay, and the Beauly/Inverness Firths and Riff Bank also held large numbers of Red-throated Diver.

Grebes

Four species of grebes were recorded: Slavonian Grebe *Podiceps auritus*, Little Grebe

Table 1. Average numbers (November–January) of divers, grebes and ducks in the Moray Firth between the winters of 1998/99 and 2003/04.

	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04
Red-throated Diver	147	57	88	123	78	88
Black-throated Diver	3	10	10	20	8	7
Great Northern Diver	11	8	20	46	41	41
Slavonian Grebe	51	15	19	55	42	54
Scaup	242	306	348	451	728	453
Eider	1,326	674	994	1,076	606	1,335
Long-tailed Duck	1,761	1,040	2,270	2,467	2,684	3,806
Common Scoter	3,066	2,014	2,571	2,775	5,577	3,678
Velvet Scoter	604	220	581	824	1,181	1,242
Goldeneye	607	651	728	991	663	531
Red-breasted Merganser	392	235	210	274	196	220
Goosander	52	2	2	15	1	3

Tachybaptus ruficollis, Great Crested Grebe *P. cristatus* and Red-necked Grebe *P. grisegena*. Slavonian Grebe was the commonest species, with average winter numbers varying between 15 (in 1999/2000) and 55 (in 2001/02) (Table 1). Numbers peaked in November in all years, except in 2003/04 when the highest number was in December (Fig. 2). The maximum count was of 98 Slavonian Grebe on the Helmsdale coast in November 1998. Numbers varied greatly between sites and years, with most birds seen in the Dornoch Firth, the Cromarty Firth, and the composite area comprising Nairn/Culbin Bars and Burghead Bay (Fig. 3).

The average winter numbers of Little Grebe varied between one (in 1999/2000) and 12 (in 2001/02) with a peak of 18 in December 2001/02. Little Grebes were commonest in the Beaully/Inverness Firths.

Seaducks

Of 10 species of seaducks identified during the survey, Common Scoter, Long-tailed Duck *Clangula hyemalis* and Eider *Somateria mollissima* were the most common species, accounting for over 70% of all the ducks recorded. The average winter number of Common Scoter varied between 2,014 (in 1999/2000) and 5,577 (in 2002/03) with a peak of 8,333 in January 2003 (Table 1, Fig. 2). The numbers in the first two winters might have been slightly higher because over 500 unidentified scoters were recorded in 1998/99 and almost 200 in the following winter.

The average winter numbers of Long-tailed Duck varied between 1,040 (in 1999/2000) and 3,806 (in 2003/04), with a peak of 5,456 in January 2004. Eider counts varied between 606 (in 2002/03) and

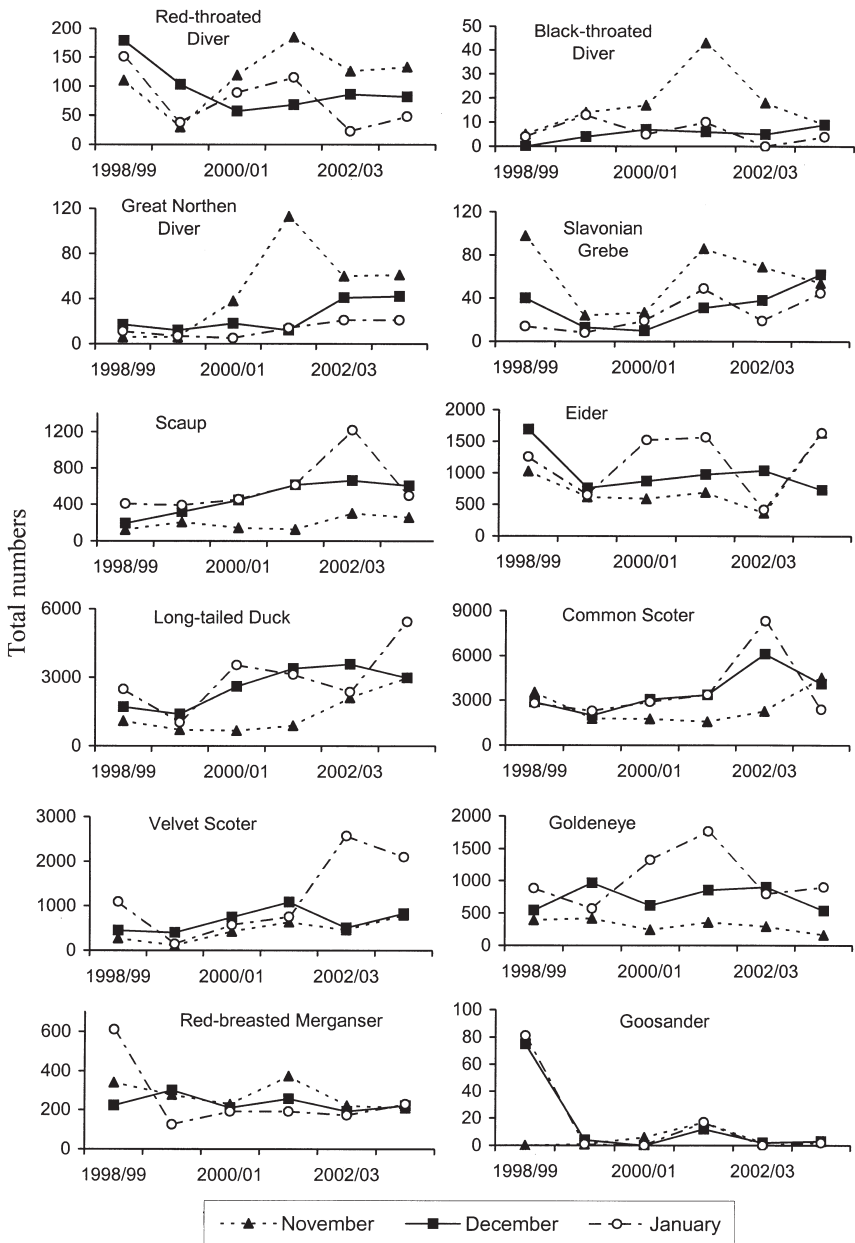


Figure 2. Numbers of grebes, divers and seaducks in the Moray Firth in November, December and January between winters 1998/99 and 2003/04.

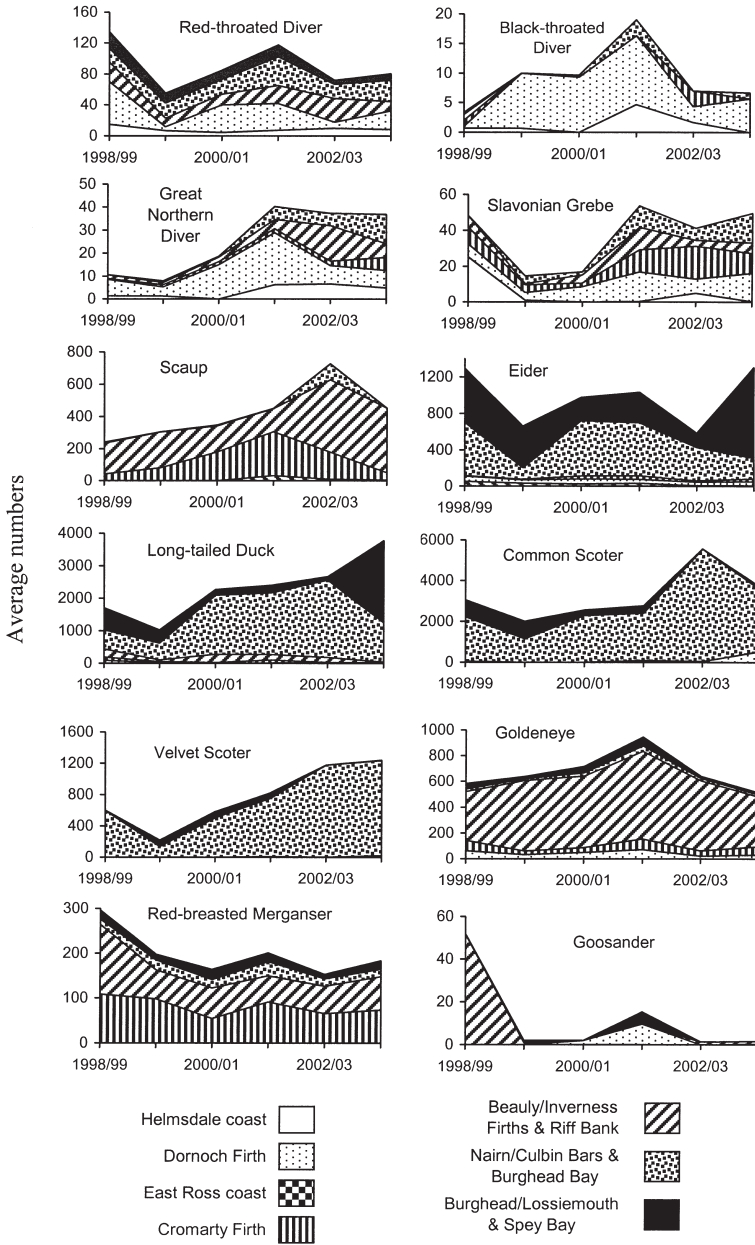


Figure 3. Average winter numbers of grebes, divers and seaducks in the Moray Firth between winters 1998/99 and 2003/04. Some sections are combined – see Fig. 1.

1,335 (in 2003/04), with a peak of 1,640 in November 2003 and January 2004 (Table 1, Fig. 2).

Generally, numbers were low in November for the majority of species and increased in December and January (Fig. 2). There were, however, a few exceptions as Red-breasted Merganser *Mergus serrator* and Goosander *M. merganser* did not show a clear seasonal pattern and neither did Velvet Scoter *Melanitta fusca* in the first four years of the study period.

The distribution pattern varied amongst the species, some of which varied annually (Fig. 3). Goldeneye *Bucephala clangula* favoured the Beauly/Inverness Firths and Riff Bank, whereas Scaup and Red-breasted Merganser reached highest numbers in the Beauly/Inverness Firths and Riff Bank and the Cromarty Firth. Long-tailed Duck, Common Scoter, Velvet Scoter and Eider favoured Nairn/Culbin Bars and Burghead Bay. However, while numbers of Velvet Scoter continue to increase at Nairn/Culbin Bars and Burghead Bay, numbers of Eider continue to decrease.

International and national importance

Great Northern Diver and Slavonian Grebe were the only species whose average maximum numbers in the Moray Firth exceeded 1% of the international total during the six winters (1989/99–2003/04) (Table 2).

The Moray Firth also supported nationally important numbers of an additional eight species: Red-throated Diver, Scaup, Eider, Long-tailed Duck Common

Scoter, Velvet Scoter, Goldeneye and Red-breasted Merganser (Table 2).

When individual sites were considered, nationally important numbers of Scaup, Long-tailed Duck, Goldeneye and Red-breasted Merganser occurred in the Beauly/Inverness Firths (including Riff Bank). Nairn/Culbin Bars/Burghead Bay and Burghead/Lossiemouth/Spey Bay supported nationally important numbers of Long-tailed Duck, Common Scoter and Velvet Scoter. The Dornoch Firth was nationally important for Red-throated Diver and the Cromarty Firth for Scaup and Red-breasted Merganser.

Comparisons with previous surveys

Almost all species showed considerable changes in numbers and distribution in the last six years of the study in comparison with earlier periods (Table 3, Figs. 4–10). For Red-throated Diver, the average maximum winter numbers in the Moray Firth dropped from 459 to 141 between 1990/91–1994/95 and 1998/99–2003/04 (there were no comparable data available for the earlier periods) (Table 3). In the 1980s, Red-throated Diver favoured the Outer Dornoch Firth, Nairn/Culbin Bars, Burghead Bay and Spey Bay (Barrett & Barrett 1985b; Evans 1998). In the early 1990s, Spey Bay became the most important section, along with the Beauly/Inverness Firths (Table 3). However, since then, declines have occurred in all sections, with numbers in Burghead Bay, Beauly/Inverness Firths and Spey Bay dropping by 74%, 90% and 91%, respectively.

Goosander, Eider and Long-tailed Duck have declined in numbers since the early

	Red-throated Diver	Great Northern Diver	Slavonian Grebe	Scaup	Eider	Long-tailed Duck	Common Scoter	Velvet Scoter	Golden-eye	Red-breasted Merganser
International threshold	1,000	50	35	3,100	15,600	20,000	16,000	10,000	4,000	1,700
National threshold	49*	30*	7*	76	730	160	500	30	249	98
Dornoch Firth	50	22	22	0	46	34	226	12	18	25
Cromarty Firth	3	1	15	210	19	68	0	0	89	114
Beuly/Inverness Firths and Riff Bank	28	9	11	412	38	205	3	0	878	143
Naim/Culbin Bars and Burghhead Bay	40	8	12	54	715	2,200	3,623	1,284	37	2
Burghhead/Lossiemouth and Spey Bay	23	5	3	0	611	1,176	649	69	49	29
Whole Moray Firth	141	<u>50</u>	<u>61</u>	616	1,370	3,306	4,188	1,333	1,123	328

Table 2. Average maximum numbers of divers, grebes and ducks in the Moray Firth between the winters of 1998/99 and 2003/04, and the 1% thresholds for sites to qualify as internationally or nationally important for these species. Counts that exceed the threshold value for international importance are shown in bold and underlined, whereas those that exceed the threshold value for national importance only are shown in bold. Only those species and sites that qualify as internationally or nationally important are listed. * – 50 is normally used as the minimum threshold.

	Outer Dornoch Firth	Cromarty Firth	Beauly/ Inverness Firth	Nairn/ Culbin Bars	Burghead Bay	Spey Bay	The whole Moray Firth
Red-throated Diver							
1990/91–1994/95	80	12	154	68	74	225	459
1998/99–2003/04	50	3	15	29	19	20	141
Black-throated Diver							
1990/91–1994/95	17	1	5	1	14	3	31
1998/99–2003/04	11	0	1	1	1	0	18
Great Northern Diver							
1990/91–1994/95	11	1	1	1	10	6	25
1998/99–2003/04	22	1	3	5	3	3	50
Slavonian Grebe							
1990/91–1994/95	28	18	13	2	16	1	54
1998/99–2003/04	22	15	11	4	9	2	61

Table 3. Mean maximum numbers of divers and grebes in the main sections of the Moray Firth for the periods 1990/91–1994/95 (Evans 1998) and 1998/99–2003/04 (this study). There are no data for the earlier periods.

1980s (Figs. 4–6). Between 1980/81 and 1988/89, Goosander numbers peaked at more than 1,200 each winter in the Beauly Firth (Evans 1998). In the early 1990s, their numbers were much lower, peaking at between 200 and 600. In the last six years, numbers dropped even further and, apart from 1998/99, never exceeded 20 (Figs. 2 & 4).

Eider has declined by 53% since the early 1980s (Fig. 5). The Sutherland coast was the main site where the average maximum numbers ranged between 1,300 and 2,400 in the 1980s and 1990s. The numbers there then dropped from 1,336 to 73 between 1990/91–1994/95 and 1998/99–2003/04. At the same time, numbers increased on the Morayshire coast, but not sufficiently to

offset the decline on the Sutherland coast. As a result, in the whole of the Moray Firth Eider declined by a further 43% between 1990/91–1994/95 and 1998/99–2003/04 (Fig. 5).

Long-tailed Duck has declined by 76% since the early 1980s (Fig. 6). All sections of the Moray Firth were affected, but the decline at Nairn/Culbin Bars and Burghead Bay was the most pronounced, with numbers dropping from 9,000 in the early 1980s to around 5,000 in the 1990s, and to just over 2,000 in the most recent six winters of the study. The increase in the average winter number in the whole Moray Firth within the last five years (from 1,040 in 1999/2000 to 3,806 in 2003/04; Table 1) was not sufficient to offset the decrease from 8,744 in the early

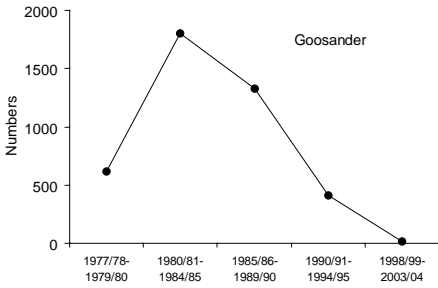


Figure 4. Average maximum numbers of Goosander in the Beaully Firth between winters 1977/78 and 2003/04. Data for the years 1977/78 to 1994/95 inclusive were taken from Evans (1998).

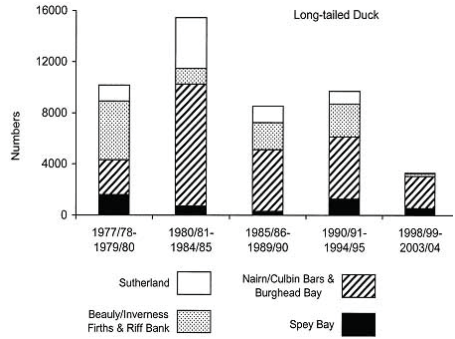


Figure 6. Average maximum numbers of Long-tailed Duck in different sections across the Moray Firth between winters 1977/78 and 2003/04. Data for the years between 1977/78 and 1994/95 and section divisions were taken from Evans (1998). Sutherland refers to the Helmsdale coast, the Outer Dornoch Firth and the Inner Dornoch Firth.



Figure 5. Average maximum numbers of Eider in different sections of the Moray Firth between winters 1977/78 and 2003/04. Data for the years between 1977/78 and 1994/95 and section divisions were taken from Evans (1998). Sutherland refers to the Helmsdale coast, the Outer Dornoch Firth and the Inner Dornoch Firth; East Ross refers to East Ross coast and the Cromarty Firth; Morayshire refers to all the sections between Nairn/Culbin Bars and Spey Bay.

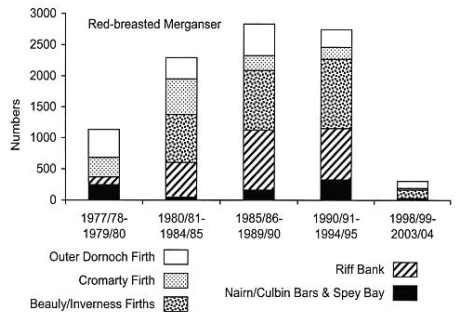


Figure 7. Average maximum numbers of Red-breasted Merganser in different sections in the Moray Firth between winters 1977/78 and 2003/04. Data for the years between 1977/78 and 1994/95 and section divisions were taken from Evans (1998).

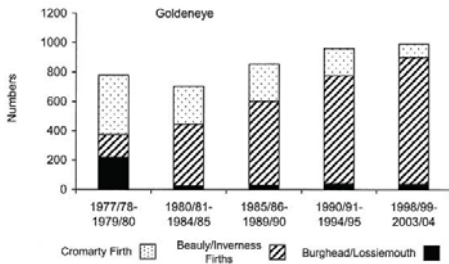


Figure 8. Average maximum numbers of Goldeneye in different sections of the Moray Firth between winters 1977/78 and 2003/04. Data between 1977/78 and 1994/95 and section divisions were taken from Evans (1998).

1990s to 3,306 in 1998/99–2003/04. During that period, numbers along the Sutherland coast and at the Beaulay/Inverness Firths and Riff Bank dropped by over 90%.

After an increase in the average maximum number between the late 1970s and the late 1980s, Red-breasted Merganser declined from 2,498 to 328 between 1985/86–1989/90 and 1998/99–2003/04 (Fig. 7). In the 1980s and early 1990s, the Beaulay/Inverness Firths and Riff Bank were the main areas for this species, with average maximum numbers exceeding 1,000 (Fig. 7). Several hundred Red-breasted Merganser were also found in the Outer Dornoch Firth and the Cromarty Firth. However, this is no longer the case because numbers decreased in all these sections between 60% and 98% between 1990/91–1994/95 and 1998/99–2003/04.

Goldeneye was the only species that has continued to increase since the late 1970s and early 1980s, accompanied by

considerable change in distribution (Fig. 8). In the Cromarty Firth and at Burghead/Lossiemouth, numbers have declined by 80% since the 1970s, but have increased in the Beaulay/Inverness Firths from 154 in the 1970s to 864 in 1998/99–2003/04.

Scaup, Common Scoter and Velvet Scoter have increased since the late 1980s (Figs. 9 & 10). Scaup numbers increased from 478 to 616 and there has been a change in distribution since the 1980s. For Scaup, the Outer Dornoch Firth used to be the most important site in the later 1970s and 1980s, with average maximum winter numbers exceeding 300 and 400, respectively. Numbers then declined and, in the last six years of the study, Scaup abandoned this section altogether (Figs. 3 & 9). At the same time, numbers in the Beaulay/Inverness Firths and the Cromarty Firth have increased.

Common Scoter and Velvet Scoter declined in numbers between the early 1980s and late 1980s; Common Scoter from 6,706 to 1,838 and Velvet Scoter from 2,835 to 562 (Fig. 10). Numbers of both species then increased between 1985/85–1989/90 and 1998/90–2003/04, but not to their former levels. There were considerable variations within individual sites. The greatest variations in numbers occurred at Spey Bay where, during the 1970s, around 6,000 Common Scoters and 5,000 Velvet Scoters were present every winter, but declined to a peak count of 18 Common Scoters and eight Velvet Scoters in 1986–87 (Mudge & Allen 1980). After an increase to 1,041 and 207 for the two species, respectively, during the early 1990s, numbers dropped again to 441 and 65 in the last six years of the study

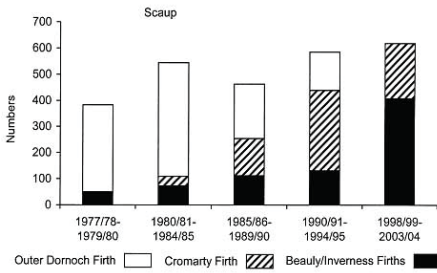


Figure 9. Average maximum numbers of Scaup in different sections in the Moray Firth between winters 1977/78 and 2003/04. Data between 1977/78 and 1994/95 and section divisions were taken from Evans (1998).

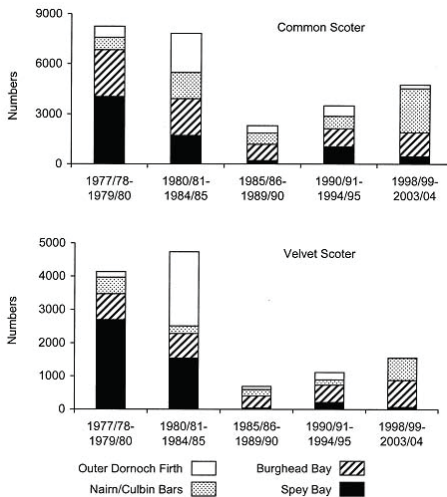


Figure 10. Average maximum numbers of Common Scoter and Velvet Scoter in different sections in the Moray Firth between winters 1977/78 and 2003/04. Data for the years between 1977/78 and 1994/95 and section divisions were taken from Evans

(Fig. 10). Similar fluctuations in numbers occurred in the Outer Dornoch Firth, with a drop from 630 to 230 and from 220 to 10 for Common Scoter and Velvet Scoter, respectively, between the early 1990s and 1998/99–2003/04. By contrast, numbers of both species increased at Nairn/Culbin Bars and Burghead Bay over the same period (Fig. 10).

Discussion

Comparison of the counts of divers, grebes and seaducks between 1998/99–2003/04 and earlier periods revealed some significant long-term changes in the number and distribution for several species. For some of the species, these changes were linked to general trends observed in the whole of Britain, whilst for others they may reflect local changes in the environment.

Some ducks benefit from food provided by man. Sewage and distillery outfalls are known to attract Goldeneye and Scaup (Campbell 1978; Salmon 1988) and alterations to discharges at outfalls have affected the numbers and distribution of both species in the Moray Firth. During the 1970s, concentrations of Goldeneye were present at sewage and distillery outfalls in the Cromarty Firth, the Inverness Firth and at Burghead/Lossiemouth (Fig. 8) (Mudge & Allen 1980). When improvements were made to the outfall discharges at Burghead Maltings in the 1980s and at the distilleries in the Cromarty Firth in the 1990s, the numbers of Goldeneye decreased in these areas and the birds shifted to the Beauly/Inverness Firths, where the main Inverness sewage

outfall operated. Scaup, on the other hand, were concentrated mainly at the Balblair and Glenmorangie distilleries in the Dornoch Firth in the 1970s (Fig. 9). In response to discharges being relocated to deeper water in the 1990s (Scottish Environment Protection Agency (SEPA), pers. comm.), Scaup numbers declined in this area and birds moved to the Beaully/Inverness Firths. However, the sewage outfall in the Beaully/Inverness Firths also underwent considerable improvement in 2000, when the amount of suspended solids was reduced and released further east in deeper water. Despite these changes, the Beaully/Inverness Firths still support 77% and 66% of Goldeneye and Scaup, respectively. Items from effluents (mainly grain) can contribute considerably to the diet of Goldeneye and Scaup, but invertebrates are also important. The increased organic content in the substrate and water column caused by the sewage discharge results in the increase in numbers of molluscs, crustaceans, annelids and nematodes (Campbell 1978; Player 1971). Campbell (1978) argued that, for Goldeneye and Scaup, items of food in the effluent are of secondary importance to sewage-enriched populations of invertebrates. Therefore, although improvements in effluent quality in recent years might have reduced a direct source of food for the seaducks, the birds might still benefit from enhanced invertebrate populations in the Beaully/Inverness Firths.

In the Moray Firth, as elsewhere, the Eider congregates where its prime food source, the Blue Mussel *Mytilus edulis*, is abundant (Player 1971; Campbell *et al.* 1986; Milne & Campbell 1993). A commercial

mussel fishery operates in the Dornoch Firth. However, it is unknown whether, through removal of food or disturbance, it has contributed to the 95% decline in Eider numbers on the Sutherland coast within the last 10 years. A review of the harvest by the Dornoch mussel fishery may help in establishing the cause of the decline in Eider here.

Both Red-breasted Merganser and Goosander are fish-eating birds and the increase in their numbers in the 1980s was associated with a fisheries ban that began in 1979 in the Moray Firth (Aspinall & Dennis 1988). However, the increase was short-lived, and the decrease in numbers of both species may be linked to declines in wintering Sprat *Sprattus sprattus* and Herring *Clupea harengus* populations that also influenced other top predators in the Moray Firth (Thompson *et al.* 1996; Tollit *et al.* 1997). In addition, there has been a widespread decline in the UK. According to the national index, in 2000/01 numbers of Red-breasted Merganser dropped to their lowest level in 11 years (Pollitt *et al.* 2003). This was reflected in counts at 14 out of the 17 most important sites in the country.

The numbers of Red-throated Diver using the Moray Firth might have been underestimated in this study because surveys in the 1980s showed that their numbers are much higher in the early winter, when many birds are on passage, with smaller numbers in mid and late winter (Barrett & Barrett 1985b). During the 1980s, numbers were estimated at over 1,500 in October, whereas later in the winter numbers dropped to between 200 and 650 (Barrett & Barrett 1985b). In this study, numbers varied

between 23 and 185 between November and January (Fig. 2). The national index for this species does not show any clear pattern in recent years (Pollitt *et al.* 2003). The increase in Great Northern Diver numbers in the Moray Firth, on the other hand, reflects the continuing increase in this species in Britain during recent years (Pollitt *et al.* 2003).

Although the study found a decline in winter numbers of Long-tailed Duck in the Moray Firth over the last 20 years, the actual decline may have been even greater because the counts in the 1980s failed to detect up to two thirds of the population (Campbell *et al.* 1986). Long-tailed Ducks occur well offshore, making it difficult to count them from the land. In the 1980s and 1990s, shifts between sections were frequent, and detection of trends within those sites was difficult (Evans 1998). The decrease within individual sections between earlier years and the last six years, however, is evident (Fig. 6).

The decline of Common Scoter and Velvet Scoter in the late 1980s is not understood, nor is the increase since the late 1980s (Fig. 10) (Evans 1998). These patterns appear to be part of wider changes because annual variations in peak numbers in the Moray Firth are similar to those at other estuaries in Scotland (Pollitt *et al.* 2003).

In the 1980s, the Moray Firth supported internationally important numbers of Common Scoter, Velvet Scoter, Long-tailed Duck, Red-breasted Merganser and Goosander (Mudge & Allen 1980). The area no longer supports such numbers of any of these species. This is due partly to changes in the criteria for assessing national and international importance.

Despite these reductions, the Moray Firth is still one of the most important sites for wintering seaducks in Britain, supporting internationally important numbers of Great Northern Diver and Slavonian Grebe and nationally important numbers of eight other species (Table 2). It continues to support the largest numbers of wintering Long-tailed Duck and the second largest numbers of Great Northern Diver, Red-throated Diver, Slavonian Grebe, Common Scoter, Velvet Scoter and Goldeneye in Britain (Williams 2000; Pollitt *et al.* 2003).

Wintering seaducks in the Moray Firth, as elsewhere, are often confined to small areas. They are even more concentrated at night roosts (Hope Jones 1979; Mudge & Allen 1980). Such concentrations are therefore vulnerable to incidents of oil pollution. The impact that even small-scale oil pollution has on ducks is high (Greenwood & Keddie 1968; Player 1971; Hope Jones 1979). In the Moray Firth, the main sources of oil pollution are shore-based installations and boats (MacLennan 1986). Although the incidence of oil pollution has decreased since the 1980s, it still remains a threat.

Other threats to seaducks in the Moray Firth include shellfish fisheries and coastal developments. Although wildfowling has never posed a major threat to seaducks in the Moray Firth, in the estuaries shooting licences are still being issued for Red-breasted Merganser and Goosander (M. Marquiss, pers. comm.) as a measure to protect stocks of Salmon *Salmo salar* smolt.

There is a need for continued monitoring of divers, grebes and seaducks in the Moray Firth. However, we lack basic knowledge of the changes in their food supplies (fish

and invertebrates). Without this information it is very difficult to interpret changes in waterbird numbers and distribution. More effort should be made to integrate bird monitoring with measurements of water quality, fish and shellfish populations.

Acknowledgements

We thank K. Chisholm, R. Evans, Dr. R.W. Summers and Dr. P.M. Thompson for their comments on an earlier draft of this manuscript. M. Hancock's assistance with computing and T. Burns's help in producing Figure 1 are gratefully appreciated. Financial support to conduct surveys was provided by the Talisman Energy (UK) Ltd.

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