Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 3

Annual surveillance of summer Shelduck populations in the Milford Haven Waterway and Daugleddau Estuary, Pembrokeshire

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Crynodeb

Mae Aberdaugleddau yn Sir Benfro yn dal niferoedd o bwysigrwydd rhanbarthol o Hwyaden yr Eithin (Tadorna tadorna) yn ystod misoedd y gaeaf. Ceir hefyd boblogaeth fechan o adar sy'n nythu ac adar heb fod yn nythu, sydd wedi bod yn destun arolygaeth flynyddol rhwng 1992 a 2019, fel rhan o raglen arolygu'r amgylchedd a gydlynir gan Grŵp Arolygu Amgylcheddol Dyfrffordd Aberdaugleddau.

Disgrifir nod ac amcanion, dulliau a chanlyniadau'r arolygon blynyddol dros gyfnod o 28 mlynedd yn y papur yma. Awgryma'r data fod maint y boblogaeth sy'n nythu wedi amrywio yn ystod y cyfnod rhwng 1992 a 2019: cofnodwyd cynnydd yn y nifer o nytheidiau rhwng 1992 a chanol neu ddiwedd y 1990au, yna gostyngiad yn y nifer cyn cynnydd eto o 2014 ymlaen. Roedd cyfartaledd maint y nytheidiau hefyd yn amrywio yn ystod y cyfnod. Gwelwyd amrywiaeth hefyd yn nifer yr Hwyaid yr Eithin nad oeddynt yn nythu, ond o ddechrau'r 2000au ymlaen, ymddengys ei fod yn tueddu i ostwng.

Nodir a thrafodir yn fyr rai o'r ffactorau allanol a lleol a allai fod wedi dylanwadu ar y tueddiadau yn y boblogaeth Hwyaid yr Eithin yn Aberdaugleddau rhwng 1992 a 2019.

Summary

The Milford Haven Waterway and Daugleddau Estuary in Pembrokeshire hold regionally important numbers of Shelducks during the winter months. There is also a small summer breeding and non-breeding population that has been the subject of annual surveillance between 1992 and 2019, as part of an environmental surveillance programme co-ordinated by the Milford Haven Waterway Environmental Surveillance Group.

The aims and objectives, methods and results of the annual surveillance carried out over a period of 28 years are described in this paper. The data suggest that between 1992 and 2019, the size of the breeding population fluctuated: an increase in the numbers of broods was recorded between 1992 and the mid-late 1990s, followed by a decline and then another increase from 2014 onwards. The mean size of broods also varied during this period. The numbers of non-breeding Shelducks recorded during the spring have also varied although from the early 2000s onwards, the overall trend appears to have been downwards.

Some of the external and local factors that may have influenced the trends in summer Shelduck populations in the Milford Haven Waterway and Daugleddau Estuary between 1992 and 2019 are identified and briefly discussed.

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 4

Introduction

The Milford Haven Waterway and Daugleddau Estuary (here-in after referred to as the estuary system) are a natural drowned valley (ria) system that stretches from the entrance to the Milford Haven Waterway at St Ann's Head to Haverfordwest on the Western Cleddau and Blackpool Mill on the Eastern Cleddau. The estuary system encompasses shallow bays such as Angle Bay, and pills and tributaries such as Sandy Haven, Cosheston Pill, Pembroke, Carew and Cresswell Rivers and The Gann Estuary. It forms part of the Pembrokeshire Marine Special Area of Conservation (SAC) and is a Site of Special Scientific Interest (SSSI), on account of a suite of intertidal and subtidal habitats and features of European and national importance.

During the autumn and winter months, the estuary system holds nationally important numbers of wetland birds, including Shelducks *Tadorna tadorna* which (until the 2000/01 winter) exceeded the threshold for national importance in their own right. Data from the Wetland Bird Survey (WeBS) counts during the 1999/2000 winter indicated that the estuary system held approximately 19% of the total Welsh population during that winter (Haycock 2000). Numbers of Shelducks over-wintering in the estuary system have, however, fallen in recent years and they no longer reach qualifying levels for national importance (Haycock 2019).

The Shelduck is one of the few species of wetland birds that regularly breed within the estuary system: the small summer breeding population was the subject of intermittent boat surveys during the 1960s and 1970s. Annual summer Shelduck surveys using a repeatable survey method were trialled in 1991 and full surveys have been carried out since 1992 (Hodges 1992-2019), as part of an annual environmental surveillance programme commissioned and co-ordinated by the Milford Haven Waterway Environmental Surveillance Group (see End Note).

The scope, aims and objectives, methods and results are described in this short paper. It concludes with a discussion of some of the factors that are likely to be influencing summer Shelduck populations in the estuary system.

Scope of the annual surveillance of summer Shelduck populations

All the major tributaries, pills and bays within the estuary system between the entrance to the Milford Haven Waterway at St Ann's Head and normal tidal limits on the Eastern and Western Cleddau (which together form the Daugleddau Estuary) that are accessible by boat were included in the annual surveillance of summer Shelduck populations (Figure 1). Also included were Westfield Pill, The Gann Estuary/Pickleridge Pools, the lower Pembroke Mill Pond and Carew Mill Pond, which were surveyed on foot (the two mill ponds were created as a result of historical impoundments on the Pembroke and Carew Rivers respectively and are considered to be part of the estuary system).

Aims, objectives and methods

The main aims and objectives of the annual surveillance of summer Shelduck populations were to:

- Locate and count pairs and territorial males without broods;
- Locate pairs or single adults with broods and ascertain the number of ducklings in each brood;
- Locate and count any non-breeding Shelducks present during the first survey in June and any recently fledged juveniles in the second survey, in July/early August.

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 5



Figure 1. Areas included in the annual surveillance of summer Shelduck populations

The opportunity has also been taken to locate and estimate the numbers of any other wetland birds present in the estuary system during the surveys, although these additional data are not the subject of this paper.

The annual surveillance of summer Shelduck populations between 1992 (the first year of full surveys) and 2019 has been carried out via a combination of boat and land-based surveys. In the early years, the Pembrokeshire Coast National Park Authority (PCNPA) made available its Water Ranger patrol boat crewed by PCNPA's Water Ranger for the surveys. Latterly, the Port of Milford Haven (which took over the Water Ranger project in 2012 following a period of joint management between the Port and PCNPA) made its Water Ranger Patrol Boat (currently an 8m Humber Ocean Pro-Rigid-Hulled Inflatable Boat) crewed by the Port of Milford Haven Water Ranger and Assistant Water Ranger available for the surveys.

The surveys were generally carried out in mid-June and mid-July although in some years, the second survey was carried out in late July/early August. The dates and timings of the surveys were dictated by the requirement for rising spring tides that enabled boat access to most of the areas within the estuary system included in the annual surveillance programme. Where boat access was not possible, surveys were carried out on foot using the standard methods that are used to conduct the winter WeBS counts. These were generally carried out on a falling tide which permits access to the foreshore and to strategic view-points. A log was kept of the surveys and all sightings of Shelducks and other wetland birds were marked onto 1:25,000 scale OS base maps (data collected for other wetland birds were subsequently passed on to the local WeBS Co-ordinator).

The following data were collected during the boat and land-based surveys:

June

- Locations of pairs or single adults with broods;
- Numbers of ducklings in each brood;
- Locations and numbers of territorial males without broods;
- Locations and numbers of non-breeding Shelducks;
- Locations and numbers of all other wetland birds present during the surveys.

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 6

July/early August

- Locations of pairs or single adults with (late) broods;
- Numbers of ducklings in each brood;
- Locations and numbers of surviving ducklings (from the first round) and recently-fledged (juvenile) Shelducks;
- Locations and numbers of all other wetland birds present.

The pairs without broods recorded during the June survey were likely to have failed or were late in their breeding attempts (in the latter case, broods would be likely to have been picked up and recorded as new broods in the second survey in July/early August). Single males occupying territories (which include foraging areas) on the foreshore in June may have had females sitting on nests away from the foreshore. Pairs without broods and single (territorial) males were therefore treated as part of the breeding population, as distinct from any non-breeding Shelducks that were present (usually in groups) in June. By the second survey in July/early August, non-breeding Shelducks, together with adults without broods had (usually) left the estuary system, and were presumed to be en route to the annual moult grounds.

During the surveys, a careful note was made of any movements of birds up or down, or between different parts of the estuary system in order to avoid double-counting. Disturbance was kept to a minimum through, for example careful and considerate boat-handling by very experienced crews with a detailed knowledge of the estuary system.

Results

Distribution of Shelducks in the estuary system

Shelducks with broods were recorded in most parts of the estuary system between 1992 and 2019. In terms of the frequency and numbers of broods seen, the most important parts of the estuary system during this period include the Western and Eastern Cleddau, the Carew and Cresswell Rivers and Pembroke River (Figure 1). Up to four broods have been recorded in each of these areas annually. In other parts of the estuary system such as Cosheston Pill and Sandy Haven, broods have only been recorded on an occasional basis.

Broods were seen fairly regularly in Angle Bay in the 1990s however, by the early 2000s, Shelducks had disappeared as a breeding species from this part of the estuary system. Broods were also seen on an almost annual basis in Westfield Pill until the year 2000, since when there have been no sightings of broods in this part of the estuary system. Shelducks (as a breeding species) also appear to be absent during the spring and summer from other parts of the estuary system such as Llangwm and Garron Pills.

Pairs without broods (which may have already failed in their attempts to breed by the time of the first survey in mid-June) and single territorial males have also been recorded in most of the principal tributary rivers and pills during the same period.

In addition to the breeding population, non-breeding Shelducks were recorded in the estuary system during the first survey in late June. The majority of these birds were seen in areas such as the Western Cleddau, Eastern Cleddau, Carew and Cresswell Rivers and Pembroke River. Small flocks have also been observed in other parts of the estuary system such as Millin and Sprinkle Pills (which are tributaries of the Western Cleddau), Cosheston Pill and Angle Bay, although on a more irregular basis.

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 7

Breeding population size

Figure 2 shows the total number of broods seen during the surveys between 1992 and 2019.

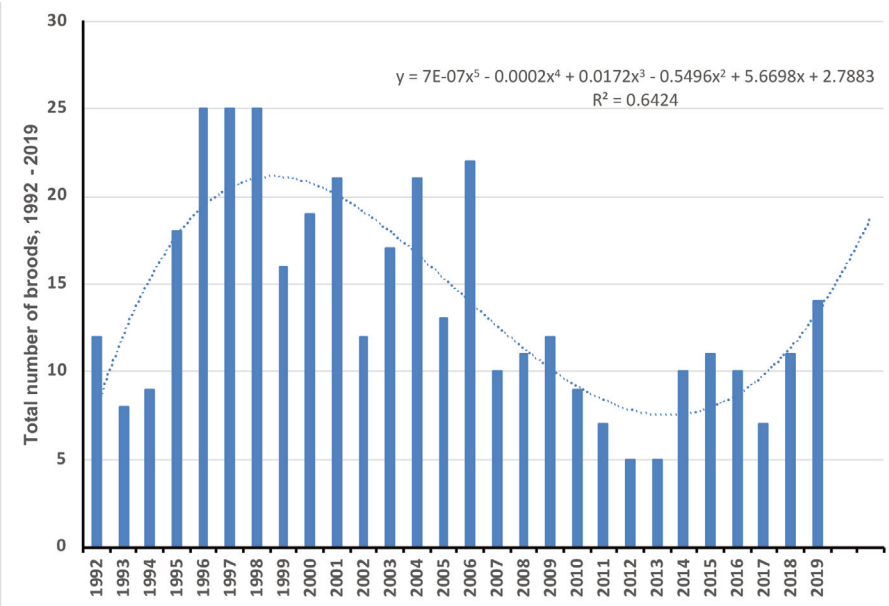


Figure 2. Total number of broods recorded 1992-2019

The trend line in Figure 2 (R^2 value = 0.64) suggests that the total number of broods recorded each year from the commencement of the annual surveillance project in 1992 to the mid-late 1990s increased from 12 to a peak of 25. After 1998, the numbers of broods gradually declined and reached the lowest numbers recorded to date in 2012 and 2013 (five broods in both years). The springs and summers of both these years were particularly cold and wet. Figure 2 also suggests that the numbers of broods are currently on an upward trend: a total of 14 broods were recorded in 2019 which was the best year (in terms of the numbers of broods seen in the estuary system) since 2006.

Brood sizes

Figure 3 (below) shows the average brood sizes recorded in the estuary system between 1992 and 2019.

The mean brood size has varied between years, ranging from 3.2 ducklings per pair (recorded in 2012) to 8.9 ducklings per pair in 2017. Figure 3 suggests that mean brood sizes tended to be higher in the early 1990s, although from the mid-1990s to *c*.2010, there was a steady decline in the mean size of broods followed by an increase in brood sizes, peaking in 2017 (R^2 = 0.52).

The numbers of ducklings in each brood recorded during the surveillance period ranged from 1 to as many as 20. Large broods of ducklings were more common in the 1990s than in recent years, with broods of 10 or more quite regularly recorded on e.g. the Western Cleddau, Eastern Cleddau, Cresswell, Carew and Pembroke Rivers. Shelducks lay on average 8-9 eggs (Cramp et al 1977); broods of 10 or more ducklings (in which all ducklings were of a similar size/age) may indicate "dump-nesting" whereby two or more females lay their eggs in the same nest, leaving the owner of that

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 8

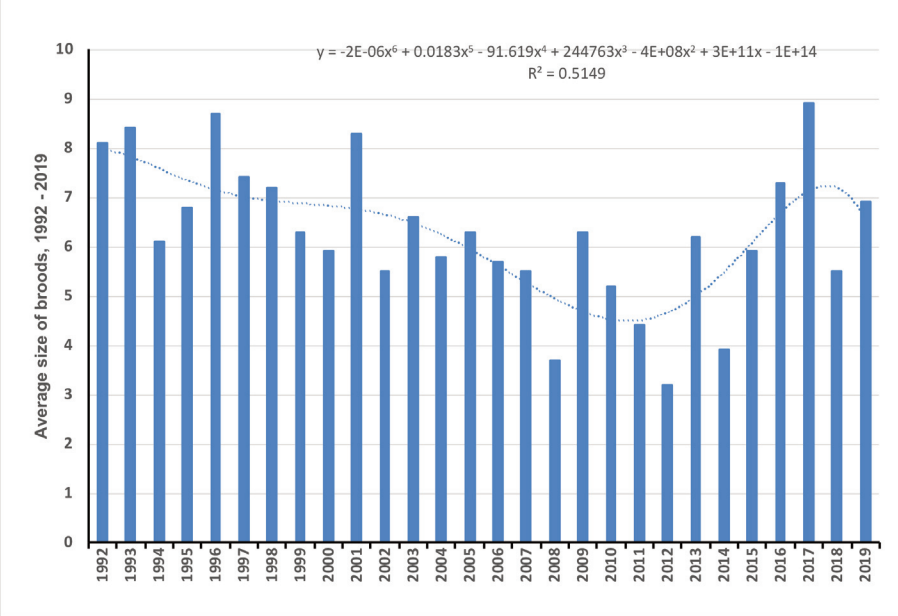


Figure 3. Mean size of broods recorded 1992-2019

nest to incubate all the eggs. Such behaviour may suggest competition for good nest sites, the level of which may vary between years depending on the numbers of pairs attempting to breed.

Broods comprising only one or two ducklings suggest either nest failure or that ducklings failed to make it to the water for example, as a result of predation. In some instances, it is also likely that small brood sizes were the result of ducklings being lost after reaching the water but before the surveys were carried out, again possibly due to predation.

The combined numbers of well-grown ducklings and recently fledged juveniles seen in the second surveys (the survivors of broods seen during the first surveys in June) varied between years, from just seven in 2002 and 2012 to 103 in 1997 (from 25 broods). Higher numbers of well-grown ducklings and juveniles from broods seen during June surveys were recorded during the 1990s than in the 2000s and 2010s.

Non-breeding population

The numbers of non-breeders recorded in June between 1992 and 2019 are shown in Figure 4.

Small flocks of non-breeding Shelducks have been recorded in several parts of the estuary system in June each year. These flocks are likely to have been predominantly birds that had spent the preceding winter in the estuary system, although they may also have included birds that may use the estuary as a stopping-off point during movements between wintering grounds elsewhere and their annual moult grounds.

The data shown in Figure 4 suggest that between 1992 and 2019, the numbers of non-breeders recorded during the surveys in June have varied considerably between years. The highest number of non-breeders recorded in the June surveys was 183 in 1998 which coincidentally followed the

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 9

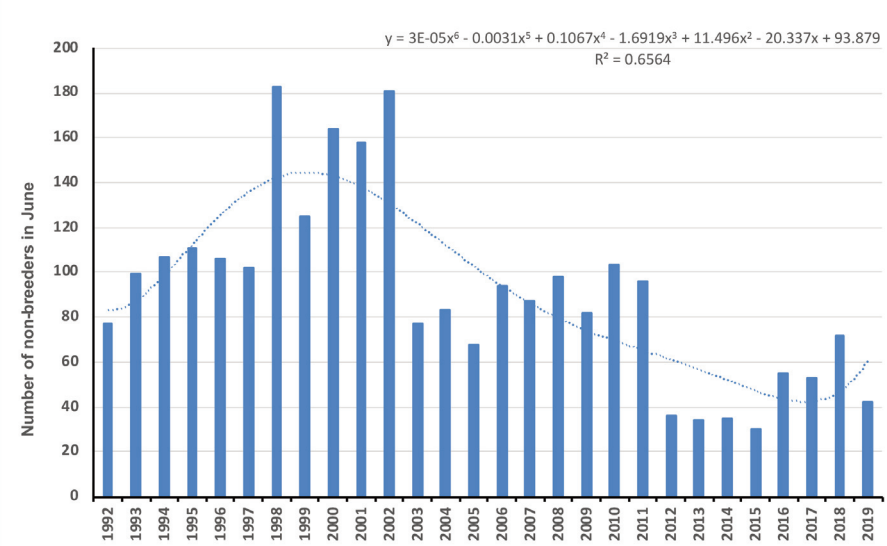


Figure 4. Numbers of non-breeders in June 1992-2019

second highest peak winter count recorded between the 1991/92 and 2018/19 winters. The lowest number of non-breeders seen during the June surveys was 30 in 2015. Although the numbers of non-breeders present in the estuary system in spring have fluctuated over the years, the overall trend appears to have been downwards since *c*.2001 (R^2 = 0.65).

Discussion

There are many external and local (site-based) factors acting alone or in combination that may have influenced the numbers of Shelducks that attempted to breed, the success (or failure) of breeding attempts and the number and size of broods that are subsequently seen on the water during the period covered by the annual surveillance. These include:

The number of Shelducks that winter in the estuary system. In the Milford Haven Waterway and Daugleddau Estuary, winter maxima tend to occur in January and February. In the 1980s, average peak counts exceeded 1,000 birds (it reached over 2000 birds in the 1987/88 winter). During the 1990s, winter maxima dropped to less than 700 birds. The decline in the wintering population in the estuary system continued through the 2000s (by which-time, the number of over-wintering Shelducks in the estuary system had fallen below the qualifying level for national importance for this species) and has been below 500 since the 2013/14 winter. The numbers of Shelducks recorded during the 2015/16 winter peaked at 264, the lowest winter peak count in the estuary system since 1992 (A. Haycock pers. comm. 2020).

WeBS data for the UK as a whole suggest that since the 2013/14 winter, there have been signs of an up-turn in the trend in the numbers of Shelducks overwintering in the UK (Haycock 2018; Frost *et al*. 2019). This tends to suggest that the decline in the numbers of Shelducks overwintering in this estuary system have been more pronounced in the past four to five years than in the UK as a whole. The reasons for this are not clear, although external factors such as changes in annual moult grounds may have played a part. Analysis of the data obtained on summer Shelduck populations in

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 10

the estuary system carried out as part of a review of the annual surveillance programme commissioned by the MHWESG has however, shown a moderate correlation between the number of adult Shelducks recorded during the breeding season and the population trends at the Wales/UK level picked up by WeBS. This suggests that the trend may have reflected changes at a wider (i.e. regional/national) level rather than site-specific impacts (Green *et al*. in prep.).

Adverse weather conditions. Heavy rain and low temperatures could contribute to the loss of eggs and newly-hatched ducklings which are potentially vulnerable to chilling/water-logging if left unattended (e.g. as a result of disturbance at the nest). Although they are known to nest in (or even under) buildings, in trees and other structures above the ground, Shelducks usually nest on the ground e.g. in old rabbit burrows, under dense patches of scrub and even in artificial structures such as culverts and covered drains (Cramp *et al*. 1977). Nests on the ground are at risk from flooding during periods of intense rainfall. In 2012, the number of broods seen on the estuary and the average brood size were the lowest since the annual surveillance began in 1992. The spring and summer that year were particularly cold and very wet: the relentlessly bad weather may (at least in part) help to explain the very poor outcome of the breeding season.

Disturbance from water-borne activities. Recreational boating and other water-borne activities have the potential to contribute to losses of ducklings e.g. by causing the scattering of broods thereby exposing individual ducklings to a higher risk of predation. No incidents of disturbance of Shelducks as a direct result of recreational activities on the water have been observed during the surveys, and none have been reported (B. MacFarlane pers. comm.). The relative insignificance of recreational



Shelduck (Bob Garrett)

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 11

disturbance may be due (at least in part) to the designation (in the late 1970s) of the most sensitive parts of the estuary system (including all the areas that are important for Shelducks) as Dead Slow Minimum Wake areas by the Port of Milford Haven. The purpose of the designation of these areas is to help ensure navigational safety; to protect wildlife from disturbance and to avoid damage to estuary habitats (Port of Milford Haven 2020). Enforcement of the speed restrictions that apply within the designated areas has been carried out by the Water Ranger since 1992.

Predation. Predation is likely to have been the most significant factor affecting the numbers and sizes of broods seen in the estuary system. Ground predators such as Foxes *Vulpes vulpes* and Rats *Rattus norvegicus* are likely to be responsible for the predation of eggs and ducklings in the nests, and are likely to have a significant impact on the numbers of ducklings that make it from the nest to the water. The locations of nest sites are not known, although they can be some distance from the estuary. Ducklings (led by their parents) can face quite a trek from their nests to the (relative) safety of the water: some broods have to negotiate roads and other hazards in addition to avoiding predators whilst attempting to reach the water (pers. obs.; R. J. Haycock pers. comm.). By the time they reach the water, some broods may already have been depleted or perhaps lost altogether as a result of predation.

Once on the water, predation is likely to be a major factor in the survival of ducklings to fledging. Otters *Lutra lutra*, together with avian predators such as Herring Gulls *Larus argentatus* and Lesser Black-Backed Gulls *L. fuscus* are chief among the suspects. On one occasion during the 2019 surveys, two Herring Gulls were watched working as a "pair" to distract the adults whilst scattering the brood in order to make it easier to "pick off" individual ducklings. Although they failed on that occasion, gulls have been observed successfully grabbing ducklings from the surface of the water during the surveys (pers. obs.). Predation of adults is also known to occur. Foxes patrol the foreshore and there has been at least one instance of a Fox taking an adult female Shelduck witnessed during the surveys (pers. obs.).

The formation of creches (whereby broods are amalgamated and are guarded by "baby-sitters" that delay their departure for the moult grounds for this purpose) is not often observed on this estuary system: perhaps broods are too few and scattered to trigger this behaviour (which among other things, could be a defence mechanism against predators).

Extent and quality of foraging habitat. Key factors in the size and productivity of the breeding population are the extent and quality of foraging habitat, which also sustains the over-wintering population. Shelducks are at the top of their food chain and a consistently poor breeding performance could indicate a decline in in the extent and/or quality of their favoured foraging habitat and food. In north-western Europe, the diet of Shelducks is dominated by the mud snail *Peringia (Hydrobia) ulvae* which is typically sieved from or just below the surface of slightly "sloppy" mud (Cramp et al 1977; Viain et al 2011).

There have been no major losses of foraging habitat in the estuary system in recent years, although minor losses may have occurred in one or two places. There may also have been localised changes in the substrate that could affect the distribution of mud snails, however, there is no evidence to suggest that this has occurred. If there have been any changes, they are likely to have been on a small scale with no significant effects on food distribution and availability.

Other factors that could influence the quality of the foraging habitat include acute and chronic pollution derived from e.g. the accumulation of contaminants in the sediments. Pollution could potentially affect the abundance and distribution of food and also the health of bio-accumulators such as Shelducks. One of the most recent (and largest) acute pollution incidents to have affected the estuary system was the Sea Empress oil spill which occurred at the entrance to the Milford

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 12

Haven Waterway on 16th February 1996. During the spill, oil was stranded on the upper shores in the Milford Haven Waterway, in Angle Bay and in Pembroke River, both of which held wintering Shelducks at the time of the spill (Sea Empress Environmental Evaluation Committee 1998). Post-spill monitoring showed that relatively few Shelducks showed any obvious signs (e.g. oil on feathers and bare parts) that they had been affected by the oil: most simply moved away from or avoided oiled areas. The 1996 breeding season that followed was one of the three most successful between 1992 and 2019 in terms of the number of broods recorded, suggesting that the oil spill had no effect on the breeding population.

Current evidence of the environmental health of the estuary system indicates that the estuarine waters are nutrient-enriched (by dissolved organic nitrogen in particular), and the dense growths of opportunistic macro-algae e.g. *Ulva* species that are present throughout the estuary system are linked to nutrient enrichment (Natural Resources Wales 2016). This evidence also suggests that there is a high level of anoxia in surface sediments beneath the dense algal mats that blanket the intertidal mudflats where Shelducks forage for food. Monitoring carried out in 2007, 2012, 2015 and 2018 in the intertidal areas revealed that mud snails continue to be widely distributed and abundant in the estuary system (M. Camplin pers. comm. 2019). Where there were dense blankets of algae, mud snails migrated into the algal mats possibly in response to the anoxic conditions that had developed beneath the mats.

The remobilisation of estuarine sediments could result in localised changes to sediment characteristics which in turn could affect the distribution of and accessibility of food to Shelducks. It is possible (but not proven) that bioaccumulation of remobilised contaminants could also affect adult breeding performance and the survival and development of ducklings. Although a drop in the number of broods seen in the estuary system occurred within a year or so of high levels of dredging activity (Little *et al*. 2015), no causal relationship has been established.

It is not known whether factors such as changes in the nutrient status of the estuary system have had any effect on the summer Shelduck populations. Analysis of the data on the numbers of broods and ducklings recorded during the period covered by the annual surveillance showed, however, that both are strongly correlated with the total number of adults recorded. This suggests that the variation in the numbers and sizes of broods between years is linked to changes in the adult population rather than to any site-specific pressures affecting productivity (Green *et al*. in prep.).

Concluding remarks

Shelduck populations in the autumn and winter are well-documented by the WeBS however, breeding Shelducks are poorly represented in local and national monitoring schemes (such the BTO's Breeding Birds Survey) (Green *et al*. in prep.). As a consequence, the status of Shelduck as a breeding species in Wales is not well understood. The annual surveillance of summer Shelduck populations in the Milford Haven Waterway and Daugleddau Estuary between 1992 and 2019 has provided a useful insight into the dynamics of a small breeding and non-breeding population of Shelducks that may help to increase our understanding of what may be happening in the Welsh breeding population as a whole.

Shelducks are at the top of their food-chain and as such, they are potentially useful indicators of environmental change. Although data analysis has shown that the links between variations in the size of the breeding and non-breeding population and productivity are to external rather than site-specific factors, future trends may signal environmental changes within the estuary system that may warrant investigation.

Birds in Wales 17-1 text.qxp_Layout 1 27/08/2020 13:03 Page 13

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End Note

The Milford Haven Waterway Environmental Surveillance Group is a collaborative group of statutory bodies, industry and others with an interest in the environmental quality of the Milford Haven Waterway. The Group's purposes include the provision of high-quality environmental information and to contribute to the maintenance, enhancement and safeguard of the Waterway's rich and diverse marine environment (**https://www.mhwesg.org.uk**) The Group maintains an annual programme of surveillance of the marine physical and chemical environment, marine biology and ornithology in the Milford Haven Waterway and Daugleddau Estuary, from a line between St Ann's Head and Sheep Island at the entrance to the Waterway to the upper tidal limits of the Eastern and Western Cleddau Rivers.