Shorebird community variations indicative of a general perturbation in the Mont-Saint-Michel bay (France)

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Abstract

The Mont-Saint-Michel bay located on the East Atlantic Flyway is the first site in France for wintering shorebirds, with, on average, 53,000 individuals in January. Seven species represent 96% of that community: dunlin (Calidris alpina), knot (Calidris canutus), oystercatcher (Haematopus ostralegus), curlew (Numenius arquata), grey plover (Pluvialis squatarola), bar-tailed godwit (Limosa lapponica) and black-tailed godwit (Limosa limosa). The international bird census organised by Wetlands International in mid-January gave us the opportunity to study, for a 23 years period, population variations in the bay. Despite a quite good carrying capacity, we showed that the decreasing proportion of 4 species in the bay relative to the other French populations may indicate a general perturbation of the bay. We discuss the different hypotheses to explain that observation.

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Résumé

Variations des stationnements de limicoles indicatrices d’une perturbation générale en baie du Mont-Saint-Michel (France). La baie du Mont-Saint-Michel, située sur la voie de migration Est-Atlantique, est le premier site français pour l’hivernage des limicoles avec, en moyenne, 53 000 individus en janvier. Sept espèces représentent 96% du peuplement : le bécasseau variable (Calidris alpina), le bécasseau maubèche (Calidris canutus), l’huîtrier pie (Haematopus ostralegus), le courlis cendré (Numenius arquata), le pluvier argenté (Pluvialis squatarola), la barge rousse (Limosa lapponica) et la barge à queue noire (Limosa limosa). Les comptages internationaux organisés par Wetlands International à la mi-janvier nous ont permis d’étudier, sur une période de 23 ans, les variations de populations dans la baie. Malgré une bonne capacité d’accueil, nous montrons que, pour 4 espèces, les proportions dans la baie par rapport aux autres populations françaises diminuent, ce qui pourrait indiquer une perturbation générale de la baie. Nous discutons les différentes hypothèses pouvant expliquer cette observation.

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Keywords: coastal mudflats; disturbance; wetlands; wintering shorebirds; Mont-Saint-Michel bay

Mots-clés : baie du Mont-Saint-Michel ; vasières côtières ; perturbation ; zone humide ; limicoles hivernants

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1. Introduction

Coastal intertidal mudflats along the East Atlantic migration routes are known to be of great importance for migrating and wintering Palearctic shorebirds or waders (Aves: Charadrii) [1]. Their high primary productivity provides sufficient resources for primary and secondary consumers, as shorebirds that feed on benthic macro-invertebrates. In such areas, waders play a key role in food web control and consequently, play an important role in the ecosystem functioning. Resources have to be shared between different users such as fish communities but also different human activities. Along the French coast, the Mont-Saint-Michel (MSM) bay is an important migratory stopover and the first wintering area for several shorebird species. For that reason, it is of international importance according to RAMSAR criteria. In case of cold winter, the bay becomes a refuge for birds usually wintering along the North Sea, when the availability of resources decreases.

The MSM bay has been studied intensively in the recent years in order to understand its global functioning with a special focus on primary production, nutrients fluxes due to abiotic and biotic transport [2]. In that framework, a number of studies have clearly demonstrated the patrimonial and biological functions of salt marshes i.e. for fish communities [3]. Different levels of the trophic webs have been considered from the primary producers, primary consumers [4] to fish communities [5]. Abundance of wintering waders has been monitored regularly since 1977. In this paper, our aim is to study population variations of the main wintering wader species for a 23 years period. We intend to show that their relative importance compared to French wintering sites can provide an indication of a general perturbation of the bay.

2. Materials and methods

2.1. Site

Between Brittany and Cotentin, the MSM bay (48°40’N, 1°35’W) is located in the south of the Normano-breton gulf (Fig. 1). With 500 km², it includes an important intertidal zone (240 km²) and salt marshes (40 km²). It presents the second highest tidal range in Europe (reaching 16 m). Since the 1970’s, that bay sustains an increasing high shell-culture production concentrated in the west: 5000 t/year of oysters on 12.2 km² and 10 000 t/year of mussels on 271 km of mussel-beds [6]. Moreover, salt marshes favour an important sheep production.

2.2. Bird counts

Winter counts were performed each year in mid-January when the number of shorebirds is at its maximum. These counts became regular in the MSM bay since 1977, which corresponds to the beginning of the synchronised counts on the French coast organised by Wetlands International (formerly B.I.R.O.E.) [7]. In the period 1981–1993, an average of 53 000 shorebirds wintered there [8]. Seven species represented more than 90% of the community: dunlin (Calidris alpina), knot (Calidris canutus), oystercatcher (Haematopus ostralegus), curlew (Numenius arquata), grey plover (Pluvialis squatarola), bar-tailed godwit (Limosa lapponica) and black-tailed godwit (Limosa limosa). In that study, we focused on those seven species, whose wintering population sizes were compared to those in all available sites along the Northern and Atlantic French coasts during 23 years (1977, 1980–2001). French Mediterranean waders were not taken into account, because we only focused on the East Atlantic Migration ways. Moreover, for those seven species, the number of wintering birds is negligible in the French Mediterranean sites compared to Atlantic ones. Three species were partially monitored in some years: 1977 for dunlin, 1977, 1980 and 1992 for bar-tailed godwit, and 1977, 1980 and 1995 for black-tailed godwit. For those species, the years cited above were excluded from the analysis. Several winters were particularly hard and favoured the presence of waders wintering usually further north: 1977, 1980, 1985, 1987 and 1997. We used Spearman correlation coefficients ($R_s$) to test trends over the years.

According to the Ramsar international convention, international and national values of a wetland are given when this site receives respectively 1% of the birds from a world population or 1% of a national population. These values were compared for the seven species between two periods using international and national population-size estimates [9,10].
3. Results

On average, from 1977 to 2001, more than 53,000 wintering shorebirds occurred in mid-January in the whole MSM bay and accounted for less than 1% of the total Western Palearctic population, more than 2% of the North-western European population and more than 12% of the French coast population [11].

Seven species represented 96% of the community: 55% for dunlin, more than 18.5% for oystercatcher, 8% for knot, 5.5% for curlew, 5% for grey plover, 2% for bar-tailed godwit and 2% for black-tailed godwit. The number of five species presented no significant tendencies over the study period (in all case $P > 0.05$): between 1977 and 2001, on average 10,200 oystercatchers ($R_s = -0.117$), 2,850 curlews ($R_s = 0.36$), 930 black-tailed godwits ($R_s = -0.25$), 4,000 knots ($R_s = -0.03$) and 29,860 dunlins ($R_s = 0.14$) were recorded in mid-January. Grey plover numbers increased significantly during the 23 studied years ($R_s = 0.57$, $P < 0.01$): between 1977–1990, an average of more than 2,360 individuals was observed whereas the population size increased to 3,520 individuals between 1991–2001. Conversely, the bar-tailed godwit numbers decreased significantly ($R_s = -0.51$, $P < 0.05$): on average, 1,340 individuals wintered between 1981–1990, whereas the population size reached 660 individuals between 1991–2001.

At the beginning of the 1990s, the MSM bay had an international value for dunlin, oystercatcher, knot, grey plover and black-tailed godwit. This site also had a national value (1% of the French population) for curlew and bar-tailed godwit. The last estimates (year 2001) showed that this bay has lost its international value for oystercatcher and black-tailed godwit.
Fig. 2. Proportion on national (Northern and Atlantic French coasts) population occurring in Mont-Saint-Michel bay of seven wader species from 1977 to 2001. Tendency curves are drawn.
Fig. 2 shows the evolution of the proportion of Northern and Atlantic French waders wintering in the MSM bay. Three of the seven studied species presented stable proportions: grey plover, black-tailed godwit and curlew whereas the overall wintering French populations of the two first species are increasing ($R_s = 0.73, R_s = 0.38; P < 0.001$ respectively) or stable for curlew ($R_s = 0.32, P > 0.05$) (see also [12]). Conversely, the proportion in the MSM bay of dunlin, oystercatcher, knot and bar-tailed godwit decreased steeply whereas the wintering French populations of the three first species are increasing ($R_s = 0.87, R_s = 0.76, R_s = 0.62; P < 0.001$ respectively) or stable for bar-tailed godwit ($R_s = 0.01, P > 0.05$) (see also [12]).

4. Discussion

The MSM bay is the most important wintering site in France for shorebirds due to its position along the East Atlantic migration route and its large mudflats with important available resources. The January census in the period 1977–2001 revealed approximately stable numbers for the studied species except for bar-tailed godwit, whose number decreased significantly and grey plover with a slight increase. Such results are informative only if they are compared to the other counts available along the whole French coast at the same period, in order to separate the effects of a global natural population variation in Europe detected almost everywhere from located variations at specific sites. In that latter case, a decreasing relative number could be indicative of a perturbation whose causes have to be determined. Compared to other wintering sites along the Channel and Atlantic coast, two groups of waders were identified:

- Local trends matched national trends as in grey plover, curlew and black-tailed godwit;
- Local trends did not match national trends (national numbers increased when local ones decreased or were stable) as in dunlin, oystercatcher, knot and bar-tailed godwit. In this case, it is suggested that a perturbation of the environmental conditions occurs in the bay.

4.1. Effect of ineffective reproduction and migration

Demographic stochasticity could also impair the overall wintering population of waders in case of ineffective reproduction. However, all reproductive populations of these species seem to be stable and are not globally threatened in their breeding habitats [13]. Moreover, the breeding ranges of oystercatcher and black-tailed godwit [13] and the breeding populations of bar-tailed godwit [14] seem to slightly increase. Consequently, the observed decreasing proportions in the MSM bay are apparently not related to ineffective reproduction. Those populations do not match the general trend in France and we would rather support the hypothesis of less attractiveness of the MSM bay possibly due to (i) detrimental effects on feeding condition, (ii) human disturbance and (iii) pollution.

The hypothesis of a migration route change is unlikely considering that breeding and French wintering populations are both stable or increasing [12,13].

4.2. Effects of variations in food availability

As most estuarine salt marsh systems, the MSM bay is highly productive. The large amount of organic matter exported from salt marshes towards mudflats leads to high intertidal macrozoobenthos productivity which is almost equally distributed across the bay (on average 13.3 g/m² of ash free dry weight in May (no data available for winter) [15]. This productivity easily supports the annual food intake by waders estimated at 2.1 g/m²/year [16]. Although the macrozoobenthic community is dominated by polychaetes westerly and by Macoma baltica easterly, the total macrozoobenthic biomass does not differ significantly between western and eastern sectors [15]. Nevertheless, most waders are usually located in the western part of the MSM bay characterized by muddy sediments. The nature of the sediment which is sandy, unstable and harder at the east of the MSM [4], reduces food accessibility.

The various wader species are distributed on the flats according to the tidal elevation: grey plover and curlew forage preferentially on the upper part of the tidal flat whereas the other species are mainly located lower [17].

During the study period, two major events were described: (i) the density of prey communities (Nereis sp and Macoma baltica) decreased significantly from
1980 to 1990, at least at the west [18,19] and (ii) the production of farmed mussels and oysters increased significantly from the 1960s [20]. This increasing production is likely to have caused a modification of wild filter feeder communities due to increased competition which is enhanced by a spreading population of introduced Crepidula fornicata (a filter-feeding Gastropod) in the subtidal zone. With 160,000 t of total fresh weight, it is the most abundant macrozoobenthic species [21].

Recent data on Nereis diversicolor density (biomass data being unavailable) showed that this species is more densely distributed in the eastern part around the MSM (average of 16.3 individuals/m$^2$) compared to the western part of the bay (4.7 individuals/m$^2$) [4].

Both godwits and grey plover focus on polychaetes (Nereis diversicolor, Arenicola marina) [13,17]. Stable densities of black-tailed godwit and grey plover may be due respectively to feeding site shift or to diet change. Indeed, the black-tailed godwit moved toward the east around the MSM. In 1999, 92% of black-tailed godwits were located around the MSM rather than in the western sector [22]. On the other hand, grey plover may present a mixed diet in which crabs can participate to a large proportion [13]. Conversely, we noticed a decreasing number of bar-tailed godwit. Preferentially located in the east of the MSM bay between 1980–1994 probably because of its preference for medium sediments, this species changed several times its feeding sites [17] to be now located in the western part of the bay despite the presence of thin muddy sediments. Its floating behaviour is difficult to explain; it may be due to food depletion on the formerly preferred site but data are lacking at present to confirm that hypothesis. Another reason could be disturbance due to human activities (see below).

Oystercatcher and knot feed on Bivalves (Macoma baltica, Cerastoderma edule) buried in soft sediments [13]. Thus, the observed reduction of prey density during the study period decreases the suitability of the area for those specialised species.

Dunlin and curlew consume a wide range of prey items [13]. Dunlin forages polychaete worms, small gastropods, crustaceans and bivalves preferentially extracted from soft sediments covered by a film of water. Curlew, preferentially located in the upper tidal zone, consumes crabs, small bivalves, large polychaetes and surface-dwelling insects. According to their generalist diet, they are not likely to be influenced by the decrease of the Nereis and Macoma populations.

On the other hand, the spread of salt marshes (30–35 ha/year) [6] may result in decreasing available feeding areas as observed in Great Britain for dunlin and oystercatcher threatened by the increasing area of mudflats colonised by Spartina anglica [23].

4.3. Effects of human disturbance

Oyster and mussel cultures are restricted to the western part of the bay where waders usually concentrate. The effect of those human activities on waders is not obvious as observed in Ireland where no effect was noticed [24] but in the MSM bay, increasing aquaculture production is likely to enhance disturbance. It may influence the behaviour of foraging waders particularly sensitive to disturbance such as godwits, knot or curlew, whereas dunlin and oystercatcher are rather tolerant [8,13].

Curlew and grey plover are less sensible to this human disturbance because of their varying diet and foraging behaviour in small scattered groups up to tidal flat and in the salt marsh, conversely to waders feeding around mussel beds as dunlin, oystercatcher and knot. These species moved slightly to the east where preys are less available in hard sandy sediments. Black-tailed godwits moved eastward, around the MSM.

Among the seven studied species, Dunlin is the only one unhunted wader. In the MSM bay, shooting pressure is more important during August and September, mainly in western part of the bay, and preferentially concerns oystercatcher and black-tailed godwit (V. Schricke, pers. comm.). However, it induces disturbance of all waders in their feeding areas by: (i) displacing birds from preferred feeding and roosting habitats, (ii) causing under-exploitation of potential feeding grounds and (iii) altering their diurnal rhythms that result in an increasing escape flight distances [25]. Tourism, shell-reef extraction for agriculture, and vehicle traffic due to aquaculture are also sources of disturbance for resting waders. Despite their importance for shorebirds, resting places located up to the tidal flat essentially around the western sector are not protected. Such disturbance entails energetic costs and may have a substantial impact on the number of birds in the long term. For instance, the important frequentation of
one beach by hunters, pedestrians and horse trainers north-east of the bay induced the shifting of bar-tailed godwit from the most frequently used feeding area at the north-east of the bay to more northern sites; that seems to be one of the reason to explain its decreasing number [17]. The population size could be therefore more limited by general disturbance than available resources.

4.4. Effects of pollution

Pollution due to river inputs (3 main rivers located in the eastern part of the bay) or organic pollution due to the high density of shellfish cultures could possibly alter the trophic web’s quality and be a cause of bird community variations. We did not find any evidence for that in the bibliography: [20]. However, more studies are needed to confirm this fact. One should especially consider the increasing maize production in the continental reclaimed marsh near the bay. Large amounts of pesticides could possibly affect water quality in the future and could impair reproductive performance of waders [26].

5. Conclusion

We observed that most species that usually feed at the lowest level of the tidal flat decreased more steeply compared to other sites along the Atlantic and Channel French coasts (oystercatcher, dunlin, knot, bar-tailed godwit). Black- and bar-tailed godwit wintering populations remained stable but changed their foraging location in the bay probably indicating that some perturbations exist especially at the bottom of the tidal flat. Conversely, birds feeding higher on the mudflat, near the salt marsh, did not tend to decrease (grey plover, curlew).

Although the MSM bay remains doubtless an important area for wintering shorebirds with most of their numbers being quite stable throughout the studied period, its carrying capacity considerably decreased since the early 1970s [27]. Studying the proportion of each wader species relative to other wintering sites is, at present, more informative as regards to the ‘health’ of the bay. From that point of view, shorebird communities can be considered as good indicators of perturbation: they quickly respond to environmental variations and can consequently help in early diagnostic of these wetlands’ modifications. The present study is a kind of alarm bell to indicate a general perturbation of the MSM bay. It is true that it is still not very conspicuous but it could get worse in the future. In a conservation framework of migrating shorebirds, environmental management should think of the origin of trouble (notably disturbance). Some species are vulnerable in Europe such as black-tailed godwit, bar-tailed godwit, curlew, dunlin and knot. Considering the importance of the connectivity between all coastal intertidal mudflats, good and rational measures should be applied from now on to the MSM bay in order to reduce disturbance and possible competition. This would enable this bay to remain a long term attractive site of international importance for wintering waders populations.

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