Birds and Pacific Oysters

Figure 1:
Different types of Pacific Oyster beds (Photos: A. Schmidt).

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What will happen to birds when Pacific Oysters take over the mussel beds in the Wadden Sea?

Abstract

Since the beginning of the 21st century the introduced Pacific Oyster (*Crassostrea gigas*) has increased significantly in the Wadden Sea. One of the preferred settling structures for oyster larvae are existing mussel beds, resulting in a conversion of a large fraction of mussel beds into oyster beds. As mussel beds are one of the preferred foraging habitats for birds, this has led to the concern that birds might lose feeding opportunities in the Wadden Sea. However, the available data suggest that for birds feeding on the associated fauna (i.e. Curlews (*Numenius arquata*) feeding on shorecrabs (*Carcinus maenas*) no difference in habitat quality is to be expected. For birds feeding on mussels, the conversion of mussel beds to oyster beds is probably negative, but reactions are species specific. Herring Gulls (*Larus argentatus*) feed on shorecrabs on old mussel beds, but swallow small mussels whole on young mussel beds. However, contrary to mussels, even small oysters cannot be detached from the substrate. Oystercatchers (*Haematopus ostralegus)* can feed on oysters, as indicated by studies elsewhere in the world, but profitability of this new food source has still to be determined. At present, feeding densities on oyster beds are lower than feeding densities on mussel beds. Common Eiders (*Somateria mollissima)* are most probably not capable of feeding on oysters, so that this species might suffer most from the change in the foraging habitat.

Introduction

After introduction by oyster-farming to the Oosterschelde in 1964 and the Lister Deep area in 1986, the Pacific Oyster (*Crassostrea gigas)*, native to Japan and south-east Asia, has increased exponentially in numbers and area covered in the Wadden Sea since the beginning of the 21st century (Nehls & Büttger 2007). One of the preferred settling structures for oyster larvae are existing beds of the Blue Mussel (*Mytilus edulis)*. Nowadays, e.g. in the Wadden Sea of Lower Saxony, every intertidal mussel bed holds at least some oysters (Nehls & Büttger 2007). Coverage of mussel beds with oysters as well as the structure of the oyster beds themselves differ between the beds, ranging from widespread beds to dense reefs (Fig. 1).

Mussel beds are preferred foraging habitats for many birds in the Wadden Sea (Nehls et al. 1997; van de Kam et al. 1999). These beds are not only used by birds feeding on Blue Mussels, but many species feed on the associated fauna living on and between the mussels (van de Kam et al. 1999). Main mussel feeders are the Oystercatcher (*Haematopus ostralegus*) and the Common Eider (*Somateria mollissima).* Although Herring Gulls (*Larus argentatus)* also feed on small mussels, they can only do this on young mussel beds. On old, well-established mussel beds they take mostly shore crabs (*Carcinus maenas*). Other species visiting mussel beds regularly, like the Curlew (*Numenius arquata*), the Redshank (*Tringa totanus*), the Black-headed Gull (*Larus ridibundus*), the Dunlin (*Calidris alpina*) or the Bar-tailed Godwit (*Limosa lapponica*) do not feed on mussels but on crabs and polychaetes (van de Kam et al. 1999, Nehls et al. 1997).

In this review we want to analyze the effects of the transition of mussel beds to oyster beds on birds. As almost no data from the Wadden Sea are available, this is done by reviewing published literature from other parts of the world where the Pacific Oyster had been introduced earlier and proliferated for a longer period than in the Wadden Sea.

Oyster beds as foraging habitat

In comparison to surrounding mudflats, oyster beds are a preferred foraging habitat (Escapa et al. 2004, Wijsman et al. 2006). On sample plots, bird densities were higher on the oyster bed than on bare mudflats for most bird species foraging on oyster beds and on adjacent mudflats . This resembles the situation for mussel beds. Hence, oyster beds seem to attract foraging birds. (An alternative explanation is that both mussel beds and oyster beds preferentially occur on rich parts of the intertidal area). In the Wadden Sea densities of foraging birds on oyster beds are at present lower than on mussel beds. A comparison of bird densities on a mussel bed which turned into an oyster bed within 10 years in the Königshafen, located in the northern part of the Wadden Sea, showed a marked difference in densities in the main bird species between the two states of the bed (Fig. 2). Densities on the mussel bed were 3 – 5 times higher than on the oyster bed. However, we have to keep in mind that observations were made in different seasons and with different total numbers of birds present in the area, which might influence recorded bird densities. This applies in particular to the Curlew, which appears only in low numbers in spring in the Königshafen. Numbers in October and winter are much higher, which might explain the observed difference between the densities on mussel and oyster beds. Nevertheless, bird densities on oyster beds in the Königshafen were at a level similar to those in other parts of the world (Fig. 3). A comparable result was obtained for the Mokbaai on the island of Texel, where a mussel bed was transformed into an oyster bed. Here, on average 30 Oystercatchers fed on the mussel bed during low tide in the years 1983-2002, and this number dropped to only 4 Oystercatchers after the transformation into an oyster bed in the years 2003-2005 (Cor Smit, pers. comm.). Furthermore, studies on mussel beds in the Dutch Wadden Sea consistently show much higher feeding densities of Oystercatchers than shown for the Königshafen (Table 1). Since Oystercatcher prefer to feed on mussels of intermediate and large size, the feeding densities on mussel seed beds are generally low. When data on mussel seed beds are excluded, the discrepancy between Königshafen and Dutch mussel beds is even more extreme, suggesting that Königshafen may not be typical. Thus, feeding densities of Oystercatchers may strongly be reduced after a mussel bed is turned into an oyster bed.

On the basis of the present scant information we conclude that mature oyster beds may offer a similarly attractive foraging habitat for birds that

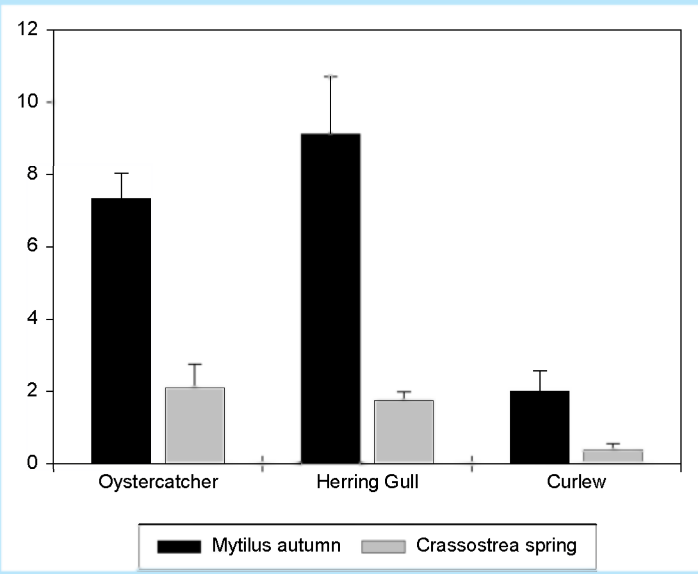
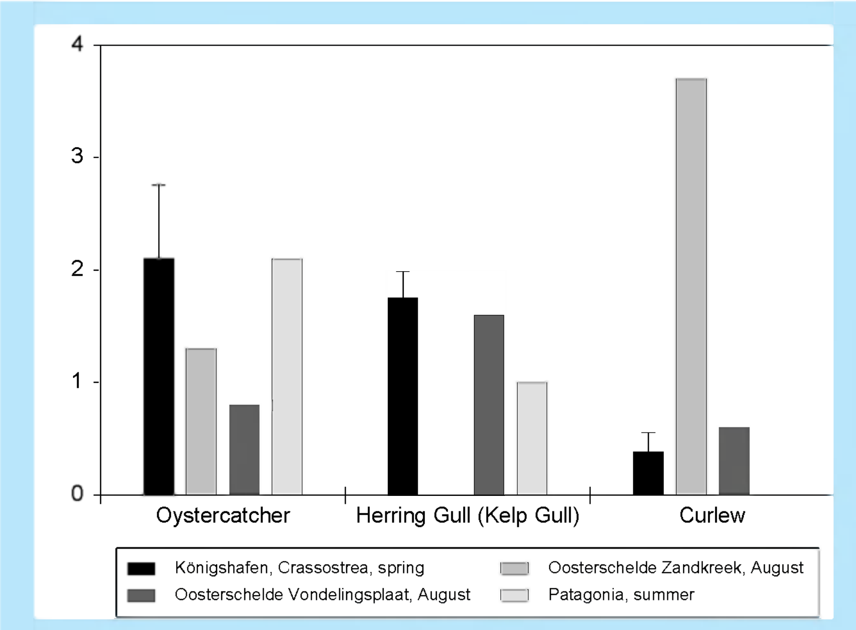


Figure 2: Mean bird densities (+ SE) per exposure period on a mussel bed in autumn 1993 (data from Nehls et al. 1997 and Hertzler 1995; 5 plots, 0.25 ha each) and from the same bed in spring 2005 when it had turned into an oyster bed (data from Wehrmann et al. 2006; 6 plots, 0.01 ha each). The bed was located in the Königshafen at the northern end of the island of Sylt. For Oystercatcher and Herring Gull on the mussel bed all data from August – October were pooled, and on the oyster bed all data from March – May were pooled. For Curlew only data from October on mussels and May on oysters are shown. For each bird species $p < 0.05$ (Kolmogorov-Smirnov two sample test).

Figure 3: Mean bird densities (+ SE for the Königshafen) per exposure period on different Pacific Oyster beds. Data from Wehrmann et al. 2006 (Königshafen), Wijsman et al. 2006 (Oosterschelde), Escapa et al. 2004 (Patagonia).



do not feed on the mussels themselves, compared to mature mussel beds. However, this is obviously not true for Oystercatchers and Herring Gulls. Further investigations concerning the use of mussel and oyster beds by birds are necessary.

Apart from the oyster being the dominant species, also the morphology of an oyster bed differs from a mussel bed. The surfaces of the shells themselves, as well as the aggregations of the bivalves have different structures (Görlitz 2005). For the associated fauna, all species present on a mussel bed were also present on an oyster bed. Only the dominance relationships between the species are different (Nehls & Büttger 2007). The different morphological structures in combination with a change in the interrelationships of epi- and endofauna might result in a change in prey availability for birds. Detailed investigations have not yet been carried out on this topic.

Oysters as food for birds

Oysters might be a replacement for mussels in mussel feeding birds. For the Oystercatcher, worldwide six studies were available which reported Oystercatchers feeding on oysters (Baptist 2005, Butler 1979, Dewar 1922, Lunais 1975, Tomkins 1947, Tuckwell & Nol 1997). Most of the recent observations come from the Americas, where the American Oystercatcher (*Haematopus palliatus)* might have *Crassostrea virginica* even as its staple food (Tuckwell & Nol 1997). American Black Oystercatchers (*Haematopus bachmani)* manage to open *Crassostrea gigas* with a shell length of up to 16 cm (Butler 1979). Recent observations of European Oystercatcher feeding on *Crassostrea gigas* exist for the Oosterschelde (Baptist 2005) and the Wadden Sea (Kees Oosterbeek, pers. comm., Wiebke Esser pers. com.). However, profitability of Pacific Oysters of different size for Eurasian Oystercatchers is yet unknown. It seems likely that the larger specimens are unavailable to the birds, as this species can grow to shell lengths up to 30 - 40 cm (Nehls & Büttger 2007), although the normal size range is 8 – 20 cm (Nehring 2006). Thus, even Oystercatchers that are very proficient at feeding on oysters may find only a small percentage of the oysters available as food on mature oyster beds, if recruitment fails for some generations. However, until now shell lengths of oysters in the Wadden Sea are well within the size range preyed upon by the American Black Oystercatcher. Clearly, further investigations are necessary to see whether

Table 1: Average densities of feeding Oystercatchers during low tide on mussel beds in the Dutch Wadden Sea.

Habitat	Period	Density (birds/ha)	Source
Old mussel bed	Winter 1970s	37.2	(Ens et al. 1993)
Old mussel bed	Late summer 1970s	32.7	(van de Kam et al. 1999)
Experimental (old) mussel bed	Summer 1996	11.9	(Ens & Alting 1996)
Mussel seed bed	Summer 1996	9.4	(Ens & Alting 1996)
Mussel seed bed without cockles	Late summer 2001	14.5	(Ens et al. 2004)
Mussel seed bed with cockles	Late summer 2001	17.5	(Ens et al. 2004)

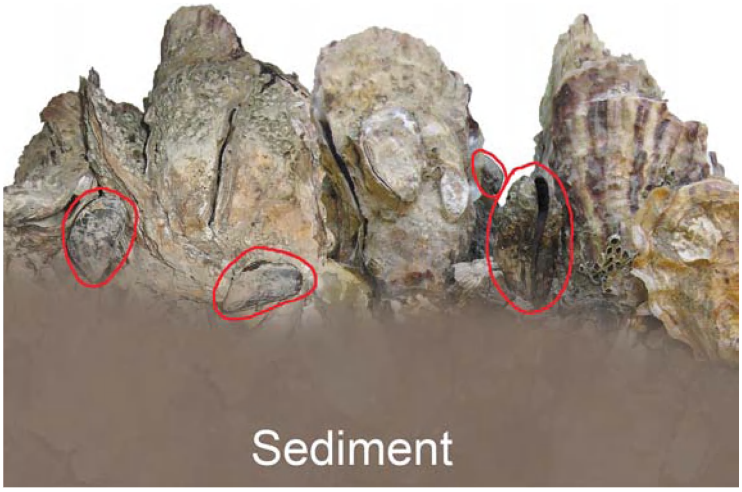


Figure 4:
Mussels (encircled) settling on Pacific Oysters in an oyster reef. Sediment surface is indicated by the shaded area (Photo: A. Schmidt).

oysters form a good replacement for mussels in this bird species. It might even be that European Oystercatchers need several generations to learn how to handle Pacific Oysters as efficiently as their American counterparts obviously do.

For Herring Gulls, only a few published observations exist showing that these birds feed on oysters. On one occasion on the island of Texel with an oyster bed close to a dike covered with concrete or asphalt, Herring Gulls were observed dropping oysters to break them open (Cadée 2001). However, they only managed to break 33.6 % of the oysters. In contrast to oysters, Herring Gulls managed to open 100 % of the dropped mussels in the same situation. Obviously, shell dropping of oysters seems to be not as efficient as of mussels, although profitabilities have not been compared yet. Furthermore, as Herring Gulls prefer to feed on small seed mussels, this food source might be lost for the gulls if the mussels settle on or between the oysters. Availability of mussels settling on oysters is yet unknown but might be lower than in a pure mussel bed. All in all, for Herring Gulls oysters appear not to be an attractive alternative food to mussels.

The Common Eider has so far only once been described as a predator on oysters, and the source is very anecdotal (NIMPIS 2002). We think it is very unlikely that Common Eiders do take oysters. It is difficult to imagine how they could succeed in tearing a Pacific Oyster loose from the substrate and subsequently swallow it. Although Common Eiders prefer subtidal mussels as a food source (Kats 2007), they also forage on intertidal mussel beds (Nehls 1995), where most of the oysters in the Wadden Sea settle at the moment. Additionally, it is unlikely that Common Eiders take mussels attached to oysters. Therefore, this species obviously loses foraging opportunities when mussel beds turn into oyster beds. Whether this has an effect on the population level of the Common Eider in the Wadden Sea remains to be investigated.

Conclusions

When a mussel bed turns into a Pacific Oyster bed, the impact on birds has to be considered at the species level. Birds foraging on the associated fauna are most probably little affected, because the associated fauna of oyster beds and mussel beds appears to be very similar. Oystercatchers might be negatively affected until they learn how to handle the new prey species. Yet, even then it appears that on oyster beds a smaller percentage of the shellfish biomass might be available than on mussel beds. Herring Gulls lose part of their former prey source and Common Eiders lose a foraging habitat completely. As shellfish feeding birds are already declining in the Wadden Sea (Scheiffarth & Frank 2005), a further threat might arise through loss of intertidal mussel beds as foraging habitat. Therefore, the impact of the increase in Pacific Oysters on population levels of mussel eating birds needs to be studied. Our hypothesis is that there is an effect on Oystercatchers, even if they learn to handle oysters efficiently, a small effect on Herring Gulls (since they eat many other prey), and a measurable effect on Common Eiders, especially if subtidal mussel beds are also overgrown by Pacific Oysters. In the Wadden Sea, the initial spreading of Pacific Oysters has occurred in the intertidal zone, but more and more observations are reported of Pacific Oysters attached to subtidal mussels (Nehls & Büttger 2007).

Further research should focus on the functional relationship between the oyster bed and shellfish eating birds. The profitability of the Pacific Oyster for birds feeding on it is unknown. Furthermore, the availability of food on an oyster bed for all bird species foraging in this habitat needs to be studied. This also includes mussels settling on oyster shells (Fig. 4).

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