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History of human settlement, cultural change and interference with the marine environment

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Abstract Humans have been present in the Wadden Sea area since the end of the last ice age, but their perception of and interference with their marine environment has changed over time. In this paper, I will give an overview on the interactions between man and nature since the 6th millennium B.C., on the opportunities for human settlement as well as on restrictions posed by the maritime environment. Only after many centuries of passive adaptation did the local farming population begin to modify their immediate surroundings. They made a living as cattle breeders, supplemented this with fishing, hunting, weaving, salt production and peat digging. Efforts to transform the agricultural landscape did not start before the 11th century A.D., when the first dikes and canals were constructed. The consequences were profound. By the end of the Middle Ages, the dikes had become totally indispensable. The land under cultivation was perceived as a sacred inner world, conflicting sharply with the marine environment outside its flood-gates. This essentially dichotomous world-view held out until the 19th and early 20th centuries. As we will see, however, the actual settlement history had been marked by various gains and losses, by successes as well as by setbacks. Not only did humans destroy valuable natural resources, but they also created alternative habitats for novel species. I conclude that the initial tendency towards increasing natural and cultural diversity has been reversed during the last few centuries. Yet, mounting conservationist concerns may cause a turning-point.

Keywords Wadden Sea · Coastal wetlands · Man-made landscape · Man and nature · History

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Introduction

In June 1610, the marshland farmer Jan Cornelis Femmes from Vrouwenparochie (near Leeuwarden, The Netherlands) established himself on Kamperzand, a desolate sandbank lying in the tidal inlet between the barrier islands of Terschelling and Ameland. The reason for this peculiar step was a bet with his colleague Thomas Thomas, to whom he had sold a parcel of ploughs and wagons for an excessive sum of money. In order to get paid, Jan was obliged to persist in the wilderness for a full year without the support of family or friends. If he failed, Thomas would get the merchandise for free. As soon as he arrived, Jan constructed a cabin on stakes, which could be moved up and down with a jackscrew, just like the roof of a haystack. Food supplies were stored on its floor. Despite his ingenuity, however, Jan had an extremely difficult time during the winter storms and spring tides. The cabin hardly survived as the jackscrew was carried away by the waves. Jan had already conceded to the idea that he would get drowned: he tied himself to the rafters so as to get a decent burial when the wreckage was washed ashore. Luckily, the cabin was spared, but its solitary inhabitant became obsessed with loneliness. For 27 days, haze and darkness blotted out the bell-towers of civilization. He later told his grandchildren that evil spirits living in the North Sea continuously haunted the place. On no account would he have repeated the experience.

Yet, after the dreadful winter days the fine season set in. Dozens of vessels with their crews, as well as seal hunters from the adjoining islands, visited the cabin. Jan was able to rescue several cows and horses that had been carried out to the sea by the tide. He caught many fish in his fish-traps, particularly plaice (*Pleuronectes platessa*), flounder (*Platichthys flesus*), dab (*Limanda limanda*) and eel (*Anguilla anguilla*). Sometimes, he could observe cod (*Gadus morhua*), smelt (*Osmerus eperlanus*) and seals (*Phoca vitulina*, maybe *Halichoerus grypus*) nearby, indicating that storms were approaching. Once he found

a deceased seal calf (*Phoca vitulina*) washed ashore. Above all, however, the white-tailed eagle (*Haliaeetus albicilla*) held sway, catching a great number of 'sea coots' (*koertvogels*¹), but Jan Cornelis bravely seized its prey and ate the birds himself (Winsemius 1620; Becker 1691-1693: vol 4; Sannes 1951).

The story of Jan Cornelis might have been quite exceptional. It was not for nothing that the provincial government of Fryslân took offence at his actions and ordered that the cabin should be removed, under the pretence that ships might be misled. Only under great public pressure (many people had taken a bet on the outcome of the venture) did the authorities give in. Obviously, Jan's efforts to defy the forces of nature met with great public interest. Yet official disapproval, as well as popular fascination, reflected a more general attitude concerning the outskirts of civilization. Living in solitude at the fringes of the North Sea was generally considered to be an unusual and disturbing experience. Most people agreed that the realm beyond the safety of the dikes was a potentially dangerous place (Schama 1991; Corbin 1994; Knottnerus 1997). Sometimes they even considered the inhabitants of the islands savage and ferocious, because the latter did not participate in the delicate socio-political arrangements of mainland society. The unembanked forelands were the places where evil spirits were expelled to and where the outcasts of society received a dishonourable burial. In summertime, hundreds of fishermen and seal, fowl and egg hunters earned their living on the extensive shallows, which were demarcated each spring in order to facilitate small-scale shipping. During the winter, however, the area was deserted, except for the occasional impudent wrecker and desperate skipper.

For sure, people have been living in the Wadden Sea area for thousands of years. However, during most of this time they were hardly able to perceive their own presence as part and parcel of wetland ecology. Particularly during the late Middle Ages (1300–1500 A.D.) and the early Modern Age (1500–1800 A.D.) nature was perceived as the counterpart of society, at most as some kind of anti-society with its own rules and properties, more often, however, as a potential enemy that had to be challenged and besieged. It was not before the Enlightenment and the Romantic movement of the early Industrial Age that people began to see nature as something by itself, to be appreciated and to be studied on its own accord (Groh and Groh 1996; Fischer 1997). Notwithstanding this fact, conventional ideas about the opposition of nature against civilization have prevailed up to the present, whether with an emphasis on catastrophes (e.g. storm surges), plagues and natural decay, or,

alternatively, as a glorification of pure nature uncorrupted by the actions of men. The latter became fashionable during the 1960s and has held sway since then.

Adaptive strategies

As far as we know, humans have always been present in the Wadden Sea area (for overviews see Abrahamse et al. 1976; Fischer 1997; Knottnerus 1994, 2001). As soon as rising sea levels reached the present coastline during the early Atlanticum (6th millennium B.C.), a string of barrier islands came into existence, separating the North Sea from the mud flats and sandbanks at its rear. The sheltered lagoons, with their diversity of fish, shellfish, fowl and wild plants, must have offered ample opportunities for Mesolithic hunters and gatherers. The archaeological evidence is scarce, however, as it has been largely destroyed by wave erosion or buried under massive layers of sediment. A rise in sea levels boosted natural developments (Behre 2003). It trimmed the barrier islands, eroded the extended moraine ridges and provided the sediments for the formation of pristine salt marshes. During periods of regression extensive mires emerged, which were subsequently flooded during periods of transgression. By the first millennium B.C. a broad belt of salt marshes bordered most of the coastal area. Its highest parts became increasingly fit for human settlement, but huge bogs isolated these marshes from their Pleistocene hinterlands. Mires and bogs also covered parts of the Wadden Sea, particularly at its outer edges, where tidal impact was less pronounced than in the central parts of the German Bight. Reports about floating peat banks and bog oaks carried away by the floods have been frequent from Roman times until the early Modern Age. The only surviving tidal raised bog (at the Jade Bay) is expected to disappear within a few decades (Behre 1991).

Some of the earliest known Neolithic communities were well adapted to living in wetland areas (Louwe Kooijmans 1993). Summer camps of the sedentary Swifterbant and Ellerbek–Ertebølle cultures have been excavated in the Zuiderzee area as well as on the banks of the Elbe River near Hamburg. Step-by-step Neolithic and Bronze Age settlers learned to use the fertile salt marshes and riverain thickets for pasturage, agriculture and fishing. Yet permanent settlement was largely restricted to higher grounds. In fact, many sites might be considered as outposts of the upland Funnel Beaker Culture and its successors. On the moraine islands of Sylt, Föhr and Amrum, as many as 77 megalithic graves and 1,000 Bronze Age barrows have been located, while the adjoining mud flats and sandbanks provided dozens of flint daggers and sickles. At the mouth of the Ems River, a megalithic chambered tomb has been discovered under several feet of clay and peat (Bierma et al. 1988; Bantelmann 2003).

¹*Koertvogels* might be explained as a hypercorrect form of *koetvogels*. The original Dutch word *coet*, Middle English *coot(e)* must have described a whole range of dark grey aquatic species, among which the guillemot (*Uria aalge*, Dutch *zeekoet*, Frisian *skût*) and the scoter or sea coot (*Melannita nigra*), which both hibernate in the Wadden Sea (Eigenhuis 2004; pers. comm.)

Wetland settlements are only known from the Western edges of the Wadden Sea area. They have been associated with the Vlaardingen Culture (3500–2700 B.C.), an amphibious counterpart of the Funnel Beaker Culture, as well as with the Single Grave Culture (2900–2300 B.C.). Both types of settlements combined agriculture with fishing and fowling. Apparently, locals had learned to build seaworthy boats at an early date. Archaeozoological research has revealed traces of cod and haddock (*Melanogrammus aeglefinus*) caught in the tidal inlets or on the open sea (Zeiler 1997; Van Heeringen and Theunissen 2001: vol 3). Wherever possible, diets were supplemented by shellfish. During the Bronze Age (2100–600 B.C.) the island of Helgoland, 100 km off the coast, developed into a centre for copper production, flint mining and amber trade (Hoops Reallexikon, S.V. Helgoland).

Modifying the landscape

Whereas Neolithic settlers merely exploited the wetlands as they found them, Bronze Age farmers began to modify their immediate surroundings (c.f. Rippon 2000). They started by cutting down thickets and woodlands in order to obtain timber, fuel and fodder. They made ditches to surround their fields and occasionally raised their farmyards in order to cope with increasing groundwater levels. About 1350 B.C., relatively large numbers of colonists settled at a former salt marsh estuary on the Noord-Holland peninsula. A 9th-century B.C. site has been excavated on the banks of the Weser River (Buurman 1996; Hoops Reallexikon, S.V. Rodenkirchen). Both areas were characterized by a freshwater environment. The river banks of the Ems were first colonized during the 7th century B.C., the Elbe River banks at the latest during the 4th century B.C. In each case, settlements were abandoned as soon as forward-pushing mires and recurrent sea-breaches submerged the area. In Roman times, the riverbanks were densely populated: by then, the original elm-ash tidal forest had been largely destroyed (Behre 1995a, 1995b).

The adjustments required for living in the unprotected salt marshes were even more profound, as people had to cope with shortages of fuel, timber, cereals and drinking water, as well as with the risk of storm surges. The first settlers may have been transhumant pastoralists who took their cattle to higher grounds during the winter season (Bierma et al. 1988). Probably the expansion of inland bogs reduced their means of subsistence and made them look for alternatives in the rapidly expanding marshes. The salt marshes were largely treeless, covered by a broad spectrum of habitats ranging from *Spartina* swards and *Aster*- and *Artemisia*-dominated salt meadows to brackish reed swamps, freshwater sedge beds and transition mires, bordered by raised bogs and alder-birch swamp woods (Behre 1985). Intensive grazing and mowing, however, created an open landscape in which black-grass communities (*Juncetum*

gerardi) and *Puccinellia* grass lawns were the dominant vegetation.

The Fryslân and Groningen coastal marshes were the first to receive permanent human settlement, which took place in the 6th and 5th centuries B.C. The other coastal districts were colonized in the first century B.C., the Schleswig–Holstein marshes somewhat later (Kossack et al. 1984: vol 1; Bierma et al. 1988; Behre 1995a, 1995b, 2001; Meier 2001; Bantelmann 2003). Additionally, the moraine plateaus and outcroppings bordering the Wadden Sea (including the future islands of Texel, Föhr and Sylt) came to harbour large populations. Several barrier islands may have been inhabited as well. Yet archaeological findings are totally absent due to coastal drift.

As a rule, the first salt marsh settlements were established on the surface just above high-tide levels, which were at least 1.25 m lower than they are today. Subsequently, the inhabitants began to raise their farmyards. Only after several generations did they start to build collective raised mounds from sods and dung on which they situated their farms and infields. Occasionally, quays measuring three to four feet in height surrounded the infields (Bazelmans et al. 1999). Step-by-step, the settlers became fully adapted to living in tidal areas, preserving winter stocks of hay, fuel and drinking water, and tilling the stiff clay soil during the brief summer season. Various tribes shared virtually the same technology. They cultivated salt-resistant summer crops, mainly field beans (*Vicia faba* var. *minor*) and hulled barley (*Hordeum vulgare* var. *tetrastichon*), supplemented by oats (*Avena sativa*), flax (*Linum sativum*), emmer wheat (*Triticum dicoccum*), gold of pleasure (*Camelina sativa*) and probably kale (*Brassica oleracea* var. *acephala*). Ditches radially descending from the village mound and running towards tidal creeks and gullies carefully drained the outfields. The farms, accompanied by helmed haystacks and artisan pit-houses, were located side by side along the slopes of the mound. Alternatively, on the banks of the Elbe River, where the tides were less pronounced, farms were situated on a row of house platforms bordering a tidal creek. The aisled longhouses had roughly the same structure as their Bronze Age predecessors. Cattle were stalled in the side-aisles behind a gutter; the living quarters were located in the adjoining hall. Wells and ponds guaranteed fresh water supplies; dried cow-dung, reed or peat served as fuel; timber, weaponry and querns had to be imported. The coastal farmers were primarily cattle breeders, exchanging their surplus products with the upland villagers or selling them to Roman traders (Kossack et al. 1984: vol 1; Bierma et al. 1988).

The early history of coastal settlement is one of successes and setbacks (Behre 2001, 2003). Sites that had been populated during times of maritime regression were later abandoned because of rising seawater levels and increased storm surge frequencies. Fresh layers of sediment covered the existing salt marshes, forcing the settlers to move towards recently deposited seashore banks

or, alternatively, to find refuge on the edges of the raised bogs. The abandoned backswamps turned into peat moors. Particularly during the Migration Period (450–600 A.D.), tribal wars and the introduction of malaria took a heavy toll. The existing population was decimated. A new generation of settlers came from the east, others subsequently moved back, colonizing the Lower Saxon and southern Jutland coasts as well as the western barrier islands. Apparently, the Lower Saxon and Jutland barrier islands had not been settled before the High Middle Ages (1050–1300 A.D.) (Abrahamse et al. 1976).

Basic technologies remained practically the same. The majority of the Early Medieval settlers were ethnic Frisians, who mastered the skills of wetland settlement far better than their Danish neighbours who stayed on higher grounds. Archaeological finds show a rich and diverse material culture, characterized by extensive maritime contacts and a considerable degree of specialization (Schmid 1991; Knol 1993; Heidinga 1997). Next to stockbreeding, sheep breeding and some arable farming, people were engaged in the production of dyed cloth, salt and hides. Trade concentrated on the exchange of foreign luxury products, which were vital for the gift economy of local warlords and their retainers. A new type of trading village came into existence, situated along tidal creeks and populated by merchants, skippers and artisans. In many cases these trading villages developed into centres of political and ecclesiastical power (Kossack et al. 1984: vol 2).

The Frisians were specialists in salt making, for which they burned silted peat as well as eelgrass (*Zostera marina*) and boiled the ashes. In order to obtain the raw material, they dug off the tidal peat banks, which were more or less systematically destroyed. For 100 kg of salt, at least 4–10 cubic metres of peat or, alternatively, 11 loads of eelgrass had to be processed. The extent of the devastated area is unknown, but it must have numbered thousands of hectares, reinforcing the natural erosion of the tidal bogs. Salt making was introduced in Roman times and became increasingly popular in the Early Middle Ages (600–1050 A.D.). By the end of the Middle Ages most tidal bogs had disappeared. The only remaining salterns closed down in the 18th century (Marschalleck 1973; Oost 1995; Van Geel and Borger 2002).

Most of the coastal villages were largely agricultural. Farm construction probably remained the same as before, but sod walls temporarily replaced the wickerwork, probably because of the depletion of willow carr. Most dwelling mounds had a freshwater pond, often connected to a natural well. The infields were located on elevated mounds, banks and holms, surrounded by ditches and hedgerows. After the harvest these served the sheep flocks as a winter refuge. The outfields were parcelled out into privately owned fields, leaving only the remote meadows and peat moors undivided. Historical evidence about fishing is scarce. The indigenous word for cormorant (*Phalacrocorax carbo*) meaning ‘beggar, glutton’ suggests that medieval Frisians still considered

these birds as serious competitors to man (Sjölin 1961). The usual fishing techniques may have involved reed fences, weirs, pikes, fish-traps and nets made of sea clubrush (*Scirpus maritimus*). Plaice, flounder and dab were consumed in considerable quantities, but finds of whiting (*Merlangius merlangus*), cod and haddock give evidence that sea fishery was known as well. Sturgeon (*Acipenser sturio*) and salmon (*Salmo salar*) catches seem to have been limited to the major river mouths (Illing 1923).

To a certain extent, the coastal society may be considered as a peculiar socio-ecological niche amidst largely unspoilt natural reserves (Knottnerus 1994). People could make use of abundant natural resources, they had ample opportunities for trade and communication and they were relatively safe from inland human predators. The risks of piracy attacks were considerable, though, but normally the coastal inhabitants were not the passive victims presented in history textbooks. In fact, they were often involved in piracy themselves. Nevertheless, contemporaries did not have any idea about nature. What they saw was a bunch of chances, risks and opportunities. The forces of nature were perceived as an extension of their own social world of friends and foes, something to keep in with or, alternatively, to fight against (Gurevich 1985; Knottnerus 1997).

Transformation

From the 9th or 10th century A.D. the great transformation of the coastal landscape set in (Schmid 1991; Behre 1995b; Meier 2001). The backswamps and peat bogs were systematically drained and reclaimed. Subsequently, the former salt marshes came to be protected by sea walls repelling the floods and retaining subsoil freshwater supplies. By the 13th century, a 1.0–2.5 m earthen wall surrounded most districts, with valve sluices for drainage purposes at the lowest points (Kühn 1992; Kramer and Rohde 1992; Van der Ven 2004). Coastal society turned inward, its population increased, reaching an unprecedented level of prosperity. Arable farming was extended, partly with the help of new peat crops such as black oats (*Avena strigosa*), rye (*Secale secale*) and buckwheat (*Polygonum fagopyrum*); the cattle herds grew in number. Shipping and sea fishing, on the other hand, became restricted to a limited number of harbour sites. As early as the 13th century, the islands of Sylt and Neuwerk served as roadsteads for the herring fisheries around Helgoland. Additionally, the novel technique of long-line fishery came to be introduced from Flanders around 1500. Probably grey whales (*Eschrichtius gibbosus*) and grey seals (*Halichoerus grypus*) were hunted too, leading eventually to their extinction (Illing 1923; Wolff 2000). Urban demands for cattle, cereals and dairy products boosted agriculture and commerce. The volume of maritime trade grew, making the recently settled barrier islands a strategic position along the major east–west corridor. Moreover,

the booming cities also provided the local population with a mental horizon, defining their political identity and religious world-view.

It is a common misconception, however, to presume that medieval dike-building and drainage measures created the present-day marshland environment. For sure, they represented a major socio-ecological innovation, accompanied by novel patterns of co-operation and organization that could only be undone at great cost. But the dikes were feeble, and major storm surges swept freely over their tops. Several districts relapsed into their original state for decades. The indigenous population continued to live on elevations, and they restricted their agricultural activities to cattle farming and growing spring wheat. In fact, the coastal economy was largely seasonal. Each spring its inhabitants consecrated their outfields with festivities and large bonfires, which also marked the beginning of the shipping and fishing season. With the arrival of the autumnal rains, which inundated most of their fields, they returned to the safety of their farmsteads, followed by rodents, mustelids and hedgehogs that could only survive in the vicinity of men (Knottnerus 1997).

The reclamation of the backswamps and peat bogs, moreover, had unforeseen repercussions as it caused topsoil erosion and land-surface subsidence (Borger 1992; Van der Ven 2004). Again and again settlers were forced to retreat to higher grounds and to restrict arable farming. Human activities may have contributed to the widening of the Zuiderzee and the destruction of the Nordfriesland mires during the High Middle Ages. They were certainly responsible for the formation of the Jade and Dollard Bay in the 14th and 15th centuries. As a consequence, tidal volumes that had been reduced by dike-building measures grew again, encroaching on the barrier islands and causing damage to the mainland coast (Oost 1995). The barrier islands, on the other hand, may have suffered from wind erosion due to extensive grazing, fuel gathering and sod cutting as well as the introduction of rabbit farms in the 14th century, thereby contributing to the inherent instability of the coastal dunes. The absence of mustelids hunting rabbits must have been detrimental here.

To a large extent, the coastal environment was still largely amphibious. Even though human intervention led to an overall reduction in the available range of natural habitats, it also created novel ones, in which specific vegetational communities could thrive. These included ridge and furrow cereal fields, humid pastures, *Molinia* grasslands, waterlogged *Glyceria* meadows, *Cladium* beds, marsh-fens, flood swarts, floating rafts and a whole range of freshwater and brackish habitats. As the landscape was predominantly handmade, habitats were often relatively small and variegated. People benefited from the growing number of available anadromous and freshwater fish species, particularly eel and pike (*Esox lucius*), which were highly valued. But they also had to contend with typical wetland plagues, such as sheep liver flukes (*Fasciola hepatica*), netted slugs

(*Deroceras reticulatum*) and leatherjackets (*Tipula paludosa*), which could not have survived in the unembanked salt marshes. Moreover, the regular deposition of fertile clay that sustained the fertility of the land came to a standstill. Soils were being leached and lost their permeability. Finally, mosquitoes became more numerous, as they found ample opportunities to breed in brackish water. As a consequence, malaria became endemic, leading to widespread health problems and increased death rates (Knottnerus 2002).

In the long run, more and more wetlands were transformed into agricultural land. As early as the 13th century, a local chronicle described the fate of a former backswamp lake: “The area used to be rich of fish and fowl, now it produces floating grass [*Glyceria*], mixed with reed and sedge, but in time it may develop into a pasture, its surface being strong enough to carry the grazing cattle” (Lambooi and Mol 2001, p. 428). In fact, medieval man was quite confident about his mission to contain the forces of nature. Human society was considered as a holy city surrounded by evil powers, symbolized by ghosts and goblins, wolves and whales, dragons and sea-monsters, which all had to be driven out off the wastelands and into exile (Gurevich 1985).

Locked behind the dikes

Decisive changes took place in Early Modern Age (1500–1800), when people began to reconstruct their dikes until these were strong enough to stand substantial storm surges (Fischer 1997; Knottnerus 2001, 2003; Van der Ven 2004). As soon as the risk of flooding declined, a growing number of farmsteads and cottages were reallocated from the village mounds into the open fields. The remaining salt marshes were for the greater part embanked. Extensive drainage schemes guaranteed a substantial lowering of the water tables. Arable farming was intensified, increasingly so since the middle of the 18th century. By 1850, 60–80% of the coastal marshes were used for cereal production, whereas the acreage of winter cereals had increased as well. The most significant newcomer was oilseed rape (*Brassica napus* ssp. *Oleifera*), which proved to be a very lucrative crop. Step-by-step artificial meadows, dominated by red and white clover (*Trifolium pratense*, *T. repens*) or darnel (*Lolium temulentum*), came to replace the natural grasslands.

The resulting homogenization of the agricultural landscape had far-reaching consequences, as it greatly reduced the relative abundance of many species. True enough, the actual variety of coastal and wetland habitats remained extant until the 19th century, despite the growing pressure on natural reserves. Nevertheless, the acreage of wetlands and salt marshes rapidly declined. Large-scale arable farming gave way to new pests and diseases: cereals were vulnerable to plagues caused by rodents and anthropophilic birds such as sparrows, starlings, pigeons and crows. The 16th-century marshes were still essentially a wetland habitat, limiting the vole

plagues to years of drought. At that date, the root vole (*Microtus oeconomus*) may not have been extinct yet. Additionally, there are reports indicating that the striped field mouse (*Apodemus agrarius*) incidentally invaded the marshlands (Prummel 1999; Dahlmann 1978: vol 2). In the 18th century field voles (*Microtus agrestis*) were the major plague. Apparently, they preferred rain-spoiled years, indicating that the land had been drying up lately.

Population growth caused an increasing pressure on the remaining wetlands. Extensive regulations of inland hunting, fowling and fishing were introduced in the 16th century, reserving these activities to the local elite. Nevertheless, coastal fishing and fowling remained largely free. Fowling had been perfected since the end of the Middle Ages with the help of duck decoys, bird-nets and shotguns. According to a report from the 1530s, local hunters used to catch large quantities of golden plovers (*Pluvialis apricaria*), ducks and geese, the latter being salted and sent abroad. Additionally, people were known to eat herons, storks, cranes, gulls, quails, snipes, lapwings and hoopoes, complemented by tiny delicacies such as finches, thrushes and wrens (Ritter 1913–1914). Habitat change must have reduced the supply of fowl. Additionally, large-scale egg hunting and killing off breeders, particularly on the islands, had a detrimental effect on coastal wild-stocks as they resulted in the extinction of several marine bird species (Wolff 2000).

More and more, reed swamps, willow carrs, sedge and clubrush beds became valuable assets, as they provided thatch, twigs and ropes for various purposes. Dike-building necessities had already caused large-scale deforestation in the 16th and 17th centuries. By the 19th century a large reed bed before the gates of Hamburg was thought to be worth as much as an entire forest in Hungary (Kohl 1990). Shortages of timber and fuel came to be met with imported peat and locally produced bricks, for which extensive peat moors and rich pastures were destroyed. In order to obtain mortar, local skippers ransacked the fossil mussel banks (*Mytilus edulis*) of the Wadden Sea, with detrimental effects on living benthic organisms. In Ostfriesland alone more than 30,000 tons of mussel-shells were collected each year during the 19th century (Klöver 2000). In Noord-Holland the eelgrass banks were periodically harvested so as to get building material for the dikes.

As before, urban markets were the driving force behind the growth of the coastal economy. From the 16th to the 19th century maritime trade climaxed, as the owners of the growing number of small vessels preferred the trajectory through the Wadden Sea as against the route along the barrier islands. In fact, human presence in the area may have been far more disturbing to wildlife than it is today. Coastal fisheries were intensified, leading to the decimation of ray (*Raja batis* and *R. clavata*) and flounder stocks as early as the 17th century. The offshore oyster banks probably disappeared because of overexploitation (Illing 1923; Holm 1993; Lozán 1994; Wolff 2000). Pressure may have been reduced, however, as the islanders became involved in foreign merchant

shipping and whale hunting, which provided them with a regular income.

The ongoing pressure of modernization

The arrival of the 20th century may be considered as a turning point. By then the effects of industrialisation took the lead. Agriculture, dike building, hydrological management and fishing became mechanized to a large extent. The agricultural landscape was stripped to its essentials; the scale of human intervention grew to an unprecedented level. Transitional brackish habitats virtually disappeared, as the dikes were raised to a level at which they became an impermeable boundary between the maritime landscape and its hinterland. Urban settlements, traffic roads, harbours and industrial sites have closed in on the maritime fringe, whereas a growing number of tourists boosted human presence in hitherto sparsely populated regions. Tourism, moreover, has also been largely responsible for the booming idea that the coastal landscape is something to be valued of its own. In fact, conservationist ideas have become increasingly popular during the last decades of the 20th century. This may indicate a new turn in the Wadden Sea's historical fate.

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