Rehabilitation and management of the Baltic coastal lagoon habitat complex

Holms island

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Content

Preface

The aim of the LIFE Baltcoast project was to restore habitats and their typical flora and fauna in lagoon and coastal meadow complexes and adjacent habitats in the Baltic Sea region. The “Baltic coastal lagoon habitat complex” covers the following habitat types: lagoons, meadows, mudflats, beaches, stony banks and dunes.

LIFE-Baltcoast - “Rehabilitation of the Baltic coastal lagoon habitat complex” differs from other coastal development projects in many respects. Above all, the chosen reference area – the complete Baltic coast – is quite large. Within this area a total of 34 project sites have been selected, all located in N2000 areas, comprising almost 20,000 ha and stretching over five countries (Germany, Denmark, Sweden, Estonia and Lithuania) bordering on the Baltic Sea. 24 partners from these different countries were involved in the project in the period from 2005 to 2012.

Selection of project sites - The 34 project sites sites were selected by the planners of the project in the different member states. The selected sites represented the best remaining coastal nature conservation sites with open habitats. The sites were chosen and delineated within the Natura 2000 network in order to integrate all habitat types relevant to the lagoon habitat complex. Each project area comprises its own set of habitat types of different quality and composition. Most areas are integrated into the coastal landscapes and subject to numerous influences, which, from a nature conservation point of view, have been mostly negative.

Picture 0.a - The retention of water in early spring improves breeding habitat for dunlin (foreground) and ruff (background) at Högby hamn (S) (Photo Susanne Forslund)

Target species - For the Baltcoast project some of the species, characteristic of the lagoon habitat complex, were selected as target species. In all participating states long time declines in the local populations has resulted in local extinctions and remaining populations around the Baltic Sea are often very small. The LIFE-Baltcoast project tried to develop and establish management schemes for the project sites, which restores the Baltic lagoon habitat complex and improves the conditions for the target species, as Baltic dunlin, ruff, natterjack toad, green toad, and the creeping marshwort.

Status of habitats - More or less severe changes happened in the last decades at these sites affecting the natural hydrology and/or the traditional land use. This resulted in:

- A decreasing quality of the N2000 habitat types, e.g. only 6% of the salt meadows on the German Baltic coasts are at a “favourable conservation status”.
- A break up of the habitat complex which is a problem for species depending on open landscapes. At the same time many coastal grasslands developed towards brackish

reed-beds and wooded dunes. These habitats types are the result of succession processes.

The effects of these processes were that the populations of originally typical “coastal species of the Baltic Sea” - e.g. Baltic Dunlin, Ruff, Black-tailed Godwit, Natterjack Toad and Green Toad –target species of the Baltcoast project - declined. This decline was ongoing for several decades even let to local extinction of several of the species. These target species of the Baltcoast project can be described as “flagship species” meaning, that improving the habitat for these “flagship species” will benefit other similar species with similar habitat demands as well.

Best practice guideline - The present guideline is the result of an intensive multi-year co-operation of all who are involved in this lagoon project. It should inspire site managers and it should help to:

- Create “Baltic sea coastal species” friendly and site specific conservation strategies
- Select proven conservation measures to develop the habitat types
- Monitor the population development and quality of habitats
- Choose the right “After-LIFE” conservation measures and
- Organise necessary resources for the long term conservation work

1. Introduction to the Baltic Coast

1.1. The landscape - now and then

The Formation of the Baltic Coastal Habitats -The current coastline of the Southern and western Baltic developed due to land subsidence in Germany, Poland, Lithuania, and parts of Denmark. Erosion processes created coastal slopes. Marine sediment transport parallel to the coast provided material for development of sandbanks and beach ridges which can develop further into dune systems. This process is called spit development. By spit development bights/bays are partly cut off from the Baltic Sea. Especially when streams flow through the lagoons, they are being kept connected to the sea.

The former bight then becomes a lagoon with brackish water, depending on the flood frequency from the Baltic. Typical habitats around the lagoon are those from the spit development such as beaches, beach ridges with sea holly (*Eryngium maritimum*) and dune systems of different types as white dunes with marram grass (*Ammophila arenaria*), grey dunes with lichen rich dry grasslands with marsh daisy (*Armeria maritima*), and brown dunes with heath (*Calluna vulgaris*). Depressions in between the dunes are called dune slacks and are often characterized by small fens and temporary ponds, which can be breeding sites of natterjack toads.

Other habitats develop around the lagoon itself. At the edges of the now sheltered lagoon, coastal grasslands develop under grazing. Salt influence allows specialized plants to grow and they form the Atlantic salt meadow. The lower salt meadow is characterized by flooding annually and is therefore rich in creeks, pools and puddles. Some of these waters are only temporary and after drying out specialized salt-adapted plants colonize the mudflats such as saltwort (*Salicornia europea*) and tangwort (*Bassia hirsuta*). The parts of the salt meadows above 1 m above sea level are less often flooded and are therefore more influenced by freshwater. Shallow depressions are filled up by rain and provide breeding sites for natterjack toads and green toads. Dunes and beaches are their foraging habitats.

Open, coastal meadows are maintained by grazing animals and salt influence. Under these conditions scrub and reed beds cannot develop. Short swards with few seeds and regularly flooding keep mice populations down and therefore mammalian predators find neither food nor hiding places. Different water bodies of fresh- and salt water, shallow shores and mudflats provides foraging places for waders. For centuries, under these conditions, the

lagoon habitat complex was a perfect breeding site for meadow birds such as Baltic dunlin, redshank, ruff, and black-tailed godwit.

Coastal species need often a complex of different habitat types within an area where they can find food, rest and reproduce. These species further need, on top of the specific composition of habitat types, a specific water regime and vegetation structures for successful survival and reproduction. This habitat composition around Baltic coastal lagoons we named “Baltic lagoon habitat complex”.

History of grazing: impacts on the pre-historic landscape - Open coastal habitats have undergone considerable degradation both in quantity and in quality, during the last decades. Even if the remaining habitats in the centre of the Natura 2000 protection areas are still in good shape, the ecological connections between the different habitats are impaired. An essential question, which need an answer is - why are open habitats and their species so “management depending”- whereas humans are managing landscapes for nature conservation only the last 40 years? To understand this management dependency of species we have to look back into the European “land use” history.

European nature and species had developed during the last 2 Mio years within the Tertiary and Quaternary. In this long period a mega-herbivores have influence landscapes and succession processes. A mega-herbivore fauna comparable like the African fauna today also created a significant amount of open habitats.

Picture 1.1.a - Cattle grazing a salt meadow - a reminiscence from the past (photo: Niels Damm)

Additionally dynamic processes as coastal floods inhibited growth of woods along the coasts. Due to that many European species depend on open habitats. The mega-herbivore fauna survived several glacial periods. From 650.000 BP onwards the European herbivores lived in coexistence with the *Homo heidelbergensis*. Even the occurrence of the *Homo neanderthalensis* did not affect the herbivore fauna.

After melting of the ice in the last weichselian glaciation, which ended about 10,000 to 15,000 years ago, the area adjacent to the Baltic Sea was colonised by herds of wild grazers. At first these were mainly reindeer but as it became warmer, wild horses, ox and red deer followed on. The animals were hunted by Stone Age nomadic hunters. When humans settled down and started farming, wild grazing as a natural process was replaced by human extensive farming practices, and the wild grazers were replaced by domesticated cattle and horses.

From wild herbivore grazers to domesticated animals - The complete recovery of tree growth in Europe after the retreat of the ice was inhibited by humans, who introduced grazing animals as horses and cattle in the up-coming farming systems in the Bronze Age. This led to the development of semi-natural grasslands and species depending on open landscapes still experienced similar conditions as before under mega-herbivore grazing regimes.

This agricultural practice remained largely unchanged over many centuries. In southern Sweden grazing of coastal meadows can be traced back to the Bronze Age. Remnants of these old grazing landscapes can be found all along the Baltic Sea coast e.g. in Southern Sweden: Eskilstorps ängar in Vellinge and parts of the island Öland have been grazed since the Iron Age (UNESCO). These semi-natural grasslands along the Baltic coast, such as Boreal coastal meadows and Atlantic salt meadows are important hot spots for biodiversity with species adapted to the very special conditions of the habitats and some occurring only on these types of meadows.

Salt meadows for example are host to about 450 species restricted to this habitat type. Birds such as dunlin, with a mainly northern distribution range, have probably been using the Baltic shores as breeding grounds ever since the ice of the last glaciation disappeared. Nature was able to adapt to the gradual changes over thousands of years; species adapted both to coastal dynamics and the impact of agricultural grazing. Even endemic plant species such as the Baltic Gentiana (*Gentianella baltica*) and Baltic rush (*Juncus balticus*) depend on grazed areas at the Baltic Sea coast. Furthermore, the survival of open habitat depending species, as Baltic dunlin or the natterjack toad, was only possible because of the grazing tradition at the Baltic Sea. Otherwise reproduction sites as short grazed meadows for Dunlin and shallow pools for the natterjack toad would have been overgrown by dense and tall vegetation.

Abandonment of grazing: effects on species and habitats - As a consequence of the collapse of the former Soviet Union, on the Eastern Baltic, in Estonia and Lithuania, grazing ceased almost entirely. Coastal grasslands were quickly overgrown by reed beds and later by scrub like juniper, willow, and elder. Alongside these changes, grassland species and waders disappeared from many areas.

The LIFE-Baltcoast project was started with the aim of improving wildlife conservation conditions within the lagoon habitat complex, in particular to meet the habitat requirements of certain target species – ruff, dunlin, natterjack and green toads. Where the target species were still present, the strategy was to halt decline by re-establishment of suitable habitats. For some sites, which had previously been breeding areas of the target species, creation of suitable breeding habitats was undertaken to facilitate future re-colonisation. When it came to the birds, it was decided to first concentrate on actions which improved breeding areas, in order to provide successful reproduction, before focusing on transit and winter resting sites.
On the Western Baltic coasts, farmers became less and less interested in grazing the coastal areas. Much of the land behind the dikes, often pump drained, was ploughed and converted to arable land. In Denmark and Germany arable farming and pig production replaced dairy cattle and grassland farming in many places, causing abandonment of wetter coastal meadows. In Sweden intensification of agriculture did not happen everywhere and traditional grazing regimes on coastal meadows survived, supported by agri-environmental schemes during last 20 years.

Wherever the grazing ceased, it led to local extinction of the above mentioned species, caused by reed and scrub overgrowing the former coastal grasslands. This happened locally in nature reserves in Germany due to more “wilderness friendly” conservation policy in the late 1980’s. The same process – on a larger scale- was documented from Estonia due to changes of the farming economy after independency. Only in areas with continuous grazing regimes - as in some parts of Denmark, Estonia and in Sweden, where traditional grazing regimes were kept as part of the agricultural practice - the Baltic dunlin survived.
Thus, many species today depend on these semi-natural conditions, so the fast changes in land management, which have occurred over the recent decades, have had severe consequences for nature.

Picture 1.1.b - Overgrown coastal habitat

1.2. The Baltic lagoon habitat complex

The Baltic coast has been a very dynamic landscape over the past some thousand years. Melting ice from the glaciers, flooding of the Baltic Sea basin by freshwater and then by sea water, land uplift and land subsidence, the force of wind and water are events, all which define the changing borderline between land and sea. Changes in this area occur rather frequently even today. Such changing conditions require special adaptations of organisms living in the habitats of the shores of the Baltic Sea. The Baltic lagoon habitat complex consists of the following habitat types:

Coastal lagoons (1150) - Lagoons are a characteristic element of wave-eroded coasts in the western and southern Baltic. In the Northern and eastern Baltic land uplift creates lagoons by separating shallow bights from the sea. Lagoons are fully or partially separated from the sea.

The salinity in the lagoons depends on freshwater inflow and frequency of flooding by seawater. The water level can differ over the year. Lagoons are affected by the land use, especially by nutrients from farming, when brooks and rivers lead water from agricultural areas into the lagoon.

Sandbanks, mudflats and beaches (1110, 1210, 1220, 1310) - Waves form the changing borderline between land and sea. Sandbanks, the drift line, mudflats and sandy beaches are habitats which change rather frequently. For many birds these habitats are important feeding areas, and some species breed there as well. Today most beaches are visited for recreational activities and on only few sites public access is fully prohibited. Some habitat types such as “annual vegetation of drift lines“ (1210), can develop to the full extend only under such protection. Shore birds as e.g. Little Tern are sensible towards disturbance at their breeding sites at the beaches.

*Dunes (2110, 2120, *2130, 2140, *2250)* - These are a sequence of different dune habitat types from embryonic dunes at the upper beach to the higher wind moved “white dunes” further inland. When dunes become overgrown by vegetation they are called fixed dunes. Due to the humus accumulation the soil conditions change and thus also changes the vegetation - from lichen rich dry grasslands to heathland.
Dunes are part of the historical cultural landscape. Dunes have been affected by many changes in land use in the past 100 years. Extensive land use in dunes already stopped in the 1930’s due to lack of interest of farmers. Later, as tourism, at least in the Western and Southern Baltic, became important many dune sites along the Baltic coast became popular excursion spots. Dunes have since become a part of the coastal protection and today dunes are therefore protected against erosion and moving sand. Nutrient enrichment caused by rain is an important factor that changes flower-rich grass- and heathlands towards monotonous grasslands dominated by dense grass swards of *Calamagrostis epigeios, Carex arenaria* or *Festuca rubra*. Fauna biodiversity in dunes systems is depending on patches of bare ground, open moving sand and low, flower-rich vegetation.

Picture 1.2.a - Typical coastal meadows in the Western Baltic are Atlantic salt meadows. The salty, often flooded parts are the lower salt meadow. Above app. 1 m NN flood frequency is low and less salt tolerant vegetation occurs. Due to low salinity of the sea water salt meadows around the Baltic Sea depend on grazing, otherwise the lower salt meadow becomes overgrown by reeds. On aerial photo reed beds are the brownish vegetation on the island in Eichholzniederung (D). The upper salt meadow will be colonized by scrub and later forest as visible in foreground. (Photo Heiko Grell)

Coastal meadows (1330, 1630) - Atlantic salt meadows, developing between land and open salt water or brackish water, are regularly flooded by the tides in the western Baltic. The upper and lower salt meadows can be distinguished on the basis of the amount of salt water inflow. Only salt-tolerant plants can cope with these shifting salinity conditions.

Due to lower salinity in the Baltic Sea in the Eastern and Northern Baltic regions, boreal coastal meadow replace Atlantic salt meadows. Most of the areas were traditionally used for mowing or grazing, keeping the vegetation low and rich in vascular plants. Characteristically the vegetation occurs in distinct zones, with saline vegetation closest to the sea.

Both types of coastal meadows constitute important resting and breeding sites for waders. In the upper salt meadow breeding ponds/waters of Natterjack Toad and Green Toad occur in rainwater-filled depressions.

By coastal protection measures and farming practise coastal meadows were drained and land-use was intensified or for agricultural less attractive meadows, abandoned. In some areas of Germany, Denmark and Estonia, up to 90 % of former coastal meadows disappeared with severe consequences for the biodiversity.

*Dry habitats (5130, *6120, *6210, 6280, *7210)* - These different types of dry grasslands are typical for Sweden and the Baltic states. These grasslands are all defined by calcareous soils and low rainfall. Natural depressions are found all over the open grassland and may be flooded temporarily. When traditional grazing by sheep or cattle stops, shrubs, for example Juniper (*Juniperus communis*) or Blackthorn (*Prunus spinosa*) overgrows the open lands.

Picture 1.2.b - Coastline with salt tolerant vegetation

Human impact and changes in land use over the last 200 years have had a severe impact on coastal land scapes. In the Western Baltic up to 90% of former wildlife habitats had been lost over the last decades. A diverse range of causes led to dramatic declines in both the Eastern and Western Baltic. The situation was so severe that even nature reserves were affected by developments in recent decades. Therefore an urgent need to improve the conservation condition of coastal habitats around the Baltic lagoons in general existed when the Baltcoast project began in 2005.

The Baltic lagoon habitat complexes were often subject to negative developments in recent decades, even though the corresponding coastal sections are protected by law in the individual countries. Zones of protection were often delimitated too tightly and are strongly influenced by agriculture or regional tourism. Some habitat types such as beaches or the upper salt marsh were sometimes not included in the protection zones and used in different ways.

The lagoons themselves were often diked and used as reservoir for the drainage of adjacent plots. The influence of coastal dynamics has been limited for many lagoon habitat complexes, their water regime significantly altered. In most cases, the natural water exchange with the Baltic Sea has more or less completely stopped.

Within the protected areas, negative developments may occur when the grasslands of semi-natural open landscapes are either used too intensively or abandoned. Especially salt meadows and partly also alvars are affected by unwanted up-growth of tall vegetation, the development of dense litter layers, and bush encroachment. In the lagoons, high nutrient inputs, limited water exchange have led to undesirable developments.

The major threats towards lagoon habitat complexes may be classified as follows:

Changes of the natural hydrology - For flood protection and intensification of land use, upper salt meadows have been diked and drained, pump draining units were built. Consequently the natural water level had been lowered down, and native species lost their habitat. Ditches in the lower salt meadows were built to drain the surrounding land to make it useful for agriculture. The result was an unnatural meadow hydrology.

Nutrient enrichment - Especially in Western Europe intensive livestock farming and traffic are sources of massive nitrogen output. The high atmospheric nutrient load, in combination with these from adjacent fields and catchment areas of lagoons increases vegetation growth and effects deteriorates water quality. To a certain extent it is possible to counteract this by increased management, but increased management activities are likely to cause negative effects on species e. g. reduce the breeding success for meadow birds. Nutrient enrichment also affects species negatively by causing higher predator density and reduced breeding success for toads by bad quality in breeding waters.

Ceasing of traditional management and natural succession - When agricultural practices changed and cattle ceased to graze salt meadows, those sites were overgrown by reed bed. Overgrown salt meadows are lost as breeding grounds for BaltCoast's target wader birds like Baltic dunlin, ruff, redshank and others. Lack of grazing meant that shallow depressions - breeding sites for natterjack and green toad - became overgrown and shaded and could not be used for reproduction anymore. In the case of the upper salt meadows, the main reason for the change of the habitat was agriculture and its need for land. Over the decades more and more salt meadows have been drained and put to arable use. On dryer habitats, such as grey dunes, cease of grazing initiated natural succession towards woodland structures, where typical coastal species, adapted to open and dynamic habitats, cannot exist.

Predation - Construction dikes and pump draining stopped the natural dynamic within lagoon habitats. These dynamic processes are important for coastal breeding birds, as they guarantee predator free breeding areas every year. Reduction of regularly flooded coastal meadows results in mammalian colonisation (mice, rabbits) and an increase of predators. Additionally, the development of higher vegetation structures gives bird predators like foxes and martens better cover in the land surrounding bird breeding grounds.

Invasive species - Since men have explored the world, goods have been exchanged – even centuries ago. Seamen and traders brought products including plants to the Baltic countries. Around 1850, *Rosa rugosa* came to Europe. Unfortunately for dune habitats this is an undesirable plant which spread quickly by seeds and roots. The Japanese rose can form a uniform dense coverage. In doing so, *Rosa rugosa* became a problem as an invasive plant (neophyte) that displaced native species. This has happened - to a lesser extent also with other invasive species - over large swathes of the Baltic coast.

Tourist infrastructure - Especially in the second half of the 20th century, coastal areas became popular as tourist attractions and for leisure activities. In this context, camping grounds or holiday houses were built on dunes or dry sites, close to beaches or coastal meadows. In this process, dune ground was levelled, completely stopping the natural dynamic shifting of dune sand by water and weather. As a result, whole areas of dry sandy dune habitats and dry grasslands were lost. Development of tourist infrastructure also often entails construction of roads to beaches or camping grounds and parking lots, segmenting

and mitigating valuable coastal habitats. Beaches are prepared for leisure activities, beach drift is removed.

2. An integrated conservation strategy for the Baltic lagoon habitat complex

Thanks to the international co-operation and the exchange of experience, the present guideline for lagoon habitat complexes may now help to bring about a considerable improvement regarding the formulation of development goals and management plans including the provision of suitable and tested methods. We strive for the best development possible, which results in an optimally adjusted concept for the lagoon habitat complexes considering both the historical development of the areas and forecasts. The projected climatic changes in particular will directly or indirectly alter the coastal habitats and lead to increased dynamics. The aim is not only to conserve the coastal species and habitats, but also to prepare the Natura 2000 network along the Baltic Sea for the future. We take up the challenge with international co-operation.

2.1. General considerations

The aim of the LIFE-Baltcoast project was to develop coastal habitat types for species depending on a specific composition of habitats and specific habitat structures. The challenge was to do so under the different conservation backgrounds and traditions. Not only between member states but between the different project sites as well, different organisations had different foci of nature conservation in the past. Thus one important goal of the LIFE BaltCoast project was to create a multi-national network of experts and authorities along the Baltic coast in order to counteract the negative developments in the remaining coastal areas with lagoon habitat complexes together. The exchange of experience and the formulation of common development goals was one way to acquire external advice on local site management.

Different attitudes towards nature conservation - When discussing aims for long term nature conservation on a specific site questions such as the following often occur: “Open landscape or succession?” “Reed beds or salt meadows?” “Which habitat types should be improved by

the management?”. The answers to these questions are depending on many aspects. In this chapter trends in the discussions are highlighted and navigation aids through a complex topic presented. The term “nature conservation” has different connotations for different groups of persons dealing with nature conservation; a large variety of topics and keywords are connected to it: biodiversity, mother nature, wilderness, species protection, eco-system services, habitat protection, animal welfare, climate protection, habitat directive. Further, conservation traditions differ between different stakeholders and regions. When decisions on the management for a certain nature conservation site have to be taken, all these aspects are influencing people´s opinions and decisions. At the moment two general conservation orientations are discussed among nature conservationist in Germany: management of semi-natural habitats as conservation aim or “new wilderness” as a “hands-off conservation”. The “new wilderness” (wilderness being that which evolves at a site with only a minimum of human interference) differs from “real wilderness”, which is defined by e.g. the IUCN wilderness criteria (size, human population density, impact of natural processes, etc.).

Many of the central European conservation sites are much smaller than real wilderness areas, lack big herbivores and predators. They also often lack natural processes such as floods, fire, etc. which create dynamical processes in the wilderness with the result of a large variety of habitats on landscape level. So the “new wilderness” areas are much more stable in the development than the “real wilderness” according to the IUCN criteria.

This is especially the case for nature reserves along the Baltic coastline, which is dominated by coastal protection measures. Under such conditions “new wilderness areas” develop much more uniform into a final succession stage: different woodland types or reed beds or even scrub dominated by the invasive species *Rosa rugosa*. Open habitat types as salt meadows, grey dunes, shallow dunes slacks, etc. and species depending on such open habitats are excluded by this concept. The “new wilderness” idea has its roots in the “nature development by succession” strategy, already practised in the late 1980’s. It resulted in the loss of the Baltic dunlin in several German breeding sites. Conservation management, especially grazing, was stopped and succession processes soon led to final succession stages.

Probably due to other reasons succession in many areas around the Baltic Sea in Lithuania, Latvia and Poland was facilitated and the same result occurred: the Baltic dunlin became extinct in Lithuania and nearly extinct in Poland.

2.2. Practical steps

For these plans an expert group visited each site and discussed management options with local managers on site for improving the conservation status of the habitat types and/or the management of the target species. The recommendations from these expert visits outlined the conservation strategy of the site specific plans. During the project conservation effects regarding this outline were evaluated at regular intervals, often also by experts from the project. Conservation effects were communicated for each site annually, available on www.life-baltcoast.eu.

The possibilities, measures, and experiences for counteracting the different threats will be presented in the following chapters. How, for example, can a salt meadow in an advanced stage of abandonment be re-developed into a species-rich, floriferous area? Before this question can be answered however, it has to be clear in which direction an area or individual habitat types should be developed. The realisation of project goals is always preceded by the question “Where to?”. Therefore, a decision tree has been developed (chapter 8), which enables the regional managers to decide which direction the development should follow in a concrete case. Only after the goals have been defined can the questions of how, when and by which methods and measures these can be achieved be answered.

Favourable conservation status in the project area... - According to the EC Habitats Directive and EC Birds Directive, EU member states have the obligation to safeguard a favourable conservation status of their designated special protection areas and in addition of a number of listed species. Concerning safeguarding a favourable conservation status of habitats, the conservation status can be looked upon at three different levels (as described by Habitat Directive documents, e.g. Søgaard et al, DMU 2003 in their ‘Criteria for favourable conservation status’):

- The size and distribution of the habitat
- The structure and functionality within the habitat and
- The presence of characteristic species

In the coastal lagoon habitat complexes, dealt with by the BaltCoast EU Life project, several managed grassland habitats constitute an important part. They include in particular the EU habitats 1330 Atlantic salt meadows, 1630 Boreal Baltic coastal meadows, 6280 Nordic alvar, 6270 Fennoscandian lowland species-rich dry to mesic grasslands, 6410 Molinia meadows and 6210 Semi-natural dry grasslands and scrubland. The fact that the presence of the various grassland habitats with their rich and specific meadow bird and meadow plant communities is in the modern landscape - with its lack of large natural grazers, -depending on management was realized in Denmark, Sweden and Finland in the late 1960's and early 1970's (with classical studies published by Møller 1975, Larsson 1969 and 1976 and Soikkeli & Salo 1979 presenting the evidence) and similarly in Estonia in the mid 1990's. Since then, evaluations of grassland management practises and guidelines for best practises have been regularly published in national and international publications.

... and its limits - Trying to establish proper habitat management it became evident, especially for bird and amphibian experts, that to obtain a favourable conservation status in the grassland habitats the demands of meadow birds and meadow toads were much more comprehensive than demands of plants and invertebrates. This holds e.g. true in the case of the scale of the landscape where proper management had to be considered. This scale was much larger especially in case of meadow birds, because the level of predation pressure is of such vital importance. This means that meadow bird populations have large difficulties in surviving in fragmented landscapes; largely because they suffer when rodent-rich habitats or habitats rich in alternative prey for their main predators are present nearby their meadow breeding habitats. Thus presence of habitats like overgrown grassland, scrub, woodland and reed beds within up to 2 km distance or more to otherwise suitable meadows for breeding meadow birds directly impacts breeding possibilities negatively, and therefore safeguarding a favourable conservation status for meadow birds does also involve managing the landscape in a wider scale.

In many cases the demands of meadow birds and toads are also much more comprehensive than just creating the right vegetation height, structure and composition. For example, hay making in early June combine good hay quality for the farmer and the creation of an open meadow. However, if ruffs are breeding in the meadow such a mowing would cause a complete breeding failure for that species, as all breeders have eggs or small chicks at this time, and they will be destroyed or killed by the mowing machine. The same holds true for

very high densities of grazers in May and June. Mowing and grazing schedules must therefore be adjusted according to the breeding cycles of the most vulnerable meadow birds.
In conclusion, out of the three levels to safeguard a favourable conservation status in management dependent grassland habitats, the actions in order to provide conditions for the presence of the most vulnerable characteristic species are by far the most comprehensive. Optimizing management conditions for these characteristic species will at the same time be a good general habitat management for the other two levels while the opposite not necessarily is the case.

Defining target species for the project - The crucial thing in order to obtain favourable habitat management is therefore to identify the most vulnerable characteristic species in the grasslands at a certain site with the most specific habitat management demands. During the work with coastal and alluvial meadows in the Baltic including the Swedish west-coast, all of Denmark and the Wadden Sea the following species have been identified as the most demanding species:

Meadow birds: Baltic dunlin (*Calidris alpina*), ruff (*Philomachus pugnax*) and black-tailed godwit (*Limosa limosa*). In addition when there is distributional overlap in the eastern Baltic with breeding aquatic warbler (*Acrocephalus paludicola*) or great snipe (*Gallinago media*), the latter two species are even more vulnerable and management should primarily be directed towards these species.

Picture 2.2.a - Ruffs are declining dramatically all over the Baltic as a consequence of a combination of destruction of staging sites and lack of wet meadows and proper meadow management for breeding - one of the projects target species

Meadow plants (and invertebrates): Slender hare's ear *Bupleurum tenuissimum* and dune gentian *Gentiana uliginosa*, which are both concentrated on anthills of the yellow meadow ant *Lasius flavus*.

For the manager of a coastal or alluvial meadow the first step towards a favourable conservation status would be by providing information on, whether any of the most vulnerable and demanding species are at present living or could potentially live at the site in case there was proper management. For this purpose a decision tree was elaborated and is annexed to this guideline. Site specific information of the BaltCoast project areas, where the above mentioned species are found at present, were found recently or could potentially be found (with the precondition of the right management) is made available within this guideline or on the project´s webpage.

3. Target species of the Baltic lagoon habitat complex - habitat requirements and management conclusions

3.1. Meadow birds: Dunlin, Ruff and Black tailed godwit

3.1.1. Habitat requirements

The three shorebird target species in the Baltic lagoon habitat complex dunlin, ruff and black-tailed godwit are all confined to wet meadows. However, the specific habitat features preferred by the three species differ somewhat. In tables 3.1.1.a and 3.1.1.b the key features of the breeding habitat of the three species are listed

Photo 3.1.1.a: Optimal ruff habitat is lacking at most of the former coastal sites around the Baltic Sea. Meadows with shallow fresh water flooding -as here the “Salmi meadow” in Matsalu NP in Estonia- have been drained and converted to fertilized meadows or even arable fields. (Photo: Martin Altemüller)

Baltic dunlins are almost exclusively found in two types of wet meadows. They breed in grazed relatively narrow coastal meadows along the shore-line dominated by halophytic vegetation, and such meadows they share with redshanks, common ringed plovers, oystercatchers, avocets and lapwings and in parts of the Baltic also turnstones.

They also breed – often in larger numbers – in more extensive and diverse coastal and inland wetland meadows used as pastures with a mixture of sub-habitats like pools and wet depressions, halophytic short-grazed areas and wet areas with softer bottom. In particular where there are also areas with late hay-making and after-grazing they share these meadows with a whole suite of meadow birds like ruffs, black-tailed godwits, redshanks, lapwings, avocets and oystercatchers.

Habitat feature	Dunlin	Ruff	Biological function
Water table	Wet meadows with a high water table and late drying out of wet features in the meadow, typically still with open water in late May/early June	Wet meadows with a high water table, selects meadows with a water table <40 cm below surface early June	High water table: Attracts adult breeders by providing food also for chicks later. Prevents high rodent densities and thus fewer egg and chick predators attracted. Reduces vegetation growth and prolongs the available breeding period
Surface structure	Dependent of well developed structures with pools and gullies, which gradually dries out during late May and June	Attracted by meadows with structures, which safeguard available invertebrate food for chicks and adults when the depressions dry out	Surface structure provides a diversity in moisture of the meadow under various weather conditions causing an increased availability of adult and chick food
Height of vegetation at nest	Nests are situated in 5-15 cm high vegetation in an open landscape with a good view by the incubating bird	Nests are situated in 10-20 cm high and not very dense vegetation at a site with a fair view by the incubating bird	The specific demand is a compromise between good camouflage of the eggs and a good view by the incubating bird for optimal anti-predator behaviour
Height of vegetation where chicks are reared	Chicks are reared in open vegetation 2-20 cm high	Chicks are reared in open vegetation 10-20 cm high	The specific demand is a compromise between good camouflage and food availability of the chicks; too dense and high vegetation reduce chick survival
Low productive meadows	Confined to meadows with an open and slow growing vegetation	Confined to meadows with an open and slow growing vegetation	Low vegetation and a high degree of openness is necessary for antipredator behaviour and chick food availability, slow vegetation growth is necessary in order to provide a sufficiently long and late breeding season
Salt	Breeds in salt, brackish as well as fresh meadows	Avoids breeding in meadows where salinity of wet features is regularly > 5 per mill	Ruff is a freshwater species with poorly developed salt glands. This may explain preference. Other possible explanations are that increase in salinity changes invertebrate and vegetation communities to less favourable types for ruff, e.g. causing poorer egg camouflage and chick food
Meadowbird antipredator shield	Reproduce much better near nests and in particular families of strong aggressive species, especially lapwing	Reproduce much better near nests and in particular families of strong aggressive species, especially lapwing	Strong aggressive species like lapwing are able to reduce predation on eggs and chicks significantly by attacking and stressing aerial and mammalian predators, this also affects survival of eggs and chicks of neighbouring more timid and weak meadowbird species
Predator restriction	Large sites have higher breeding potential than smaller sites. Habitat fragmentation increase predation level. Dunlin avoids edge habitats	Large sites have higher breeding potential than smaller sites. Habitat fragmentation increase predation level. Ruff avoids edge habitats	Increase of reproduction rate, as ground nesting meadowbirds are very vulnerable to predation of eggs and chicks
Introduction of kestrel and peregrine by establishment of nest boxes	Kestrels have been seen to specialize in capturing adult and chicks of dunlin	Ruffs, especially lekking males, apparently are preferred prey for peregrines	Meadowbird population survival is dependent of high adult survival. Introduction of extra powerful predators causes meadowbird breeders to cease breeding due to fear. Also introduction of extra potentially specialized effecient predatiors of chicks may compromise successful reproduction

Table 3.1.1.a - Key habitat features in lowland breeding habitat of dunlin and ruff in the Baltic countries

Habitat feature	Black-tailed godwit	Biological function
Water table	Wet meadows with a fairly high water table attract breeders, and chick and first year survival significantly higher for chicks bred in wet meadows with ground water table <30 cm below surface	High water table improve feeding conditions: For adults by increasing the soil penetrability and increasing density of available earthworms; for chicks also by increasing food availability - insects living in the vegetation. Prevents high rodent densities and thus fewer egg and chick predators attracted.
Surface structure	Attracted by meadows with permanent pools nearby and waterfilled foot drains	Pools and waterfilled foot drains function as invertebrate reservoirs, providing chironomids for adults
Height of vegetation at nest	Nests are situated in 5-15 cm high vegetation in an open landscape with a good view by the incubating bird	The specific demand is a compromise between good camouflage of the eggs and a good view by the incubating bird for optimal anti-predator behaviour
Height of vegetation where chicks are reared	Young chicks until the age of 2-3 weeks are reared in vegetation 15-30 cm high	The specific demand is a compromise between good camouflage and food availability of the chicks
Meadowbird antipredator shield	Reproduce much better near nests and in particular families of lapwing	Aggressive lapwings are able to reduce predation on eggs and chicks significantly by attacking and stressing aerial and mammalian predators, this also affects survival of eggs and chicks of neighbouring black-tailed godwits
Salt	Huge majority of temperate breeders found in fresh and fresh-brackish wet meadows. Only very locally breeds at sea shore meadows	Poorly understood why breeding in salty meadows does not occur on a more large scale. Species do not feed on saltwater mudflats
Predator restriction	Large sites have higher breeding potential than smaller sites. Habitat fragmentation increase predation level. Ruff avoids edge habitats	Increase of reproduction rate, as ground nesting meadowbirds are very vulnerable to predation of eggs and chicks
Introduction of kestrel and peregrine by establishment of nest boxes	Adult black-tailed godwit breeders are prefered prey for peregrines	Meadowbird population survival is dependent of high adult survival. Introduction of extra powerful predators causes meadowbird breeders to cease breeding due to fear. Also introduction of extra potentially specialized effecient predatiors of chicks may compromise successful reproduction

Table 3.1.1.b - Key habitat features in lowland breeding habitat of Black-tailed godwit in the Baltic countries

3.1.2. Management conclusions

The three species have all been intensively studied in Northern Europe, the dunlin in particular in Finland, Sweden and Denmark (e.g. Finland: Soikkeli 1967, Soikkeli & Salo 1979, Pakanen 2011, Pakanen et al. 2011; Sweden: Blomqvist & Thorssell 1988, Blomqvist & Johansson 1991, Jönsson 1991, Larsson et al. 2002, Blomqvist et al. 2010; Denmark: Thorup 1998, 2003, 2004; Germany: Heldt 1966), the ruff in Denmark and the Netherlands (e.g. Møller 1978, Beintema 1991, Thorup 1998, 2003, 2004) and the black-tailed godwit in particular in the Netherlands (e.g. Beintema 1991, Groen 1993, Groen et al. 2012, Kentie et

al. 2013) and Denmark (e.g. Møller 1978, Thorup 1998, 2003, 2004). Favourable management for the three species is listed in table 3.1.2.a

Habitat feature and management	Dunlin	Ruff	Black-tailed godwit
Water table -natural hydrology	Accept/create as high water table as possible by preventing all drainage and blocking all ditches and foot drains from February till early July	Accept/create as high water table as possible by preventing all drainage and blocking all ditches and foot drains from February till early July	Accept/create as high water table as possible by preventing all drainage and blocking all ditches and foot drains from February till early June
Water table -managed hydrology	Keep water table above 40 cm below surface of breeding habitat till early June	Keep water table above 40 cm below surface of breeding habitat till early June	Keep water table above 30 cm below surface of breeding habitat and water in footdrains and ditches till late May
Surface structure	When re-wettening a previously drained area it may often be necessary to restore wet features by removing harsh vegetation or even soil in the depressions and to install a number of blockings in order to retain the winter precipitation as temporary wetlands on the meadows	When re-wettening a previously drained area it may often be necessary to restore wet features by removing harsh vegetation or even soil in the depressions and to install a number of blockings in order to retain the winter precipitation as temporary wetlands on the meadows	
Grazing - period and density	A quite high grazing pressure is necessary to create the demanded short and open vegetation. Grazing period and density is a compromise between the grazing needed and avoidance of nest destruction by the grazing animals. Preferable grazing start is between 26 May and 5 June, and grazing density until 25 June should not exceed 1.5 animal per hectare. In July till November the grazing density can be much higher.	Grazing period and density is a compromise between the grazing needed and avoidance of nest destruction by the grazing animals. Ruff is a late breeder, and grazing should never start before very late May or June. Most ruffs are found in regularly mown meadows with additional low density grazing, and grazing density in the nest period late May till early July should not exceed 1-1.5 animals per hectare. In mid July till November the grazing density can be much higher.	Grazing period and density is a compromise between the grazing needed and avoidance of nest destruction by the grazing animals. Godwit chicks select quite high vegetation the first 2-3 weeks after hatching - second half og May and June - and a mosaic meadow landscape with both grazed and ungrazed areas in that period is prefered.
Grazer	Grazing animals must not graze too selectively, and they should graze down shorelines of wet features and coasts. Cattle or a mixture of cattle and horses are preferable grazers. Sheep are poor grazers for meadowbirds because they graze very selectively	Grazing animals must not graze too selectively, and they should graze down shorelines of wet features and coasts. Cattle or a mixture of cattle and horses are preferable grazers. Sheep are poor grazers for meadowbirds because they graze very selectively	Grazing animals must not graze too selectively, and they should graze down shorelines of wet features and coasts. Cattle or a mixture of cattle and horses are preferable grazers. Sheep are poor grazers for meadowbirds because they graze very selectively
Mowing	Careful grazing with a late release and low grazing density in the nesting period often cause overgrowing in parts of the meadows. In such cases some additional late mowing is necessary. Mowing should be postponed till after 15 July, and the areas where mowing is needed can be located by a specialist. Mowing height should be as short as possible, and maximum vegetation height after mowing should preferably not exceed 5-6 cm	Ruffs are attracted to wet meadows with late mowing or a combination of late mowing and low-intensity grazing. Mowing should never take place before 15 July, and in wet years there may still be many chicks on the meadows until late July. Mowing height should be as short as possible, and maximum vegetation height after mowing should preferably not exceed 5-6 cm	Godwits are attracted to wet meadows with a fairly late mowing or a combination of late mowing and low-intensity grazing. Mowing should not take place before 1 July. In fertilized meadows the breeding cycle is a bit earlier, and here mowing can start 25 June. Mowing height should be as short as possible, and maximum vegetation height after mowing should preferably not exceed 5-6 cm

Lower limit of management	Entirely dependent of vegetation management. Very small numbers in very low densities found in a short transition period in early succession habitats just after new land formation and in very wet raised bogs. Grazing and, optimally, additional mowing is necessary in order to sustain proper vegetation height and structure	Entirely dependent of vegetation management. Very small numbers in very low densities found in a short transition period in early succession habitats just after new land formation, in early fallow and in wet raised bogs. Grazing and/or mowing is necessary in order to sustain proper vegetation height and structure	In coastal habitats and alluvial meadows dependent of some kind of vegetation management. Grazing and/or mowing is necessary in order to sustain proper vegetation height and structure
Fertilizer application	Fertilizer application destroys breeding habitat	Fertilizer application destroys breeding habitat	Moderate application of fertilizer tolerated, at maximum 50-100 kg N per hectare
Salt	No known effects on breeding conditions	Increase of salt water intake into wet features and flood water will deterioate breeding habitat.	Risky to increase salt water intake into flood water and temporary wetlands, as this may deterioate breeding habitat
Meadowbird antipredator shield	Good dunlin breeding habitat management in fresh and brackish meadows is very similar to good lapwing habitat management, so usually a well developed antipredator shield	Combination of good management for ruff and lapwing of importance for good reproduction. Lapwing breeding habitat is meadow with short og with-out vegetation	Combination of good management for godwit and lapwing of importance for good reproduction. Lapwing breeding habitat is meadow with short og with-out vegetation
Predator restriction	Keep as large management units as possible. Keep core habitat well grazed, and mow additionally if needed. Minimize overgrown patches as more vegetation causes more rodents and other alternative prey for nest and chick predators, which causes higher predation level. Trees, bushes and reed beds up to 2 km from otherwise suitable breeding habitat will increase nest and chick predation, and such habitat fragments should be avoided completely within 500 m from dunlin breeding habitat where ever possible	Keep as large management units as possible. Keep core habitat well grazed and/or mown. Minimize overgrown patches as more vegetation causes more rodents and other alternative prey for nest and chick predators, which causes higher predation level. Trees, bushes and reed beds up to 2 km from otherwise suitable breeding habitat will increase nest and chick predation, and such habitat fragments should be avoided completely within 300 m from ruff breeding habitat where ever possible	Keep as large management units as possible. Keep core habitat well grazed and/or mown. Minimize overgrown patches as more vegetation causes more rodents and other alternative prey for nest and chick predators, which causes higher predation level. Trees, bushes and reed beds up to 2 km from otherwise suitable breeding habitat will increase nest and chick predation.
Introduction of kestrel and peregrine by establishment of nest boxes	No kestrel nest boxes within 3-5 km from a potential breeding site, no peregrine nest box within 10-15 km from a potential breeding site	No kestrel nest boxes within 3-5 km from a potential breeding site, no peregrine nest box within 10-15 km from a potential breeding site	No peregrine nest box within 10-15 km from a potential breeding site

Table 3.1.2.a - Favourable management of dunlin, ruff and black-tailed godwit breeding habitat

Several studies in Sweden and Denmark (e.g. Thorup 1991, 1998) have shown that the dunlin is an umbrella species in both types of breeding habitat: when habitat management has been directed at providing optimal habitat for dunlin (as shown in table 3.1.2.a), the living and breeding conditions of all other meadow bird species have been improved simultaneously. When optimal habitat management for ruff is added – in particular late hay-making in wet meadows – the living conditions of the other meadow birds are further improved, showing that ruff is another species which can be treated as umbrella species.

That ruff is an umbrella species, is in accordance with the findings of Beintema (1986) in Dutch polders: he found that the top 10% of ruff sites also held high densities of all other meadow birds, in contrast to e. g. the top 10% of lapwing sites, which only held low densities of most other species and no ruff at all. Dunlins are not breeding in Dutch meadows and therefore included in the analysis by Beintema.

Photo 3 - One of the project actions “Restoration of depressions” created new ruff feeding habitat. The ponds are also calling sites of the green toad at Ottenby, Sweden and are temporary fenced-off for optimized reproduction. (Photo: Hauke Drews)

There are two species breeding on the meadows, which are exceptions, however. The common snipe and the blue-headed wagtail at the coast are basically breeding in coastal marshes and in transformation stages from coastal meadows to coastal marshes, and in this respect they can both be said to be only marginally meadow birds. Best management for dunlin, ruff and the other meadow birds is too intensive for common snipes and blue-headed wagtails though. In the lowlands of the Baltic countries the majority of the two species are

found in other habitats: the common snipe in various natural wetlands, the blue-headed wagtail in agricultural fields surrounded by ditches, in particular in polders.

More than 40 years of Baltic dunlin breeding biology studies in Germany, Finland, Sweden and Denmark have provided very exact knowledge of breeding habitat demands of this biogeographical population, which is one of the most threatened populations in Europe.
Nevertheless, the conservation priority is very different among the different countries within the distribution of the Baltic dunlin. In Finland, Estonia and Sweden Baltic dunlin is high on the conservation agenda, and also in Denmark the dunlin is quite high on the agenda with a national management plan and some regional actions towards improvement of the living conditions of the species. On the other hand, dunlin conservation management is very low – or non-existing – on the agenda in Germany (away from Kirr), Kaliningrad region in Russia and Lithuania, whereas some local actions have been performed recently in Poland.
Historical data provide us with information of overall population trends since the early 1970es. These 40 years of trend data reveal, not only large-scale population declines with the extensive cessation of grazing and mowing in the 1970es all over the Baltic, but also a hitherto unexplainable marked overall population increase in the second half of the 1980es. That such a huge increase could take place in a period where there were no simultaneous systematic improvement of habitat management in the direction of fulfilling dunlin breeding habitat demands demonstrates, that unknown macro factors may again in the future give the possibility of a dunlin population recovery, given that favourable breeding habitat will still be present at a large number of sites widely distributed over the past distribution area.
In 2010 and 2011 there were some indications that a new period with population increase may have started, as a slight population recovery was seen both in Denmark, Sweden and Estonia, and for a number of years the number of breeding pairs in Finland has been stable. E. g. Saltholm in Denmark and Tygelsjö ängar in Western Sweden were re-colonised after a number of years without breeding dunlins.

In order to safeguard that potential recovery sites will be available, it is recommended to elaborate an international recovery plan. Such a recovery plan should include a designation of the most important past and present dunlin breeding sites, with recommended actions according to the presented dunlin habitat demands (table 3.1.1.a) that would recreate suitable dunlin breeding habitat in the designated sites. A recovery plan ought also to have a priority list of sites in which to reintroduce favourable management immediately according to

the known dispersal patterns of the species. Dunlins need a kind of “stepping stones” to support dispersal of dunlins from already established sites to future sites with aimed re-colonization. As mentioned above, initiatives to recreate suitable dunlin breeding habitat will at the same time provide optimal breeding habitat for a whole suite of other meadow birds.

3.2. Colony breeders: Avocet, common tern and little tern

3.2.1. Habitat requirements

The three target colonial bird species avocet, common tern and little tern have very different breeding strategies and do not share their breeding habitat requirements very much, so each species is dealt with separately.

Avocet

Avocets are nesting in open areas without vegetation or with very short vegetation, situated near favourable feeding areas for adults and chicks on sand- or mudflats or along shores with shallow water. Most avocets breed in colonies. These colonies can be of various sizes, the majority of colonies have less than 15 pairs, but a few large colonies contain a high proportion of the total number of pairs. In areas with a fairly high predation pressure from mammalian predators, but with favourable feeding conditions, single pairs may disperse in short-grazed coastal meadows as an anti-predator strategy.

The demand for very open nesting habitat means that avocets are mainly found on grassland with a high grazing pressure or on sites with recent accretion of land.

Avocets attack aerial predators, when the predators are approaching nest or chick rearing areas, and they are generally able to keep such predators away. However, some individuals of predators like marsh harriers, peregrine falcons or kestrels may specialize in hunting adults, chicks or eggs of avocets, thereby reducing the breeding success of avocets significantly.

Photo 3.2.1.a: Coastal birds are breeding at the ground. Therefore their eggs and chicks have high risk of being predated. Colony breeders try to limit this risk by forming a colony. All birds together can better scare away birds of prey or gulls during day time. The high density of nest on the ground is very attractive for night active mammalian predators as fox or marten. This predation risk can be reduced by breeding on islands as the pied avocet does on Landgrens holme in Falsterbo (S). (Photos P-G Bentz)

Common tern

In the Baltic, common terns breed in small or moderate-sized colonies, mostly situated on small islands or islets in sheltered bays or at coasts with shallow water. On many occasions common terns breed in mixed colonies, especially with black-headed gulls, but at several sites also together with arctic terns and/or avocets.

Additionally, the species breeds in fresh water lakes, and also here the single pairs or small colonies are usually situated on islets.

The breeding on islets is a strategy to avoid predation by mammalian predators. Although the common tern tolerates a little higher vegetation on their breeding site than e.g. arctic terns or avocets, overgrowth with reed, bushes or trees forces the common terns to cease breeding on an islet. So grazing or coastal dynamics are necessary to keep a sufficiently open and short vegetation for the species.

Little tern

Little terns – as well as the other typical tern species of the Baltic arctic and common terns – are nomadic breeders, often found in small colonies. The breeding habitat of little tern as well as arctic tern is shingle or sandy ground with no or only sparse vegetation, typically for newly formed spits and islets at the beach. Little terns are also found breeding on sand bars just above the water line or on sandy areas created during construction work. Arctic terns (and common terns) are very aggressive, and they are able to minimize predation by avian predators via mobbing. Little terns can profit by that by breeding in mixed colonies. But they are vulnerable to mammalian predators like foxes, mustelids and rats (and unleashed domestic dogs). In order to avoid these predators, terns prefer to breed on islands or islets when available.

As most other terns, little terns have a very high annual adult survival and a subsequent slow reproduction. A bird can rely on several breeding seasons, and it is not necessary for the species survival that all seasons produce a breeding output.

The little tern is a very dynamic breeding species and a typical pioneer species in the way that a large proportion of the breeders establish in newly created breeding habitats. This habitat may be created by construction work or by coastal dynamics. Many breeding sites are only temporary, and the little terns move quite soon again when they become unsuitable due to establishment of vegetation, destruction again by coastal dynamics or change in human land use.

3.2.2. Management conclusions

The selection of breeding sites without disturbance and with a minimal predation risk in a given year, is a very important issue for the three target colonial species. Thus safeguarding available breeding sites with low predation risk and low human disturbance is a key element in the conservation management of avocets, common terns and little terns.

Immediately before the breeding season all the three species have a sort of inspection period, when they monitor the presence of the most important predators at potential coming breeding sites. Thereafter they select the most promising sites and start the establishment of

their breeding colony. The availability of suitable islets with the right vegetation structure and situated near good feeding sites is a limiting factor, and such sites become even more limited, if regular visits by humans on favourable breeding islets are not restricted. Perhaps the single-most important management measure is to monitor the range of potential breeding islets and ascertain where individuals of the colonial species select to breed in a certain year, and then close public access to the selected islets in the breeding season April till July.
Foxes and rats can colonize small islands and other islets otherwise free of mammalian predators by crossing the ice in winter. The breeding conditions at important breeding islets can be improved significantly, if they are checked for predators immediately after ice melt, and when it is necessary mammalian predators present are extirpated, optimally before early April, when the earliest colonial breeders the avocets start selecting the breeding sites of the year.

In chapter 5.2.3., various measures to control predation of colonially breeding birds are described in more details. In the next species accounts paragraphs, it is explained which management measures are specifically suitable for each of the three target species.

Avocet
A fragmented landscape with many structures and habitat edges reduces the visibility of the surroundings by the incubating or chick rearing avocet. Without a full overview 250-500 m away, avocets can no longer perform the optimal anti-predator behaviour, and the breeding success declines. An important management measure for avocets is defragmentation of the landscape, by cutting bushes, trees and reed, in particular in the surroundings of otherwise favourable breeding sites like islets, small islands or peninsulas with restricted access for mammalian predators.

When the landscape character allows it, fencing an avocet colony by an electric fence may increase the breeding success significantly. In order to prevent intrusion of foxes and other mammalian predators, several lines of electric wires are necessary, the lowest close to the ground, the highest at minimum 120 cm above the ground. Such an electric fence requires quite some maintenance work. Grass must be mown under the fence several times during the breeding season to avoid short cuts in the lowest wire. The electricity must be checked regularly, as predators also check the possibility to enter regularly. The fence must be

erected and removed every year before and after the breeding season in order to have the colony site grazed.

Grazing is an important management measure to keep the breeding area with short vegetation. Wherever possible, grazing should only take place outside the nesting season to avoid trampling of eggs. Preferably, colony areas should be fenced off between mid April and late June. Exclusion of grazing animals and predator exclusion by electric fence can be combined.

In recent years, in connection with dike building or other construction work near the coast, creation of artificial wetlands with breeding islets is often part of the construction. In many cases, such breeding islands have become attractive breeding sites for avocet colonies. Often the breeding at this type of sites is only temporary, however, because breeding islets often become overgrown after a few years. Regular removal of up-growth on the islets like reed or bushes can safeguard continuous breeding for many years.

Regularly, in search for predator free nesting sites, avocets select nesting sites up to a few km from good feeding areas at the coast. Where this is the case, it is important for the breeding success that chicks can walk relatively unhindered from the nest to the feeding site at an age of only a few days. In such places an important management measure is to create and maintain an open passage, as chick mortality can be high when the small chicks have to cross areas with reed beds or other dense vegetation.

Specialized aerial predators can pose a significant limitation of the reproductive output, and peregrine falcons may even pose a threat for the adult avocets. Two potentially very important predator species, the kestrel and the peregrine falcon, do not naturally belong to the wide open coastal landscape, but are found here primarily because the establishment of nest boxes has provided new nesting opportunities. It is recommended to create zones covering areas within 15 km from breeding areas for avocets (and vulnerable meadowbirds like dunlin, ruff and black-tailed godwit), wherein placement of peregrine nest boxes is avoided. Similarly, it is recommended to avoid installment of kestrel nest boxes within 5 km distance from breeding areas of avocets (and dunlins).

Photo 3.2.2.a - Great reproduction success in order to protect little tern colonies at beaches other fence types were used

Common tern

Historically, numerous small islands and islets were grazed by sheep or cattle, but such grazing is not attractive nowadays, and many otherwise attractive predator-free islands are overgrown. Re-introduction of grazing on small islands and regular cutting of bushes, trees and reed on overgrown islets will improve the breeding conditions of the species significantly. The construction of small artificial floating islets (rafts) at sheltered places in lakes and closed bays has shown to provide attractive breeding sites for common terns. Such rafts can supplement the natural breeding sites by adding a number of predator free possible breeding sites.

Little tern

Due to the pronounced nomadism of the species, a high degree of flexibility in the management measures is of importance. Therefore, early localization in April and early May of the selected breeding sites of the year is recommended, followed by temporary public access restrictions to minimize disturbance.

Additional anti-predator management like well-maintained electric fox fences can help minimizing predation for a while, when e.g. a peninsula can be fenced off against mammalian predators. Fences into the water can be built as a swimming fence or with iron elements. A swimming fence needs daily maintenance because of drift removal and battery exchange for recharge. The iron elements in concrete basements can withstand the drift better, but when vegetation debris and other flotsam is hanging in the fences the elements are easily crashed by storm waves. So even such iron fences have to be regularly cleaned and to be removed as soon as possible after breeding season. For more details and information on the experience obtained during the BaltCoast project see chapter 5.2.3.

3.3. Bufo calamita

3.3.1. Habitat requirements

Around the Baltic, *Bufo calamita* naturally occurs in coastal meadows with short vegetation, sandy soil conditions and shallow, sunexposed waterbodies for reproduction. *Bufo calamita* is a pioneer species with the ability to quickly make use of new habitats within its activity range. Such habitats may be temporary pools caused by natural forces like strong rain or other changes in the local hydrology, caused by storms. In the past and present, human activities also provided for new breeding habitats: ditches, artificial ponds or gravel pits. The latter feature in fact is nowadays a very important secondary breeding habitat for the natterjack. Often isolated populations of *Bufo calamita* were able to survive in gravel pits which provide excellent habitat structures (shallow, temporary waterbodies, sandy soil, regularly disturbed landscape features).

In detail, important habitat features of *Bufo calamita* in the northern part of its distribution area around the Baltic are:

Aquatic habitats - stable populations of the natterjack are depending on suitable breeding habitats. A minimum of at least five, fully sun exposed breeding ponds with different water depths is favourable. The availability of different ponds guarantees successful reproduction in years with different climatic conditions.

Breeding ponds may have any size – from 1 m² to many hectares. In general they should not be too deep, around 30 cm. Shallow ponds warm up quickly and allow a fast larval development. Additionally, shallow ponds regularly dry out, thus maintaining a low level of predators on the tadpoles in the water body. *Bufo calamita* can tolerate salinities up to 5 – 7 $^{0}/_{00}$ for spawning. On inland meadows and salty coastal meadows the presence of *Agrostis stolonifera. Heleocharis palustris* or similar low plants in the pond is positive for the breeding success, as the plants provide both hiding places and a good supply of oxygen in eutrophic conditions. Breeding ponds (almost) bare of vegetation, e.g. in field floodings, in gravel pits, or behind natural sand walls along the seashore, are also close to optimal. Good breeding sites are usually found by migrating males, where they start to call and attract conspecifics.

Photo 3.3.1.a - Optimal natterjack toad breeding habitat is a grazed, shallow flooded upper salt meadow with good freshwater quality as here on island of Saltholm (DK). Green toad uses similar waters, but which are deeper and might also be slightly brackish. Natterjacks can use waterbodies with a salinity up to 5 0/00, green [variable] toads up to 8 0/00. (Photo Niels Damm)

Terrestrial habitats - suitable terrestrial habitats of *Bufo calamita* feature short, bare ground, scattered or dispersed vegetation, most often sandy and easy-to-dig soil conditions. All these elements form a landscape which offers only a minimum spatial resistance for the toad. With their hit-and-run survival strategy, the natterjack is depending on a landscape which allows easy seasonal and daily migration. The animals forage during the night, hunting invertebrates in open areas. Hiding places, such as small holes, loose earth or washed up pieces of wood are sought out during daytime. Main migration routes between land habitats, hibernation sites and breeding ponds should not have vegetation higher than 2-5 cm. Under conditions as described above, the population should have a minimum of 5 ha at its disposal, each adult toad needing approximately 50m². While juveniles and adults usually prey on bigger invertebrates, newly metamorphosed toadlets need plenty of small prey during their first weeks. Such prey - e.g. collembolae or small flies - is abundant on mudflats. Such mudflats are created when a pond slowly dries out. The receding water leaves moist and soft ground with a high number of suitable prey. Each breeding site should have a minimum of at least 1000m² of such mudflats. Hibernation sites for the toads can be any type of frost free subterranean hiding places, such as piles of stones, mouse holes or cellars. For recently metamorphosed animals a close distance of hibernation places to the breeding pond is important as the small toads are often not strong enough to reach faraway hibernation sites.

The following table (table 3.3.1.a) provides an overview of important habitat elements:

Stage in life cycle	Sub-habitats and their features	Biological function
Adults	Migration route from land habitats/hibernation sites to breeding ponds with short vegetation (2-5 cm) or bare ground	Enables *Bufo calamita* to migrate and orientate on longer distances
Egg laying	Breeding ponds: temporary, freshwater or slightly brackish (up to 5 – 7 $^0/_{00}$), clean natural oligo- to natural eutrophic waterbodies	attract calling males, good reproduction success because of low invertebrate predation on larvae caused by drying out
Egg laying	Water depth: around max. 30 cm, fully sun exposed	good reproduction success due to fast growth in high water temperatures
Upgrowth of tadpoles	Positive vegetation: short flooded grass-like plants or without vegetation	Hiding possibilities in the grass, good oxygen supply under eutrophic conditions
Reproduction habitat	Pond complex with > 5 calling ponds of different depths	Allows reproduction under different weather conditions (wet or more dry spring/summer periods)
Upgrowth of toadlets	Moist mudflats adjacent to the breeding pond, optimal in up-drying breeding ponds (> 1000 m²)	Foraging habitat for freshly metamorphosed toadlets
Survival of subadults and adults in summer	Bare ground or open meadow or easy dig able, loose sand: 50 m² per individual, 5 ha per population	Foraging land habitat for adults and juveniles, daytime hiding places for toads (digging into the sand)
Survival of subadults and adults in winter	Loose sand, rabbit holes, stone piles, old stone fences or cellars	Hibernation in frost free conditions

Table 3.3.1.a - Habitat requirements for *Bufo calamita* in the Baltic

3.3.2. Management conclusions

The following general rules should be considered when managing *Bufo calamita:*

- Catastrophes as alien invasive species, salt water flooding or diseases are to be avoided.
- Flexibility in habitat management, for “fine-tuning” of calling sites so that reproduction can take place by e.g. adjusting water depth or improve of grazing management for the necessary vegetation structures,.
- Reactivate the “toad habitat complex” of good breeding ponds, safe terrestrial habitat and hibernation sites.

  - In the first instance, good reproduction ponds – as fresh as possible in egg laying time – with several hundred young ones per pond/year are needed:

- breeding waters are typically a shallow temporary freshwater flooding in well grazed meadows, which are in optimal case dry most time of the year and filled with water for five to nine weeks after heavy rain in late winter, spring or summer.

- The right grazing in coastal meadows and dunes creates structurally rich grasslands with low, open vegetation and patches of bare ground. Sunlight can warm the ground, with the results that food is reachable and toads hiding in loose sand can warm up for night-time hunting.
- Within the “toad habitat complex”, night traffic on roads through villages, along the coast (e.g. to camping sites) can cause high loss rates, and should therefore be minimized. Migration over arable fields can lead to similar high losses due to ploughing and to toad contacts with fertilizer, which can cause severe chemical burns on the toad’s skin.

To successfully carry out management measures for the natterjack, all relevant aspects of the habitat structure must be considered. Under extreme ecological conditions such as are extant along *Bufo calamita´s* northern distribution boundary, a negative state of only one habitat feature may have severe consequences for a population. The following managing guidelines for habitats are suggested:

Aquatic habitats - the model for suitable aquatic habitats for *Bufo calamita* is based on the positive habitat features that were described above:

- shallow (~30cm) freshwater bodies
- temporary character
- gentle slopes
- high sun exposition
- complex of several breeding sites
- low vegetation cover

Photo 3.3.2.a - Blocking of small ditches in grazed, unfertilized meadows let reappear flooding in short grass, which are the best breeding waters for natterjack toads (egg-string in foreground) as here at Schwansener See (D), where the population increased from 12 calling males to about 100.

To create such habitats, basically two different strategies can be distinguished: 1) restoring and revitalizing natural dynamics of a site and 2) creating new breeding habitats by digging ponds. Of course, in many cases both methods will be applied and carried out simultaneously.

The first strategy aims at restoring or changing the local hydrological situation in such a way that suitable aquatic habitats appear by themselves. Concrete measures for this strategy might be for example the breaking of drainage systems, the opening of silted channels or the building of small dams in order to increase water retention. This strategy is quite often the more elegant and less invasive one of the two methods. Especially in sensitive areas - like most coastal meadows or lagoons - it can be a very useful management tool. When restoring

a former favourable situation with its own ecological dynamic, this also quite often means that the management needed in the future to maintain a suitable condition can be reduced to a minimum.

Terrestrial habitats - the model for suitable terrestrial habitats for *Bufo calamita* bases on the positive habitat features that were described above:

- open areas with short vegetation (2-5cm) or bare ground
- dunes or dunelike structures
- existence of hiding places and sandy, easy to dig soil
- minimum size of 5ha terrestrial habitat

An important feature for *Bufo calamita* is the existence of predominantly short vegetation or patches with bare soil. This characteristic can best be gained or maintained by implementing a grazing regime on the affected site. Details on that issue are given at several other sites in this guideline (chapters 5.1.1., 5.1.2., 5.1.3., 5.2.2.). Remaining work for the creation of the terrestrial habitat consists in the preparation of the landscape for grazing (removal of dense woodland structures, reedbeds etc.) and - in some cases - the addition of lacking landscape elements. The latter might be the artificial creation of dune like structures (as windbreaker and warm microhabitat) or loosening of hard-packed soil.

Photo 3.3.2.b - Dune slack like new ponds had been created at a former camping site. These are reproduction ponds for re-introduced natterjack and green toad populations. Adjacent grazed, sandy habitats are optimal foraging and hibernation sites for the toads. Monitoring board in foreground. (Photo Hauke Drews)

Some thought should be given towards the requirements of metamorphosing toadlets. Usually, after metamorphosis the animals are rather weak and small. In order to guarantee reproductional success, they must be provided with the possibility to both put on weight fast and then be able to reach safe hibernation sites quickly. To do so, mudflats should be created close to the breeding ponds. Patches of open and fully sun exposed ground must be nearby and be placed in such a way that they form stepping stones for migrating animals in autumn. All ground work is easiest undertaken with an excavator. In most cases such a machine will be present at the site anyway when creating aquatic habitats.

Hibernation sites - Distance between hibernation quarters and summer habitats as well as well-grazed structures in between influences the survival rate of *Bufo calamita*. As a rule of thumb, potential sites should be maximum 100m distance away from aquatic habitats. For hibernation, sandy, dry areas such as dunes are preferred by natterjacks for digging

themselves in. An effective and cheap way to create hibernation quarters artificially is to create a pile of bigger stones, buried up to 2/3 into the ground and covered with turf sods or some kind of fleece. Animals can enter the pile through gaps. The pile should consist of a minimum of 4 tons of stones

3.4. Bufo viridis

3.4.1. Habitat requirements

The green toad, *Bufo viridis* or *Bufotes viridis*, should probably be divided into two distinct species*, B. viridis* and *B. variabilis*, of which the latter is the one that occurs along the Baltic Sea. The green toad is less tolerant than the natterjack toad to atlantic climatic conditions with mild winters and cool summers. Therefore, it has a more south eastern distribution. It is a species that has been hit by especially strong declines in its frequency and distribution range. For instance, in Sweden, natural populations have survived only in three localities in the very south west of the country. And in Schleswig-Holstein, natural populations have survived only on the western part of Fehmarn and a few places south of Lübeck (in Lauenburg).

Photo 3.4.1.a - Bufo viridis, one of the target species of the BaltCoast project

Aquatic habitats - Like the natterjack toad, it is very much a pioneer species. The water bodies where it breeds can be of extremely differing kinds, varying in size from 2 m² to 50 hectares, and with water depths from about 20 cm to several meters. They may hold fresh water or brackish water up to 8 o/oo salt. The only common feature is that they are fully sun exposed and have very little vegetation along the banks.

Being a pioneer species, the green toad breeds especially in new water bodies. These can be temporary flooding that arise when drainage pipes get clogged or when mud, sand or gravel is rearranged along a river or a coastline. They can also be water bodies that arise in chalk, sand, clay or gravel pits.

The common principle for all such water bodies is that the amount of predators and competitors is low. For instance, in some field flooding, tadpoles of *Bufo viridis* may be the only macroscopic animal life. When such water bodies get permanent, they will be colonised by many other species, such as leeches, predatory insects, and newts. Newts, in particular, will eat many tadpoles. Tadpoles of *Rana* species are competitors which may eat the toads´ eggs or ultimately cause their tadpoles to die.

If new water bodies are not available, the toads breed in ponds where the vegetation is kept very short or sparse by other means, mainly be grazing. The grazing has to be rather intensive, so that the vegetation along the banks is just short grass.
A third possibility is to breed in water bodies with banks of some hard material, e.g. rockpools, water bodies with banks consisting of concrete, or artificial ponds on plastic sheets.

In any case, the water body has to be in some way extreme, so that the occurrence of predators and competitors is reduced as much as possible. Fish are usually not tolerated, but low amounts of sticklebacks (*Pungitius* or *Gasterosteus*) is usually tolerated. Breeding is rarely possible where *Triturus cristatus* lives. Ducks and ducklings, wild waterfowl, and gulls, eat eggs and tadpoles. Many bird species, e.g. lapwing, gulls and crows, eat newly metamorphosed toadlets.

Aquatic microhabitat - The eggs are typically placed in flooded grass or around straws; thus, for egg laying, a little vegetation may be useful. The newly hatched tadpoles feed in very shallow water at the banks. Older tadpoles typically feed on the bare bottom in the deepest parts of the water body. Tadpoles are better protected from vertebrate predators if they can hide between stones in the water, or in flooded grass.

Terrestrial habitats - The newly metamorphosed toadlets typically feed on small flies and collemboles living on the newly exposed mudflats around retreating water bodies. They soon move on, and typically migrate to distances of 0.5 – 3 km from the breeding site. Adult toads spend the summer at places with good sun exposition and some type of bare ground. The most frequently used habitat is at human settlements. They especially favour old farm buildings, where they live in the yard, at or in old barn buildings, in heaps of stones, bricks or firewood, in or under flowerpots, under terrace flagstones, in dung heaps, and in greenhouses. They come out at night and typically patrol along the walls of the buildings, catching beetles and other insects moving around there. If not living at buildings, they seek out other places with some type of bare ground, often paved areas, the bare bottom in gravel pits, footpaths lined with gravel, stone fences and stone heaps, sea shores, and all kinds of ruderal areas. Some herb or grass vegetation is tolerated, but there must be considerable bare ground between the plants. Woody vegetation is detrimental. Where areas grow in with trees and bushes, green toads are soon replaced by common toads.

The microhabitats where they spend periods of inactivity are avities or holes of some kind. If there are not already suitable cavities, e.g. under the floor of a barn building, they dig holes themselves, often in south facing slopes. Hibernation is also spent in such holes. If the winter is hard and the frost goes deep, they dig further down. If the winter is mild, they may come out of their holes and bask in the sun, even during winter like in February. The very mild winters of atlantic climates may cause them to be too active during winter, and thereby hamper them.

Migrations and colonisation - Green toads do not usually migrate so extremely far away from the breeding site as is sometimes seen in natterjack toads. But they do migrate rather far. Many individuals settle as far away from the breeding site as 3 km.
If a group of toads has settled at a human settlement 3 km from their place of origin, and if a new pond is made near the house, they will often colonise the new pond.

Toads may also swim in salt water. There are many indications that they may cross stretches of sea and colonise islands and peninsulas.

The following table 3.4.1.a provides an overview of important habitat elements:

Stage in life cycle	Sub-habitats and their features	Biological function
Adults	Sunexposed areas with sparse vegetation or bare ground. No trees	Bare areas are optimal for feeding and migration
Egg laying	Breeding ponds: temporary or permanent, freshwater or slightly brackish (up to 7 – 8 $^{0}/_{00}$), with little or no vegetation. Fully sun exposed	good reproduction success due to fast growth in high water temperatures
Upgrowth of tadpoles	Positive vegetation: short flooded grass-like plants or without vegetation	Hiding possibilities in the grass, good oxygen supply under eutrophic conditions
Reproduction habitat	Pond complex with > 5 calling ponds of different depths	Allows reproduction under different weather conditions (wet or more dry spring/summer periods)
Migration	Avoid road kills by erecting toad fences or banning traffic close to breeding sites	Green toads are more vulnerable than all other amphibians to road kills, especially because they often spend nights on paved areas
Survival of subadults and adults in summer	Areas of bare ground, with no or only scattered vegetation. Often up to 3 km from the breeding site. Good hiding places, such as heaps of rubbish	
Survival of subadults and adults in winter	In existing cavities or in holes dug out by the toads themselves	Hibernation in frost free conditions

Table 3.4.1.a - Habitat requirements for *Bufo viridis* in the Baltic

3.4.2. Management conclusions

To successfully carry out management measures for the green toad, all relevant aspects of the habitat structure must be considered. Under extreme ecological conditions such as are extant along *Bufo viridis* northern distribution boundary, a negative state of only one habitat feature may have severe consequences for a population. The following managing guidelines for habitats are suggested:

Aquatic habitats - suitable aquatic habitats for *Bufo viridis* must fulfil the following criteria. Apart from these, they may be of any kind:

- full sun exposition
- little or no vegetation cover
- few predators – absence of fish and of *Triturus cristatus*
- salinity of max. 8 ‰.

To create such habitats, basically two different strategies can be distinguished: 1) restoring and revitalizing natural dynamics of a site and 2) creating new breeding habitats by digging ponds. Of course, in many cases both methods will be applied and carried out simultaneously.

Photo 3.4.2.a - Stony beaches are preferred foraging habitat for Green toad good hiding structures in upper beach. (Photo Hauke Drews).

On a short term, digging new ponds is an effective method to boost the population of green toads. The toads will typically be very effective in finding the new pond already in the first

year, and the tadpoles will survive there extremely well, thereby producing a very large cohort of small toads. However, the pond will be much less suitable already after 2-3 years. The problem is to create a breeding site that functions on a longer term. Often, the only possibility to do this is to have the banks grazed, by cattle, horses, sheep or some other animal. The usual experience is that on a long term, the breeding population survives only in grazed localities.

Terrestrial habitats - Usually, the most important terrestrial habitat is at nearby houses. Therefore, it is important to speak with people about not making their place too tidy. They must leave some cracks and cavities and stone heaps etc. Or, alternatively, they may make their place of living attractive to both humans and toads by having many flowerpots, and decorative stones, rockeries etc. Also, flagstone terraces are excellent.
Outside of human settlements, it is important to avoid that the ground is covered 100 % by grass or any other vegetation. Establishment of gravel paths may be helpful. It may be necessary to implement a restoration scheme where parts of the area are scraped free of all vegetation at regular intervals, e.g. a third every year in a three-year rotation.

Hibernation sites - Hibernation sites are secured by providing frostfree microhabitats of the types referred to. Outside of human settlements, one may establish stone heaps or provide south facing slopes / terraces.

3.5. Population management for amphibians

Before a reintroduction of one of the toad species is carried out, the entire habitat complex for the Natterjack or green toad has to be in good condition. Threats that resulted in the extinction have to be identified and eliminated.

Once the suitability of the foreseen reintroduction site has been verified, suitable sources for spawn have to be found. This can either be a nearby population or - if any - animals directly from the target site.

These phases of rearing can be distinguished. 1) collecting spawn 2) rearing eggs and larvae 3) keeping metamorphs and 4) release:

Collecting spawn - spawn of the target species has to be collected from the source population. It is advisable to take eggs from many different egg strings, thus the genetic variability is enhanced. Some eggs can be severed from the egg-string using small scissors. No dead, fungus infested or sick looking eggs should be collected in order to avoid sicknesses. As both *Bufo viridis* and *Bufo calamita* larvae are rather robust, collecting a big safety surplus is ususally not necessary. If the anticipated number of released animals is for instance 1.000, collection of 1.500 eggs will suffice.

Rearing eggs and larvae - eggs have to be reared to larvae or metamorphs of the planned release size. The most practical way of doing so is to create artificial habitats that resemble natural conditions. This may be, for instance a 3*3m plastic outdoor swimming pool, equipped with a sandy bottom and some 20-30 cm of water. To the water should be added plants and mud from the source site. Predators on larvae, such as dragonfly larvae, have to be removed. Depending on the density that the larvae are being kept, regular water change may be necessary. Additional feeding (protein-rich food) is necessary to facilitate a fast growth. The water in the rearing basin must be kept warm (25-30° water temperature is optimal, not over 35°) and constant supply of air be installed (e.g. with standard aquarium air pumps).

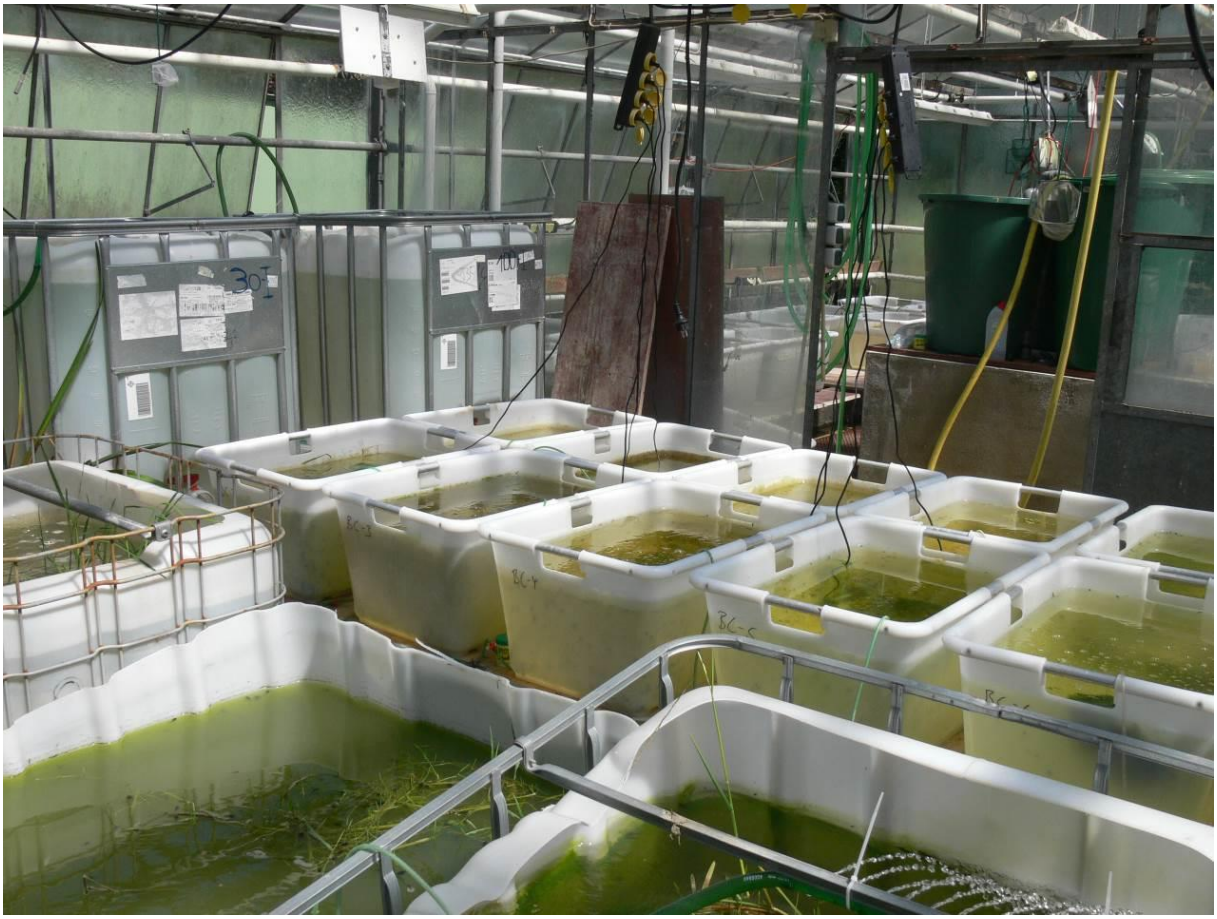


Photo 3.5.a - For reintroduction of the toad species the next populations were used to collect eggs. These were reared in stations -as here in a glasshouse in Kiel- to big tadpoles or young toads. (Photo Hauke Drews)

Keeping metamorphs - Once the larvae enter the metamorphic stage they must have the possibility to leave the water, otherwise they will drown. An economic way of offering that possibility is to build a little island into the breeding container. Floating islands, such as wooden planks, are not suitable since most animals will not find it. Metamorphed toads have to be put to their terrestrial habitat where they can start to feed. The habitat should again resemble natural conditions - mudflats. To create these, big, flat containers can be equipped with mud and plants taken from a natural mudflat. Only a small part should be water. If kept outdoors, the mud has to be moistened regularly when exposed to sunshine. In that way, the animals can feed on their natural food, collembolae at first and later bigger invertebrates such as little flies. Additional food for bigger animals can be provided e.g. by putting seaweed abundant with *Talitrus saltator* into the container.

Keeping many young toadlets and feeding them up is both time and space consuming work. Therefore the toads are often released as soon as they have completed their

metamorphosis. Observations from the BaltCoast project however indicate that it might be better to release 100 toads measuring 3,5 - 4 cm instead of 1.000 measuring 2 cm. The bigger and stronger the released animal is, the higher the chance that it survives the critical first few weeks, puts on weight and may reach a suitable hibernation site. Good results for rearing toads to a big size (4-4,5cm) were reached by a method for outdoor rearing, developed by AmphiConsult. 100m² were fenced in with a frog fence. Inside the fence, the natural habitat of the toadlets was imitated: small dunes, sandy areas, mudflats and small pools. The area was on hot days kept moist with a sprinkler. Food was provided partly natural by immigrating invertebrates, partly by additional feeding with *Talitrus saltator*. The site was protected against birds with a bird net.

Photo 3.5.b - The “outdoor rearing” developed by Amphi Consult allowed producing already big toads for release. This is an advantage in coastal areas, where wet sites around breeding ponds can have severe bird predation on very young toads. Bigger toads can live on dry habitats and will leave pond edges directly after release. These animals started to call one year earlier after release then those released younger or as big tapoles(Photo Florian Bibelrieter)

Release - Release sites have to be chosen carefully. In general, toadlets are to be released on mudflats where they can find shelter against predators (e.g. gulls or green frogs) - in or

close to small stands of short vegetation. The toadlets should be released at different sites at early evening in order to avoid a total failure caused by predation. Tadpoles should be released into shallow, well structured water which will not dry out before the animals can finish metamorphosis. In the BaltCoast project, 15% of the reared animals were always brought back to the source site to compensate for the original removal of spawn.

Practical advice

- spawn should be collected from many different egg-strings in order to achieve a high genetic diversity
- in order to rear a given number of toads, 1.5 times that number of eggs should be collected
- rearing works best under conditions as close to nature as possible - excluding predation, early drying up and sicknesses
- it is preferable to rear toads to a rather big size after metamorphosis than to release small animals or larvae
- animals are to be released where they find food and shelter from predators

3.6. Apium repens

3.6.1. Habitat requirements

The creeping marshwort *(Apium repens)* is a tiny plant species from the parsley family and it is threatened across the whole of Europe (both Annex II and IV species of the habitat directive). Ecology and biology of *Apium repens* are still not well known. In the western Baltic, the most northern site it is found is on the island of Fehmarn at a former coastal meadow which has been grazed by cattle since the plant was found there in the 1980s. In Denmark, creeping marshwort has been extinct for the last two decades.

Photo 3.6.1.a - The creeping marshwort (*Apium repens*) is a tiny plant species from the parsley family and it is threatened in whole Europe. (Photo: Heiko Grell)

The plant occurs in wet grasslands with short sward - it can grow on different types of wet soils but finds it hard to survive if hit by flooding with salt water. Furthermore, because it is low-growing, it is easily shaded out by taller plants. Therefore *Apium repens* requires hard grazing to create a short

sward. Even if grazing stops for only a few weeks during summer, competing grasses will outcompete *Apium repens,* as an experiment showed. An investigation carried out by the University of Hamburg (Prof. Kai Jensen) indicates that the distribution of *Apium repens* is not limited due to specific germination requirements, as the species was found to germinate under a wide range of temperature, light and water conditions. Seeds were, however, found to require either an exposure to cold temperatures or a light stimulus to break their dormancy. The results from the seed bank analysis shows that *Apium repens* builds up a

seed bank in the soil. It could thus be possible that the reestablishment of suitable management regimes on formerly known sites might lead to a regeneration of the species.

Results from competition experiments and a transplantation experiment indicate, that competition leads to reduced biomass and has a negative influence on both vegetative and generative reproduction. This could explain why *Apium repens* occurs primarily on grazed sites where the
growth of potential competitors is reduced by herbivores. When reintroducing the species to a formerly known or newly established site, it will most likely be necessary to introduce a regular mowing or grazing regime to create conditions suitable for the establishment and reproduction of *Apium repens*.

Summarizing, creeping marshwort habitats need the following characteristics:

- Neutral to basic soils
- Intermediate to high disturbance frequencies and intensities
- High but fluctuating water table
- A comparatively high nutrient content.
- *Apium repens* is “disturbance dependent”, which means the site has to be managed by grazing or mowing in order to prevent the plant becoming overgrown by competing plants.
- Bare ground is needed for germination and therefore trampling by grazers is positive (possible exception: first month after planting)
- High and fluctuating water levels are needed: High water table in winter with an inundation (flood) phase which protects the plant against frost damage and low water levels, but wet soils during summer to encourage possible flowering and seed development.

3.6.2. Management conclusions

For successful management of creeping marshwort following aspects are relevant:

- Management has to guarantee an all-time short swart, otherwise creeping marshwort will be overgrown and disappear in a few weeks. Nutrient poor soils are helpful because other competing plants grew less high.

- The plant is also sensitive to summer drought, so the sites needs to be near to groundwater level, keeping the soil moist all time. Another feature of the sites is a flooding during winter, so that the creeping marshwort is under water. It is assumed that this flooding protects the plant against frost.
- Summer flooding do not seem to have a positive impact, because then the grazing pressure from the cattle is reduced. Creeping marshwort does not flower under water and of course seeds are not produced in such a year.

As these preliminary results do not yet allow for definite conclusions regarding adequate management measures for the conservation of *Apium repens*, current management regimes should be continued as hitherto and all extant populations should be monitored carefully.

Photo 3.6.2.a - Since the ecology of the specie, e.g. germination, seed dispersal, seed survival in the soil, salt water tolerance and the soil characteristics were not known, the working group of Prof. Kai Jensen at the University of Hamburg carried out an investigation in the lab and in the field. (Photo: Sandra Burmeister)

3.7. Additional animal and plant species

On an overall project area of 20,000 hectares, the LIFE BaltCoast project encompassed 33 habitat types of the Habitats Directive in varying forms and frequencies. Special focus was put to twelve habitat types, which show a large amplitude of site variations within their distribution range along the Baltic coast. For good site management it is necessary - but not

sufficient - to pay particular attention to the specific demands of selected target species. In this case these were Baltic dunlin (*Calidris alpina schinzii*), Ruff (*Philomachus pugnax*), Black-tailed godwit (*Limosa limosa*), Pied avocet (*Recurvirostra avosetta*), Little tern (*Sternula albifrons*), Common tern (*Sternula hirundo*), Natterjack toad (*Bufo calamita*) and European green toad (*Bufo viridis*). In addition to these species, management and site development must also be oriented towards other breeding bird species of the project areas, towards species listed in Annex II of the Habitats Directive, and towards the multitude of animal and plant species that are characteristic for the respective habitat type.

Habitat types must be conserved in their entirety and in their variational range and be restored to a state that reflects a favourable conservation status, including all populations of characteristic animal and plant species. So far, the availability of data that would form the basis for this task is sufficient only for birds, amphibians, and plants to be adequately considered in the management. For many other animal taxa - such as bats, beetles, dragonflies, grasshoppers, ants, butterflies, and moths; but also for fungi, algae, mosses, and lichens - there is an unfortunate lack of specific data systematically collected in the protected areas. In some places, studies have been made on single species groups, in others little pieces of individual information is available. It is nearly impossible to find them all and take them into consideration when developing management tools.

Picture 3.7.a. - *Salicornia europeans* - a typical species of the salt meadows

In the course of the LIFE BaltCoast project, only two animal species (Common seal (*Phoca vitulina*) and Grey seal (*Halichoerus grypus*)) and one plant species (Least moonwort (*Botrychium simplex*)) from Annex II of the Habitats Directive have been reported from project sites so far. Reported populations of Annex IV species are, apart from the above-mentioned Natterjack toad and the European green toad, limited to the Moor frog (*Rana arvalis*), the Great crested newt (*Triturus cristatus*), and the European Fire-bellied toad (*Bombina bombina*). Other species of Annex IV like bats, fishes, and reptiles, are not listed in the standard data sheets of the 35 project areas. Well-known are only the occurrences of breeding birds and passage migrant birds.

Existing data gaps should be filled in future. The idea is to record information about all Annex IV species that potentially occur in the protected areas and about the characteristic animal and plant species of the habitat types. Management of each protected area must be individually adapted to its own inherent history and development potential. The decision tree of this guideline (Chapter 8) can be an important aid for establishing priorities and solving conflicting objectives.

In Germany, it has proven useful to pay additional attention to relevant habitats and structures: percentage of open soil, flowering aspects, condition of the litter layer, anthills, and cowpaths. Those elements usually represent the conservation status of habitat types and the colonisation options for typical species quite well.

4. Recommended monitoring methods

4.1. Recommended monitoring methods for bird target species

Monitoring perspectives in the target bird species: As national counting programmes are primarily set up in order to cover or to sample population trends on a national scale; such programmes are often too coarse-grained and not sufficient, when the aim is to evaluate a specific site, and its attractiveness and functionality for a specific target species. The monitoring manual should be adjusted to the level of information needed, the attractiveness of a site can be evaluated by surveys on population sizes, whereas if the functionality of a

site is the issue – i.e. are the target species actually reproducing themselves or is the site a population sink? – monitoring must also to a certain extent include a survey of the breeding success of the target species.

However, monitoring of population sizes only can also be seen as a kind of monitoring of functionality on a longer time-scale, as a continuous lack of recruits will eventually lead to population declines. In long-lived species as the meadowbirds and colonial breeders targeted here, the time lag between the seasons with unfavourable breeding conditions and the seasons with marked population declines may include many years, and in situations where the aim is to evaluate specific management or other conservation initiatives, such a time lag will obscure the results completely.

Therefore, the recommended methods for monitoring of the target bird species in this context include measures to evaluate the reproduction on a very broad scale.

4.1.1. Meadow birds

Baltic dunlin - Background breeding biology information of importance for monitoring: Territories are established from early-mid April, with the last pairs entering the meadows in early May. First egg clutches are laid from late April to late May while replacement clutches are laid till mid or late June dependent on weather and habitat characteristics. Laying period is 5 days and incubation period 21 days. Chicks fledge and become independent after 18-23 days; they find their food themselves and are generally attended by one or two parents almost the entire period up to independence. The latter half of this period, mostly only the male stays with the chicks. After independence, breeding adults leave the area.

Up to hatching, breeders behave inconspicuously apart from the relatively limited time when the males or the pairs are displaying. One parent lays hidden in the grass on the eggs; the mate usually feeds elsewhere on common feeding grounds. After hatching (from late May) successful breeders all of the sudden become conspicuous, because they alarm noisily around the hidden chicks, when an observer is approaching. This obvious alarming behaviour continues until independence of the chicks (or until the chicks are lost).

Survey methods: Due to the inconspicuous behaviour of the birds during incubation, surveys must be performed by walking through the area where all suitable breeding habitats should be visited with less than 75-100 m distance.

Because many breeding sites have fairly small areas with suitable breeding habitat, the most important aim is often to identify whether the Baltic dunlin is breeding or not, while at other sites the main task is to estimate the number of breeding pairs.

Documentation of breeding: Beside direct evidence of breeding like nests, copulations or alarming behaviour there are a number of indirect indications of breeding. With experience, Baltic dunlins can be distinguished from northern breeders by their small size (including short bill) and a less bright breeding plumage, with a diffuse edge of the black area of the belly, and brownish red fringes of the back feathers and wing coverts rather than the bright orange-red fringes of the northern breeders. Observations of Baltic dunlins in May and June are good indications of breeding. Almost all northern breeders have left the Baltic in early June, and they return from late June. Observations of dunlins in meadows between 3 and 20 June are indications of breeding as are repeated observations of a dunlin in the same spot of the meadow during May and June. At the April-early May count northern migrants may also perform aerial displays.

Photo 4.1.1.a - Susanne Forslund project manager from Kalmar County looking for ruff at Sydöstra Öland, Sweden. (Photo: Hauke Drews)

Counting: In order to obtain a reasonable estimate of the number of breeding pairs at a site, at least one survey in late April or early May and two surveys in June must be performed (see table 4.1.3.a). Especially in narrow coastal meadows where the meadows are likely to dry up during May the birds are time constrained, and here the early count is essential, as failed breeders may leave the area before June. There should be an interval of at least 7 days between the first and second count in June. Each pair and single individual are included as indicative of a breeding pair except birds seen feeding only or roosting at common feeding sites. Map all observations. Use the number from the survey with most “breeding pairs” as indication of the minimum number of breeding pairs at the site. Add pairs from other visits that were found more than 300 m from observations at the “maximum survey”. Be careful at the April-early May survey not to include northern migrants.

Additional counts, e.g. one in late May and/or one in late June, may improve the data quality significantly.

All indications of breeding success like the number of alarming pairs/males and observations of chicks or very young juveniles should be noted as measures of the breeding conditions at the site.

Where to search: During breeding, dunlins live in fairly open grassland and often concentrate inland along the coast or in the neighbourhood of pools, ponds and gullies, recently dried out or with shallow water. Breeding dunlins are rarely found in high vegetation (>15 cm) away from permanent or temporary water bodies, and they are never found in reed or among bushes.

Ruff - Background breeding biology information of importance for monitoring: Males are lekking (“dancing”) at communal leks or loosely around feeding females on the meadows where fecundation takes place. In this way they are very conspicuous. However, only the females take care of nest building, incubation and chick rearing. Eggs are laid primarily in second half of May and June. Egg laying period is 4 days and the incubation period 22 days. The mothers attend the chicks for 7-13 days where after the females leave the area and the chicks are left alone another one to two weeks before fledging.

Up to hatching, breeding females behave inconspicuously. Unless flushed, she lays hidden in the grass on the eggs only interrupted by short feeding breaks. After hatching (from around 6-10 June) successful females become conspicuous for a fairly short period, when they constantly alarm around the hidden chicks, when an observer is sufficiently close (<40-75 m), uttering fairly low rasping grunts and restlessly flying in small circuits.
Survey methods: Breeding females are chosen as the “breeding unit”. Due to the inconspicuous behaviour during incubation, surveys must be performed by walking through the area where all suitable breeding habitats should be visited with less than 75-100 m distance.

Documentation of breeding: Presence of ruff females (reeves) after the northern breeders have left the Baltic and before they return on the autumn migration is strongly indicative of breeding attempts. Between 21 May and 12 June there are usually no non-breeders present, and occurrence of reeves in this period is interpreted as breeding evidence. Also the presence of male ruffs between 21 May and 8 June is indicative of breeding of the species in the neighbourhood.

Counting: In order to obtain a reasonable estimate of the number of breeding females, at least three surveys in late May and June must be performed (see table 4.1.3.a). Intervals of at least 7 days between the counts are preferable. Try to detect as many flushed reeves as possible on the meadows, when they flush from their nest. Map all observations. Use the number of females from the survey with the most individuals as indication of the minimum number of breeding females at the site. Add females from other visits that were found more than 300 m from observed individuals at the “maximum survey”. Alarming females observed in the same area with more than 13 days in between are almost certainly different individuals, and extra females identified in this way should also be added.
Additional counts in late June or early July may reveal late breeders overlooked earlier in the season.

All indications of breeding success like the number of alarming females, or large chicks or very young juveniles seen before 10 July should be noted as a measure of the breeding conditions at the site.

Where to search: During breeding reeves live in fairly open grassland and often concentrate near or in natural depressions like recently dried out pools or gullies. Nests and families are also found in higher vegetation (< 20-25 cm) given that the vegetation is fairly open and easily penetrable by the females as well as by the chicks. Breeding ruffs are never found in reed or areas with bushes.

Black-tailed godwit - Background breeding biology information of importance for monitoring: Egg laying takes place from the second half of April to mid-late May. Before laying, territories are very flexible, and the number of breeding territories is best surveyed during the main incubation period. Laying takes 5 days, and the incubation period is 23 days. In the pre-breeding period in April the birds gather at good feeding areas in fresh wetlands, and from there they disperse to the breeding areas, which may be up to some km away.

The two sexes share the incubation, and the bird not on duty is usually in the neighbourhood feeding and guarding, being ready to attack intruding predators, in particular aerial predators.
Survey methods: Distant mapping by use of telescope – if possible from an elevated point – is preferable to walking through the area, because godwits are flying around a lot, but walking may be necessary in large areas and/or areas with poor visibility.

Counting: The preferred counting period for counting pairs is before mid May; later, the visibility decreases due to the up-growing vegetation and thereby the coverage. The number of individuals is counted and multiplied by 0.7 to calculate the number of pairs. Alternatively the number of mapped nest territories is used as the basis for the breeding estimate. With some experience it is possible to identify the sex of the birds during mappings – males are on the average much more bright orange whereas the females are brownish beige. Sexing improves the possibility to identify territories and pairs significantly.

Successful families are quite conspicuous, as the parents are alarming a lot. Counting in June of families provides important additional information on the breeding conditions of the species at the site.

Where to search: In the Baltic, black-tailed godwits breed locally on well managed wet hay meadows and pastures. Elsewhere in the Baltic countries good numbers are also found in polders and extensive raised bogs.

4.1.2. Colonial birds

Avocet - Background breeding biology information of importance for monitoring:

Breeding avocets are colonial, and they are nomadic and may perform large-scale displacements within the same breeding season when experiencing extensive predation, disturbance or flooding of eggs and nests. Most colonies are found on small islands, others on short grass meadows near water bodies in areas not frequently visited by mammalian predators. Egg laying starts around 15 April, and replacement clutches are laid well into June. Laying takes 5 days, and the incubation period is 24 days. Adults take their chicks to flats rich in invertebrates without or with very short or open vegetation.

Survey methods: Usually avocets breed in short vegetation or on bare ground, and the birds in and around the colony are quite visible. Therefore, it is often straightforward to count the number of avocet individuals from the distance, ideally from an elevated point (observation tower, small hill, dike etc.). When an observer approaches a colony, some birds often fly relatively far away making counting difficult.

Counting: Because of the nomadic nature of the avocet, and in order to avoid double counting, the counting period is restricted to less than 3 weeks in May (see table 4.1.3.a). Additional counts of adults in April, and of chicks in June-July may add important information on the breeding conditions on the site.

Photo 4.1.2.a - Avocet

The best measure of the size of the breeding population is obtained by a count with telescope from an elevated point at sufficient distance from the breeding colony to avoid that the birds are disturbed and chased away. The number of individuals in or near the breeding colonies are counted (excluding chicks), and as compensation for birds feeding elsewhere the number is multiplied with a factor 0.7 to estimate the number of breeding pairs.

Counts of chicks – under undisturbed conditions – on the mud or sand flats during June and July provide important information on breeding success at the site. In particular during low water situations when feeding conditions are optimal.

Where to search: Coastal meadows with short vegetation and islets near sheltered mudflats should be checked for presence of avocets. Similarly inland wetlands with short-grazed meadows and/or sand/mudflats above the waterline may house breeding avocets. Avocets are so strikingly visible that it is usually quite fast to assess whether breeding avocets are present at a certain site in a given year. Breeding data stored in the BaltCoast meadowbird database provide information on past breeding sites in Denmark, Sweden and Estonia and are helpful in selecting which sites to search.

Common tern - Background breeding biology information of importance for monitoring: Breeding common terns are colonial, and they are nomadic and may perform large-scale displacements within the same breeding season when experiencing extensive predation, disturbance or flooding of eggs and nests. At the coast they breed in grasslands and dunes with short vegetation and on islets in coastal wetlands, often in mixed colonies with arctic terns. Inland common terns breed single or in colonies (mostly in fairly small colonies) at lakes and larger ponds, mostly on islets with short or open vegetation. Inland, the common tern is the only Sterna species. Accepts floating man-made rafts for breeding. Egg laying starts early May in the inland, two weeks later at the coast, and replacement clutches are laid till early July. Laying takes 1-3 days, incubation 21-22 days. Chicks are fed by their parents near the former nest, and they fledge after 3 to 4 weeks. The young birds stay several months after fledging with their parents.

Species identification: In coastal habitats in the Baltic, where common terns often breed in mixed colonies with its sister species arctic tern, species identification of the two species pose a serious challenge even among some experienced ornithologists. Consult an

advanced field guide and/or a high quality identification paper. Key features are bill colour and bill shape (blood red in arctic tern, often without black tip, relatively short, slim and curved; more orangey red in common tern, always with a prominent black tip, bill longer and more bulky) and distribution of black, dark grey and translucency on the wings. Legs of arctic tern are very short, often invisible on the sitting bird, legs of common tern are observably much longer. Also the alarm cries are quite different for the experienced observer.

Survey method and counting: In order to avoid double counting of breeding pairs that have moved after large-scale loss of eggs, the counting period is restricted to 3 weeks in late May – early June (see table 4.1.3.a). Additional counts of chicks in June-July may add important information on the breeding conditions on the site.

The best measure of the size of the breeding population in more open and visible colonies is obtained by a count with telescope from an elevated point at sufficient distance from the breeding colony to avoid that the birds are disturbed and chased away. If the colony is partly or completely concealed in vegetation or behind higher features, the best counting method may be to wait for a common flying up of the birds, which happens regularly as reaction to a visiting aerial predator or apparently spontaneously. The number of individuals in or near the breeding colonies are counted (excluding chicks), and as compensation for birds feeding elsewhere the number is multiplied with a factor 0.7 to estimate the number of breeding pairs.

Where to search: Widespread where there are islets and small peninsulas with short vegetation at sheltered coasts and in freshwater lakes.

Little tern - Background breeding biology information of importance for monitoring:
Breeding little terns are colonial, and they are nomadic and may perform large-scale displacements within the same breeding season when experiencing extensive predation, disturbance or flooding of eggs and nests. Breed on beaches or shorelines, in white dunes and estuaries on sand without vegetation or at most very sparsely vegetated. Colonies very vulnerable to mammalian predators, and often situated near the high tide line on spits, banks and islets. Egg laying takes place primarily mid May to mid June. Laying takes 1-4 days, incubation 18-22 days. Chicks are fed by their parents near the former nest-site, and they fledge after 3 weeks. The young birds stay several months after fledging with their parents.

Survey method and counting: In order to avoid double counting of breeding pairs that have moved after large-scale loss of eggs, the counting period is restricted to 3 weeks in late May – early June (see table 4.1.3.a). Additional counts of chicks in June-July may add important information on the breeding conditions on the site.

Most colonies are situated quite open, and often it is possible to count the number of birds in the colony with a telescope from an elevated point at sufficient distance from the breeding colony to avoid that the birds are disturbed and chased away. If this is not possible, the best counting method may be to wait for a common flying up of the birds, which happens regularly as reaction to a visiting aerial predator, a visiting person or apparently spontaneously. The number of individuals in or near the breeding colonies are counted (excluding chicks), and as compensation for birds feeding elsewhere the number is multiplied with a factor 0.7 to estimate the number of breeding pairs.

Where to search: Little terns select little disturbed beaches, dunes, sands and sand- and mudflats above the waterline, and such places should be scanned systematically for the presence of breeding birds. The majority of breeders return to some classical breeding sites year after year, but some birds are more opportunistic and can be found on new breeding sites.

4.1.3. Recommended survey periods

In table 4.1.3.a the recommended survey periods of the meadowbird target species, the colonial target species and some additional meadowbirds are listed.

Table 5.3: Overview - recommended survey periods for birds							
	25 Apr - 10 May	6 - 25 May	23 May - 1 June	3 - 10 June	11 - 20 June	21 - 30 June	1 - 10 July
Target meadowbirds:							
Dunlin	pairs	(pairs)	(pairs)	pairs, families	pairs, families	(pairs, families)	(pairs, families)
Ruff			females	females, families	females, families	females, families	(families)
Black-tailed godwit	pairs	(pairs)		families	(families)	(families)	
Target colony breeders:							
Avocet		adults		chicks	chicks	(chicks)	(chicks)
Common tern			adults	adults	(chicks)	(chicks)	(chicks)
Little tern			adults	adults	(chicks)	(chicks)	
Other meadowbirds:							
Lapwing	pairs	families	(families)				
Redshank	(pairs)	pairs		pairs, families	pairs, families	(families)	(families)
Oystercatcher		pairs	(pairs)	pairs	(families)	(families)	(families)
Common ringed plover	pairs	pairs		(families)	(families)	(families)	(families)
In black: main survey periods; in () and purple: useful and informative additional surveys							

Table 4.1.3.a - Recommended survey periods for bird monitoring

4.2. Amphibians

In order to monitor *Bufo calamita* and *Bufo viridis*, the following procedures are suggested:

- Recording of calling
- Counting males
- Recording egg strings
- Recording larvae
- Recording newly metamorphosed toadlets
- Recording adult toads in the summer habitat
- Capture-recapture

Recording of calling - The easiest way to record the rare toads, *Bufo viridis* and *Bufo calamita*, is to visit the breeding sites at night when the males are calling. They call so loudly that they may be found from a great distance, up to 2 km. The breeding localities may shift from year to year depending e.g. on changes in rainfall and water levels, and the toads are sometimes able to colonise new localities over large distances. Therefore, one should not just listen at known ´traditional´ localities, but also listen at other sites where the animals might possible appear.

The males call typically from the last third of April and some weeks ahead, with *calamita* calling at slightly lower water temperatures than *viridis*, which means that it starts a little earlier.

The optimal time for hearing the males may differ from country to country and year to year, depending on temperatures and on other weather factors. Typically, surface water temperatures should be at least 12° C in the evening after sunset for *viridis*, and slightly lower for *calamita*. There may be differences between populations, some calling earlier in the season than others. Indeed, choruses at some localities may start only well into May, when choruses at other places are about to finish.

If April-May is very dry and water levels are low, all breeding activities may be postponed until rain comes. In extreme cases, breeding activities for most individuals may be postponed to the end of June or the start of July. They will then start after heavy rain.
Also, there may be populations where the first individuals start to call in April, and other individuals call much later, in May or in June. This may be due to different seasonalities encoded in the genes.

Usually, the toads are very sensitive to wind, and they will call only if the weather is fairly calm. When a flag is stretched out in the wind, the weather is too windy for them. There may be exceptions to this rule, however.

If the weather has been bad for some time, and the weather suddenly becomes perfect for calling, then the toads will have much energy, and they will call from early evening to very late in the night, or even to about dawn. Thus, they may be calling up to six hours, which leaves much time for recording. In the next night, they will also call until late in the night; but if the good weather continues, they get tired, and later in the season, they will call for only 1½ to 2 hours per night.

Concerning *calamita*, the calling is nearly always very loud. It may be heard at distances of at least 1 km, and often 2 km. For *viridis*, if the weather is perfect, and/or if the toads have found a new locality and apparently want to attract other individuals, the calling will be equally loud. But if the locality is the same old pond as always, and the weather is not very good, calling may be much weaker, and sometimes it can be heard only a few hundred meters away.

The first part of the night, when the toads call loudly and constantly, is ideal for localising new breeding localities. One walks toward the sound until one finds the exact place. From about

midnight onwards, intervals between calling bouts get longer and longer, and in the end, the males just sit silently at the water´s edge.

Often, the number of males present will be 5 to 10 times the number of males that call at a given moment. But there is no reliable proportionality between the number of males present and the number of males that actively call. In localities where the animals are extremely numerous, they need not call at all to attract females. Often each individual will call only at long time intervals; one may notice the exact place from where the sound comes, and then notice if the next calling sound comes from the exact same place or another place some meters from the first. If the latter is the case, this will usually mean that one has heard two different males.

Photo 4.2.a - A green toad refuses to take part in the census

Counting males - Usually, not all males call at a time. So, to get an exact figure for population size, one must localise every single male, whether it is calling, sitting silently, or in amplexus. This is most easily done in such places where all males sit at the water´s edge. You use a strong torchlight and walk slowly along the banks, counting the animals as you see them ahead of you. The animals are blinded by the direct light and do not move very much. Do not

turn around, because then the animals will see you as a dark figure contrasting with the light behind you, and then they will dive.

This method is especially fine for well known localities. You can come there relatively late in the night, even after all calling has ceased, and still get a reliable count of the number of males active at the breeding site.

If the males are not concentrated along the banks, but scattered all over the water surface, they may still be counted. After some time, they get accustomed to the disturbance, and you may walk in waders between the calling males.

The number of males sitting in the water does not indicate the population size of males. Even at the peak of the calling season, many males will not be in the water, but in their winter or summer habitat. You should not expect that all males will ever be in the water at the same time. This is especially true for *B. viridis*.

Recording egg strings - in ponds with shallow, clear water, one may count the number of egg strings to get a figure for the number of breeding females. In most localities, however, it may be rather difficult to find the egg strings, which lie in flooded grass or in muddy water. Therefore, counting of egg strings is not a generally recommendable method.
Egg strings typically hatch after about 4 days, and the period of spawning will typically extend over several weeks. So it is not possible to see all egg strings by visiting the locality only once.

Photo 4.2.b - Pair of natterjack toads spawning in a shallow flooding at Schwansener See (D). (Photo Hauke Drews)

Recording tadpoles - Newly hatched larvae spend the first days at the waters edge close to where they were hatched. In clear water, they may be easily seen and recorded as the offspring from one egg string per group of larvae. Older tadpoles may be found be direct inspection or by dipnetting.

Tadpoles of *calamita* are typically in flooded grass in extremely shallow water (water depth typically about 5 cm). They can only be caught with a dipnet with a straight side that can be drawn through the grass just above the bottom. Older tadpoles of *viridis* usually stay at the bottom in the middle of the water body. Here, too, one will need a dipnet with a straight side that can be moved just above the bottom. They will often swim in schools, that is, one may search for a long time and catch none, and then suddenly one gets a hundred tadpoles in one sweep.

Recording newly metamorphosed toadlets - The newly metamorphosed toadlets are active in daytime and may be seen by walking around the perimeter of the water body. They will often hide under any objects lying on the ground, and may be found resting under such objects.

Recording adult toads in the summer habitat - Adult toads may be found outside of the breeding season by walking around in suitable habitats at night with a torchlight. The weather must be calm and not cold, and results are best if it is raining or has just rained a few hours

ago. This is done most easily with *viridis*, which usually forages on areas with bare ground, where they are relatively easily seen. If the locality has short grass vegetation as well as bare ground, few individuals will be on the grass, and most on bare ground. *Calamita* forages more often on grass; but here they may be less easily seen than on bare ground.

Capture-recapture - If one needs a reliable estimate of the total population, one has to identify the individuals. That is, each caught individual must be marked in some way. Methods that have been applied are marking by toe clipping, marking by injecting PIT marks under the skin, or photographing the individuals. The latter method is especially fit for *B. viridis*, where the very characteristic spot pattern is specific for each individual, like a finger print, and nearly constant over the years. The individuals are photographed, and a file kept of the photographs which will allow one to record when the same individual is found again at a later occasion. In the capture-recapture method, the total number of individuals is calculated from a formula. If there are just two catching bouts, the formula is simply:

$$\frac{\text{(no. captured at first bout) X (number captured at second bout)}}{\text{(no. captured at both bouts)}}$$

For more complicated catching systems, and for calculating confidence intervals, one may consult standard text books on field biological methods. The capture-recapture method is of course rather expensive in terms of time and manpower and thus it cannot be used as a routine monitoring method.

4.3. Vegetation structure monitoring

Vegetation monitoring of the eleven LIFE BaltCoast project areas in Germany was realised by interlacing sampling levels of different scales. To get an overview, the sites were surveyed as a whole on a rough scale. Structural parameters were recorded in finer detail on a smaller scale - especially important features were precisely recorded. All information was combined in a GIS-based computer analysis (ArcView).

The vegetation monitoring consists of five recording levels:

- analysis of existing data

- oblique aerial photographs of all project areas
- transects through the project areas
- GPS-supported precise mapping
- GIS-based computer analysis

Vegetation monitoring was carried out at the beginning of the LIFE BaltCoast project, being repeated after four years. It supplements the mapping of habitat types of the Habitats Directive in the protected areas, which was available at the beginning of the project and should be repeated every six years in order to fulfil the reporting commitment to the EU.

Investigation of previous data - Before field studies, available data about the protected areas was analysed. Nature conservation associations, authorities, and individual experts of the areas were consulted and asked for general information on the history of the development of the area and the presence of characteristic animal and plant species; data bases and literature were consulted. Precise recordings of site-occurrences of plant species were copied into the GIS, further data was compiled in lists. Digital maps, recent aerial photographs, and topographical maps were available.

Oblique aerial photographs - Preoperational work preceding field investigations also included taking oblique aerial photographs of all protected areas, taken from a light aircraft (Do 27) in autumn of 2005 and 2009. 30–50 oblique aerial photographs of different resolution were taken in each area. General photos give an overview, detailed photos show individual features. Aerial photos were taken at the beginning of the project and four years. In the beginning, the aerial photographs were used to outline sub-areas (polygons) which should later be surveyed in more detail, and as help for orientation in the field. Both sets of photos, taken at a 4-year interval, allowed documentation of the initiated measures and first records of their large scale effects. Photos of the first round allowed finding all relevant plots and structures again during the second flight. Oblique aerial photographs constitute a valuable working basis for the management plans.

Transects through the project areas - For the field investigations, maps based on b/w aerial photographs indicating occurrences of relevant plant species were printed. These maps also contained the above-mentioned polygons, representing potentially interesting areas, to be investigated in detail. In each protected area, a representative plot of about 50 ha was

divided into 20 to 30 polygons. For each of the total of 344 polygons (average size of 2 ha), 14 structural parameters were registered, occurrence of significant species recorded, and the state of the plots textually described.

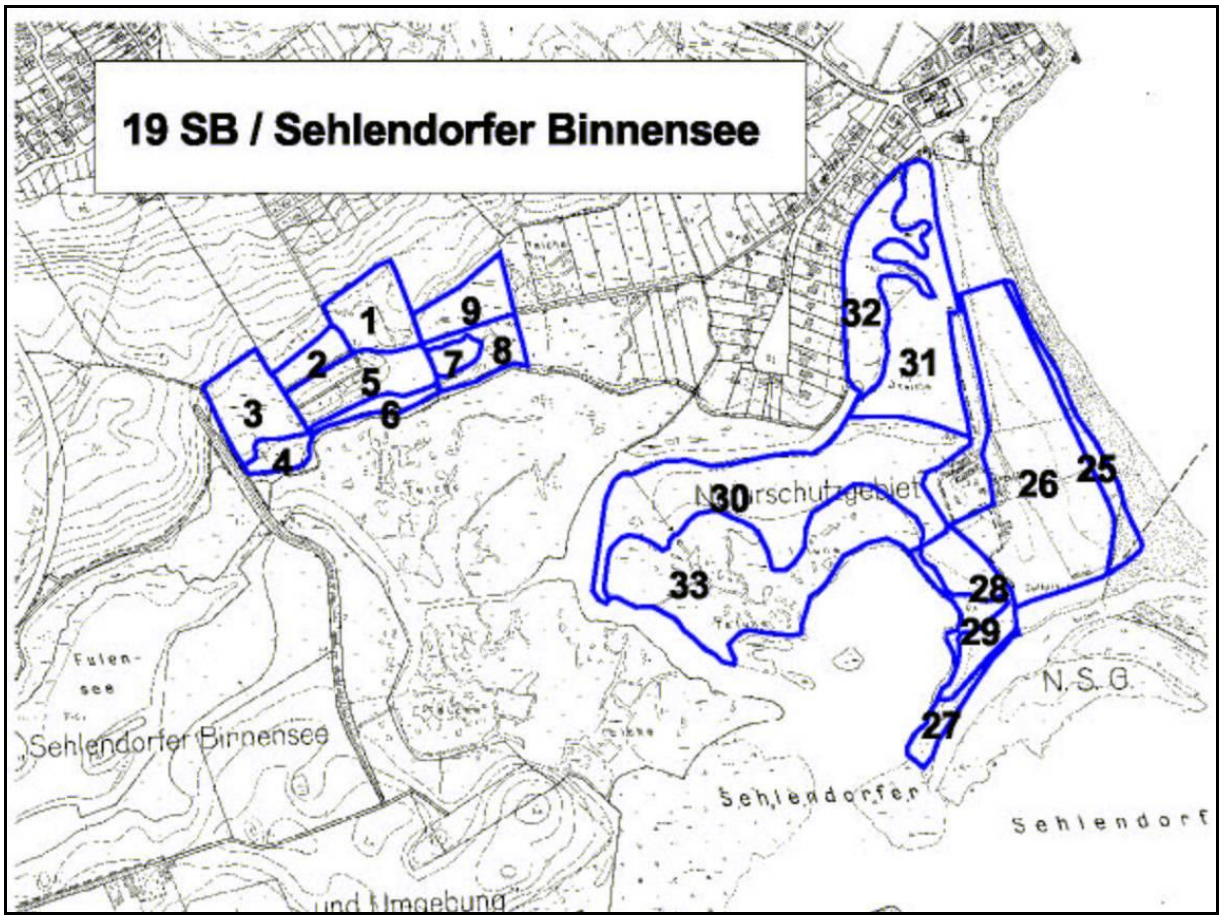


Fig. 4.3.a - Example of outlining polygons at Sehlendorfer Binnensee.

Among the recorded structural parameters are: percentage of bare soil, thickness and coverage of litter layer, coverage of herbs and grasses, vegetation height, and coverage of different vegetation layers (in cm of growth height). Coverage of cryptogams and woodland plants was determined, together with information of damages caused by feeding animals and condition of inflorescences. The estimated values were - a given uncertainty accepted - recorded and classified at a five-class scale. The classification made it possible to generate maps of the structural parameters, using GIS software.

All polygons were visited, occurrences of rare and/or specific plant species recorded. The polygon sub-areas of the project sites were inspected carefully and in a systematic way. The

tacks of the first round of transects was recorded by GPS and therefore available for orientation during the second investigation round.

GPS-supported precise mapping - The first investigation round resulted in finding 903 occurrences of 112 rare and typical coastal species. These were revisited during the second investigation round after four years. Changes in abundance, vitality and domination were classified and later - GIS based - linked and cross checked with management measures. The development of 395 woodland plants (information on species, height, and condition recorded during the first investigation round) was recorded analogically, with a special focus put on effects of established grazing regimes.
The dispersal and abundance of the Japanese rose (*Rosa rugosa*) was all the times closely examined. Comparing the gathered data with the oblique aerial photographs, development trends of the species after subjecting it to grazing pressure were made visible.
State and development of coastal landscapes - in particular of individual habitats and plant populations - were documented during both inspections by numerous digital photographs. Each photo was tagged to a specific location. In this way it was possible to take a series of comparative photographs at important sites.

GIS-based computer analysis - Polygon and point data were processed by a GIS system. Analysis of the data was used to generate action plans and for fine-tuning the conservation measures. The situation at the beginning of the LIFE BaltCoast project could be compared with the situation, as recorded four years later. The data is available for future surveys.

Data was analysed in three different ways:

- Object-related. Data of structural parameters and species were analysed separately. In this way it was possible to show how e. g. the percentage of open soil, litter layer or the population of an individual plant species did develop over the time in all project areas.
- Measure-related. Interfacing the collected data with carried out measures allows to observe the effects of an individual measure. For example the development of the litter layer, the vegetation height or the condition of inflorescences can be retraced in all grazed project areas.

- Area-related. The development of species, structures, and the whole vegetation can be reconstructed for each individual project area. This information can be very useful for future management and corresponding management planning.

The presented monitoring of the eleven German project areas helped to compile valuable, high quality data, both very useful for the planning of the management and for the concrete realisation of measures and project aims.

5. Recommendations on specific habitats and threats

5.1. Habitat management

5.1.1. Coastal meadow management

Improving the conservation state of habitat types 1330 (Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)) and 1630* (Boreal Baltic coastal meadows) was one aim of the BaltCoast project. For coastal meadows of the Baltic included into the Baltcoast project, these main problems can be identified: unfavourable succession trends, melioration measures and nutrient enrichment.

Meadows are dependent on agricultural use. As the need for stable grasslands - which can be grazed by heavy cattle and are passable for tractors - grew during the last decades, land use on coastal meadows was intensified. Meadows were drained by foot drains and ditches, wet depressions were filled in. Abandoned meadows gradually turned into reed beds or woodland. Most birds and amphibians confined to coastal meadows, including the target species dunlin, ruff, natterjack and green toad, could exist neither in intensively used meadows nor in succession stages with stands of tall vegetation. Concrete conservation actions of the BaltCoast project aimed on the restoration of a pre-intensive state of the meadows: wet soil in spring as foraging and nesting area for waders, flooded depressions as breeding sites for the target toads and large areas of grassland, which give wader birds the necessary overview over their breeding area.

In order to restore a favourable conservation state, a set of different conservation actions has been elaborated by the project team and implemented on site during the project. Basically two different types of actions must be distinguished: (I) initial mechanical actions preparing a site and (II) establishing a grazing regime. Actions of type (I) addressed the issues of improving hydrology, restoration of depressions and removal of unwanted vegetation:

Optimizing hydrology - For the reactivation of the natural hydrology 16 km of ditches, foot drains or drainage pipes were blocked or removed at 12 sites. An excavator scraped off material for the blockings from surrounding grassland. Doing so, shallow depressions - which may later retain precipitation - were automatically made in the meadows. The removal of drainage pipes (especially in upper salt meadows) led to a reactivation and rewetting of natural depressions and old ponds. The optimization of the natural hydrology created shallow water areas on the meadows. Especially in spring, such shallow, well grazed flooding, surrounded by low vegetation structures attract wader birds to the sites. Deeper water bodies caused by blockings were used by *Bufo virids* as reproduction habitat at some Danish sites.

Photo 5.1.1.a - Coastal meadows are -as many semi-natural habitats- threatened either by intensification or by abandonment. Boreal coastal meadows in the Eastern Baltic were often abandoned 15 years ago as in Teorehe (Est). (Photo Heiko Grell)

Restoration of natural depressions - Lack of grazing often led to nutrient enrichment in natural depressions, caused by run-off water from nearby fields. In this case the depression was scraped clean with an excavator. The removed soil and mud was used to block drainage ditches or spread over neighboring agricultural fields for soil improvement. The re-activated depressions got filled by precipitation. The new fresh water bodies in the upper salt meadow zone were used by toads as breeding sites and by ruffs for foraging.

Removing unwanted vegetation - If coastal meadows were too overgrown by native or invasive woodland species, these had to be removed in order to facilitate subsequent grazing. Likewise, dense grass swards and extensive reed beds were mown in order to promote a faster development of grassland and open lagoon edges. Especially in Estonia, removal of scrub played an important role. There, juniper and willow bushes can easily take

over boreal coastal meadows. Salinity of the Baltic is so low, that periodic flooding does not negatively affect their spreading. The Estonian partners Kihnu strait Marine Park and Pöjakonn organized conservation camps with volunteers in order to remove scrubs.
After the first mechanical actions, grazing regimes were established in order to further improve the conservation state and to maintain it at a high level:

At Atlantic salt meadows or Boreal coastal meadows grazing was improved or reintroduced by different types of cattle and konik-horses. The grazers reduced the litter – old plant material at the soil surface from previous years - as well as the coverage of reed beds (lower salt meadows) and dense swards of e.g. red fescue or tall fescue (upper salt meadows). Especially konik-horses were effective against reed by digging up the nutritious roots during winter. At some sites, reed or dense swards of grasses were mown before grazing. Open habitats created in this way were being kept open by the grazers afterwards. It turned out in fact, that initial mowing helped the grazing animals - kindly supported by geese - to faster create the desired vegetation structures. In cases of reed beds on overgrown salt meadows the cattle were attracted to the mown sites.

The reduction of litter resulted in more light reaching the soil surface; plants of lesser height were able to germinate and step by step became more frequent. Most of these plants are herbaceous flowering plants - often characteristic species of the meadow type habitat. As a result, the habitat´s diversity, considering both plants and associated invertebrates, is growing. Monotonous reed beds along the shores of lagoons and in shallow depressions disappeared while other habitat types - such as *Salicornia*-mudflats, Atlantic salt meadows or Boreal coastal meadows - developed.

Photo 5.1.1.a + b: The upper salt meadow often is indicated by anthills as here at the Eskkiltorpsängar (S), which is coastal meadow grazed for centuries. On anthills sometimes the Baltic field gentian (*Gentianella campestris baltica*) can be found. (Photos: Hauke Drews)

Practical advice - For successful management of coastal meadows two key factors restoration of the natural hydrology and the grazing regime have to be taken into account:

- Blocking of ditches and restoration of natural depressions are important tools to restore natural hydrology of salt meadows. By that not only habitats for birds and toads are improved, also the diversity of water and swamp plants will increase
- For grazing management robust cattle are recommended, because breeds such as Galloway and Highland have many advantages. These cattle weight less and are not afraid to walk on wet soils, graze also plants with only little nutrient and counteract by their grazing behavior more grasses then herbaceous plants.
- Grazing densities range from 0,5 to 1,0 cattle per ha depending on the soil fertility and the height of the swards. The grazing must be performed without fertilization, without additionally supplementary feeding and – if possible - as whole year grazing. During winter cattle graze the vegetation left over from the summer before. In late winter the vegetation of the site should be short. In summer there can be a slight “under grazing” except at sites to be managed for Dunlin and toads. In slight “under grazing” conditions in summer herbaceous plants can flower and produce seeds. This is an important effect in cases of habitat restoration, when rare plants shall re-colonize the

site from a few small plots.

- Grazing units should be large and should include lagoon edges, shore lines, lower and upper salt meadow. For directing the grazing pressure to target areas mobile fences can be used. Fences should be made visible for birds by using a white 6 mm electric round cord instead of a thin iron wire.
- Experienced coastal meadow managers, ornithologist, botanist and herpetologist should be involved when planning a site restoration to ensure existing habitat characteristics are not lost and that the best possible conservation strategy for habitats and species is put in place. Fresh water dominated coastal grasslands which are live breeding sites for typical “freshwater dependent species” such as natterjack and green toad or meadow birds such as ruff or black-tailed godwit should not be re-flooded with salt water until a similar number of suitable quality fresh water meadows had been developed and the species to be displaced have succeeded in colonizing the new sites.

5.1.2. Restoration of grey dunes

Improving the conservation state of habitat type 2130 (Fixed coastal dunes with herbaceous vegetation "grey dunes") was one aim of the BaltCoast project. For grey dunes within the Atlantic and Boreal part of the Baltic, several main threats can be identified: lack of grazing, nutrient enrichment, lack of sand supply and human impact.

For all these threats, several countermeasures have been already tried in the past as summarized in the Technical report 2008 / 04-24 "Management of Natura 2000 habitats * Fixed coastal dunes with herbaceous vegetation ("grey dunes") 2130". Within the BaltCoast project, initial mechanical measures were carried out on relevant sites, to be followed up by the installation of a suitable grazing regime. Intensity and type of grazing was discussed and decided within the expert groups and site managers. Later fine tuning was applied when necessary. The combination of these two measures - mechanical preparation of the site and subsequent grazing - proved to be a sufficiently good approach towards a significant improvement of the conservation state of grey dunes.

Photo 5.1.2.a. - Typical dune habitats at the Western and Northern Baltic coast are not widely distributed and often much smaller then at the North sea as here at the spit of Hyllekrog (DK). (Photo Hauke Drews)

Dune habitats along the coast are subject to tourism since many decades. Camping tourism started in the 1950th. First camping sites were established often in dune areas along the western and southern Baltic coast. For camping usage the dunes were leveled, dune slacks - breeding sites of natterjack toads- were filled up and small roads with clay sand were constructed to enable car driving to each camping place. Water pipes and electricity wires were put into the ground. Buildings with tourist infrastructure were erected. Dunes were significantly changed by that and most of the dune habitats disappeared or survived only and the fringes around the camping sites. Further, nutrient enrichment and the establishing of *Rosa rugosa* caused the natural dynamic of grey dunes to cease. Open and sun-exposed patches - previously regularly created as a result of sand movement - were stabilized by woodland plants. As a result, typical plants and animals of the grey dunes - to name two, *Bufo calamita* and *Gallium verum* - were suppressed.

Restoration of dunes might be needed for different reasons, as e. g: to reduce the impact from former camping sites use or to stop negative succession processes initiated by nutrient enrichment caused by precipitation. To counteract succession mainly caused by nutrient enrichment, grazing in dune systems was initiated in several sites in Denmark and Germany. The aims for the grazing management were:

- Reduction of litter and dense grass swards, dominated by a few grass species
- Initiation of the spreading of characteristic dune plants
- Bare ground patches for insects as nesting grounds

It turned out that with the reduction of the litter layer, succession was turned towards a positive trend. Dense grass swards were converted to floriferous grasslands again. Plants depending on light for germination spread (*Sedum sp., Dianthus deltoides* and *Gallium verum*). Old heather was grazed down severely but rejuvenated both from roots and seeds. Grazing animals created bare patches of soil along their paths, favorite resting places or where they dug up roots. These areas were the germ cells for renewed sand movement. Indicators for this process - *Phleum arenarium* and Co*rynephorus canescens* - were recorded at the project sites Oehe-Schleimünde and Weißenhäuser Brök.

Practical advice - For successful dune “restoration grazing”:

- It is important to reduce the litter <u>and</u> enable rare herbaceous plants flowering and fructification. In cases of small sites with low number of rare plants, it is recommend to start a grazing as “winter grazing” from September to end of April. With the break in summer herbaceous plants can flower and spread by seeds.
- After 3 to 4 summers the target plants often have spread so far that the grazing systems can be switched to whole year grazing especially if it is targeted against Japanese rose or other scrub.
- If dunes are grazed in one grazing unit with salt meadows, then the grazing effect in the dunes summer is low, because the cattle very much prefer the nutrient rich salt meadow vegetation.
- To maintain a good conservation status in open dune habitats a winter grazing might be sufficient. The conditions for “winter grazing” are:
  - Supplementary feeding over winter has to be avoided otherwise the positive effects cannot be expected.

- Robust cattle are expected to lose weight during winter from fat stored from the previous summer. For cows this is important, because they otherwise might not become in calf.

- A frost free water supply is demanded often by vets/ veterinarians, but often the cattle prefer to drink brackish water from lagoons.

5.1.3. Coastal lagoon management

Improving the conservation state of habitat type 1150 in the Baltic (Coastal lagoons) was one aim of the BaltCoast project. For coastal lagoons included into the Baltcoast project, problems were mainly caused by suppression of natural dynamic processes of the habitat by human. A deterioration of many lagoons in the Baltic was the result. To address this problem, a more natural hydrology and trophic level of lagoons was restored within the framework of the project.

Photo 5.1.3.a - Due to diking and draining, lagoons were lowered or dried up and due to lack of economy in grazing, coastal landscapes changed: salt meadows and shores became overgrown. During this succession, typical habitats as lower salt meadows and mudflats with saltworth disappeared resulting in the loss of breeding birds as dunlin, ruff, avocet and local extinction of natterjack and green toad at many sites. (Photo Amphi Consult)

Lagoons are expanses of coastal water, wholly or partially separated from the sea, which are salty/brackish or with a higher degree of freshwater influence. Naturally they are at least temporarily influenced by seawater. Often they are separated from the sea only by narrow

storm beaches, less frequently by shingle banks or rocks. During winter storm tides they are affected by seawater. Lagoons are a characteristic element of wave-eroded coasts. The salinity and water volume in lagoons is highly variable. Lagoons in grazed salt meadows are important water bodies in the coastal habitat complex with influx from the Baltic Sea. Due to diking and draining, lagoons were lowered or dried up completely. When grazing ceased because it became uneconomic, coastal landscapes changed: salt meadows and shores became overgrown. During this succession, typical habitats like lower salt meadows and mudflats with saltworth disappeared, resulting in the loss of breeding birds such as dunlin, ruff, avocet and the local extinction of natterjack and green toad at many sites.

In order to restore a favourable conservation state, a set of different conservation actions has been elaborated by the project team and implemented on site during the project. Main management actions for coastal lagoons were: restoration of the hydrological regime, measures against nutrient enrichment and cleaning/deepening of lagoons.

Restoration sea water inflow- In the past, lagoons were separated from the sea by human activities, as e.g. building of little roads, creating shallow walls to avoid regularly flooding or draining lagoons via one-way pipes, or deep ditches, etc. The natural interaction of the lagoon with the sea was disturbed; salinity and water tables changed gradually. For revitalization of the lagoons, a connection between sea and lagoon was re-established - either by reopening a natural connection to the sea or by closing a pipe draining the lagoon to the sea. The different actions aimed to simulate or restore a natural exchange between the Baltic and the lagoons, resulting in more natural habitats along the edges of the lagoon, e.g. as foraging habitat for waders. By this action 70 ha of lagoons were successfully connected in Denmark, Estonia and Sweden.

Preventing nutrient enrichment - Nutrient enrichment of lagoons via their catchment is a problem in the western Baltic: neighbouring fields are intensively used. Drainage water or surface effluents are often directly conducted into the lagoons. At three sites the project created by-pass drainage systems or established drainage water cleaning ponds at the end of small drainage systems. By-pass drainages considerably reduced inflow of phosphor and nitrate into the lagoons - the water quality became suitable for breeding of the green toad and natterjack toad.

The creation of drainage water cleaning ponds is a workable solution for smaller drains. Ponds were sized so that the upcoming vegetation could bind all nitrates. Run-off from the ponds was directed to grassland. Percolation through grass constitutes an additional nutrient catching effect - visible by a lower productivity grass plants along the percolation line.
The suggested measures come to their limits as most of the lagoon´s nutrients originate from small streams or brooks, which cannot be treated with this method.

Cleaning and deepening of lagoons -Natural succession of open habitats towards woodland is strongly linked to modern agricultural techniques: melioration, fertilization and cessation of grazing. This causes lagoons to silt up. Restoration measures therefore involved the cleaning and deepening of lagoons. First, reed beds were removed and then recently deposited silt excavated. The phosphate rich material was spread on neighbouring fields. In this way, open lagoons were re-created.

Photo 5.1.3.b. - The restoration of the natural hydrology was one of the strategies to improve conservation status of lagoons. Here land owners inspect a groundsill at Högby hamn (S). The former ditch was closed and the natural outflow system was reactivated with a groundsill, which secures a certain water level in the lagoon. (Photo Susanne Forslund)

A combination of initiation of grazing of the often over grown lagoon edges, restoring natural hydrology and restoring a good water quality by removing the top nutritious sediment enhances the quality of the breeding habitat for waders and toads greatly, e.g. as at Högby hamn, Ottenby, Store Vrøj, Dejrö and Südwest-Fehmarn.

The aim to re-connect the separated coastal lowlands with the Baltic Sea again was put into practice on a rather limited scale during the project term. In Denmark, suitable measures to improve the connection between lagoon and Baltic Sea were started (Sites Nr. 1, 5, 10, 13).

The development goals for the protected areas and the necessary measures to achieve them are described in the management plans that have been made. The realisation is planned in the medium to long run after the necessary discussions and participation procedures. For six of the eleven protected areas in Germany, for which no measures (C2) for the improvement of connection between lagoon and Baltic Sea were projected for the project term, specific development suggestions were worked out and put up for discussion. In the management plans, development programmes for parts of the German protected areas Schwansener See, Kleiner Binnensee, Wesseker See, Eichholzniederung, Wallnau, and Neustädter Binnenwasser were given.

The measures proposed in the management plans range from the temporary opening of floodgates to the dismantling of dams and pumps. The extent of the realisation is left to the time after the project (After LIFE), but via the management plans it will be part of the future development planning within the Natura 2000 network.

Practical advice - The hydrology of several lagoons has been changed back to a natural state either by reopening a natural connection to the sea or by closing a pipe draining the lagoon to the sea. The lagoons now keep water longer or have a more dynamic water level and salinity. Cleaned lagoons were greatly improved by the project actions. Open and clear water with a high oxygen level were recreated. Water plants and swamp plants re-germinate from seeds in the bottom/silt. The plant diversity of the cleaned lagoons increased. For the improvement of the lagoon as a habitat:

- One should aim on the restoration of the natural hydrology if not other more important management concerns are in contradiction to this. Diked lagoons should be re-connected to the sea in general, if this this connection was destroyed by coastal protection or land use measures. But when planning such projects it must be secured

that grassland values on low lying fresh water meadows can be retained above flood level on upper salt meadows instead.

- In some cases removal of silt is recommended to create open water in old lagoons again and to improve the water quality for benefit of wader birds and toads.
- As follow-up management grazing is needed otherwise reed beds spread fast and fill up the shallow waters again with plant material.

5.2. Specific Threats

5.2.1. Restoration of a favourable hydrological situation

Natural hydrological conditions in the lagoon habitat complexes have been significantly changed in the past by humans. Dams, dikes and floodgates changed the hydrological regime of whole lagoons, drainage systems and drainage ditches affected single habitats. Wet, natural depressions were filled in. As a whole, melioration and damming of the lagoon habitat complex resulted in increasingly bad conditions for many typical coastal species - both plants and animals.

Several measures of the LIFE BaltCoast project aim on improving the disturbed hydrological conditions within protected areas:

- Blocking of drainage ditches
- Revitalizing natural depressions
- Creation of shallow ponds
- Raising of ground water level

Blocking of drainage ditches - By blocking ditches, the drained area will gradually become wetter. Water retention on the site is improved, and the ground water table is slightly raised. Later on, near-natural slough systems will form in those salt meadows that are flooded more often.

Ditches can be blocked passively - by simply stopping maintenance work - or actively by filling them (partially) in. In the latter case ditches are blocked with soil from the surroundings on a length of 3–5 m. Such blockings should be made - depending on the relief - at intervals

of 10–100 m. Usually, they will be built with an excavator. Fresh soil that is filled into the ditch will sag later on. The amount of sagging must be anticipated when the ditch is blocked. The blockings must be able to withstand flooding and trampling of grazing animals. Between the blockings, long stretches of stagnant water will appear often suitable habitats for characteristic animal and plant species.

Ditches were often dug along land borders and therefore often accompanied by a fence. Fences along ditches should be removed whenever possible: grazing cattle may then enter the ditch for watering. Steep slopes will be flattened and upcoming reed be kept at bay. In this way, valuable, well structured riparian habitats are created and the deterring optical effect of the reed screens on nesting birds is diminished. If fences may not be removed, they should be at least 10m away from a ditch.

Passive blocking of ditches happens automatically once maintenance is stopped; the smaller the gradient, the faster sedimentation will block the ditches. Heavy grazers support this process by grazing the lush vegetation growing along the ditch and at the same time trampling the soft soil of the riparian zone. This natural silting up of ditches takes a longer time; changes in the landscape do take place gradually. This may be an advantage when working with sensitive animal and plant species, which can better adapt to slow wetting of the site than to abrupt changes of their habitat.

For each site, a specific solution and blocking strategy should be developed. Ditches with steeper slopes or ditches in sand or loam have to be blocked in any case. At sites with a low gradient (fen or salt peat), passive blocking is to be preferred. In this way damages to the sensible habitat caused by the heavy digging machines is kept to a minimum.

Revitalizing natural depressions - Large-scale drainage of lowlands of the lagoon habitat complexes resulted in the loss of many natural wet depressions. Drainage caused them to dry out earlier and to have less water; some depressions were filled in completely. Drainage - often in combination with fencing off the depressions or a general cessation of use - leads to overgrowth by tall vegetation. Many are therefore densely overgrown, having accumulated an excess of organic material. This process was accelerated by drainage activities, nutrient enrichment, and the lack of use.

Damming drainage ditches, breaking drainage pipe, re-introduction of a grazing regime and reopening the connection of the sites with the Baltic Sea are necessary. Dredging and cleaning natural depressions is an additional, sometimes necessary measure to restore the natural habitat features of the depressions.

The measures were carried out as carefully as possible with an excavator, which cleaned depressions off mud, organic material and established stands of reed. The material was removed from the site and spread on neighbouring fields. By that depressions were in deepened and the vegetation thinned out. Areas of open water were created, helping to warm up the pond.

When cleaning depressions it is important not to destroy the potential of the site to recover and develop towards a near-natural condition; characteristic animal and plant species of the habitat have to be protected. Therefore, suitable parts of the depression where they occur must remain untouched by the measures.

Cleaning depression should be carried out in late summer or autumn, when the water level is low and the surrounding soil as dry as possible. In the long run, the measures can only be successful if the factors that have led to the unfavourable conservation state are removed. Cleaned depressions should therefore be subjected to grazing. Further, near-natural water levels in the depressions - if they have been drained or disconnected from flooding - have to be restored. For the a good development of Natterjack toad larvae, the newly created, open water bodies must be shallow, quickly warm up, and hold water for a sufficiently long time.

Creation of shallow ponds - Additional creation of new, shallow ponds may be necessary at some locations in order to provide for good ecological conditions of the target species. In many protected areas this may even be the only way to improve the hydrological situation to create suitable conditions for species such as Natterjack toad and European green toad. Already after a short time will the newly created shallow ponds be able to fulfil valuable habitat functions also for other characteristic animal and plant species that are to be protected and whose populations are to be developed.
Every site has a different, site-inherent colonisation potential, which is determined by its characteristics and history. It is no precondition for the creation of new ponds that the target species are already present at the site. Creation of new, shallow ponds can therefore not just

follow a simple routine, but must be adjusted to the conditions and purpose of the area in question.

Potential locations for new ponds must be evaluated regarding the general local conditions, pedology and hydrology. Excavated material can remain on-site, to be thinly spread around the pond - of course taking care not to cover valuable plant communities. If no suitable sites for depositing the material are available, it must be taken away from. Pond morphology should be adjusted to the requirements of the demanding target species. Usually, the water bodies that were created during the LIFE BaltCoast project had to be very shallow and sunny, allowing the water to quickly warm up and enable grazing animals to keep developing vegetation in check. On sandy soils, a sufficient supply of water must be planned for.
Number, shape, and location of the ponds depend on the options and the requirements of the protected area. The requirements must be individually evaluated, taking into account existing remnants of populations and habitats and the potential of the protected area in question.

Photo 5.2.1.a - A revitalized shallow depression on Halmo (DK) is now used by *Bufo calamita* and *viridis* for spawning (Photo: Florian Bibelriether)

Raising of ground water level - At sites where the coastal lagoon habitat complex has been disconnected from the Baltic by dikes and/or is drained by floodgates and/or pumps, restoration of more natural conditions is only possible, if a reopening of the connection would not affect neighbouring sites.
Otherwise, an improvement of the regulation and a raise of the water levels within the protected area should be considered. The present regulation by floodgates and pumps must be critically reviewed and, if possible, changed. Possibilities for establishing a reconnection between the lagoon and the Baltic should be analyzed. Doing so, the demands of nature conservation, the conservation goals for the site, economic requirements and the protection of humans have to be considered.

An analysis of the Germany project sites - performed in the course of the management planning -showed that an improvement of the hydrological situation by raising the ground water table could be achieved for six out of eleven. A clarification phase, involving authorities and land owners, as well as a legal permit to carry out the actions are required. Realizing a more natural hydrological condition by adjusting ground water levels must be postponed till after the project (After LIFE). The management plans make it possible to integrate these suggestions into the future development planning of the Natura 2000 network.
The natural situation at the Baltic lagoons has often been altered through the building of dams, dikes, and floodgates. It was tried to protect the affected lowlands from the high waters of the Baltic Sea and to drain the hinterland – mostly including the lagoons – to a lower level. The artificial separation of the lagoons goes hand in hand with freshening of the water in the dammed lowlands and the reduction of water table fluctuations. The changes are biggest, where the water level of the separated lowlands with lagoon habitat complexes is pumped below the water level of the Baltic Sea, as it is the case at Wesseker Lake (project area No. 20 in Germany). Given the shortness of the project term, the extent of landscape-ecological changes, the strong interest of the local population, and the large number of people and authorities that have to be involved, only a limited contribution can be made in the course of the LIFE BaltCoast project to improve the connections between lagoons and Baltic Sea.

5.2.2. Grazing regimes

History of grazing - There is proof that the fertile lowlands along the Baltic coast have been used as pastures by the local population for centuries, partly for millenia. It was this utilization that formed the semi-natural open-landscape habitats of the alvars, the boreal meadows, and the different types of salt meadows. In the course of changes that affected the former traditional forms of land-use, there has been a period of intensification after 1900 and, more pronounced, after 1950. Many lowlands were diked, drained, and intensively used as farmland or for touristic purposes. The remaining areas of open landscapes, which are today the core areas of the Natura 2000 protected sites, were usually fertilized and intensively grazed.

As a rule, the intensification of land use continues as long as it is profitable. However, in many coastal areas, land use has already become unprofitable in the 1970s and 1980s. Therefore, many formerly used salt meadows and lagoon habitat complexes have become subject to secondary succession after abandonment, particularly in Denmark and Germany. In the Baltic States, the abandonment of many areas started already after the occupation by the Soviet Union. In these countries, there was no period of land use intensification after 1950. Extensive conservation use was sporadically applied in coastal regions to meet nature protection requirements. Usually, however, nature protection had only little influence on the land use intensity and has – at least in Germany – not been able to take adequate care of the largely abandoned areas so far.

Cessation of grazing and its results - From a nature protection point of view, abandonment and the resulting onset of secondary succession is presently a much larger problem for the salt meadows and the lagoon habitat complexes than intensive grazing. The cessation of use results in depauperization and tall growth. Dense and thick litter layers have formed, which impair in particular the site-specific, poorly competitive animal and plant species. The conservation status of the fallow habitat types is unfavourable and does not tap the potential of the protected areas at all. In cases where the traditional use had stopped a longer time ago, tall-growing ruderal species and reeds have immigrated and dominate the aspect of the lowland areas today. Salt meadows and boreal meadows are colonised by Common reed (*Phragmites australis*) in the medium term. These dense terrestrial reed beds are succession

stages of former species-rich pastures and therefore not to be compared to near-natural reed stands in shallow waters. The occurrence of dense shrubs, which is another succession stage in formerly used coastal sites, will be dealt with separately in chapter 5.2.5. and 5.2.6.

The BaltCoast grazing strategy - At the beginning of the LIFE BaltCoast project, many project areas were impaired by the proliferation of fallow species, overgrowth by Common reed, and thick layers of litter. The present habitat types of the Habitats Directive with their characteristic species should therefore be developed to a state that is richer in species, blossoms, and structure. For that purpose, grazing was newly established in some project areas, or existing grazing regimes were modified. The aim was to find modern forms of utilization that could counteract the general increase of fallow species in the protected areas and help to achieve the goals of nature conservation.

Photo 5.2.2.a - Winter grazing by highland cattle taking the litter at Weißenhäuser Brök (D). (Photo Heiko Grell)

The LIFE BaltCoast project was able to show some achievements and development tendencies. The spread of fallow species was successfully counteracted by grazing. Old litter layers were reduced, and vegetation height was significantly lowered due to the browsing of grazing animals. These effects could be controlled via grazer density and grazing time. More intensive grazing over a longer period of time has larger effects, which set in sooner.
It has proven to be useful in the project areas to employ the most robust breed of grazers possible, i.e. races that are often not traditionally used. Robust cattle breeds like Scottish highland cattle or Galloway or robust Konik horses seem to be most suitable to reach today's ambitious nature conservation aims in the pastured lagoon habitat complexes. These robust animal races can be used easier and with smaller restrictions in habitats of unfavourable development status and areas of pronounced secondary succession after abandonment; they also require only little care compared to other breeds. (Other breeds of grazers can also be used, though.)

In protected areas, where the traditional use with standard local breeds has been continued and proven to be suitable and successful regarding the aims of nature conservation (for example in Sweden), the tradition should of course be further continued. However, in abandoned coastal lowland areas, where the pasture tradition has been interrupted anyway and a new form of land use shall be established, tailored to the demands of nature conservation, the robust breeds of grazers that are available today should be given preference. Extensive year-round cattle grazing turned out to be particularly successful.
The positive effects of grazing as a means of landscape care can be controlled through the choice of breed, the grazer density, and the grazing time. The corresponding decisions should be made purely according to the interests of nature conservation and be adapted to the requirements of the habitat types to be protected including their characteristic animal and plant species. Hence, the establishment of a grazing regime requires a preceding discussion about the aims and the nature conservation values. Possible conflicts of aims have to be considered and to be solved e. g. with the help of the decision tree presented in Chapter 8. Development goals have to be formulated, and grazing must be continued over a sufficient period of time. The chosen grazing regime should only be modified according to new findings or nature conservation demands. Regular monitoring suited to give information about the quality of the habitats and the development of the specific target species is necessary for an optimally adjusted grazing regime.

Adapting grazing regimes to management goals - It has become apparent in many project areas, where conservation grazing was newly established, that one should use a flexible grazing management scheme on largest possible plots according to the targets set. By generously dividing the available pasture area in the lagoon habitat complexes, it could be achieved for some sub-areas to be grazed more intensively than others and for some habitats to fall temporarily fallow. In case of year-round grazing the animals usually graze all sub-plots simultaneously. Undergrazing can be avoided by using a sufficient number of animals. In this manner, the grazing intensity can be differentiated in the summer months and particularly during breeding season without changing the herd size. The flexible grazing management – so-called “Staffelweide“ (differential grazing) – meets the high demands that are made by nature protection on conservation grazing. The term “Staffelweide” was introduced in Germany in the course of the research project Höltigbaum, which focussed on the development of large semi-open pastures.
Adapted to each situation, the flexible conservation grazing is a target-oriented tool, well suited to effectively counteract secondary succession in coastal habitats. When using it, it is important to develop an individual, locally adapted solution for each protected area so that both over- and undergrazing can be avoided.

In the course of the LIFE BaltCoast project, extensive autumn or winter grazing regimes with robust cattle have been established in several project areas. This kind of grazing contradicts the economical demands of traditional grazing, but it is well suited to meet the high demands that are made by nature protection on conservation grazing. In this way, animal and plant species that are locally characteristic of the habitat types can develop undisturbed in the summer months. Results are structurally diverse, species-rich, flowery vegetation stands. Biomass that has developed during the summer and litter are removed by the grazing animals during the winter months until the next vegetation season. By autumn or winter grazing, even old litter layers can be removed, and unwanted plant populations, e. g. of tall-growing reed species, neophytes, or encroaching shrubs, can be forced back. A low density of grazers and a short grazing period result in only slow changes of the habitat structures.
Extensive conservation grazing restricted to the autumn months is suitable for particularly sensitive habitat types with numerous endangered and delicate plant species. If, in contrast, short swards without disturbing, view-blocking obstacles are to be developed for the benefit of endangered grassland bird species, a higher grazer density and/or a longer grazing period are necessary. By means of controlled grazing, it is usually possible to meet the different

requirements of a project area. For this, access to the land is needed, clear targets have to be set for the whole area, and the pasture must be divided by fences.

In protected areas with year-round grazing, only few animal transports are necessary as long as the animals can find enough food. Here, it is recommended to apply the “Staffelweide” system, e. g. in order to provide enough winter fodder.

Photo 5.2.2.b. Koniks grazing coastal habitats

In protected areas with pure summer or winter grazing, animal transports cannot be avoided. Nearby alternative plots significantly reduce the amount of work involved. Optimal management is possible, when suitable plots are available in the immediate vicinity of the project area.

The semi-natural open landscape habitats of the Baltic coast can be conserved and developed by a grazing management, orientated to the nature conservation targets. Spread

of fallow species and overgrowth with tall growing Common reed or shrubs can be successfully counteracted. However, this is no backward-looking development of traditional forms of land use. The new possibilities that arise from the use of robust cattle and horse breeds and improved access to larger areas will lead to habitats that are different, but nevertheless highly valuable from the nature conservation point of view. The habitat complexes of the lagoons will probably look different than several decades ago and also be colonised differently. By means of adequate conservation grazing, the protected areas can be developed for the future so that they are up to new challenges, such as the sea level rise, changes in the distribution limits of species, or the general landscape-ecological development.

As the type of optimal grazing regime - winter grazing, summer grazing, prolonged summer grazing, etc. - strongly depends on the possibilities and management goals for the site, no management conclusions will be given at this point. Please compare the relevant chapters within these guidelines for detailed information. Instead, general practical advice for managing grazing actions, derived from the BaltCoast project actions is given in the following paragraphs.

Practical advice - In the coastal areas of the Baltic Sea, the use of grazers requires a special management and several practical aspects to be considered:

1) Fencing in general
2) Fencing along shores and water lines
3) Flood protection for grazing animals
4) Cattle troughs with freshwater
5) Shelter from bad weather

1. <u>Fencing in general</u>

Those parts of the protected areas along the Baltic coast that are to be included in year-round or temporary conservation grazing have to be fenced. It has to be ensured that the grazing animals remain on the designated pastures even under bad pasture or weather conditions, and that they do not get to adjacent pastures, streets, or touristic facilities. The different countries bordering on the Baltic Sea have traditionally different habits and legal rights in this matter. Whereas e. g. in Estonia rather simple one-row fences are considered to

be sufficient in remote areas, it is customary in Germany to secure public paths and pastures of the Stiftung Naturschutz using at least three rows of barbed and two rows of smooth wire.
To secure the pasture management in the different protected areas and to ensure a flexible grazer density on different sub-plots in different seasons of the year, both fences to the outside and fences between the pasture units are necessary. The number of fences should be kept to the necessary minimum, though. Outer fences must be secured best.
There is a high risk of accident for birds at all free-standing fences, i.e. those which do not border on a reed stand or a hedge. The use of wire netting, barbed wire, and multi-row fences should be avoided here, if possible. Barbed wire is associated with a high injury potential for birds, and many birds do not notice smooth wire, which may result in collisions. Hence, the fences should be made well visible for birds, particularly along the water line.
In practice, it has proven successful to tie some nylon string around the smooth wires that are located in places of particularly high risk. Electric fences with white cord of approx. 5 mm diameter are a highly recommendable solution. Such cord fences are accepted by grazing animals and noticed by birds. They can be used for the temporary subdivision of flexible pastures in the coastal regions. The outer fences of most protected areas have to be secured more strongly by multi-row fences, though. Power supply for the electric fences can be realised locally through storage batteries (up to 4 kJ) or centrally via the house service connection (up to 10 kJ). The latter requires less maintenance while offering a higher security and should therefore be preferred.

2. Fencing along shores and water lines

Pasture fences along shores and water lines are particularly challenging. There, one has to be prepared for an increased collision risk for birds, fluctuating water tables, high mechanical stress through waves and flotsam, and unwanted earthing. Fences should in general not be put up parallel to the shoreline. Thus, pastures should integrate the shore and the shallow waters and be marked off by fences running perpendicular to the water line. The fences must extend far enough into the water to hinder the grazers from leaving the pasture even at low tide. The length of the fence depends on the soil morphology and the subsoil consistency. The fences can be optically elongated by floating ropes, buoy, and floating wooden beams. All fences at or in the water must be well visible. Thick white nylon cords have proven to be better than the usual thin wires.

3. Flood protection for grazing animals

The animals grazing the lowlands along the Baltic Sea must have the possibility to retreat to elevated plots in case of high water. Flooding occur irregularly and may occur at any time of the year. Lasting high waters are more likely to occur in the winter months, though. Hence, sufficient flood protection for the animals must be given particular attention whenever year-round grazing regimes are introduced.

Whenever protected sites include elevated dune areas or hills, these should be accessible in case of emergency. If they comprise only flood-prone lowlands and/or lagoons, there must be a connection to the elevated hinterland. In areas with year-round pasture, sub-areas suitable for winter pasture should be taken into account right from the beginning. These plots must ensure sufficient nourishment for the grazers and be located sufficiently elevated to stand a high water situation that lasts for several days. The grazing animals must be familiar with the elevated plots and become conditioned to them by feeding them there from time to time.

4. Cattle troughs with freshwater

The freshwater supply for the grazing animals must be secured even under unfavourable conditions. Problems might occur as a result of lasting droughts, floodings with salt water, or, in winter, frozen soil and water bodies that are completely frozen through. The Baltic Sea and the lagoon waters are too salty to serve as the only source of water in the long run, even for robust cattle. In the East, the salinity is lower, but there, the water also freezes earlier and remains frozen for longer. The recommended maximum salinity is 9 PSU.

Is has proven success to desludge natural depressions and install several additional troughs in the pastures. Installation and improvement of such shallow waters depend on the demands of the characteristic species of these habitats and in particular those of the target species Natterjack toad and European green toad. However, these waters also serve as freshwater troughs for the grazing animals. This extensive use as troughs secures their lasting preservation and keeps them in favourable state. The ponds should therefore be fully integrated in the pastures, including their complete shoreline. Extensive grazing and trampling of the shore are to be aspired to; under- or overgrazing of the shore is to be avoided. Only if the water supply through ponds and Baltic Sea is not sufficient for meeting the demands of the grazing animals, should artificial troughs and pumps be installed. The temporary use of water tank vehicles is also possible, if a shortage of water is imminent as a result of lasting dryness or if dune sites with no or not enough water bodies should be grazed specifically.

5. Shelter from weather

Grazers need shelter from bad weather, particularly from wind and wetness and not so much from dry winter cold. Permanent shelters have the disadvantage of heavy trampling and nutrient enrichment in their vicinity; they also support the spread of pathogens. Mobile shelters can be used, if required. In case of year-round grazing with robust cattle or horse breeds, the grazing animals often seek shelter in shrub stands or wind-protected depressions. Should such places not be available in necessary size, it should be refrained from pasture during the winter months, or suitable shelters should be installed.

Photo 5.2.2.c - a mobile shelter for livestock

Results - The reintroduction of - in many cases- whole year grazing with robust cattle as traditional land use was the key measure for improving habitat complexes in coastal grasslands. Grazing with cattle has a long tradition, not only in the Baltic area (chapter 1.1.).

At the beginning of BaltCoast, reinstatement work such as mowing and building fences, shelters and watering facilities was needed in the intended areas of the project. Afterwards, the cattle took care of the vegetation condition by grazing. Especially in Denmark and Estonia the project partners implemented a successful “cattle lending system”: Interested

farmers could sign a lending agreement for robust cattle which includes that the offspring belongs to the farmers to start up their own herd after the end of the leasing contract. The partners in Lithuania have followed a similar approach in this project as well as in other LIFE projects.

The intention to improve the quality of lagoon habitats by whole year grazing can be evaluated as an overall success. Moreover, through BaltCoast the tradition of grazing in coastal habitats has gained new impulses and a restart, especially in Denmark and Estonia. The grazing influences the vegetation because robust cattle naturally eat all sorts of grasses and also most woody plants. But also a prolonged summer grazing – a grazing continuing into the winter as long as possible - with ordinary dairy cattle made a huge difference compared to no grazing. The important factor seems to be that the grass sward is grazed down to a height of max 10 cm at the end of the grazing season and that afterwards no re-growth happens. This includes also hard grasses with low nutrient value for the cattle. Often these grasses are only taken, when better grasses are not re-growing any more. Therefore the grazing has to be prolonged into the winter until the grazing aim of low vegetation is reached. One advantage of that system is the higher number of cattle available from normal dairy farms.

5.2.3. Control of predation on breeding birds

Predation has a severe impact on the reproduction for many breeding birds in coastal areas. Affected are mainly clutches and nestlings, which fall prey to land mammals like fox or marten or to other birds like gulls, corvids, or birds of prey.

Most vulnerable to predation are the colonially breeding birds including the three project target species avocet, common tern and little tern. Often just a single visit in a colony by one mammalian predator in the incubation or chick rearing period causes a complete depletion of the breeding colony, because nests and broods are concentrated at a limited space and are easy to find by the predator.

The natural behaviour of colonially breeding birds is a high turnover between possible colony sites. This strategy of unpredictability is only possible if enough potential breeding sites are

available. Especially for beach breeding birds nowadays suitable sites are often occupied by tourism. Ground nesting species dispersed on wet grassland, the so named meadowbirds including the three project target species dunlin, ruff and black-tailed godwit, tolerate a higher visiting frequency of predators, because the nests and chicks are spaced out and well camouflaged in the vegetation and are much more difficult to find for a visiting predator.
Predation is a natural element of the food web and has an important regulatory function in the ecosystem. However, in many protected areas along the Baltic coast, the predation of some breeding bird species, including both colonial and dispersed species, has assumed alarming proportions. Accordingly, measures to counteract the predation have already been undertaken for many years. Corvids and gulls are scared off, foxes and other predators often shot. In some cases, fences have been used to protect meadow bird species or breeding colonies of coastal species such as little tern against foxes.

In the course of the LIFE BaltCoast project, the effectiveness of various measures has been checked in the project areas, and recent literature on predation issues has been evaluated. Furthermore, experience from different countries, regions and habitats was exchanged. From this work, the experience, considerations, conclusions and recommendations described below have been reached.

In order to cast light on the predation in the project areas in more details, two predation studies were conducted in the early stages of the BaltCoast project in two areas on Öland in Sweden and in W Estonia, respectively.

The huge predation project on Öland, including study sites with extensive killing of corvids and mammalian predators and other sites as control sites, showed, that mammals were by far the most important predators for meadowbirds, whereas the killing of a substantial proportion of the corvids did not seem to have a measurable effect. Sarcoptic mange killed most of the foxes in the area in the first years of the study, the predation level dropped markedly, and badger soon became the most important predator on eggs.

In Estonia, numbers of meadowbirds have declined significantly for years in coastal grasslands, whereas in the same period, the same species have established and are constantly increasing in raised bogs. Hatching rates were compared in the two habitats, and

nest predation could not explain the difference in trends in the two habitats, as the predation was found to be at the same level.

In many areas foxes seem to be the single-most important predator for meadowbirds and colonial breeders alike. The carrying capacity for foxes in the landscape has risen significantly during the last decades, and this is considered to be the most important regulatory factor of the fox population. The increasing nutrient input in the landscape and the abandonment of land use in many areas, including the protected ones along the Baltic coast, create higher food abundance and better hiding places for foxes and as well as for other mammalian predators.

So far, many measures taken to counteract predation by limiting the number of foxes have shown only little or at least no lasting success. The traditional fox hunt, usually performed as a battue in winter, does often not result in any significant and long lasting reduction of the predation in the protected areas. Stable fox populations are able to cope with losses as high as 65% per year. Even the shooting of pregnant vixens (which is at least in Germany prohibited by game law) would not help to reach the desired goal, because the reproduction is quickly taken over by other females of the fox population. The shooting of single foxes has even been seen to be counterproductive since changes in the dominance-hierarchy may lead to increased predation. Even if the fox population can temporarily be reduced, other predators like badger, weasel, marten, or mink may take over the food resource in the eggs and chicks of ground nesting birds. Only in areas like islands or peninsulas where landscape elements prevent a rapid reestablishment of populations of foxes and other mammalian predators, hunting may have a significant negative impact on predation lasting an entire breeding season.

Under natural conditions, the predation is significantly lower only on islands or after the predator population has suffered a considerable drop as a result of a disease or a particularly severe winter.

In conclusion, the hunting of single predators in the small protected areas along the Baltic coast is no suitable measure to improve the situation of the breeding birds significantly and with a lasting effect. Within the project six management measures have been worked with more thoroughly, in order to examine their effect on minimizing predation:

- Lowering the capacity for predators
- Defragmentation - reduction of the possibilities of surprise attacks by predators
- Fencing off larger areas
- Fighting foxes and other mammalian predators instead of hunting
- Fencing off breeding colonies
- Creation of new breeding islands and rafts for colonial breeders

The first three measures are basically directed at lowering predation of the dispersed breeding meadowbirds, the fourth affects both meadowbird and colonial breeder predation, whereas the last two are directed at colonial breeders only.

Lowering the capacity for predators

The size and density of the predator populations, and hence the magnitude of the predation problem for ground-nesting meadowbirds, is mainly a function of the food and habitat capacity of the landscape. Because of their smallness, the protection areas along the Baltic coast themselves have only limited effect on the predator density in the adjacent landscapes. However, the carrying capacity of the protected areas with respect to predators is of high importance for the protection of the meadowbirds. Good settlement and hiding opportunities for ground predators and a sufficient year-round food supply (especially a lasting high mouse population density) is attractive for the predators, and the subsequent increased presence of predators affects significantly the breeding success of the ground-nesting birds negatively. Furthermore, many protected areas are drained and abandoned so that mice can find ideal living conditions including high food supply and many hiding places.

By pushing back the results of abandonment and subsequent secondary succession (fallow species and bush encroachment) in the coastal regions and by creation of more natural hydrological conditions, which include regular flooding, the settlement opportunities for ground predators as well as rodents are reduced. The conservation grazing that has been introduced in many protected areas in the course of the LIFE BaltCoast project is therefore well suited to lower the capacity for predators in the areas in the long run. The grazing is necessary and helpful, but does not have a marked positive effect, if the areas are too small and predators can constantly immigrate from outside, as it is for example the case in some of the well-grazed, but narrow salt meadows that belong to the reference areas at the Swedish

coast. In several other project sites though, the areas are much larger, and here the improved grazing introduced by the project must have reduced the attractiveness for predators significantly.

In addition to the conservation grazing, the hydrology of many areas can be improved in order to reduce the capacity for rodents and predators further. For this, individual solutions, which are locally practicable and sensible, must be worked out.

Defragmentation - reduction of the possibilities of surprise attacks by predators

The meadowbirds have developed a whole suite of anti-predation behaviour. In the large, strong and conspicuous meadowbirds this behaviour includes aggressive attacks of intruding predators, in the smaller species it includes leaving the nest in the right moment, and seeking protection under the umbrella of the stronger species. All types of anti-predation behaviour depend of an unobstructed view from the nest or from near the chicks to be sufficiently efficient, and therefore the predation level near habitat edges is much higher than in the middle of a large, open meadow.

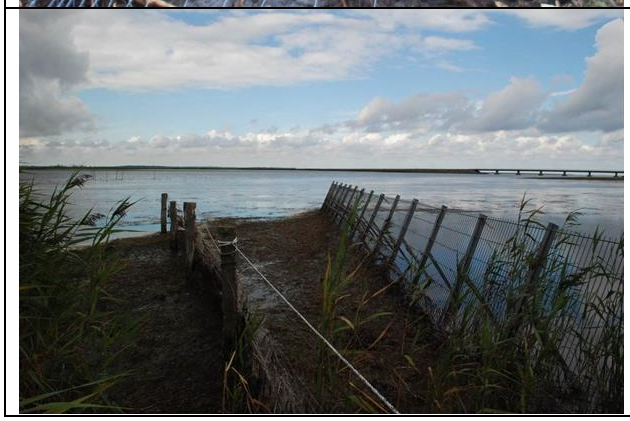
50 years ago, large, open landscapes consisting entirely of pastures and hay meadows were widespread, also in the Baltic. Since then, a large-scale fragmentation of the landscape has taken place, and a Baltic coastal landscape today consists of a mixture of habitats: pastures intermingled with small patches of trees planted as game coverts or shade for cattle, reed beds in the wetter parts, where it is too laborious to mow or complicated to graze, overgrown patches due to abandonment etc. Such structures in the landscape increase the possibilities for predators to conduct surprise attacks, and they tip the fragile balance and result in that the predation is getting too high and they limit the area of the meadows suitable for breeding. Defragmentation of the landscape by removing structures and habitat edges increases the breeding success and the available breeding habitat for the meadowbirds. This management action has been undertaken in several project sites, resulting in much higher numbers of breeding meadowbirds expectedly at least partly because of a decrease in predation, although this has not been studied.

Fencing off larger areas

At two Danish project sites, Horsnæs on Ulvshale and Hyllekrog, the BaltCoast project established fences in order to fence off larger areas, where the predation pressure on meadowbirds was estimated to be much too high for successful breeding. The aim was to reduce the frequency of visits by foxes from neighbouring areas, and thereby reduce the predation on meadowbird eggs and chicks. In general, not much is known on the optimal construction and the effects of this type of fences, and the project collected valuable experience on this issue.

At Horsnæs a 2 km fence was erected to prevent fox predation in a meadow area of 90 ha. The fence was 120 cm high with an electric wire on top, a little lower than the optimal height, because local hunters demanded a height that roe deer should be able to jump over. In front of the fence the net was extended 40 cm on the ground in order to avoid that foxes could dig their way into the area. Into the shallow water of the sea the construction was made very robust in order to avoid destruction by sea weed and ice, after a first unsuccessful attempt with a weaker construction. The gates were the weak point of the fence also after the soil here was made more firm with stones and gravel, and traces showed that unidentified mammals had dug themselves under. A way to prevent this is not yet developed. The effect of the fence on the breeding success was difficult to assess; the hatching success within the fence the first year was very high, but the effect was difficult to evaluate because in two unfenced control areas nearby, the hatching success was similarly high in the same year.

At Hyllekrog a 400 m long 140 cm high fence fences off a 5 km peninsula with an area of around 100 ha meadow and sandbar. The fence is extended a further 400 m to the north in shallow water to avoid that foxes use the mudflats to pass the fence. Here the fence is not yet functional, as it has not been possible to eradicate the foxes living permanently inside the fence.

	Project area No. 13, Horsnæs on Ulvshale A 2 km fence 120 cm high fences off 90 ha of coastal meadow. Next season meadowbirds had a very high hatching success, but this was also the case in neighbouring control areas, however. *Photo: Kåre Fog*
	Towards the sea, a very firm construction protects the fence against sea weed and ice. *Photo: Kåre Fog*

Figur 2.2.3a. Fighting foxes and other mammalian predators instead of hunting

In the past, fox hunting (and hunting of other predators) was so intensive and wide-scaled that the overall level of foxes was much lower than at present. At present, large-scale fox hunting in the Baltic countries is of such low intensity, that it probably has little effect on the general breeding success of ground nesting birds. Locally, fox hunting may still have positive

effects on the breeding success of birds, but in most situations, better breeding success can only be achieved, if the predators, mostly foxes, are systematically fought. This involves that as many individuals of a population as possible have to be eliminated in a large area. Fighting against predators is in particular effective on islands or peninsulas, where predators cannot re-colonize the area immediately. After each re-colonization, the action has to be repeated, mostly before each new breeding season of the ground-nesting birds.

Foxes are best fought against at their earths. The use of artificial earths has proven successful. They are accepted very well by foxes, if construction and location are suitable. In the course of the control measure, all foxes including whelps and vixens are killed in the artificial earths shortly before the bird breeding season. The fox population can be reduced as a whole, if many inhabited earths are raided simultaneously in a largest possible area. The effect equals that of a severe winter or a drastic epidemic. Depending on the location of the protected area and the fox population pressure in the surroundings, the living spaces that have become vacant are re-colonised more or less quickly. At least in the bird breeding season following the measure, a higher breeding success may be achieved by the ground-nesting grassland and coastal species.

Fencing off breeding colonies

Fox fences to protect breeding colonies were tested in several project sites. There were some tests run for further development of the fences. The challenge was to build an electrical fence which could go far enough into water without getting damaged. Two models were used for that:

- iron gate elements installed into the water and
- an electric swimming fence was invented and tested by NABU Wallnau

Above the flood line the fox fences where ordinary permanent or mobile electric fences often integrated into the cattle fence.

The success of fences against ground predators depends on the effectiveness of the fences used. Some foxes are able to jump fences of 130 cm from a standing position; they are good swimmers and can hence reach fenced peninsulas by water; they are also able to breach a fence by digging under it. Even electric fences are sometimes quickly surmounted, if

attractive food resources lure at the other side. In case of smaller ground predators, the mesh size of the fence is of utmost importance. Most of the hitherto used fence types against ground predation, such as the five- to seven-row electric fences of 100 cm height, are thus effective for only a short period and quickly overcome. Foxes are capable of learning and often find new ways if the formerly used ones are blocked.

A functional fox fence must therefore be about 150 cm in height. At best, it should have an overhang and be electrified. On peninsulas, the fence must extend far into the water and have a sufficiently fine mesh. In a reference area in Germany (Cismar), the installation of several rows of fences has proven to be effective over many years to protect the colony of little terns there, as it keeps even small ground predators away. In Cismar, narrow-rowed electric fences, chicken wire, and overhangs are used in an installation containing three lines of fences altogether.

The swimming fence needs daily maintenance because of drift removal and battery exchange for recharge. The iron elements in concrete basements can withstand the drift better, but when vegetation debris and other flotsam is hanging in the fences the elements are easily crashed by storm waves. So even such iron fences have to be regularly cleaned and to be removed as soon as possible after breeding season.
All fences shall be mounted before the bird breeding season and they require a lot of maintenance. Predators find holes very quickly and can take advantage of any weak point. When fences are used to protect breeding colonies, they have to be completely secure, because even single predators can ruin the breeding success of a whole colony. There is no point in attracting birds to a seemingly safe place, if safety cannot be provided for the whole breeding and raising period. A well fenced area equals functionally a breeding island in the landscape.

	Project area No. 23, Grüner Brink Different electric fences against foxes have been tested on a sandy peninsula with a little tern breeding colony. The mobile fences were extended into the Baltic Sea. The orange floats are meant to adjust the fence to the sea swell and the water level. The fence is functioning, but flotsam must be removed regularly.
	Reference area, Cismar, Germany Breeding colony of 30 to 50 pairs of little tern (*Sterna albifrons*). Each year, an area of 30 m × 50 m with no vegetation and adjacent to the Baltic Sea is successfully fenced against predators. The fence consists of three independent lines with chicken wire, electric wire, and very dense multi-row wires with overhangs and a sub-surface protection against digging.

Figur 5.2.3b. Fencing of a breeding colony at the Baltic coast.

Creation of new breeding islands and rafts for colonial breeders

A high predation risk in existing breeding colonies on the mainland or on island regularly visited mammalian predators can be counteracted by installation of solid breeding islands or floating breeding rafts. Islands can be built up from sand or gravel in the shallow waters of the Baltic Sea or in coastal lagoons; it is also possible to transform peninsulas into islands by interrupting their connection to the main land. The creation of such new artificial sand islands is always connected with a major interference in the landscape and a high effort necessary for the installation and – possibly – for lasting conservation measures. It can hence only be recommended in isolated cases, in which the landscape structure is already disturbed, or where shallow, temporary breeding islands is a typical element of the local natural coast dynamics. Island--s that are built up too high will quickly be colonised by unwanted ruderal vegetation and hence lose their attractiveness for beach and gravel breeders. If, on the other hand, the breeding island is constructed too shallow, it will easily be flooded by high waters, resulting in a loss of clutches and/or chicks. However, when an adequate construction is provided, such shallow sand or gravel islands can offer suitable breeding places, inaccessible to ground predators, for gulls, terns, avocets, and other coastal birds.

In contrast to solid breeding islands, anchored breeding rafts float and can thus adapt to water table changes in the shallow waters of the lagoons. There are many different types of breeding rafts. Their construction must allow chicks that went aboard to get back onto the raft on their own, this aspect proved important for common tern chicks and was developed within this project. Furthermore, there must be shelter against raptors on the floats. Since these floats usually have to be launched anew each year, attention should be paid to environmentally compatible materials and easy handling. Small floats made from straw bales as well as larger floats based on a modular construction system have proven successful in practice. Breeding rafts are accepted mainly by common terns and gulls. In several project areas, it has been possible to create new, suitable breeding habitats for common terns in the form of breeding rafts. Little terns do not accept such rafts, because they do not land exactly at their nest but want to walk a certain distance on the ground to get from their landing place to their nest.

Avocets avoid rocking rafts, but they accept breeding platforms that are fixed to the ground and islands. At the project site Schwansener See in Germany a breeding platform has been

successfully tested. This platform has been used by a small colony of avocets for several years.

	Project area No. 23, Grüner Brink / Fehmarn Building of small breeding island with straw bales. In front another type of floating breeding platform / ponton for common terns
	Project area No. 23, Grüner Brink / Fehmarn Small breeding island made from straw bales. Each island can be used by up to 2 pairs of common tern or black-headed gull. The islands are inspected by the terns immediatly after building. Because of competition with black-headed gulls the islands shouldn't be built before return of terns in spring.

Figur 5.2.3c. Artificial breeding aids for coastal birds.

Case study: Improvements of the breeding conditions for avocets at Falsterbo, Sweden

In the project site Falsterbo an avocet colony, breeding on an islet in a shallow lagoon was protected against mammalian predators, and the hydrology was improved.

The islet is usually isolated from the surrounding meadows by water, but from time to time very low water levels have made the breeding colony accessible to four-legged predators. On the other hand, at other times high water levels have caused damage and disturbance to the colony as eggs have been washed away.

The standard cattle fence did not prevent four-legged predators such as foxes, badgers and free-running dogs to reach the breeding colony when low water levels occurred. Furthermore, foxes occasionally have been seen swimming/wading over to the islet even at high water levels.

In many years water fluctuations as well as predation from mammals wiped out the colony and caused complete reproduction failures.

In order to improve the breeding conditions in the avocet colony a temporary dam was constructed, as an initial action, to keep a stable water level around the islet in the breeding season. This prevented flooding. Later this dam was replaced by a permanent dam. Furthermore the barbed wire fence was reinforced and an additional electrical fence was integrated into the standard cattle fence. In the final stage (March 2012) four barbed wires (total height: 120 cm) and three electrical wires proved to be the appropriate construction. A ground-level line prevents predators crawling underneath, and a top line prevents them jumping over. The grass has to be mown twice in the breeding season to avoid short-circuiting the ground-level line. In the last two years an additional electric fence was put up around the breeding islet, as an ”inner defence” to prevent cattle access to the colony during the nesting period in order to avoid egg trampling. This fence was removed as soon as the clutches were hatched.

With the continued improvements the reproduction has become better and better over the years. During the seven project years, the colony increased from around 50 pairs to a maximum of 202 pairs, and in 2012, when all protection measures were installed and working, 350 juveniles fledged from the colony.

Figure 5.2.3. Even when a bird colony is strong and remote mammalian predators can learn to find a colony, and also a small island can be reached by swimming. This experience is so valuable for a predator, that this individual often will come back also in following years. So bird colonies are naturally not safe and stable. Colony birds avoid such predation pressure by switching to another breeding site. (Photo: P-G Bentz)

5.2.4. Nutrient enrichment

The lagoons in the fertile lowlands along the Baltic coast are naturally eutrophic habitats, regularly receiving nutrient-rich water either from the hinterland or from the Baltic Sea. If the bedrock is lime or marl also nutrient-poor lagoons may have formed, especially in the eastern part of the Baltic coast. Some lagoon habitat complexes show signs of acidic paludification. This process is usually - especially in the western part of the Baltic coast - confined to relatively small areas, which then form highly valuable relict sites for endangered animal and plant species.

The original trophic conditions of Baltic lagoons and adjacent lagoon habitat complexes are nowadays disturbed in most areas. An excessive nutrient input by air or water leads to nutrient enrichment. In the past, nowadays protected areas were fertilised. Draining of

lowlands also enforces nutrient enrichment, causing mineralisation of fens and salt peats, thus releasing nutrients.

Available nutrients are converted into biomass. Nutrient enrichment of the sites leads to taller and denser vegetation stands, which has a particularly negative impact on light-dependent and not very competitive species. Grazing is a way to counteract the excessive development of vegetation but may not always be in accordance with conservation goals. Therefore efforts must be undertaken not to treat the symptoms but to cure the illness: to reduce nutrient input into the system of the coastal lagoon habitat complex.

Photo 5.2.4.a - Dunes as “natural nutrient poor” systems today receive in the western Baltic that amount of fertilization via rain and aerial deposition, which was 100 years ago, put to the most productive arable fields. Today this nutrient input results in fast succession towards grass and later scrub dominated vegetation. Typical dune species rich dune vegetation is replaced and dynamics are reduced by fixing the sand as here on Hyllekrog (DK). (Photo Hauke Drews)

Reduction of the nutrient loads of air, precipitation and ground water is a topic for the national politics of the partner countries. In the framework of the LIFE BaltCoast project, only local nutrient sources can be dealt with – and reduced, if possible. The general principle is to prevent direct nutrient input into the system and to remove nutrients by harvesting biomass.

For the protected areas with their shallow ponds and lagoon habitat complexes, conservation grazing (see chapter 5.2.2.) and the re-establishment of near-natural water levels are fundamental prerequisites for a reduction of the nutrient load. Additionally, fertilisation - especially with mineral fertilisers - should be avoided within the protected areas.

Diversion ditches and pipes - Some protected areas receive nutrient-rich water from the farmed hinterland. Sometimes, ditches direct these effluents directly into the valuable lagoons. In these cases and when no other solution for this problem could be found, new ditches or pipes were installed that guided the effluents around the lagoon, discharging them directly into the Baltic. Both pipes and ditches were used at Swedish and Danish project sites. The lagoon - significantly less contaminated - is able to slowly recover. Usually, this requires conservation grazing of the lagoon habitat complexes and, if necessary, a careful reduction of tall growing reeds and/or dredging. Diverting the nutrient-contaminated water does not address the root of the problem; but it does helps to improve the conservation state of sensible habitats within the project sites.

Cleaning ponds - An alternative to this method is the creation of cleaning ponds (also chapter 5.2.1.). These ponds collect nutrient rich water before it enters the lagoon habitat complex, or the Baltic. The stagnant water-bodies act as catchment and clearing unit, where nutrients are converted into biomass. The usually luxuriantly growing vegetation will be consumed by grazing animals. Slow irrigation of the cleaned water onto the adjacent pastures leads to the development of wetland and purifies the water further on its way to the lagoon. At best, the nutrients are completely converted into (plant or animal) biomass on their way from the hinterland to the lagoon, and further to the Baltic Sea. At several German project sites, drainages and outflows from intensively farmed plots have first been conducted into newly created water-bodies before letting them enter the lagoon habitat complex.
The cleaning system with ponds is dependent on a minimum slope of the relief. Its operational efficiency depends on the amount of nutrient-rich water and the concentration of nutrients. Small cleaning ponds are well suited to clarify agricultural drainages and small

outflows. At the same time they may fulfil habitat functions for specific aquatic species and may even be suitable for some target species of the LIFE BaltCoast project such as Creeping marshwort (*Apium repens*) or Natterjack toad (*Bufo calamita*).

Large scale solutions - In case of larger streams or rivers, the nutrient load can only partly be reduced by methods as described above. In such cases, larger technical solutions like purification plants or extended sewage farms have to be installed, before the water reaches the protected areas. Corresponding suggestions have been integrated in the management plans, if applicable. The options for realising such large-scale technical solutions in the time after the project (After LIFE) have to be discussed among the partner countries and for each project site. Due to the Water Framework Directive (WFD) of the European Union, some improvement of the frame conditions might be expected for the future – also for the protected areas of the LIFE BaltCoast project. However, the realisation of incisive and extensive measures cannot be expected immediately. Therefore all small-scale measures, helping to reduce the nutrient load of the Baltic habitat complexes are of high importance for the site-specific characteristic animal and plant species.

Practical advice - To reduce the nutrient concentration within the Baltic lagoon habiat complexes often only small scale sources can be addressed:

- Diversion ditches and pipes can be installed to guide nutrient rich effluents around sensible areas.
- Cleaning ponds can be installed to catch and purify water from adjacent areas before it will be spread over the to be protected areas

5.2.5. Natural succession

Cessation of traditional land use in the protected areas along the Baltic coast leads to ruderalisation and an increase in fallow plant species, followed by bush encroachment in the former open landscape. As a result of the undisturbed succession, first shrub and tree species will occur in the long run, if the soil is suitable and the sites are not subject to high natural dynamics by wind, water, ice, and fire, or calamities. As a rule, the appearance of woodland plants is a natural development process. At the Baltic coast, this process has been

increased by limiting the natural coast dynamics, by drainage and fertilisation in the protected areas, and partly also by direct plantations.

Natural succession and project goals - For the BaltCoast project, the establishment of dense woodland plants in project areas with lagoon habitat complexes, extended salt meadows, and dune landscapes is negative. The development of shrubs and trees is inconsistent with the protection aims of conserving the near- or semi-natural open landscape habitats along the Baltic coast with their characteristic animal and plant species.

With the assistance of the LIFE BaltCoast project, open (because of traditional use) habitats along the Baltic coast within the Natura 2000 network were conserved and restored as far as this was still possible after the far-reaching, partly irreversible changes that have been made in the landscape. The appearance of woodland plants is therefore an indicator for a negative development; it is not in accordance with the requirements for conserving the populations of coastal and grassland bird species.

Baltic dunlin (*Calidris alpina schinzii*), Ruff (*Philomachus pugnax*), Black-tailed godwit (*Limosa limosa*), and Pied avocet (*Recurvirostra avosetta*) are target species of the LIFE BaltCoast project and particularly sensitive against the encroachment of woodland plants in the vicinity of their habitats.

The target species Natterjack toad (*Bufo calamita*) and European green toad (*Bufo viridis*) are less sensitive against the appearance of woodland plants, as long as those do not grow so dense as to change the whole habitat and its micro climate. The occurrences of these amphibian species depends much more on water levels, links between habitats, and suitable spawning waters.

For many characteristic plant species of endangered open habitats and for the majority of the habitat-typical invertebrate species, the appearance of woodland plants is at first positive: it enhances the structural diversity and creates new habitats. Only later, when the woodland plants get too dominant and start to alter the site-specific water and nutrient conditions, will the open habitat species feel negative effects.

Ensuing woodland species cause problems and pose a severe potential danger (especially for the bird species of the open landscape), are: Common juniper (*Juniperus communis*), Sea-buckthorn (*Hippophae rhamnoides*), Hawthorn (*Crataegus spp*.), Blackthorn (*Prunus spinosa*), European gorse (*Ulex europaeus*), and Japanese rose (*Rosa rugosa*), Grey alder (*Alnus incana*), Willow (*Salix spp.*), Birch (*Betula spp*.), Pine (*Pinus spp*.), and Poplar (*Populus spp*.). In each protected area, only a few woodland plant species have a key role.

Counteractions against natural succession - In the different protected areas, the appearance of woodland plants was counteracted by cutting and grazing, depending on the extent of encroachment and the severity of conflict with target species of the open landscape.
Cutting is necessary in case of dense stands of woodland plants or single tall individuals. Out of consideration for the breeding season of birds, the cutting is normally done during the winter months; this can also be carried out after the breeding season in late summer. The latter is the better choice, as it minimises damages and allows animal and plant species to quickly adapt to the new situation. Legal aspects in the partner countries must be considered – in Germany, for example, cutting is allowed only until the 1st of March.

The cut material must be removed from the sites. Trunks of larger specimens can be used as firewood; juniper wood is well suited for carving. Smaller cuttings such as branches and twigs should be burned or shredded and disposed. Solitary trees or shrubs may be left to rot where they were cut, as long as this has no detrimental effect on the protected species or habitats.
Cutting of woodland plants has to be regarded a single measure for restoring the corresponding area. In any case the purpose and the aim of the measure must be individually weighed for each protected area and for each affected sub-plot. Furthermore, the situation should be documented by photographs taken before and after the measure.
The success of such a measure will last only, if new appearances of woodland plants are prevented. Woodland species can quickly regenerate from roots and stubs or germinate anew on disturbed soil. To keep the areas open in order to support the target species, conservation use must be applied to the cleared plots. Mowing is possible, but, in contrast to grazing, difficult to carry out in the areas in question.

Grazing against succession - In the framework of the LIFE BaltCoast project, it has been demonstrated at several protected sites how a new establishment of woodland species can be averted or at least reduced by conservation grazing with cattle and/or horses. In addition,

several new findings have been made in Germany, where in the „Halboffene Weidelandschaften“ (semi-open pasture landscapes) the grazing of former shrub and tree stands has lasting positive effects on the target species of the open landscape. By grazing, the young shoots of woodland plants are permanently browsed, so that often after only two years, nearly no new shoots emerge from the roots and stubs any more. Newly established shrubs are soon browsed by the grazers, as long as they are still short. The effect can be controlled and flexibly adjusted to the area in question via the number of grazing animals, the choice of breed, and the grazing period.

As of about 3 m height most tree species are too tall and their trunks too thick to be lethally damaged by browsing animals. Exceptions are possible, e. g., when the bark is stripped off completely or when the root collars are damaged severely enough to be colonised by detrimental fungi. Tall trees and shrubs should therefore be felled and removed from the plots. Power saws can only be used for this purpose if the trunks are thick and stable enough. This is for most woody species the case as of about 2 m height.

Young woodland plants remaining on the plot and stump sprouts are browsed very effectively by the grazing animals. Both horses and cattle (and, in other areas, sheep) browse the trees and prevent further spread of woodland habitats. This is – a sufficient grazing pressure given – also possible with pure winter grazing. The most striking initial success can be observed for the browsing of softwood and coniferous wood. Young pines, for example, survive the browsing only shortly and are hardly able to recover. The stump shoot of birch, willow, and poplar is very vital and can grow larger very fast since cutting them does not damage the roots. Depending on the number of young woodland plants and stubs on the one hand and the grazing pressure on the other, it is possible for woodland species to survive for several more years in the area. A new development of tall shrubs and trees on the site, with the known negative effects on grassland bird species can be avoided establishing a sufficient grazing pressure.

Picture 5.2.5.a + b - In the „Halboffene Weidelandschaft Höltigbaum“ (semi-open pasture landscape Höltigbaum) - a project of the Stiftung Naturschutz in the inland of Schleswig Holstein - it was possible to enhance the effect of cutting and grazing by placing the cut in about 1 m height instead of close to the ground.
Thus, the grazing animals could find the stubs much quicker in the tall grass vegetation and browse the young shoots that had developed at the cut considerably easier. In addition, the amount of work involved in the cutting was reduced, and the stubs remaining in the terrain added valuable micro habitats e. g. for beetles and reptiles.

The hardest case - thorns - Shrubs with deterring thorns are particularly difficult to repress. Especially areas with old, well-developed thorn shrubs and abandoned plots with expansive woodland structures are hard to change into an open landscape. In such cases, more intensive grazing is necessary in addition to tree and shrub cutting. Cutting of extensively dispersed thorny-scrub vegetation such as Blackthorn, Sea buckthorn, and European gorse should be done with larger motorised equipment rather than chain saws.

When excavators are used, thorn shrubs can be removed including their root systems and later burned on-site. Such drastic measures and the utilization of large machines should only be applied after careful consideration and must be in accordance with the management goals of the site.

After cutting, thorn shrubs will very likely regenerate from their roots. For a lasting success, the measures would have to be repeated regularly – an effort that is normally not justified.
In some BaltCoast project areas and reference sites of the Stiftung Naturschutz Schleswig-Holstein, the development of thorn shrubs could be suppressed by a subsequent permanent grazing with robust cattle. The still low thorn shrub populations are thinned out, and in the case of hawthorn, characteristic sphere-shaped growth-forms develop. Areas cleared from thorn bushes remain open, and single, low-growing and compact stands of the bushes (often

in ball-shape) are not high enough to cause a strong deterring effect on grassland birds. On plots with conservation grazing, remaining shrubs are often to be considered a structural enrichment; they are also important special habitats for numerous typical animal species of the coastal habitats.

The effects of subsequent grazing on recovering thorn bushes are the smaller the more extensive and shorter the grazing is. Depending on the initial situation, it is thus possible to control the effects on the shrubs as well as on the other vegetation of the area in question by choosing the appropriate grazing regime. Grazing pressure should be as high as possible, without damaging the valuable populations of protected animal and plant species. It is therefore mandatory to find an adequate individual solution of suitable, flexible, and effective grazing of woodland plants for each protected area (or each section that is affected by bush encroachment)

By cutting and grazing, it is possible to repress species like Hawthorn, Blackthorn, Sea-buckthorn, and Juniper (which tends to form rather dense stands especially in Estonia) as well as the neophytic species Japanese rose. Detailed information on the neophytic Japanese rose, which poses a severe problem in many protected areas along the Baltic coast is dealt with in chapter 5.2.6.

Practical advice - To tackle the problem of natural succession, a combination of two measures is suggested. 1) Cutting or mechanical removal of woodland plants and 2) (subsequent) grazing.

- Establishing a grazing regime is essential to keep slow down or stop natural succession towards woodland. Type of grazing and grazing pressure depends on the local situation and should be decided together by conservationists, site managers and persons experienced with grazing.
- Cutting or mechanical removal of dense woodland structures can either be a preparational action before grazing will be started, or it can be repeated at intervals to preserve an open character of a site if grazing is not possible.
- If an excavator is used to remove woodlands, roots should be taken out, too. This considerably reduces the regeneration potential of the woodland species.
- Mowing is an alternative to grazing to keep an area open, but under the viewpoint of conservation aims not the optimal solution.

5.2.6. Invasive species

Definition: Neophytes are plant species that were actively introduced or spread by mistake by man after 1492. Since then, neophytes have contributed significantly to the species richness of the native flora (indigenous species and archaeophytes). In Germany, about 12,000 plant species have been introduced, 1000 of which are still considered as “transient”, another 400 as “naturalized” species

About 50 naturalized neophyte species are regarded as “invasive” in Central Europe and have negative impacts on the biocoenoses of their living spaces. However, from a nature and species conservation point of view, only very few neophytes are considered as significantly problematic in the biotopes they have colonised.

In the BaltCoast project areas, the following invasive species - all introduced from outside Europe as garden plants - were identified as a threat:

a) Japanese rose (*Rosa rugosa*)
b) Japanese knotweed / Giant knotweed (*Fallopia japonica* / *F. sachalinensis*)
c) Giant hogweed (*Heracleum mantegazzianum*)

Among the project partners the consensus was reached that populations of invasive neophytes should not be allowed to further expand. Strategies and methods were to be elaborated to mitigate negative ecological effects caused by the neophytes, to prevent further spreading of their populations or, where possible, eradicate them in protected areas.
Reducing the populations of the Japanese rose turned out to be the biggest challenge in the coastal habitat complexes. Different methods have been tested, some of which have already led to good results during the project term.

a) Japanese rose (*Rosa rugosa*)
The Japanese rose colonises those parts of coastal spits and dunes that are located higher than 60 cm above mean sea level. Negatively affected are therefore white and grey dunes and – to a lesser extent – also brown dunes and shingle beaches located at higher altitudes.

In the western Baltic Sea – in project areas in Germany, Denmark, and Sweden – exist quite extended and dominant stands of *Rosa rugosa*. The rose has already colonised 5–10% of the colonisable area and is spreading further. In some cases, dune areas of up to several hectares are already completely dominated.

According to the development observed during the last decades, the yearly dispersal rate of the Japanese rose in coastal areas is about 10%. Anticipating a constant expansion rate, the colonisable dune landscapes of the project areas will hence be completely overgrown by *Rosa rugosa* within 25–50 years. Effects on species composition, quality and structure of all coastal habitats would be disastrous. In case of a further spread of *Rosa rugosa*, the demand to conserve or restore a favourable status for the habitat types in the protected areas could not be met any more.

To aggravate the situation, the dispersal rate of 10% is not a fixed quantity, but merely an average value of the hitherto development. The results from Krummsteert (project area 22, Western Fehmarn) show that the rose establishes many new settlements after heavy flooding. At the site mentioned, a local dispersal rate of 300% was determined within 4 years. Today, climate experts project a significant rise of the sea level and an increase in extremely high tides. It is therefore likely for the Japanese rose to spread more and more due to passive dispersal of seeds and plant material; large source populations exist in nearly every project area. If no suitable measures are taken in the coastal areas, the problems caused by *Rosa rugosa* will become graver.

Past efforts of pushing back *Rosa rugosa* were mainly mowing and uprooting actions - with only short term success. Rose populations are capable of quickly recovering from roots or remnant stands. Mowing sometimes even resulted in particularly dense and productive rose stands carrying numerous fruits. The main reason for the past failure is that the counteractions were only single events. Neither follow-up examinations nor touching-up actions were carried out.

Both mowing and uprooting were found to be effective measures, given that they are carried out carefully and persistently. Such experiments are being successfully carried out in Schleswig-Holstein (Geltinger Birk). Here, tests of mechanical and chemical control of the Japanese rose are performed simultaneously. Even after a short testing period good results

were achieved, but the measures are both costly and work intensive. One of the projects goals therefore was to find out, if the Japanese rose can be suppressed by cattle grazing.
Initially grazing was implemented in order to improve the conservation state of salt meadow and dune habitats of the Habitats Directive. Later on, grazing animals were observed to have a significant impact on local populations of *Rosa rugosa*. Grazing animals browse leaves, fruits and young shoots; bark is stripped off thick trunks of the rose bushes during winter months. Stands of the Japanese rose were browsed and thinned out, prevented from further dispersal, and partly even completely destroyed.

Year-round grazing showed best results. While summer grazing also results in a rather fast reduction of the rose stands, the effects of conservation grazing limited to autumn or winter are initially smaller. The results of these different grazing intensities on *Rosa rugosa* are understandable since grazing affects only the above ground parts of the plants. The rose recovers from the root zone; the stronger and more regular the above ground damages occurs, the harder it is for the plant to regenerate. It is therefore likely that the same positive effects that were found for year-round and summer grazing will - delayed - also appear for conservation grazing.

Long-term grazing of the project areas will have the best future results: the cattle, which like and prefer to browse the Japanese rose, do their conservation job with great patience and perseverance. Therefore, stands of *Rosa rugosa* should be subdued to grazing wherever possible. But the grazing pressure must be carefully adjusted to the demands of sensitive animal and plant species and habitat types of the area in question. *Rosa rugosa* will then be suppressed more or less vigorously and quickly. Additional mowing of the grazed stands is not necessary and may be even counterproductive. For many areas, it would already be a great success to prevent further dispersal of *Rosa rugosa*.

It takes a long time to reduce extended and dense stands of Japanese rose, which tries the patience of stakeholders. Monitoring should happen every five years, recording extent, height and density of the stands. Aerial photographs do notably help with the analysis.

Photo 5.2.6.a - As coastal protection measure areas of drifting sand were planted with *Rosa rugosa* in the last century. The Japanese rose is very competitive, so that this specie replaces natural vegetation in dunes with an increase of coverage in average 10-15% per year, but flooding and other calamities can multiply this. Fruits spread by flood and also by fox, which like to feed these. (Photo Heiko Grell)

Grazing can be the first choice measure for fighting *Rosa rugosa* in many sections of the Baltic coastline. Mechanical and chemical measures could be restricted to persistent remnants or parts of habitats unsuitable for grazing.

One example of a non-grazed protection area that has already been freed from all Japanese rose stands is Bottsand near Kiel (Schleswig-Holstein, Germany). In this area, mechanical measures could meanwhile be reduced to a yearly removal of newly occurring young plants.

Photo 5.2.6.a + b - Protection area Bottsand near Kiel. Due to yearly removal of sprouts of the Japanese rose (*Rosa rugosa*), the area is completely free of stands of this neophyte, which are otherwise rather common along the coast.

Conservation grazing by cattle damages the stands of Japanese rose persistently. Intensive year-round or summer grazing regimes show faster results than extensive or winter grazing. Grazing immensely reduces the need for mechanical or chemical measures to control the Japanese rose and thus the necessary amount of work.

b) Japanese knotweed / Giant knotweed (*Fallopia japonica* / *F. sachalinensis*)

Both knotweed species are invasive neophytes that cause problems in many areas marked by human influence. They form very dense, dominant stands crowding out indigenous species. Along the coasts, problems caused by knotweed arise only in the vicinity of human settlements and camping grounds; insofar as the BaltCoast project is concerned, the knotweed species are therefore of subordinate importance. Only at a few places - e.g. former camping ground Tivoli (project area 19, Sehlendorfer See) existed single dominant stands.

At abandoned places, where no mechanical or chemical countermeasures are carried out, knotweed populations will step by step extend to all suitable sites and finally form uniform stands. In the Tivoli example, existing stands of knotweed were grazed for several years by Scottish highland cattle. The cattle consumed above ground plant material, damaging also the rhizomes. As a consequence the knotweed stands are heavily repressed or completely destroyed. Small, low growing remnants that often remain for many years have no relevant negative influence on the habitat types of the Habitats directive any more. If grazing is continued sufficiently long it will lead to an eradication of the species at the site.

Outside grazed areas, the two knotweed species can only be controlled mechanically or chemically – or be accepted as naturalized elements of the landscape. In the project areas of the Habitats directive along the Baltic coast, there are presently no knotweed problems outside of conservation grazing areas.

c) Giant hogweed (*Heracleum mantegazzianum*)
Giant hogweed is an invasive neophyte, which spreads along fringes and fallows. It also occurs along the shore at BaltCoast project areas. Tall growing stands of Giant hogweed spread out and out-compete indigenous species like, e g., European angelica (*Angelica archangelica*) or other specific perennial riparian species.

In areas of the BaltCoast project, some stands of Giant hogweed have been controlled mechanically or chemically, some parts were grazed. Mechanical and chemical measures are labour-intensive and must be continued over many years to achieve a lasting success. Single actions are unsuccessful in the long run because the populations recover from roots or seeds. Regular cutting of the above ground parts of the plant can reduce the stands significantly, provided the measure is taken before the plants come into flower.

Subduing stands of Giant hogwood to grazing is an easy way to control the species. Robust cattle like Scottish highland cattle or Galloway consume the above ground parts of the plants and damage the rhizomes. Grazing initially reduces the extent and the height of the stands and can, sufficient grazing intensity provided, completely eradicate them in the medium term. Despite its defence mechanisms - which are not strong enough to keep robust grazers at bay - Giant hogweed is sensitive to grazing.

6. Communication tools

Often complex situations at the project sites required interdisciplinary approaches for finding and elaborating workable solutions. Therefore special attention and care was put towards establishing helpful communication routines in order to guarantee a successful project implementation.

Another aspect to be dealt with by communication tools was the following: the Baltcoast team consisted of over 40 persons from 6 countries with different cultural background and

education. An important task for a project of this dimension is to form a clear-cut team out of the variety, to further mutual understanding and to mediate, where misunderstandings might impede cooperation.

Representative routines and strategies that were found to be helpful will be described in the following subchapters.

Expert visits - The overall aim of the project was to improve the conservation status of the targeted habitat types within the lagoon habitat complex - to create conditions that would enable the target species (*Calidris alpina*, *Philomachus pugnax, Bufo viridis*, *Bufo calamita*) to re-colonise previously lost breeding areas anew or at least offer them suitable conditions for the future. At sites where target species were still present, the aim was to halt declines by re-establishing favourable habitat conditions.

As was described earlier (see chapter 2), the need to find complex solutions for the sites posed an ambitious challenge for the project team. A high degree of interdisciplinary team work was necessary in order to be successful. This was partly realized by organizing expert groups and expert visits: highly qualified professionals from different fields worked together to find solutions for concrete conservation issues. In this way ornithologists, botanists and amphibian experts were able to establish a reliable routine of cooperation, to regularly exchange knowledge and to profit from each other´s expertise. At many sites this was a new and hitherto untried conservation strategy.

At the beginning of the project an expert group visited all project sites. Based on its findings and discussions with the local managers, site specific action plans were outlined to be implemented during the project. Expert visits took place in each of the project countries, having both a theoretical as well as a practical part. The experts were also ready to answer and help with specific questions touching their special field. Additionally, all partners had the opportunity to exchange experiences in annual workshops on site in each of the participating countries.

Photo 6.a - Baltcoast project experts discussing the “harsh grass problem” with farmer: In the salt meadows a harsh grass -the tall festcue (*Festuca arundinacea*)- became established in large areas of grassed meadows. Normal dairy cattle do not like to graze this grass. With low grazing pressure the grass can produce seeds and spread in the meadows. (Photo Hauke Drews)

Fine-tuning-management - At the beginning of the project, no ready recipes were at hand of how to deal with the ecological problems at the project sites. These had to be found and developed during the project. To do so, an expert group was established. Still, no guarantee was given that the suggested actions would bring about the desired results.

Therefore the development of the conservation status of the sites dealt with was closely watched. Unlike at conventional projects, members of the BaltCoast team checked all measures continuously if the planned aims had been achieved by the actions. If the outcome was other than expected, local project managers would again discuss other options with experts on site. As a result, the actions would be adjusted or discarded in favour of other, more promising strategies. As the project´s aim consisted in creating favourable habitats for the target species, this “fine-tuning management” was necessary repeatedly during the

project. The planned for option to alter and adapt management strategies must be considered a one of the main reasons for the good success concerning habitat management of the target species *Calidris alpina*, *Philomachus pugnax, Bufo viridis*, *Bufo calamita.*
The applied strategy of fine-tuning management proved to be an extraordinary communication tool, greatly benefiting the project.

International Networking - For a long time, the understanding of the conservation needs of the target species was severely hindered: relevant information - population size and trends, carried out management actions - had not been systematically collected and was not exchanged on a regular basis between stakeholders. International and even regional cooperation was thus slowed down. During the BaltCoast project, a large amount of data of breeding numbers of the target bird species (dunlin, ruff, avocet and black-tailed godwit) was, together with data on land use practice, collected from both published and unpublished sources. The international network of bird experts, created within the frame of Life BaltCoast, facilitated to a great extent the access to hitherto scattered, fragmented and unpublished data. Data was stored in a database developed for this purpose and is available at:
www.life-baltcoast.eu

On a few occasions, the international Baltic network of bird experts joined the annual conference of the International Wader Study Group, where knowledge and experience was exchanged with a wider audience. An international networking group of amphibian experts was continued from the former LIFE-Bombina project, both improving and consolidating it for the benefit of this project.

Conservation camps - Practical conservation camps were carried out in the project´s partner country Estonia. These camps took place at all Estonian project sites, at some sites several years in a row. The aim of the conservation camps was to practically improve the conservation state of the project sites as well as to integrate the wider public in conservation management. Dissemination of the project´s goals, knowledge and results among third parties is a positive side effect of such actions. People who took part in the camps gained knowledge about the species inhabiting the coastal areas, their threats and possible conservation actions.

7. Case studies

7.1. Conservation history of the Baltic dunlin

Prioritization of conservation goals - All habitat types of a given project area should be restored to a favourable conservation status of quality grade “A”. There are, however, usually several possibilities how this status should be like. In addition, the habitat types are ecologically connected so that an individual solution has to be found for each habitat complex.

The following question arises: „From the nature protection point of view, what can be reached at best in the lagoon habitat complexes under the prevailing circumstances, considering the historical developments of the areas and possible irreversible changes, but also possible future events?“

In the BaltCoast project, we orient the long-term goals for the areas to the highest value that can be reached from a nature protection point of view. This requires a discussion about the nature protection value of coastal species and habitats and some optimistic realism. Some species and some habitats are much more difficult to restore, but may at the same time have a higher integrative value for the complex coastal habitats than others.

The last existing and the few potential (breeding) habitats of the Baltic dunlin (*Calidris alpina schinzii*) for example have to be given a higher priority than floriferous salt meadows with Sea aster (*Tripolium pannonicum*). Whereas the flowery salt meadow with all its local facets can be developed all along the Baltic coast (given the right management and suitable soil conditions), only few sites will hold the potential to serve as breeding habitats for the Baltic dunlin, a very rare species which is globally threatened with extinction.

In the past, there have been no binding quality standards for the necessary prioritization of protection aims for the Baltic coastal areas. Usually, local solutions were chosen, which often did not tap the full ecological potential of the areas. Individual stakeholders have a particularly strong influence on “their” protected areas.

The Baltic dunlin - a self-fulfilling prophecy - The development of the Baltic dunlin may serve as a negative example. Its populations dropped significantly in the 1960's and 70's. The countries bordering on the Baltic Sea reacted quite differently to this phenomenon, which was known among the ornithological experts and the nature conservation authorities.

While Sweden and Denmark made efforts to keep at least the main populations and established a broad-scale management for the Baltic dunlin in the salt meadows, many areas were simply set aside in Germany. Here, the Baltic dunlin was practically given up as aim of protection and has already become extinct in the heads of the responsible decision makers, despite the fact that there are remnants of the population with development potential. In Germany, species like the Baltic dunlin and the Ruff (*Philomachus pugnax*) are practically not covered by the grid of the bird monitoring conducted in the European bird sanctuaries, so that the negative expectations fulfil themselves.

7.2. Improved management focussed at the needs of dunlin and ruff brings dunlin back and stops a decline in ruff numbers at Saltholm, Denmark

Saltholm is a 1600 ha island situated in Öresund between Copenhagen and Malmö. A large part of the island consists of diverse wet meadows, where the centre meadows of the island is almost fresh, and gradually they become more salt the nearer they are situated to the coast. From the 1960es to the 1990es up to 1100 cattle summer-grazed the meadows of Saltholm and in the 'golden age' of meadowbirds in the late 1970es and the 1980es more than 1000 pairs of meadow breeding shorebirds could be found here including 10-20 pairs of dunlin, 30-60 females of ruff and 9-12 pairs of black-tailed godwit.

During the 2000s it became more and more complicated to achieve summer-grazers to the island and the grazing regime gradually shifted to a lower number of whole-year grazers. At the beginning of the LIFE-BaltCoast project in 2005-06 the number of summer-grazing cattle was down at 150 and in addition 300 adult and 150-250 calves grazed permanently. The average grazing pressure on the island was still quite high, but by inspection it became clear that an unwanted overgrowth had taken place of some of the formerly best areas for the

most vulnerable meadow birds dunlin and ruff on the northwest and north-central parts of Saltholm.

This unfortunate situation was reflected in the declining numbers of breeding dunlins. In 1995 there were still 8 pairs, in 2000-2006 the number dropped to 1-2 pairs. When species experts visited Saltholm in early June 2006 only one breeding dunlin could be found, and furthermore the breeding habitat of this pair was far from optimal, as most of the site was overgrown with too high and dense vegetation, and the territory was at the edge of a common gull colony, causing an apparent high risk of egg and chick predation. At a thorough survey in 2007 no breeding dunlins were found at all for the first time in the hundred years the bird fauna on Saltholm has been regularly monitored. Similarly, ruff numbers dropped in the same period with 11 females as late as 2003, but only 3 females in 2006 and 4 females in 2007. In the same years the natterjack toad was no longer observed, a species sharing very much its demands to the breeding habitat with dunlin and ruff, and also this species was most likely at the brink of extinction. It was obviously very urgent to act, if the formerly rich meadow bird and amphibian diversity should survive.

Project strategy - The main aims of the LIFE-BaltCoast project were to

- restore the short grassed halophytic meadows with partly overgrown small pools and gullies inside the western shore on the northern part of the island
- remove the high and lush vegetation surrounding the central wetlands on the northern half of Saltholm. This strong vegetation prevents the use of the wetlands by meadow birds like ruff, and in addition high vegetation favours an important predator of meadow bird chicks the herring gull, which breeds abundantly and successful in such vegetation
- ensure that the present core area for meadow birds like black-tailed godwit, ruff and redshank in an area in central Saltholm devoid of breeding herring gulls keeps its favourable vegetation height and structure.

Actions - There were basically two potential ways to achieve the wanted shift in grazing pattern of the cattle: by force (specific fencing) or by attraction. The LIFE-BaltCoast project tried the second way: to attract the cattle to graze in the targeted areas. A quite simple adjustment was to move the site where winter-feeding of the cattle with local hay took place closer to the areas targeted for more grazing.

A more laborious action was to create a cyclic mowing schedule in the targeted areas adjacent to the central wetlands and the slow growing halophytic vegetation to the northwest, areas otherwise unprofitable for achieving good hay and partly also on uneven ground difficult to mow. Immediately after such areas are mown they become very attractive to grazing cattle.In the first place it was considered to add an action with removal of harsh vegetation including litter from some of the depressions in the meadow bird core area However, an evaluation in the summer 2011 showed that, with the contribution of an unusually wet autumn, cold and snowy winter and dry spring 2010-2011 with reduced vegetation growth, cattle had removed almost all of that type of vegetation during the intensive winter and spring grazing that year.

7.2.a. + b Dunlin in typical habitat at the nesting place on Saltholm June 2011 (Photo Martin Altemüller)

Success - In 2010 and 2011 the aim was achieved: Both the targeted areas have been restored and are now dominated by short grass.

In 2010 a large evaluation bird survey was performed and the good state of the vegetation management was also reflected in the number of vulnerable meadow birds. One pair of breeding dunlin was found for the first time since 2006, and at a much more favourable short grazed breeding habitat than in 2006. At an additional quite brief survey in 2011 two pairs of dunlins were found, of which at minimum one was successful and seen with chicks. One of the 2011 breeding birds had been ringed as a breeder in the Foteviken area in Sweden in a previous year, underlining the potential of dispersal to restored areas when the distance is only a few tens of km.

Another gratifying result is the fact that ruffs continuously breed on Saltholm. During the last ten years this species has declined dramatically everywhere in Western Europe, and ruffs have disappeared from most of its temperate breeding sites. Apparently, targeted management pays for the species, and both in 2010 and 2011 6 breeding females were recorded on Saltholm. This island must now be far the most important coastal site for the species in the Baltic. In Denmark only the Tipperne peninsula in western Jylland has more breeding ruffs, and the nature reserve Tipperne is the only site where management for many years has been specifically directed at suiting the ruff. The Saltholm population constitutes more than 10% of the Danish total, and one third of the ruffs in Denmark outside Tipperne.
At the 2010 breeding bird survey, also a record high number of breeding black-tailed godwits were found at Saltholm, 18-26 pairs, and it was even more promising when it could be established that a minimum of 18 pairs had hatching success that year. Without doubt, Saltholm functions as a key site for successful breeding for the three target species in years, when sufficient precipitation creates favourable wet meadows in spring.

7.3. Preparing Schwansener See for *Bufo calamita*

During the Baltcoast project, several sites - e.g. Schwansener See (D), Sehlendorfer Binnenwasser (D), Urehoved (DK), have been revitalized and restored for *Bufo calamita*. One site example - Schwansener See - will be described in detail to explain the major points.

Before starting the concrete conservation measures, the site was an old coastal meadow which had been drained during previous decades. Picture 7.3.a below shows the site just before the work started.

Picture 7.3.a. - Schwansener See (March 2010). At the right side a wet depression is visible. The dark line behind represents a small asphalt road, slightly higher than the project site (Photo: Florian Bibelriether)

Figure 7.3.b. shows a drawing of the drainage pipes that have been found during the digging campaign. The project site is situated in the middle right, where the dark lines (drainage pipes) diversify. The main job at the site was to investigate the drainage system and destroy it - while neither taking care that neighbouring plots nor the public road get flooded.

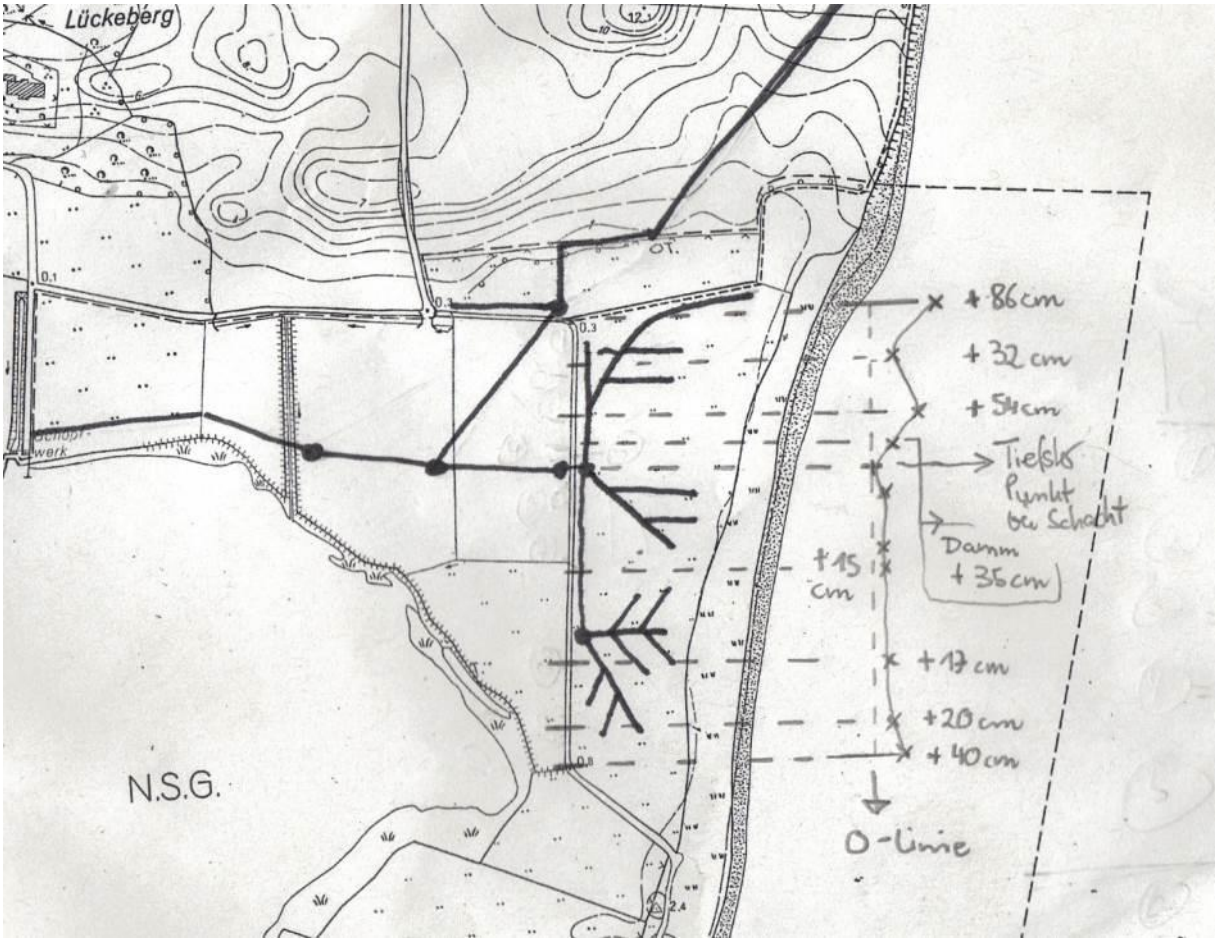


Figure 7.3.b - Drainage pipes (black lines) at the site Schwansener See (middle right)

Picture 7.3.c shows a small dam in front of the little asphalt road that was piled up in order to increase the water retention on the site. In that way, a spacious natural flooded area was reactivated.

Picture 7.3.c. - Schwansener See (March 2010). Water retention on the site was improved by piling up a small dam in front of a road. (Photo: Florian Bibelriether)

Picture 7.3.d. shows a newly dug breeding pond for *Bufo calamita* which was additionally created on the site. The pond bottom is clay, of a brownish hue.

Picture 7.3.d. - Schwansener See (March 2010). A new breeding pond for *Bufo calamita* was dug at the site. (Photo: Florian Bibelriether)

7.4. Reintroduction of toads in Germany and Sweden

At Sehlendorfer Binnensee a camping site was entirely removed and dune habitats and four shallow ponds created. Natterjack toads and green toads were released at the site and within 5 years a population of 20 calling males of natterjack toads and 15 calling males of green toad became established. Yearly reproduction was monitored and in 2012 a grazed flooded depression in another project site was colonized over a distance of 5 km along the coast by a single male.

For the re-introduction of the green toad at Ottenby on Öland another strategy was followed. Eggs were collected and in captivity toads were reared by the Zoo Nordens Ark until they became adult. These animals were released next to the hibernation sites at the Ottenby bird station and lighthouse in early autumn. The following spring first calling males were heard in lagoons, which had been restored. The reproduction was successful in the first year after release.

Photo 7.4.a + b - Claes Andrèn releasing green toads together with children at Ottenby Fågelstation on the island of Öland (S). For the reintroduction the toads were reared at the Nordens Ark Zoo from other Swedish population. (Photo: Susanne Forslund))

Results

- Natterjack toad populations were secured: in Denmark at Bågø (DK), Halmø, Endelave, Halk Nor, Urehoved and in Germany at Schwansener See, Südwest-Fehmarn
- Reintroductions after habitat management were successful in Germany at Schwansener See (D) and Sehlendorfer Binnensee (D), in Denmark at Urehoved (DK)

7.5. Creating reserve populations for *Apium repens*

Another objective of BaltCoast was the preservation of *Apium repens*. To do so, seeds from *Apium repens* were collected and from these seeds high numbers of small plants in pots were produced. These plants were used to establish back-up populations for one source population in Schleswig-Holstein by planting at each site (three sites in total) approximately 200 pots, each with in average 4 plants. The plants were planted in 6 stripes from dryer parts of reactivated depressions or ponds into the water. 3 stripes were grazed by cattle, whereas the other 3 stripes were protected against grazing. The further development was monitored during next years.

Only at one of this three sites, the creeping marshwort established very successfully and spread all over the pond. In a new release campaign as an “after Life activity” more sites, also outside the project, were selected and will be planted with the creeping marshwort. Results are:

- With the increased knowledge based on scientific investigation of the ecology of *Apium repens,* the conservation management was improved.
- *Apium* reserve populations were established at three German sites: Eichholzniederung, Sehlendorfer Binnensee and Südwest Fehmarn.
- A conservation guide for Apium repens was written by Kai Jensen, Jan Schwerdtfeger & Sandra Burmeier

7.6. Sehlendorfer Binnensee

As an example how restoration can change the negative development again, at the site Sehlendorfer Binnensee the restoration of a former camping sites was carried out by removing scrub, water pipes, electricity wires, installations as concrete pavements and clay sand roads. The surface of the site was re-created with shallow “beach ridges” and “dune slack like depressions”, leaving the site with many open and bare of vegetation places. In this way, the constant recreation of a mosaique pattern of micro habitats was enabled. Subsequent grazing by robust cattle will prevent a renewed succession towards woodland stages. All clay sand was put min 1 m under the beach ridges. Valuable vegetation patches on the camping ground was GPS-logged and the during the construction work these patches were marked and kept untouched. At present, the site is in a considerable good conservation

state, both *Bufo calamita* and *Bufo viridis* were reestablished and are successfully reproducing.

Photo 7.6.a.: Aerial view to the formerly leveled camping area which was restructured with dune slack like depressions and dune like sand piles. The site is grazed together with adjacent salt meadows. (Photo Heiko Grell)

7.7. Changing hydrology for the better

In the following, some site examples will be given, illustrated by pictures.

Reesholm (Project area No. 15)

Picture 7.7.a: The extended depression in the salt meadow is drained by numerous ditches. After flooding, the water is quickly drained off so that there is presently neither a suitable spawning habitat for the Natterjack toad (*Bufo calamita*) nor a possibility for amphibious water plants to establish. As a countermeasure, ditches are nowadays not cleared anymore and have been blocked at several places.

Picture 7.7.b.: Natural filling-up of the ditches decreases the drainage. Extended flat ponds have evolved which temporarily carry water and show increased salinity due to yearly drying up. The wetting of the salt meadows happens only slowly, as the ditches are not blocked by dams. This is necessary because the reeds shall first be forced back through grazing.

Kleiner Binnensee (Project area No. 18)

Picture 7.7.c. - In the salt meadows, straight ditches and the former, now partly drained slough system can be recognised. The ditches are fenced and overgrown with reeds, which produces a deterring optical effect, e. g. on meadow bird species. Damming the ditches at several places resulted in the raising of the ground water table, re-activated the sloughs and lets natural depressions keep water longer. Fences along the ditches are to be relocated.

Reference area (Geltinger Birk)

Picture 7.7.d - New shallow waters have been installed in the beach berm. The sandy material was thinly spread in the surrounding. The open and temporary character of the pond, the sandy soil, and the integration in the pasture are necessary site parameters in this coastal habitat for the target species Natterjack toad (*Bufo calamita*)

South-west Fehmarn (Project area No. 22)

In Germany, it was possible in one special case with no existing external issues to realise an improved regulation of water levels during the project term. At Wallnau (project area No. 22) on the Island of Fehmarn, salty seepage water leaks underneath the dike, infiltrating the drained lowland of the former Baltic Sea lagoon. Salt water used to be conducted by ditches to the pump and to the floodgate and had only little influence on the area. By changing the damming possibilities in the existing dewatering system, salt water can now be kept longer on the site and be directed into areas with depressions that fall dry in the course of the year and can thus be salinated. In this way, the habitats for salt-tolerant animal and plant species could locally be significantly improved.

Picture 7.7.e - Seepage water entering from underneath the dike is kept back in near-natural lagoons. Thanks to improved damming possibilities of the ditches, the saline water can be specifically conducted into a depression with remnants of salt meadow vegetation (pale area on the left and above the centre). Evaporation of the salt water results in salination of the depression, improving the site conditions for halophilic target species.

Weißenhäuser Brök (Project area 20) and Sehlendorfer Binnensee (Project area 19)

Picture 7.7.f. + g - Disturbed connection of the lagoon with floodgate and pump; not natural (site 20, left) and Near-natural connection to the Baltic Sea; free outflow and inflow are possible (Site 19, right)

Teorehe (Project area No. 29)

Picture 7.7.h - The large lagoon and the lagoon habitat complexes are separated by old dams that are typical for the landscape. The connection between lagoon and Baltic Sea has been re-established at several places. The water can now flow more or less freely in both directions, and fish have access to the Baltic Sea as well.

7.8. Fighting *Rosa rugosa*

Initially, different types of scrub grew at project sites in dryer parts of coastal meadows and dunes. While most scrub species are native, the alien invasive species *Rosa rugosa* threatened to severely decrease the ecological value of many project sites. Grazing significantly reduced scrub in general. Native species - even those with thorns - were reduced, dense scrub was broken up by cattle.

Cattle use scrub in different ways: in windy coastal areas scrub provides wind shelter and also shade. Scrub and trees are used by the cattle to rub themselves. Doing so, they break small trees damage the root system of scrub. This eventually leads to the elimination of woodland plants. The same applies to the Japanese rose, which is grazed during the entire annual cycle. In March, bark is a supply of first fresh nutrients and stripped off by cattle. Later, fresh shoots, buds and fruits are consumed. During winter, some cattle that have learned how will pull up and eat the remaining roots. Single, smaller stands of the Japanese rose were eradicated completely by highland cattle (Sehlendorfer Binnensee). When *Rosa rugosa* forms larger stands, effects are less but the coverage and height of the Japanese rose was still significantly reduced. In opened up scrub, typical plants of grey dunes reestablished themselves. Thus, extinction for rare plant species caused by Japanese rose was reduced significantly (Weißenhäuser Brök and Schwansener See).

Photo 7.8.a + b - Year round grazing cattle can eradicate whole Japanese rose bushes (left 2007, right 2012), if grazing pressure is high enough as here at Sehlendorfer Binnensee (D) by highland cattle. (Photo Hauke Drews)

At the Danish site Store Vrøj, Japanese rose bushes were initially pulled up with a special claw, attached to a small excavator. Most of the plants - including the roots - were removed in this way. Although the plants recovered from the remaining roots, the former dominance was not reached again. Galloway cattle grazing the site helped to keep *Rosa rugosa* in check. Additional mechanical eradication measures carried out the following year will probably lead to a final success in restoring the site. On Endelave and Halk Nor (also Denmark), Galloway cattle reduced stands of the Japanese rose significantly by crushing the plants and consuming the fine leaves. At these two sites no mechanical removal was necessary; good results (although not a complete eradication) were reached merely by grazing.

7.9. Improvements of the breeding conditions for avocets at Falsterbo, Sweden

In the project site Falsterbo an avocet colony, breeding on an islet in a shallow lagoon was protected against mammalian predators, and the hydrology was improved. The islet is usually isolated from the surrounding meadows by water, but from time to time very low water levels have made the breeding colony accessible to four-legged predators. On the other hand, at other times high water levels have caused damage and disturbance to the colony as eggs have been washed away.

The standard cattle fence did not prevent four-legged predators such as foxes, badgers and free-running dogs to reach the breeding colony when low water levels occurred. Furthermore, foxes occasionally have been seen swimming/wading over to the islet even at high water levels. In many years water fluctuations as well as predation from mammals wiped out the colony and caused complete reproduction failures.

In order to improve the breeding conditions in the avocet colony a temporary dam was constructed, as an initial action, to keep a stable water level around the islet in the breeding season. This prevented flooding. Later this dam was replaced by a permanent dam. Furthermore the barbed wire fence was reinforced and an additional electrical fence was integrated into the standard cattle fence. In the final stage (March 2012) four barbed wires (total height: 120 cm) and three electrical wires proved to be the appropriate construction. A ground-level line prevents predators crawling underneath, and a top line prevents them jumping over. The grass has to be mown twice in the breeding season to avoid short-circuiting the ground-level line. In the last two years an additional electric fence was put up around the breeding islet, as an ”inner defence” to prevent cattle access to the colony during the nesting period in order to avoid egg trampling. This fence was removed as soon as the clutches were hatched.

With the continued improvements the reproduction has become better and better over the years. During the seven project years, the colony increased from around 50 pairs to a maximum of 202 pairs, and in 2012, when all protection measures were installed and working, 350 juveniles fledged from the colony.

8. Decision tree

The following decision tree is intended to help managers of wet grassland and other coastal and alluvial grassland habitats and dunes in coastal lagoon complexes to take the most qualified decisions on 1) when to manage and 2) how to make priorities when managing such habitats.

The decision tree has three levels: Step one will identify whether the site has special affinities in order to protect some particularly vulnerable species in these habitats that demand species specific habitat management; step two will identify whether the site has other important habitat management demanding species. If none of the species concerned by step one or two is connected to the site, step three provides some general advice in good habitat management.

The tree is divided in 3 steps and has to be followed from step 1 to 3. Actions on step 1 and 2 are not reached by simple agri-env-scheme, see table #4.1. for details. This is why extra funds for reaching special aims are needed.

STEP ONE: Check if there are particularly vulnerable species at the site that demand species specific habitat management

Is the site a breeding site for Baltic dunlin or does it have a high potential (table) for the species? (The list in table 5.4a-e presents such sites in Denmark, Sweden, Estonia, Schleswig-Holstein and Mecklenburg-Vorpommern) → **Manage dunlin breeding habitat as described in table 5.1**

Is the site a breeding site for ruff or does it have a high potential for the species? (The list in table 5.4a-e presents such sites in Denmark, Sweden, Estonia and Mecklenburg-Vorpommern) **Yes** → **Manage ruff breeding habitat as described in table 5.1**

Is there an option to create a new breeding site for ruff with all the necessary habitat features described in table 5.1? → **Consider creating a new ruff breeding site, as there are only few such potential breeding sites, and manage the ruff breeding habitat as described in table 5.1**

Is the site a breeding site for natterjack toad or does it have a high potential for the species? (The list in table 5.4a-e presents such sites in Denmark, Estonia, Schleswig-Holstein and Mecklenburg-Vorpommern) → **If the species is still present or could be present: manage meadow habitat and adjacent areas as described in table 5.2. If the species is gone extinct manage according to table 5.2 and consider re-introduction. If the site is suitable as stepping stone for natural dispersal and/or summer habitat only, manage according to 5.2. In all three situations, follow population management as described in table 5.2**

Are there anthills constructed by the yellow meadow ant *Lasius flavus* at the site? **Yes** → **Manage the anthill meadows with the special anthill flora as described in table 5.3**

No

↓

STEP TWO: Are there other important species that demand a specific habitat management?
This step includes also colonial breeders on coastlines (incl. avocet)

Is the site a breeding site for green toad or does it have a high potential for the species? (The list in table 5.4a-e presents such sites in Denmark, Estonia, Schleswig-Holstein and Mecklenburg-Vorpommern)

Yes →

If the species is still present or could be present: manage meadow habitat and adjacent areas as described in table 5.2. If the species is gone extinct manage according to table 5.2 and consider re-introduction.
If the site is suitable as stepping stone for natural dispersal and/or summer habitat only, manage according to 5.2.
In all three situations, follow population management as described in table 5.2

Is the site a breeding site for black-tailed godwit or does it have a high potential for the species? (The list in table 5.4a-e presents such sites in Denmark, Sweden, Estonia, Schleswig-Holstein and Mecklenburg-Vorpommern)

Yes →

Manage meadow habitat as described in table 5.1

Are there islets in coastal lagoons or sheltered bays with restricted access for mammalian predators at the site?

Yes →

Keep the vegetation short and the islet open in order to provide breeding sites for avocet (and terns)

No

↓

STEP THREE. As there are no vulnerable species demanding specific species-dependent habitat management, best management at the site is general proper habitat management.
For the various habitats in question such good habitat management is described in table 5.5.

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