coastal meadow management

Best Practice Guidelines

The experiences of LIFE-Nature project "Boreal Baltic Coastal Meadow Preservation in Estonia" LIFE00NAT/EE/7083

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content

LIFE-Nature Project

Management

Amphibians • birds • plants

Experiences

By way of introduction

RIINU RANNAP, VOLDEMAR RANNAP

Boreal Baltic coastal meadow, which is included in Annex I of the Habitats Directive as a priority habitat type, occurs in Europe only in some sections at the Baltic Sea coastline. This habitat type is most frequently found in Estonia and to a lesser extent in Sweden, Latvia and Finland.

Coastal meadows are one of our first seminatural communities, which originated thousands of years ago, when people started grazing animals in the areas rising from the sea. This was easy to do, as the labour of clearing trees was not an issue in young coastal areas. The centuries-long combined impact of human activities and the sea created the diverse mosaic of coastal meadow habitats that accommodated numerous plants and animals.

Ever since World War II, the less fertile pastures have been falling out of use more and more. The proportion of cultivated grasslands was increased and wet coastal grasslands were subjected to amelioration. The number of cattle decreased constantly. Coastal meadows began to grow over with rank vegetation, reed and brushwood.

The area of managed coastal meadows has decreased from 29 000 ha to 8000 ha over the past 50 years (Luhamaa et al. 2001).

The gradual disappearance of coastal meadows resulted in the loss of plant and animal species adapted to this habitat type. Thus the numbers of the Baltic dunlin, ruff, black-tailed godwit and other coastal waders have decreased drastically, and the natterjack toad has almost completely disappeared from coastal meadows.

In order to prevent the coastal meadows from completely disappearing from our nature, the restoration and increased usage of coastal meadows was launched in the second half of the 1990's, after decades of destruction. Restoration was initiated in the form of organising work camps in protected areas with the help of volunteers. The first international projects ensued and national support was issued for coastal meadow management in some protected areas.

The possibility to apply for funds targeted at nature protection from the EU nature protection fund LIFE-Nature presented itself in the year 2000. In the following year the project "Boreal Baltic Coastal Meadow Preservation in Estonia" for the preservation and restoration of coastal meadows was launched. 75% of the project's budget was financed from the EU LIFE-Nature fund. The project was implemented by the Estonian Ministry of Environment. Matsalu Nature Reserve and the Danish company Amphi Consult acted as project partners, and the Danish Co-operation for Environment in Eastern Europe (DANCEE) was project co-financier.

The project covered four counties with the largest coastal meadows in Estonia: Saare, Hiiu, Lääne and Pärnu counties. The selected coastal meadows were situated

on Manilaid, Kihnu, Ruhnu, Võilaid, Harilaid, Käina, Kassari, Saarnaki, Saastna, Salmi, Penijõe, Põgari-Sassi, Haeska, Kumari, Tahu and Hara.

All these 16 areas were former or current habitats of the natterjack toad, which is the indicator species of a well-managed coastal meadow. Most of the best Estonian Baltic dunlin areas were included among project areas as well.

The principal aim of the project consisted in preserving and partly restoring the Baltic Sea coastal meadows and in improving the living conditions and conserving the populations of their characteristic species, such as the natterjack toad and coastal waders.

When the project began, the conditions of the various project areas were very different. The coastal meadows of Matsalu, Käina and Kassari had been managed for years, as opposed to Manilaid and Harilaid, where people had lost all interest in the subject. The common feature that linked all project areas was the lack or non-existence of economic resources. Keeping dairy cattle had become unprofitable and switching over to beef cattle and sheep required finances that people did not have. The technology used for coastal meadow management was to a large extent a remnant of Soviet collective farms in heavy need of repairs, and the farmers could not afford purchasing new machines. Fortunately, people interested in modernisation and project activities were found in all project areas.

A total of 1700 ha of coastal meadows were managed and restored in the course of three and a half years. In order to secure the continuation of this process, ca 40 km of electric fences were erected, bush cutters were purchased for the management of small islands and islets, farmers at the Matsalu National Park were provided with a tractor and mowing equipment, 113 head of beef cattle and sheep were purchased: their numbers were more than doubled by the end of the project.

In order to restore the mosaic appearance of coastal meadow habitats, 66 natural depressions were cleaned of reed and willow thickets. Shallow coastal meadow ponds and depressions constitute important foraging sites for waders and breeding sites for the natterjack toad. About 30 000 natterjack tadpoles originating from isolated quarry populations were introduced into restored coastal meadow ponds. This was done to create reserve populations on coastal meadows in order to preserve the genetic material of natterjack populations. An action plan was drafted for the management of further protection of the natterjack toad and for the continuation of initiated activities.

Improving the living conditions of coastal meadow species and the creation of new and suitable habitats had a positive effect on coastal waders as well as the condition of natterjack populations. As a result species such as the black-tailed godwit, lapwing, redshank found their back onto the coastal meadows of Manilaid. The Baltic dunlin population of the coastal meadows of the Matsaly Bay remained stable. The ruff returned to the Penijõe coastal meadow. The numbers of the natterjack toad increased on Kumari islet. The decrease of natterjack numbers was halted on Manilaid and at Hara. The first positive results

were gained at Saastna, where natterjack re-introduction had been initiated first, even before the launch of the project. The natterjacks introduced to Saastna in 2000 successfully spawned in 2004. In the rest of the areas re-introduction results are to be expected in a couple of years time, when the reintroduced natterjacks will have reached sexual maturity.

The project paid great attention to educational and informational activities. Folders on coastal meadow management, the condition of the natterjack population and protection management were published. Information boards were erected and the creation of a permanent exposition on Matsalu coastal meadows was supported. A film on coastal meadows was shot as well.

In terms of coastal meadow restoration, a great deal was achieved with the help of volunteers in the form of work camps. The project's three and a half years included fourteen work camps with more than 200 participants.

As the Danish company Amphi Consult was one of the project partners, international cooperation played a particularly important role in the project. The active exchange of Danish and Estonian experts, study tours for ornithologists, herpetologists, botanists, nature protection specialists and project areas' managers to the various coastal meadows in Denmark and Estonia allowed all participants to learn from one another's experiences, discuss various problems by expanding on them, often seeing them in a new light and finally finding solutions to these problems. The Estonians could find out about the methods of active protection of coastal waders and amphibians, as the Danes have been practising this from the beginning of the 1980's already. The Danes, in their turn, got from Estonia many new ideas and experiences on coastal meadow management, as well as extensive information on our coastal meadow species.

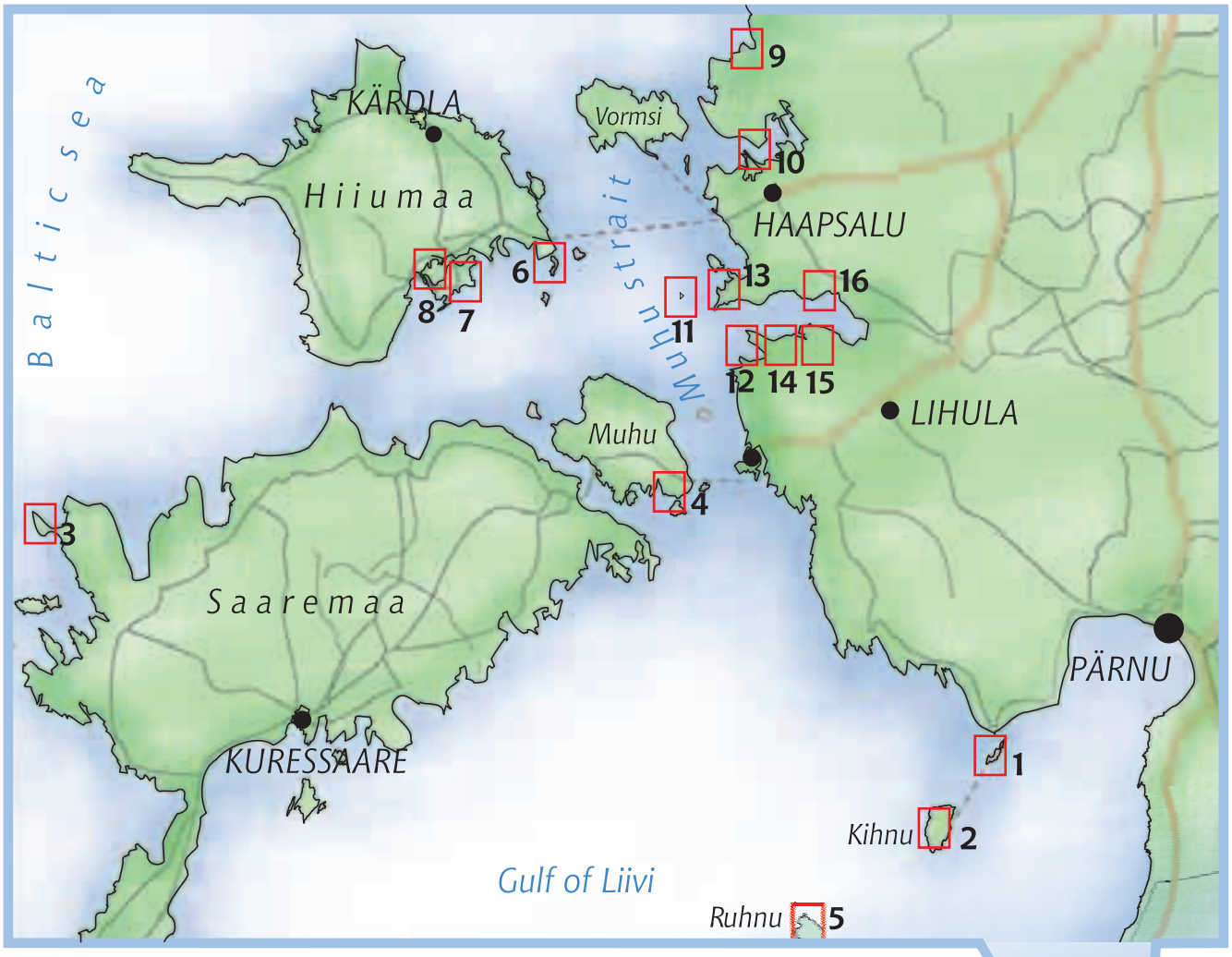
The project included two international workshops and a final seminar. The participants of both workshops and the seminar included experts and specialists from Estonia, as well as various other European countries, such as Byelorussia, Denmark, Finland, Sweden, Latvia, Lithuania, Germany, Ireland, Netherlands, Russia, Slovenia, Ukraine and England. International workshops of such kind afforded specialists from different parts of Europe the chance to find out about and participate in project activities, to learn from one another's experiences and to exchange information. The participants often came to the conclusion that many countries face the same problems and that learning from the experiences of others helps to find the best solutions, which can then be applied in at home.

As the project progressed, the number of people interested in coastal meadow management and willing to participate increased considerably. People also revised their attitudes towards their surrounding nature: coastal meadows, which had often been considered pastures and hayfields of little value, became to be appreciated for their diverse biota. This change was brought about with the great help of specialists from the environmental services of Pärnu, Hiiu and Saare counties, employees of the Matsalu and Vilsandi national parks and the Viidumäe and Silma nature reserves, Hiiumaa Protected Areas Administration, Kihnu Strait Marine Park, Estonian Seminatural Communities Conservation Association, Estonian Fund for Nature and Estonian Sheep Breeding Association. Nevertheless, the most decisive role in the successful management and restoration of coastal meadows was played by local inhabitants

The LIFE-Nature project helped to awaken the people's interest and desire to participate; coastal meadow restoration and further management was initiated with the project's resources. Further coastal meadow preservation greatly depends on the development of Estonain agriculture and support systems.

The current publication provides an overview of the information on and practical experiences in the management and restoration of the Boreal Baltic coastal meadow habitat type gathered in the course of the LIFE-Nature project "Boreal Baltic Coastal Meadow Preservation in Estonia". The authors have made an attempt to select the best part from years of learning, personal experiences and practice that might be of assistance for people interested in coastal grassland management on this side of the Baltic Sea and beyond, and maybe even further.

As habitats are always interconnected with species, this publication also deals with typical coastal meadow species and their habitat demands, risk factors and habitat restoration opportunities. As coastal meadows and seminatural communities cannot survive without human activities, this publication also pays special attention to cooperation with local people – the main managers and preservers of coastal meadows.



Project areas

1	Manilaid	7	Kassari	13	Põgari-Sassi
2	Kihnu	8	Käina	14	Salmi
3	Harilaid	9	Hara	15	Penijõe
4	Võilaid	10	Tahu	16	Haeska
5	Ruhnu	11	Kumari		
6	Saamaki	12	Saastna		

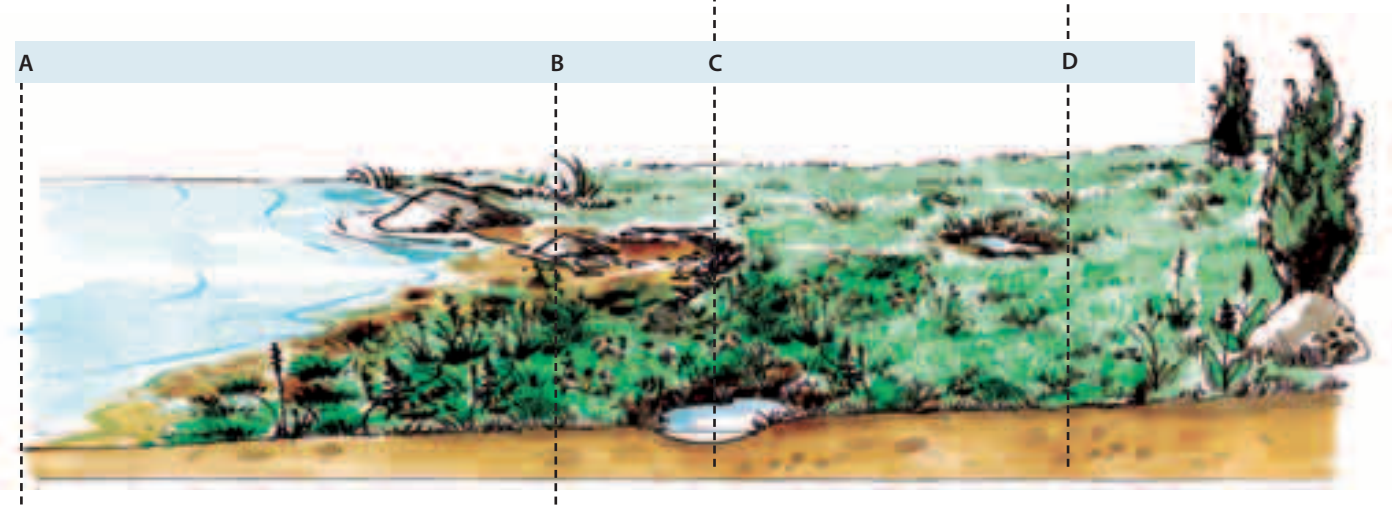
Coastal meadow as a habitat

KAJA LOTMAN, ILONA LEPIK

A coastal meadow is a community influenced by seawater that is situated on smooth coastal areas. The development and perseverance of coastal meadows depends on natural factors, such as the fluctuation of sea level, waves and the movement of ice, as well as on hundreds of years of human influences in the form of mowing and cattle grazing. A coastal meadow can be divided into various zones on the basis of the sea's degree of influence; these zones are characterised by plant species that tolerate various levels of salinity and humidity.

Suprasaline zone (C) is an area outside the direct impact zone of the sea.
As soil may be salty in places, this area features plant species characteristic of the saline coastal meadow as well as those of other coastal meadow types. Red fescue (*Festuca rubra*) is often the dominant species. Various sedges can be found. The most common ones are carnation sedge (*Carex panicea*) and glaucous sedge (*C. flacca*). The zone also features many orchids, such as marsh helleborine (*Epibactis palustris*), musk orchid (*Herminium monorchis*) and fly orchid (*Ophrys insectifera*). If the zone is left unmanaged, the wetter areas become tufted and the drier areas grow over with foggage and scrub invasion begins. This brings about the dominance of high nitrophilous species or those characteristic of marsh areas, including tall fescue (*Festuca arundinacea*), brown sedge (*Carex disticha*), purple moor-grass (*Molinia caerulea*) and meadowsweet (*Filipendula ulmaria*).

Meadow situated near the coast (D) is a drier meadow that is linked to a coastal meadow.
The vegetation is characteristic either of an alvar or a hayland, depending on soil fertility. This type of meadow often features a great variety of species, including a range of orchids. These areas need management as well, and when kept clear, they increase a coastal meadow's value.



Sub-saline zone (A) is generally an area under water that dries up when water level decreases.
The plants that grow in this zone are situated in shallow water most of the time. The species characteristic of managed coastal meadows include sea arrowgrass (*Triglochin maritimum*), slender spike-rush (*Eleocharis uniglumis*), sea aster (*Aster tripolium*) and saltmarsh-grass (*Puccinella maritima*). If coastal meadows are unmanaged, this zone becomes occupied by tall water plants, such as common reed (*Phragmites australis*), sea club-rush (*Bulboshoenus maritimus*) and grey club-rush (*Schoenoplectus tabernaemontanii*).

Saline zone (B) is usually a dry area that becomes covered with seawater when waves are strong or water level is high.
This zone is traditionally covered with various low plant species. The most characteristic ones include sea-milkwort (*Glaux maritima*) and saltmarsh rush (*Juncus gerardii*). Alongside these two species, many typical coastal meadow plants are present, including sea plantain (*Plantago maritima*), strawberry clover (*Trifolium fragiferum*) and red bartsia (*Odontites verna litoralis*), lesser and seaside centaury (*Centaurium pulchellum, C.littorale*) and dune gentian (*Gentianella uliginosa*); also present are plants with a wider ecological amplitude in relation to salinity, such as autumn hawkbit (*Leontodon autumnalis*), greater yellow-rattle (*Rhinanthus serotinus*), silverweed (*Potentilla anserina*), red fescue (*Festuca rubra*) and creeping bent (*Agrostis stolonifera*). All the species typical of this zone disappear if management ceases, as the area is then invaded by reed and nitrophilous plant species, such as families of docks (*Rumex sp*), goosefoot (*Chenopodium sp*) and orache (*Atriplex sp*); perennial sow-thistle (*Sonchus arvensis*), creeping thistle (*Cirsium arvense*), spear thistle (*C. vulgare*) and common couch (*Elymus repens*). Typical coastal meadow plant communities can survive longer only on open peninsulas due to the strong impact of the sea and the presence of migratory geese swarms.

Areas that are often flooded by the sea may feature salines, which come to being as a result of the evaporation of salty water from the clayey soil and the combined impact of ice and waves. Salines are home to particularly halophilous species, such as annual sea-blite (*Suaeda maritima*), common glasswort (*Salicornia europea*) and stalked orache (*Halimione pedunculata*). The trampling of cattle also attributes to the formation of salines.

Values of coastal meadows

Criteria of valuable coastal meadows.

Valuable coastal meadows can be identified by criteria like:

- low vegetation (3-10 cm) on the most part;
- diversity of species characteristic of coastal meadows;
- absence of reed on long stretches of beach;
- larger than 5 ha and wider than 100 m (measured from the water's edge);
- presence of rear or endangered species;
- presence of shallow water bodies;
- long standing (constant) tradition of land use and the merits of a seminatural community.

Coastal meadows as habitats for many plant and animal species.

Coastal meadow is a transitional area from an aquatic community to a terrestrial community, offering a rich food base and diverse habitat complexes to all forms of life. An open coastal meadow constitutes a habitat for species that are adapted to the meadow's specific conditions, as well as for species that simply require an open landscape.

Coastal meadows feature very specific plant communities.

Coastal meadows are home to halophilous plants as well as to plant species with varying salt tolerance. Many species, such as sea-milkwort, strawberry clover, sea plantain, sea arrowgrass and plants of the salines only grow on coastal meadows.

In addition to halophilous plants, the higher parts of coastal meadows feature various other meadow species, such as orchids, gladioluses, etc.

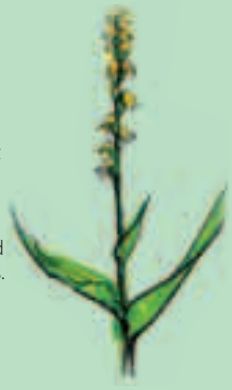
Coastal meadows feature many habitats for birds.

One of the main values of coastal meadows is a varied bird community. Birds use coastal meadows for resting

CREEPING BENTGRASS is a plant species that grows in shallow coastal ponds of low salinity, which can be used as breeding sites for the natterjack toad and feedings grounds for the dunlin (schinzii). The geese passing through are also fond of this plant.

SEA PLANTAIN occurs on managed coastal meadows and grows in the sea's impact zone. If management ceases, is replaced by reeds.

MUSK ORCHID is a rather inconspicuous member of the orchid family, but quite typical of wet meadows. The plant grows only on managed coastal meadows.



Northern Lapwing, Baltic Dunlin, Black-Tailed Godwit and Common Redshank are typical coastal meadow birds that depend on coastal meadow management.

during migration, foraging and nesting. Various waders are typical coastal meadow species; perching birds are present as well. Numerous bird species from diverse systematic units can be found passing through and foraging on coastal meadows. The larger a coastal meadow is, the more diverse and numerous is the present bird community.

The more typical coastal meadow birds can be divided into various groups according to their needs.

Large open wetlands constitute foraging and resting sites for migratory geese and waders, and nesting sites for various waders, such as the ruff (*Philomachus pugnax*), curlew (*Numenius arquata*), redshank (*Tringa totanus*) and black-tailed godwit (*Limosa limosa*).

Trimmed coastal meadows with shallow ponds constitute nesting and foraging sites for waders, such as the lapwing (*Vanellus vanellus*) and dunlin (*Calidris alpina schinzii*). The largest remaining Baltic dunlin communities in Europe are situated on the coastal meadows of Estonia (mainly Matsalu). A management plan for the preservation of this species in Estonia has been drawn up, stating that coastal meadow management is the main instrument for dunlin preservation.

An open coastline with shallow water is necessary for many water and coastal birds, such as the oystercatcher (*Haematopus ostralegus*), ringed plover (*Charadrius hiaticula*), ducks, gulls and terns.

Coastal meadows constitute typical natterjack toad (*Bufo calamita*) habitats.

While many amphibians live and breed on coastal meadows, only the natterjack toad is above all adapted to live on well-managed coastal meadows. The natterjack toad needs areas with trimmed-down vegetation and shallow water ponds for breeding. This species used to be quite widespread on the western coast of Estonia, but now only a few small populations remain as a result of coastal meadow overgrowth. A management plan has been composed with the aim to protect the natterjack toad and bring it back to coastal meadows. The plan prioritises the need to manage coastal meadows.

Coastal meadows provide invertebrates with various micro habitats.

Coastal meadows feature invertebrates of aquatic as well as terrestrial lifestyle. Some insect species are typical of coastal meadows, including some cicadinean (*Cicadinea*) and beetle (*Coleoptera*) species. Many insects, such as vegetarian beetles, weevils (*Curculionidae*) and leaf beetles (*Chrysomelidae*), as well as butterflies (*Lepidoptera*) depend on an open landscape and the existence of certain plant species. Others populate coastal meadows because of the open landscape, which is a result of trampling and the trimmed-down vegeta-

tion achieved with grazing. Many insect species, such as dor beetle (*Geotrupes stercorarius*), Hister bimaculatus, Emys hirtus, Staohylinus pubescens, dung beetles (*Aphodius spp*), etc. are lured to coastal meadows by cattle excrements. Coastal meadows with a long standing grazing tradition feature sods generated by ants, such as garden ant (*Lasius niger*) and yellow meadow ant (*L. lavus*). These ant species are depend on long term grazing. Many invertebrates populate water bodies situated on coastal meadows. The medicinal leech (*Hirudo medicinalis*) for example used to be widespread in the residual lakes of coastal meadows, but is disappearing as grazing has ceased.

Coastal meadows as a part of cultural heritage

As coastal meadows have been used as pastures and hayfields on the coasts of the Baltic Sea for thousands of years, they have moulded our landscapes as well as the people. If these areas are abandoned, both the landscapes and the link to the work and way of life of earlier generations will disappear, and a valuable part of cultural heritage will be lost. Old stone fences that separated jointly used pastures and fields, pathways laid of stone, ditches dug by hand for gaining more land from the sea, drinking and retting spots – all attest to the ancient use of coastal meadows. All these sites are considered a valuable part of cultural heritage that should be preserved as well, if at all possible.

Aesthetic value of coastal meadows

The aesthetic value of coastal meadows lies in the beauty of landscape as well as in the visual attractiveness of its biota, particularly birds. A managed coastal meadow offering an open view to the sea is a landscape image enjoyed among others by people who do not know how to appreciate the other values of coastal meadows. People are becoming more and more interested in observing and spending time in nature. One of the manifestations of this interest is the so-called bird tourism – and this is where coastal meadows with their rich bird life offer extremely fascinating experiences and observation opportunities.

Threats

- Construction activities have changed many naturally valuable coastal areas into harbours, leisure or residential areas.
- Drainage changes water regime, resulting in the disappearance of shallow water bodies and plant communities characteristic of coastal meadows.
- As a result of the need to expand agricultural land, some of the coastal meadows have been transformed into fields. Although this is no longer a threat to coastal meadows nowadays, many coastal meadows have already been ruined, and as we know, the restoration of a coastal meadow is very expensive and time-consuming, and sometimes even impossible.
- Fertilisers from fields located near the coast often find their way onto coastal meadows, favouring the domination of nitrophilous plants species and the overgrowth of shallow ponds characteristic of coastal meadows.
- Reed and scrub overgrowth currently constitutes the main threat to coastal meadows. This problem was brought on by changes in land use, which resulted in

The Natterjack Toad *Bufo calamita*.

the abandonment of coastal meadows as unsuitable for intensified land use.

The situation of coastal meadows in Estonia

In the beginning of the 20th century coastal meadows were used extensively as pastures and hayfields. The greatest changes in the status of coastal meadows took place probably during the 1960-70's, when amelioration increased the importance of cultivated grasslands in terms of cattle breeding and mowing hay. In addition, the water regime of coastal meadows began to change and the use of fertilisers became more frequent. The accumulation of nutrients onto coastal meadows brought on by the uneconomical and careless way of doing things in the Socialist era (fertiliser distribution from aeroplanes, spreading manure on snow, etc.) favoured reed growth and generated changes in the biota of coastal meadows. The area of coastal meadows diminished even more drastically when Estonia regained its independence in the beginning of the 1990's and agriculture was suffering greatly. As a result, the numbers of cattle diminished and coastal meadow management was continued only in a few places with extremely low grazing pressure. The area of managed coastal meadows decreased from 29 000 ha to 8 000 ha in the second half of the 20th century. Nowadays, the disappearance of coastal meadows has been halted with the help of various projects and management compensations paid to farmers, and extensive coastal meadow restoration has been launched.

Purchasing cattle in the course of various projects and giving them to the use of farmers constitutes one of the measures used to improve the situation of coastal meadows.

Coastal meadow management

Grazing has constituted one of the main traditional uses of coastal meadows. Grazing is particularly well-suited for the management of stony coastal meadows and areas strongly influenced by seawater, where mowing is difficult or vegetation too poor for making hay.

Effect of grazing

The impact of grazing on coastal meadows manifests in the from of trimmed vegetation and trampling. The advantages of grazing are given below.

- Foggage or high vegetation is prevented, as plant growth is under constant control.
- Variety of plant species increases, as tall plant species are eaten, providing low plants better light. The bare land generated by trampling affords seeds better growth conditions and favours the growth of certain species.
- Grazed coastal meadows do not develop permanent wrack piles, as the cattle trample on them, break them up and eat the tall nitrophilous plants growing on them.
- Cattle keep the coastline open, thus preventing reed growth.
- Trampling and trimming the vegetation keeps the shallow ponds typical of coastal meadows from growing over.
- The trampling of cattle creates erosion, which keeps the soil low and expands the sea's area of influence. Salt is not washed away from the soil rendered solid by trampling. As a result, the salinity of constantly grazed coastal meadows is greater than that of ungrazed coastal meadows.

Beginnings of grazing in Estonia

Various grazing methods have been employed in Estonia throughout history:

- unsupervised grazing;
- grazing with a shepherd employed by a village or several villages;
- grazing by taking turns (one family at a time handles grazing);
- grazing with private shepherds;
- grazing with cattle fences.

Unsupervised grazing constitutes the oldest grazing method. Fields were surrounded with fences and the rest of land could be grazed. This grazing type was practised the longest on small islands, where fields were small. The method of grazing employed generally depended on land ownership and population type. Until farms were bought for perpetuity and divided into

Gathering site.

lots, pastures were common property and the cattle of a whole village or several villages were kept on these joint pastures. This tradition disappeared in Southern Estonia in the last decades of the 19th century, while Western Estonia and islands staid true to this grazing type until the 1930-40's, particularly on coastal meadows. Pigs and geese were also grazed in addition to horses, sheep and bovines until the beginning of the 20th century.

Yards, fields and cattle-trails were separated with fences and enclosures. The most common type of enclosure was the pole fence widely used in Northern Europe, which consisted of slanted posts densely leaned between pairs of wattle poles. Another quite widespread variation was a similar, but sparser fence of posts leaned between crossed poles, usually built to protect hayfields. Fields and cattle-trails were bordered by dense palings made of horizontal laths attached between pairs of poles.

By the 17th century at the latest, stone fences laid of stones picked from rocky fields had spread. Maintaining and repairing fences required great efforts every year. As pastures became fenced the need for shepherds decreased. Fencing was made easier with the introduction of barbed wire in the 1920's. During the era of collective farms, large collective cattle were kept separate from families' cattle. 40% of Western Estonian families still kept their cattle on joint pastures as late as in the 1960's. Many families practised joint grazing in Matsalu up to this day. The cattle of a whole village were kept on Haeska coastal meadow for example. Fences were only used for separating young animals, bulls and dairy cows, later also beef cattle. The European system of agricultural support will put an end to this grazing style, as each receiver of support must be responsible for grazing in a certain area.

The extensive use of electric fences began in the 1990's. Nevertheless there are still farmers who have more faith in barbed wire fences.

Fencing

Various factors should be taken into account when erecting cattle fences.

The choice of a fence type could depend on the following:

- volume of work;
- finances (investment possibilities);
- the type of cattle;
- the need for a permanent or a mobile fence;
- the appearance of the fence and whether it harmonises with the landscape (this is important mainly in the vicinity of tourism-related objects).

As cattle usually stay on a coastal meadow throughout the whole summer, the fence should be planned in such a way that animals could be gathered up while on the pasture. To this end, a gathering site or a feeding ground should be built outside the valuable meadow area in order to be able to lure the whole cattle there from time to time (especially towards the autumn). This keeps the animals from becoming estranged or wild. Additional fodder should not be given in

Advantages
- Can be installed rather easily and quickly.
- Temporary inner fences can be used.
- With sufficient current intensity and correct installation, animals are kept safely inside the fences.

Disadvantages
- Electric fences require a considerable investment to be made all at once. Nevertheless, there is a choice of cheaper and more expensive accessories – a suitable solution can be found.
- Wild animals can run into the fence and break it (especially if a new fence has been erected).
- Water level should be monitored throughout the grazing period, as the electrified part of the fence should not come into contact with water.

large quantities or often, as the resulting influx of nutrients might disrupt the meadow's natural balance. It is for the same reason that it is not recommended to join natural and cultivated pastures and let cattle move freely from one pasture to another. In such a case, seeds of unwanted plants might also find their way onto coastal meadows, diminishing the meadow's variety of species.

Electric fences

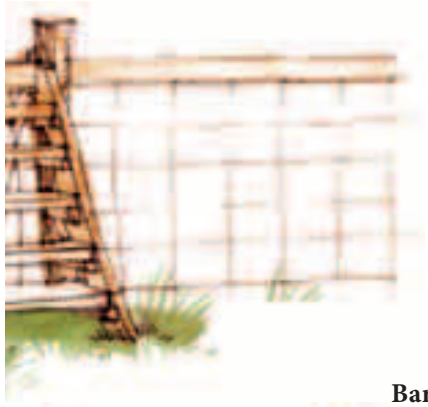
Constructing a proper permanent fence requires a lot of time and effort, as well as expert advice. An electric fence should be designed in such a manner that it would no longer need further remodelling. Temporary fences can be used for regulating and adjusting grazing pressure as needed.

In order to keep wild animals from running into the fence and to warn people, it is advisable to mark the fence with an eye-catching (preferably white) ribbon. It would also help to switch the current on a couple of weeks before grazing begins, all the while keeping the fence intact. This familiarises wild animals with the electric fence, keeping them from breaking it during the grazing period.

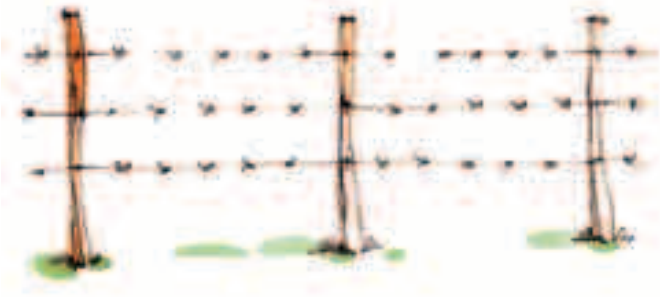
If cattle have not been inside an electric fence before, they should be trained with a smaller fence before being let on the pasture. This will keep the animals from escaping from fences and breaking them.

Mesh fences

Mesh fence is currently the most frequently used and the most suitable fence type for grazing sheep. When sheep are grazed together with larger cattle, the mesh fence should be secured with an electric or a wooden fence.

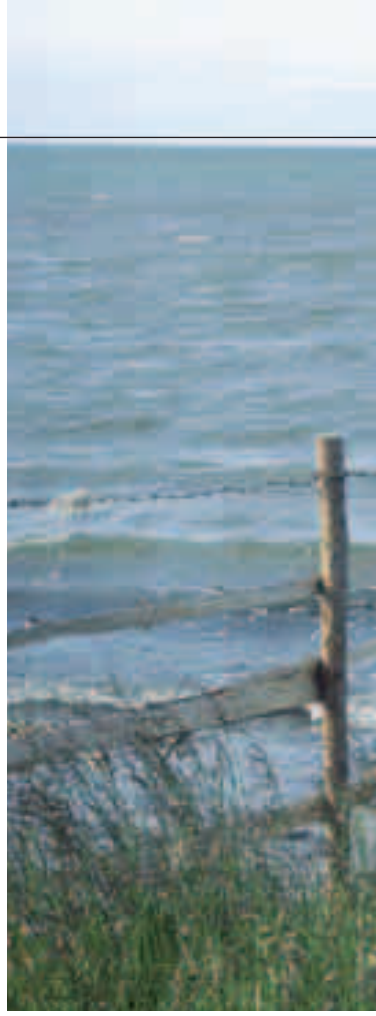


Barbed wire fences



Advantages
- Are quite resistant.
- As barbed wire fences have been used for a long time, the preservation of an existing fence is quite cheap.
- Make for good water fences that are sometimes flooded and must be renovated every year.

Disadvantages
- Constructing new barbed wire fences is labour intensive.
- As tearing down old fences is very labour intensive, they are often left standing, thus constituting a threat to animals, mowing equipment and people, not to mention their low aesthetic value.



Wooden fences

The construction of traditional wooden fences can be related to forwarding ancient skills and it could thus be executed as a part of learning activities (workshops) or work camps.

Advantages

- Harmonise with landscape.
- Keep animals inside the fence. Wooden fences have been used for a very long time and there are various types according to different types of cattle.
- As wooden fences constitute a traditional fencing method, keeping them in use adds cultural value.

Disadvantages

- Constructing is labour intensive.
- Only make for permanent fences.

Coastal meadows often require fences that continue into the water – water fences. They are needed to prevent reed overgrowth on the coastline. This type of fence should be repaired every year, as winter ice and storms damage it greatly.

Stone Fences

Advantages

- Stone fences constitute a traditional fence type that has been used for a very long time. With restoring stone fences, the values created by our forefathers are restored as well.
- Stone fences are very resilient.
- Stone fences enrich the landscape and offer micro habitats for various plant and animal species.

Disadvantages

- Are very labour intensive.
- Recommended only for bordering large areas and as permanent fences. Old stone fences often surround old fields, not pastures.

Stairgate.

Self-closing gate.

Cattle fence on the coast of Saaremaa Island.

Gates

In order to avoid forgetting to close the gates, visitors should be provided with separate passages through cattle pens in the more frequented places.

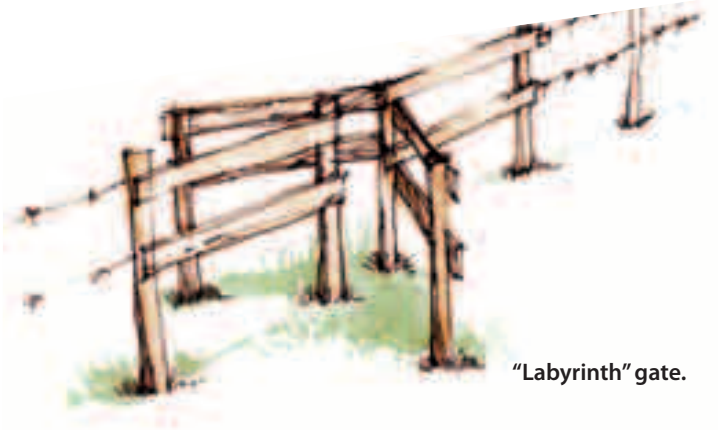
An existing fence could be fitted with a staircase anywhere and anytime. A staircase is a walk-only passageway.

A turnstile and "labyrinth" are also only suitable for walking through, but it is to their advantage that they can be fitted easily even onto temporary fences.

Building a self-closing gate requires a little bit more time and effort. As an advantage, this gate type can be used both for bike and riding trails that pass through pastures.

A sheep or bovine proof bridge makes it possible to pass through pastures by car without needing to open or close the gates.

Bridge gate.



"Labyrinth" gate.

Turnstile gate.

Grazing season

Grazing season generally begins in the first half of June and lasts until mid-October. If grazing pressure is strong, the season could start around June 10th – June 15th, when most of bird chicks have hatched. If grazing pressure is weaker or when restoring a seriously overgrown coastal meadow, grazing should begin as early as possible. The autumn pressure should be adjusted according to the amount of vegetation. Autumn and winter grazing help to decrease foggage and scrub. In the winter cattle feed on plant species that they generally avoid in the summer, such as sedges and tufted hairgrass. As these plants keep growing even under snow, they provide cattle with very valuable nutrients at wintertime.

Worm control and the use of antibiotics should be avoided during grazing season, as these medications may damage meadow invertebrates. Consequently, worm control and other treatments should be conducted prior to releasing cattle to pasture.

Livestock

Various livestock species and breeds have their unique characteristics. If it is possible to select species and breeds for coastal meadow management, the features of the particular meadows should be taken account and the selection should favour the type of cattle that is best suited for the area concerned.

Bovines are very suitable for coastal meadow management. They like to spend time in shallow water, thus preventing reed from spreading. On the other hand, bovines tend to avoid eating brushwood during the summer season and steer clear of grass growing on their excrements. Bovine-grazed pastures consequently develop so-called luxuriant tufts. Young animals or beef cattle are better-suited for coastal meadows, as they do not need daily care and can be left on a coastal meadow for a longer period. The breeds of dairy cattle most suitable for coastal meadows are the low-maintenance older breeds, such as the Estonian Native Cattle. The breeds of beef cattle most suitable for coastal meadows are the middle-sized beef breeds, such as the Hereford, Aberdeen Angus, and Scottish Highland Cattle.

Advantages and special characteristics of mid-sized beef cattle breeds

- These breeds are not picky about food quality, as they are quite old and have been bred for grazing on natural pastures often of low productivity.
- As they endure harsh climatic conditions well, they can be outside in winter, nor do they need fully accessorised barns. In winter they find shelter in the forest. In the absence of a suitable forest, a light shelter should be built. If the animals are fed there, the problem of manure needs solving. To this end, the feeding grounds have a concrete floor.

Scottish Highland Cattle.

- The long grazing period helps to save on additional fodder and decreases foggage. As cattle feed on foggage and scrub during wintertime, they can get most of the necessary food from nature, provided that the winter is quite warm and a winter pasture exists. Winter pastures can be made up of drier areas, meadows with scattered trees, fields and hayfields, as well as of coastal meadows that provide sufficient food and shelter.
- As these breeds are rather light-weight, they are well-suited for managing wet areas because they do not trample excessively on the plants or get stuck in mud when moving about in the reeds.
- These breeds do not generally have any trouble giving birth. Using the studs of the Aberdeen Angus or Scottish Highland Cattle secures a particularly easy labour. As pure-bred beef cattle give little milk, their calves usually grow slowly. It is thus recommended to schedule labour in March or April, so that the main sucking period of calves coincides with the time when pastures have an abundance of fresh grass. In this case calves will have grown enough by autumn and can survive the coming winter without any problems. Giving birth outside in the snow does not harm the calf. It is important for the mother to immediately lick the calf clean and to start suckling. As the cows of these breeds generally have a strong maternal instinct, when branding a calf, the reactions of the mother should be observed closely and the calf should be kept from crying out too loudly. The mother should not witness its calf being taken away, as some cows may react aggressively when their calves cry out or are taken away.
- The meat of these breeds is of high quality, as the taste of the meat has been improved considerably in the course of the lengthy breeding process.

Horses are well-suited for drier areas with hard soil. They can also eat reed in water bodies with a firm bottom. Horses trim the vegetation low. They shave the sods of tufted hairgrass (not favoured by bovines) and also eat plants that grow on bovine excrements. Horses are a suitable addition to bovines. When grazing only with horses, grazing pressure should be decreased during the birds' nesting period, as horses move about a lot and might disturb the birds and destroy their nests by trampling on them. The small and resilient Estonian Horse has proved very suitable for coastal meadow management. Horse breeds that are too cultivated may develop problems with hoofs and legs when kept in wet areas.

Sheep prefer drier areas.

Sheep are rather choosier about their food. The prefer the juicier herbs to the more wooden stems of Gramineae. As sheep prevent scrub growth, they are well-suited for coastal meadows under restoration. It is recommended that in areas with valuable vegetation, sheep be let on pastures in the second half of the summer, as they might eat plants selectively in springtime, which results in a decreased variety of species in areas systematically grazed by sheep. Sheep prefer drier areas and avoid wet places. When sheep are kept on a coastal meadow, the wetter parts may develop reed overgrowth. It is advisable to use sheep together with bovines. Similarly to horses, sheep also disturb the birds nesting on the ground, as they move about a lot and are closer together than bovines. One of the issues of grazing sheep on coastal meadows is the need for proper sheep-proof cattle fences.

As goats are very fond of eating tree branches and leaves, they are well-suited for the restoration of areas overgrown with scrub. Goats like to climb and they jump high, they thus need even more secure cattle fences than sheep.

Although goats can graze together with sheep, there is always the danger that the buck might decide to dominate the sheep flock as well. In order to avoid this development, the buck must be younger than the ram. If this is not the case, the ewes might not breed.

Combined grazing

Different types of cattle have always been grazed on common pastures. Combined grazing is the most efficient solution from the point of view of nature protection and for the cattle themselves, as it helps to avoid excessively one-sided consumption and a decrease in the variety of plant species. Combined grazing also diminishes parasite damage. Alternate grazing of different species in the same area serves the very same functions.

Grazing pressure

Grazing pressure (number of animals per ha) depends on the characteristics of the meadow, mainly on humidity and soil fertility, as well as on the specific year. Proper grazing pressure increases a meadow's natural value as well as the feed value of plants. Excessively low grazing pressure generates overgrown grass of diminished value and causes the meadow to grow over with foggage and brushwood. Grazing pressure that is excessively high decreases the variety of plant species, thereby deteriorating the cattle's food base. It should also be kept in mind that the "outflow" of nutrients caused by constant grazing slows down the growth speed of meadow plants, thus decreasing the meadow's productivity year by year. The variety of species increases, while food quantities diminish. As a result, more animals can be let onto a coastal meadow under restoration than onto a meadow that has been managed constantly.

Grazing systems

Various grazing systems have evolved in accordance with experiences and special characteristics of different areas. Every cattle owner chooses the most suitable grazing system. Grazing systems can vary from year to year, depending on changes in the water level and the speed of grass growth. The principal aim of grazing systems lies in making the most of the pasture's feed value and securing low vegetation in an area as large as possible.

• **Constant grazing** – grazing the same number of animals in the same area throughout the entire grazing season.

This is the easiest and the most widely-used system. The downside is that if grazing pressure is low, the cattle are not able to trim the grass in the entire area during

spring. As a result, the overgrown and wooden plants are left uneaten, generating excessive foggage and areas with high vegetation for the next spring. If grazing pressure is too high, the cattle will lack food in the autumn. This system is appropriate if the meadow is in a relatively good condition and grazing pressure is tried and tested. The result is a rather mosaic meadow with vegetation of varying height, which should be mowed now and again. Such a meadow can have quite a diverse vegetation and invertebrate collection.

• **Constant adjusted grazing** – constant grazing in the same area with a decreased number of cattle in the second half of the summer. An even grazing pressure is achieved and the well-being of animals improves. The easiest way to organise this system is to expand the pasture by adding the adjacent mowed areas. This system is particularly appropriate in areas where a part of the land is mowed or that feature such rare plant species that might be eaten by the animals in springtime. These species will have generally bloomed by the second half of summer and are thus not threatened by mowing or being eaten. On the other hand, the trampling of cattle favours seed germination. Constant adjusted grazing basically constitutes a traditional way of land use, where the animals were released onto aftergrass in the autumn. Such a combination of mowing and grazing generally results in the greatest variety of plant and animal species.

• **Rotational grazing** – the entire area is divided into paddocks, where cattle are grazed after determined intervals. In late spring-early summer the resting period could be two weeks, increasing up to at least four weeks as autumn approaches. The number of paddocks should thus be increased as the autumn nears. Here again, mowed areas could be used to that end. Although this system is the most labour intensive, it guarantees the most efficient meadow use. The result is a well-managed meadow with low vegetation. Another advantage of rotational grazing is that it offers a better overview of the situation of cattle and the pastures. This system is suitable for improving the condition of meadows that are under restoration, as cattle can be guided to areas in need of greater pressure or kept away from the main bird nesting areas in the spring. In addition, cultivated hayfields can also be used as paddocks after being mowed, as this prevents the constant influx of nutrients onto natural coastal meadows.

Mowing

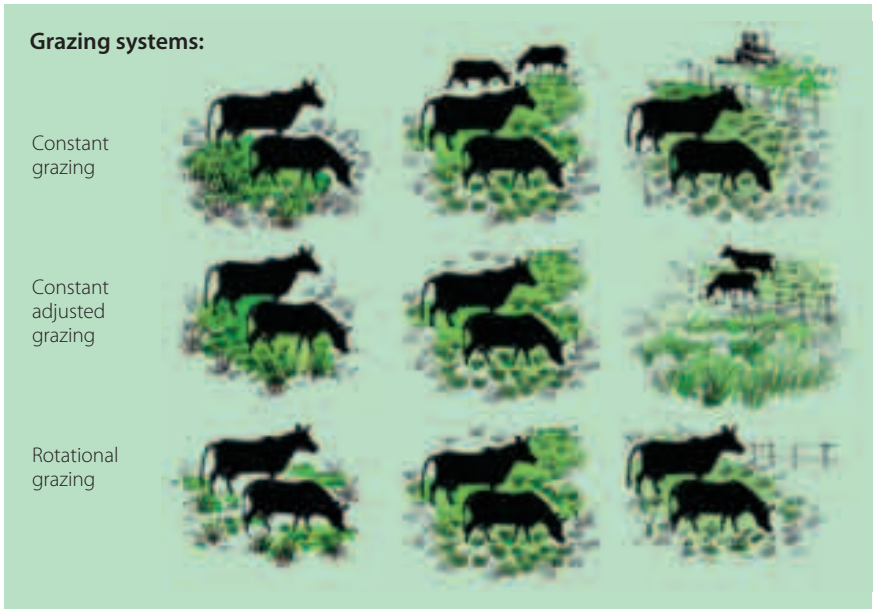
Mowing as a management method

Mowing is an appropriate management method for drier, flat and less stony coastal meadows. Mowing should be continued in areas that have traditionally been mowed, as these areas have developed a very unique and often rich-in-species plant life. Mowing should also be

Type of meadow	Animals per ha				
	Heifers > 1year.	Cows ca 600 kg	Nursing cows with calves	Sheep with lambs	Horses
Coastal meadow	1,6	1,0	0,5	2,5	0,8
Meadow near the coast					
dry	1,0	0,5	0,3	1,8	0,5
humid	2,0	1,4	0,6	3,3	0,5
wet	2,2	1,5	0,7	-	0,6
aqueous	2,0	1,3	0,6	-	-

Recommended grazing pressure during a 130-140-day grazing season (Johansson, Ekstam, Forshed)

Grazing systems:



preferred in places where rare plant species are found. Mowing can be initiated after July 1st, preferably as late as possible. The mowed hay must be removed.

The most valuable meadows are a result of mowing and consequent grazing, as this combination provides the plants a chance to bloom and bear fruit first, and the consequent trampling and fertilising done by cattle favours seed germination.

Mowing can also be used for controlling the growth of reed and the rest of uneaten grass on coastal meadows that are overgrown with reed or suffer from low grazing pressure, provided that grazing is employed as well.

Suitable method.

Not suitable method.

Mowing equipment

• Mowing with a tractor

In order to minimise the damage done to birds and animals living in the grass, mowing direction should not be aimed from the sides to the centre.

The increasingly popular rotor mowers are perfectly suited for coastal meadow restoration. However a bar mower is more recommended in terms of nature preservation. It was discovered that the sounds generated by the bar mower scare the animals away from the mower, while the rotor mower, which does not emit similar sound, may place the animals in danger. A bar mower also enables to mow higher, which is also more nature-sparing.

Small areas are mowed with trimmers and small motorised tools.

• Small equipment

A small bar mower or a manual scythe are best suited for mowing small areas. The manual scythe can also be used for mowing in wet places, but this instrument is unfortunately employed less and less, and people are forgetting how to use it.

Trimmers are recommended only for meadows under restoration, as its aggressiveness may damage the more valuable plants.

Restoration of meadow by using bush crusher.

Coastal meadow restoration

The restoration of an overgrown meadow is a time-consuming process. The main problems of coastal meadows include foggage, scrub and reed overgrowth. The condition of a coastal meadow should be determined at first, followed by a decision concerning the extent and methods of restoration. It is often preferable to restore step by step, refraining from clearing too many areas at once. Restoration must be followed by constant management.

Foggage

Foggage constitutes a threat mainly in the higher parts of a coastal meadow, but also in the wet marshy areas.

The thick foggage accumulated throughout years is a problem, because:

- it obstructs the growth of many plant species (by decreasing the variety of species);
- as migratory geese fail to find fresh grass on the meadow in springtime, they proceed to pillaging braird fields and cultivated haylands;
- many waders cannot find suitable nesting sites, as visibility reduces, food base deteriorates and the movement of their chicks is obstructed;
- the natterjack toad's foraging and breeding conditions worsen;
- the quality of cattle fodder deteriorates.

To get rid of foggage, the area should be mowed or burnt.

Burning foggage enables to restore the coastal meadow quickly. The grass that starts to grow afterwards tastes better to animals. Mosaic burning is the most suitable type for preserving meadow biota, as some parts are left unburnt.

Nature and human safety should always be kept in mind when planning foggage burning.

- As burning may damage meadow biota (insects, amphibians, reptiles, rodents, etc.) it should be conducted only when the ground is frozen.
- The Rescue Board and neighbours should be notified in advance.
- Foggage should not be burnt alone.
- Burning is allowed only on an airless day.

Brushwood

Junipers and pines start to grow in drier and higher areas, while willows and alders accumulate in the marshy areas.

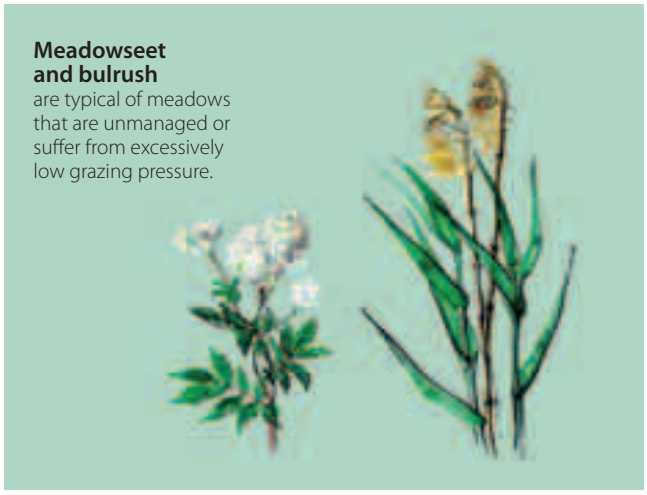
Brushwood constitutes a problem because:

- it hinders the growth of meadow plants, decreasing the variety of species;
- predators, such as foxes can sneak up on birds;
- habitats become fragmented and many species that prefer large open landscapes disappear.

Bush cutting is appropriate only on managed meadows or immediately before management begins. In order to eliminate species that develop suckers (alder and willow), cutting should be repeated several times. In order to avoid the growth of suckers after the trees themselves have been cut, preliminary exhaustion of trees is recommended. This means that a year or more before cutting down the tree, a piece of bark 10 cm wide is peeled off.

Extensive brushwood areas should be cut down step by step. Single large trees or small coppices should initially be preserved, as they provide cattle with sunshade and the cattle destroy the potential suckers by trampling.

The best time for bush cutting is in July-August, as new brushwood grows slower then. Sheep, goats and beef cattle help to prevent the re-emergence of brushwood after cutting.



Meadowseet and bulrush are typical of meadows that are unmanaged or suffer from excessively low grazing pressure.

In mowed areas the trees and bushes should be uprooted or cut very closely, and the areas themselves should be re-mowed each year.

One of the most recent tools used in bush cutting is the bush crusher, which splits the stub in multiple direc-

Reed burning.

Mowing reed by hand.

tions instead of cutting it straight. As a result, the stubs become less viable.

Reed

A coastal meadow that has been out of use for a long time may have developed considerable reed overgrowth. Bulrush spreads itself on the meadows as well as in shallow water. Reed is extremely thick in back-water, where bulrush is joined by other tall water plants, such as grey club-rush, sea club-rush and narrow leaf cattail.

The negative consequences of reed overgrowth are:

- it hinders the growth of meadow plants, decreasing the variety of species;
- the habitats of species that need open landscapes disappear;
- the open coastline necessary for many birds disappears;
- shallow water bodies grow over, which brings about the disappearance of the breeding ponds of amphibians and the foraging grounds of birds.

The best method for fighting reed is mowing and grazing during vegetation period. As cattle gladly eat young reed, grazing on reeded coastal meadows should be initiated as early as possible in spring. Reed should be mowed or burnt during winter to make it more attractive to animals. Cattle will steer clear of a 2-m-high reed thicket in the summer, as they are afraid of mosquitoes and other blood-sucking insects. If animals fail to eat the reed in spring, it becomes wooden and will not attract cattle. If this is the case, reed should be mowed in summer. Thick reed growing in very shallow water poses a great problem; it should be cut by using special equipment. One solution could be to mow a couple-of-metres-wide tunnel into the reed when water level is low – cattle can thereafter start expanding that tunnel.

Overgrown coastal meadow on Manilaid Island.

Boreal Baltic coastal meadow management for *Bufo calamita*

RIINU RANNAP

Bufo calamita has the smallest bio-geographical range of the three Bufo species (*B. bufo*, *B. calamita*, and *B. viridis*) found in Europe. It is nowadays distributed only in Europe, occurs from the Iberian Peninsula in the south-west to as far as the Baltic coast in the east of the continent, but is absent from the Southern Alps and the Balkan Peninsula (Sinsch 1998, Beebee 2002).

Over the past 50 years, *Bufo calamita* has witnessed a steady decline in its numbers, by now having reached a point where it has disappeared from many parts of its distribution area. *Bufo calamita* has declined substantially at its range margins in northern France, Ireland, Britain, Belgium, Sweden, Denmark, Latvia and Estonia (Beebee 2002). In many countries, such as Germany, Switzerland, Austria, Czech Republic it occurs nowadays only in secondary habitats, such as sand, gravel, clay and stone quarries, garbage dumps, open brown coal mines, etc (Sinsch 1998).

The main reason for the extinction of the species is the disappearance of suitable habitats due to decreased or ceased management (grazing, mowing), changes in the water regime caused by land drainage, excessive use of fertilisers and pesticides or afforestation. *Bufo calamita* is listed in Annex IV of the Habitats Directive.

B. calamita is gradually becoming extinct on the Baltic coast. In the 2000's only about 60 populations of *Bufo calamita* have remained on the Baltic coastal meadows belonging to Denmark, Sweden, northern Germany, Latvia and Estonia. There might be more populations on coastal meadows in Poland and Lithuania, since the situation there is not well-known. But the Polish and Lithuanian coastlines are also dominated by sand dune habitats rather than coastal meadows (Rannap et all. 2003).

Bufo calamita habitat requirements

Bufo calamita is associated throughout its distribution range with open habitats, with sandy soil and shallow ponds. Sandy soils are particularly favoured because they often support low-growing vegetation and are easy to burrow in. Shallow ponds are often temporary, and thus have relatively few tadpole predators and competitors. A common factor is temperature – open habitats and shallow ponds are warm habitats in spring and summer, and *Bufo calamita* is adapted to relatively high temperatures in all stages of its life cycle (Beebee 2002).

These conditions are mainly met in only one habitat type in Estonia - Boreal Baltic coastal meadows. Therefore in Estonia, *Bufo calamita* has primarily occurred on coastal meadows traditionally used as pastures. The fact that *Bufo calamita* is a pioneer species that populates new and suitable areas quickly, having taken coastal meadows into extensive use during the previous centuries, contributed significantly to the species' distribution in Estonia. The impact of the sea and constant grazing has kept the vegetation low and the area open on coastal meadows (Rannap et all. 2003).

Adult and juvenile *Bufo calamita* require open, sun exposed terrestrial habitats with extensive areas of low vegetation or minimally vegetated ground for hunting their invertebrate prey, which they do by active pursuit. Open and sun-exposed coastal pastures also attract a significantly larger number of suitable prey invertebrates (particularly *Hymenoptera*) than areas left under foggage or overgrown with brushwood. Livestock attract a multitude of insects that constitute vital prey for adult and juvenile *Bufo calamita*. The sturdy and short-legged *Bufo calamita* finds it easier to migrate in areas with low vegetation. Coastal meadow habitats often also include terrestrial areas with a light sandy soil suitable for digging daytime shelters, and stone fences and stone piles suitable for hibernating.

An important general point is that the *Bufo calamita* population size is usually limited by the number of suitable breeding ponds available rather than by the extent of terrestrial habitat. Since large populations are less susceptible than small ones to genetic impoverishment and to extinction by accident, a sound management strategy is to maximise the numbers of breeding sites as the first priority in most situations (Beebee, Denton 1996).

Coastal meadows provide for the reproduction of *Bufo calamita* a large number of sun exposed, ephemeral ponds with shallow gradually shelving margins and few predators or competitors. Shallow ponds secure rapidly rising water temperature, which is vital for tadpole development. These ponds dry up by the end of the summer and therefore contain a significantly smaller amount of predators (fish, invertebrates) that might harm the tadpoles. Competition with other amphibians is also non-existent.

Bufo calamita has adopted a rather unique breeding strategy in those temporary water bodies: compared to other amphibians, it has a notably longer breeding period,

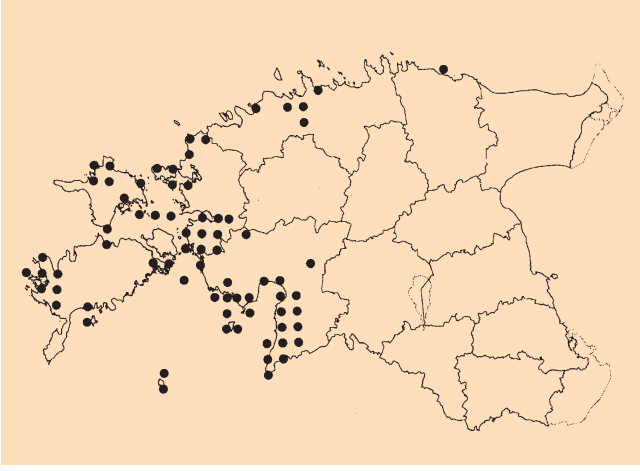
Above: *Bufo calamita* require open, sun exposed terrestrial habitats with extensive areas of low vegetation or minimally vegetated ground.

Belowe: One of the last breeding ponds of *Bufo calamita* on Manilaid.

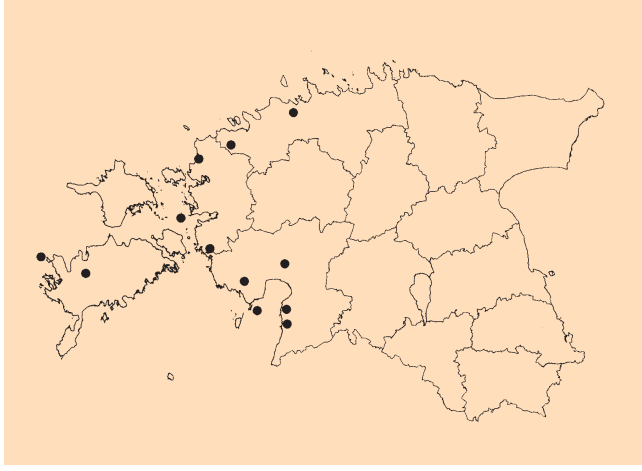
Before initiation of grazing, the old reed has to be cut down or burnt.

lasting from late April to early July. During this period, *Bufo calamita* does not breed constantly – it varies its breeding activity several times over the period, largely depending on rainfall. When it rains, the dried ponds fill up with water again and *Bufo calamita* raises its breeding activity (Rannap et all. 2003).

These natural depressions functioning as breeding places have been kept clean of dense vegetation by grazing. If these shallow ponds grow over, *Bufo calamita* will lose suitable breeding conditions. *Bufo bufo*, *Rana temporaria* and *Rana arvalis*, on the other hand, prefer to breed in water bodies with dense vegetation. Consequently, *Bufo calamita* is rendered a loser in the competition with other amphibians, being a much more demanding species that requires a combination of warm water, oxygen, few predators and low vegetation.



Distribution of *Bufo calamita* in Estonia in the first half of the XX century



By 2004, only 14 isolated *Bufo calamita* populations with a total of ca 1000 specimens had remained.

Threats to the habitat

Decreased grazing intensity has caused the formerly intensively grazed coastal meadows with low vegetation to become covered with foggage, reed and brushwood, thus rendering them unsuitable for *Bufo calamita*. If grazing is insufficient, wetter depressions and concavities are the first to overgrow with rank vegetation (often *Carex sp.*, *Scirpus sp.*) disliked by livestock. Consequently the layer of dead plants keeps piling up from year to year, causing natural depressions to clog up, become muddied and finally dry up.

Both of these habitat features – the terrestrial and aquatic habitat should be within the same patch of land or very close to each another. *Bufo calamita* will not cross extensive areas of unsuitable terrain to move between summer/winter and breeding habitats (Beebee, Denton 1996).

Bufo calamita is very demanding on its living conditions: it requires open sun-exposed aquatic and terrestrial habitats combined with good wintering sites, particularly in the border areas of its distribution range. If one of the habitat features is missing or disappears, the entire habitat is rendered unsuitable for *Bufo calamita*. The disappearance of each separate habitat factor within the whole habitat complex leads to decreased viability within a population and ultimately to extinction.

Impact of habitat destruction on the species

In the first half of the 20th century *Bufo calamita* was a rather common species in the coastal areas and on the islands of western Estonia and Pärnu County. At that time the total number of documented *Bufo calamita* localities in Estonia was 123.

During the 20th century *Bufo calamita* has witnessed a steady decline in its numbers, having by now reached a point where it has disappeared from many parts of its distribution area. By 2004, only 14 isolated *Bufo calamita* populations with a total of ca 1000 specimens had remained (Rannap et all. 2003).

Social and economic changes that have taken place over the second decade of the 20th century have had a destructive impact on coastal meadows in Estonia. Amelioration, excessive use of fertilisers and pesticides, carried out during the Soviet times, especially over the period extending from the 1960's to the 1990's, damaged the natural water regime and balance of coastal meadows.

Fig. 1.
Diminishing of the area of Boreal Baltic coastal meadows in Estonia

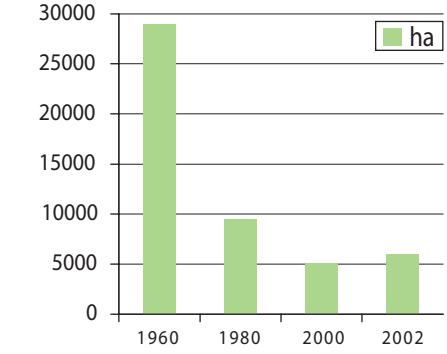
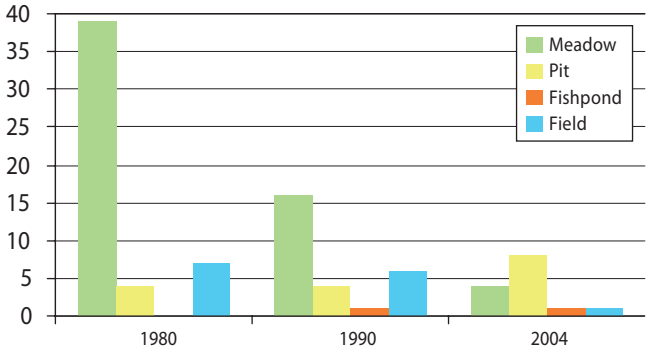


Fig. 2.
Bufo calamita habitats in Estonia.



As a result, coastal meadows dried up and/or began to rapidly overgrow with reed. The drastic decline of grazing over the past decades (1990-2000) has caused Boreal Baltic coastal meadows to become overgrown with high vegetation and scrub (Rannap et all. 2003).

Of the 29,000 ha, which was the estimated total area of managed coastal meadows in the 1960's, only 9500 ha remained in use by 1981; by 2000 the area of managed coastal meadows had decreased up to 5100 ha (Luhamaa et al. 2001) (Fig. 1).

In 1980, 39 populations of *Bufo calamita* out of 50 were situated on coastal meadows. By 2000, only four

Breeding pond overgrown with reed.

Natural depressions on the coastal meadows have usually been restored with the help of bulldozers.

coastal meadow populations had remained. As most of the former coastal meadow areas have become unsuitable for *Bufo calamita*, they presently inhabit mostly sand and gravel pits – places where the conditions resemble their natural habitats (Rannap et all. 2003). (Fig. 2)

It can thus be concluded that *Bufo calamita* – a species adapted to live on well-managed coastal pastures is on the verge of extinction in Estonia.

Habitat management for *Bufo calamita*

The survival of the species requires preserving and restoring its suitable habitats. As *Bufo calamita* has populated primarily coastal meadows in Estonia, it is crucial, from the point of view of its survival, to continue the management of existing coastal meadows and to launch the partial restoration of coastal meadows overgrown with brushwood and reed.

The following should be taken into account in turning a coastal meadow into a suitable *Bufo calamita* habitat:

Terrestrial habitat

In order to keep the vegetation on coastal meadows low (with vegetation less than 5 cm tall), constant grazing is required; if grazing has ceased at some point, it should be restarted. Grazing regimes using domestic livestock (beef cattle, horses, sheep as well as goats) is the most important conservation method for *Bufo calamita*.

The best results are gained by grazing mixed cattle consisting of beef cattle, sheep and horses (goats) – all grazed together in the same area. Beef cattle, horses and goats secure low vegetation in wetter areas, while sheep prefer higher and drier spots. Livestock also like to tram-

Restored breeding pond on Saastna.

Beef cattle likes to enter the wet depressions.

Overgrown depressions situated on small islets have been cleaned or restored by hand.

ple in depressions, thus preventing these from growing over. Sufficient grazing intensity on a coastal meadow is required in order to achieve suitable living conditions for *Bufo calamita*, the minimum being one animal or two sheep per ha.

When large areas of reed or scrub encroachment have developed, manual or mechanical clearance is the first step towards the recreation of open habitats. The reed should be cut and then burnt or taken away in the winter when the ground is frozen.

Meadow areas under severe foggage can also be burnt in late autumn or early spring, as the livestock are not fond of eating foggage, but young grass sprouting in spring.

If grazing intensity is not sufficient enough for securing low vegetation, coastal meadows should be mowed in the autumn (in September) in order to prevent foggage on coastal pastures and to preserve *Bufo calamita* habitats. Shallow depressions and concavities should definitely be mowed also in order to prevent them from growing over. The mowed hay should be taken away; it should by no means be left on the coastal meadow.

Winter grazing of coastal meadows with cattle is an effective way of controlling the growth of young junipers, willows, pine trees, reed and other grasses which otherwise spread in the area.

Aquatic habitat

Coastal meadows have many shallow depressions and concavities resulting from their natural micro-relief, which grow over with rank vegetation (often *Carex sp.*, *Scirpus sp.*), if grazing intensity decreases or grazing stops. Livestock usually prefer not to feed on such vegetation

If grazing intensity can be increased, the livestock are able to eat or trample the depressions bare. But if the depressions contain large amounts of old reed, willows or other wooded plants difficult for the animals to eat, cleaning the water bodies of high vegetation first is recommended: reed and other high plants should be mowed and bushes cut down.

If sufficient grazing pressure cannot be obtained, special fencing should be used for forcing the animals to stay and graze on the edges of *Bufo calamita* breeding ponds and in the close surrounding.

If grazing intensity is insufficient it is also possible to clean the shallow water bodies of high vegetation and mud when restoring a coastal pasture. This should be done in order to attract livestock, who enjoy coming to drink and trample in such shallow ponds with clean water, thus preventing them from growing over in the future.

Water bodies on the coastal meadows have usually been restored with the help of bulldozers in Estonia.

Overgrown depressions situated on small islets have

also been cleaned or restored by hand, as transporting a bulldozer onto them has been impossible

The best time for cleaning natural depressions from high vegetation and mud is when the coastal meadow and depressions are rather dry, but the soil is not totally frozen yet: that is from July until November. Starting the work earlier may endanger other amphibians that may breed in overgrown water bodies (*Triturus vulgaris*, *Rana sp.*, *Bufo bufo*).

A place for depositing the soil should be selected carefully. Nutrient-rich mud and soil could be taken away from the coastal meadow, but it can in some cases be removed the pond and smoothened with machines. It is crucial to leave the coastal meadow's natural image intact!

When restoring depressions, their total suitability for Bufo calamita's breeding demands should be secured. A restored depression should be gently sloping and shallow, and it should dry up by the end of the summer.

As the depressions must be temporary, *Bufo calamita* habitats should be provided with several depressions of slightly varying depths. Unless there is reason to believe that the water table is experiencing a long-term downward trend, any temptation to deepen depressions should be resisted. Excessive depth is likely to benefit competitors and predators of *Bufo calamita* tadpoles rather than *Bufo calamita* itself. If a breeding pond is too deep and consequently does not dry up, it will soon be populated by predators (*Coleoptera* and dragonfly *Odonata larvae*, leaches *Hirudinea*, diving beetles and other aquatic invertebrates) that are not usually present in temporary depressions with sparse vegetation. These invertebrates feed on the spawn and tadpoles of amphibians and can therefore often damage the viability of their populations. However, digging small sumps in the lowest part of a depression can de beneficial as a rescue measure for tadpoles in very dry years.

Restoration of breeding ponds can be a valuable method for boosting *Bufo calamita* populations, especially if old ponds have disappeared or deteriorated.

Hibernation sites and shelters

Besides terrestrial habitats and breeding ponds, a habitat complex suitable for *Bufo calamita* should also include shelters and hibernation sites. As *Bufo calamita* is primarily a crepuscular and nocturnal animal, it spends its days hiding in suitable shelters. It can find daytime shelter under driftwood and rocks, inside stone piles and fences, and it can also dig itself into sandy soil.

Newly metamorphosed individuals, who are active in daytime as well during their first weeks, need to be able to hide between and under sods, pieces of board and stones situated nearby the breeding ponds. If the surroundings of a breeding pond are very bare, small toads easily fall prey to birds and other predators. It is thus important to provide the surroundings of newly restored breeding ponds with pieces of board, stones and sods, which function as shelters.

Bufo calamita's hibernation sites include stone fences and piles, buildings and cellars as well as sandbanks or ploughed fields that they dig into. Hibernation sites should be situated no further than 500 m from the breeding and foraging areas.

Bufo calamita protection management in Estonia 2001-2004

As the numbers of *B. calamita* had declined catastrophically in Estonia over the past decades, it became clear that without rapid initiation of activities for preserving the habitat and the reintroduction of the species at suitable sites, *B. calamita* would face extinction in Estonia.

Active protection of *B. calamita* was enabled by the LIFE-Nature project "Boreal Baltic Coastal Meadow Preservation in Estonia" launched in 2001, with one of its established aims being the rescuing of still-existing populations of *B. calamita* in Estonia and the establishment of reserve populations in additional suitable habitats in order to ensure the preservation of the gene-fund of the species. All 16 coastal meadows included in the project constituted either the last refuge or best possible reintroduction sites for *B. calamita*. As *B. calamita* is especially adapted to coastal meadows in Estonia, the species can therefore serve as an indicator species for a well-managed coastal meadow.

In the course of the three and a half years that the project ran, *B. calamita* terrestrial and aquatic habitats were restored on three coastal meadows where the species till occurs and on 13 coastal meadows where *B. calamita* has disappeared but could be reintroduced.

Although limited management activities were still continued on various coastal meadows at the time the project was launched, it was not enough for the preservation of *B. calamita* living conditions. Thus grazing pres-

sure had to be increased in various project areas. Grazing had to be re-launched in areas where it had ceased.

In addition to the restoration of terrestrial habitats, the preservation and launch of reintroduction also requires the existence of suitable water bodies. To this end, 66 breeding ponds and natural depressions were cleaned, deepened and restored on coastal meadows.

The restoration of habitats and breeding ponds resulted in increased numbers of *B. calamita* on Kumari islet. The decrease of the species was successfully halted on Manilaid and at Hara.

All 14 currently existing Estonian *B. calamita* populations are dispersedly scattered and quite small. As a result, they are very sensitive to changes in environmental conditions. In order to guarantee the preservation of the genetic material of the existing *B. calamita* populations, the project's activities included the creation of reserve populations in former coastal meadow habitats that have been restored by now. As the existing *B. calamita* populations are located mainly in inland quarries away from the coast, *B. calamita* is not able to find its way to the restored habitats situated many kilometres away on its own.

Reintroduction was first launched on the coastal meadows of Matsalu National Park: in Saastna, Salmi and Penijõe. The coastal meadows of Tahu, Haeska, Pagarand, Kihnu, Saarnaki, Käina and Kassari soon followed.

The first calling males were heard as early as in the spring of 2003 in Saastna – the first place where *B. calamita* reintroduction had been initiated in 2000, even before the beginning of the project. The *B. calamita* reintroduced as tadpoles spawned there for the first time the following spring.

As *B. calamita* reaches its sexual maturity at the age of three years, calling males can hopefully be heard at other reintroduction sites in the coming years.

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Cages for tadpoles rearing on Kihnu Island.

Restoration of breeding sites for threatened toads on coastal meadows

LARS BRIGGS

Bufo viridis and *Bufo calamita* have been experiencing a strong decline in Denmark, where both species traditionally had strong populations in coastal meadow and other coastal habitats. Because of the many still existing seminatural habitats and a widespread tradition of grazing lasting until the 1970's, many populations had survived until 1990 in South Funen Archipelago and on the west and north coast of Funen. Many of these populations were small and suffered from a lack of breeding success in 1988-90. According to a plan to create breeding sites for those species, 23 new ponds were created and 25 were restored for *Bufo viridis*, and six were restored and eight new ones were created for *Bufo calamita*. Furthermore, a cattle grazing was reintroduced on 73 hectares of coastal meadows and fields. The decline in cattle grazing was stopped or partly stopped in the 1980's on a number of islands and mainland sites and it could continue from beginning of 1990's with economic support from EU agri-environmental schemes but often with a period of 5 to 15 years with a lack of grazing in between..

Over a period of seven years the number of *Bufo viridis* increased from 244 adults to 3550 adults in the seven most threatened island populations. The overall situation has improved from 1644 adult toads in 1988-90 to 4950 adults in 1995-97. The population increase continued until 2004, exceeding 10 000 adults. The number of ponds with *Bufo viridis* males had risen from 29 in 1988-90 to 61 in 1995-97. The number of ponds with breeding success had increased from 11 to 22 during the

period. Over the same seven years the results for *Bufo calamita* populations increased from 3376 adults in 1998-90 to 5062 adults in 1995-97; until the period 2000- 2004, when the total number dropped again in several large populations and many of the small populations were lost mainly due to insufficient grazing. The study tours included in this LIFE-project revealed several answers as to why the grazing of coastal meadows is nowadays insufficient despite many attempts and economic support for this purpose.

Introduction

The southern islands and coastline of Funen in Funen County used to offer a large number of possible breeding ponds on coastal meadows, in which *Bufo viridis* and *Bufo calamita* could breed. Grazed coastal meadows, sandy and stony coastal habitats, dry permanent grasslands and small villages constituted the terrestrial habitat for foraging. Despite the excellent habitat conditions in Danish coastal areas, *Bufo viridis* has been reported to be declining rapidly in all regions of Denmark since 1940 (Fog 1988 and 1997, Amtkjær 1988) and also in Funen County (Briggs 1989). *Bufo calamita* was also reported to be in a rapid decline in Eastern Denmark (Fog 1988). *Bufo viridis* is also reported as being in decline and threatened in nearby regions of the Baltic Coast distribution area of Schweden (Andren pers. comm.) and Schleswig-Holsten (Winkler, C. & U. Dierking 2003). The status in Funen County was described in 1989 (Briggs 1989). There was an urgent need to undertake conservation measures to prevent further loss of localities. In 1990, the nature protection office of Funen County decided to carry out a recovery programme for *Bufo viridis*. As *Bufo calamita* was also known to be in strong decline in Funen County, it was hoped that measures done for *Bufo viridis* could also help *Bufo calamita* at the sites where the two species co-existed. Further resources were allocated to try to rescue six populations of *Bufo calamita* that used to be very large and had entered into a decline during the 1980's.

A number of ponds were dredged or dug anew, especially in 1990-92, followed by the introduction of grazing on the coastal meadows or in the coastal grasslands surrounding a number of the ponds. In one case, reintroduction of *Bufo viridis* was conducted. The projects were carefully monitored every year at several sites and less frequently at a number of other sites (often remote islands).

Methods

Monitoring methods

Four island populations of *Bufo viridis* and *Bufo calamita* (Avernakø (Avernak-Korshavn) – a twin island separated by a road dam, Birkholm, Skarø and Hjortø) and five populations of *Bufo calamita* (Fyns Hoved, Bøgebjerg, Bogensø, Dalby Bugt and Knudshoved) were moni-

Funen County (B.v. - *Bufo viridis* B.c. – *Bufo calamita*)	Hectares of coastal meadows and coastal fields with introduced cattle grazing		Number of ponds	
	Re-initiated	Continued	Restored	New
Avernakø (B.v &B.c)	33 ha		4	1
Birkholm (B.v &B.c)	25 ha		5	2
Skarø (B.v &B.c)				5
Hjortø (B.v &B.c)	15 ha		4	3
Strynø (B.v)			2	2
Drejø (B.v)			3	1
Ærø (B.v)				
Lyø (B.v &B.c)				
Tåsinge (B.v &B.c)		Part of island	5	4
Knold-Dyreborg (B.v &B.c)		Part of island	1	4
Bjørnø (B.v &B.c)		Part of island		1
Hjelmshoved (B.v)		Entire island	1	
Odden (B.v)		Entire island		
St. Egholm (B.v &B.c)		Entire island		
Fyns Hoved (B.c)	15 ha	Part of area	3	2
Bøgebjerg (B.c)	3 ha		1	1
Bogensø (B.c)		Part of area		1
Dalby Bugt (B.c.)		Part of area		1
Knudshoved (B.c)	20 ha			3
Thurø (B.c)		Part of island	2	
Total	111 ha		31	31

Table 1.
Habitat restoration in *Bufo viridis* and/or *Bufo calamita* localities in Funen County. Grazed coastal meadows and coastal fields in hectares and the number of ponds restored or created in the period 1987-1995

A pond dug for *Bufo viridis* in the upper part of a coastal meadow on Korshavn in 1990 that in 2004 still functions as a breeding pond for *Bufo viridis* due to grazing around the pond.

tored for males and breeding success during some years from 1990 to 1997. One of these populations (Avernak-Korshavn) had been monitored also in 1982-83, as well as in 1987-89. The Strynø population of *Bufo viridis* and the populations of *Bufo calamita* were monitored annually.

Some of the populations of *Bufo viridis* and *Bufo calamita* (Tåsinge, Knold-Dyreborg, Lyø) and the separate populations of *Bufo viridis* (Ærø and Drejø) and *Bufo calamita* (Thurø) were monitored only in some years for males and breeding success, and the smallest islands (*Bufo viridis* on Hjelmshoved and Odden, and *Bufo viridis* and *Bufo calamita* on Halmø and St. Egholm) were monitored yearly for breeding success.

The number of males was counted 2-3 times on spring nights, using flashlights. The weather conditions were optimal for counting calling individuals on these nights. The maximum number of males of *Bufo viridis* can be multiplied by four to get the approximate population size in small, partly isolated ponds (Rich 1996), and since we have no correlation between calling males and actual number of males for *Bufo calamita*, it is assumed that multiplication by four can also be applied here, the same as for *Bufo viridis*. Breeding success was detected with the help of dip-nets in the months of June-July.

Nature restoration methods

Methods of restoring the habitats of *Bufo viridis* and *Bufo calamita* were the following:

Grazing of coastal meadows

Coastal meadows left out of farming use for more than ten years became an unsuitable habitat for *Bufo viridis* and *Bufo calamita*. In the wet parts of the coastal meadows breeding success and sometimes-even attempts to breed stopped. The dry parts became less suitable as terrestrial habitats for foraging toads.

These coastal meadows were fenced and agreements with local farmers were concluded; as a result, a cattle grazing was re-initiated.

Fences were built with the economic support from Funen County, and farmers sometimes got financial support per hectare from EU agri-environmental funds.

Grazing of abundant fields

Old fields near the coast became economically unprofitable during the 1990´s. EU agri-environmental support ensured the long-term non-fertilised mowing or grazing of these fields. Farmers were further asked especially to re-initiate grazing instead of mowing in these fields.

Pond restoration and new ponds

Overgrown coastal meadow ponds were restored by removing reeds, other high plants and organic matter with digging machines. New shallow ponds were also dug, using machines and in few cases man power.

A total of 25 ponds were restored and 23 ponds were dug anew for *Bufo viridis* (table 1), and six were restored and eight new ones were created for *Bufo calamita*. Another approximately 10 to 15 ponds were affected positively by the reintroduction of grazing on coastal meadows, thereby reducing overgrowth. A cattle grazing was relaunched in three localities (Avernak-Korshavn, Birkholm and Hjortø), on 73 hectares of coastal meadows and abundant coastal grasslands. Furthermore, the EU agri-environmental schemes made it economically beneficial to continue grazing in a number of *Bufo viridis* and/or *Bufo calamita* localities (Tåsinge, St. Egholm, Odden, Hjelmshoved) and in *Bufo calamita* localities (six sites with only *Bufo calamita*), where cattle grazing was declining and clearly on the road to disappearing altogether.

Reintroduction of *Bufo viridis* eggs

As *Bufo viridis* was expected to be extinct on Birkholm by 1990-92, *Bufo viridis* eggs were reintroduced onto the island. 10 000 eggs were introduced in 1994, and another 4500 again in 1995. The eggs were placed into four ponds dug in 1990.

Results

Results for *Bufo viridis* when the actions were targeted at *Bufo viridis*:

The results of the conservation work for *Bufo viridis* are seen in table 2. When the activities began in 1998-1990, a number of 12 isolated *Bufo viridis* localities on 12 islands were known. One locality (Lyø) became extinct in 1991 before any conservation measures had been introduced. Five localities (Knold-Dyreborg, Bjørnø, Hjelmshoved, Odden, and St. Egholm) were in such a good condition that monitoring was less intensive and habitat management was minimal. Seven localities had altogether 244 adult *Bufo viridis* and breeding success was very limited. If pond restoration had not been initiated already in 1985-87 on Avernakø-Korshavn and Hjortø, there would have been only one pond with breeding success in 1988-90 in these seven localities. Over a period of seven years the number of *Bufo viridis* increased from 244 adults to 3550 adults. Furthermore, a few individuals of *Bufo viridis* were found in localities (Drejø and Ærø) were they had not been seen for 25-50 years.

The overall situation has improved from 1644 adult toads in 1988-90 to 4950 in 1995-97. The number of ponds with *Bufo viridis* males has risen from 29 in 1988-90 to 61 in 1995-97. The number of ponds with breeding success has increased from 11 to 22 during the period.

The best results in population increase were achieved on islands where pond restoration/digging was followed by the introduction of grazing in the areas surrounding the ponds (Avernakø-Korshavn, Birkholm and Hjortø). Population increase was significant also on Tåsinge, where a large part of the coastline is grazed. On Avernakø-Korshavn, which consists of two islands connected with a kilometre-long stone and asphalt road dam, 10 % of the total population or 240 adult *Bufo viridis* seemed to migrate from one island to the other within 1993-95. The longest distance to a new colonised pond was 5 km. As on Skarø island only pond digging occurred, a population decline from 80 to 40 adults was the result, but the

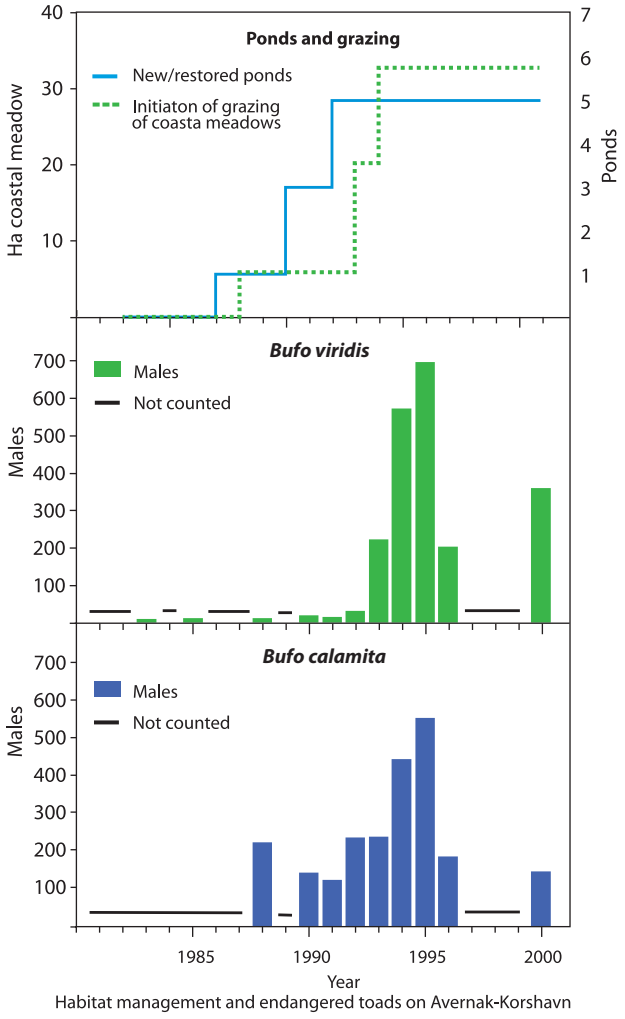


Figure 1:
The combined effect of breeding pond creation and reestablishment of grazing on *Bufo viridis* and *Bufo calamita* on Avernakø twin island (Avernak-Korshavn).

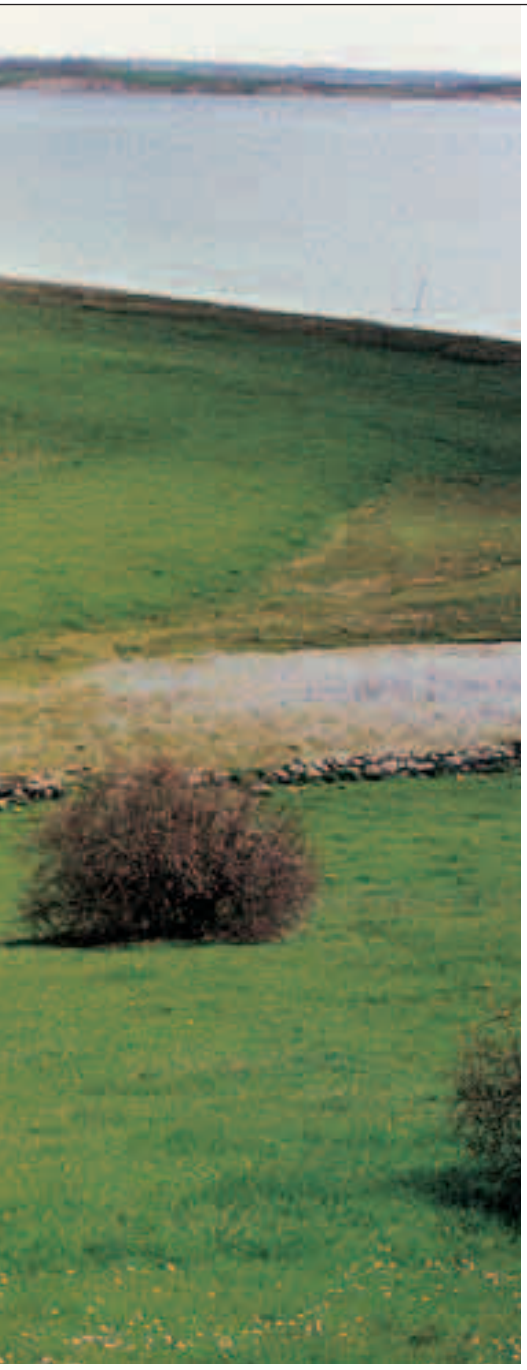
population could be saved from total extinction, since breeding was successful every year in the dug ponds. On Strynø, where ponds were dug but grazing not initiated, extinction was prevented and a population increase from 12 to 36 adults was achieved in seven years.

Result for *Bufo calamita* when the actions were targeted mainly at *Bufo viridis*:

Bufo calamita often occurs one the same islands as *Bufo viridis*. Pond restoration/digging and reintroduction of grazing did have a positive effect on *Bufo calamita* in one case, where the *Bufo calamita* population was already quite large (Avernak-Korshavn). The *Bufo calamita* population

Knold at Dyreborg, 2001.
These two ponds both have low vegetation inside the ponds and the grass around the ponds is also short and grazed. The ponds host a calling population of 200 to 300 males, both ponds feature almost annual breeding success and the surroundings of the ponds have low vegetation suitable for Bufo calamita foraging and migration.
The area is not supported by EU agri-environmental schemes but is one of the few coastal meadows where grazing is economically possible without agri-environmental schemes. The coastal meadow has low vegetation of suitable height both in the ponds and on the meadow, which makes it an almost perfect habitat for *Bufo calamita*.

increased from 400 adults in 1990 to 2200 adults in 1995 (figure 1). In two cases (Birkholm and Hjortø), where *Bufo calamita* populations were very small (<20 adults) and those of *Bufo viridis* as well (<50 adults), pond restoration/digging followed by grazing had a favourable effect on *Bufo viridis* alone. *Bufo calamita* became extinct or reached the verge of extinction, since only *Bufo viridis* achieved breeding success in the new ponds. When both species are low in numbers any attempt of habitat restoration may favour only one species, and its must also be said that the new dug



Endelave island, 2001.
On the right side of the picture there is an ungrazed former coastal meadow that is now a reedbed. Here, between 0 and 1 males of *Bufo calamita* are calling annually. Breeding success is not recorded.

Monnet on Tåsinge Island, 2001.
The population is small and 5 to 10 males call annually. The meadow is with low green vegetation and the very suitable breeding ponds feature breeding success. The surroundings of the ponds appear yellow and the grass is too high, thus it is not suitable for *Bufo calamita* foraging. The area is supported by EU agri-environmental schemes.

was targeted on *Bufo viridis*. In coastal meadow localities, where grazing was continued or not absent for more than a decade (Tåsinge, Bjørnø, Knold-Dyreborg), the two species continued to co-exist and often with *Bufo calamita* as the dominating one in numbers.

Results for *Bufo calamita* when the actions were targeted at *Bufo calamita*:

New breeding ponds were created in six localities where historically only *Bufo calamita* occurs. The creation of breeding ponds managed to stabilise and locally increase the *Bufo calamita* population in the four closely situated localities (Fyns Hoved, Bøgebjerg, Bogensø and Dalby Bugt). The number of localities with breeding success increased as well. At one local Fyns Hoved site the population had been declining considerably until 1988. While no males were heard in 1988 and 1989, four old males appeared, called and reproduced after the restoration of one breeding pond. Thus the local population increased to an average of 50 males until 1995 to 1997.

When ponds were created on Knudshoved in 1991, only a few adults remained and the population finally became extinct. When two ponds were dug on Thurø in 1994, three males called in the restored breeding pond the following year, but it was too late and the population became extinct.

Out of four localities where the population had shrunk to fewer than 20 adults or less, in two the process was turned around.

In two localities where the populations had shrunk to about 100 to 200 adults, the populations were stabilised and breeding success consequently increased.

Development of populations from 1997 to 2004

Bufo viridis:

After 1997, not all populations where monitored as closely as in the period from 1988 to 1997, but qualitative comments based on monitoring can be given for many sites anyway.

After 1997, 11 new ponds targeting *Bufo viridis* have been established. The general positive trend for *Bufo viridis* has continued up to 2004, as the total population size has more than doubled to somewhere between 10 000 and 20 000 adults. The increase in adult toads has mainly occurred on Birkholm, Tåsinge, Strynø and Strynø Kalv. Two new islands have been colonised or re-colonised by the toad (Strynø Kalv and Dejrø), but some localities have dropped in numbers (Bjørnø, Skarø, Hjelmshoved and Hjortø). On 3 out of 4 localities where numbers dropped there was a stop in grazing.

***Bufo calamita* at *Bufo viridis* sites:**

The general decline in the number of localities seems to continue since the localities with small populations have become extinct (Skarø, St. Egholm, Avernak and Lyø) due to insufficient grazing, to much saltwater in the last vulnerable breeding sites, fertilizing og coastal meadows and due to an already small population size . Large populations of *Bufo calamita* (Bjørnø and Korshavn) have also suffered a decline recently, mainly due to insufficient grazing and also due to much salt water in the last and vulnerable breeding ponds.

Bufo calamita:

The four populations that had survived until 1997 continued to increase and finally doubled to a total of 1200 adults in 2004, and the grazing was also continued on a sufficient level.

Discussion and conclusions

It is possible to cease the decline of *Bufo viridis* populations by digging and restoring ponds. Grazing is considered an important follow-up measure, and the quality, yearly continuation and intensity of grazing can vary much from site to site and still yield positive effects. If populations are small, extinction can be prevented and it is even possible to increase population size. This was demonstrated in Funen County in the course of this project and also in various parts of the island of Samsø in Denmark (Amtkjær 1995). Experiences with coastal meadows indicate that grazing must be initiated a least a few years after pond digging/restoration in order to ensure a more considerable population growth and maintain a larger population.

According to a nation-wide survey conducted in Denmark on the survival of rare amphibians five years after pond restoration has been carried out, *Bufo viridis* appeared to have survived only in 72% of the cases compared to six other rare species that survived in 82% to 100 % of the cases (Fog 1997). It was concluded that the open areas free of vegetation on the banks had become rare already one year after restoration, thereby limiting the breeding success of *Bufo viridis*. Although this conservation project on coastal meadows in Funen County shows that populations can be saved and even increased by pond restoration projects only, the results of the combination of pond restoration/digging and grazing indicates the importance of grazing in maintaining large populations of *Bufo viridis*.

Finding *Bufo viridis* on Drejø and Ærø is a proof of the large spreading potential of this species. Drifting in the sea or sailing with people are two possible ways of spreading, since *Bufo viridis* is known to be found in fishermen's nets, as well as collected in Avernakø harbours by sailing tourists and brought to release on Ærø.

The seven years of work (1990-1997) on the conservation of *Bufo viridis* has given sufficient hope that all remaining populations will survive and the result until 2004 support this. Although monitoring and additional breeding ponds or grazing initiatives are needed on a smaller scale to maintain all populations.

Recovery actions for the protection of both *Bufo viridis* and *Bufo calamita* at the same site must be done

Hjarnø island, 2002.
Coastal meadow one year after the change in grazing system. Before 2002, the farmer had a flexible grazing system with 0 to 14 head of cattle on the meadow depending on grass growth in that particular month and year – this grazing system kept the vegetation short at all times. Such a system is normally only carried out using traditional farming skills and by older farmers. The new system introduced after 2002 is supported by EU agri-environmental schemes and a fixed number of six head of cattle for the area has already resulted in the appearance of first clumps of tall uneaten grass. As the dead grass and organic matter piles up over the years on the meadow, it becomes unsuitable for *Bufo calamita* foraging and the edges of the breeding pond become too overgrown for breeding.

Coastal meadow locality for *Bufo viridis* and *Bufo calamita* on Bjørnø in 2002 after several years without grazing.
The overgrowth process was halted for a period in 2002 after a saltwater flooding in the winter of 2001/2002. However the breeding success failed in the year after flooding which negative for such an isolated population.

carefully by combining breeding pond restoration and creation with a carefully designed grazing plan in order to preserve the favourable conservation status of both species.

While it is possible to cease *Bufo calamita* population decline by digging and restoring ponds, the actions must be followed up with grazing initiatives. Grazing must be of high quality, high intensity and it must by carried out every year with the same high intensity in order for it to benefit *Bufo calamita*. If the population is in a steady decline, recovery actions should be conducted before the population drops to below 50 adults and preferably when the population has still at least 100 to 200 adults.

Problems with grazing coastal meadows in a correct way for ensuring toad survival

The restoration and creation of breeding sites helps both toad species. The fact is that grazing maintains favourable breeding sites. So it is important that nature administrations encourage landowners to initiate and continue grazing of their coastal meadows; economic motivation is provided at the moment by the EU agri-environmental scheme. During the study tours of this LIFE project a large number of coastal meadows with *Bufo calamita* occurrence were visited and the striking discovery was that it was difficult to find coastal meadows with optimal grazing for *Bufo calamita*, despite the fact that many areas were supported by EU agri-environmental schemes.

Experience with Scottish Highland Cattle in Matsalu Nature Reserve, Estonia. The use of cattle types that can stay outside longer into the winter or the whole winter can be the modern solution to the creation of low vegetation of the height necessary for *Bufo calamita* and *Bufo viridis* before the spring starts.

Pictures (see above pages) reveal some of the findings on how the habitat value for *Bufo calamita* increases with higher grazing intensity or indicates a typical change when areas are transformed from traditional management to EU agri-environmental scheme supported management.

The left side of the picture features 3 to 10 males calling annually and no breeding success has been recorded so far. The ponds have a slightly yellow appearance indicating overgrowth of Scirpus maritimus. The surrounding coastal meadow looks very yellow and as the grass is too high, it is not suitable for *Bufo calamita* foraging. This area is supported by EU agri-environmental schemes.

Funen County	*Bufo viridis* adults		Number of ponds adults (tadpoles)	
	1988-90	1995-97	1988-90	1995-97
Avernak-Korshavn	40	2400	7 (3)	23 (4)
Birkholm	20	920	1 (0)	7 (5)
Skarø	80	40	2 (0)	1 (1)
Hjortø	52	168	3(1)	6 (3)
Strynø	12	36	2 (0)	3 (1)
Drejø	0	4	0 (0)	1 (0)
Ærø	0	10	0 (0)	0 (0)
Lyø	12	0	2 (0)	0 (0)
Tåsinge	28	240	3 (1)	6 (1)
Knold-Dyreborg	100	100	1 (1)	5 (2)
Bjørnø	500	500	3 (1)	4 (1)
Hjelmshoved	300	300	2 (2)	2 (2)
Odden	200	200	1 (1)	1 (1)
St. Egholm	300	300	2 (1)	2 (1)
Total	1644	4950	29(11)	61 (22)

Table 2: Areas with *Bufo viridis*.
The maximum number of adult *Bufo viridis* in the period 1988-1990 and the maximum number of adult *Bufo viridis* in the period 1995-97, and the number of ponds with occurrence of calling males of *Bufo viridis* and of the number of ponds with breeding success of *Bufo viridis* (in brackets) in 1988-90 and 1995-1997

The positive and negative influence of saltwater flooding

The influence of salt on coastal meadows and their ponds is a factor that can be both positive and negative. The extreme flooding with saltwater that happens in some years can periodically halt succession in ponds, which is positive for toads. After some years water quality will be restored and improved and breeding can become successful again, as was observed on Knold, Avernak-Korshavn and Bjørnø. However, if the population is very small and depends only on breeding ponds, saltwater flooding may have catastrophic results, since just a few years without breeding can wipe out small populations. This very same negative effect of saltwater combined with poorly grazed coastal meadows helped to push the small populations of *Bufo calamita* on Skarø, Hjortø, St Egholm and Birkholm into extinction.

Some positive experiences:

1. It was possible both to restore and dig new ponds, which resulted in favourable breeding success for *Bufo viridis* and *Bufo calamita*.
2. Landowners are willing to provide space for new ponds and take part in the reintroduction of grazing on coastal meadows.
3. Many populations of *Bufo viridis* and *Bufo calamita* have a good chance of survival, if breeding ponds are created and correctly designed grazing is maintained.
4. *Bufo viridis* is a fast coloniser of new ponds within an

island, even when the populations are small and it can possibly spread from island to island by sea or on board ships.

Some negative experiences

It is very difficult to ensure a continuation of efficient grazing on many smaller islands with both species occurring together, thus it often happens that focusing breeding pond creation often tends to favour one species. In the conditions of a lack of continuous grazing, it seems that *Bufo viridis* is favoured over *Bufo calamita*.

Bufo calamita is not such a fast coloniser as *Bufo viridis*, especially when the populations are small and situated on coastal meadows.

Genetic variation

In order to make sure that the highest degree of genetic variation is maintained, all populations should grow as fast as possible to an effective population of 500 adults. This is the number necessary to ensure that not too many alleles are lost due to genetic drift (Lehmkuhl 1984). Not all islands may maintain an effective population size of 500, but since *Bufo viridis* can probably move from island to island, several nearby islands may together form an effective population size of 500.

Acknowledgements.

Funen County administration is thanked for their willingness to entirely finance pond restoration and digging. Furthermore. Funen County directed the EU agri-environmental funding to the these important coastal meadows. Some inhabitants of small islands made a particularly great effort in finding pond sites or contributed their labour or machinery. They are Anders Svendsen and Mogens Rasmussen, Hjortø and Jens Bech, Strynø. Thank you to those who helped with collecting data: Anne Margrethe Andersen, Jens Bech, Niels Damm, Erhart Ecklon, Lars Hansen, Anders Sahl Nielsen, Randi Nikolajsen, Peter Skriver, Silke Vanselow.

DANCEE (a programme of the Danish Ministry of Environment) and EU LIFE-programme are thanked for supporting the Danish-Estonian study tours to Danish coastal meadows during the years 2000-2004, which further helped to collect data and analyse data on the toad population. The herpetologist participating in the data collecting and analysing where Lars Chr. Adrados, Ilona Lepik, Piret Pappel and Riinu Rannap.

Funen County	*Bufo calamita* adults		Number of ponds adults (tadpoles)	
	1988-90	1995-97	1988-90	1995-97
Avernak	40	20	1 (0)	1 (0)
Korshavn	400	2200	5 (1)	7 (3)
Birkholm	12	0	1 (0)	0 (0)
Skarø	200	40	1 (0)	1 (0)
Hjortø	28	0	1(0)	0 (0)
Halmø *	100	100	2 (0)	2 (0)
Lyø	100	20	4 (0)	1 (0)
Tåsinge	20	40	2 (1)	3 (1)
Knold-Dyreborg	1000	1000	1 (1)	5 (2)
Bjørnø *	1000	1000	6 (3)	4 (1)
Ærø	20	0	1 (0)	0 (0)
St. Egholm *	50	50	2 (0)	1 (0)
Total	2970	4470	27(6)	25 (7)

Table 3: Areas with *Bufo calamita* where *Bufo viridis* also occurs.
The maximum number of adult *Bufo calamita* in the period 1988-1990 and the maximum number of adult *Bufo calamita* in the period 1995-97, and the number of ponds with occurrence of calling males of *Bufo calamita* and of the number of ponds with breeding success of *Bufo calamita* (in brackets) in 1988-90 and1995-97.-

* Localities marked were monitored only for breeding success and population estimates are not so precise.

Funen County	*Bufo calamita* adults		Number of ponds adults (tadpoles)	
	1988-90	1995-97	1988-90	1995-97
Thurø	100	12	4 (0)	1 (0)
Knudshoved	50	0	1(0)	0(0)
Fyns Hoved	16	200	1(0)	5(2)
Dalby Bugt	200	200	2(0)	4(2)
Bøgebjerg	120	120	1(0)	1(1)
Bogensø	20	60	1(0)	2(1)
Total	406	592	10(0)	13 (6)

Table 4: Areas with *Bufo calamita* where *Bufo viridis* was never recorded. .
The maximum number of adult *Bufo calamita* in the period 1988-1990 and the maximum number of adult *Bufo calamita* in the period 1995-97, and the number of ponds with occurrence of calling males of *Bufo calamita* and of the number of ponds with breeding success of *Bufo calamita* (in brackets) in 1988-90 and1995-97.

* Localities marked were monitored only for breeding success and population estimates are not so precise.

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Suitable habitat management for Danish bird populations

OLE THORUP

Dunlin

Black-tailed godwit

A number of spectacular bird species are in Denmark largely confined to wet grassland. Many of these declined markedly during the last century including the three meadow breeding shorebirds dunlin, ruff and black-tailed godwit.

In the past, dunlins and ruffs were common and widespread breeders in fresh and brackish meadows all over Denmark and dunlins were also found in salt-marshes. Black-tailed godwits were found more locally and had their peak occurrence in the second half of the 20th century (Kjærbølling 1852, Hørring 1926, Heilmann & Manniche 1939, Thorup 2004). Nowadays, suitable breeding habitat for the three species is hardly found in inland grassland anymore, and the present breeding distribution is primarily in coastal grassland and coastal polders (Grell 1998).

In 2002, the Danish Ornithological Society (DOF – BirdLife Denmark) conducted an analysis of available data on population sizes of the three species since the first country-wide surveys were performed in the 1960s and early 1970s (Thorup 2003a, 2004). In this analysis a major decline was documented in all three species, with a population reduction of 43% in dunlin, 81% in ruff and 24% in black-tailed godwit between 1977-82 and 2000-02. The 2002 Danish totals were estimated at 350 pairs of dunlin, 150 females of ruff and 709 pairs of black-tailed godwit (Thorup 2004).

Furthermore, there had been a continuous restriction of the number of occupied breeding sites. Compared with 1964-72, only 24% of the number of breeding sites in dunlin, 14% in ruff and 39% in black-tailed godwit were still occupied in 2000-02 (Figure 1). When population development and habitat management was compared, habitat management was found to explain a large part of the divergence between population developments at various breeding sites (Thorup 2003a, 2004).

The species

Dunlin

The Danish breeding dunlins belong to the small, genetically quite distinct, biogeographical population Baltic dunlin. This population is confined to fresh and brackish

meadows and salt-marshes around the Baltic Sea and along the eastern shores of the North Sea. The population total is approximately 1,100-1,400 pairs (≈ 3,000-4,000 individuals). Denmark is thus housing some 30% of the total, and most of the remaining pairs are found in Estonia and Sweden (Thorup in print).

Ruff

The meadow breeding ruffs in Denmark belong to a huge European and west and central Siberian population consisting of, at least, 700,000 breeding females. The bulk of these are found in natural habitats in peatland and tundra in Russia and northern Scandinavia. In Russia, Belarus and northern Ukraine an estimated 5,000-15,000 females are still breeding in wet grassland, while in the western part of the formerly extensive distribution area in temperate wet grasslands less than 2,000 breeding females are left. Fifty years ago this number was approximately ten times higher (Thorup in print). At a population level the meadow-breeding portion is insignificant.

Black-tailed godwit

Danish black-tailed godwits are the north-westernmost outposts of a continental European population numbering some 90,000-120,000 pairs (Thorup in print). Almost the entire population is found in wet grassland in hay meadows and pastures, whereas historical natural habitats suitable for breeding like steppic wetlands and moist and open depressions in moors and floodplain marshes nowadays have almost completely been converted to other habitats (Glutz von Blotzheim et al. 1977, Beintema et al. 1995).

During the last 20 years population sizes in the major populations in the Netherlands, Germany, Poland and Belarus halved, and the relative importance of the Danish breeders increased from 0.5% to 0.7% of the total.

Good habitat management for breeding meadowbirds

Extensive breeding biology studies in the Netherlands (Beintema 1991, Beintema et al. 1995, Schekkerman 1997) and at Tipperne, Denmark (Møller 1978, Thorup 1998, 1999 & unpubl.), that among other things investigated nest site selection, distribution, dispersal, nest success, fledging success and population dynamics, have provided a fairly detailed insight into how to maintain proper habitat management for breeding dunlin, ruff and black-tailed godwit (Table 1).

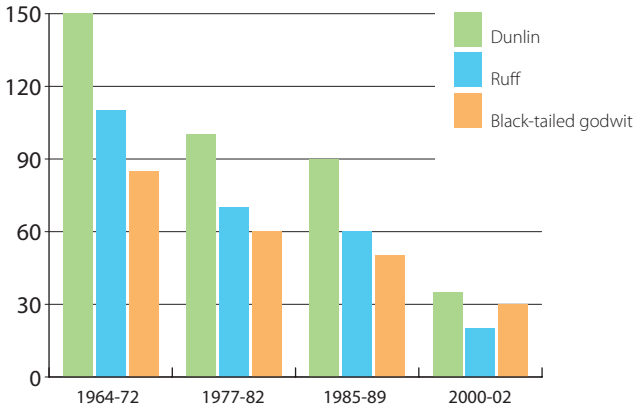

Figure 1.
Number of breeding sites in Denmark of dunlin, ruff and black-tailed godwit in four periods 1964-2002.

Thorup 2004

Dunlin

75-125 years ago breeding dunlins were found in high numbers in most wet meadows in Denmark, salt as well as fresh, and the breeding population may have been as high as 50,000-100,000 pairs (Holstein 1935, Heilmann & Manniche 1939, Thorup 1998). In this period pastures and hay meadows were a most valuable resource to the farmers, and in order to ensure an abundant grass production, low grasslands were kept wet well into May-June. The extent of area with meadows peaked between 1888 and 1915, and since then a large proportion of the meadows has been drained and converted into cultivated land whilst many other areas, unsuitable for cultivation, were abandoned, in particular during the last 30 years (Johansen 1985, Bjørn 1988, Thorup 1998).

Good habitat management for breeding dunlin broadly is to manage wet grasslands as similar as possible to the utilization of the meadows in the late 19th and early 20th century. This includes high water table, no improvements in the shape of ditching, ploughing or levelling, moderate grazing pressure, late mowing and no application of fertilizers nor herbicides and insecticides.

Overall, dunlin is a bird found in very low and open vegetation. Typical nest tufts are 5-15 cm high, and dunlins make no use of higher and dense vegetation in any period of their life cycle. However, producing a homogeneous low sword by grazing alone implies a very high grazing pressure from early in the growth season, and such a grazing scheme causes a very high nest loss rate due to destruction

	Dunlin	Ruff	Black-tailed Godwit
Water table	Wet meadows. Groundwater table at maximum 30 cm below surface in May and early June. Drainage not accepted.	Wet meadows. Groundwater table at maximum 30 cm below surface in May and early June. Drainage not accepted.	Wet meadows. Groundwater table at maximum 30 cm below surface in May.
Surface structure	Dependence of well developed structures with pools and gullies, which gradually dry out during late May and June.	Dependence of well developed structures with pools and gullies, which gradually dry out during late May and June.	Apparently no demands.
Fertilizer application	Fertilizer application destroys breeding habitat.	Fertilizer application destroys breeding habitat.	Moderate application of fertilizer accepted, at maximum 50-100 kg N per hectare.
Grazing 1)	Cattle or horses released after 25 May (density corresponding to 1 young cattle per ha) or 5 June (density corresponding to 2 young cattle per ha)	Cattle or horses released after 28 May (density corresponding to 1 young cattle per ha) or 5 June (density corresponding to 2 young cattle per ha)	Cattle or horses released after 15 May (density corresponding to 1 young cattle per ha) or 25 May (density corresponding to 2 young cattle per ha)
Mowing 2)	Mowing after 15 July.	Mowing after 15 July.	Fertilized meadows: Mowing after 20 June. Meadows not fertilized: Mowing after 25 June.
Salt	At least 10 per mill salt and perhaps seawater accepted in water systems of the meadows.	Vulnerable to salt and the species abandons sites approaching approximately 5 per mill salt in the water systems of the meadows.	At least 10 per mill salt accepted in water systems of the meadows.
Height of vegetation at nest.	Nests situated in 5-15 cm high vegetation with a good view.	Nests situated in 10-20 cm high and not too dense vegetation with a fair view.	Nests situated in 5-15 cm high vegetation with a good view.
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.	Young chicks (until the age of 2-3 weeks) are reared in vegetation 15-30 cm high.
Lower limit of management.	Grazing and/or mowing is necessary in order to sustain proper vegetation height and structure.	May breed temporarily in moist and slowly growing fallow but in the long view grazing and/or mowing must sustain proper vegetation height and structure.	Grazing and/or mowing is necessary in order to sustain proper vegetation height and structure.
Anti-predator shield	High-density populations more productive when high densities of avocet, lapwing and black-tailed godwit provides an anti-predator shield. Hence good management also for these species of importance.	High-density populations more productive when high densities of avocet, lapwing and black-tailed godwit provides an anti-predator shield. Hence good management also for these species of importance.	Improved hatching success when breeding with high densities of lapwing.. Hence good management for lapwing of importance.

Table 1. Proper management for dunlin, ruff and black-tailed godwit in Denmark in order to ensure suitable conditions for successful breeding (based on studies in the Netherlands and at Tipperne; Møller 1978, Altenburg et al. 1985, Beintema 1991, Beintema et al. 1995, Thorup 1998 and unpublished).

From Thorup 2004.

1): Calculated on the conditions that at maximum 25% of the nests are destroyed by the grazers.

2): Calculated on the conditions that at maximum 20% of the chicks are killed during mowing.

and disturbance by grazing animals. Therefore, the optimal way to create/retain dunlin habitat is by grazing with a fairly late release date with moderate densities of cattle or horses combined with regular mowing in, at least, every three to four years (Table 1).

Ruff

In the 19th and early 20th century the ruff were common and widespread in moors and wet meadows in Denmark, in particular in areas rather thinly populated by humans – as early as 1852 and at least until hunting was banned in the breeding season in 1931, hunting was supposed to have an important impact on distribution and abundance (Kjærbølling 1852, Heilmann & Manniche 1939).

Ruff breeding habitat is very similar to that of the dunlin and, excluding the hunting issue, the two species have had comparable population trends. However, ruffs are avoiding the saltiest parts of the coastal meadows, and consequently drainage and cultivation of the inner parts of the coastal meadows affected ruff to a still higher degree than the dunlin.

Good habitat management for breeding dunlin in fresh and fresh-brackish meadows is also good management for ruff (Table 1). Because the ruff uses nest tufts with a height of 10-20 cm – somewhat higher than the dunlin – ruffs need more vegetation heterogeneity, and ruffs seem particularly to benefit from regular late mowing. Mowing produces areas with relatively open vegetation that grows to the desired height in the main ruff nesting period in May and June.

Black-tailed godwit

The black-tailed godwit was never a

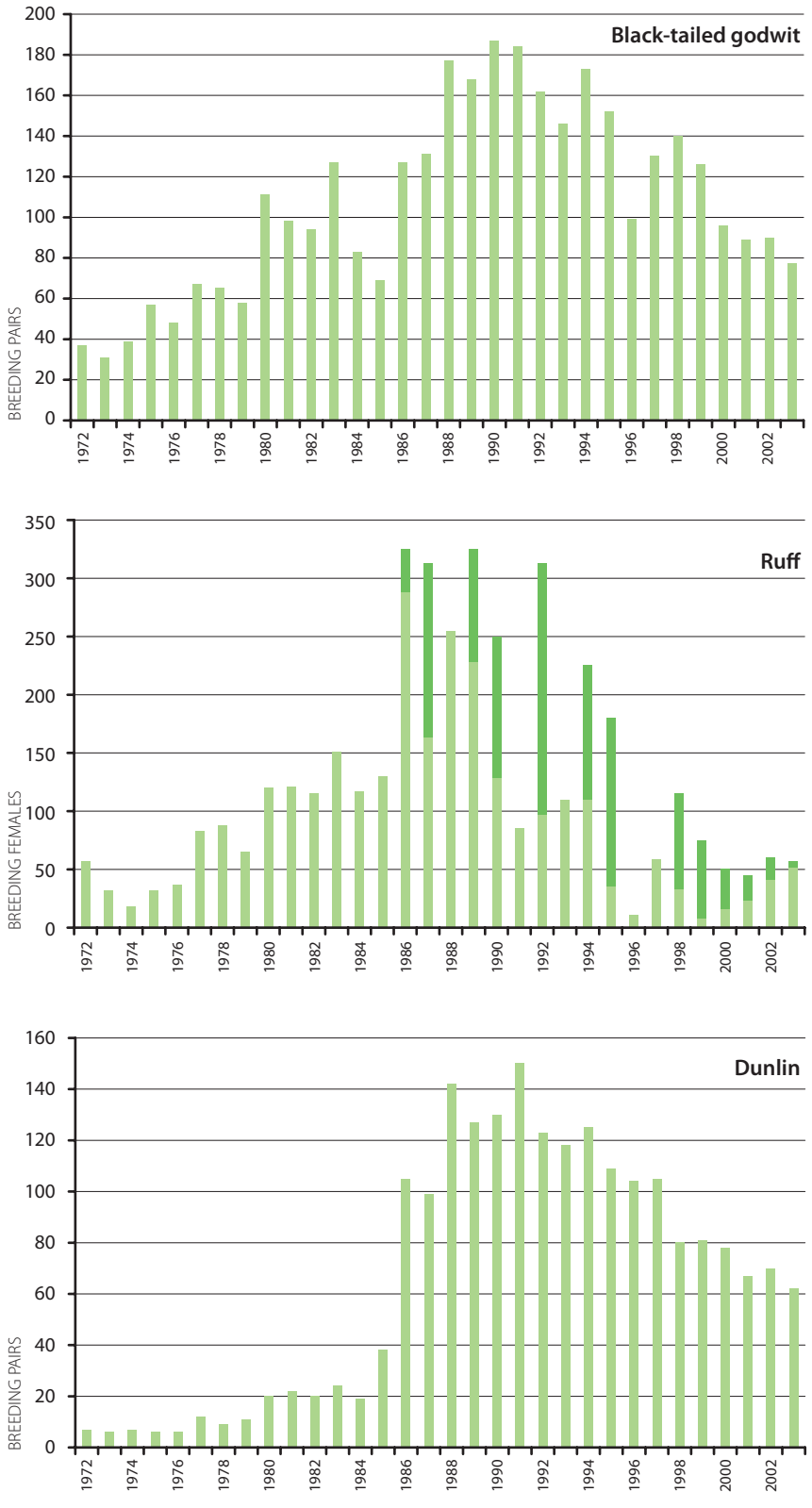

Figure 2.
Number of mapped and counted breeding pairs (in ruff females) at Tipperne 1972-2003. In ruff open bars indicate an estimate of the number of additional unsuccessful females not found during the counts (calculated from nest distribution and hatching data). From Thorup 2003a, 2003b.

really widespread and common breeder in Denmark, and the vast majority was found, in the past, in extensive hay meadows and pastures along the west coast of Jylland (Kjærbølling 1852, Heilmann & Manniche 1939). Most likely, both climate and hunting influenced this breeding distribution. During the 20th century the species became more widely distributed, and although poorly known, the number of breeding sites probably peaked in the middle of the century, whereas the breeding number peaked around 1980 (Thorup 2004).

Very often, good habitat management for dunlin and ruff also provides good breeding conditions for black-tailed godwit (Table 1), although black-tailed godwits probably have some additional specific demands for, e.g., soil structure but this is not studied in Denmark. On the other hand, good management for black-tailed godwit does not necessarily suit dunlin and ruff: black-tailed godwits tolerate a moderate application of fertilizer and mowing in late June, while such management is detrimental to breeding dunlin and ruff (Table 1).

Tipperne

Breeding dunlin, ruff and black-tailed godwit are nowadays very concentrated in Denmark, and in 2002 some 20% of the dunlins, 45% of the ruffs and 13% of the black-tailed godwits were breeding at one site, Tipperne (Thorup 2003a).

Tipperne is a publicly owned nature reserve situated on a peninsula in a huge brackish water lagoon, Ringkøbing Fjord, at the west coast of Denmark, 55º 53' N, 8º 12' E. The reserve consists of 545 ha of wet meadows surrounded by reed beds, wet dunes and immense shallow water areas with wind flats.

Following a decade with overgrowing and a subsequent decrease in meadowbird populations, a management programme was set up in the early 1970s. The extent of management was gradually expanded and optimised according to the observed impacts to the breeding birds until a nearly optimal form was reached in the middle of the 1980s (Thorup 1998).

The changes in habitat management did impact the population sizes of the three species (Figure 2). Gradual

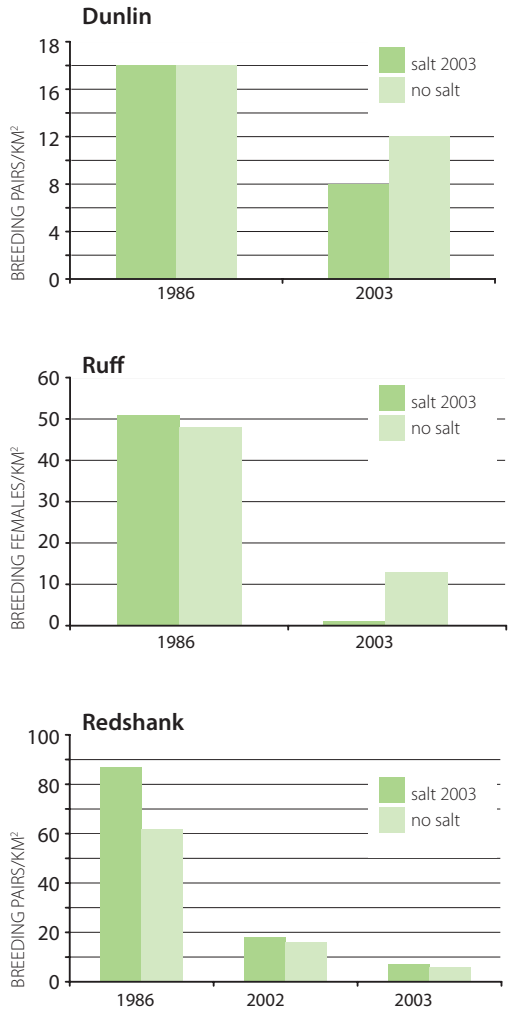

Figure 3.
Breeding densities of dunlin and ruff in 2003 and densities of successful redshank in 2002 and 2003 in meadows with low salinity (app. 0.1-3.5 per mill) and higher salinity (> 5.0 per mill), respectively, and breeding densities in the same areas in 1986, where all meadows were with low salinity. The difference is statistically significant in ruff ($c^2 1 = 18{,}79$; $p < 0{,}001$), small and not significant in dunlin ($c^2 1 = 1{,}399$; $p > 0{,}05$), whilst there is no difference in redshank.

Ruff.

reintroduction of grazing took place during the 1970s, and since 1976 all meadows have been grazed annually with 1-1.7 young cattle per ha with the highest densities in the 1970s and early 1980s (Thorup 1998). The late 1970s populations of the three meadowbird species were around the double of the pre-management populations. In 1984 an extensive mowing programme was initiated, and since then all meadows have been mowed at least once in a three-year cycle. This additional mowing had an immense impact on the meadowbird populations. In particular in the dunlin the population increase was far above the most optimistic expectations – from the early 1980s to the late 1980s the population level increased from 20-25 to 120-150 pairs. In the same period the ruff population approximately tripled and the godwit population doubled (Figure 2).

In order to counteract a high level of nutrients brought into the lagoon by the rivers from surrounding farmland, intake of salty seawater and outlet of fresh water was increased from the winter 1995-1996. As an undesirable side effect, the water regime of the lowest meadows at Tipperne changed from 'fresh-brackish' (below 3 per mill salt) to 'salt-brackish' (5-15 per mill salt). This change affected breeding species not tolerant to salt, e.g. lapwing and ruff, negatively, and apparently this change also delimited alternative prey for the most important predators on breeding meadowbirds and their eggs and chicks (Thorup 2003a and unpubl.).

A direct effect of the increased salinity was detectable in the decline and redistribution of ruffs that almost ceased breeding in the lower meadows with increased salt influence, whilst a similar cessation did not take place in

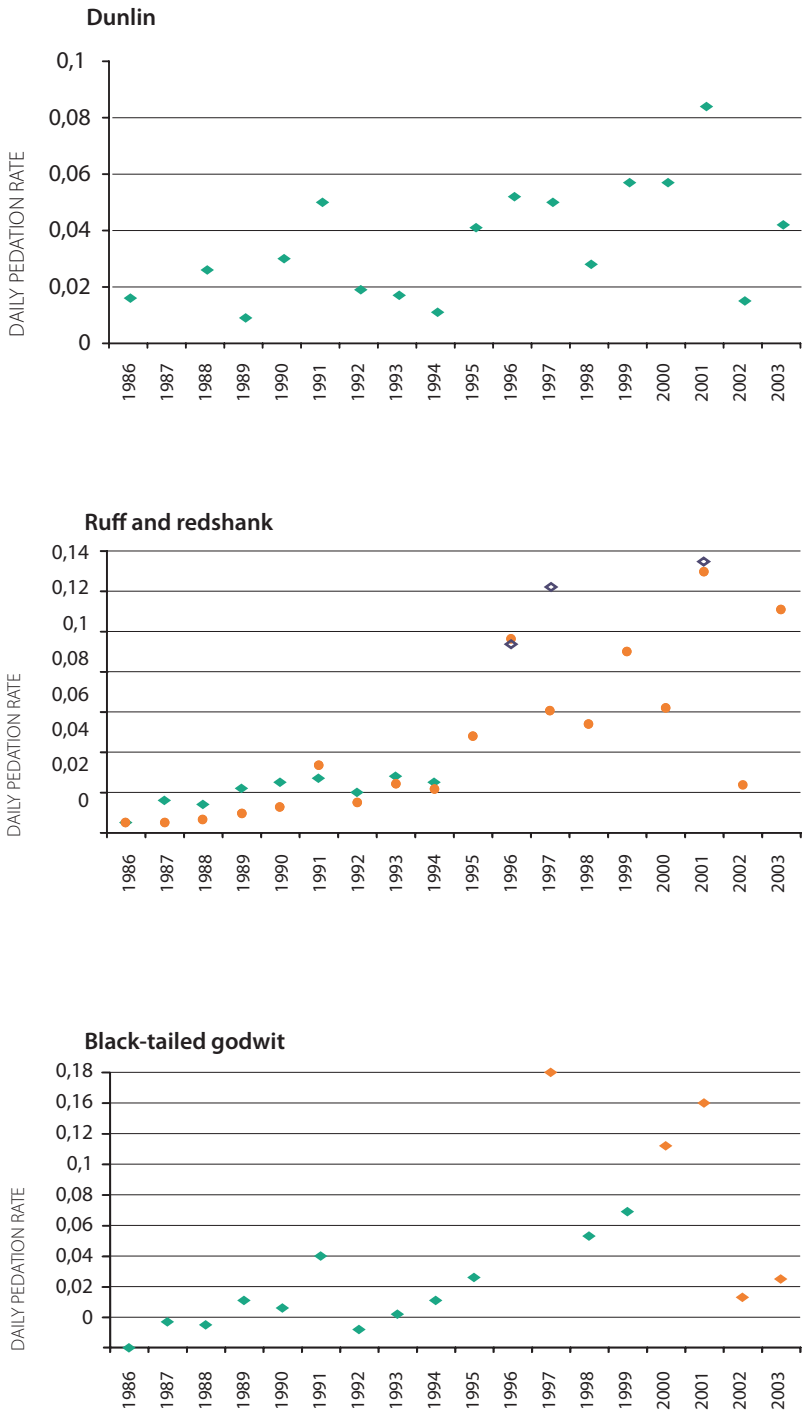

Figure 4.
Daily predation rates in nests of 1) dunlin, 2) ruff (diamonds) and redshank (circles) and 3) black-tailed godwit at Tipperne in the years 1986-2003. Predation rates calculated from data with more than 100 nest-days shown with filled symbols, and with 50-99 nest-days with open symbols. Species and years with less than 50 nest-days not shown due to very low data quality (explanation of terms see Mayfield 1975, Beintema 1992). Redshank data are given as reference to ruff predation due to few monitored ruff nests after 1995; the two species select similar nest habitat and showed a fairly uniform predation pattern in the seasons with a fair number of surveyed nests of both species (1986-1995). From Thorup 1998, 2003b and unpubl.

breeding dunlin (Figure 3). Neither did the redshank, a common breeder also in salt-marshes, avoid the meadow areas with increased salinity, pointing at the fact that the redistribution of ruff was not caused by a general change in the salty areas making them unsuitable to breeding shorebirds (Figure 3).

The habitat change due to more salt in the water regime was followed by a marked increase in predation (Figure 4). It is not possible to give an exact maximum value that allows a successful breeding – there are too many other parameters influencing the total breeding success that are much less well known: nest trampling by cattle, nest flooding, fledging success, no of clutches per season, juvenile survival, adult survival etc. But a daily predation rate of above 0.04-0.05 (corresponding to a hatching success of a nest in the magnitude of 25-40%) hardly allows a reproduction that can compensate adult mortality. 1986-1995 only one out of 29 'species-years' (black-tailed godwit in 1991) was above the 0.05 value, whereas 17 out of 23 'species-years' had daily predation rates above 0.05 in 1996-2003. Most likely, the missing recruitment in the seasons since 1998 explains a large part of the declines observed in that period.

The abrupt change in predation pattern does not coincide with a marked change in the number of potential predators. The change is most likely, at least partly, linked to prey shifts and shifts in search images among the main predators after the change in salt intake and a subsequent strong decline in lapwing breeding density. The suggested interactions between habitat change and predation pressure have not been studied into detail at Tipperne, however, and knowledge on potential interactions is generally rather fragmented and the issue not properly investigated (Evans 2004).

Acknowledgements

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Thorup, O. in print: Breeding Waders in Europe: a year 2000 assessment. – International Wader Studies 14.Figure 1. Number of breeding sites in Denmark of dunlin, ruff and black-tailed godwit in four periods 1964-2002 (from Thorup 2004).

Changes of bird communities in relation to management of coastal meadows in Estonia

ANDRES KURESOO
EVE MÄGI

In this overview the coastal meadow stands for wider meaning of coastal grassland – area, which has at least some common border with the sea and which has got meadow plant cover and which is as a rule managed (grazing, mowing). In current overview we include both wet and drier meadows of the coastal zone, including those which are not under the direct influence of seawater (pastures). In narrow meaning coastal meadows are influenced by seawater and could be divided into sub-saline (permanent or frequent flooding), saline (flooded during wave action or high water level) and supra-saline (influence during storms) zones. As a result, a zonal distribution pattern is characteristic to the plant cover of the shore.

Estonian coastal grasslands belong to the North European group of maritime salt marshes. The distribution and variety of coastal grasslands are much influenced by the neotectonic land uplift (2-3 mm per year in Western Estonia) and more brackish conditions than in Western Fennoscandia. As a rule, Estonian coastal meadows are primary. They have developed on unvegetated soil on land rising out of the sea. The grasslands here have a long history of use for grazing by cattle, sheep and horses and to a lesser extent for haymaking. The rapid decline of such management after the World War II, which took place elsewhere in Europe, was postponed in Estonia for several decades due to the Soviet agricultural practices. The principles of such economy allowed extensive use of farmlands, which was comparable to traditional land-use and therefore large number of species-rich coastal communities preserved until re-privatization of land in 1990s.

Coastal meadows are distributed in Western Estonian coasts and islands, main reason for their disappearance is

the change or end of their traditional land use. On the contrary, similar areas in Western Europe have been disappeared mainly due to the agricultural intensification (Beintema 1991). The total area of Estonian coastal grasslands has been estimated at 28,750 ha in 1950s and only 9450 ha in 1978-81. By 2000 the total area of coastal meadows has been reduced to 8000 ha (Luhamaa et al. 2001)

The recent inventories concerning Estonian biodiversity have clearly demonstrated the rapid reduction or degradation of semi-natural wetland habitats (Leibak & Lutsar 1996, Luhamaa et al 2001). Sustainable extensive agriculture, which has been a common land use practice in Estonia until recent period, has practically ceased in Estonia in the course of last economical transition. Thanks to the subsidies the grazing of coastal areas was started again in 1996 (Matsalu NR) and since 2000 in several other protected areas.

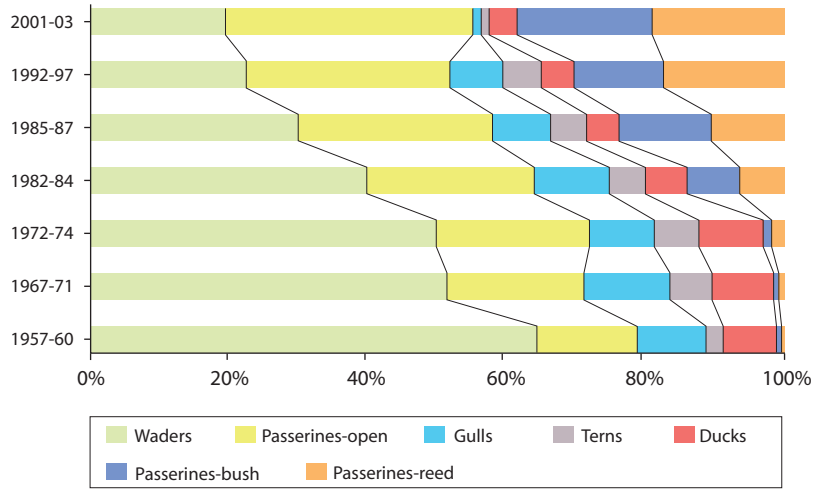


Figure 1.
Changes of proportion of different bird groups in community of coastal meadows of Matsalu Bay (southern coast) in 1957-2003.

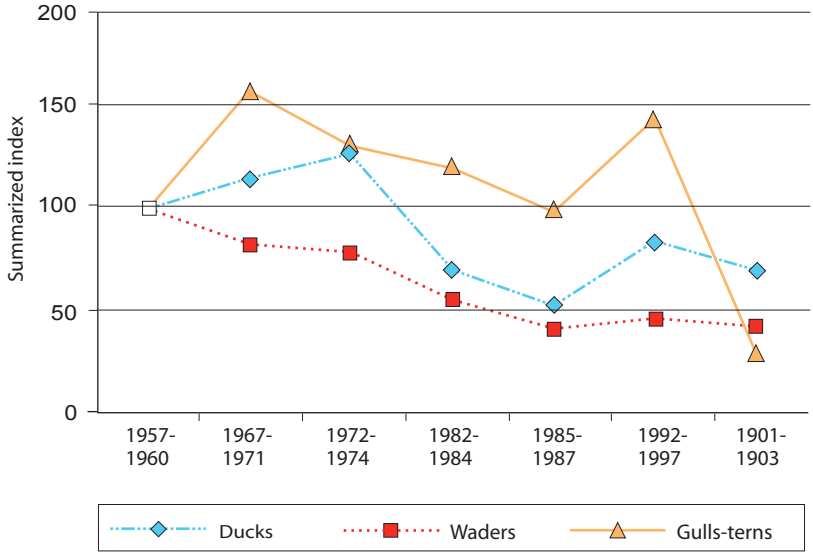


Figure 2.
Breeding bird indices (summarized by systematic groups) of non-passerines derived from transect counts performed in coastal meadows of southern coast of Matsalu Bay in 1957-2003. The index was arbitrarily set at 100 in the first period of survey (average of the period 1957-60).

Material and methods

Matsalu Nature Reserve (1957-2003)

Breeding bird censuses were performed since 1957 in the coastal meadows of Matsalu Bay. The transect counts have been carried out on the southern coast (40 km). The whole project was for longer period interrupted in 1975-1981 and 1988-1991 (Mägi et al., 2004 in press)

Survey is based on simultaneous count by one or two observers, performed twice in breeding season - in the second half of May and the first half of June (Onno 1963). The observer(s) walk along the coastline and register all territorial birds in the joint survey belt with unlimited width (50-600 m, 200 m as average). Calculated "breeding pairs" can be used as population indices as accuracy of this method is estimated to be between 30-80% (Onno 1963). Because of the gaps in the database the analyses is based on averages from seven 3-6 year periods.

Western Estonia 1999-2003

Bird monitoring has been carried out in the West-Estonian coastal meadows in 1999-2003. Altogether 20 plots has been in use with the total size of 1805 ha in 4 counties. In each current year 13-14 permanent plots

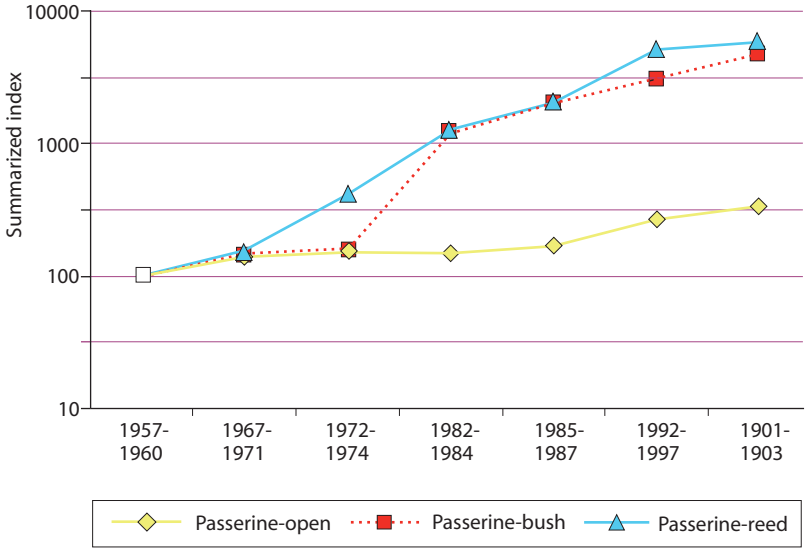


Figure 3.
Breeding bird indices of passerines derived from transect counts performed in coastal meadows of southern coast of Matsalu Bay in 1957-2003. The index was arbitrarily set at 100 in the first period of survey (average of the period 1957-60). Index values are given in log-scale.

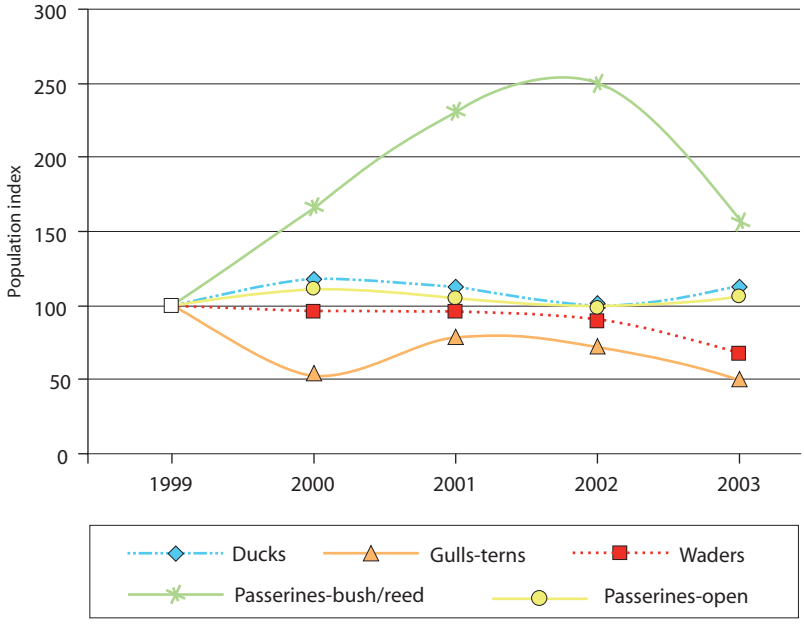


Figure 4.
Breeding bird indices derived from mapping censuses performed in coastal meadows of Western Estonia in 1999-2003. The index was arbitrarily set at 100 in 1999.

have been repeatedly covered (variation of coverage 1136-1353 ha). Plots were set up in meadows with high or medium nature conservation value as evaluated during countrywide inventory of semi-natural meadows in 1993-1995 (Leibak & Lutsar 1996). The modified mapping census of land birds widely used in Swedish coastal meadows (Öland & Gotland islands) was applied (Ottoson et al. 1989). During field work the sampling plot was divided into subareas according to the borders of existing management. Each plot was visited 2-3 times from mid-May until mid-June.

During the survey one to three observers walked simultaneously along the coastline with distance of 100 m from each other as average and registered all territorial birds on map.

Registrations of birds were copied from 2-3 field maps in order to separate clusters of registrations that refer to one pair of breeding pair. In practice, the cluster analysis was used in limited number of cases. As a rule for each species the maximum value of registered territories from visits was taken as a number of breeding pairs.

Changes of meadow bird communities

Changes of bird communities of coastal meadows in relation to habitat change

Long-term monitoring of coastal meadows of Matsalu NR demonstrate following:

1. species composition started to change radically since early 1980s and even recent large-scale attempts to restore habitats and to reverse undesirable decline of endangered bird species (e.g. waders) have not been successful yet (Figure 1);
2. Populations of non-passerine bird species characteristic to open meadows declined in large extent, the decline of waders is the most alarming (Figures 1-2);

3. Numbers of passerines increased dramatically, including 3.4 times in passerines of open meadows and exponential growth of both reed- (since early 1970s) and bush-confined passerines (since early 1980s) (Figures 1 and 3). From this species group the real winners from the overgrowth of meadows are passerines with large ecological amplitude like Reed Bunting *Emberiza schoenobaenus*, Sedge *Warbler Acrocephalus* schoeniclus and Whinchat *Saxicola rubetra*.

Figure 4 illustrates the recent changes of coastal meadow bird populations in wider scale (Western Estonia). Compared with Matsalu data, it is clear that general picture in Estonian coastal meadows is even worse as short-term monitoring has demonstrated rapid decline of several bird groups (gulls, terns and waders). Alarming situation is caused by overall unequal management of meadows. Populations of characteristic breeders (waders, gulls/terns and passerines of open meadow suffered severely in 2002 and 2003, which is partly explained with extreme drought in spring.

Population changes of characteristic species of managed coastal meadows

Waders

Wader species, which prefer to breed on heavily grazed meadows (short-grass waders) have been most sensitive to habitat changes and have shown dramatic long-term decline in numbers (Figure 5).

Future of the populations of the Dunlin *Calidris alpina schinzii* and Ruff *Philomachus pugnax* in Estonia will depend almost exclusively on the continuation of traditional use of semi-natural meadows (Kuresoo et al., 2003, Mägi, 2002). At the same time, the Lapwing *Vanellus vanellus* and Black-tailed Godwit *Limosa limosa* are more plastic in habitat use and re-colonize other biotopes. Figure 6 presents detailed history of the population of the Black-tailed Godwit in Matsalu NR. Besides of decline caused by environmental variables, population processes in 1960s (decline of population due to the high mortality rate in cold winters) and subjective factors (like observer bias), there is a very clear negative trend both on the coastal and floodplain meadows, which is not explainable by mentioned factors only. The crash of the meadow population, documented in mid-1980s in Matsalu does not mean that population is vanished, but rather indicates a major shift of breeders to other habitats. According to monitoring data of bird communities in mires Black-tailed Godwit started its rapid colonization of Western Estonian raised bogs (Lihula, Nätsi, Marimetsa, Kõima, Tuhu etc.) in mid-1980-s as well (A. Leivits pers. comm.).

Wader species, which breed in medium grass and tolerate moderate overgrowth of meadows have been in

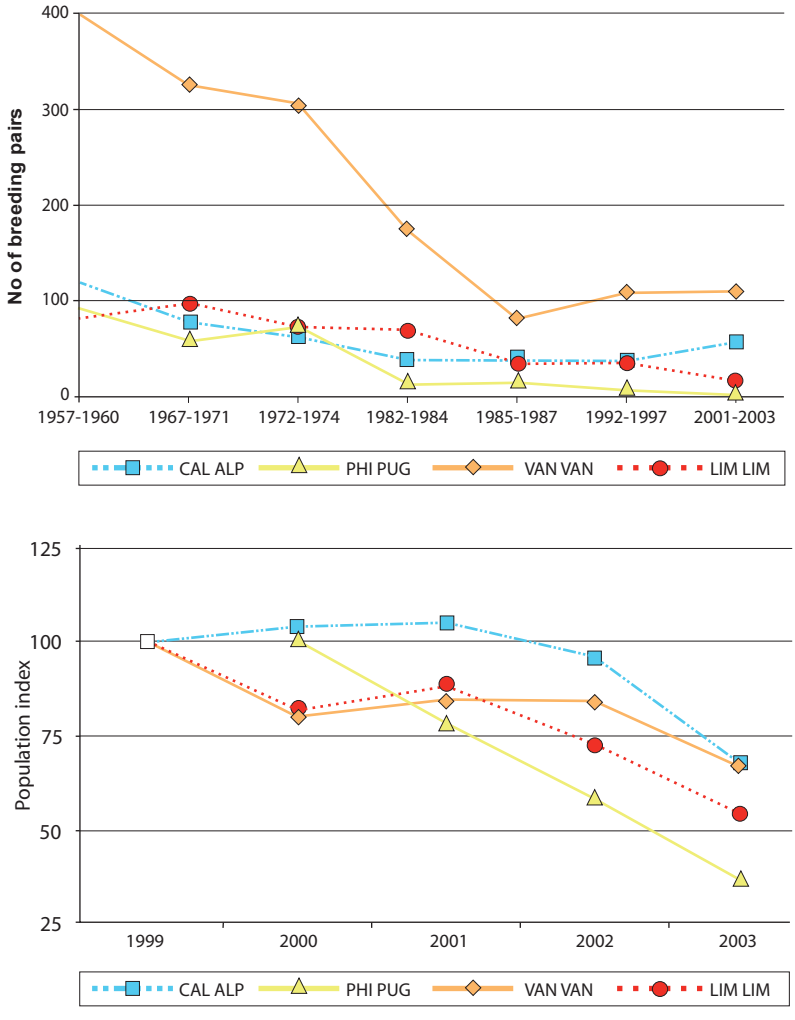


Figure 5.
Changes of numbers of short-grass waders (Lapwing – VANVAN, Dunlin – CALALP, Ruff – PHIPUG, Black-tailed Godwit – LIMLIM) in southern coast of Matsalu Bay in 1957-2003 (upper graph, no. of 'breeding pairs') and in Western Estonia in 1999-2003 (lower graph; population indices).

long-run stable (Figure 5, Matsalu) or even increased in numbers.

Redshank *Tringa totanus*, known having a broad ecological amplitude, has been particularly tolerant to substantial changes in habitat characteristics. It seems to belong to those species, which get even a short-time advantage from rapid overgrowth of meadows (happened in Matsalu in early 1990s), in contrast to the Common Snipe *Gallinago gallinago*, which has been only real winner from habitat changes in the last couple of years.

However, the recent trends of numbers of medium-grass waders in Western Estonia have been negative (Figure 7, W-Estonia), which may indicate on un-tolerable degradation level of the coastal meadows in general. Another reasonable explanation to these trends are extreme droughts in springs of 2002 and 2003, which affected nearly all wader and duck populations (see Figure 5, 7; Western Estonia).

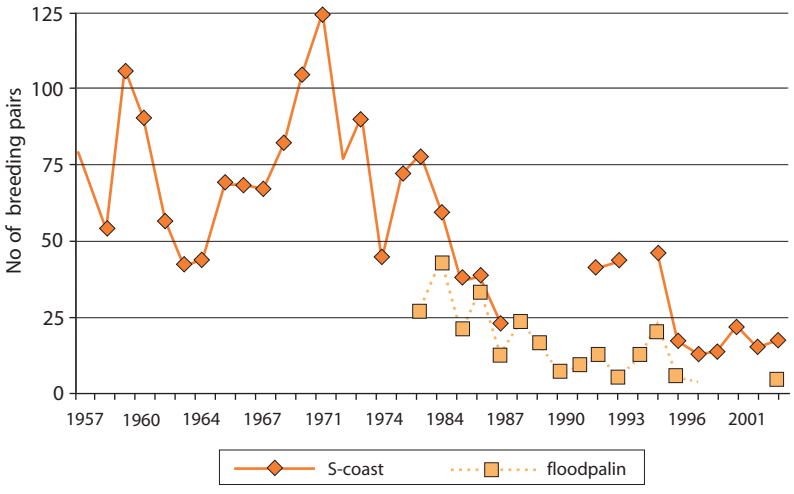


Figure 6.
Changes in numbers of the Black-tailed Godwit Limosa limosa in semi-natural meadows of the Matsalu Nature Reserve in 1957-2003. S-coast - coastal meadow in southern coast of Matsalu Bay; floodplain – floodplain meadows of Kasari River.

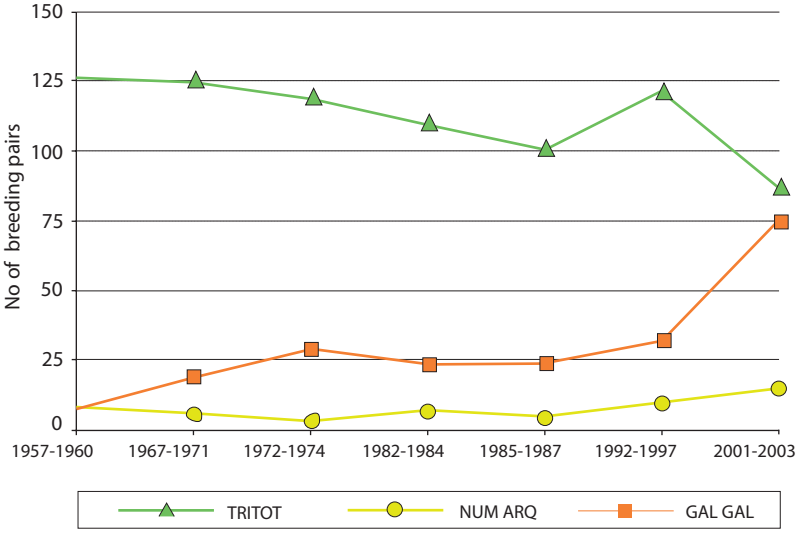


Figure 7.
Changes of numbers of medium-grass waders (Redshank – TRITOT, Curlew – NUMARQ, Common Snipe – GALGAL) in southern coast of Matsalu Bay in 1957-2003 (upper graph, no. of breeding pairs) and in Western Estonia in 1999-2003 (lower graph; population indices).

Ducks

Most sensitive duck species on changes of traditional management are the Pintail *Anas acuta*, Shoveler *A. clypeata* and Garganey *A. querquedula* (Kuresoo et al. 2003) The numbers of breeding Pintails on coastal meadows fell under critical level already in 1980s and due to the shortage of data it is not analyzed here. Although Pintail's key habitat has been historically floodplain meadow, it also breed in higher parts of coastal meadows, in vicinity of wet coastal depressions and lagoons. By now, majority of such habitat patches are overgrown by juniper thickets.

The Garagney tend to abandon small wetland sites, there traditional management (hay-making, grazing) of meadows has been stopped. Short-term trend (1999-2003) of the breeding numbers in Estonian coastal meadows is clearly negative (Figure 8; Estonia). At the same time the breeding numbers are still stable or even increasing in larger wetlands, in particular on those, where management of meadows is subsidised by the government (Figure 8; Matsalu).

The role of coastal meadows as breeding habitat for Shoveler is increased due to the crash of island population. At present, it is still too early to report on recovery of the population in late 1990s, which has actually happened with Garganey's

population in coastal meadows. First signs of improvement of Shoveler's reproduction are noticed in the northern coast of Matsalu Bay. Recent large decline in breeding numbers was observed elsewhere in West-Estonia. The recovery of the Shoveler is seemingly more dependent on removal of extensive reed-belts on the coast compared with the Garganey.

The Mallard Anas platyrhynchos and Gadwall A. strepera are more tolerant to the overgrowth of meadows, but may abandon poorly or unmanaged meadows as well.

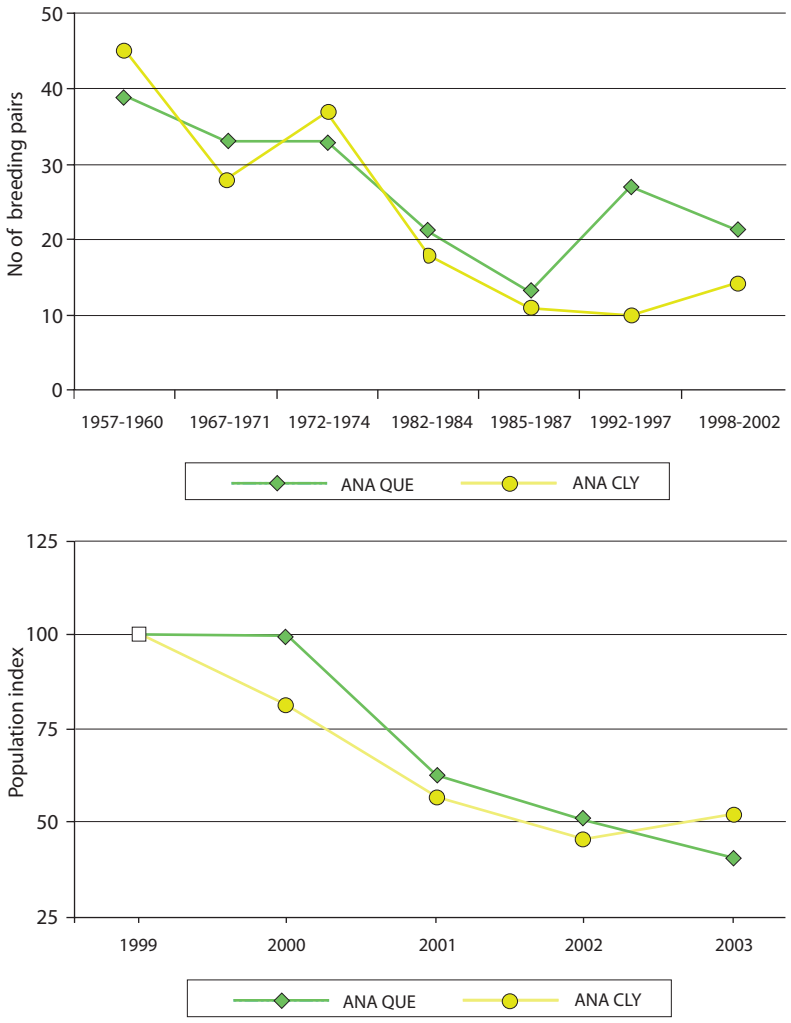


Figure 8.
Changes in numbers of the Garganey (ANAQUE) and Shoveler (ANACLY) in coastal meadows of the Matsalu Nature Reserve in 1957-2003 (upper graph, no of breeding pairs) and in Western Estonia in 1999-2003 (lower graph; population indices).

Causes of long-term changes of numbers of meadow birds in Matsalu NR

a) Environmental variables.

Annual weather variables can effect the whole breeding performance of populations. Most trivially, short-term population trends can be linked to the frequency of severe winters (like European winter 1961/1962; Glutz v. Blotzheim 1975). Moreover, low numbers were explained with bad weather prior to breeding and dramatic spring cold spells (1966, 1988) (Paakspuu 1973). High water level in spring provides more food for waders and causes their peak numbers (Paakspuu, 1974).

Changes in density of ground predators (Red Fox, Racoon Dog) influence numbers of all species. Quick expansion of the Mink Mustela vision in Matsalu was registered in 1980s (Paakspuu, Meriste, 1981). Crash of several waterfowl and wader populations both in coastal and alluvial meadows during the same period may be associated with increased predation and disturbance by the mink.

As a consequence of land uplift (2-3 mm/year) coastal biotopes are moving westwards. Previous favourite breeding grounds are presently far from the sea and overgrown and therefore unsuitable.

b) Population dynamics

of the species over wider range is not analyzed here, but it is obvious that population expansions or reductions are of more general nature for the whole range. For example the Dunlin's population reached its peak national numbers both in Finland and in Estonia just in 1950s (Soikkeli 1967), right before the bird monitoring was started around Matsalu Bay. Several expansive species (Shelduck *Tadorna tadorna*, Gadwall *Anas strepera*, Scarlet Rosefinch *Carpodacus erythrinus*) started to breed on meadows during the study period.

c) Observer/count factors.

Variation in results is partly caused by different observers (Paakspuu, 1972, Mägi et al., 2004 in press). The lower (biased) density of Lapwing was registered also in springs,

Period *	Habitat/management changes	Loosers	Winners
1957-1960	90% from survey area grazed or mowed	Highest densities of waders and ducks typical to coastal meadows recorded	
1967-1971	First changes of habitat (growth of bush)recorded	Dunlin Ruff Pintail	Gulls, ducks
1972-1974	Expansion of reed coverage recorded		Passerine-reed
1982-1987	65 % from survey area grazed or mowed, grazing pressure in decline	Lapwing Black-tailed Godwit Great Ringed Plover Garganey, Shoveler	Passerine-bush
1992-1995	32 % from survey area managed, continuous decrease of grazing animal numbers		Passerine-open, Common Snipe
2001-2003	35 % from survey area managed, increase of patchiness of habitats due to the large variety of management efforts	Redshank Gulls Oystercatcher	Gadwall Dunlin ? Shoveler ?

Lessons from long-term monitoring in Matsalu NR
Changes in management and its effect to the breeding community of coastal meadows (1957-2003, southern coast of Matsalu Bay).

* - Additional comments on the substantial changes of management (Mägi 2002):

1957-1965. Land use was more or less as in pre-war period. Hay was made mostly by hand and by horses, and cattle was kept on the coastal meadows. Only small collective farms (one-village farms) had been created by that time. Coastal meadows and pastures remained similar to the previous period. However, as the result of land uplift, dredging of rivers and continuing draining activities caused the loss of some open water areas in reed-bed.

1970s. Haymaking ceased in coastal meadows, large number of young cattle was released to the meadows by collective farms.

1982-1989. Collective farms were developed and joined several times during last two decades. Big farms were built close to villages, only few small farms were left on the coast. Tractors were used instead of horse- and hand-haymaking. Lots of wet areas were abandoned and they were overgrown by reed and bush. A former most favorite breeding ground, south-eastern coast, was scarcely used as a pasture for young cattle.

1990-1995. The collapse of soviet system reduced number of cattle on coastal meadows in the first half of 1990s. The grazing of coastal areas practically ceased for a couple of years. Only small patches were used by local farmers. The same happened in Kasari meadow - main breeding ground was not mowed at all in 1993-1995.

1996-2003. Thanks to the subsidies the grazing of coastal areas and mowing of Kasari meadow was re-established. However, period of unmanagement took it share and only last few years situation is normalizing

then the warm weather triggered early breeding (Paakspuu, 1975). Bad weather like strong wind (Paakspuu, 1973) affects the performance of the observer as well as that of the birds in the counts.

d) Habitat correlates.
Habitat changes were first mentioned in 1967, when rapid growth of brushwood was named as a factor causing changes in bird fauna in the southern coast (Paakspuu, 1972). The increasing coverage of reed area favoured Crested Grebes *Podiceps cristatus* in early 1970s (Paakspuu, 1974) and reed warblers in early 1980s (Kastepõld, Kastepõld 1990). The same authors describe how the reduction of grazing pressure lead to remarkable local habitat changes in the area monitored in 1982-1987. The coast started to overgrow with junipers (*Juniperus communis*) and alders (*Alnus incana*) and great amount of dead plant material accumulated to the meadows.

Main conclusion: Most of the long-term trends correlate with habitat changes in coastal meadows of

Management action	Positive effect to the breeding bird populations
1. Increase of number of cattle up to some optimal level in large meadow areas; merging small meadow plots; mixed grazing (cattle, sheep and horses)	All characteristic species (excl. Curlew, Common Snipe, Meadow Pipit)
2. Removal of extensive reed-belts from the coastal part of meadows (special breeds of cattle, mechanisms)	Dunlin, Oystercatcher, terns, Ringed-Plover, ducks
3. Haymaking; also in combination with grazing	Ruff, Garganey, Black-tailed Godwit, Yellow Wagtail
4. Management of coastal lagoons and depressions (juniper and bush removal, supported by later grazing)	Pintail, Garganey, Shoveler, Ruff in particular, but several other waders species as well
5. Creation of artificial pools	Similar as 4. , but further monitoring is needed, other endangered vertebrate species
6. Predation control	All species, but not analyzed in current overview

Table 2. Main management actions and possible positive effect of habitat management on breeding bird populations

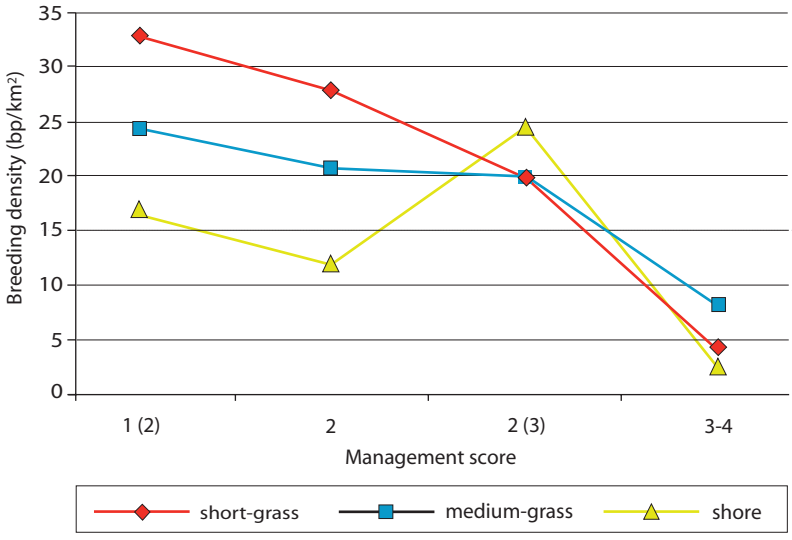


Figure 9. Breeding densities of different wader-groups (11 species grouped as short-grass/see Fig. 5/, medium-grass/see Fig. 7/ and those 4 species, which are not typical meadowbirds – Oystercatcher Haematopus ostralegus, Turnstone Arenaria interpres, Ringed Plover Charadrius hiaticula and Avocet Recurvirostra avocetta) according to the management scores.

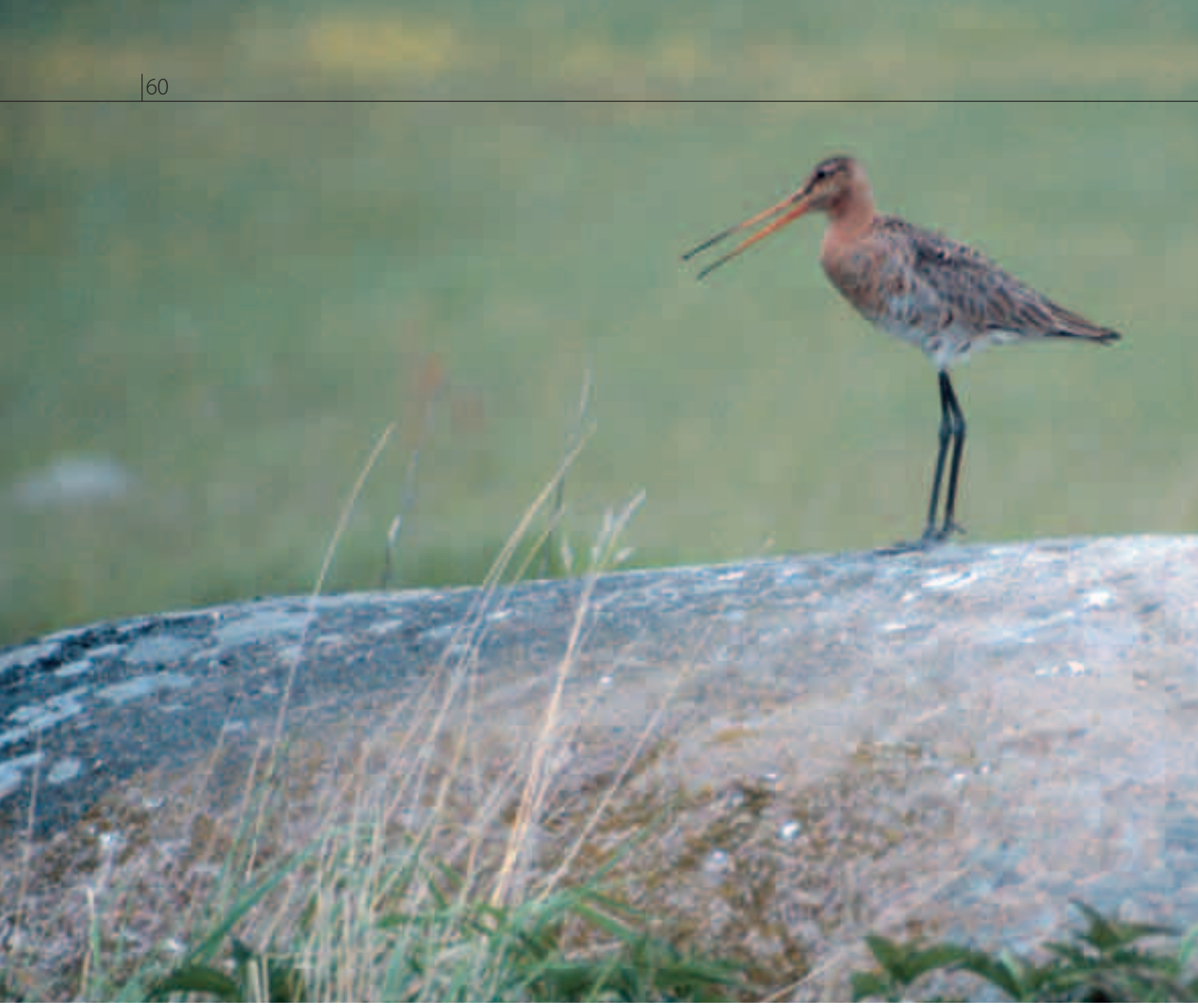
Matsalu, whereas environmental variables cause predominantly short-term effects. Important changes of management practice in coastal meadows of Matsalu Bay in the course of whole monitoring period and recorded notable shifts in bird numbers (loosers, winners) are listed in Table 1.

Management of coastal meadows and changes of bird populations

Relations of habitat management and bird populations are demonstrated in two different ways. The historical approach is summarized in the paragraph 3.1, the comparison of meadow bird communities in the course of the rapid succession process (late 1990s) is given in the paragraph 3.2.

3.2 Comparison of breeding densities of waders in Western Estonian coastal meadows in 1999

An attempt to evaluate the population densities of waders in relation to management was made in Western

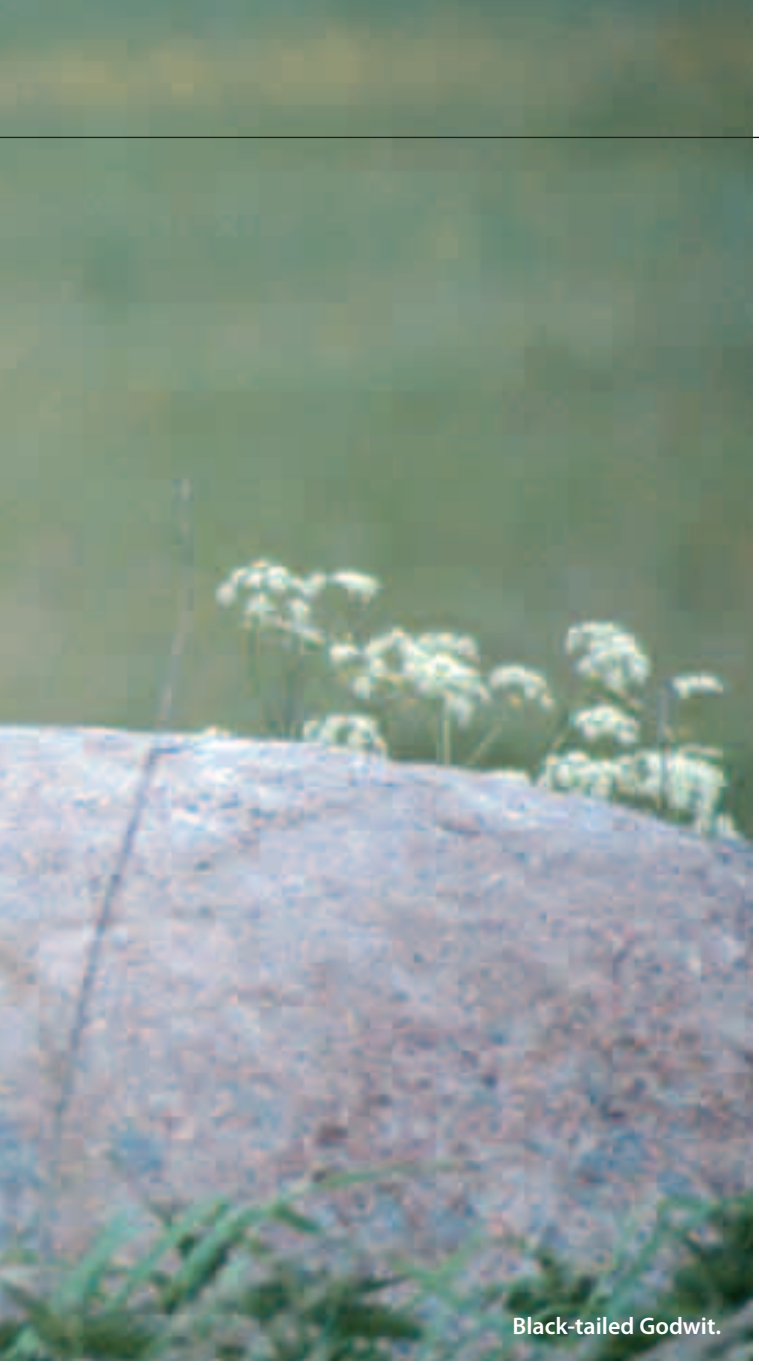


Estonian meadows in 1999.The evaluation of management scores (1-4) on each meadow plot was carried out as follows (Ottoson et al. 1989):

1. Well managed – crazing (mowing) sufficient to avoid dead grass, bushes and trees;
2. Temporarily managed - crazing (mowing) is regularly carried out, but dead grass and bushes start to expand;
3 Poorly managed – dead grass cover most of the meadow and bushes and trees are frequent;
4 Unmanaged – the whole area is full of dead grass; fences are broken or taken off; high bushes and trees are common all over area and nobody is cutting them any more.

As a rule different management scores were recorded within the single study plot, which means that management was in practice rather characterized as mixed – for example the score 1(2) means well managed areas, which have been long used as a good pasture, but due to the recent decline of grazing animals numbers, first patches of bush, reed or dead grass appear to the high parts of the plot etc. All together 20 plots with the total area of 1652 ha were surveyed. Different management types were represented quite equally – score 1(2) with 31%, score 2 with 27%, scores 2(3) and 3-4 both with 21 % from the total area.

3.3. On requirements and recommendations of restoring bird communities of coastal meadows (tab 2).



Black-tailed Godwit.

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Summary

Most of the long-term trends of breeding birds correlate with habitat changes (management, uplift of land) in coastal meadows of Matsalu, whereas other environmental variables like climate cause predominantly short-term effects.

From the species characteristic to the coastal meadows the short-grass waders (Dunlin, Ruff, Lapwing and Black-tailed Godwit) and ducks (Pintail, Shoveler, Garganey) are most sensitive to the changes of management. Medium-grass wader species (Redshank, Curlew) and several ducks (Mallard, Gadwall) are more tolerant to these changes, but may abandon poorly or unmanaged meadows as well. From this group only Common Snipe may get short-time advantage from overgrowth of meadows. Breeding densities of waders using as a rule unvegetated parts of the coasts (Oystercatcher, Ringed Plover, Avocet, Turnstone) are less dependent on the meadow management. However, their numbers on abandoned meadows tend to decline as well due to the indirect reasons such as the rise of predation in the coast and the collapse of the vital breeding community of birds close-by with following loss of joint protection against predators, provided by several aggressive wader, gull and tern species.

Real winners from the overgrowth of meadows are passerines inhabiting reed and bush, in particular the species with large ecological amplitude like Reed Bunting Sedge Warbler and Whinchat.

Coastal meadow management from a botanist's point of view

TIIT KALJUSTE

Matsalu Nature Reserve is home to the most extensive coastal meadows in Estonia, surrounding Matsalu Bay as a sometimes narrower, sometimes wider stretch. Considering that a coastal meadow is generally bordered by the sea and covered with meadow vegetation, the Matsalu Bay area boasts with ca 2500 ha of similar communities. This area includes flooded (saline) communities, suprasaline marsh meadows, transitional areas to dry alvars, as well as completely dry alvars.

1)Saline zone –

area influenced by salty seawater. This part of the coast can in its turn be divided into various subzones. One of the most extensive and valuable ones is the low vegetation area of salt mud rush (*Juncus gerardii*), with creeping bentgrass (*Agrostis stolonifera*) as co-dominant. While the community itself is poor in species (less than 10 species/ m2), its value derives from its large area, which attracts great bird swarms. Cattle prefer the saline zone with open beach, where the high tide remains only for short periods. The plants of this community (salt mud rush, seabeach sandwort, seaside plantain, sea arrow-grass, etc.) are meatier and with higher feed value.

The coastline of several shady beaches is covered with reed. Although fresh reed shoots make for good fodder, reed is still a great problem for flooded coastal meadows. The high tide water breaks through the reed and becomes filtrated; as a result the coastal meadow is left with water poor in nutrients. Meadow plants wither and the watery and low in nutrients (mainly in nitrogen) meadow begins to grow over with reed and moss. The cattle tend to avoid such areas.

In places this zone features salines – areas with unique and sparse vegetation (common glasswort, annual seablite). As the existence of these areas is namely related to floods of salty water, it is important to keep the coastline free of reed. Salines are at the same time extremely sensitive to grazing, which is why grazing should be avoided in these areas.

A typical saline zone is of such a young age that its crust has not fully developed yet. There is no danger of growing over with brushwood, as the trees and bushes cannot tolerate salty soil.

2) Suprasaline zone

may be quite narrow due to relief, but it may also reach a width of hundreds of metres in places. In the latter case, the area is of low value in terms of vegetation, as well as difficult to graze (the cattle tend to abandon the area).

The grass layer is relatively high and dense, often suffering from excessive humidity and sods. The number of species per square metre usually reaches 15; grass layer coverage is more than 80%.

A typical suprasaline area is covered with sods of purple moor grass, which constitute ¾ of the grass layer. Red fescue, common sedge and downy-fruited sedge are

Sea milkwort.

present in larger numbers as well. Cattle avoid this area, tend to desert it and only take some bites when passing through. Sodding cannot thus be blamed on animals – it is the way the plants grow. Treading among the sods only makes them more edgy. The threat of growing over is moderate.

The transitional area between the suprasaline zone and a drier community may turn out to be surprisingly rich-in-species, with 30-40 species per square metre, which include species characteristic of wetter communities as well as those of drier ones (ecotone).

3) Alvar –

a dry calcareous community with specific vegetation. Plants are often low, covered with hairs or a wax layer, and leaves in a radical rosette. The area is very rich-in-species (ca 30 species/m^2), as one area unit accommodates numerous specimens. There is a great danger of growing over (with junipers, alders, and pines in the rest of Western Estonia). Cattle, especially sheep enjoy the area. Plants may face a lack of water and nutrients.

History

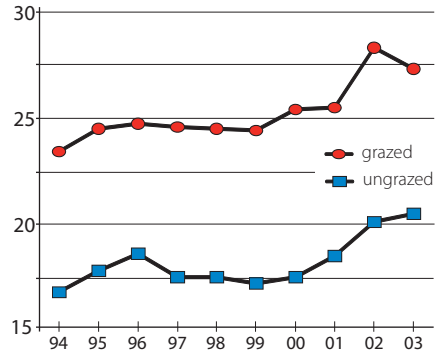
The grasslands surrounding Matsalu Bay originated as a result of soil elevation and constant grazing. It can only be assumed as to how long, where and how intensely these areas have been grazed. The coastal meadows of Matsalu were used most extensively and intensely in the first half of the 20th century. The experts say that the highlight of the variety of plant and other species in the area was reached during the final decades of the 19th century.

As many farms ceased to exist during and after the Second World War, the number of cattle diminished considerably. Many farmlands and natural grasslands fell out of use. Cultivating the soil was restarted with the arrival of collective farms, concentrating on mass production this time around. Thus the emphasis shifted from natural grasslands to cultivated grasslands, and the more fertile coastal areas underwent drainage. Cattle were concentrated into ever-increasing farms and small farmers faced extinction. The total amount of cattle (bovines, horses, sheep) largely remained constant in Estonia until the 1980's, when the boom of large bovine farms hit Estonia. Changes nevertheless occurred in the structure of cattle: the number of bovines almost tripled in the period of 1950-1984, while the number of sheep

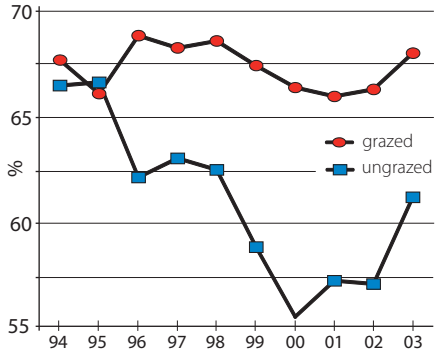
diminished by almost two times and the previously large number of horses almost shrank up. The significance of the private sector diminished constantly, so that by 1984 the bovines of small farmers constituted only 13% of their total amount. This explains as to why the less productive coastal grasslands fell out of use and the cattle moved on to more productive cultivated grasslands.

Despite these changes, grazing in the coastal areas surrounding Matsalu Bay could be considered satisfactory until the beginning of the 1980's, while the end of the decade witnessed a rapid decline, taking into account the political turmoil of that period. If the territories of the current Matsalu National Park boasted with more than 2000 bovines (only a small fraction grazed on coastal meadows) in the middle of the 1980's, their numbers had dropped three to four times by the beginning of the 1990's. By 1994, grazing on coastal meadows had ceased almost completely. The size of the cattle managing coastal meadows kept on decreasing until the years 1998-1999, despite the fact that the compensations mechanism had entered into force already in 1996.

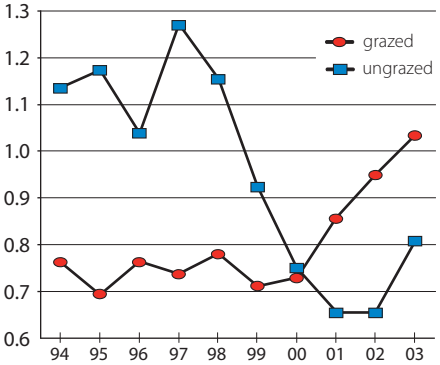
Certain positive tendencies in coastal meadow management emerged in the year 2000. The number of cattle was increased on many coastal meadows and grazed areas were expanded. While bovines have constituted the main cattle, horses, sheep and some goats have also been used. Purchasing beef cattle that graze on coastal meadows all year round (Scottish Highland Cattle, Herefords) has been the main trend of recent years. Coastal grasslands have not been mowed due to rocky soil.



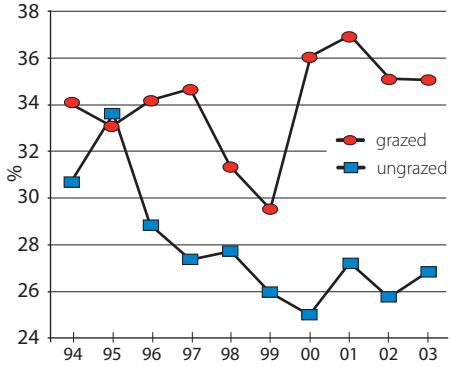
The number of species has increased by *ca* 15% both in grazed and ungrazed squares.



General grass layer coverage in grazed and ungrazed squares



Changes in the coverage of Leguminosae in grazed and ungrazed areas



Gramineae coverage in grazed and ungrazed test squares

Coastal meadow at Pagarand, Matsalu NR.

Special characteristics of natural grasslands

Natural grasslands can be distinguished from cultivated grasslands on the basis of the following characteristics:

1. less productive;
2. grass layer is more uneven;
3. grass community with a great variety of species, more leaved forbs (in contrast, cultivated grasslands only have sown leaved forbs (clovers, etc.));
4. delayed vegetation period;
5. natural sources of drinking water (brackish seawater);
6. existence of trees and bushes (shelter from the wind);
7. less vulnerable to trampling;
8. grass is eaten more unevenly.

The purpose of grazing from the biological point of view is to increase and preserve the variety of species on coastal meadows. This concerns plants, insects, soil biota, as well as birds nesting/resting on coastal meadows. Everything is interconnected, with low grass as the combining link. All else depends on this to a smaller or larger extent.

From an economic standpoint, grazing animals on coastal grasslands is less profitable and farmers are thus in need of compensations. However, activating and maintaining a coastal grassland requires less investments than founding a cultivated grassland.

Changes in vegetation

Vegetation monitoring was launched in 1994 in order to gain feedback on the results of the management plan introduced in the same year. Thirty test squares ($1m^2$) were placed randomly on coastal meadows and thereafter monitored once a year.

A period of eleven years is long enough to explore changes in vegetation, particularly in the conditions of vary-

Birds-eye Primrose.

Reed burning.

ing grazing pressure. Vegetation changes take place slowly, and secondary and random factors (subjectivity of observers, weather, etc.) may have a great impact on the result.

While the greatest changes took place on coastal meadows where management had ceased, alterations were also observed in the vegetation of areas that were constantly grazed. The first changes occurred in the quantitative make-up of species. While changes in the types of species take longer to occur, changes in quantities due to the disappearance or emergence of some external factors (grazing) take place more rapidly.

The number of species in grazed and ungrazed squares

The average number of species in ungrazed squares was 17-18, in grazed squares the same number was 24-25, which is 40% more than in the ungrazed squares. Nevertheless, this tendency cannot be considered a direct result of grazing, as communities with a smaller variety of species have traditionally been less suitable for grazing – they have contained either too many sods or too much water.

This can only be explained by the fact that all the species that were initially unregistered have been finally located. The more considerable increase that took place in 2002-2003 in the number of species in squares that had been constantly grazed was due to intensified grazing. At the same time, grazing was restarted in areas that had long been ungrazed, resulting in an increase in the number of species there as well.

General coverage has remained at the same level in constantly grazed squares, while decreasing in ungrazed squares until the year 2000, when the re-introduction of grazing brought about a stable increase. The principal factor decreasing coverage has been the emergence of foggage. Production numbers are also in decline, but the monitoring did not target this aspect.

Impact of grazing on vegetation

The impact of grazing can be direct or indirect. As insufficient grazing constitutes the main problem in Estonia, the negative aspects of excessive grazing are not discussed here.

Direct impacts include the eating of plants, trampling and fertilising, while the disappearance of foggage, the community becoming drier and the changes in vegetation that in their turn influence insect and bird communities can be considered an indirect impact.

The uniqueness of grazing lies in preferring certain plant species or groups to others. As some species bloom before cattle are released to pasture, they are less sensitive to grazing. Certain species resist grazing better than others; species with a radical rosette or of short length have an advantage for example. Whatever the situation, the cattle are unable to eat, even with an average (optimum) grazing pressure, so many *Gramineae* or sedges that it would radically decrease their coverage. Tall, leaved plants with one upright stem that bloom in the second half of the summer constitute the only exception to this rule, as they are unable to develop a sufficient amount of offsets in dry conditions.

Anemone.

The number of species in a grazed community may increase even by a third. The changes take place slowly and can be identified with the help of detailed research. Some species will disappear (protected species included) if special measures are not taken to protect them.

Preferences of cattle

1) Cattle prefer higher and drier, as well as waterside areas. Sodded areas (e.g. those of purple moor grass sods) are generally used only for passing through. The area between a saline coastal meadow and a drier alvar (suprasaline zone and the excessively wet concavities between coastal banks) is usually insufficiently grazed. While sheep prefer a drier community and shorter grass, cows settle for wetter communities and taller vegetation. Horses enjoy *Gramineae* and trample more. The advantage of Scottish Highland Cattle lies in their ability to graze all year round, which increases their efficiency in coastal meadow management.

Although the various types of cattle have their own preferences in taste, they are able to learn from their fellow animals as well as from other species feeding on the pasture. Thus, combined grazing yields the most stable results.

2) The cattle's undisputed favourites are juicy leaved forbs, primarily Leguminosae (tares, sweet peas, clovers, *Astragalus*, deervetch). Despite being constantly "trimmed", the numbers of *Leguminosae* grow with the increase of grazing pressure. The introduction of nitrogen into circulation plays an important role here, as nitrogen deficiency hinders the distribution of *Leguminosae* on coastal meadows. Nitrogen from air bound by *Rhizobacteria* constitutes a mere 10% of the nitrogen circulation of *Leguminosae*.

3)As there are not enough *Leguminosae* to satisfy all cattle, the next preferences are *Gramineae* and sedges, such as blue moor grass, sheep's fescue, red fescue, creeping bentgrass, quaking grass and downy-fruited sedge. Purple moor grass is eaten when there is not anything else left. If the percentage of *Gramineae* in all communities was 32-33 back in 1994-1995, ten years later the difference of *Gramineae* coverage in the two different communities has increased up to 8% (35% in grazed and 27% in ungrazed communities).

Grazing makes communities drier, as the foggage layer preventing evaporation has disappeared and the soil is better exposed. As a result, many plant species that prefer humidity, but also endure dryness are in decline or disappear completely from drier alvars (glaucous sedge, downy-fruited sedge, red fescue).

It is hard to make any recommendations concerning grazing pressure, as the more productive meadow

sections (e.g. sodded purple moor grass meadows) might not be to the cattle's liking. Dry alvars with modest vegetation on the other hand are the cattle's favourite and there grass is often trimmed totally down.

Coastal meadow restoration

Bush cutting

Tree and bush layer constitutes one of the components of natural pastures. Single trees and bushes diversify the landscape and increase the variety of species. They also provide shade to cattle.

While intensive grazing prevents the emergence of new scrub, the trees and bushes that have already grown tall must be eliminated by hand. Some sheep breeds feed on junipers as well, but they are able to reach the height of 90-100 cm.

In case unwanted bushes have appeared on a coastal meadow, it should first be determined whether there is any of the meadow vegetation left under the bushes and trees. If that is the case, eliminating bushes will be easier and meadow vegetation will recover quickly. If on the contrary, the bush and tree layer is already so thick that the base vegetation has grown sparse and no longer resembles that of meadow vegetation, the scrub should be eliminated step by step. The cut bushes should generally be removed or burnt. When eliminating deciduous trees and bushes, large quantities of roots die, thereby releasing stored-up nitrogen. This brings about the proliferation of various nitrogen-friendly pioneer species despite the fact

Common Tansy.

that the seeds of meadow plants remain stored up in the ground for decades.

Cleaning coastal meadows of juniperous overgrowth is a separate problem. The most effective repellent for small junipers is the springtime foggage burning, whereafter the bare stumps should be removed with bush cutters. A burnt stump will remain on a coastal meadow for at least 10-15 years.

Meadow vegetation under large junipers disappears completely and the vegetation that emerges after clear cutting bears no resemblance to the original meadow vegetation. That is why junipers should be cut step by step. As junipers are of high recreational value, larger junipers could be formed into tree-like shapes. A penumbral environment allows for the re-emergence of grassy vegetation with a smaller variety of species than an open landscape, which is at the same time more productive.

Burning foggage

Burning foggage can be a part of initiating coastal meadow restoration or an emergency management measure in the absence of necessary grazing pressure. Damage to nature is minimised when foggage is burnt when the ground is still frozen. Foggage burning has been conducted on the Matsalu coastal meadow on a couple of occasions. Observations indicated that the impact of the

Restored coastal meadow.

procedure lasted up to three years on the alvar previously under sever foggage. By the fourth year the area was again covered with considerable foggage, creating the need to repeat the procedure. The species make-up did not indicate any changes brought on by the burning procedure. Foggage was also burnt on a sodded meadow of purple moor grass. The line between the unburnt and the burnt section was visible in the summer, and the purple moor grass might have shown some indications of better growth. The sod edges had become sharper as a result of burning. When the squares were inspected in the autumn, the species make-up did not appear to have had undergone any changes.

What was surprising though was the arrival of migratory birds (geese) to the burnt coastal meadow. The fresh juicy grass was now more available. It could thus be concluded that the better coastal meadows are managed the more migratory birds find their way there and abandon fields, which significantly reduces damages to farmers.

Avoiding reed overgrowth

Reed overgrowth constitutes one of the main problems of unmanaged coastal meadows. The potential of reed overgrowth is greater on shady beaches, where sediments form and dead algae and macrophytes tend to wash up. A part of Matsalu Bay – the sparse beach reeds by the Salmi back-water transformed into a dense thicket in two years after grazing ceased in the area in 1995. The thicket rapidly expanded towards the mainland during the next four years and then stopped. It developed freely only within the area that rhizomes had invaded. Further expansion takes place on the expense of rhizome growth, which is ca 1 metre a year according to literature. New reed growth may occur in the inland as well, which speeds up general overgrowth in the area.

Beef cattle can easily do away with sparser reed located on the mainland in narrow zones, provided that grazing pressure is sufficient. The efficiency is the highest when cattle eat the young offshoots at springtime. Reed that grows in the water cannot be removed with the help of cattle. The only feasible solution is smashing the rhizomes. The reed rhizome is relatively fragile and breaks easily in the soft mud under tractor wheels. With this procedure reed growth will be obstructed for years.

Conclusion

It is a general rule that the restoration of an area that once was grazed takes as much time as has passed since grazing ceased. While the aspect and species make-up of a community may be restored faster, it takes more time to achieve the quantitative similarity (quantities of species in appropriate proportions) and to restore the biota dependant on local vegetation.

It takes up to 50 years to transform an overgrown area into a stable meadow community with a large variety of species with the help of grazing (provided that trees and bushes are removed first). In case a part of the previous meadow community has been preserved, the number of species should be increased by 50% at the least. If meadow vegetation is non-existent, it should at first be created, which might prolong the restoration process even more.

Short-term grazing on a coastal meadow does not yield positive results. It might even cause harm, as the plants suffering from nitrogen deficiency may start to flourish the next year and generate more foggage in the coming years.

Monitoring the Wild gladiolus (*Gladiolus imbricatus*) population under different meadow management regimes

MARIKA KOSE, MARI MOORA

Typical view of the coastal meadow and its Wild gladiolus population in a section grazed by sheep after the gladiolus has flowered. This method prevents the meadow from overgrowing but enables the seeds of tall grasses, including the Wild gladiolus to ripen. Sheep appear to be good distributors of seeds.

Introduction

Coastal meadow management and restoration for nature conservation purposes has been in most cases initiated by ornithologists. Therefore meadow management regulations have first and foremost been adapted for bird conservation purposes. The other main targets in Estonia have been amphibians, especially the Natterjack toad and its re-introduction onto the well-grazed coastal meadows. The botanical value of coastal meadows has been also recognised. The main assets are saline and suprasaline plant communities, only found on coastal habitats. The species list of the coastal meadows is not usually very long but several orchid and sedge species make it more significant.

Conditions in the study area

On Häädemeeste coastal meadow the conditions for coastal meadow vegetation are not typical. The area, south from Pärnu, is not calcareous like most coastal meadows in Western and Northern Estonia. Here the soil is sandy with clay stripes in between. The area is flat and meadows sometimes extend to 2 kilometres from the shoreline still flooded by seawater at least once a year. The nutrient rich and relatively moist soils provide typical coastal meadow vegetation but in addition many features of the floodplain are present. The grass grows thicker and higher, giving relatively more biomass than on limestone. Some floodplain species, including the Wild gladiolus are also very numerous here.

The material and method

The area has been recognised as the biggest Wild gladiolus population in Estonia and according to the oral data of many botanists, the biggest in Europe. When starting with intensive coastal meadow restoration works during the LIFE-Nature project (see article on page 86) we had the hypothesis that the Wild gladiolus and other tall perennial herbs do not prefer the very same conditions as the coastal meadow birds do.

Therefore we tried to find the areas with all possible different management regimes and establish a long term monitoring system there.

In 2002, four areas with different management regimes were chosen: grazed by cattle, grazed by sheep, mown and not managed. Two sampling areas (about 20x20 m) were identified in each area. 10 squares (1x1m) were randomly created in every area. All Gladiolus shoots were counted, divided into three classes: juveniles (1 leaf), prematures (2 leaves) and generatives (shoot with flowers). Animal eating as well as plant species in and around squares was registered. In 2004, one section grazed by sheep was not managed in the same way as in previous years, and a new sheep grazed area was added. In addition to the four previous categories a fifth was added: sheep grazing with subsequent mowing.

Results and discussion

1. While the total number of gladiolus shoots has

increased during the past three years, in grazed areas the number has remained the same as in 2002.

2. The increase in the total number is the result of an increase in the number of juveniles. That may be due to wet summers, but as the increase is ten times bigger in the mown area than in other places, the weather cannot be the main reason here (see figure 1).
3. Although grazing as a means for keeping the meadows open is necessary, it is not favourable for gladioluses in the long term. The numbers have not increased, and a reducing trend can be expected instead. That is because fewer specimens can develop to flowers and seeds.
4. Sheep are selective gladiolus eaters and damage shoots more than cattle (see figure 2).
5. Changing the management scheme from a sheep pasture to a mown meadow increased significantly the number of juveniles as well as flowering shoots (see figure 3). This supports the idea of complex management of plant communities with tall herbs, when some years have less pressure than others or when in some years the areas are only mown.

Recommendations for further management

When planning the management of meadow communities with vegetational value, particularly communities with flowering perennial tall herbs, some aspects must be considered: all means that keep meadows from overgrowing with trees are good in the long run.

Figure 1. Mean number of herbivore damaged plants under sheep and cattle grazing in Häädemeeste coastal meadow over three successive years.

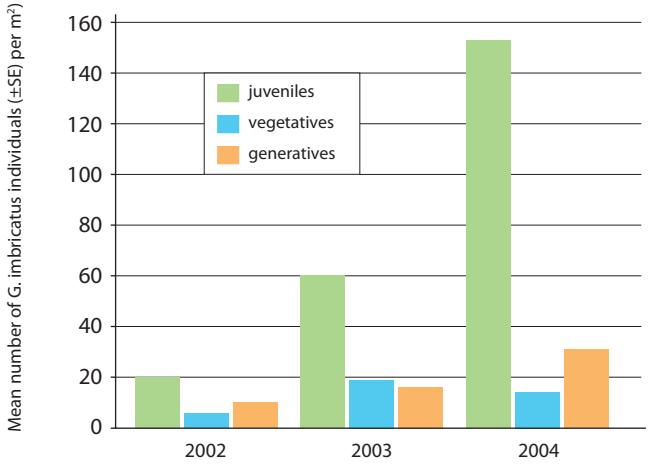


Figure 2. Mean number of Gladiolus imbricatus juvenile, vegatative premature, and generative individuals under sheep grazing (2002) followed by mowing (2003 and 2004). Bars with different letters are significantly different to the Tukey HSD test.

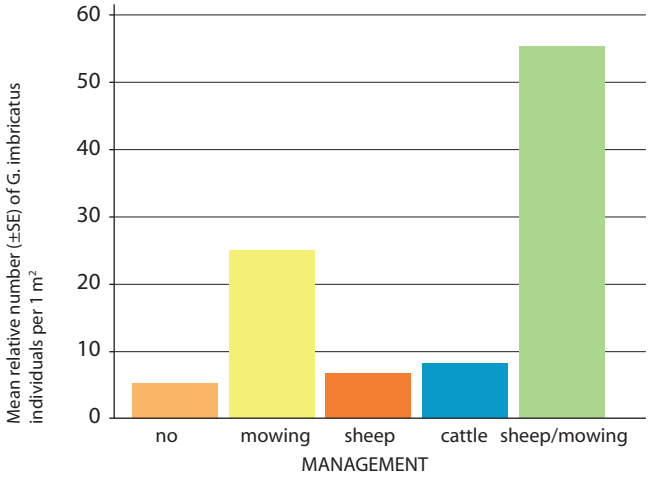


Figure 3. Mean number of Gladiolus imbricatus individuals per m2 under different management at Häädemeeste coastal meadow.

The socio-economic aspect of coastal meadow management:
the Matsalu example

KAJA LOTMAN

The Matsalu coastal meadows originated as a result of the constant grazing of the coastline, which is ever-receding due to land elevation; they thus constitute both primary and semi-natural communities. Their preservation consequently requires constant grazing (or mowing).

The need for pastures and meadows played a crucial role in the formation of semi-natural communities. For thousands of years, the exploitation of meadows remained largely sustainable both in the ecological and the economic sense. As agriculture intensified, the situation changed – the meadows were either turned into fields and cultivated grasslands or were simply left out of use. Sustainable exploitation of meadows without subsidies is no longer profitable in today's Europe. The reason lies in the unnatural structure of contemporary agriculture, which is the product of decades of artificial intensification. Making the sustainable usage of meadows profitable

without subsidies is even more difficult in Estonia, as the agriculture here hovers on the verge of extinction after the market was unilaterally opened.

Although Eerik Kumari, the founder of Matsalu Nature Reserve, already expressed the need to continue grazing on coastal meadows as a part of their management, it is not an exaggeration to state that coastal meadow protection as we know it was initiated after Estonia regained its independence. Agricultural hardships brought on by the radical shift to market economy increased significantly the dangers caused by ceased grazing and mowing (while the problems inherent in the Soviet mass agriculture disappeared). It became necessary to provide assistance to farmers implementing coastal meadow grazing. The Matsalu wetland management plan approved in 1994 stated the need to enter into contracts with farmers in order to secure grazing and mowing on meadows. The funds for concluding the contracts stipulated in the management plan were for the first time included in the State Budget in 1996. That year can be considered the beginning of contemporary meadow management in Estonia.

The system for concluding meadow management contracts was elaborated on the basis of the one used in Sweden prior to the accession into the European Union. If grazing was employed, the farmer was paid on the basis of the number of grazing days, and the number of hectares, if mowing was employed. As the first payments were rather modest, they have been revised repeatedly. A manner of meadow management similar to that of Matsalu was soon adopted in other protected areas involved in meadow protection.

A uniform meadow management system was introduced in Estonia in 2001, and it complies with the EU rural development regulation. Pursuant to this, the funding of the management of any kind of meadows is based on the number of hectares managed, irrespective of whether the areas are mowed or grazed. The funding rate on coastal meadows is 64 euros per ha. In the years 2001, 2002 and 2003 the managers of Matsalu coastal meadows (farmers, agricultural private limited companies, private persons and non-profit organisations) were paid more than one hundred thousand euros. While in the first year, the payments were effectuated on the basis of a directive issued by the Minister of Environment; this practice was replaced in 2002 by the issuing of the Minister's regulation.

The parties involved in coastal meadow management can basically be divided into three groups:

1) undertakings with agriculture as their primary activity (45%)
2) persons with agriculture as their subsidiary activity (37%)
3) persons (landowners) whose purpose is the preservation and restoration of scenic landscape (18%).

The subsidies awarded to agricultural undertakings operating in the Matsalu wetland are an incentive to use coastal meadows even if the amount of cultivated grasslands is sufficient. Agricultural undertakings located further away find it sensible to bring their animals to the Matsalu wetland coastal meadow only if there is a lack of pastures in their own area. In such a case subsidies help to compensate for transportation costs. Coastal meadow management compensations might prove to be a decisive factor for a retired person with maybe a couple of cows, who is hesitating whether to continue or give up keeping animals.

The subsidies, particularly the ones paid before 2001, managed to attract farmers and help them cope with the running costs of keeping cattle. These subsidies have not however enabled the farmers to carry out all the necessary investments. This is where several projects have stepped in by facilitating the necessary investments, providing livestock, electric fences and equipment. The providers of foreign subsidies include the EECONET Action Fund, the Swedish WWF, SIDA and EU LIFE-Nature. The WWF and SIDA Väinameri project stands out, as it puts a special emphasis on the socio-economic aspect of coastal meadow management, concentrating on educating farmers and marketing in addition to purchasing livestock and equipment. The activities also include the development of handicraft and tourism-related products and improving the administrative capacity of local governments, which all contribute indirectly to the management of coastal meadows.

As a result of the executed development and projects the number of sheep and cattle has almost doubled compared to 1996 despite the general degeneration of Estonian agriculture. In 2003, 1341,750 ha of coastal meadows were managed in Matsalu under the compensation agreements.

In order for Matsalu to be able to provide a stable resting and nesting place for birds and living conditions for the natterjack toad, the area of managed coastal meadows and the number of livestock should increase without a doubt. The restoration of coastal meadows definitely requires more funds than the current 64 euros per ha. This amount is also losing its value in the current conditions of a general increase in prices.

The payment of coastal meadow management compensations is currently implemented by the Ministry of Environment, which is not the general practice in EU member countries. After having joined the European Union, it is recommended to carry out most of these activities in the framework of the agricultural environment programme (i.e. under the Ministry of Agriculture), in order to facilitate the use of EU agricultural refunds; this need has also been taken into account in the rural development plan. It is at the same time evident that it is not realistic to transfer the entire funding to the Ministry of Agriculture: unclear land ownership or the legal status of a meadow manager often stands in the way of concluding an appropriate contract. Declaring all coastal meadows as agricultural land on time, which is the precondition for granting area-related aid, is also problematic. It is therefore imperative that both the Ministry of Environment and the Ministry of Agriculture take part in future coastal meadow management. If the current tendencies persist, it is unlikely that coastal meadow management could be profitable without the necessary financial aid.

Managing meadows or managing people? Coastal meadow restoration and management in the Häädemeeste region

MARIKA KOSE, MATI KOSE, AIVO KLEIN

Situation on coastal meadows

Reed expansion

The coastal zone of South-Western Estonia has historically been used as pastures and hay-meadows. As the area eastward from the coast, behind the dunes was covered with wet forests and bogs, most of the population in the region had centred on the coast. Changes in state governments, land ownership and land use policies that took place over the last century had the same effect on the Häädemeeste meadows as on any other region in Estonia. Collectivisation changed the structure and intensity of land use in the 1940-50's; single cow owners had to use marginal parts of the pastures. Since the 1960's, many large land units were only used as hay meadows or not used at all in good hay years.

Period of large-scale collective farming 1965-1999

At the beginning of the 1990's the number of collective farm cows reduced quickly and the numbers of single cows in farms started to decline as well. At the time of the inventory in 1994 the larger meadow massifs were open and with low grass. When the LIFE-project started in august 2001, high reed was almost everywhere, as the year 2000 had been the first year without any activities in the coastal area.

Machinery and animals available

When the LIFE-project began, only one agricultural enterprise existed in the Häädemeeste region. That was a local re-organised collective farm with outdated tractors and other agricultural machines, all quite old. The existing milk cattle had been taken to inland fields and a large number of animals was sold each year just to fill the budget gaps. A few cows or some summertime bulls were kept in some farms of the coastal area but most households had empty sheds and old tractors, usually out of order.

People and land ownership

The potential coastal meadows (historically about 1000 ha) of the LIFE-project had all once been in private hands, all in the form of narrow stripes, as was so common on the Estonian coast. By the project's launch, less than half of the land had been restituted to the people, who did not actually use the land. Most of the landowners were local people and still had some tools and skills of making hay or keeping animals. Some pieces of land were also owned by people living in nearest towns. Several land units were in the process of being restituted or privatised, but the procedures had not been finished mostly due to the age of the people or because the families were too big. When the LIFE-project started, the project management and the Häädemeeste municipality discontinued the ongoing restitution processes. The land was put forward as state nature conservation land in total of 612 ha in seven cadastre units, the largest one being 127 ha. Instead of the land purchase procedure the project management paid for the measurement procedure, which was ten times cheaper than land purchase.

A public meeting about the LIFE-project was held on 3 November 2001, introducing the project to local people and offering help with animals, machines and know-how for coastal management. The ideas were popular and in the following months, several people found courage to restart farming with the help of the LIFE-project.

2002 – The great initiative

Animals and machinery

The purchase of the first 14 Limousine cows in February 2002 was the crucial point for the project success. Only then the local community started to believe that all the stories about the support and motivation concerning meadow restoration are true. At the beginning of February, the project management took the five farmers who wanted to start with keeping horses to an Estonian Native Horse Society meeting at Matsalu NP. There, connections with horse breeders were established, and they were subsequently visited on Saaremaa Island. This resulted

in taking seven Estonian Horses to Häädemeeste in the months of March and April. The first Herefords were purchased in July and the two LTZ tractors arrived in August. The farmers, being aware of the project's financial possibilities, proposed that instead of the planned bigger and expensive machines, cheaper and simpler ones could be bought. This enabled to buy more machines that met the needs of the farmers better and were also easier to handle and repair.

The arrival of two LTZ tractors to Rannametsa port.

First year of grazing on Piirumi meadows after 15 years of abandonment. In May, the grass was so high that the 50 young heifers taken to graze there from the neighbouring farm were completely lost in tall grass.

The borders of the new fence were established and marked with sticks in the spring of 2002. The old common pasture on the coast of Häädemeeste village used to be well-managed for centuries. All the neighbouring households wanted to have the meadow in good condition, while also demanding for strong fences and gates for each house.

The old fence and the new fence.

The summer of 2002 was extraordinarily dry. The water was shallow at the shore. The Estonian horses could graze the entire shoreline and the fence prevented them from leaving their pasture through the shallow water.

Preparatory actions

Fences constituted the first priority in most of the farms and land management units. In 2001, a few farmers took the risk of mowing the reed and tall grass in August. Also a few had some animals grazing in August and September, provided that they had managed to repair old fences or built new ones. The meadow managers were building different types of fences, trying to recall the old traditional fencing types in the region. Wooden posts with two barbed wires were mostly used. But as experiences from 2001 had shown, heifers and any other animals strange to the area tend to break through the fences and roam around restlessly, unlike like milking cows, which used to be slow and calm. Therefore many farmers preferred the electric fence in 2002. In places where people's houses and fields were too close, extra wire fence was added to keep the animals away from the village and the roaming dogs and children out of the meadow.

While it was quite easy to agree with the farmers and locals about the location of fences near the village, it turned out to be more difficult to convince them to fence the shoreline properly.

Few farmers took the trouble in the first years to fence the shoreline in water that failed to reach by a few meters inland onto solid ground. A well-grazed shoreline is crucial for nesting waders; migratory birds also prefer areas where the shoreline is clear of tall reed stems or reedbeds. As the importance of a clear shoreline with short grass was explained during many meetings and site visits, the fences moved closer to water year by year.

The same place in the spring of 2003. In autumn the fences were gathered from the shoreline to prevent them from drowning or being broken by ice. In the spring the water was high.

The problem with fencing the shoreline also had to do with the vast reed overgrowth. It was hard to detect the shoreline from distance and it was not easy to fix the fences in muddy shallow water. Every year new areas were cleaned of old reed in spring by burning: this has enabled to build the fences in shallow water and restore the crucial habitats for birds to a better condition almost everywhere.

Monitoring of birds and vegetation

Intensive monitoring actions on coastal meadows and along the shoreline started in 2002. The monitoring of bird fauna consisted of two separate tasks. The first one involved the count of migratory birds in spring and autumn, the second count included nesting birds, waders and all other species breeding on coastal meadows. Meadow management quality was evaluated and registered on a four-point scale at the same time. It must be said that although the area, in suitable condition for waders, was available and slightly increasing every year, the numbers of protected waders remained the same through all the years. This could be explained with the dramatic decline in wader numbers all over Europe. Still, the numbers of Lapwings (Vanellus vanellus) are slowly growing, and as it is an "umbrella species" for many other species, there is still hope of increasing the populations of the Black-tailed godwit, Baltic godwit and Redshank (concerning vegetation monitoring see article about Gladiolus imbricatus on page 70).

2003 – Actions have become popular

The LIFE-Nature project was launched together with the Estonian national scheme of subsidies for coastal meadow management. Together with LIFE-project support this had significant influence on local people of Häädemeeste and Tahkuranna municipalities. The bird watching tower built on the Häädemeeste –Pulgoja coastal meadow had become a popular visiting destination not only for birdwatchers and numerous tourists but also for local people. The feeling of being positive and useful for nature conservation and the possibility for farms to survive and develop in the new economic situation encouraged many people to join the coastal meadow management scheme in 2003. By that time the LIFE-project had created a sort of "club" effect. A lot of people had lost their income and identity when collective farms disappeared. That usually meant the end of keeping farm animals in small farms as well. When the LIFE-project support provided the good reason and possibility to start with the activities again with the added value of restoring the beautiful coastal landscape people had been used to in their childhood, the idea was warmly welcomed. During 2002-2003 the project management organised numerous study tours to different farms and seminars concerning conservational land management, green farming and sustainable tourism in nature reserves. All this encouraged people to join in, as they saw that they were not the only ones and such ideas are widespread.

More horses and cattle

A demand for more beef cattle presented itself among

farmers by the winter of 2003. In January, 10 half-breed Herefords were bought. Additional Estonian Horses were also bought from Saaremaa in March. In spring several new farmers started coastal meadow management and tried hard to learn from the others' experiences of previous years.

Problems with fences in water

Although the subject was explained to farmers on several occasions, fencing the shoreline properly in shallow water was not so easy. The water was quite high in spring and the weather was windy. Farmers with smaller areas could mana ge well; new farmers in particular prepared very suitable fences. But farmers who had larger territories and more preparatory work to do were late with fencing and could not put them into water in time.

In 2002 and 2003 many meadow areas were burned before grazing activities started. The old reed stands had not been touched in the previous decades and included a lot of garbage from sea and dead reed remnants. It was impossible to build fences in such a thick reed, plus the animals did not like to move around in sharp reedbeds.

Aerial photo of the Häädemeeste Suurküla coastal meadow in the autumn of 2003. The shoreline is uneven and curvy; fences have been difficult to build. They must be removed and cleaned in late-autumn every year. The photo also shows that as in the first years of grazing the amount of biomass in the restored area is too big, it must be mown as well.

Picture IMG-0636. The biggest and principal bridge built with the help of the LIFE- project. The bridge connects parts of the coastal meadow. It has to be wide enough to let through a cattle of 100 animals and strong enough to allow a tractor with a mower to cross it.

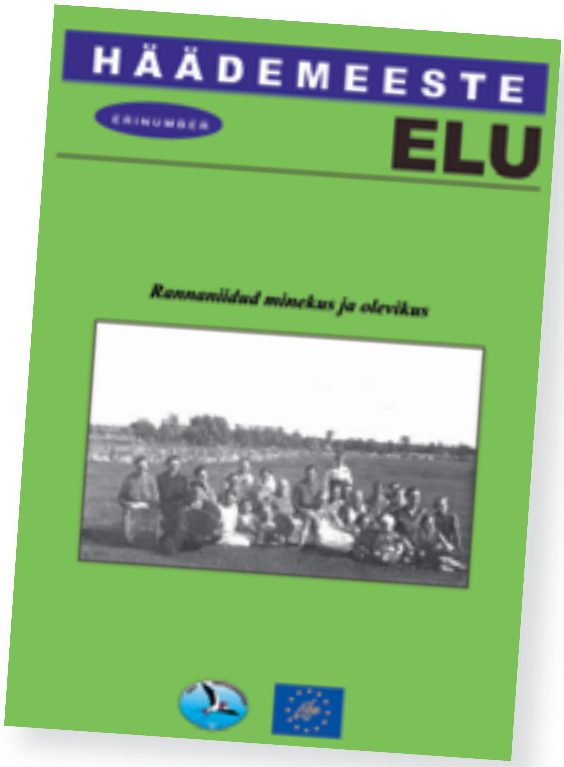
Building bridges and cleaning ditches

The restoration efforts in 2002 had shown that the ditch systems dug in Soviet times to drain the fields behind the coastal meadows were not helping coastal meadow management. A lot of them were channels for reed expansion, and bushes and trees had started to grow on the banks as well. These ditches were cleaned of vegetation, mown especially with bush cutters several times during the vegetation period; two of them were also cleaned of mud and alder and reed roots. As some of these ditches divided the meadows into separate parts and could not be crossed either by tractors for mowing or by cows, a need for bridges occurred. In the time of collective farms the land around the meadows was state-owned and accessible for tractors and animals.

Small predator control (fox hunting)

In 2003, large areas of cleaned coastal meadows attracted more animals than just the breeding waders, ducks and passerines. All the farmers noticed the foxes in daylight roaming around the meadow. Many foxholes were discovered in stone piles. Some landowners in the region are hunters themselves and knew about the numerous foxes, minks and raccoons in the area. In summer

they could not have been hunted but a plan was prepared together with local hunting society to hunt out as many foxes as possible. Project management helped to fund five hunting licenses for the coastal meadow and distributed them to the local hunters interested in foxes. Altogether more than 25 foxes were shot during the winter 2003/2004. Since the LIFE-project launch farmers had also cleaned a lot of ditches of bushes and cut off single trees or whole tree groups. This had diminished the opportunities for crows and ravens as well as hiding possibilities for foxes and raccoons.



Booklet about coastal meadow management history and media events

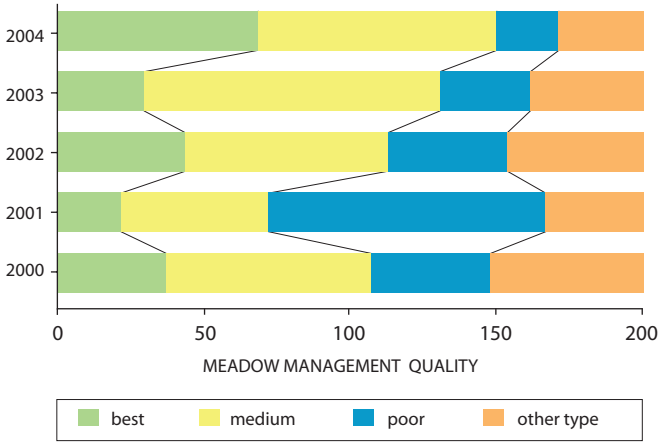
At the beginning of 2003 the project management picked up an idea of local people to issue a publication on the management history of the coastal meadow. This booklet included a lot of people's memories, old photos and drawings of different objects connected to coastal meadow management. The booklet was very popular among local people and also found warm reception from scientists and conservationists.

Public interest towards the project activities and coastal meadow restoration had also been significant. At Easter-time in 2003 and 2004 the LIFE-project management organised working camps for volunteers to help local farmers clean the meadows of garbage, old fences, trees and bushes. The collaboration between farmers and volunteers was successful on both occasions, and a lot of knowledge and information was exchanged. This kind of attention raises the awareness and motivation of farmers and gives them positive feedback. In 2003, the LIFE-project management organised a seminar on coastal meadow management where local farmers also participated and gave presentations.

2004 – The year of confidence

The 2004 vegetation season was faced well-prepared by farmers. In wintertime many farmers had finally decided to take more animals than usual in summer to increase grazing pressure. When reedbeds were removed from meadow vegetation in the previous years, mowing was also necessary. This was quite a slow procedure and tractors and mowers broke often. The usual efficiency was about 2 hectares a day on hummocky and uneven landscape. Many farmers also considered the revision of their grazing system so that in the first half of the season the animals would be near the shoreline, later moving more inland to guarantee lawn-like conditions for nesting waders. 2004 was also the year when European agri-environmental funds became available and farmers could apply for more subsidies for coastal meadow management.

The spring was favourable and allowed the farmers to build proper fences; grazing started quite early and effectively. But the summer happened to be wet and the sea level was constantly high. This favoured plant growth and kept meadows wet and muddy. Consequently, cattle fell ill with a foot disease in July. Cattle with swollen feet were not eating grass for a while and did not move around in reed. As a lot of reed was left over by the cows on some parts of the coastal meadow and as the tractors could not access it either, project management and farmers decided to leave it be until spring and burn it on snow. On the other hand, three previous years of fighting reed had lead to such a positive result that on most of the meadows there was no need for mowing in August – the animals



Graph on meadow management quality in the LIFE-project area. Out of the 600 hectares under management, on about 200 hectares continuous bird monitoring for breeding birds has been ongoing since 2000 as a part of the Estonian coastal meadow monitoring program. At the same time meadow quality has been evaluated.

The blue section of the column indicates best, the red medium, and the yellow poor management. The light blue represents other habitats on meadows (shrub, sedge, reed, etc.). This graph shows how in the spring of 2000, which was the first management year in the area, the conditions on the totally unmanaged meadow were not too bad as left from last autumn. However, by the spring of 2001 the situation was the worst. As activities started again in August of 2001, the situation had slightly improved by the spring of 2002. As in 2002 a lot of new areas were taken under management, the activities and the animals were scattered over larger areas.

Although the number of hectares was raised to 500 in all meadow areas, the quality suffered. As it reflected in the low numbers of breeding waders, the farmers were informed and after several meetings and planning in the middle of the season of 2003, the efforts were concentrated on improving the quality of the meadows. The activities also included extensive shoreline reed burning in early spring of 2004.

had done such a good work. The reed, which in earlier years used to give 2/3 of the biomass, was suppressed and the ordinary meadow plants were providing normal amounts of food.

Public interest in the LIFE-project - several excursions, workshops and seminars held in the region and field trips to the project area

Starting with the project's coastal meadow management seminar in 2003, the attention towards the area continued in 2004. There was a BEF LIFE COOP seminar on coastal meadows held at Häädemeeste along with a field trip to the meadows. Project management also hosted a seminar on endangered coastal waders, where specialists discussed the situation and conservation of coastal meadow waders across the Baltic Sea. EOS had two workshops on public participation and agricultural consultancy in the Häädemeeste locality. The project management hosted several excursions and study tours in the area for universities, conferences and schoolchildren. Each time local land managers were asked to participate and show around on their land. This helped to raise the awareness of land managers also, not only the visitors.

Summary

The present paper describes the process of restoration and management of the coastal meadows in SW Estonia

at the Luitemaa NR. The Estonian Ornithological Society initiated a relevant EU co-funded "Life-Häädemeeste" (LIFE00NAT/EE/7082) project, which started in 2001. It was dedicated to gearing up the restoration process and encouraging local farmers and community to take part of the management. The project has successfully helped to recover the coastal meadows of the Luitemaa NR – the area of managed meadows has been increased from almost 0 ha in 2000 to over 600 ha in 2004. The restoration and management of coastal meadow habitats has also prevented the endangered coastal meadow wader and amphibian population from becoming extinct. Starting up meadow management has become socially acceptable and economically appealing as well. Partly due to LIFE-project investments, partly due to state management support, taking care of meadows offered new economic perspective and occupations for several coastal villagers and farmers; this in its turn increased the popularity of and wide participation in the conservation of SW Estonian coastal seminatural meadows.

Suiteable stems of the cut junipers have been transported to mainland and used for fence building.

Coastal meadow management on Kumari Islet, Matsalu Nature Reserve

ILONA LEPIK

Kumari Islet lies in Western Estonia in Väinameri area and is part of the Matsalu Nature Reserve. The Islet is 16 ha large and the distance from mainland is 5 km. It has been inhabited by people in the beginning of XX century and used for grazing or mowing until 1960. Nowadays it is a bird protection area and people's access is strongly regulated. Main reason of the interest to restore the meadows here, is the last population of Natterjack Toad (*Bufo calamita*) of Matsalu area. Because of lack of management on the islet, the habitat has became unsuitable for Natterjack Toad. This species prefers shallow breeding ponds with low vegetation and open areas with short grass.

Problems

The spawning pond on Kumari is a small coastal lagoon. The lagoon gets most of its water from rain. Only very seldom seawater gets there. Usually the lagoon dries up in summer. This lagoon is the only water body on the islet. Four other species of amphibians - Common Toad (*B. bufo*), common frog (*Rana temporaria*), moor frog (*Rana arvalis*), and smooth newt (*Triturus vulgaris*) - also breed there. Tadpoles of Natterjack Toad are bad survivers in the conditions of the interspecifc competition in the pond. To avoid the competition, the tadpoles of *B. calamita* stay usually in the shallowest edge of the pond, where they can get trapped and will dry up, if the water level goes down. Due to overgrowth with reed and moss the lagoon has became unsuitable for Natterjack breeding. The shallow edges are too vegetated and water disappears very quicly. Overgrowth of the pond with high reed gives most suitable breeding conditions to Common Toad. Increase of the number of common toads on the islet has been noticed (figure 1). Competition rate between Natterjack Toad and Common Toad on land habitat is high due to same kind of food. To secure the successful breeding of the Natterjack Toad, the lagoon has to be cleaned from reed and mud.

Overgrowth of the meadows with high vegetation and bushes has also negative effect on the survival of Natterjack Toad. The natural succession is leading to the domination of Common Toad on the islet. The restoration of the meadows is essential, to secure the survival of the Natterjack Toad.

Actions

Actions for restoration of the habitat of the Natterjack Toad started in 1994 with the first work camp of volunteers and the stuff of Matsalu NR. Since that work camps have been held every year in August. Transportation of big machinery to Kumari is not possible, and therefore only small machines, like bush-cutters or tools like shovels, could be used. The work camps have been organized with help of Estonian Seminatural Community Conservation Association and Estonian Fund for Nature. In 2001-2004 the work camps were financially supported by LIFE Nature project Boreal Baltic Boreal Coastal Meadow Preservation in Estonia. The camps have been very popular among students and other young people. Also local people from the villages of Matsalu NR have been involved. The work is supervised by the staff of Matsalu NR.

Actions in the breeding pond

- First 2 years part of the lagoon was cleaned by digging out the roots of the reed. No mowing was done.
- In 1996 the shallow part of the lagoon was mowed.
- Since 1997 all the reed have been cut and burned.
- Since 1998 also mud and roots of the reed have been dug out and transported away.

Best result was achieved with cutting the reed and removing it first and digging the mud and roots of reed out afterwards.
Mowing of the reed was done with bush-cutter. Digging was done with shavels. For transportation of the mud different simpel carrying equipment were used.

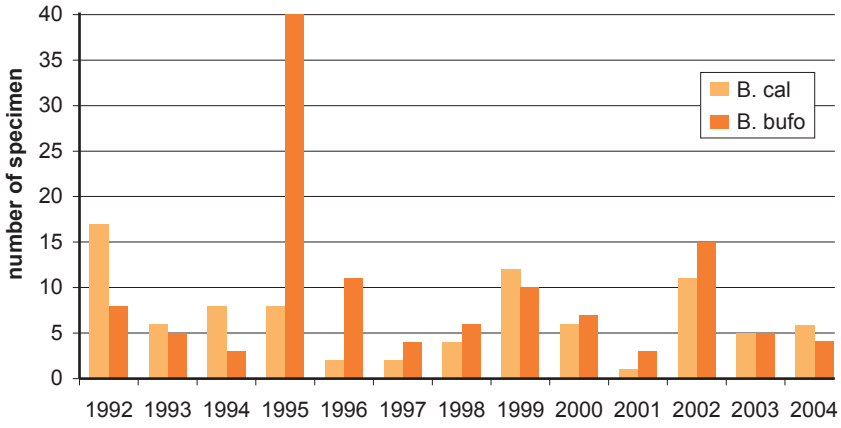


Figure 1.
Number of specimen of *B. calamita* and *B. bufo* found on 1 km long counting transect on Kumari Islet.

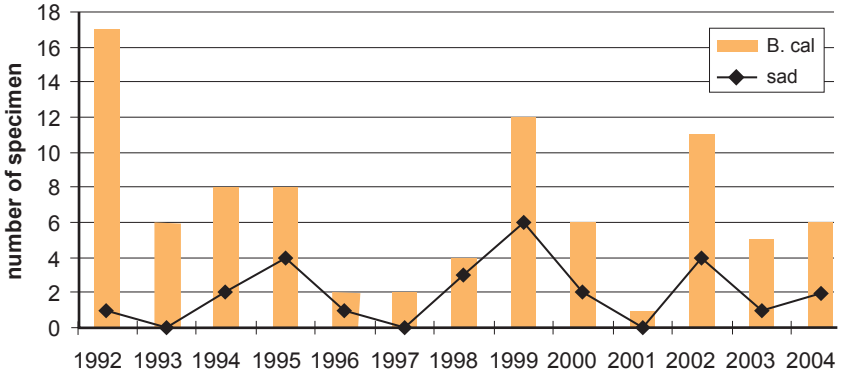


Figure 2.
Number of specimen of *B. calamita* found on 1 km long counting transect on Kumari Islet. Specially marked subadult specimens indicate successful breeding year before.

The tadpoles of the Natterjack Toad of *Bufo calamita*.

Thanks to management the lagoon is open in spring and vegetation of the surrounding starts to change.

Actions in the terrestrial habitat

- First 3 years some bush cutting was done, to create tracks and corridors between the bushes.
- Existing open areas have been enlarged, by bush cutting since 1997.
- The surrounding of the breeding pond was cleaned from bushes in 1997 and 1998.
- The surrounding of the breeding pond has been mowed and the hay collected since 1997.
- In 2002 and 2003 some open areas were mown.
- Some sheep graze the islet all year round since 2001.

The effect and future

The data about Natterjack Toad abundance originates from line counts. The data shows low level but continuous breeding success since the habitat management has started (figure 2). The islet's small population has been kept alive until this day. Without any management, this population, probably, would have been died out or declined into dangerously low numbers by now.

- The work camps must continue and main efforts should be made to mow the open areas.
- Breeding pond should be kept open (figure 5). To clean all the possible breeding area of Natterjack Toad with handwork, the work must go on several years. Reedcutting is nessecary every year.
- More sheep is needed.
- To secure breeding of many possible birds, that can benefit of the meadow management; fox, that comes to the islet in winter, must be eliminated every year

Manilaid 2003

Manilaid 1999

Manilaid – island of coastal meadows

RIINU RANNAP, VOLDEMAR RANNAP

Manilaid is a small island at the mouth of Pärnu Bay. It is ca 4,5 km long and almost 1 km wide. A high ridge of boulders, gravel and sand runs across the length of the island, subsiding into the sea at both ends of the island. The ridge constitutes the island's only road, which is bordered with the farms of the island's only village, Manija. Small patches of field are situated right beside the farms and alongside the gravel road. Manilaid does not have any forests. Most of the island is covered with coastal meadows that have suffered serious reed expansion in the past years, forming extensive reed fields in places.

Manilaid remained uninhabited until the beginning of the 20th century. It belonged to the Pootsi manor situated on the mainland and was used as hayfield.

When population on Kihnu island increased in the beginning of the 1930's and land shortage became a problem, the Estonian government decided to offer patches of land on Manilaid. Manilaid was consequently divided into gores, which were distributed to people by ballot. As a result, some 39 new households were created. The number of animals in farms was initially small, but grew constantly. In the 1940's-1970's each family had a couple of cows and a number of sheep. Some 80 cows and 300 sheep were grazed on the island's coastal meadows at that time. Horses were kept jointly by various families.

Due to the fact that while it belonged to the manor, hay was mowed constantly on Manilaid, the island's coastal meadows had originated before the island became populated. Although some of the meadows were turned into fields, most were still used as pastures and hayfields. According to older inhabitants, only small patches of reed could be found at that time. Low vegetation, countless sun-exposed shallow coastal ponds and sand and gravel ridges, as well as the fact that fields and farmhouses were situated right alongside coastal meadows – all made the island a paradise for the natterjack toad and several coastal waders. The air was bursting with the loud rattle of natterjacks on warm spring nights.

The social and economic changes that took place in the end of the 1980's and in the beginning of the 1990's changed the island's life radically. As the smoked fish plant situated near the harbour on the mainland closed its doors, people lost their jobs. Fish production decreased and the young who would have liked to stay on the island were forced to leave due to lack of work. The Pootsi primary school was closed as well. And finally, when milk was no longer bought on the mainland, the island's young people did not have much left to do. As people were leaving, the number of animals steadily decreased as well, reaching a catastrophic level by year 2000. By then, the island was left with two cows, a couple of horses and some 30 sheep.

Social changes left their mark on nature as well. As grazing pressure decreased, the wetter coastal meadows with numerous shallow ponds and waterholes were abandoned. Precisely these areas were important natterjack breeding sites and coastal waders' foraging grounds.

Work camp on Manilaid.

When grazing ceased, the former coastal meadows and pastures were rapidly invaded by reed and brushwood. These areas now offered suitable living conditions for foxes, minks and grass snakes, whose numbers quickly began to rise. Thick reed made it easy for the predators to sneak up on bird nests unnoticed. The natterjack toad became the grass snake's primary food object. Habitat changes and increased number of predators deterred many bird species from coastal areas. The numbers of the natterjack toad entered a rapid decline as well.

Similar changes were noticed on other Estonian islands – Kihnu, Ruhnu, Saaremaa, Hiiumaa and Vormsi. Socio-economic changes manifest themselves most rapidly particularly on islands.

By the year 2000, most of the coastal meadows on Manilaid had overgrown with reed and the natterjack toad had reached the verge of extinction. That is why Manilaid was chosen as one of the target areas for the LIFE-Nature project "Coastal meadow protection in Estonia". Most of the island's inhabitants were older retired people, who had trouble finding motivation to restore coastal meadows. The natives of small islands generally have a conservative nature and they are stuck in their beliefs. While this has helped them survive in harsh conditions, it nevertheless generates scepticism towards new tendencies. This is especially true when these new ideas come from outsiders and fail to immediately click with the mindset of local people.

Scottish Highland Cattle, bought by the LIFE-Nature project.

Back in 2000, only one family on Manilaid was immediately ready and willing to participate in coastal meadow restoration. The family in question, the Riida tourism farm was interested in restoring the island's scenic nature. They burnt the old reed on the farm's coastal meadows already in the winter of the same year and mowed the area repeatedly during the spring-summer growth period. Typi-

cal vegetation had been partly restored by autumn. From then on the project sort of centred around Riida tourism farm, which became the island's exemplary area.

The Estonian system of compensation payments for managing seminatural communities was launched in 2001. This coincided exactly with the beginning of the coastal meadow project. In order to receive compensation, the landowner or manager had to write an application and conclude a contract. The inhabitants of Manilaid were not very open to concluding contracts. On the one hand, they were afraid if taking on responsibilities that many older people might not have handled and on the other hand, the whole system was new and unknown to them. People are watchful of the doings of other in small communities and no one wants to be the first to do something. The new situation and opportunities had to be introduced and explained to the island dwellers. As the people involved in the project were not very familiar to local people, it became necessary to find a person who was well known and respected on the island. Thus a specialist from the Pärnu County environmental service who owned some land on Manilaid was incorporated. The contracts needed for coastal meadow management and restoration were finally concluded by visiting people and talking with them one to one. The subsidies received for coastal meadow management motivated people to keep on managing existing coastal meadow patches and to start using reeded areas as well.

The natterjack toad has been one of the native habitants of Manilaid coastal meadows. The last decades have witnessed a constant decline in its numbers due to deteriorating living conditions. As grazing pressure decreased, the wetter meadow areas developed reed overgrowth and soon became unsuitable for natterjack breeding. The factor that defines the size of a natterjack population is precisely the number of suitable breeding ponds. The restoration of shallow coastal meadow ponds and clearing of reed needed to be initiated immediately in order to save the remaining natterjack population. A caterpillar had to be used to minimise damage to soil and plants. But even the idea of letting a machine the size of a house onto the small island's coastal meadows scared local people. The family of the Riida tourism farm offered their help once again by agreeing to the restoration of two ponds on their coastal meadow. The whole village gathered around to witness the event. After lengthy discussions well into the night, several farmers signed up for ponds the next day already.

A special ferry trip was ordered to transport the buldozer to the island.

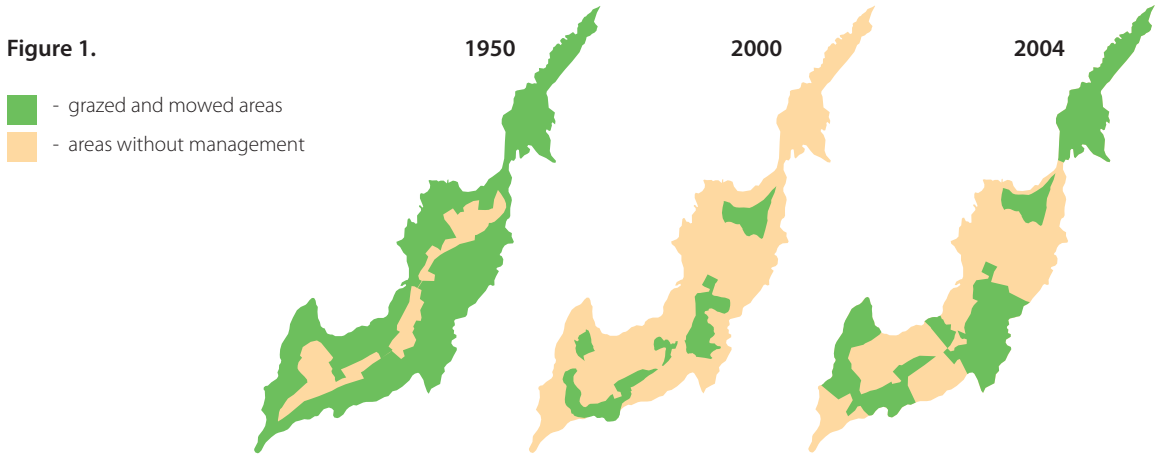
Restoration of breeding ponds for *B. calamita*.

Cattle on Riida meadow in 2004.

As most of the coastal meadows on Manilaid had always been grazed, it was one of the project's aims to restore the traditional functions of coastal meadows, which would also secure the management of these areas once the project had ended. Initially nobody wanted to hear of starting keeping cattle. As dairy cattle are the traditional type of cattle in Estonia, farmers were daunted by the problems that come with dairy cattle, the disposal of milk being the principal one. Once it had become clear that the project included plans to purchase beef cattle from Sweden, namely the resilient Scottish Highland Cattle and Hereford Beef Cattle, many people became interested. Once again, the Riida tourism farm family was the trendsetter; they also managed the largest coastal meadow area. Three head of Scottish Highland cattle and a ram were taken to Riida's coastal meadows in the autumn of 2002. Sheep were purchased with the help of the Pärnu County environmental service. Grazing and the restoration of shallow coastal ponds helped to recreate the mosaic appearance of coastal meadows, which in its turn brought back the once-disappeared waders: northern lapwings, black-tailed godwits and even ruffs.

When the number of animals doubled at Riida in the spring of 2003, a problem with the land arose. The pasture became too small for the acquired bovines and sheep. Luckily the neighbours lent their helping hand by allowing the Riida cattle to graze on 10 ha of their unused coastal meadow. The necessary winter hay could be bought from other neighbours who expanded their mowed areas to that end. The animals purchased by the project for the Riida farm turned out to generate income for several island dwellers and helped to begin re-using various coastal meadow areas. The ever-increasing number of animals and the need for hay and pastures created a snowball effect of sorts, when a support that started out as small began to multiply itself year after year.

When the inhabitants of Manilaid saw that the project at hand yielded actual results, their attitude



changed considerably. People started to remember the times when all coastal meadows on the island had low vegetation and reed fields did not cover up the view to the sea. In time, others became interested in restoring or expanding their coastal meadows. This time the farmers themselves approached the project, asking for advice and help. They were given bush cutters for clearing coastal meadows, and reed cutting work camps were organised. The project also helped with erecting new cattle fences and purchasing more sheep.

By the time the project ended in 2004, the coastal landscapes of Manilaid had undergone a considerable change compared to the year 2000 (Fig 1). Many coastal meadow bird species had begun nesting on the island again. Nine natterjack toad breeding ponds had been restored. Although the numbers of the natterjack toad did not increase during the project, the protective measures employed helped to halt the natterjack's decline.

As the activities consisted in restoring and managing seminatural communities, such positive results could not have been achieved without the support and participation of local inhabitants and landowners. This applies to all project areas, not only Manilaid.

Co-operation with local people provided many useful experiences for future as well. It became clear how important it is to employ people who are familiar with local conditions and are known and respected by local people, when introducing new ideas and planned activities. This helps to achieve a better contact, avoid mistrust and possible confrontations.

It is extremely important to find time to interact with locals, to hear out their concerns and doubts and to explore potential solutions.

The attainment of a positive attitude does not always require considerable material investment; often a small aid or support is sufficient. In light of all this it can be understood how a friendly and active interaction with local people helped to carry out the project's objectives.

It is quite obvious that one project is not enough to bring about a definitive change in the development of an area. But it is indeed possible to change people's attitudes. The project could not have asked for a better recognition than that which was manifested in the summer of 2004, when a woman from the village came up to the men standing at the harbour of Manilaid, looked up her husband and told him to go home and cut down the reed growing behind the house in order to gain as good a view to the sea as the neighbours. This would have been unimaginable three and a half years ago when the project began.

Although Manilaid constitutes one of the sixteen areas included in the LIFE-Nature project of coastal meadow protection, it is a good example of how small changes can lead up to great results.

The calling male of the natterjack toad.