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# The Tøndermarsk Law: Approaches to Biodiversity Conservation and Cultural Landscape Preservation in Tøndermarsken

"Created by the sea and shaped by the people"

Source: Nielsen, 2021

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## Abstract

Biodiversity loss has been one of the major human concerns during the last century. In order to protect and prevent biodiversity loss, several agencies, both national and international, have implemented different regulations to monitor decreasing species. Whether or not these efforts help the cause is often a big debate in the protected areas, as the causes of biodiversity loss are complex to define, and often create conflict with local communities and cultural aspects related to them. This report seeks to investigate the relevance of the Tøndermarsk law (1988) whose purpose was protecting the natural landscape, mainly intended as a bird population, together with the cultural landscape, in the Tøndermarsken area, south Denmark.

In doing that the report has undertaken an interdisciplinary approach to the problem, using both qualitative and quantitative methods, from natural and social sciences. The findings suggest that the Tøndermarsk law initially seemed to fulfill its purposes, but after the intervention of multiple international nature agencies claiming the need for extra conservation efforts, true success of the law began to be debated. As a result, the Danish Nature Agency employed multiple conservation tactics in the area. This paper will join studies that reveal a complex reality connected to a unique landscape, where both natural and human related aspects must cohabit to keep existing and this balance is often hard to achieve.

**Keywords:** Biodiversity, Bird conservation, Grazing, Cultural heritage, Tøndermarsk law, Marshland, Parasites

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Sincerely,
Dylan Gribble, Ida Brix Lassen, Laura Tilli, Christian Baldassari, Sara Charbonnier

## Disclaimer

This report is based on two weeks of supervised field work and data collection in Tønder Municipality, Denmark. The report expresses the analysis and views of the students, which may not correspond with the views of the persons and institutions who the students have engaged with, or the University of Copenhagen.

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## List of Abbreviations and Acronyms

| | |
|---|---|
| DBPF | Danish Bird Protection Fund (Fugleværnsfonden) |
| DNA | Danish Nature Agency (Naturstyrelsen) |
| DOF | Danish Ornithologist Organization (Dansk Ornitologisk Forening) |
| EU | European Union |
| MVJ | Agri-environmental measures (Miljøvenlige Jordbrugsforanstaltninger) |
| SSI | Semi-structured Interview |
| UN | United Nations |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| WSNP | Wadden Sea National Park |

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# 1 Introduction

According to the UN Sustainable Development Goals Report (2021), “more than a quarter of species assessed by the IUCN Red List are threatened with extinction”, which can be equated to more than 134,000 animal species. Biodiversity loss is an acute crisis of our time, currently occurring at an unprecedented rate (SCBD, 2020) - three decades since the statement of biodiversity loss as a concern of international importance (UN, 1992). Biodiversity loss occurs at local to regional level and has pervasive effects on the Earth system. Human activities, such as changes in land use, are the main cause of the acceleration. These changes include the conversion of natural ecosystems into agriculture (Rockstrøm et al., 2019).

Protected areas are considered the “cornerstones of biodiversity conservation’’, working as the main means of biodiversity conservation (CBD, n.d.). Areas are protected either through national laws, international agreements or other means such as a community’s recognition of traditional rules (Lauche, 2011). Within the EU, areas are protected as Natura 2000 areas under the Habitat-, Ramsar-, and/or Bird Directive, which are the “centerpiece’’ of EU’s biodiversity and nature conservation policies (IUCN, n.d.). Countries are thus obligated to restore or ensure conservation status for the habitats and species which justify the designation of each Natura 2000 site (Miljøstyrelsen, 2021). Similar to its international counterparts, the state of Denmark is dedicated to environmental protection. The Nature Conservation Act (Naturbeskyttelsesloven) is a law that aims to protect the natural values in Denmark. Specific areas can also be protected under the act through different categorizations such as §3-areas, national parks and state protected areas (Miljøstyrelsen, n.d). However, as discussed in Yeni (2014), the presence of people often has a negative impact on conservation, and that it may only be achieved in the absence of human influence.

In addition to international and national approaches to conservation, local legislation related to preservation is prevalent. The Tøndermarsk law is a unique example of a local preservation law. It is applied to the area of Tøndermarsken in Southwestern Denmark. Despite its small size, the landscape has unique cultural and ecological significance. Throughout history, it has gained cultural and economical importance due to the dike system, which protects Tøndermarsken from

flooding from the sea and allows farmers to control water levels for the purpose of grazing. Tøndermarsken “is created by the sea and shaped by the people ", one of the earliest examples of coastal protection. (Tøndermarsk Initiativet, 2022.) Control and regulation of the Wadden Sea through the dike system have become central to the cultural heritage of the area due to its history and ability to alter the landscape. Additionally, Tøndermarsken is home to the third-largest bird population in Denmark when it comes to the number of bird species which makes it an important location for conservation purposes. Tøndermarsken is therefore designated by UNESCO as a natural heritage site and recognized as a Natura 2000 area for its significant birdlife. (Clausen et al., 2016.)

In the 1980s an increasing number of grazing fields came under cultivation, which threatened the rich birdlife in Tøndermarsken (DNA, 2011). The Tøndermarsk law was established in 1988 in order to protect the cultural heritage and biodiversity - i.e. stop the bird populations from declining - of the area (Retsinformation, 2004). This raises the question of whether biodiversity and cultural heritage can truly be protected at the same time. 34 years after the establishment of the law, this study attempts to answer and discuss the following research question: “What is the relevance of the Tøndermarsk law?”. Specifically, this paper will explore ‘relevance’ related to how the law is practically implemented within Tøndermarsken and if the objectives of the law, related to conservation of the landscape, have been met with success.

### 1.1 Study area

In this study, when referring to ‘Tøndermarsken’, we refer to the area under the Tøndermarsk law, which is shown on Figure 1, while we specifically investigated Ny Frederikskog and Gammel Frederikskog during our field work.

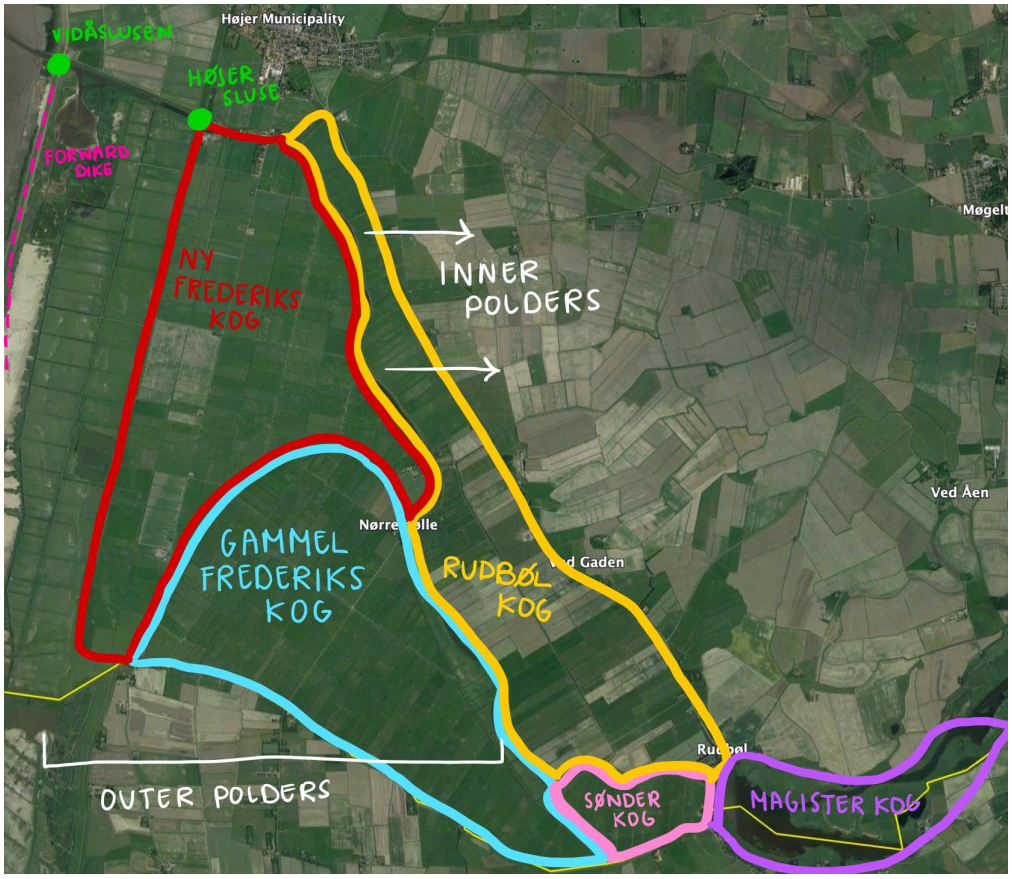


Figure 1: Study area - the area of Tøndermarsken with the Tøndermarsk law. (Source Google Earth)

# 2 Background

## 2.1 The creation of Tøndermarsken

Tøndermarsken consists of marshland which was created 3,000 years ago by the sea, creating a landscape that is very low in elevation and providing an excellent opportunity for grazing and agriculture because of highly fertile soils caused by nutrients left from flooding sea and rain water (SSI with Historian from Sønderjylland Museum). The natural landscape is characterized by numerous lakes and streams which form a delta around the Vidå River. Historically, severe winter storm flooding prompted Tøndermarsken inhabitants to begin construction of a complex system of dikes and canals that started in 1556 and ended with the Vidå Slusen and Forward Sea Dike in 1981, which is the only dike still used for coastal protection. The dike system created an abundance of land that has been used for agricultural purposes, especially grazing in the area which created an important cultural landscape still today. (Tøndermarsk Initiativet 2022.)

When the Danish crown regained control of the area after the First World War, the state recognized Sønderjylland as the 'lost daughter coming home to Denmark', which, along with increased flooding from the east, motivated the state to take an interest in modernizing the area. (SSI with Historian from Sønderjylland museum). After the drainage of the marsh in 1927, the modernization that took place included the addition of dairy cattle grazing, corn production, and hog raising to the already existent beef industry (Overgaard, 2018).

In order to control the flow of water into and within the marsh, a system of electric pumps were created. Through the canals, water is led to the pumping stations, where it is raised up into the diked waterways. Another integral part in the dike system are the sluices which act as a gate, directing water from the Vidå through canals. Sluices close when the sea water level is higher than the river water level in Vidå. The Dike Guild (*Digelag*), is a group of local residents employed by the municipality who are responsible for controlling the use, functioning, and maintenance of the dikes. They are the only group authorized to pump and divert water. (Tøndermarsk Initiativet, 2022.)

Following a record-breaking storm in January 1976 citizens urged for the creation of a new dike to increase protection, leading to the construction of the Forward Sea Dike in 1981. Margrethe Kog was an area of reclaimed marsh created by the new dike and was taken over by the state with the intention to protect important bird species. In the same period there was an increasing shift from grazing land to cropland, paired with a significant decline of the bird population. The threats toward the cultural use of the land and the biodiversity loss regarding birds brought the state in 1988 to create a special law titled Tøndermarsk law to protect and preserve the area. (SSI with WSNP informant.)

### 2.2 The Tøndermarsk Law

The purpose of the Tøndermarsk law is to preserve the outer polders of Tøndermarsken and the lower part of the Vidå system: "as a unified nature area of national and international importance and to inform the public about the conservation values of Tøndermarsken". The law was made to ensure the maintenance of the landscape, cultural, and biological values associated with the management of grassland, while also ensuring the maintenance of the regular water level

fluctuations in the drainage system and pumping water from the Vidå into the ditches in the areas to be used for irrigated pasture. At the same time, agricultural management and veterinary hygiene shall be taken into account. (Retsinformation, 2004.)

The law was passed in 1988, revised in 1994 and 2004 (Retsinformation, 2004). At the time, the increase in cereal agriculture was thought to be the primary threat to biodiversity and the landscape (SSI with WSNP informant). The law covers the area within the outer dike and the lower part of the Vidå river, which consists of the outer polders: Gammel Frederikskog, Ny Frederikskog, Rudbøl Kog, Sønder Kog and Magister Kog which can be seen in Figure 2.

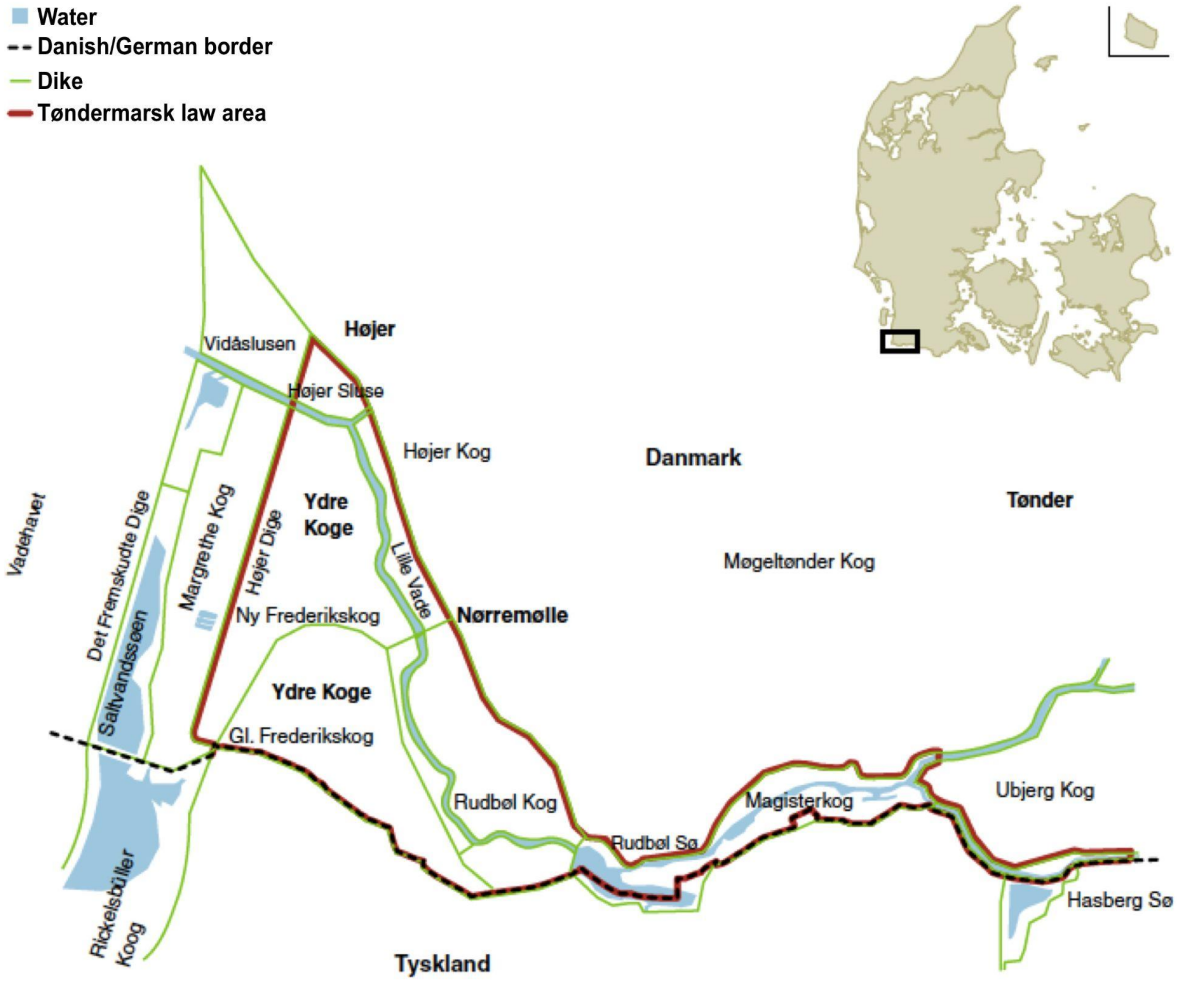


Figure 2: Map of the outer polders in Tøndermarsken. The red line marks the area within the Tøndermarsk law. (Source: Clausen et al. (2007))

The outer polders in Tøndermarsken cover an area of 1,884 ha, seen in Figure 2. Gammel Frederikskog has never been cultivated, while other polders such as Ny Frederikskog and Rudbøl Kog were cultivated before the law was implemented, and Rudbøl has fields that are still cultivated today. The Tøndermarsk law defines land management as it was at the time the law was created, and requires that this same management, such as grassland grazing, is upheld. The law also prohibits construction, including buildings and roads, unless they are meant to serve agricultural businesses outside of pig, fur, and poultry farms, and greenhouse horticulture. Furthermore, fencing is only allowed along the dikes, roads, and water channels. The state provided compensation to all landowners within the area of the Tøndermarsk law. (Retsinformation, 2004.)

### 2.3 The implementation of the Tøndermarsk law

In 1992, the European Commission expressed concern about the bird conservation in Tøndermarsken, but the Danish State did not take action, which resulted in the Danish Ornithological Society (DOF) bringing a complaint to the European Court of Justice about the mismanagement and inadequate protection of Tøndermarsken in 2002. This began a broader debate about the success of the Tøndermarsk law, particularly concerning the success of bird conservation. (Hansen, 2017.)

To encourage land management in Tøndermarsken that benefits biodiversity, in 2001, several voluntary subsidy schemes were established. These subsidies allowed farmers to apply for grants regarding modified land management practices under the agri-environmental measures prefered by the state for bird conservation (Miljøvenlige Jordbrugsforanstaltninger, MVJ). The MVJ scheme also included a regulation limiting the grazing of fens to 0.8 animal units per ha. (Danmarks Miljøundersøgelser, 2010.) After the implementation of the scheme, there was no longer a continued decline in bird populations, but no considerable increase was noticed (Clausen & Kahlert, 2007). The scheme was phased out between 2008-2009 due to poor economic conditions and widespread opposition among private landowners, and farmers again started draining the fens in Tøndermarsken (Hansen, 2017). In 2009, the Minister of Environment signed an agreement with Tønder regarding continued bird-friendly management of state/municipality-owned land. The Minister also expressed the hope that more private

landowners would join the scheme again, after economical improvements of the scheme (Miljøministeriet, 2009). But the hope was not fulfilled, since private landowners did not join the scheme. DOF once again expressed their concern about the decreasing breeding bird populations in Tøndermarsken, wishing for the state to take over areas where the private landowners did not commit themselves to manage the areas in a bird-friendly way (DOF, 2009).

From 2012 to 2017, state and private landowners traded land plots extensively, allowing the state to gather their land into one big area of about 200 ha in Gammel Frederikskog, an area which they saw as the most attractive area for bird conservation. The land swap allowed the state to manage their fens more consecutively, allowing the creation of a large bird sanctuary area, while private owners could continue draining their fens for grazing areas without intruding on state-sponsored bird conservation (Figure 3a and 3b). At this time, the protection of the cultural landscape came into question because the increased sitting water on fens was not compatible with the landscape type protected by the law. (Hansen, 2017.)

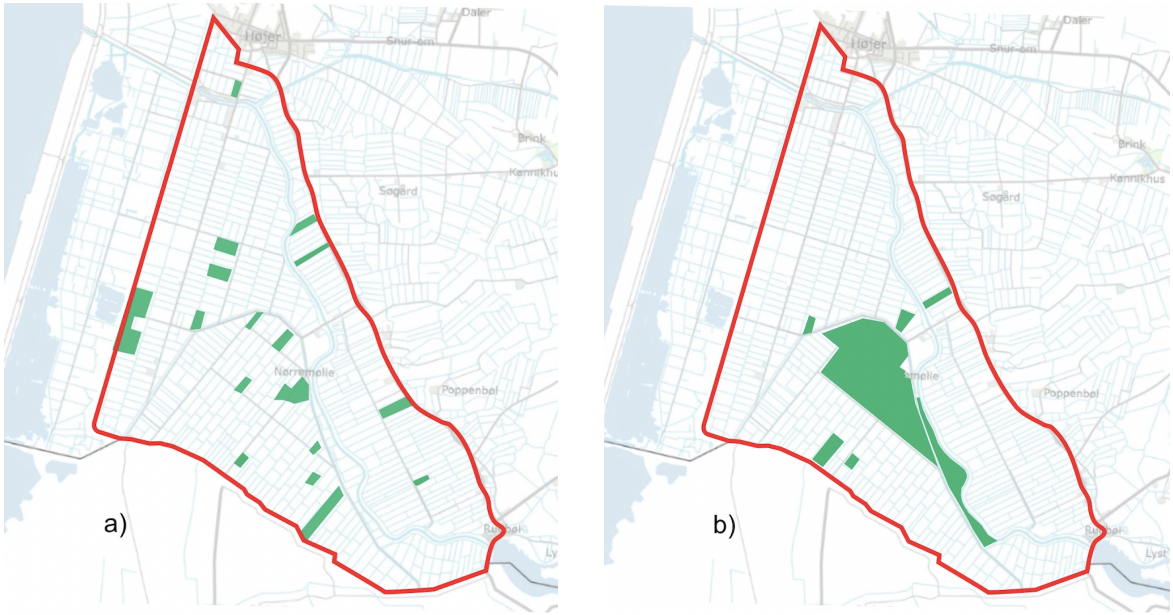


Figure 3a: State-owned land before the land swap (green color) (Source: DNA)
Figure 3b: State-owned land after the land swap (green color) (Source: DNA)

When managing their land, the DNA took advice from the Environmental and Planning Committee, who in 2010 recognized the need for further protection of Tøndermarsken's unique

values (DNA, 2011, 33). As a result, the DNA began managing state-owned land using the ‘more water and fewer foxes’ basis that involved increasing water cover and controlling predators, while continuing to buy land to allow for the expansion of these practices (ibid.).

The fields in Tøndermarsken - or fens as they are called in marshland - form a mosaic land divided by canals where the water is pumped out of the marsh during winter months and in during summer months. Extensive rotation grazing has been the main practice for 100 of years carried out by the farmers in Tøndermarsken, where small herds of grazing animals were moved from one fen to fen in order. During the grazing season, the water in the canals keep the grazing animals on their respective land separated between fens because they are unable to cross. Winter is the rainiest season during which the rain accumulates on the surface of the fens due to their low permeability characteristics caused by the high percentage of clay. (SSI with WSNP informant.) Traditionally the rainwater has been drained from the fens into the main canals by a human-made drainage system. This system consists of two types of channels dug on the land: the grøblerender and the drainage channels (Figure 4). The grøblerender collect the rainwater from which it flows into the drainage channels and further into the main canal, - keeping the surface of the land dry. DNA claims that this is not ideal for birds, This is claimed to be harmful to the birds as it dries the land and deteriorates the bird habitats of the birds. (SSI with DNA informant A.)

The drainage system in the outer polders consists of surface run-off through parallel ditches called *grøblerender*, and cross ditches (referred to here as drainage channels) draining to canals between fens. The recommended drainage system change involves clogging the drainage channels from the canals (Figure 4b), which will allow the rainwater to collect on the ground, ideally into the bird breeding months. This practice is allowed as long as small lakes will not be made on the fens, which violates the assurance under the Tøndermarsk law that states the landscape cannot be changed. (SSI with DNA informant A.)

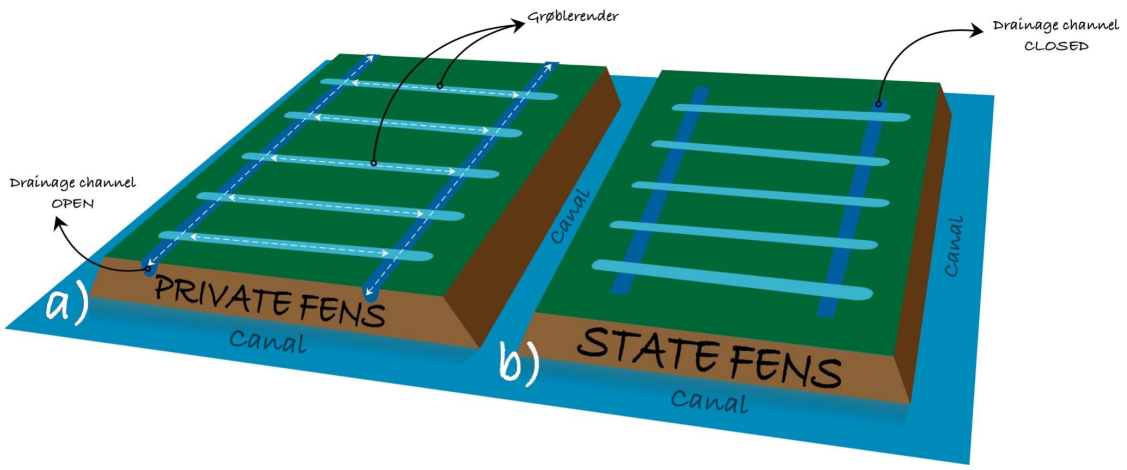


Figure 4: Drainage system in the privately owned fens (a) and state-owned fens (b)

The Environmental and Planning Committee recommended to the DNA that for the purpose of breeding meadow birds, water cover should be increased from March to June, either through changing the drainage scheme or changing conditions in the existing irrigation system. (ibid.) Meadow birds have specific ecosystem requirements that make breeding in Tøndermarsken attractive and successful. Chief among these requirements are water conditions on the fields. Meadow birds require shallow, muddy water puddles sitting on fields from the end of March, when the breeding season begins, until the end of June or July- depending on the species. The increased water level makes the ground less hard and more suitable for birds to search for insects that live within the first few centimeters of the soil. There are also specific requirements related to grassland conditions which are closely dependent on grazing- particularly cattle grazing. Cattle graze differently than other grazing animals like sheep, leaving behind a heterogeneous vegetation landscape of preferred height. Breeding birds have differing grass height preferences which is one of the reasons a heterogeneous landscape is preferable. Shorter grass, 5-10cm height, is useful for hiding from predators and taller grass, 10-20 cm are used to place and hide nests. (SSI with DBPF informant.) A representation of the main aspect depicted in the area can be seen in Figure 5.

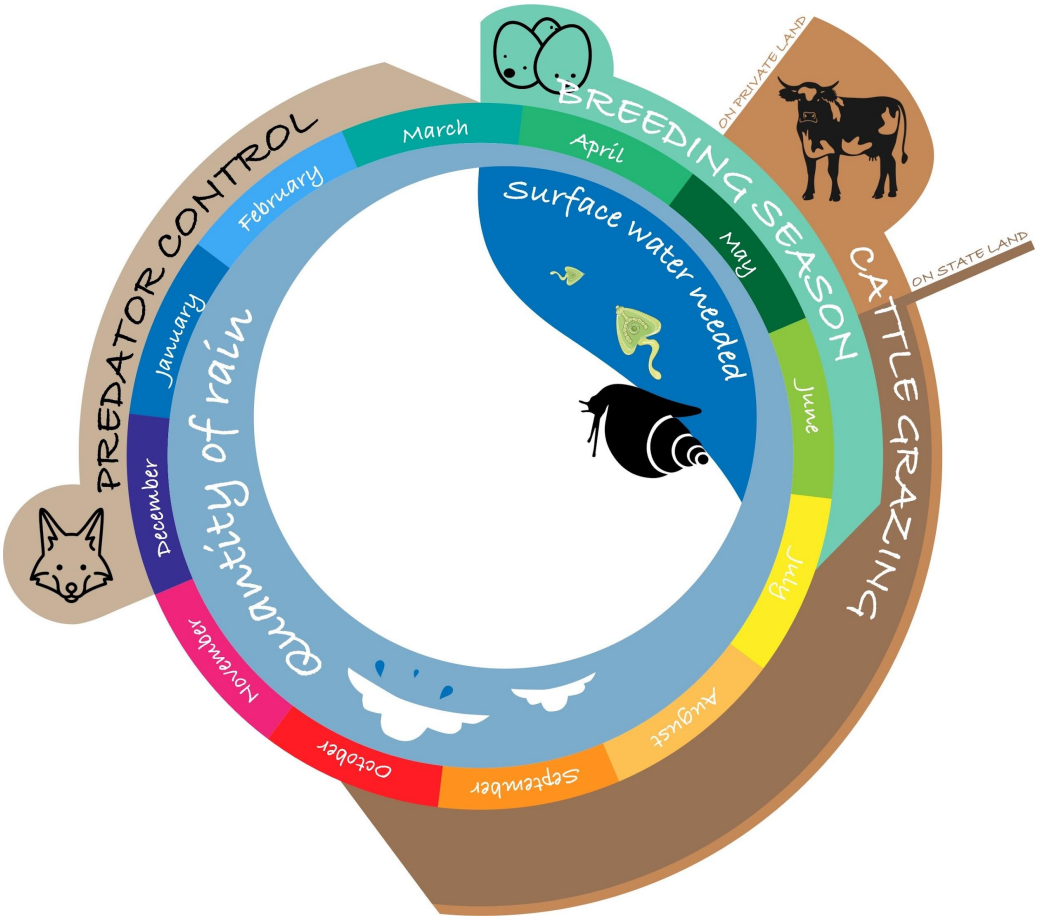


Figure 5: Circular calendar of the main practices and natural conditions in Tøndermarsken.

# 3 Methods

The section that follows is a brief discussion of methods performed for the project before the fieldwork in Tønder, and after it for the data analysis. Field research was conducted in Tønder from February 28th to March 11th 2022. The goal of the various methods used was to gain expert-based knowledge, local perceptions, and to evaluate hypotheses, including the research question. This section is divided into qualitative and quantitative methods.

## 3.1 Qualitative methods

### 3.1.1 Literature review

Before leaving for Tønder, literature was reviewed in order to learn more about the area and trends in bird populations. Literature was also used to analyze historical data. While in Tønder,

we also reviewed literature that informants sent us about the Tøndermarsk law, bird population trends, and the cultural history of the area. One limitation about reviewing literature was that most literature about the area was written in Danish, and only one of our group members speaks Danish.

### 3.1.2 Interviews

While in Tønder, 11 semi-structured interviews (SSI) were conducted with various actors (given pseudonyms), including three local farmers, three informants from the Danish Nature Agency (DNA), an informant from the Danish Bird Protection Fund (DBPF), an informant from the Wadden Sea National Park (WSNP), a historian from the Sønderjylland museum, and two local residents. Interviews were conducted to learn about local perceptions and to understand the different practices surrounding farming in the area. Although only three farmers were interviewed, this creates a representative view of farming in the area because the majority of farmers graze their animals outside of the Tøndermarsk area.

Questions asked to all informants including perception of the Tøndermarsk law, state vs. private land management practices, bird population changes, and cultural heritage- in an effort to gain perceptions coming from opinions with different interests. The various SSI guides can be found in Appendix 6. One limitation of the interviews was that we tended to ask questions in the moment based on what was said by the interviewee as we felt that it was important to allow the informants to talk about what they thought was of note. Another weakness is that our semi-structured questions changed during field work due to new knowledge acquired through the week, so we did not receive answers from all informants.

### 3.1.3 Questionnaire

We created a questionnaire with 24 questions, aimed at targeting the local population of Tøndermarsken. In addition to questions used to establish participant positionality, questions involved knowledge and perceptions of the Tøndermarsk law, factors of importance in the area, and perceptions of changes in bird population and the landscape. If a respondent said they have heard of the Tønderemarsk law, they were directed to five more questions regarding the law. The full questionnaire can be found in Appendix 4.

Prior to questionnaire dissemination, it was tested on four peers, and minor changes were made based on their feedback. The questionnaire was posted in three Facebook-groups dedicated to the local residents of Tønder and Højer. The questionnaire was also given in person in local towns; Tønder and Højer; near Tøndermarsken.We received a total of 59 fully completed questionnaires. Once all responses were received, responses were coded and answer categories were combined for the purpose of statistical analysis. Using responses from the questionnaire, statistical analyses were run in order to find connections between different various factors. When evaluating the significance of the produced p-value, a confidence threshold of 0.10 was used due to the small sample size.

One limitation of the questionnaire was made obvious when distributing it in person -as we had the chance to explain what was meant by the Tøndermarsk law for those who were unsure. When given an explanation, some respondents may have responded differently to the question on the awareness of the law. Another weakness can be found in the question on perceptions of whether bird populations in the area have changed. This question lacks a temporal indication or species specification, so results were not able to support other findings from interviews.

### 3.2. Quantitative methods

3.2.1 Mud sampling

All farmers interviewed stated a concern regarding increased probability for grazing animals to contract parasites, which they attributed to increased sitting water on fens. Farmer A stated that the main reason that higher water levels are harmful to livestock is because of the presence of parasites, a statement confirmed by farmers B and C that attributed to their preference of dry grazing fens. The parasite of main concern is *Fasciola hepatica,* a flatworm, which can cause liver-fluke disease that affects cattle and sheep. This disease has been connected to farm economic losses because it affects the meat quality and money has to be spent on antibiotics for prevention. (Sørensen et al., 2018). To carry out its life cycle (Figure 6), *F. hepatica*, needs an intermediate host, a snail, to allow *F. hepatica* to be able to reach its final life stage which is linked to its parasitic abilities within cattle and sheep (Horák et al. 2019). In our research area,

the snail species *Galba truncatula* is focused on because it is the only snail present in the area conducive for *F. hepatica* life cycle transformation.

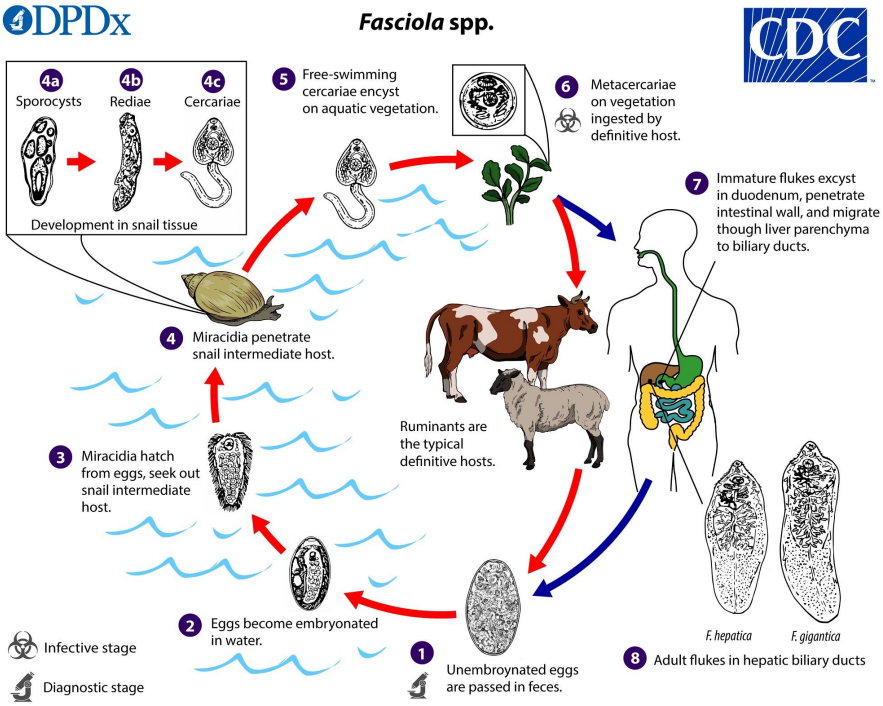


Figure 6: Life cycle of *Fasciola hepatica* (source: CDC)

In order to investigate the hypothesis made by Farmer A, and restated by Farmer B and C, mud samples from grøblerender were taken, because *G. truncatula* lives in the mud. A total of ten mud samples were taken; five samples were taken from DNA-owned land and five samples were taken from privately-owned land because of the different management styles. Each sample was composed of three mud collections from three different grøblerender. At each grøblerender, a 50x50 cm square was placed over the water to keep a consistent sample size. Samples were taken with a metal siv to drain the excess of water. Additionally, at all grøblerender sampled, the height of the water was taken to allow potential conclusions related to water height. All ten samples were investigated for the presence of *G. truncatula* through the use of a microscope.

At the locations where mud samples were taken, a GPS waypoint was made for the purpose of creating a sample collection map (Figure 7) that can allow for future discussion of how factors such as location, vegetation, and visible water may affect the presence of *G.truncatula.* Satellite

images from Google Earth were also taken to analyze for potentially visible differences in visible water and vegetation in an effort to tie visible trends to changes after events such as the implementation of the law and the 2017 land swap.


Figure 7: Map of mud sampling sites (Source: Google Earth)

A weakness of the mud-sampling method is the lack of ability to identify *G. truncatula.* Due to lack of zoological knowledge it was impossible to identify with any certainty the species of the snails found in the samples. The season may also have affected the presence of the snail. To add, only ten samples were taken which limits the likelihood of finding snails and the ability to create any statistical conclusions regarding the relationship between water height and presence of snails. Lastly, grøblerender were chosen more-or-less by random because, on private fens in particular, because not all grøblerender had sufficient water for sampling, limiting available grøblerender for testing.

### 3.2.2 Bird populations trends

Results regarding the bird population trends were made from a comparison of reports published by Clausen et. al. (2010), Clausen et. al. (2016), and Nielsen et. al. (2021). Perceptions made by informants and respondents from the questionnaire were used to support data produced by the reports used. As the breeding meadow birds are of key importance in Tøndermarsken, the species we chose to examine from the reports are the most common breeding meadow bird species in the area (Clausen et al., 2016). The chosen species are among the common meadow breeding bird species in Tøndermarsken: Eurasian oystercatcher (*Haematopus ostralegus*), Northern lapwing (*Vanellus vanellus*), Redshank (*Tringa totanus*), Great bustard (*Otis tarda*), and Black-tailed godwit (*Limosa limosa*). Only breeding birds were examined because according to DNA (2011), these are the birds which face the most decline in the area. In the reports examined, the trends are examined through the population targets set in the Statement 1999 (Clausen et al., 2016.)

All chosen bird species are also migratory birds (Statens Naturhistoriske Museum, n.d.) that have historically bred in Tøndermarsken (Clausen et al. 2016.) Due to the nomadic nature of these birds, there is no annual threshold of population that is stable. Some populations of these species stop in Tøndermarsken for their breeding season in spring, on an annual basis, if they are able to find an optimal habitat- but this is not guaranteed each year. (Newton, 2010.) As a result, certain migration species may be present during one population count and not another, but the cause of this whether it be seasonal, weather related, or other is difficult to say with certainty. The migration patterns of chosen species were not feasible for us to examine but it is acknowledged that they are of possible impact on the population trends assessed in Tøndermarsken due to their varied presence based on multiple factors.

A weakness of the research method related to bird populations is the inability to make in-person biodiversity/population measurements due to lack of time and improper season. Due to this, there is no snapshot data to compare to the trends found in the reports.

# 4 Results

## 4.1 Perceptions of the Tøndermarsk law

The Tøndermask law is unique as a means of protection - considering both the natural and cultural significance of the area. The complex, various interrelated factors, actors and contradictory interests make the examination of the function and relevance of the law challenging. Based on interviews with different actors in Tøndermarsken, it was found that farmers, informants from DNA, WSNP, and DBPF all believe that the Tøndermarsk law is necessary and useful; reasoning that the area would have been plowed and overexploited without the law. However, personal perceptions of the law largely depend on occupation and personal interests. When comparing perceptions, informants view the law through the lens of their interests; farmers see that the law has gone too far with changes in the landscape, and the informants from DBPF, DNA, and WDNP, with an interest in birds, believe the law does not protect birds well enough.

Varying perceptions were produced from interviews. For example, an informant from DBPF states that: “overall the law is good, it has helped birds. If the law was not in place, the land would be completely cultivated. However, birds have a lower priority, which is the problem with the law” (SSI with DBPF informant.) DNA informant A also believes that the Tøndermarsk law is more concerned with the protection of the cultural landscape and bird protection is a secondary concern (SSI with DNA informant). Conversely, Farmer C claims the dedication to bird preservation within the law allows the state to alter the cultural landscape under the motivation of conservation (SSI with Farmer C). This statement is echoed by Farmer B who states that the law works but not in a way favored by farmers: “ if the mode of management was kept as it used to [before the law], the fields would be beautiful and green and the cows could graze” (SSI with Farmer B). Farmer A also suggested land management be changed to allow the conversion of some fields into crop production: “not to be plowed, but to get new grass in order to see if it would have a positive effect on the birds. It would also be an advantage for the farmers.”

Farmer C comments on the way Tøndermarksen is managed today. He believes that the state is changing the landscape that people have created, and that the landscape has always been protected: "If it wasn't protected it wouldn't be a marsh. It is something we have always protected. This area is built by the people". Contrarily, Farmer C believes that the marsh would have regulated itself somehow without protection. (SSI with Farmer C.)

When asked if they knew about Tøndermarsk law, local residents A and B - business owners and active members of the community, were unaware of the law by name. After being shown a map of the area within the law and given a brief explanation, they were able to give their perceptions. They were aware of the limitations the law poses to them regarding crops and grazing, but this does not hinder their tourist-based business (SSI with Local residents A and B.) The awareness and perceptions of Tøndermarsk law can thus be said to be affected by various factors such as personal connections and occupation that impact how familiar a person is with the law.

Results from the questionnaire indicate a general lack of knowledge about the law since only 38% of respondents from the area of Tøndermarsken answered 'yes' and 62% of respondents answered 'no' to the question "have you heard of the Tøndermarsk law?" (Figure 8).

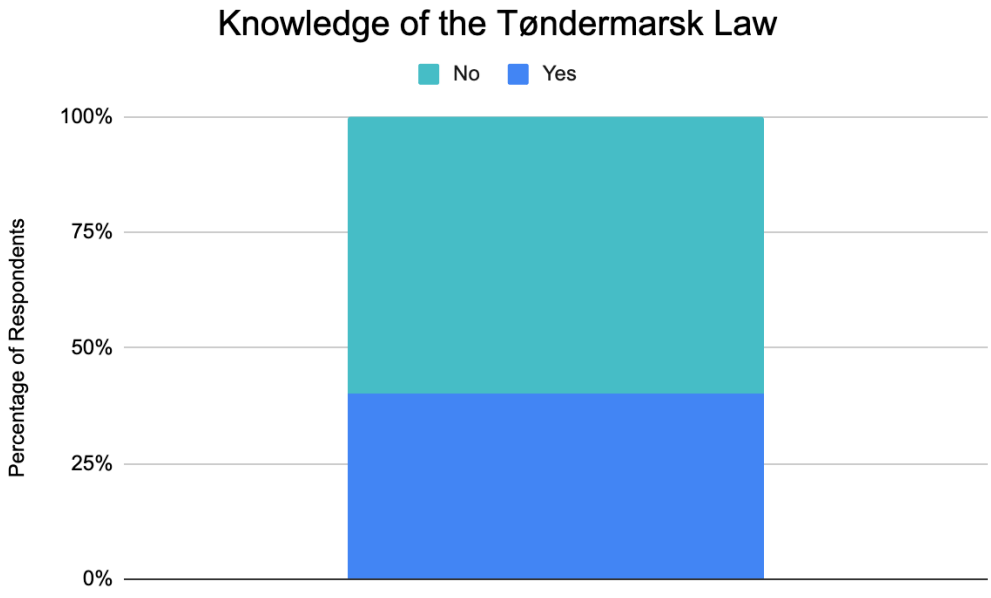


Figure 8: Questionnaire answers on knowledge about the Tøndermarsk Law.

In order to see if a statistically significant relationship exists between age and the awareness of the Tøndermarsk law, a chi square test was carried out. The null hypothesis can be rejected because the p-value of 0.092 is less than the 0.1 confidence threshold. From this, it can be stated that the results are *significant;* there is a statistically significant relationship that exists between age and knowledge of Tøndermarsk law (Figure 9).

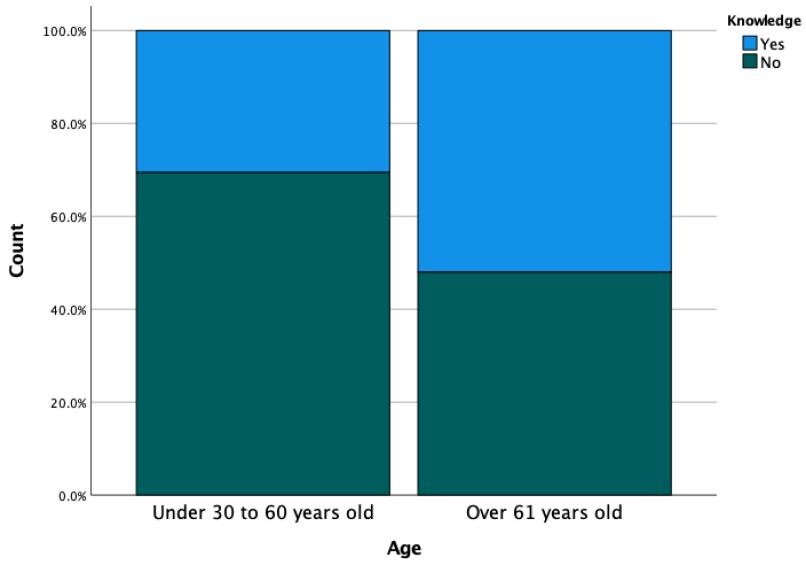


Figure 9: Correlation between age and knowledge of the Tøndermarsk law.

Furthermore, a chi square test was run to find the relationship between how often a participant visits the area within the Tøndermarsk law and their awareness of the law. The null hypothesis can be rejected because the resulting p-value is 0.077, which is less than the confidence threshold of 0.1. From this it can be stated that the results are *significant*; there is a statistically significant relationship between how often a participant visits Tøndermarsken and awareness of the law (Figure 10).

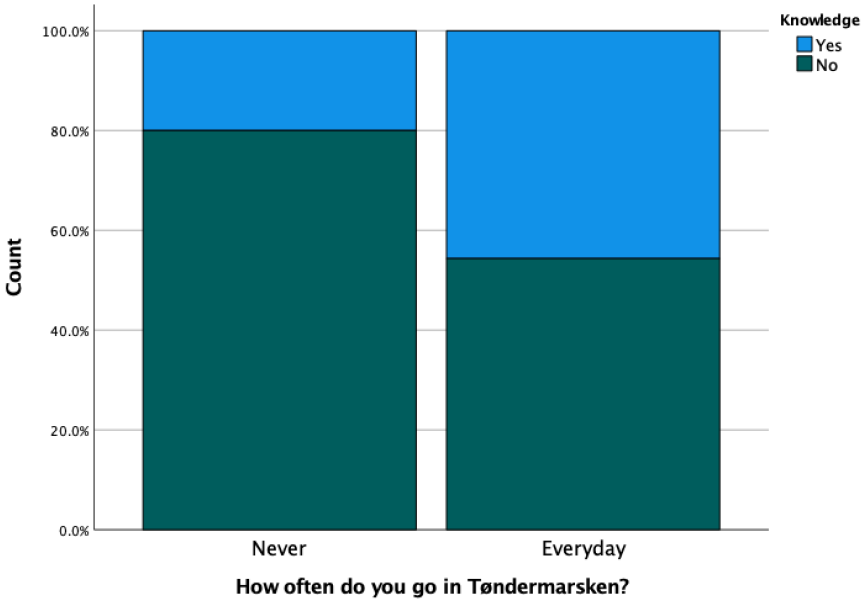


Figure 10: Correlation between visits to Tøndermarsken and knowledge of the Tøndermarsk law.

The historian from Sønderjylland museum views varying perspectives on the law from the viewpoint of the culturally significant landscape. In her opinion, the law emphasizes the protection of birds more than the cultural heritage (SSI with Historian from Sønderjylland museum.) She also believes that Tøndermarsken is not solely a cultural area or wildlife hotspot and the conversation surrounding these topics should be more intertwined. For example, "hydrology projects don't always consider the cultural history…both the biological diversity and the culture can be protected". (SSI with Historian from Sønderjylland museum.)

The questionnaire results further reflect varying perceptions of the law. Opinions of the successfulness of the Tøndermarsk law are; 52% of people saw the law as successful, 22% saw the law as unsuccessful, and 26% saw the law as neither (Figure 11). When asked to elaborate, answers included, the law increases knowledge of the area, offers security and the law makes an effort to accommodate interests vested in nature and business, while others felt there was too much resistance to the law for it to be successful.

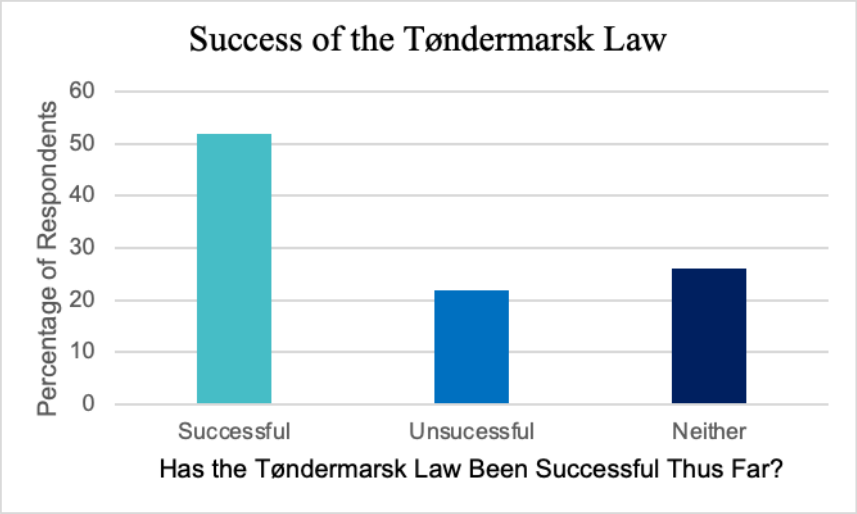


Figure 11: Questionnaire answers on the success of the Tøndermarsk law.

Additionally, when asked to judge the necessity of the Tøndermarsk law, 64% of respondents saw the law as necessary while the remaining 36% felt unqualified to answer or felt the law was unnecessary (Figure 12). Elaborative answers on this included the requirement to protect grazing, wildlife, and culture and to increase tourism, while others who felt the law was unsuccessful also believed it was not necessary.

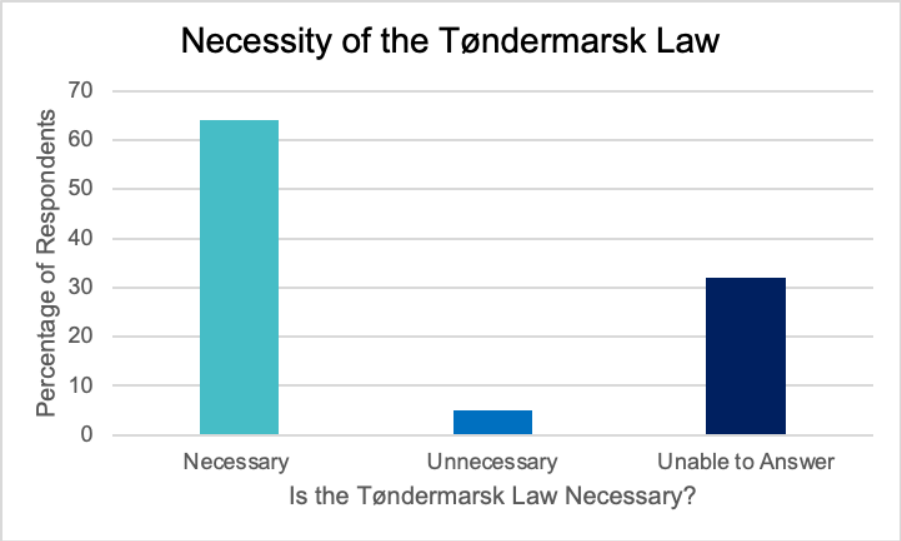


Figure 12: Questionnaire answers on the necessity of the Tøndermarsk law.

### 4.2 Bird population trends

Various bird species found in Tøndermarsken went through a decline in the 1980s. Since the establishment of the Tøndermarsk law until 2015, populations have not recovered to the pre-law levels. Populations of some bird species have increased, while others have decreased, and some have stayed the same; there have not been consistent trends across all species, and no recent increases have been significant (Clausen et al., 2016; Clausen et al., 2010.)

From the 1980s to 2015, Lapwing, Redshank, Great bustard and Oystercatcher have experienced unstable trends. Additionally, these species have not reached population targets set within the Statement 1999. Black-tailed godwit experienced sharp decline between 2009-2012 and then mild decline between 2012-2015 (Figure 13). (Clausen et. al. 2016)

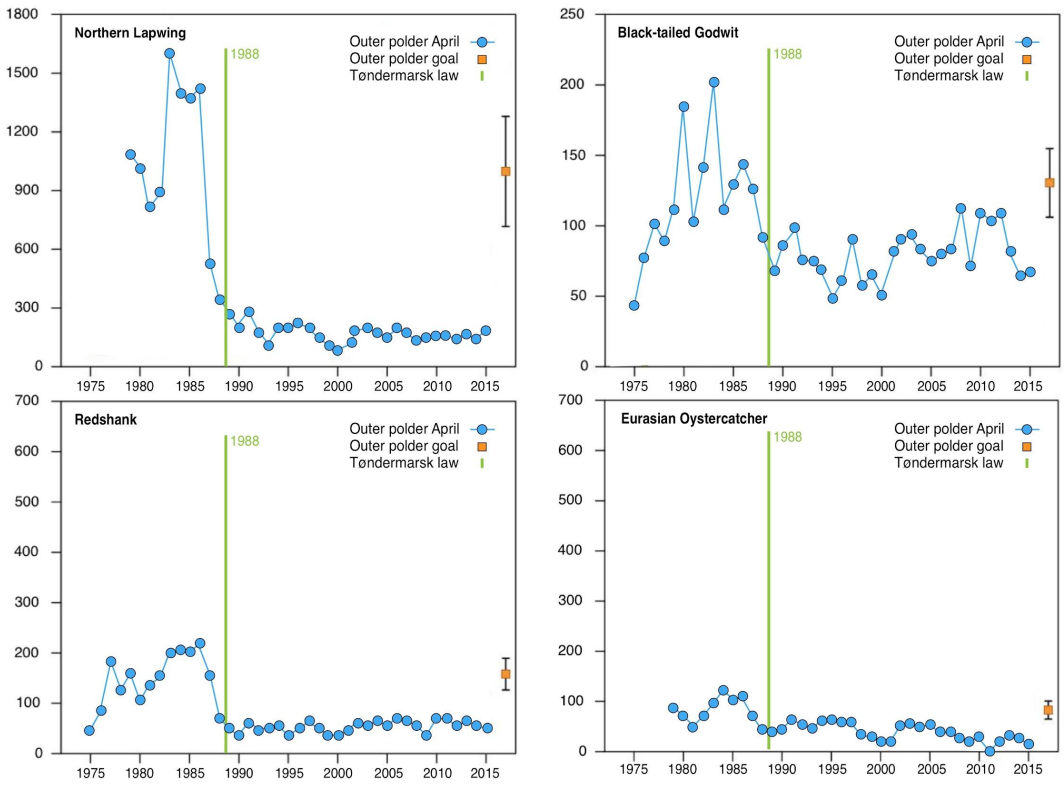


Figure 13: Development of the breeding populations of four species in Tøndermarsken outer polders between 1975-2015. In orange the objective is stated in the Statement 1999 (Danish Forest and Nature Agency 2000). All counts have been done in April, and are expressed in breeding pairs (Source: Clausen et al., 2016)

The most recent data on bird populations in Tøndermarsken only includes Gammel Frederikskog from 2021 and trends are relayed by number of pairs; this report does not make comparison to previous reports. The amounts for the chosen species, for 2021, are as follows: two pairs of Oystercatcher, 26 pairs of Lapwings, 43 pairs of Redshank, and 26 pairs of Black-tailed godwit. No conclusions on temporal bird population trends can be made based on these numbers because this report only covers one polder and collects population data in a different way than Clausen (2016). Despite low population numbers, informants from the DNA have observed an increase in bird populations within state-land since the 2017 land (SSI with DNA informants A and B), although data to support these observations are unavailable.

Farmers expressed varying perceptions of bird population trends. One farmer had not observed any changes (SSI with Farmer B), and another mentioned variation by species: "Some species decrease, others increase. We can try to change or regulate some factors, but the law cannot decide everything" (SSI with Farmer A). Geese were mentioned as a major concern because of the observed increase in populations: "35 years ago there were no geese, now there are more than 100,000" (SSI with Farmer A). Increasing geese populations pose a threat to fen vegetation because geese eat the majority of grass on the field, so there are poorer conditions left for grazing animals and birds. The increase in geese contributed to the higher water levels within the fens (SSI with Farmer A and C). Concern over geese was confirmed by DNA informant B, but he felt migration changes were affected geese increase more than water levels (SSI with DNA informant B.)

Various bird population trends are also reflected in questionnaire responses; 49% of respondents were unaware of any changes in the bird population, 34% saw the population had increased, and 12% had seen a decline (Figure 14). The causes behind the trends mentioned are mainly related to climate change and other environmental factors, increased bird protection and some mentioned actions like cultivation.

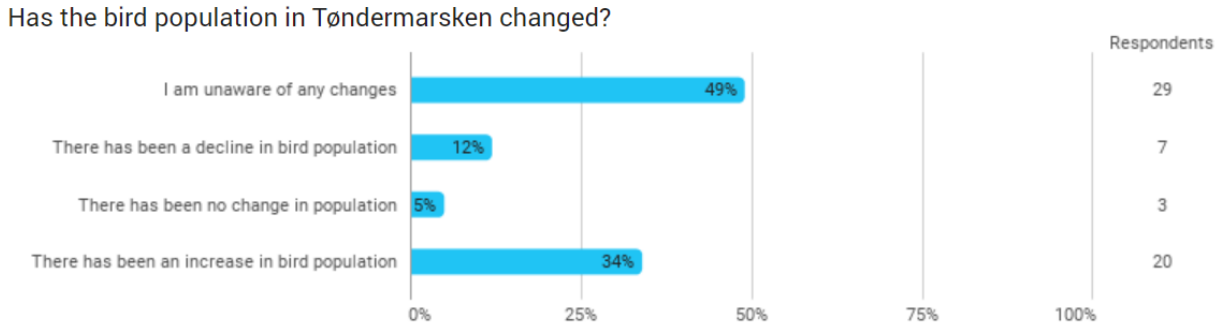


Figure 14: Locals' perception on the change in bird population trends.

The examined reports on bird population trends discuss multiple causes of declining populations related to management practices and natural conditions of the area from the 1980s onward. Additionally, it was reported that the previous amount of cattle grazing during the breeding season was too high, causing the fields to be overgrazed and unusable for nest creation, while cattle were trampling eggs and chicks (Clausen et la., 2016; DNA, 2011.) Moreover, declining trends have also been linked to weather conditions such as icy winters and poor spring rain between 1986 and 1987, followed by poor precipitation years (DNA, 2011).

Predators have also been cited as a threat to bird conservation. Between the 1990s and 2000s, mammalian predators and birds of prey were considered one of the major causes that led to a significant decline of breeding meadow species (Clausen et al. 2016). Today predators are not a principal concern of bird conservation due in part to hunters employed by the DNA and volunteers who hunt foxes and raccoon dogs before the bird breeding season who are able to keep predator stock at a level not threatening to bird conservation (SSI with DNA informant A & B.)

### 4.3 Current management practices

The state's conservation efforts in Tøndermarsken include land and water management, grazing, and predator control. DNA informant A states that it is clear that, to him, the efforts of the state are helping bird ecosystems in comparison to privately-owned land. The results of land management in Tøndermarsken are elaborated on in the next section. The amount of state-owned land has increased as the state continues to purchase land, as can be seen in Figure 15 which is

done with the goal of having more land for bird protection. According to DNA informant C, the state is not currently trying to buy up more land as it is a lengthy process completely dependent on government funding. Farmer B worries that the state plans to buy all of the land in Tøndermarsken, which he believes will have detrimental impacts on the landscape (SSI with Farmer B)

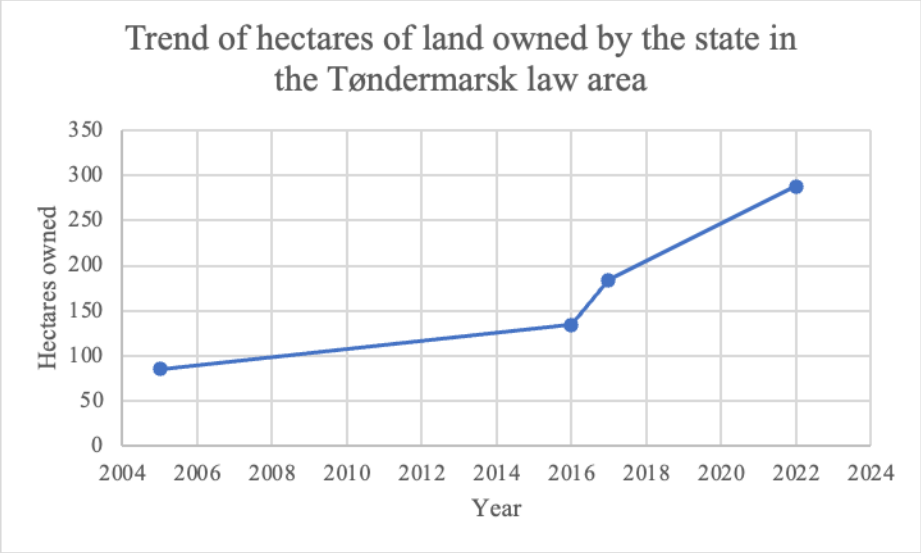


Figure 15: Amount of state land in hectares (Source: SSI with DNA informant A).

4.3.1. Water management

The Dike guild controls the use, functioning, and maintenance of the water system, including the dikes and pump stations, where the water is let into the area through channels from Højer to Rudbøl. According to the Tøndermarsk law, the Danish state pays for the costs, which is about 1 million DKK/year. According to Farmer A, the Dyke guild still follows regulations on water management from 1941. The regulations maintain things such as particular sizes of canals and grøblerender. He states that: "It would be too difficult to change these regulations now because there are so many complex and competing interests", but that there have been small changes over the years. (SSI with Farmer A.)

Within the state-managed land, the most important management practice involves closing off drainage channels to stop sitting water on fens from running into the surrounding canals. (Figure 16). By doing this, the water level is kept higher in the grøblerender during winter in order to

maintain high water levels on the field until the birds' breeding season in the spring. The state must be cautious to not create a 'lake' of sitting water as a result of increasing water sitting on the field; to do this would violate the limitations within the Tøndermarsk law which prevents the cultural landscape from being compromised. (SSI with DNA informant A). After the breeding season, cattle are let out to graze to keep the grass at an appropriate level for the birds and chicks. This management practice is not done in privately owned land, where landowners attempt to keep fens as dry as possible by leaving the drainage channels connected to canals, also shown in Figure 4. DNA informant A observed presence of more birds on fens managed by the state rather than on the drained fens, such as those owned by Tønder municipality and other private landowners (SSI with DNA informant A). We were not able to verify any of these claims in our research. Further conclusions on the development of bird population trends on state-land - and the impact of increased water levels - cannot be made due to the lack of bird population data on the years of state's management.

Figure 16: The connections of the drainage channels to the canal. The picture on the left has been taken on a privately owned field and reveals the drainage channel that flows in the canal (red circle). The picture on the right has been taken on state-owned land and reveals clearly how the drainage channel is still full of water, because the connection with the canal has been blocked.

From in-field measurements taken on the five state-owned and five private-owned fens, average surface water levels in grøblerender depict higher water levels within state-owned land, measurements can be seen in Figure 17.

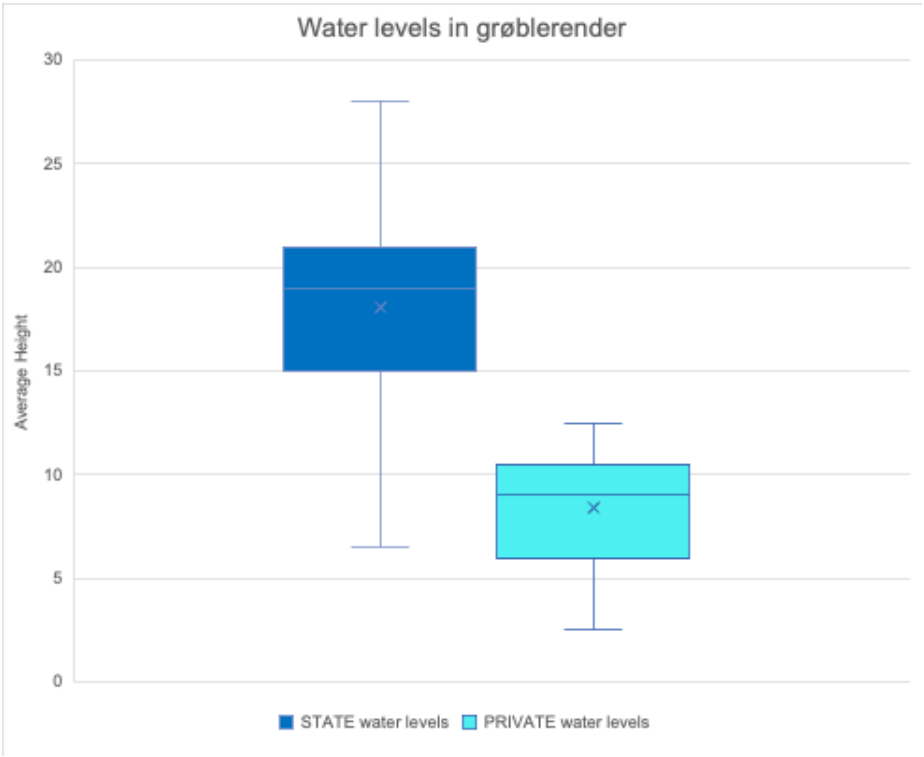


Figure 17: Data represents measurements from five plots in one state-owned fen and one privately owned fen (height in cm).

The differences in water level on the fields, which can possibly be attributed to different management practices, are visible by satellite imagery (Figure 18). The pictures below depict the portion of Gammel Frederikskog that is owned by the state today. Both pictures are from March, the picture on the left is from 2016, before the land swap, and the picture to the right is from 2022. The satellite imaginary's lack of information related to weather conditions and the likelihood of a different camera used may have biased our assumptions made based on observations.

Figure 18: Satellite images on the state-owned land in Gammel Frederikskog (Source: Google earth).
Left picture: March 2016. Right picture: March 2022. The red line marks the area that the state owns today.

The only observable water in Figure 18 (left picture) is what is present in the canals, which is shown as darker lines between the fens and within the small circular puddles on the fens. Apart from this, there are not high amounts of sitting water present on the field. When examining the satellite images it is evident that there is more water on the fields today (right picture), creating dark spots on the image. The appearance of Figure 18 aligns with changes in water levels noticed by farmers and how the DNA describes their management practices in the area.

### 4.3.2 Grazing practices

In addition to water levels, grazing practices play an essential role in bird protection. According to DNA Informant A, grazing animals are needed to achieve optimal grass height and heterogeneous landscape that is ideal for bird ecosystems (SSI with DNA informant A). Birds favor conditions of heterogeneous vegetation so there are places to hide from predators and lay eggs. While both sheep and cattle are important grazers, cattle are preferred by the state and birds because of their unique eating habits which produce preferred vegetation patterns that differ from the ways the sheep graze. (SSI with Farmer A & WSNP informant).

In order to maintain the ideal ecosystem conditions that grazing animals create, the DNA rents the state-owned land to farmers who then pay to graze their animals on this land. The DNA selects farmers by choosing the highest bidder, and in this way they can control the number of grazing animals on the state land and the season when grazing occurs (SSI with DNA informant

B). One informant from DNA reported that they are experiencing difficulty with attracting farmers (SSI with DNA informant A), while another informant did not believe that lack of grazing cattle posed an issue for the state (SSI with DNA informant C). If, however, the state is not able to find farmers to graze on their land, they are forced to mow the plots mechanically, but in a way to replicate how cattle graze. (SSI with DNA informant A ).

Farmers also believe grazing animals are important for maintaining the marsh landscape, but not necessarily for the protection of birds. Based on results from interviews with farmers and informants from DNA, it becomes clear that there are less cattle in the area of Tøndermarksen today than at the time that the law was implemented. Farmer B states that there are some farmers who have their cattle grazing in the state-owned areas, however in these areas they are not able to let cattle out to graze until June 1st, which is very late in the season, because of bird ecosystem requirements. As an organic farmer, Farmer B is obligated to have his cattle outside; he has his cattle grazing from the beginning of May to mid-October. He is using his own good soil around his farm for fodder production and therefore must rent land for the about 300 grazing heifers elsewhere. According to Farmer B there are a lot of organic farmers in the area, and with the state-owned projects in Tøndermarsken (Sejersbæk Kog, Margrethe Kog, and Gammel Frederikskog), this has made it to 'a battle of the fields' since many of the organic farmers refuse to let their cattle graze in the state owned land.

### 4.4. Outcomes of current land management practices

The water level desired by the state is not considered suitable by farmers for grazing animals because of the increase in problems related to disease, grass quality, and machinery function. The farmers have noticed a decrease in the number of cattle in the area, which is because of the raised water levels on the fens that they do not want to deal with. They also stated they would never put their cattle in the state-owned areas because they are too wet and grazing there would be too risky. (SSI with Farmers A, B & C.) When offered by the state, farmer B refused a 1000kr subsidy to raise water on his fields, claiming the subsidy would not mitigate the risk that higher water levels pose. Ideally, farmers prefer there to be no water in their fields (SSI with Farmer B).

Farmer C claims that higher water levels lead to a decline in grass quality in addition to threatening movement and machinery. Balls of grass called Common Rush (*Juncus effusus*) form due to excess water. Common Rush is invasive, difficult to remove, and cows do not want to eat it (SSI with Farmer C). The difference in grass quality on state owned land and privately owned land can also be seen on Figure 16, where the color of the grass is greener on the privately owned land where the water is drained from the fens, than on the state owned fens, where the amount of water is higher. According to Informant A from DBPF the grass is much greener and the fens are dry in the privately owned land. This fen is good from the farmer's point of view, but it is not so attractive to meadow birds. In the state-owned fen, the grass is browner and the fen is wetter, i.e. with more natural hydrology. In a wet pasture the grass grows later and becomes greener later in the season, than in a dry pasture, simply because the temperature in the root zone and on the surface is lower in the wet pasture than in the dry pasture. This is because water heats up more slowly than soil. The growth of grasses usually starts at about 8 degrees. “So the wet fen has more quality from a natural point of view, while a farmer would find it less valuable [has poorer quality]). (SSI with DBPF informant).

According to farmers, in addition to the increase in undesirable grass, increased sitting water on fens also increases the presence of the snail *G. truncatula* which can be infected by the parasite *F.hepatica* (SSI with Farmer A). The results of the ten mud samples taken to investigate the presence of snails are depicted in Table 2. As seen, only one snail shell was found out of all ten samples.

Despite visible differences between surface water levels in state and private fens, there was no observed evidence that proves a higher presence of *G. truncatula* higher water that correlates with levels found in state-owned fens. As shown in Table 1, only one snail shell was found in the P2 sample.

Table 1. Quantity of snails found in mud samples. *Note that the number of snails recorded include all snail species’ shells (dead or alive) and does not confirm species*

| | STATE OWNED LAND | | | | | PRIVATE OWNED LAND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Field code** | S1 | S2 | S3 | S4 | S5 | P1 | P2 | P3 | P4 | P5 |
| **# of snails** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

Furthermore, the shell cannot be completely identified as *G. truncatula* or a different snail (Figure 20). Figure 19 shows a photo of the shell found.

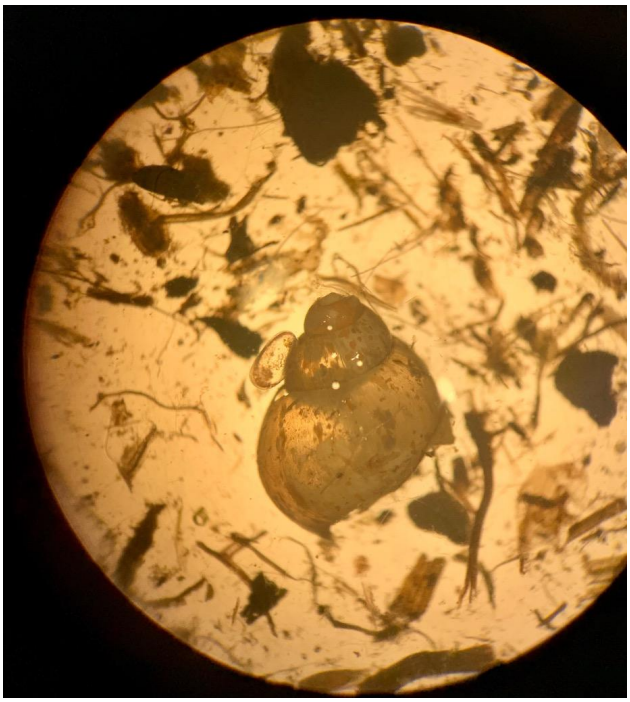

Figure 19. Photo from microscopic analysis of shell found in sample P2.

Figure 20: Photo of a snail *Galba truncatula. (*Source: Wikipedia*)*

Farmer C believes that there are now more parasites since the implementation of the law and farmers are thus required to use more antibiotics to treat them (SSI with Farmer C). But all farmers (A, B, and C) preemptively treat their sheep and cattle with antibiotics two times per year, regardless of the presence of liver fluke symptoms (SSI with Farmer A), which is also why informant B from DNA don't believe *F.hepatica* is that big a problem (SSI with DNA Informant B).

Another problem that may affect the amount of cattle in Tøndermarsken is the shift to more intensive farming practices, where cattle are kept inside and fed by schemes, which is more economically efficient than having them grazing, because the farmer then cannot control what they eat. (SSI with Farmer A and C). If it was not for organic farmers, who are obligated to have their cows grazing outside, the problem would have been bigger (SSI with Farmer B). He believes that in the future, only 'angus cows' are able to graze in the state-owned fens (SSI with Farmer B). Farmer C, also highlighted the size of the state-owned fens as a problem that ruins the landscape. "Before only five or six cows would graze in each field, but now the fens has become bigger with 60 cows on each". The cattles then walk in big groups, moving from one plot to another. DNA confirms that they increased the size of the fens, by adding water piping under fens to keep water out of the canals However, this cannot be seen from the satellite pictures (Figure 18).

# 5 Discussion

The multiple results of the study portray the complex nature of conservation in Tøndermarsken. Bird population trends, management practices, including grazing and water management are all inextricably connected, making it difficult to discern the success and relevance of the Tøndermarsk law today. The following sections will discuss our findings and used methods. Finally our findings will be discussed in relation to the broader context.

## 5.1 Discussion of findings

One of the main objectives of the Tøndermarsk law, is the maintenance of the biological and cultural values of national and international importance (Retsinformation, 2004). Upon further

investigation into the relevance of the law, and due to lack of sufficient data and lack of specific targets within the law, it can not be said with any certainty that these goals have been met; since bird populations have not experienced an overall increase, and farmers feel that the landscape is undermined because of the way the DNA manages the land. Farmer C expresses this when he says "The state wants to change what the people have created…It is something we have always protected" (SSI with Farmer C). Multiple informants expressed that if the law was not implemented, the land would have been completely cultivated, making the law relevant for landscape preservation. In spite of the main state sponsored management practice for bird protection being the regulation of the water levels, the law prohibits the state from drastically changing the landscape by increasing water levels too much. DNA (2011) describes the maintenance of cultural heritage to be "closely linked to the maintenance of the old form of operation with grazing areas and grain-cultivated areas without high vegetation as well as the seasonal drainage and irrigation". Without cattle grazing, the landscape would not be the grassland that the Tøndermarsk law states is required to uphold for both bird protection and cultural landscape. By guaranteeing grazing is able to continue, the law is still relevant when it comes to the preservation of the cultural landscape and the subsequent protection of grazing livelihoods.

Despite the importance of grazing for ensuring cultural heritage and favorable ecosystem conditions for birds, a common response heard while conducting interviews was that the ways in which the state manages the land is incompatible with desired conditions for grazing; for instance, Farmer A prefers to have no water on his fields during the grazing season (SSI with Farmer A). It can not be stated with any research-supported certainty that the state-owned lands undermine cultural protection, but it is necessary to note the lack of grazing interest expressed by farming informants that is directly related to the amount of sitting water on state-owned lands. Considering the opinions of general unfavorability of state-owned lands expressed by farmer informants, this brings in a potential topic for analysis regarding the impact state-owned lands has on cultural landscape preservation. In addition to preserving culturally significant grassland maintenance, cattle have been shown to improve habitat diversity and plant species richness (Bos et al., 2002). Bos et al's (2002) study showed that 23 out of 30 bird species in Southwestern Denmark were significantly more present in grazed areas than in ungrazed. Studies also indicate

that salt marshes with short-growing plants are not only preferred by grazing animals but also by waterbirds providing them good food provision and protection from predators (SSI with DBPF informant.)

The DNA manages their land in favor of the breeding bird populations, however, due to lack of recent and comprehensive data including all of the Tøndermarsk, it cannot be said with any certainty that the state management practices actually are increasing bird populations. Furthermore, we are unable to conclude if areas managed solely for grazing are incompatible with bird life. In line with the species habitat requirements, some interviewed farmers' affirmation related to Northern Lapwing preferring dryer crop land rather than wet land, as they were finding them on their fields. Water is an element essential to birdlife; studies have shown changing trends in bird populations related to water levels (Kim et al. 2008; Niemuth et al. 2008.), since various species require specific habitat conditions for their breeding. This makes it infeasible to operate landscape conditions for the sake of all species as they have different requirements (Clausen et al., 2016).

Since the state-private land swap in 2017, landscape management with bird preservation as the goal has been primarily carried out on state land. The closing off of the drainage channels and high water levels in the grøblerender are considered beneficial for the birds, but there are limits to this so as to not change the traditional landscape. Due to the lack of data on bird population trends after the land swap, we have been unable to verify whether or not these efforts have made a difference beyond their own observations. In addition to this, the desire of the state to purchase land calls to question the functionality of the law - if the law worked as it was intended to, ideally the state's purchases and separate management practices would not be necessary for bird conservation. Moreover, the differing practices in the state and private land, call to reassess the necessity of the law. Since bird protection management is primarily implemented in the state lands- a question can be raised about the necessity to regulate the practices on the private land by the municipality.

From the farmers' point of view, state-managed fens can be considered harmful for their grazing animals due to diseases, grass quality and machinery function (SSIs with Farmer A, B, and C).

Therefore none of the interviewed farmers would rent land from DNA. Grazing pressure (cattle per hectare) on the larger sized state-owned fens could be an indirect cause of grazing competition with larger herd sizes, since the daily intake of grass per cattle decreases with increasing herd size (Sørensenet al., 2018). Prevention of parasites is also important to achieve satisfactory growth of heifers on pasture and ensure meat quality. Larsson et al (2006) showed that rotational grazing can control the infection with *Fasciola hepatica* at almost the same level as frequent doses of antiparasitic agents. It can therefore be argued that the larger sized state-owned fens could lead to more cases of infections with *F.hepatica* (Larsson et al., 2006), however based on our in-field experimentation this was unable to be confirmed. The relation between herd size and higher risk of contracting parasites is also supported by literature (ibid).

**5.2 Discussion of methods**

Throughout our research, the use of different methods helped us to unwrap the different aspects associated with our research question on the relevance of the Tøndermarsk law. The combination of methods from social science and natural science to build up our analysis is a strength of this study as this provided a good overall understanding of the reality surrounding Tøndermarsken in relation to the Tøndermarsk law.

As one of our main methods, interviews with key informants have proven to be very interesting and effective in broadening out the situation in Tøndermarsken. These interviews gave us insight into the main issues that actors in Tøndermarsken face today. We then investigated some of the issues further, the surface water level in the grøblerender, and the quantity of *G. truncatula* in state-owned land and privately owned land in Tøndermarsken. However, studying the conditions in a marsh landscape, which is constantly changing, is difficult to do in only two weeks of field work. Because our data only show a temporal snapshot and cannot be representative of Tøndermarsken. For example, February 2022 has been the second wettest month since 1974 and unusually warm, while March so far has proven to be more dry and warm than usual (dmi, 2022). Similarly, February 2022 being an unusually wet time questions our ability to compare the two satellite images from 2016 to 2022 (Figure 18), as it appears there is much more water on the fields in 2022 than in 2016. Having temporal data, or the ability to collect data throughout the year, would have created a clearer picture on surface water level dynamics.

The farmers' concern related to the snails and the parasite can suggest the presence of the parasite in the area. Although we have reported finding a shell on one of the private fields, we are very far from confirming any differences between state owned land and private land in terms of *G.truncatula* quantities in relation to the water level management. We did not identify any living animals, the shell we have found could not be identified as *G.truncatula*, and this neither represents the presence of the snail on the field nor the absence. Our results related to the presence of the parasite may have been biased by the method and the season we chose to collect the mud samples. The main hypothesis when sampling the quantity of *G. truncatula,* was that the quantity would be bigger on state-owned land, due to the raised water level, than privately owned land. However, analysis for the presence of *F.hepatica* in *G.truncatula* would require further genetic analysis (Davis et al. 2020) which, due to economical reasons and experience, we would not have been able to conduct. Farmers' act of giving precautionary antibiotics to grazing animals needs further examination, because if this is true, this calls to question their reasoning of avoiding land with higher water levels for fear of higher risk of exposure to the parasite.

In our study, one of the main focuses is on the change in bird population trends, but as confirmed by an ornithologist (SSI with DBPF informant), it was not possible for us to do bird counting while in Tønder. Instead, we conducted a literature review on bird population trends, which limited our ability to draw conclusions. Originally, we planned to compare bird population trends from 2017 to today to the temporal change in state-owned land from the land swap (Figure 15). We planned to analyze the relationship with a linear regression to investigate if the amount of state-owned land had a positive effect on the breeding bird population trends. Unfortunately, data from after 2017 is not officially published yet. The lack of data on bird populations underlines the need for further research in Tøndermarsken.

Finally, the questionnaire proved to be an informative method in getting a general understanding of the local people's perception of the Tøndermarsk law and use of the area. However, answers we received from the questionnaires given in person may have provided different responses than those done online. Ideally, we would have standardized these methods without needing to provide additional explanation to respondents.

### 5.3 Discussion of the broader context

Prior to conducting research and field work, it was assumed that there would be a conflict between grazing livelihoods and conservation of birds due to the common assumption that natural resource extraction and conservation are unable to coexist. As put by Yeni (2014), "the key feature of conservation management [is] based on this idea of separation is the displacement of people from their living environment because providing more space for nature requires constraining people's lives and activities", which assumes the inherent incompatibility of conservation and anthropogenic activities. However, it is not always possible to separate cultural aspects and natural conservation because of deeply interconnected livelihoods. This is evident when considering natural resource use like grazing. In Tøndermarsken, the inextricable relationship is prevalent; as explained by Clausen et. al. (2013), "mowing or grazing of salt marshes is essential to maintain the low-sward, high nutrient plant communities necessary to sustain breeding and foraging birds, and once these practices are stopped, breeding waders and herbivorous birds abandon these areas" (Clausen et al., 2013, 529), confirming that traditional land management with grazing is necessary to create preferable bird conditions, important for conservation efforts.

The reality of the complex relationships which exist in Tøndermarsken depict the debate between natural conservation and cultural preservation that is ongoing worldwide (Benjaminsen & Bryceson 2012; Hiraldo, 2018). Imbalances of power between local communities and state/natural agencies often result in pressure against local people who often end up displaced or having to drastically change their livelihood strategies (Hiraldo, 2018). The Tøndermarsken case differs from these perceived realities which keep preservation and protection separate, because the area is protected by a unique local law - the Tøndermarsk law. Despite the inherent conflict that exists in how cultural protection is carried out in comparison to natural conservation, the law protects both cultural and natural values. Although some informants, for example the Historian from Sønderjyllands Museum, believe that the law does not go far enough to protect the culture, it is also voiced by other informants that the Tøndermarsk law seems to take the side of culture, protecting land-use practices, especially considering the further conservation efforts undertaken

by the DNA and the pressures made by international nature agencies such as Nature 2000 (SSI with Historian from Sønderjyllands Museum).

Conservation of biodiversity remains an important aspect in the area as it has been widely agreed on its importance for all human related aspects, both cultural, social and economical (Cardinale, 2012). Biodiversity, if well preserved, is an optimal opportunity for the development of human-related activities such as tourism (Nyaupane & Poudel, 2011). Tøndermarsken is widely famous for the migration bird phenomena of the Black Sun (*Sort Sol*), and it has been expressed by interviews and the questionnaire that it is one of the most important aspects of the area. For this reason, in 2016 an investment of 210 million DDK was given by the A.P Møller Fund and Realdania to protect the marsh, protect biodiversity, and secure better access to the area. This project has been criticized, as most money was not spent on actual environmental protection, but on the tourism project 'Our Marsh' and urban renewal of Højer. (Hansen, 2017.)

Controlling nature can be mismanaged, especially when there are external factors affecting the locally protected areas. This is the case for migrating birds (Newton, 2010). The law, put forth on a local level, aims to protect something that travels and is part of an international phenomenon rather than local. It is necessary to consider numerous factors that affect bird populations outside of the Tøndermarsk, such as migration, that can not be managed through the implementation of a local law. For example, this is seen in the case of the increase in geese population in Tøndermarksen. The geese population increase followed political changes in Russia, resulting in farmers abandoning their land that was ideal nesting conditions for geese. The geese, as migrating birds, then arrived in Tøndermarksen - an international circumstance. (SSI with DBPF informant.) Due to this complexity, the Tøndermarsk law case encompasses a colorful picture of local realities and their connections at the international level, and thus is far from being fully understood.

## 6 Conclusion

When considering the relevance of the Tøndermarsk law, there is not one overarching answer due to the variety of targets and numerous interests represented. It can be argued that the law is

still relevant when applied to the protection of the landscape, and thus the cultural heritage. As echoed by multiple informants, the law has played a crucial role in preventing overexploitation and drastic land transformations. However, in regard to protection of bird species it is unclear of the law's relevance. The law does not specifically say how protection should be approached nor does it lay out numerical targets to reach. Additionally, due to dissatisfaction with how bird conservation was being handled in Tøndermarsken during the early 2000s, expressed by DOF and the EU, the DNA took over bird conservation in the area. After the conduction of field work, there was no obvious evidence of any municipality-led conservation efforts that are separate from the state, despite jurisdiction of the law lying with the municipality. This brings the relevance of the law into question because the DNA is not a local organization and their primary motivations for conservation are related to international importance of biodiversity, more so than being motivated by the Tøndermarsk law. From this, the research question regarding the relevance of the Tøndermarsken law can be answered in multiple ways. The law continues to be relevant when it comes to ensuring grazing and the maintenance of the cultural landscape. When considering its relevance related to biological conservation, the answer is less straightforward.

The necessity for the state to become involved with conservation in the area could suggest that the law is not achieving intended protection of wildlife. The lack of a symbiotic working relationship between grazers and those who manage the DNA land may be attributed to the popular ideological sentiment that resource extraction and conservation are incompatible by nature and can not exist in the same area. Like what was recommended by Historian from Sønderjylland Museum, if the time is taken for those vested in grazing and conservation to meet and discuss a conjoined plan that facilitates grazing while considering bird conservation, the landscape could function in a way that includes all livelihoods.

Moving forward, there are multiple recommendations to consider. Primarily, it would be beneficial to have more publicized comprehensive bird population data, including temporal data and data that includes the entire Tøndermarsken. This will allow for effective analysis of changes in populations in order to understand the effects of state-owned land management to evaluate if new approaches need to be created. This is necessary due to the fact that effectiveness can not currently be concluded with supporting evidence. Secondly, more research should be conducted

surrounding the viability of approaching conservation and preservation methods in an interdisciplinary way or if management methods (conservation and grazing) should be kept separate. Further investigation could indicate that employing different land management practices could better protect biological diversity and preserve the cultural landscape because of the symbiotic nature of grassland preservation and conservation in the Tøndermarsk.

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# Appendices

## Appendix 1. Synopsis

The impacts of regulations on ecosystem conditions and cultural heritage in Tøndermarsken
Synopsis
25.2.2022

### Introduction

According to the WWF Living Planet Report (2020), there has been an “average 68% fall in populations of mammals, birds, amphibians, reptiles and fish between 1970 and 2016” (10). Due to the current global ecological crisis that threatens both the environment and consequently human survival, it is a matter of concern to find a balance between economic development and ecological conservation (Tian et al. 2018) - production and protection.

Tøndermarsken is an area in Southwestern Denmark and part of the Wadden Sea National Park. In recent years it has had to face this conflict between human development and conservation of nature. Despite its small size, it has unique cultural and ecological significance. Throughout history, it has gained cultural and economical importance due to the dike system, which protects Tøndermarsken from flooding from the sea and allows farmers to control water levels for the purpose of grazing (Tøndermarsk Initiativet, 2022). According to Tøndermarsk Initiativet (2022), “Tøndermarsken is created by the sea and shaped by the people "- one of the earliest examples of coastal protection. Control and regulation of the Wadden Sea through the dike system has become central to the cultural heritage of the area due to its history and ability to alter the landscape. Additionally, Tøndermarsken is home to the third largest bird population in Denmark when it comes to the number of bird species. The immense biodiversity makes the area an important location for conservation and recreational purposes. For its unique biological and cultural diversity, the area has gained the status of UNESCO world heritage. (Clausen et. al. 2013)

In order to preserve both cultural and natural aspects, a law titled Tøndermarskloven was established in 1988 on the area and put restrictions on the land uses. This law created regulations regarding land management in addition to regulations created by the National Park. (Clausen et al., 2016.)

We seek to answer the question: **How do land management regulations impact ecosystem conditions and the cultural heritage in Tøndermarsken?** To guide our research we will investigate the following:

- Why was Tøndermarskenloven created and how has it been implemented and perceived?
- How has Tøndermarskenloven shaped land management practices?
- How have current land management practices affected the cultural heritage and ecosystem conditions in Tøndermarsken?

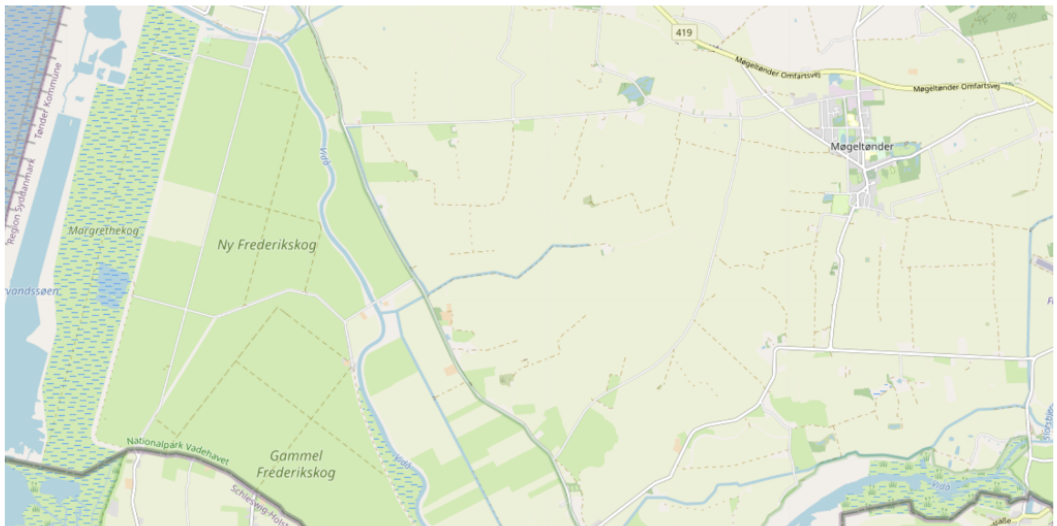
In order to answer these questions we will collect qualitative and quantitative data. Moreover, we will use an interdisciplinary approach to develop a comprehensive understanding of the research phenomena we are answering.

## Background

### The Law

The area of Tøndermarsken falls under the jurisdiction of §3 or the Danish Nature Conservation Act (Naturbeskyttelsesloven). The national act protects habitats against any anthropogenic disturbances that pose a threat to wildlife. The law allows previous practices in the area to continue as usual, except for major disruptions like drainage and replanting, but also includes limits on fertilizer use and land conversion (Miljøministeriet, n.d.).

In 1981, Tøndermarskloven was passed to target threats to cultural heritage and biodiversity posed by cereal agriculture. The purpose of the law - revised in 1994 and 2004 - is to preserve the biological and cultural diversity of Tøndermarsken, targeting the area within the outer dike and the lower part of the Vidå river. Tøndermarskloven also works to bring attention to the intrinsic value of Tøndermarsken. (Retsinformation, 2004.)



Tøndermarskloven prohibits construction, including buildings and roads, unless it is meant to serve agricultural businesses outside of pig, fur, and poultry farms, and greenhouse horticulture. Changes in terrain and vegetation are also prohibited. Furthermore, fencing is only allowed along the dikes, roads, and water channels. Finally, the law prohibits the use of certain fertilizers including phosphorus and kalium, and restricts the use of nitrogen. The state provides compensation to all landowners in Tøndermarsken (ibid.).

*Digelaget* are a group in control of the use, functioning, and maintenance of the dikes. They are the only group authorized to pump and divert water. The state bears the expenses incurred by *Digelaget* (Tøndermarsk Initiativet, 2022). The Municipality of Tønder can allow deviation from the regulations and will notify the Minister of Environment about their decisions. The municipality also ensures compliance with the Act and regulations. (Kerrigan, personal communication, 21. feb., 2022)

Figure 2: Land use map of Tøndermarsken
*Source: Google Earth*

Although the area is protected by §3, it is unusual to additionally have a conservation law for a specific area. As a means of protection, Tøndermarskloven is unique as it also regulates the

practices in the area. The law protects the ecological significance as well as the cultural heritage of the area, which impacts local conditions. Thus, it is necessary to explore the effectiveness and implementation of the law in practice - which is a widely debated issue. Our study sets out to fill this knowledge gap.

Land Practices

Nine percent of Denmark's land area consists of semi-natural lands including meadows, marshes, bog, commons and moorland; however, these are declining. Dike boundaries have been created to combat anthropogenic pressures and sea/fresh water flooding which can contribute to land loss. These areas are also impacted by modern farming practices and poor management. Salt marshes depend on grazing to maintain low-sward, high nutrient plant communities, which waterbirds need to breed and forage. (Danish AgriFish Agency, 2016.)

Livestock have traditionally played a role in coastal dune ecosystems (Damgaard et al, 2013). Grazing, both sheep and cattle, has been shown to improve habitat diversity and plant species richness (Bos et al, 2002). Bos et al's study showed that 23 out of 30 bird species in Southwestern Denmark were significantly more present in grazed areas than in ungrazed, (ibid.). Studies also indicate that salt marshes with short-growing plants are not only preferred by grazing animals but also by waterbirds. It can be inferred that livestock grazing has a positive effect on plant species richness and the overall functional diversity of the area (Damgaard et al, 2013).

The land in Tøndermarsken is both state- and privately-owned. Recently, there has been debate over the extent of protection and production in Tøndermarsken (Hansen, 2001), which is why the Danish Nature Agency (Naturstyrelsen), who are in charge of about 200 ha state owned areas in Tøndermarsken, carried out a major land distribution in 2017, which should lead to better nature management. The state and the private landowners exchanged lands so that some of the most attractive areas for bird life now belong to the state. In exchange, the private landowners have taken over surrounding state land and a number of private properties have also been merged into larger units (Naturstyrelsen, 2017). According to Tønder Municipality member, Kirsten Kerrigan (personal communication, feb. 22, 2022), the state now owns an area with the best 'bird

potential' in 'Gammel Frederikskog' and the local farmers can continue to use the land through renting.

From October to April the water in Tøndermarsken is drained by the pumping system in order to accommodate migrating breeding birds. Sheep can graze outside all year, but most are out during wintertime, possibly due to the low water levels (Hansen, 2001). Due to our limited understanding of how the law influences land management techniques, we plan to investigate temporal land management changes through field work, understand how this impacts sheep farmers in the area, and whether or not these restrictions affect their practices.

There exist different opinions about the effectiveness of the law and its necessity. Various discussions for and against the law have taken place prior to its establishment as well as after as part of the protection versus production debate. Hansen (2001) claims that the law "does not contain specific objectives for what one wants to achieve with the protection", meaning that it is unclear what measures need to be changed or implemented to maintain 'biodiversity'. We would like to explore this discussion further while in Tønder.

**Outcomes**

Ecosystem condition

The Wadden Sea National Park is one of the world's biodiversity hotspots. It has particular significance as a resting area of 10-12 million migrating birds – many of which also breed in the area (Wadden Sea World Heritage.) The area of Tøndermarsken hosts a large variety of birds – being a breeding area for at least 13 species and a resting area for 18 species. It is accordingly recognized as Natura 2000 area for its significant birdlife. Despite this designation, bird protection in Tøndermarsken is a complex and debated issue in terms of bird species decline and protection. (Clausen et al., 2016.)

EU's Natura 2000 directives, the Birds Directive and the Habitats Directive, bind restoration efforts of species and habitats. This is done through designated conservation and management efforts. Tøndermarsken's Natura 2000 area has site-specific objectives regarding bird preservation. (Miljø- og Fødevareministeriet, 2016.) The bird population count from the

mid-1980s onwards has shown a decline in various species. It is debated whether the law has aided the protection efforts, and what are the principal causes of bird decline in the area. (Clausen et al., 2016.)

The main challenges faced by Tøndermarsken related to ecological conditions required by bird life are related to water levels and predator numbers (Clausen et al., 2016). Eglington et. al. (2010) claim that the widespread drainage of grazing marshes and wetlands is the main driver of decline in breeding birds in Tønderemarsken. Predators, such as foxes and raccoon dogs, feed on both birds and eggs, also influence the bird population in a negative way (Hoelgaard et al., 2008).

Cultural heritage

The Tøndermarsk dike system is one of the first known examples of human controlled coastal protection. According to Kystdirektoratet (2020), "locally organized dike construction and operation have been carried out [in Tøndermarsken] since the middle ages". Because the dike system has been operating for approximately 500 years there are long-existing cultural ties. Additionally, the dike system allows local people to physically alter the land. The system has thus created a unique cultural landscape that is dependent on the use of the dike system. As a result, the dike system has become part of the cultural backbone of the area.

There were no major changes to the original dike system, until a series of massive storms in the late 1970s that led to the creation of the Forward Coastal Dike in 1981 (Figure 3) which is the main dike used today, while the historical dike acts as extra protection. In addition to historical significance, the dike system alters ecological conditions which can impact the biological aspect of the cultural diversity. For example, the water in the canal systems (which are a part of the dike), is raised from April to June and "grazing is managed in such a way that the meadows meet the requirements of the breeding birds" (Kystdirektoratet, 2020). Additionally, the pumping of fresh water and sea water is controlled specifically to make Margrethe Kog the ideal mixture of fresh and salt water required for bird feeding and breeding (Kystdirektoratet, 2020). The dike system relates in this way to the cultural heritage because of the unique management that alters the ecosystem that supports the biological diversity.

## Methodology

Why was Tøndermarskenloven created and how has it been implemented and perceived?

We will use qualitative data on the history of the law creation and how it works today, to answer this question. We plan to investigate different perceptions of the law and to find out which actors and stakeholders are involved. To obtain this data we will perform the following methods:

- Literature and archive search on the history of the law
- Semi-structured interviews with:
    - Municipality of Tønder
    - 'Digelaget'
    - Danish Ornithologist Association (DOF)
    - Local farmers
- Questionnaire
    - Local people's perception of the law and the area. We will ask local people from Højer, Tønder, and people who live within the area of the law, through:
        - Facebook groups
        - One day at the city center of Tønder and Høje

How has Tøndermarskenloven shaped land management practices?

We plan to explore how the law has impacted production, how the water was managed before and after the law implementation, and to explore the grazing practices before and after the law's implementation. We will perform the following methods:

- Literature and archive review
    - To learn about agriculture practices in Tøndermarsken
- Interviews
    - With farmers to find out more about grazing practices and water management
    - With experts about existing ecosystems and ideal conditions for wildlife
- Temporal data analysis
    - Temporal economic data trends (land ownership and field sizes of farmers)
- Ecosystem analysis

    - Counting sheep populations
    - Plant biodiversity assessment
    - Using GPS to analyze land characteristics and changes in farm land
    - Water level measurements

<u>How have current land management practices affected the cultural heritage and ecosystem condition in Tøndermarsken?</u>

To investigate the dynamics between birds, predator and water levels, we will carry out the following methods:

- Interviews
    - Bird experts such as Martin Iversen and others from DOF to find out the conditions they require and to verify our data
    - Martin Brink, Giuke Kretzschmer
    - Jens Laurits Hansen from the NPWS to find out perceptions
    - Local people to find out perceptions of ecological change
    - Farmers, such as Peter Sønnichsen, to find out perceptions/changes in land use practices
    - Bird watchers, recreationists to investigate changes in bird populations
    - Digelag
- Measuring biodiversity
    - Counting birds
        - Pair counting visible colonies from a greater distance
        - Pair counting non-visible colonies by counting flying adults
    - Predator assessment
        - Scat count
        - Searchlight at night
    - Plants biodiversity assessment
- Temporal data
    - Reports with temporal data about bird populations
    - Water level

- Water levels measurements
- Soil sampling
    - Nutrient analysis
    - Conducting % water level content and % of soil organic matter (SOM)
    - Measuring bulk density to determine compaction in grazing areas
- GPS tracking to set the sampling spots for all methods

To investigate cultural heritage in the area we will develop a historical background of Tøndermarsken, the construction of the dike system, the historical use of the dikes and the relevance to cultural history. We will then compare the historical culture of the area to interviews focused current day perspectives of cultural heritage to establish changes, by using the following methods:

- Interviews
    - Local expert from the Sønderjylland museum, in the department of cultural history or Tønder. From this interview we hope to learn about the history of the dike system
    - Local farmers: We have gotten in contact with one farmer, Peter Sønnichsen, and a farm stay run by Vivi and Andreas Paulsen. Through interviews with farmers we hope to gain temporal perceptions about any shifts in land management and landscape connected to water levels and the dikes.
    - The Digelage: in order to ascertain if they are aware of the cultural significance of the dikes and if their current management techniques are aligned with historical drainage practices.
- Questionnaire:
    - Facebook Questionnaire/Random sampling from the public: to gain a perspective from the local community as it pertains to how they view cultural history
- GPS
    - We plan to use Denmark's Arealinformation and Google Earth Pro in order to visualize the temporal changes in the dike system and land management

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## Appendix 2. Table of main applied methods

| Method | Description | Respondent | Amount |
|---|---|---|---|
| **Semi-structured interviews** | Current practices and perception on the law | Danish Nature Agency (DNA) | Informant A<br>Informant B |

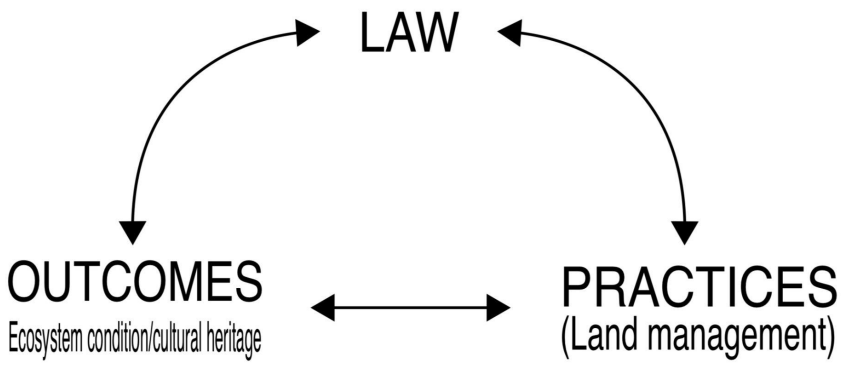
| | | | |
|---|---|---|---|
| | | | Informant C |
| | Current practices and perception on the law | Farmers | Farmer A<br><br>Farmer B<br><br>Farmer C |
| | Historical background of the area<br><br>Cultural heritage and importance og Tøndermarsken | Sønderjyllands Museum | Informant |
| | Information on bird protection and population trends in Tøndermarsken<br><br>Tour in Tøndermarsken and methodical information | Danish Bird Protection Fund (DBPF) | Informant |
| | Information on the historical timeline after the implementation of the law | National Park Wadden Sea (NPWS) | Informant |
| | Perception on the Tøndermarsk law | Local Residents | Resident A<br><br>Resident B |
| **Questionnaire** | SurveyXact<br><br>Perception of the Tøndermarsk law, use of the area and, perception on bird population trends, socio-economic background | Local Residents | Online: Three Facebook groups<br>- 29<br>In hand in the streets of Tønder<br>- 41 respondents<br><br>70 respondents |

| | | | |
|---|---|---|---|
| | | | 59 fully completed |
| **Mud Sampling** | During fieldwork: Mudsamples taken from state-owned land and privately owned land in order to investigate the quantity of the snail *Galba truncatula*.<br><br>After field work: Microscope analysis looking for visual signes | - | 3 samples per plot at 5 privately-owned fens, and 3 samples per plot at 5 state-owned fens |
| **Satellite Imagery** | Visible differences in visible water and vegetation in an effort to tie visible trends to changes after events such as the implementation of the law and the 2017 land swap<br><br>Satellite images from Google Earth | - | Two pictures: before and after 2017 |
| **Water level measurements** | Measuring the water levels in grøblerender in state-owned and privately owned land | - | Measurements at 3 grøblerender at 5 privately-owned fens and 5 state-owned fens |

## Appendix 3. Framework

The framework presented below guided the project before going to the field. With it we draw the linkages between the different aspects of the study. The starting point of the analysis is the Tøndermarske law, and related regulations impacting the practices in the area. Affected practices have certain outcomes in terms of ecosystem conditions - bird populations - and cultural heritage. The law is also affected by both the practices and the outcomes as certain conditions

can create (and already have created) a need for the revision of the regulations to make them more responsive to the conditions. However, as we learned more about the complexity of the case during fieldwork the framework became too simplistic and did not guide the final analysis.




**Appendix 4. Questionnaire**

Questionnaire - Local Residents

Hej alle! We are a group of masters students from KU currently working on a research project related to Tøndermarsken. The goal of our research is to investigate any changes in wildlife and culture in Tøndermarsken. We have created this questionnaire in an effort to learn more about the local perception related to wildlife, nature, and culture in Tøndermarsken.

We will be using this data solely for our own purpose and any personal information will not be shared. Answers will also be kept private, only seen by us and our professors, as we will only use this questionnaire for data collection to examine any patterns. All answers will be kept anonymous. If you are interested in elaborating on your answers, there is the option to leave your contact information at the end of the questionnaire!

Thank you for taking the time to do this questionnaire, any participation is greatly appreciated. Feel free to share this questionnaire with friends and family who live in the area.

Sincerely,
Sara, Dylan, Ida, Christian and Laura

****if you are uncomfortable answering any questions, please feel free to skip them****

1. What is your age?
    a. Under 30
    b. 31-40

c. 41-50
d. 51-60
e. Over 60

2. What is your gender?
    a. Female
    b. Male
    c. Other
3. What is your employment status?
    a. Employed
    b. Self-employed
    c. Student
    d. Unemployed
    e. Retired
    f. Other: _____
4. If you are employed, what is the title of your profession? _____
5. What is the highest level of education you have completed?
    a. Primary school
    b. Gymnasium
    c. Vocational School (farming school, cosmetology, mechanics, etc.)
    d. Undergraduate degree
    e. Graduate degree or higher
    f. Other: _____
6. What is the closest town to your current residence?
    a. Højer
    b. Tønder
    c. Møgeltønder
    d. Rudbøl
    e. I don't live in the Tøndermarsk area
    f. Other
7. How long have you lived in your present location?
    a. Less than one year
    b. 1-5 years
    c. 6-10 years
    d. 11-20 years
    e. More than 20 years, please specify ____

8. Do you partake in any of the following activities in Tøndermarsken? (can pick multiple)
    a. Farming (crops, grazing)
    b. Bird-watching
    c. Physical exercise

d. Hunting
e. Hiking
f. Fishing
g. None
h. Other: _____

9. How often do you go visit this area of Tøndermarsken?
    a. Never
    b. Less than 1 time per month
    c. 1 time per month
    d. More than once per month or more
    e. Once a week
    f. More than once per week
    g. Every day
10. Have you heard of Tøndermarskloven?
    a. Yes
    b. No

**If you answered "yes" to Question 12, please answer questions 13 through 19**
**If you answered "no" skip to question 19**

11. How did you hear about Tøndermarksenlov?
    a. News (newspaper, tv, etc.)
    b. Friend/Family
    c. Social media
    d. Other _____
12. Based on what you know about Tøndermarskenlov, how successful do you think the law has been thus far?
    a. Very successful
    b. Successful
    c. I don't know
    d. Neither
    e. Little successful
    f. Unsuccessful
13. Why did you choose the answer to the last question?
    a. _____
14. Have you noticed any changes in Tøndermarsken after the implementation of the Tøndermarskloven?
    a. I don't know enough about Tøndermarskloven
    b. No
    c. Yes, I have noticed the following:

    _____

_____

_____

15. Based on what you know about Tøndermarskenlov, do you believe that the law is necessary?
    a. Yes
    b. No
    c. I don't enough about Tøndermarskenlov
16. Which factors in Tøndermarsken are most important to you?
    You can choose more than one:
    a. Wildlife (birds, seals, etc.)
    b. Dike system
    c. Værfterne
    d. Natural landscape
    e. Grazing
    f. Tourism
    g. Cultural history
    h. Other: _____
    i. Please elaborate:

    _____

    _____
17. Has the bird population in Tøndermarsken changed?
    a. I am unaware of any changes
    b. There has been a decline in bird population
    c. There has been no change in population
    d. There has been an increase in bird population
18. What do you think has caused these population trends (no change, increase, or decline)? Please elaborate on your observations

    _____

    _____

    _____
19. Is there anything else you can tell us about your perceptions of Tøndermarskenlov?
    a. _____
20. If you are interested in elaborating on your experiences and opinions, please leave your contact information so we can reach you

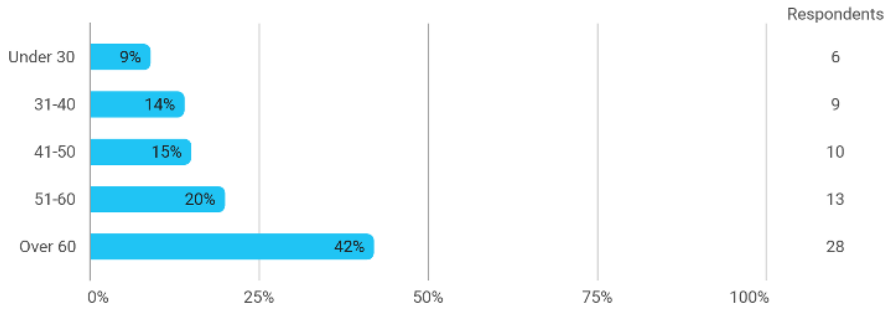
    _____

    _____

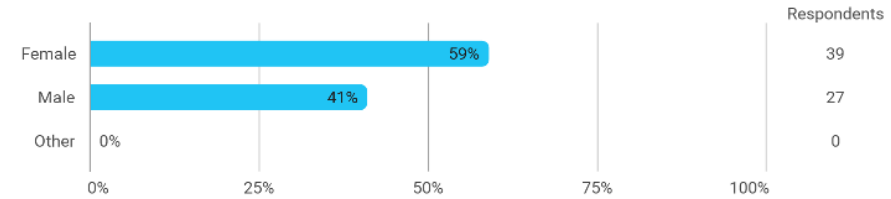
Thank you for your time and participation!

## Appendix 5. Questionnaire results

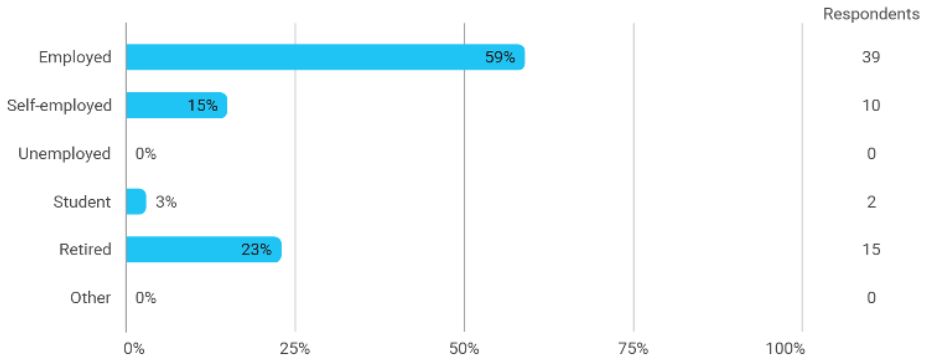
What is your age?




What is your gender?




What is your employment status?

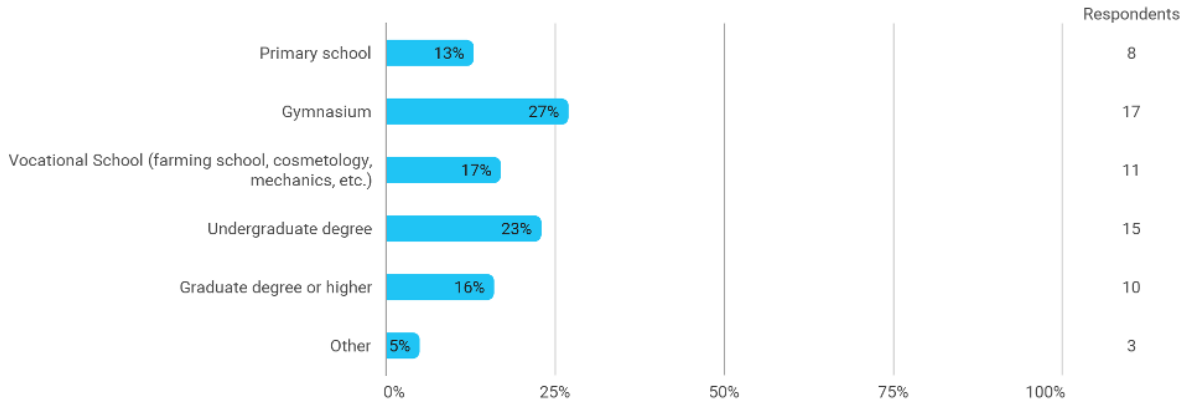



What is your employment status? - Other

If you are employed or self-employed, what is the title of your profession?

What is the highest level of education you have completed?

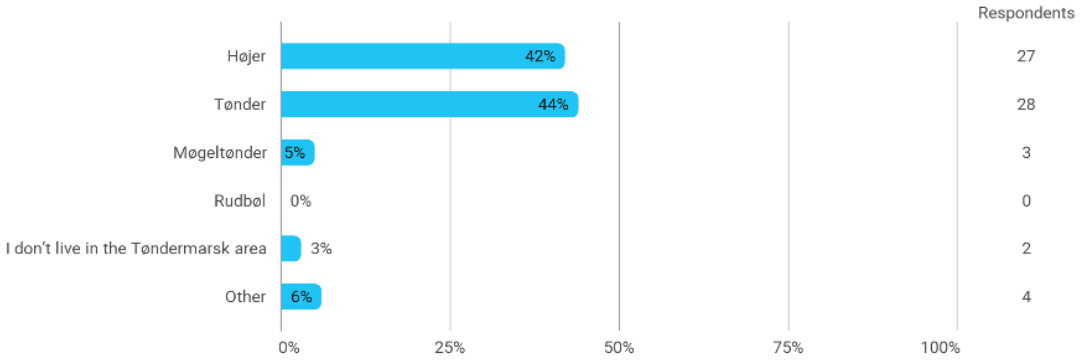
What is the highest level of education you have completed?




Other

- Diploma from Germany
- HH
- handelsskole

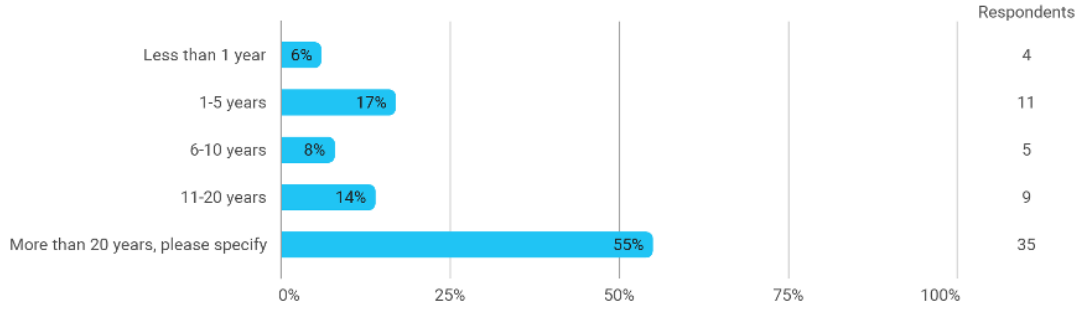
What is the closest town to your current residence?




What is the closest town to your current residence? - Other

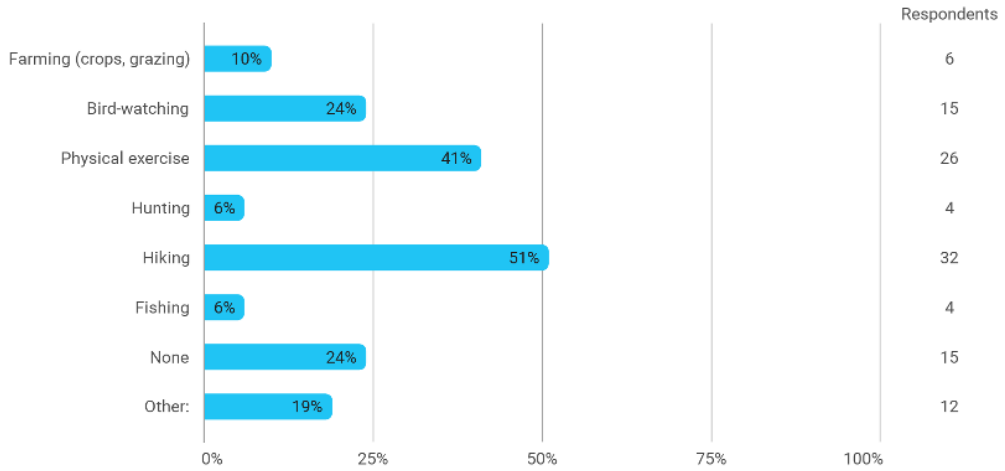
- Har fritidsbolig i Højer
- Skærbæk
- North Copenhagen

How long have you lived in your present location?




How long have you lived in your present location? - More than 20 years, please specify

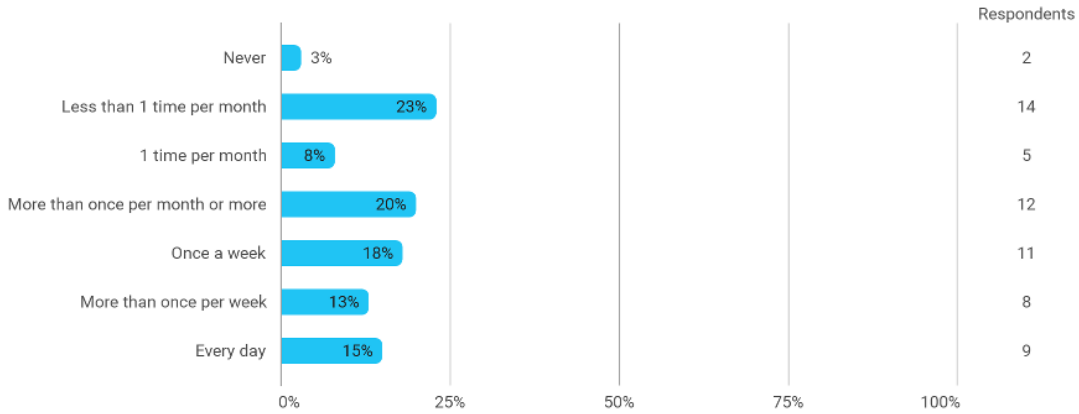
Do you partake in any of the following activities in Tøndermarsken?



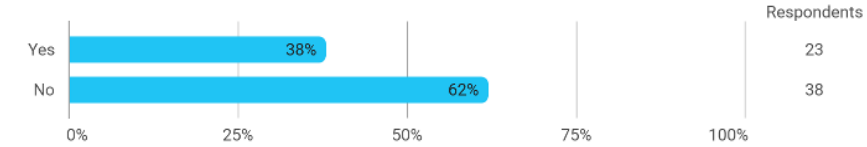

Do you partake in any of the following activities in Tøndermarsken? - Other:

- Whiskysmagning og logearbejde
- Hest, ture i skov på strand. FDF i mere end 30 år
- Walking dog
- Biking, tourism, walking
- Biking
- Walking dog
- Looking after the water tower, management
- Landscape
- Watching animals
- Cycle
- Biking
- Bruger området, men deltager ikke i noget officielt

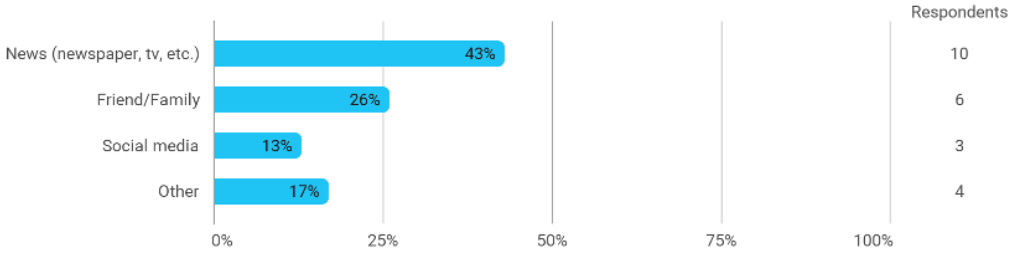
How often do you go visit this area of Tøndermarsken?




Have you heard of Tøndermarskloven?



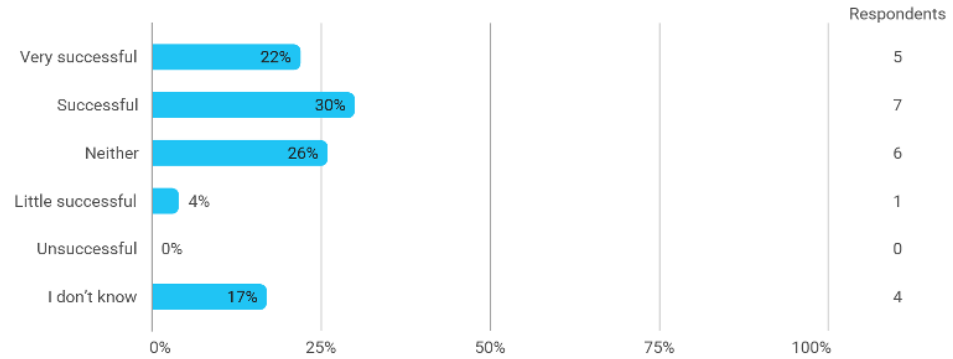

How did you hear about Tøndermarksenlov?




How did you hear about Tøndermarksenlov? - Other

- Jagtrelateret
- Har arbejdet 25 år i Miljø afd/vandløb ved Sdr.jyllands amt
- Gathering of local community meetings
- He owns a tour company

Based on what you know about Tøndermarskenlov, how successful do you think the law has been thus far?



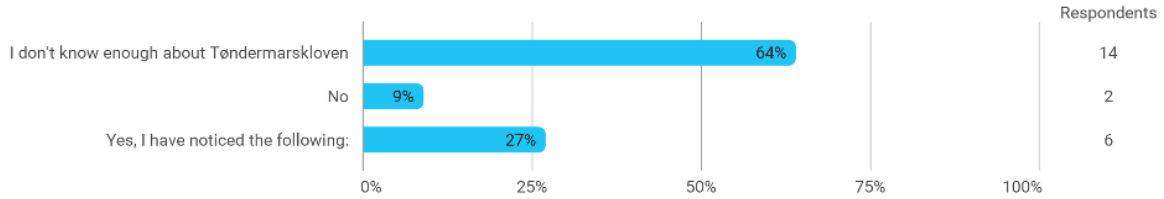

Why did you choose the answer to the last question?

- ?
- Det er svært at lave en meget succesfuld lov, da der altid vil være en vis modstand mod regulering
- Er ikke kvalificeret til at bedømme det
- Følger ikke så meget med
- Fordi loven fungerer.
- Ikke indforstået med alt
- Vigtigt at naturen har et åndehul og tænker det er et unikt område/Verdensarv, der bør bevares.

  Tøndermarsken er indvundet land og her ses hvordan det er indvundet, trin for trin, med ådigerne og de 3 havdiger.
- Fornemmelse
- Fordi hørt både godt og ondt
- Hhh
- More information, the people know more the area, show hidden treasures
- People get more information about the area and can visit
- m
- Vi udnytter votes natur på bedste vis
- fiere tiltag  implementerete _ Formelt  vaerktoej.
- det er en balancegang mellem naturpark og tilgodese erhverv. Vi kan ikke kun leve af naturpark.TIlflyning er vigtigt.

- Better preserved the area
- keg synes ike at det fingered helton som onsket men ok
- meg man
- Likes that is secures the area and it still allows for recreation
- Protected better the area improved the tourism activity
- Jeg tænker at kogene i Tøndermarsken bliver beskyttet

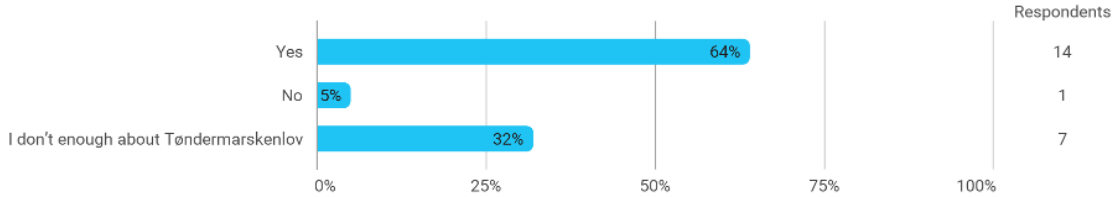
Have you noticed any changes in Tøndermarsken after the implementation of the Tøndermarskloven?



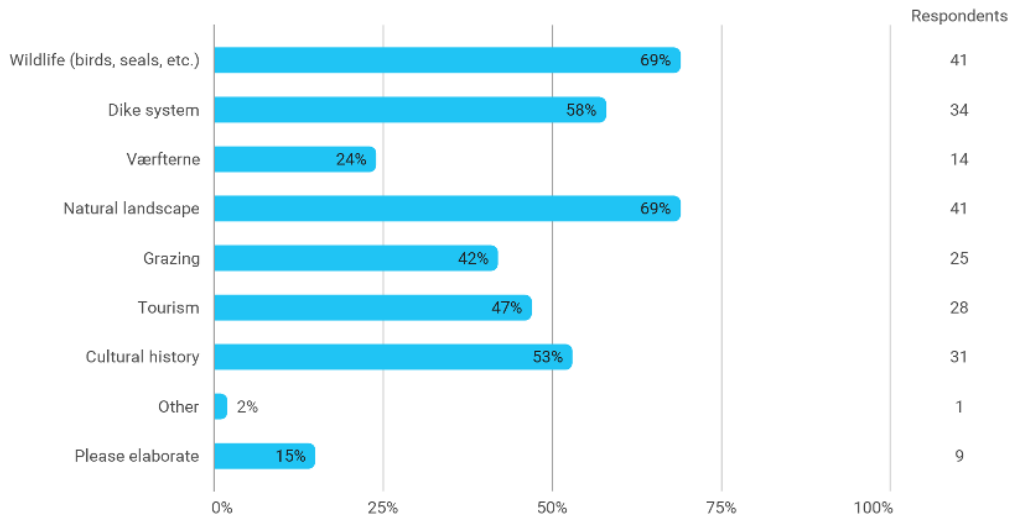

Have you noticed any changes in Tøndermarsken after the implementation of the Tøndermarskloven? - Yes, I have noticed the following:

- Der er et rigt og varieret dyreliv. Der er mange gode initiativer igang som kan fremme vores brug af naturen.
- Flere enge og afgræsning frem for afgrøder. færre kunstige hegn og andre foranstaltninger. Mange flere turister der ønsker et frirum, til sanserne. Mange flere fugle og flere arter.
- More attractive area for tourists
- Tønder marsk stier
- Some fields have become more wet, raised water level, aware of state owned land
- More tourism, increase of house prices

Based on what you know about Tøndermarskenlov, do you believe that the law is necessary?




Which factors in Tøndermarsken are most important to you? You can choose more than one:



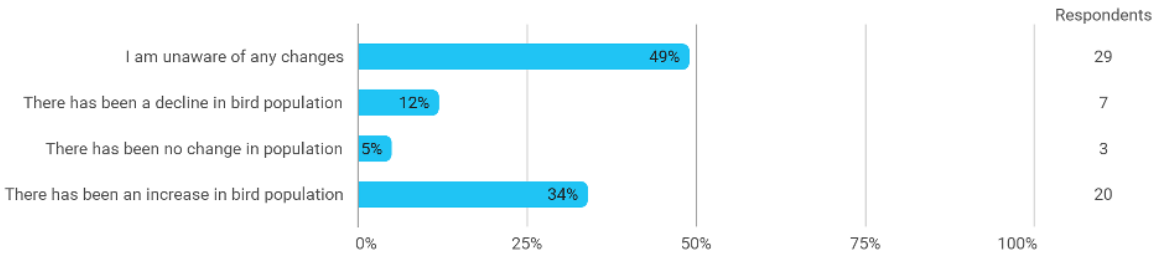

Which factors in Tøndermarsken are most important to you? You can choose more than one: - Other

- Jagt og fiskeri

Which factors in Tøndermarsken are most important to you? You can choose more than one: - Please elaborate

- No dike = flooding, security; I like nature, lot of birds;
- No dikes, no área - bird watching very important for tourists
- It makes me feel good when I go there
- Tourism important to my job, needs customer, nature important for this part of the country, don't mix it up with the climate
- Cheap for tourist, grazing part of the landscape
- Dike system because of the dike system, very much landscape and Grazing is a part of this
- Grazing is part of the landscape
- Very beautiful landscape, grazing is necessary, tourism is nice good for community, people should stay longer in hojer, hopes restoration will draw visitors
- For the business and personal pleasure

Has the bird population in Tøndermarsken changed?




What do you think has caused these population trends (no change, increase, or decline)? Please elaborate on your observations

- Klima
- Mennesker
- N/A
- Visse arter er gået tilbage, endte er gået frem.
- Ved ikke
- mange flere gæs,hvorfor ved jeg ikke
- Mere miljøbeskyttelse. Flere områder lades urørte af landbrug for at gøre dem attraktive for dyrelivet.
- Klimaforandringer
- Det ved jeg ikkr
- Trykkede “ved ikke”
- De mange foranstaltninger samt nationalpark og FN Verdensarv initiativer samt “Tøndermarsk” loven fra 1988, der ikke længere er gældende men historisk!

Måske man kunne forvente en lidt bedre forundersøgelse fra KU’s side…

- Forskellige forbud af jagt
- Balance i økosystemet og det biologiske kredsløb.
- I do not know
- Klima ændringer.
- Even if not being aware... My feeling is the population has grown in the present past.

I feel I see more Eagles/Falcons than years before.

Reserved areas without too close allowed direct contact to humans is of course also a cause to the incensement

- ?
- Dyrkning af jorden
- Bare slap af og lad os leve og bruge området
- Bedre beskyttelse
- Milde vintre
- Vi har fået mere vild natur.
- Den voldsomme vækst af bramgæs han præsset andre dyrearter væk
- There was a period in the area where the stork were lower because of less water to feed, now they are back. 30 years ago ish
- When he was little there were storks, now much less. All the nests were occupied on the newspaper
- Mere opmærksomhed omkring fuglene
- Ved ikke
- Ved det ikke
- Hat set skarven i vidaaen inde I Byen, men ved ikke hvorfor den nu er her
- Intensiveret landbrug/ draening
- Klima
- Forurening
- Der er alt for mange gæs
- klima
- det er jo naturen, der har pause, det giver mere fuglebestand.
- Ved ikke
- ved ikke

- We recognize it more now, the tourists have helped into valuing the landscape, tourism increased the awareness
- det ved her faktisk ikke
- diesel biler
- Beskyttelse af omradet
- Bedre levevilkaer
- det er et gods stead at bare for dyrerne
- Viben bird has increased, depends on season
- The flocks of sort sol have changed
- bed det ikke
- Climate change
- They have an area the state is buying from the far,era, that it will be good for birds, to put more water in
- Ved det ikke
- Baseret på oplysninger fra naturvejledere

Is there anything else you can tell us about your perceptions of Tøndermarskenloven?

- Nu tæller jeg ikke selv fuglene, så det er umuligt for mig at vurdere om der er kommet flere. Det kan vel kun bestemmes via organiserede fugletællinger. Alt andet er vel bare et subjektivt skøn. Når jeg mener at bestanden er øget, tænker jeg på antal arter. Gennem de sidste 20 år er bestanden af bramgæs eksploderet. Jeg tror også der omkring 15 år siden jeg så min første havørn i marsken. Nu kan man nærmest ikke undgå at se dem. Desuden er der inden for de sidste 5 år kommet utrolig mange sølvhejre til marsken. De var meget meget sjælne for få år tilbage.
- Nej
- De igangværende initiativer har bidraget til større fokus og mere stolthed over vores område.
- Nej
- Forbered jeres kommende undersøgelser grundigere.

Jeg troede Københavns universitet havde udviklet sig!

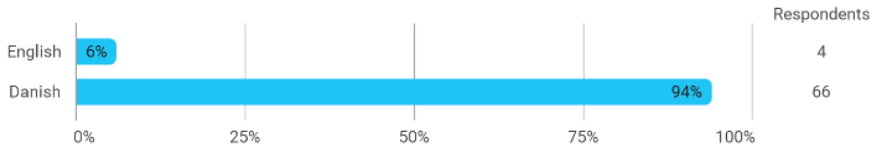
- Nej

- Fantastisk at I sætter fokus på området, og ønsker jer et dejligt ophold og håber i får rigtig mange data med hjem.
- Nej
- Nej
- Hh
- No
- No
- Nej
- Nej
- nej
- nej
- Magrethe kog lakes have attracted more birds
- I'm happy they take it serious, not just let things go, they control the changes, this have been good for homer and the whole marsh area
- Nej

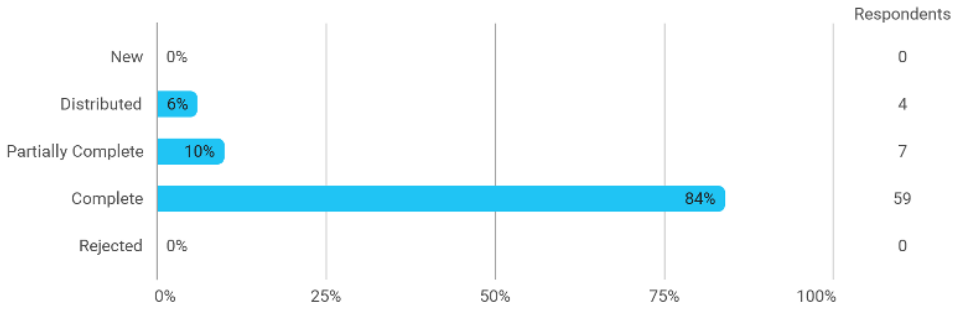
Are interested in elaborating on your experiences and opinions? please leave your contact information so we can reach you - Yes please, you can reach me by my phone or email:

- Answers kept anonymous

Language




Overall Status




## Appendix 6. Semi-structured Interview guides

### Farmer

**Introduction**

- Intro to project and consent
- Basic background questions/demographics (gender, age)
- Showing a map - where do your cattle graze?
    - Does the area change year to year?
    - Do you own the land? Rent it from private owners or the state?
    - Have you rented from the state before? Why or why not?
    - How big is the land you own/rent?
- Day-to-day activities of a cattle farmer/Practices - agriculture
    - Why do you choose Tøndermarsken for your cattle to graze?
    - Do your cattle graze or are they kept inside? Why? Organic?
    - What times of the year do cattle graze and where?
    - How many cattle do you have?
    - What do the cattle eat? How much?
    - Fertilizer/manure use
    - Where do you sell your meat/milk?
    - Can you apply for 'tilskudsordninger'?

**Water levels**

- How do water levels affect the cattle?
    - Snails/parasites, What type of prevention do you use? Antibiotics all year or just if they are infected?
    - Do the parasite OR antibiotics affect the meat quality?
- Ideal water levels for cattle?
- Land management - are you able to alter the land?
- Do you manage the land and water levels personally?

**Law**

- Do you know about the law?
- Does the law impact your agricultural practices? How?
- What do you think the law is in place to do? Agree/disagree?
- Do you think the law is working?
    - Do you consider the birds when you consider farming practices?
    - Do you think your land conditions are compatible with bird life?
    - Does the number of cattle affect bird populations?

        - Has the law changed your income, investments, and land ownership?

- Cultural landscape, to you, what is the cultural landscape in Tøndermarsken?

**Land characteristics**

- How do you think grazing vs not grazing affects the land?
- Biodiversity of plants

## Danish Nature Agency

**Introduction**

- Intro to project and consent
- Day-to-day work at DNA, what is done to improve bird populations

**Birds and land management**

- Observed bird population changes, Methods
- State owned land areas within Tøndermarsken (how, why and where)
    - Differences between state and private owned land?
- Current farmers' practices and perceived farmers' opinions
    - Water levels and why are they good/bad and for who?

**Birds**

- His perceptions on law/link to the bird population
- Discussion surrounding the law, opinions
- Bird species selection for our research (if we don't have more information on this at time of interview)
- Bird ecosystem requirements
    - Soil qualities, water levels
    - Grazing pressure
    - Predators

## DBPF

**Introduction**

- Intro to project and consent
- DOF and DBPF, day-to-day activities
- What is the DOF trying to accomplish in this area
- Has the Tøndermarskenlov impacted how the DOF goes about bird preservation- such as increasing bird preservation initiatives
- Are they hindered by the need to protect the cultural landscape?
- Are there projects they would like to do but can't for this reason?
- DOF work in Tøndermarsken - their political stance
    - Also nationally, internationally (EU - the case)
    - Politics of the law- is there competition between preservation of the cultural landscape and bird protection?
    - What sort of funding do they receive? State? Donations?

    - Are there any requirements of Natura 2000 and UNESCO that impacts their approaches to bird preservation

**Birds**

- Bird counting methods (is there anything we could try?)
- Bird species selection for our research (if we don't have more information on this at time of interview)
- Bird ecosystem requirements
    - Soil qualities, water levels
    - What does he believe is the most effective method of water management to meet the requirements of the birds?
    - Grazing effect on birds (cattle and sheep)
    - Opinion on what factor impacts birds the most

**The law**

- What was the area like before the law?
    - When did concerns about bird populations arise?
    - Has he noticed any changes in the bird population after the implementation of the law? What types of birds are increasing/decreasing (breeding, resting, etc.)
        - Cause and effect of bird population change
- Perception on law, discussion in relation to protection/production and the law
    - Competition between culture and birds? Between farming and birds?
    - What does he think of the law?

## WSNP

**Introduction**

- Intro to project and consent
- Day-to-day work at NPWS and general work of NPWS

**History of Tøndermarsken**

- Creation of the dike system, cultural landscape, why was the law created
- How has it been perceived
- What can you tell us about the competing points of view surrounding why the law was created, conflicts of desires after the implementation
- Why has the area recently become a part of the National Park, even after the implementation of the Tøndermarskenlov

**Land management**

- Temporal changes in how water is managed (before and after the law)
- Temporal changes in land use (before and after the law)
- Grazing management
- Has there been a change in how the landscape looks (before and after the law)
- Do you think current land management practices focus more on protecting the cultural heritage or protection of the birds
- How has Tøndermarskenloven shaped land management practices?
    - Farmers' practices

    - Current and past before the law
    - Water practices

**Perceptions**

- Bird populations
- Contradictions of law and how it is implemented

## Sønderjyllands Museum

**Introduction**

- Intro to project and consent
- Where are you from, what is your background? How did you end up here?
- How long have you lived here?
- What type of visitors come to the museum? When is 'high' season?

**General History**

- creation of the 16th century Dike (who, how, why)
- Settlement of the area (middle ages)
    - What was the landscape like when people began to settle here?

**History of Dikes**

- Why were the extra dikes created? (1800, 1900, others?)
- Was there conflict surrounding building the dikes when they were built?
- Can you please tell us more about the court case and conflict of interest surrounding the construction of the new dike and the Vidåslusen?

**Cultural Heritage**

- To you, how would you describe the cultural heritage in this area
- How do you think the residents in the area regard the cultural heritage and its significance? (does it matter to them, is it a big part of everyone's lives?)
- How have the dike systems created the cultural landscape?
    - Why is it a cultural landscape and not just a landscape?
- Do you feel like Tøndermarskloven does enough to protect the cultural landscape?
- Do you feel like the birds (other wildlife?) are also a part of the cultural heritage?
- How similar is the cultural landscape to the historically significant landscape like the one in the 16th/17th cen.?

**Law**

- How were the boundaries/area of the law decided?
- Are you aware of any 'competition' between the desire to protect the cultural heritage and to preserve the bird populations?
- What was the area like before the law? Has anything changed? (ie. land management, birds, etc)

## Local residents in Tøndermarsken

**Introduction**

- Intro to project and consent
- Could you introduce yourself and describe what you do?
- Please describe your business

- Who are the visitors at the B&B? General tourists, bird watchers?
- Has there been any changes in the number of visitors (apart from COVID)?

**History of area**

- How was the land used before you took ownership?
- Previously cattle/farming?
- Have you seen an increase/decrease in the amount of cattle/sheep?
- Relationship to the area/land

**Land Use**

- How is your land managed?
- How much land do you own?
- Do you have cattles or sheeps?
- How has your land changed after the stopping of cattle grazing?

**The Law**

- Do you know about Tøndermarskloven?
- Do you live in the area within the law?
- Have you experienced any changes before/after the law was implemented?
- What do you think about the law? Is it working?
- What's the general discussion about it like?
- Do you know about the project in Margrethe Kog?
- What are your perceptions about it?
- Have you noticed any changes? (bird population, water level)