NOVEMBER 2017
GLOBAL KITESPORTS ASSOCIATION

KITESURFING AND BIRDS – A REVIEW

LITERATURE STUDY

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PROJECT NO.	DOCUMENT NO.
A101232	1 FINAL

VERSION	DATE OF ISSUE	DESCRIPTION	PREPARED	CHECKED	APPROVED
1.2 FINAL	19.11.2017		MDBE/SBJ	SHC/TBKR/FLJO	SBJ

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1 Background

The objective of this study is to provide a review of the current knowledge regarding disturbance responses of birds to kitesurfing, with a comparison with the disturbance effects of other recreational activities in northwestern European coastal zones.

Recreational activities in coastal regions can have profound effects on bird populations, migratory as well as breeding birds, due to the disturbance caused by the activities. In recent years, the extent and diversity of the forms of recreational activities have greatly expanded and now include types like windsurfing, kitesurfing, jet ski, kayaking etc. on the water and driving with various types of vehicles on the beach and on tidal flats. These activities take place alongside other recreational beach front activities such as swimming, walking with dogs, jogging etc. The disturbance effects of such activities on birds and marine mammals have been widely documented but only rarely has specific and systematic efforts been made to distinguish between the various types of activities and temporal (incl. variations summer/winter) and spatial issues, site-specific characteristics etc.

The consequence has been that regulations which are issued in order to control these activities often have a generic content that does not reflect the actual disturbance effects or allow for the various activities to take place at optimal sites with little disturbance impacts.

The study will focus on kitesurfing as a specific activity, since kitesurfing is widely regarded as a major source of disturbance in coastal regions, despite that kitesurfing requires certain weather conditions and specific topographical features that strictly limit the periods and sites acceptable for kitesurfing. The review has been initiated partly in response to studies which show a common tendency to disregard some key characteristics of kitesurfing when assessing the effects on birds, in particular the specific temporal and spatial limitations to kitesurfing that restrict the occurrence and frequency of kitesurfing.

The overall objective of the study is to prepare an elaborated basis for sound and appropriate management responses to kitesurfing. The way kitesurfing is conducted and the circumstances within which kitesurfing can be carried out,

leaves a number of specific management options available to be deployed in a site-specific manner. This study sets out to facilitate a more detailed approach to instruments and mechanisms that may regulate kitesurfing in line with all other coastal zone recreational activities where required to safeguard birds.

2 Approach

2.1 Literature review

A literature review was carried out, based on a systematic search for published scientific literature and unpublished reports available (commissioned reports, grey literature). A dialog was held with a few key authors and organisations were contacted for unpublished material such as the British Trust for Ornithology (BTO), Department of Conservation New Zealand (DoC) and The Wildfowl & Wetlands Trust.

Databases searched include Google, Google scholar, Web of Science, Aarhus University Library, Scopus (Elsevier B.V.) To focus the search boolean operators (AND, OR) were used. Due to the range of names for the sport databases were searched for the words 'kite surfing', 'kitesurfing', 'parasurfing', 'kiteboarding' and 'kite boarding'.

The inclusion criteria for literature were based on relevance to the subject by including reference to kitesurfing in general and specifically to kitesurfing and bird disturbance collectively. Literature on human disturbance on birds was searched and included when relevant. Searches were carried out in September 2017.

The scientific literature published on the specific subject of kitesurfing and bird disturbance is very limited. Searching the database Scopus for literature on kitesurfing and disturbance reveals for example only two hits; Newton (2007) and Davenport and Davenport (2006), and accessing Aarhus University Library's electronic databases with the specific search *kite boarding OR kitesurfing OR kite surfing AND disturbance AND Birds* revealed 17 hits.

As kitesurfing is a relative new sport, the oldest literature included is from 2006.

Literature on bird disturbance from human activities such as recreational activities is abundant (e.g. Laursen and Holm, 2011, Laursen, et al., 2017, Le Corre, 2009, Madsen, 1995, Hardiman & Burgin, 2010), and literature concerning human disturbances in coastal areas were included in this review. The reference list included is a general overview on the subject of human

disturbance effect on birds in coastal areas and should not be regarded as a comprehensive/complete list of literature available.

The languages for literature compiled is English, Danish, Dutch and German. One single Norwegian reference was found.

Many references found were commissioned reports which have not necessarily been peer reviewed.

2.2 Perspective of the review

From a number of review studies of the disturbance effects of kitesurfing and other recreational activities on birds in coastal areas (see e.g. Krijgsveld et al, 2008, Krüger 2016, Laursen et al 2011, Laursen et al 2017) the following highly generic conclusions can be deducted:

- Kitesurfing (like other recreational activities) may disturb birds.
- Escape distances are species specific and may increase with speed, noise, and visual volume of the disturbance factor and also with flock size and stress levels of birds.
- Disturbance effects may be cumulative or even synergistic when responses are being amplified due to simultaneous or preceding disturbances.
- The impacts of disturbance on bird populations in the longer term are not known.

It can also be determined that very few studies, if any at all, have been designed to distinguish between the individual recreational activities taking place at the same time or consecutively. Repeated disturbance may result in increased alertness, larger escape distance and fewer birds present (Frid and Dill 2002). However, without a specific study design which make it possible to distinguish between the effects of the individual recreational activities it is not possible to isolate the actual effects from kitesurfing. Hence, even without ongoing recreational activities at a given site, the presence of birds at the site may be compromised by disturbances taking place earlier or even as a long-term effect of disturbance in the past.

In order to scrutinise the circumstances where kitesurfing may cause disturbances, the perspective of this review is to analyse the available data material that deals with the effects from kitesurfing on birds. Given the limited places and weather conditions that allow kitesurfing to take place it appears reasonable to try and obtain a better understanding of the actual sites and periods that may create conflicts between kitesurfing and birds.

From a preliminary screening of a number of papers and documents which reports on studies of effects of kitesurfing (e.g. literature compiled by Krüger 2016) it appears that there is a general lack of details about the actual

circumstances under which the studies were made. Further, the majority of papers and studies as eg. compiled in Krüger (2016) and elsewhere do not attempt to compare the effects of kitesurfing with other recreational uses. As long as details about the site, weather conditions, the frequency of kitesurfing at the site, other recreational activities at the site, movements and responses of bird populations etc. are not included in a study, it will remain challenging to draw conclusions about the effects of kitesurfing beyond the immediate disturbance created by humans (with or without a kite) at a given site.

2.3 Disturbance – a definition

A disturbance can be defined as "any phenomenon that causes a significant change in the dynamics or ecological characteristics of populations of birds" (EU Commission, 1992 as cited by Harradine, 1998) and disturbances in this context change the conservation status of the species concerned where a species may not be able to maintain a favourable conservation status in their natural range (EU Commission, 2000). Though this definition appears to relate to the long-term effects rather than the immediate response. Kirky et al (2004) suggest that disturbance is a change to bird behaviour compared to how it would have behaved in the absence of disturbance, and Platteeuw and Henkens (1997) describe disturbance as "any human activity inducing unusual behaviour" on birds.

When discussing disturbance, it is important to distinguish between effects and impacts (Kirby et al. 2004), where effects relate to a measurable or observable change in the behaviour of the disturbed birds as an immediate response, whereas the impacts are the longer term changes to population levels of bird . By this definition, effects can lead to impacts, if the affected bird populations are unable to compensate for the immediate effects of the disturbances.

Thus, it is important to note that the effects of a disturbance event are not necessarily the same as the impacts of that disturbance event. More generally, Gill et al. (2001a) suggested that a lack of behavioural response may not imply a lack of fitness consequence but may instead reflect a lack of choice. Beale & Monaghan (2004a) provided an empirical test showing that such theoretical arguments translate directly to the field and they concluded that it is wrong to assume that the most responsive animals are those which are most vulnerable to disturbance.

In this review, we will not look at impacts as they will always be a conglomerate of various effects accumulated over time. In fact, due to obvious methodological complexities, few studies have addressed the impacts and hence very little is known about long-term effects of accumulated disturbances. Instead, it is widely assumed that more disturbances create stronger impacts at the population levels (eg. Laursen et al. 2017) but without further studies this assumption may remain plausible if difficult to substantiate.

It is widely considered that disturbance of birds indirectly affect fitness and population dynamics because of the energy used for avoidance and lost opportunities for feeding, foraging, preening etc. Thus, disturbance can cause:

- Reduction of time available for foraging.
- Reduction of space for feeding.
- Reduction of time to carry out fitness-enhancing activities, such as feeding, parental care, preening or mating.

In this review, we see disturbance as a displacement event that involves the following factors (Delaney et al. 1999; Beale & Monaghan 2004a):

- Number of flight events.
- Distance from bird to source of disturbance (escape distance).
- Number of birds in flight.
- Time away from resting, feeding or breeding site.

The escape or flight distance of birds when disturbed varies with a range of factors, such as the species in question, flock size, frequency of disturbances, weather, season etc. (Laursen et al. 2005). The diversity of factors involved in the escape distance, makes it challenging to draw simple connections between the type of disturbance and the response displayed by birds. Despite this, the escape distance is often used to illustrate the sensitivity of birds to various human disturbances. However, numerous studies have reported on escape distances in relation to various disturbance factors, without providing details on the number and types of issues that influences the response behaviour.

Birds may also respond differently to disturbance depending on their condition, time of year etc. (Beale and Monaghan 2004). In early winter resources may be more freely available and birds may respond quicker and appear more sensitive to disturbance. Whereas later in winter when food is more scarce bird may react to disturbance differently as they are forced to optimise their foraging time and therefore show delayed response to disturbance (Goss-Custard et al 2006).

The issues are complex and the impacts of disturbance can not be assessed from simply recording the behaviour of birds and how they respond to human activity. Seen in isolation, behavioural change does not provide a clear evidence of impacts (Drewitt 2007, Sutherland 2007).

2.3.1 Disturbance – why

There are many speculations concerning the actual nature of human disturbance: Why is it that human activities may result in disturbances of birds and what are the relations between human behaviour and the birds' natural

enemies, such as birds of prey. Studies indicate that disturbance may be an effect of visible volume, movements and noise emitted from the human behaviour in the sense that more visible volume, higher speeds and louder noise may result in more significant responses by birds (Frid and Dill, 2002, Schikore et al 2013).

Many species of birds respond to the presence of birds of prey and to structures that simulate birds of prey. The historical experiment by Lorenz and Tinbergen (1938) on hawk-goose silhouettes argues that young birds respond to shapes that resemble birds of prey, but not shapes that resemble harmless bird species (Schleidt et al. 2011). In a similar study it was found that simple black silhouettes shaped like raptors as seen from below are sufficient to elicit responses qualitatively similar to those observed during natural interactions with potential predators (Evans et al., 1993).

The reaction from birds on remote-controlled model aircrafts, shaped in the silhouettes of birds of prey have been tested. The shape, colour and noise of the model did not influence results, but the way the model was piloted was most important, suggesting movement type is an important factor (Ministerie van Verkeer en Waterstaat, 1999). As indicated eg. by Schikore et al. (2013) it may be the speed of movement that creates disturbance, rather than the shape and movements of the kite. In this sense kitesurfing may be compared to windsurfing.

A different study has assessed the level of disturbance that unmanned aerial vehicles (UAV) (commonly called drones) in a range of shapes and sizes had on free-living, non-breeding waterfowl. These UAVs caused little flight response in waterfowl with only a mild swimming response at very low altitudes (15 m above water). The types resembling birds of prey caused birds to fly away from the shore toward open water. During the study reactions were observed to actual avian predators as well, which resulted in mass take off more pronounced than any evoked by the UAVs. The findings suggest that even though UAVs represent novel objects in the air, wild birds do not react to them as strongly as they do to typical aerial predators (McEvoy et al. 2016).

Together these studies suggest that birds react to silhouettes of birds of prey in movement. Whether kites are perceived as predators by birds is still uncertain and there is, to our knowledge, no studies that confirms that the silhouette of a kite causes birds to react as it was a bird of prey.

Some species of birds respond significantly greater to the presence of pedestrians than to overhead predators, suggesting a greater threat from pedestrian than a predator overflight (Holmes et al. 2005). In a study on lapwings, the response varied between if the predator was aerial or terrestrial more than with the class of predator (mammal, bird or reptile) (Walters, 1990).

Models of birds of prey are used as fear evoking stimuli to discourage birds in areas by land- or building managers. However, with time and in particular when no attacks or lethal consequences are experienced by the birds, a habituation may gradually takes place (Conover, 1977, Laursen & Rasmussen, 2002).

Habituation is the progressive waning of a response to a repeated and/or constant stimulus. Habituation counters the responses to immediate or apparent danger and thus reduces the effect of disturbance. Regular human activities, taking place at the same site in the same manner and with the same visual and aural amplitudes are likely to build up habituation with some species of birds, in particular if the activities are frequent and not harmful. However, birds tend to overestimate the risk associated with humans rather than underestimate it and are more likely to partially habituate to harmless and repetitive human disturbance rather than lose all 'fear' towards humans (Price, 2008). A study on golden plovers for example did not find evidence for habituation (Yalden and Yalden, 1989).

This question remains highly complex and the actual mechanisms behind disturbance and habituation and the longterm effect are beyond the scope of this review.

3 Kitesurfing – how, when and where

3.1 When and where

Kitesurfing relies on specific conditions regarding wind, water depth and general coastal topography in order to take place:

- The wind speed should be more than 6-8 m/sec and can be carried out with wind speeds up to a max. of 20 m/sec. It is assumed that the vast majority of kitesurfing activities take place at wind speeds between 8 – 13 m/s,
- Wind direction should be towards the coastline,
- Water depth of at least 100 cm (in order to avoid submerged stones, sand banks etc. in troughs). Kitesurfing, and in particular for beginners, can take place at lower depths but with the risk that kitesurfers may hit the sea bottom,
- The coastal landscape should be open and without gradients such as cliffs, high banks and forest cover,
- The bulky equipment and need to change from dry clothes to wet suit and back mean that kitesurfers will need direct access by car to the launch location where parking spaces must be available.

The main pulse of activity is between April and September although for dedicated kite-surfers the season will extend into the cold months. It is estimated that during the winter period only 10 % of the full number of kite-surfers are active (unpubl. info GKA). The popularity of the sport has grown substantially over the years (Fearnley et al., 2012) but the growth seems to level out at the moment. Sales statistics of all kite producers worldwide compiled by GKA (J. Vogt, pers. comm. 2017) tell that the worldwide sales of kites lie around 85.000 kites/year, but the sales of directional kite boards have decreased from 8.000 in 2013 to 7.000 in 2016 and the sales of twin tips have decreased from 37.000 in 2013 to 28.000 in 2016.

From a British study it was found that on average kitesurfing trips last 1 hour and 26 minutes and cover an average distance of 9.3 km whilst the area covered is relatively small at 0.32 km^2 (Liley et al, 2011). This site-specific information is likely to vary significantly with location, season and conditions and can as such only be regarded as an indication. But in general kitsurfers rarely venture further than approx. 500 m from from the launching site.

Generally, kitesurfers need wind speeds of at least 6-8 m/sec (10-13 knots). The windspeed depends on the equipment used, body weight of the rider and type of riding, as greater wind speeds are required for jumping. Kitesurfers typically reach an average speed of 25-35 km/h and rarely reach speeds of more than 40 km/h.

In addition to sufficient wind, each location should ideally have specific tidal and wind conditions which favour kitesurfing. Ideally kitesurfing is carried out from a launching site from the shore, which has to be without trees and other obstacles that may pose safety risks.

Coastal areas with woodland and cliffs at the seashore are not suitable for kitesurfing as the kite may tangle with the trees and cliffs if coming too close during onshore wind directions. Coasts that have no access roads and parking spaces cannot be utilised as well.

The launching area for kitesurfers poses a number of constraints to the suitability of the site:

- First of all the area needs to be of a certain size in order for kitesurfers to unroll their lines as well as space for additional kitesurfers to prepare their equipment at the same time.

- Secondly, the area needs to be without vegetation or with a lawn-like vegetation in order for the kite lines not to get entangled with vegetation during launching.

- Thirdly, the area must be located next to an access road and a parking space for cars as the equipment cannot be carried over longer distances due to the weight and bulkiness.

- Fourthly, the above site requirements must be located just off a suitable kitesurfing area, with access either by short wading to launching at suitable water depths or with direct launching from the shore provided the water is sufficiently deep.

In all, the requirements greatly limit the amount and extent of sites that are acceptable to kitesurfing. In contrast to boating kitesurfers cannot venture far off the launching site in pursuit of suitable kitesurfing waters.

3.2 Equipment

The equipment used in kitesurfing includes:

- The kite, in various designs: flat skin, inflatable, ram foils etc.,
- Lines, typically between 20-24m,
- Control and safety bar systems, and
- Kiteboard, uni-directional (surf boards) or bi-directional (twin-tips)

The kite and its pattern and colouring may have some effects on the disturbance effects of kitesurfing, as may have the length of the lines. However, there is no evidence that the colour and shape of the kite may have any effects on the type and magnitude of the disturbance (see sect. 2.3.1) and it is likely the speed and the proximity that triggers an effect on birds (Schikore et al. 2013).

The lines limit the area that may be swept or overflown by the kite and hence the longer the lines the bigger area may be covered by the kite. With the vast majority of lines being 20-24 m in length, this factor is relatively stable from site to site.

3.2.1 Spatial and temporal constraints

Kitesurfing is spatially and temporarily limited in occurrence and more so than most other recreational activities in the coastal zone, due to the specific requirements for access and launching sites (see sect. 3.1 above) as well as coastal morphology and wind speed and direction.

This perspective needs to be taken into consideration when assessing the disturbance effects and their consequences on bird populations.

Kitesurfing has the potential to disturb birds where the activity takes place at or near bird sites and in this respect kitesurfing does not differ from any other recreational and other activities that are being carried out where birds occur. However, the significant temporal and spatial limitations that regulate the occurrence and frequency of kitesurfing make it essential to assess the effects of disturbance in a much broader perspective than on the basis of single events.

4 Disturbance of birds in coastal areas

4.1 General patterns of occurrences

4.1.1 Habitats

Coastal areas in northwestern Europe generally holds an enormous importance for birds. The coastal areas in Europe are used as flyways for thousands or even millions of birds on their way between breeding areas in northern Europe and Artic areas and their wintering areas in Southern Europe and Africa. In particular, these flyways involve waterbirds such as geese, ducks and waders but also gulls, terns and other groups of birds that are associated with marine and coastal habitats.

Figure 1 The East Atlantic Flyway - an important migratory path for a large number of waterbirds. Map source: Wadden Sea Flyway Initiative (WSFI).

As an example, the Wadden Sea alone may be visited by 10 to 12 million birds during autumn migration (WSFI 2017) and the shallow coastal sea areas hold other millions of ducks and other waterbirds during migration and during winter.

Also, breeding sites for birds are concentrated in many types of coastal areas in Europe. Breeding birds in coastal areas are dominated by the same groups of birds that use the flyways along the coastal areas.

Birds occurring in the coastal areas occupy a range of different habitats that constitute a subset of coastal habitats in north-western Europe. The most important habitats for waterbirds are mudflats and tidal areas, marshes, beach/sandy shores and shallow coastal waters.

Mudflats and tidal areas

Mudflats and tidal areas constitute some of the richest natural habitats in the world, with an enormous production of invertebrates, fish and other biodiversity, nourished by the constant influx of nutrients from the sea. Being regularly exposed due to tidal water regimes or wind pressures these resources are readily available for feeding birds, in particular ducks, geese and waders that are all highly specialised in feeding in muddy, shallow substrates.

The Wadden Sea is the most prominent example of a tidal system that provides almost endless food resources for breeding and migratory birds, and with its 10.000 km^2 the Wadden Sea is of global importance for birds. In north-western Europe many sites with similar ecological characteristics are found scattered along the coastlines. All sites play a significant role in sustaining bird populations of local and international origin and their ability to make efficient use of the East Atlantic Flyway.

Marshes

In coastal areas with a shallow topographical profile and flat areas along estuaries marshes and salt marshes may form and develop into important bird habitats. Coastal marshes have traditionally been utilised for livestock grazing and has thus been kept open and maintained as important habitats for birds. Today, some of our most rarest and red-listed breeding bird species are dependent on coastal marshes and salt marshes throughout Europe.

Beaches and sandy shores

Sandy shores are found all over north-western Europe, with major occurrences in Germany, Denmark, southern Sweden and the Netherlands. Sandy shores and beaches are of less importance to migratory birds even if concentrations of waders, gulls and terns can be found in such habitats. For breeding birds sandy shores can locally be of significant importance as they may hold breeding colonies of terns and more scattered breeding sites for waders. Generally, the presence of breeding birds of some importance depends on the regular use of the beaches for recreational activities. Long-term use with recreational activities will in most cases have caused major breeding bird occurrences to disappear.

Rocky shore, cliffs

Rocky shores and coastal areas with a steep topography are rarely important as bird habitats. An exception to this are rocky cliffs that may host breeding sites of auks and a few other species of cliff nesting seabirds, but such sites are very scarce and highly localised in distribution.

Open sea

Most north-western European countries border open sea, including the exposed sea in the North Sea and sheltered seas in the areas between Germany, Denmark and Sweden. Open sea constitute a habitat for seabirds that spend winter on the open sea and which may use open sea for foraging. During moulting, some species of ducks may spend their time in open sea. Except for a few highly specialised sea birds open sea are rarely frequented during the breeding season.

Lakes and lagoons

Along north-western European coasts, large lakes and lagoons are frequently found. If of a sufficient size such areas may be suitable for kitesurfing given the right wind conditions and at the same time lakes and lagunes can be of significant importance to birds. Due to their fresh or brackish water they often host a different bird fauna than coastal bird habitats and because of their sheltered location they can be very important for staging or wintering birds, in particular grebes, ducks and geese.

4.1.2 Birds

Birds that rely on coastal habitats in north-western Europe during parts of their lifecycles are typically belonging to the following groups of birds, collectively grouped as waterbirds:

- Wildfowl (geese, ducks, swans).
- Waders (stints, sandpipers, plovers etc.).
- Terns and gulls.
- Divers and grebes.
- Herons.
- Cormorants.

These birds utilise coastal habitats for roosting, feeding, breeding, moulting. Coastal areas are particularly important for species belonging to these groups as stop-over sites during migration and during winter.

The importance of coastal areas for breeding birds is first and foremost defined by the frequent presence of breeding colonies of gulls and terns near the shoreline, and such colonies are particularly vulnerable to disturbance. In addition, some species of waders and ducks may breed in coastal areas close to the seashore. At inland sites such as lakes and lagoons other breeding birds occur, in particular herons, geese, coots, grebes and other species of ducks and waders.

Some studies on birds and human disturbances are species-specific, but in general most studies do not relate specifically to single or few species but rather to disturbances at sites with many birds present. Only rarely will it be possible to conduct studies of the effects of specific recreational activities on individual species of birds since studies are carried at bird sites which normally host a diversity of species.

Hence, for the purpose of this review, the focus will be on bird sites and not individual bird species, and birds will be referred to as waterbirds in general.

4.2 Types of recreational activities and effect on birds

4.2.1 Types of recreational activities

The coastal areas of north-western Europe are host to a large range of recreational and outdoor activities that collectively gathers millions of people. The recreational activities have diversified significantly over the last decade and the use of the individual activities have intensified enormously during the same period. In some areas with easy access to the coast and where the topography and coastal type attracts visitors the effects of the human activities on biodiversity can be significant and can lead to local pressures on birds and other biodiversity. However, when compared to all other human pressures on coastal ecosystems disturbance ranks below much more notable risks such as habitat loss, infrastructure development, pollution, resource exploitation, erosion and general effects of climate change (see e.g. EEA 2010).

The recreational activities include a long range of activities on the shore and in the water and include the following main types:

- On shores and tidal flats during low and outgoing tide: Walking (with/without dog), sunbathing, hunting, biking, birdwatching, driving with cars and ATVs,

- On the sea: Windsurfing, kitesurfing, paragliding, sailing (kayaks, rowboat, sailboats), motorboats, jet skis, swimming, fishing, bait-digging.

The types of activities that are carried out vary with the coastal characteristics and are as such unevenly distributed along the European coastlines. Again, the most frequented areas are shallow and easily accessible coastlines with sandy beaches. A large share of the recreational sailing also takes place at and near places with easy public access, though sail boating occur over larger distances and at longer distances from the shore.

4.2.2 Effects on birds of coastal recreational activities

Human activities result in disturbances of birds and disturbances may keep birds away from optimal feeding grounds, from breeding sites and from protection

from weather, birds of prey etc. The distance within which the birds take to flight as a response to a disturbance is called the escape distance. The escape distance depends on a number of specific conditions, including:

- The species of bird(s).
- The flock size.
- Type of activity causing the disturbance.
- Time of the year.
- Frequency of disturbances.
- The behaviour of the birds.

In addition, the effects of habituation create a significant challenge when assessing the responses of birds to disturbances. Habituation constitutes a highly complex issue as it may arise during generations of birds and it is likely to be species specific as well as site specific (Laursen & Holm, 2011). Further, as illustrated by urban grey-lag goose breeding populations this species may be highly tolerant to humans during the breeding season but when the individuals join other geese while on migration they may show a high degree of shyness (Kampp & Preuss, 2005). Repeated disturbances following a fixed pattern within a short period (one to few days) may also reduce shyness and thus shorten escape distances due to habituation (Laursen & Rasmussen, 2002).

Numerous studies have been carried out to look at recreational activities and bird disturbance. Studies are frequently commissioned by local authorities facing challenges such as managing recreational pressure, implementing planning policies, requirements by European legislation such as the Habitats Directive (92/43/EEC) and Bird Directive (2009/147/EC).

These studies tend to focus on designated features within European protected areas under the Natura 2000 network and Ramsar-sites. The network of Natura 2000-sites of protected areas comprises the sites designated under the EU Habitats Directive and the Birds Directive, SACs (Special Areas of Conservation) and SPAs (Special Protection Areas). The network shall enable the natural habitats types and the species' habitats concerned to be maintained at favourable conservation status in their natural range (European Commission, 2000). The protection requirements regarding Special Protection Areas (SPAs) are given in Article 4(4) in Directive 79/409/EEC which provides that, for those areas, '… Member States shall take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting the birds, in so far as these would be significant having regard to the objectives of this Article …' (EU Commission, 2000).

In EU more than 25.000 sites (terrestrial as well as marine areas) are designated, covering 18 % of the territorial surface (Bundesamt für Naturschutz, www.bfn.de/0316_natura 2000). The designation as a Natura 2000-site causes

that the features (habitats, species) for which the individual sites have been designated must be protected by means of a regulation of the land use and to some extent also the activities.

4.3 Temporal and spatial issues

The temporal aspect of when recreational activities/human disturbances are likely to cause a disturbance to birds are linked with the spatial issues of where the recreational activity/disturbance occur. Human disturbance can negatively affects birds feeding, roosting and breeding strategies, ultimately modifying spatial and temporal patterns of habitat selection and abundance.

The shore, marshes, intertidal zones, cliffs and open water offers important habitats to a range of birds at different times of the day, year and stages of the lifecycle (see chapter 4.1). Understanding this temporal habitat usage is important in assessing *when* disturbance may occur. Understanding this spatial habitat usage is important in assessing *where* disturbance may occur. These spatial and temporal patterns of habitat usage are species specific.

Below the temporal and spatial issues are described in more detail.

4.3.1 Temporal issues

Season/time of year

It is generally agreed that during the winter (November – March) disturbances of any kind is likely to have the greatest effect on birds. In European estuaries wintering bird numbers generally start building from August, peaking in December (see eg. Liley et al. 2011, Laursen & Frikke 2013). Reduced food availability, reduced fat reserves and low temperatures force birds to spend more time on feeding in order top maintain their body condition. Severe weather conditions can mean additional stress to birds (Clark et al., 1981, in Hoskin et al., 2008). Thus the cost of responding to disturbance during the winter is higher as displacement will give less time for feeding and the consequence is that birds may respond differently (less) to disturbance events during winter than when resources are richer (Beale & Monaghan 2004a). This also means that there is no simple relation between the magnitude and type of disturbance and the escape distances (Laursen et al., 2017).

As regards kitesurfing the increased vulnerability of birds to disturbances during winter time is offset by the notably smaller activity of kitesurfers during winter. The number of kitesurfers during winter may be around 10-20% of the numbers during summer, and because of reduced day length the daily activities are significantly shorter than during summer. Other recreational activities in coastal areas are less affected by winter conditions and may continue with high frequencies during winter.

Intertidal food resources are typically of higher food value during the summer but become depleted during the autumn and early winter. Overwintering birds

along the coast feed intensively during the autumn to build up fat reserves and bird loose condition over the winter (Stilman, 2012, from study on brent geese). Weather conditions, especially wind speed and direction influences escape distance (Weston et al., 2012).

In autumn food resources are freely available and birds may respond quicker and appear more sensitive, whereas later in winter when food is more scarce birds may react to disturbance differently as they are forced to optimise their foraging time (Goss-Custard et al., 2006).

Breeding

Disturbance to breeding birds may cause nest failure, predation to nests and young, causing a potential reduction in population size. Disturbance to nesting birds is likely to be caused mainly by human activities that take place onshore where most nests of waterbirds are located. In general, as kitesurfing takes place on the open water these activities will rarely affect breeding birds directly, though some disturbance may take place at the launching site, in line with other recreational activities that take place at the shoreline.

During the breeding period breeding birds may reduce their escape distance and stay longer on the nest to reduce the risk of nest predation (Laursen et al., 2017) and breeding birds may be less likely to display obvious responses to disturbance.

Human disturbance during the summer has been implicated as the cause for decline in coastal breeding populations of ringed plover in the UK and modelling carried out on plovers predicts the population would increase by 85% if human disturbance were absent (Liley and Southerland, 2007). It must be emphasised that this study does not distinguish between disturbance types and there is no evidence that kitesurfing plays a notable role in the disturbance of breeding waders.

In general, kitesurfing is likely to result in less disturbance to nest sites and breeding birds on nests as kitesurfing takes places at some distance from suitable nest sites on shore.

Moult

Moulting generally occur in late summer from July to September or longer. During this period wildfowl (ducks, geese, swans) cannot fly for a period of about three weeks and are resting at relatively shallow water at 4-8 m deep (Laursen et al., 2017). Waders are partially flightless during the moult.

During this flightless period waterfowl are especially vulnerable (Gehrold, 2014, Mosbech and Boertmann, 1999, O'Connor 2008 in Ruddock & Whitfield, 2007). Moulting areas are usually areas of low predation and abundant food resources and moulting areas can be important stop overs on migratory routes. Moulting areas can be lagoons, inland lakes, shallow offshore areas and estuaries. The salt marshes of the Wadden Sea is an important moult site for millions of

migratory waterbirds (Birdlife, 2009). However, many moulting areas are not mapped.

Time of day

Disturbance occurring to feeding in the morning can be compensated for in the afternoon, however disturbances occurring in the afternoon have been observed compensated for by foraging at night or early next morning (study on pink-footed goose, Platteeuw and Henkins, 1997). The disturbance effect of recreational activities on feeding/foraging waterbirds may therefore be higher when occurring during the afternoon.

4.3.2 Spatial issues

Several coastal types offer important habitats to a large range of birds (see chapter 4.1.1). Despite the general value of north-western European coastal areas for waterbirds there are significant differences in importance between the different coastal habitat types. Also, within-site spatial issues such as vegetation, exposure to wind and waves and human disturbance typically result in uneven distribution patterns of birds within the individual habitats and sites.

Along coasts with mudflats, tidal areas and beaches birds congregate at high tide along the high tide line and at high tide roosts, which are slightly raised areas that are not flooded during high tide. At low tide, birds tend to spread out on the exposed tidal flats that often offers a very rich foraging habitat.

Human traffic and recreational activities at high tide are likely to cause a much higher disturbance than at low tide due to the significant concentration of birds. A British study showed that human activities at high tide were more than twice as likely to cause a disturbance to birds (Ravencroft et al., 2007).

The impact of activities is site specific and related to parameters like the state of tide, number of birds present, mudflat types and upper shore characteristic (Ravenscroft, 2007). Events on the shore caused most disturbance at high tide and events occurring offshore most at low tide (Liley et al., 2010).

There was also a significant interaction between escape distance and tide, indicating that the way in which birds responded varied according to tide. At high tide, more birds are likely to take flight at closer distance (Liley and Fernley, 2011) and also major flights were more likely at high tide.

In a study in Great Britain Liley et al. (2011) showed by using GPS tags that at intermediate tide the average area lost due to disturbance from a windsurfer or kitesurfer would be around 8 ha, while a dog walker on the mudflats resulted in an area loss of around 3 ha. Such findings are obviously highly dependent on the topography of the study site and does not take into consideration the frequency of kitesurfing and dog walking. Also, off-leash dogs may behave very differently, with some dogs actively chasing birds out in the water. In a modelling study of disturbance in the Solent (UK) events was assumed to

disturb 41 ha of intertidal habitat (mean of general and dog off-leash disturbance area) (Stillman et al. 2009, Stillman et al., 2012).

Escape distances are often used to demonstrate disturbance. In Laursen et al. (2017) species-specific and vessel-induced escape distances are compiled from various studies. Escape distance varies depending on which type of vessel caused the disturbance, windsurfers and kitesurfers mean escape distance was 390 m. Many coastal activities (walking, dog walking, kayaking etc) causing disturbances to birds have no requirement as regards weather, season or certain water levels and are carried out throughout the year and in all coastal habitats.While escape distances may provide some preliminary indications of the disturbance effect of various recreational activities the actual circumstances around the disturbance event varies enormously with a multitude of factors. It may be discussed how useful it may be to present escape distances as measures of disturbance as long as it is impossible to control the circumstances with which measures are made.

4.3.3 Conclusion

The aspects of temporal and spatial issues of recreational activities have profound implications for the disturbance effects on birds. It can be misleading to extrapolate from individual studies if the specific conditions a regard time and precise area in these studies are not duly and precisely referred to.

For individual recreational activities this become even more important because of the major differences in the way the activities are conducted. Due to the highly specific conditions and requirements for e.g. weather, coastal topography and habitats, kitesurfing may be considered as one of the coastal recreational activities that faces the most obvious temporal and spatial constraints.

5 Kitesurfing - basic findings

Many studies have reported and documented that kitesurfing may disturb birds when kitesurfing takes place on sites where birds are present (see compilations eg. by Krijgsweld et al. 2008, Krüger 2016, Laursen et al. 2017, Weston et al. 2012). Studies that include observations of disturbance-initiated escape flights provide indications that kitesurfing tend to result in somewhat larger flight distances than recreational activities that are conducted with less speed or less visual volume (see eg. overview table in Laursen et al. 2017), in line with windsurfboards while motorboats and jet ski may pose stronger disturbance effects. But as mentioned above escape distances may be misleading when sued as an indication of disturbance due to the highly diverse circumstances which surrounds the individual events and the large number of variable factors that affect responses to disturbance.

However, a number of methodological issues imbedded with the majority of the cited studies require specific elaborations. The main issue is that kitesurfing takes place at sites limited in number and size due to a range of restrictions to where kitesurfing can be conducted (specific conditions regarding weather, time of season, coastal morphology, water depth, access etc). This fact makes it difficult to compare the disturbance effect of kitesurfing to other recreational activities in the coastal zones. More importantly it also means that disturbance recorded at a particular event should not be taken in account and generalised across temporal and spatial scales. Rather, the many factors that put constraints to where and how frequent kitesurfing can be conducted suggest that comparisons and generalisations across sites and events should be avoided.

Also, studies rarely take into consideration that disturbances may not be assessed in isolation. In the majority of the studies the effects of kitesurfing are surveyed and assessed without consideration for additional recreational activities (see e.g. Krüger 2016), either taking place in the site at the same time or just prior to the study on kitesurfing. Some studies report on cumulative effects of disturbance (eg. Laursen & Holm 2011) when disturbances take place repeatedly at the same place and thereby result in increased stress levels among the birds present.

However, the aspect of bird responses to ongoing or recent disturbances may be far more complex than assumed in the individual site-specific studies of kitesurfing. On one hand effects and impacts may show cumulative or even synergistic responses, if other recreational activities take place repeatedly at the same place, but on the other hand there will also be some habituation to a varying degree, which may show up as shortened flight distances and shorter recuperation. These factors are rarely or never studied and may indeed be highly challenging to include in a scientific study.

In conclusion, due to these methodological challenges we recommend that assessments of the disturbance effects of kitesurfing are conducted on broader temporal and spatial scales rather than single-site studies as has generally been the case in the majority of the studies.

In the table below we have summarised findings from a number of studies on kitesurfing and disturbance of birds, acknowledging that most studies cannot with any fairness be summarised in this way. But the purpose of the information in the table is to provide a very brief overview of the types of studies that have taken place and the key findings that these studies provide.

It must be stressed that hardly any of the studies include experimental elements or otherwise controlled study designs.

In the following sections we provide more details on the specific context that kitesurfing takes place within as this has profound significance for the study and assessment of disturbance from kitesurfing.

5.1 Study summaries

The scientific literature published on the specific subject of kitesurfing and bird disturbance is limited and in many cases flawed in the sense that recordings and observations of disturbance are frequently done in isolation, disregarding the complexity of disturbance, impacts cumulative effects, habituation etc. As discussed above the actual circumstances that prevail around individual events vary to such an extent that comparisons and generalisations across events may lead to flawed and erroneous conclusions.

The key literature with specific reference to kitesurfing and/or bird disturbance is presented in the table below (Table 1). Numerous articles, reports and studies have been reviewed as part of the process of writing this review, see the reference list in chapter **Error! Reference source not found.**.

In this section we present an overview of key studies that have been consulted as a part of the review.

Table 1 Overview of main literature covering kitesurfing and bird disturbance.

Reference	**Authors' findings**	**Sample size (N) (kitesurfers)**	**Season/ month**	**Note**
Bayne, S. and Hyland, V. (2016).	7% of disturbances were caused by kitesurfers. The presence of kite surfers in the recording area had a significant impact on the numbers of water birds counted. Definitively making the link between disturbance events and the population size of birds was beyond the scope of the report	Not mentioned in report (28+15 Swandale T. and Waite A., 2012)	January 2010-December 2011	Based on data from Pegwell Bay Bird Disturbance Study by Kent Wildlife Trust (Swandale T. and Waite A., 2012).

Reference	Authors' findings	Sample size (N) (kitesurfers)	Season/ month	Note
Swandale T. and Waite A. (2012).	7% of disturbance events were caused by kitesurfing. 8 out of 9 visits, when kite surfers were present, the numbers of water birds recorded decreased significantly after kite surfers arrived and increased when they had departed (within minutes). To birds, a kite may resemble a large bird of prey and they behave accordingly.	28+15	January 2010 and December 2011	48 recording visits, of which 9 kitesurfers were recorded. The assumed effect of the the kite as a bird of prey is not tested. Methodology applied did not allow for given conclusions.
Beauchamp, A. J. (2009)	In 11 cases did kitesurfers disturb birds, as opposed to 31 from people walking during the same period.	11	March (5 days)	No standardised method for recording disturbance. Survey period short. Survey over five days, kitesurfing occurred on two days only.
Cruickshanks, K., Liley, D., Fearnley, H., Stillman, R., Harvell, P., Hoskin, R. & Underhill-Day, J. (2010).	2 out of 36 interviewed thought kitesurfing is causing disturbance (6%). Kitesurfing ranks middle of scale of recreational disturbance (Score 66, walking 420, rowing 18).	-	-	Desk based study on interviews with Conservation managers. No empirical data.
Cruickshanks, K. (2014)	474 kitesurfers registered.	474	June-August 2014	No disturbance data collected. Sample of counts of watersports users.
Fearnley, H., Liley, D. & Cruickshanks, K. (2012)	Kitesurfing is an uncommon activity (<1%). The main pulse of activity is between April and September.	4	Winter and a few sites in summer months	Interview with kitesurfers, no disturbance data collected.

Reference	Authors' findings	Sample size (N) (kitesurfers)	Season/ month	Note
Laursen et al (2017).	Average flight distance for waterbirds in relation to kitesurfing is 390 m (9 species). The area affected over time (1 h) by disturbance from kitesurfing is above kayaking, but below sailboat, windsurfing and jet ski.	X?		Literature review. Distance data based on disturbance data from nine bird species from (Krüger 2016).
Le Corre, N., Gelinaud, G. and Brigand, L. (2009).	Kitesurfing ranks 8th as human activity considered to disturb by Breton Conservation Managers. The sport accounts for 2,7 % of total coastal activities.	-	-	Anecdotal evidence. Based on interviews with conservation managers (nine quotes).
Liley, D., Pickess, B., & Underhill-Day, J. (2006).	One kitesurfer (parasurfer) observed during 29 counting events. Kite flyers were recorded 9 times.	1	October-March	No disturbance data collected.
Liley, D., Stillman, R. & Fearnley, H. (2010).	No disturbance recorded for kitesurfing. Kitesurfers on land (4) and on water (4) was recorded in the study. 20% of potential disturbance events within a 200 m study areas caused disturbance to birds.	4 (8)	December - February 2008/2009 and 2009/2010	No disturbance recorded in relation to kitesurfing although kitesurfers were recorded on site.
Liley, D., Cruickshanks,	Just 12 of all major flight event (180 in all) were	14 (36 GPS registered	Sept. - April.	Total counts of kitesurfers was 49, only 14 potential

Reference	Authors' findings	Sample size (N) (kitesurfers)	Season/ month	Note
K., Waldon, J. & Fearnley, H. (2011).	caused by kitesurfers Average kite route is 9.3 km long and covers an area of 0.32 km². Only 1 % of observed activities were kitesurfers.	kitesurf trips)	Survey at optimal weather for kitesurfing	disturbance event. Pedestrians caused 516 disturbances (51 "major flights"), dog walkers with a dog off leash caused 267 disturbances (47 "major flights"), bait diggers caused 96 disturbances (29 "major flights"), kitesurfers caused 14 disturbances 12 are "major flights"), windsurfers caused 7 disturbances (5 "major flights"). Taking into account distance, tide and location, birds were more likely to be scared off when activities were taking place on the water and the sea than on the beach
Liley and Fernley (2011)	No kitesurfers in study	0	December - March (2010-2011)	No kitesurfers in study. 12 study events. 34 People accessing boat or water (incl e.g. windsurfers, walking across mudflat) in inertial 6 out of 20 caused major flight, 50% (10) caused no response to birds.
Liley, D. & Fearnley, H. (2012).	40 kitesurfers on water, account for 1% of potential disturbance events. Kitesurfing flushed 24 birds in total over 4 event (1%). 3 of these caused a major flight.	40	Nov- Feb	Kitesurfers recorded on 1 day only (2 days on water, 1 person), 15 people in total

Reference	Authors' findings	Sample size (N) (kitesurfers)	Season/ month	Note
Linaker (2012)	62 kitesurfers in data set. 45% caused disturbance, all at one study site. Kitesurfing accounts for 13.4 % of the activities. Although the frequency of kitesurfing was low, the impacts appear greater. Kitesurfing occured at the shore edge and waters just offshore, where the majority of birds forage,	62 (81 people, 8 animals)	Oct-march	Table (9) of recorded activities with response of birds shows no response to kitesurfing. Kitesurfers caused 60 disturbances (of which 40% are "major flights", total 24) Pedestrians with dogs caused 540 disturbances (of which 35% "major flights", total 189
Smith (2006)	A significant drop in waders coincide with the arrival of kitesurfing. Kitesurfers are a major source of bird disturbance	-	Winter 2002/2003	Informal. Based on volunteer bird watchers data.
Stillman, R. A., Cox, J., Liley, D., Ravenscroft, N., Sharp, J. & Wells, M. (2009)	Reports of problems were reported as occurring where kitesurfing takes Place near to winter wader roosts or where there are concentrations of diving birds (e.g. grebes or eider duck).	-	-	Anecdotal evidence
Bergmann, M. (2010)	Escape distances found at 100-200 m (waders, gulls). Sudden noise by falling kite raised birds at these distances.	n/a	14 days between Sept. 2009- June 2010	
Schikore, T., K. Schröder, G. Siedenschnur,	Escape distances 150-300 m (waders, gulls, ducks). No apparent difference between windsurfers and	n/a	21 days between Feb and Nov 2011	

Reference	Authors' findings	Sample size (N) (kitesurfers)	Season/ month	Note
M. Zimmermann, S. Maehder & O. Albrect (2013):	kitesurfers.			
Blüml, V., A. Degen, D. Frank & A. Schönheim (2013):	Escape distances between 20 and 200 m (waders, geese, ducks, gulls). Average numbers of birds disturbed per event was lower than by other activities. cumulative effects from kitesurfing	Windsurfers, kitesurfers	24 days between Apr and Oct 2012-2013	Habituation to recreational elements noted by the authors
Hüttemann, M. (2013):	Escape distance 150 m	All recreational activities observed, up to 37 kitesurfers at the same time.	11 days in July 2012	Only 5 out of 109 observation periods included kitesurfers. 22 of 24 disturbance events were caused by common recreational activities
Andretzke, H., J. Dierschke, F. Jachmann, K. Normann, J. Herrmann & S. Hagen (2011):	Study on response distances, not escape distances. Adjustments of flight lines in 12 out of 54 encounters between kitesurfers and birds.	Kitesurfers,	Autumn 2011, spring 2012	Authors' note that results cannot be transferred to other sites due to local temporal and spatial variability.
Van Rijn, S. H. M., K. L. Krijgsveld & R. C. W. Strucker (2006):	Escape distances between 200-500 m, up to 1000 m for big flocks of birds. Avalance effect mentioned: Larger assemblages of birds are	15 kitesurfers at single event	Nov 2006	Unusually large kitesurfing area which with disturbance zones of 1000 m amounts to 75 km^2 according to authors. Most kitesurfing areas amount to 1 km^2 or less, depending on

Reference	Authors' findings	Sample size (N) (kitesurfers)	Season/ month	Note
	more responsive to disturbance and pull more birds from longer distancens into reaction.			the accessibility. Unlikely to be representative for kitesurfing events.
Jansen, M. (2008):	Relocation of swans due to disturbance from kitesurfing		Winter season (3 years, 19 observation periods)	Study on swans.
Jansen, M. (2011):	Kitesurfers present on 36 days, accounting for total displacement of birds on 30 days. Escape distance for ducks and geese 500-750 m.		Winter season (3 years, 76 days)	

5.2 Temporal disturbance

There are a number of temporal aspects that govern where and when kitesurfing can be executed:

- Seasonality: The summer months are preferred for kitesurfing due to acceptable wind and water temperatures,
- Weather: Kitesurfing depends on certain wind conditions as regards direction and speed,
- Water level/tide: Kitesurfing needs a certain water depth and becomes hazardous at depth beyond where the surfer can still reach the seabed.

Seasonality

The main season for kitesurfing is the summer months from April to early autumn as the wind and water temperatures are reasonable during this period. A few kitesurfers may continue into the winter but due to the critically low water temperatures the number of active surfers in winter is insignificant compared to the numbers during the summer season.

Potential conflicts with seasonal occurrences of birds include breeding birds in May and June and early migratory movements of birds in late summer and early autumn. The majority of bird migration in coastal areas take place in early to mid-autumn (Aug – Oct) and again in spring (Mar – May) and this leaves a certain overlap between the main season for kitesurfing and the main presence of birds. At a local scale the presence of birds may differ significantly from this generalised patterns but it serves an overall indication of the actual periods where the main temporal conflicts may appear.

Weather

The optimal weather conditions for kitesurfing include wind speeds between 8 – 20 m/s and wind directions in angles between directly towards or parallel to the coast. This means that coasts exposed to the west are likely to be suitable more often than coasts exposed to the east due to the western wind regime that dominates north-western Europe.

Also, with higher wind speeds kitesurfers will keep longer distances to the coastline in order not risk running against banks and the shore itself.

The risk of conflicts with birds are reduced though not eliminated with wind exposure and wind speed. Birds that rest on open water will if possible locate for sheltered water parts with no or reduced wind exposure and impacts from waves in order to minimise efforts for maintaining position and reduce the risk of cooling.

Birds that feeds on tidal areas and sandy areas along the shoreline will be relocated to areas with less wind exposure and wave movements as feeding

become obstructed with wave movements. With stronger winds this effect becomes more significant.

Thus, the potential conflicts between birds and kitesurfers are reduced in areas with wind exposure and the significance of the conflict may decrease with increased wind speed, which may force resting and feeding birds to move to other and more sheltered areas.

Water level/tide

The ideal water depths for kitesurfing is at least 1.0 m as lower water depths leaves the risk of hitting banks and the sea bottom. Higher water levels are acceptable especially to more experienced kitesurfers.

Beginners may prefer water depths on 1.0 -1.5 m. Licensed kite schools and kitesurfing instructors will not teach at lower water depths because of safety-reasons and advanced riders prefer deeper waters for jumping also because of safety reasons. Courses will only take place with onshore wind or side-shore wind and at least 75 meter (ca. 3 times length of lines) away from the shore due to safety reasons. It is also important to distinguish between bi-directionals (twintip-boards) and one-directional boards (surf-boards). Bi-directional boards are used in flat water and bumpy conditions (choppy waters). One-directionals with a total market share of ca. 35% are used in waves and deep waters and not close to the shore because of fragile fins. The relative numbers of bi-directional and one-directional boards are approx. 65% and 35%, according to statistics for market-shares and total number of sold products p.a. from Global Kitesports Association (GKA).

In general, at water depths of more than 0.3-0.4 m present birds will be waterbirds, mainly ducks, geese and grebes, that are either resting/sleeping or feeding by means of diving. Waders and other shorebirds will not be present at such water depths.

Concerns have been expressed where kitesurfing allows access to otherwise remote areas of intertidal habitat, especially with onshore winds when kites will tend to drift over feeding/roosting birds (Stillman, 2009). However, the relevance of a concern of this type should ideally be tested against the availability of suitable water depths that allow kitesurfers to approach habitats for feeding and roosting birds.

As mentioned above, when the wind has gained a certain speed the open water will no longer constitute an attractive habitat for resting/feeding birds due to wind and wave exposure. Local topographical features may obviously provide certain conditions that create suitable habitats for birds despite wind and wave exposure but in general the above relation between water depth and bird occurrence should be included in specific, local assessments of possible conflicts between kitesurfing and birds (see eg. studies by Bergmann (2010), Schikore et al. (2013) and Blüml et al. (2013)).

5.3 Spatial disturbance

There are a number of spatial aspects that govern where and when kitesurfing can be executed:

- Coastal types (morphology and topography): Kitesurfing depends on the availability of specific water depths, ideally above 1.0 m. Becomes hazardous where cliffs or trees are found near the shore, or where underwater objects like rocks and sand banks are present,
- Access: Kitesurfers need access with a car to the site and a parking space in order to bring their equipment to the launching area,
- Launching area: The launching area should be big enough for kitesurfers to prepare their kites and the area should be either bare ground or covered with very short vegetation so that the kite lines can be unrolled without tangling with vegetation,
- Surfing site: The availability of the required water depths should have a certain volume (width, length) so that it makes sense to kitesurf.

Coastal type

The coastal topography and morphology play a dominant role for the features that makes kitesurfing possible. There is a clear relation between coastal types, gradients and water depths which makes is possible to a large degree to map suitable areas for kitesurfing just by knowing the coastal type/morphology.

For the importance of water depths for kitesurfing and birds see above under *Water level/tide*.

Other features of the coastal type that influence the suitability for kitesurfing include steep features on shore, such as cliffs, trees, masts etc that may tangle with the kite if the surfer comes too close to the shoreline.

5.4 Frequency of kitesurfing

As a part of an overall assessment of the importance of kitesurfing as a disturbance factor in coastal areas the actual numbers of kitesurfers and their frequency of activity should also be considered. In particular, when the actual numbers of kitesurfers are considered together with the temporal and spatial restrictions to kitesurfing the resulting frequency of surfing per coastal length is indeed very low.

As a specific example it has been demonstrated that in some areas disturbance is mainly caused by other activities, such as in the Exe Disturbance Study (Liley et al., 2011) kitesurfing accounted for 1 % (14) of all activities registered. Disturbance was caused by 14 % (188) of all activities observed in the estuary, resulting in a major flights of birds (>50 m flight distance), however 62 % (445) of all activities caused no response from the birds in the study areas. Dog

walkers with their dogs off leads on the intertidal caused the highest percentage of major flights from all the observed potential disturbance events (Liley et al., 2011). Only 4 % (4) of all major flight events (103) was caused by kitesurfers. The effect of a single kitesurfer can however have a large impact, as in the same study 85% (12) of kitesurfers on water caused a major flight event when birds were not affected by other recreational activities.

Even if the study in the above example was comprehensive in studying human disturbance of wintering waterfowl in a busy estuary with easy access for a range of recreational activities, the results relating specifically to kitesurfing were based on just 14 observations of kitesurfers. This low number of observations does not provide much information about the specific circumstances that lead to disturbance, including comparisons with other types of disturbances, nor does it allow for an assessment of the effects of the disturbance.

It is therefore important to note that studies focusing on bird disturbance caused by kitesurfing are limited. In these studies sample size in generally low, ranging from 4 to 62 kitesurfers. One study registered 4 kitesurfers, but no disturbance effect (Liley et al., 2010) (see Table 1).

In most studies kitesurfing accounted for very few of all activities registered (potential disturbance event) at about 1-2.7 %. However in one study kitesurfing accounted for 13.4 % (Linaker, 2012). This may reflect that most studies were carried out during the winter season, which is not the main season for kitesurfing, or that the sites studied are not optimal kitesurfing locations. However, it may also reflect that the majority of potential disturbance effects are mainly caused by other coastal activities than kitesurfing and highlight the sheer number of these activities and the disturbance they cause birds.

While the actual numbers of kitesurfers and their occurrence along northwest European coasts are not known it can safely be concluded that kitesurfing is executed by a very small number of practitioners and the number is likely to be insignificant when compared to the combined number of persons that regularly take part in recreational activities along the coasts.

Hence, the overall disturbance pattern that are being documented and presented in many studies during the last years should preferably be modified by taking into account the highly limited number of practitioners when seen over a larger geographical scale and in the light of the temporal and spatial limitations to kitesurfing. Obviously, on the individual sites the actual number of surfers is less important as a single kitesurfer can create as much disturbance as a group of kitesurfers, but when reviewing the impacts of kitesurfing over a larger scale the small number of practitioners and the patchy occurrence of suitable kitesurfing sites should certainly be taken into account.

As no actual numbers are known it remains problematic to include kitesurfing frequency in a specific way in assessments of the disturbance pattern. An unknown fraction of kitesurfers rarely practice the sport because of time-

consuming preparations, significant weather-dependency and long transportation to suitable sites.

However, on a local and site-specific scale the potential numbers of kitesurfers should be included in assessments in order to provide a reasonable impression of the scale of surfing in order to set proportions relative to other recreational activities in the same area/site.

5.5 Mitigation measures

A number of different conservation measures have typically been introduced to manage recreational activities in coastal areas (see e.g. overviews and compilations in Brøgger-Jensen et al. 2015, Krüger 2016, Laursen et al. 2016, Therkildsen et al. 2013):

- Designation of wildlife reserves and protected areas,
- Publishing Codes of Conduct eg. in the form of a 'Bird Aware Coastal Code' for guiding and regulating human behaviour,
- Establishing coastal recreational zones explicitly for certain activities and buffer zones against vulnerable and sensitive areas, with buffer zones respecting acknowledged flight distances,
- Regulating access and parking in order to reduce activities at the access and preparation points,
- Launching targeted information campaigns for active users of coastal areas, with signposts, flyers, information boards etc,
- Conducting impact assessments on a strategic level (regions, larger areas) and on project/activity level (specific sites),
- Education and stakeholder engagement,
- Elaborating spatial plans.

Management measures such as reserves, zones and access regulations will often be of a temporary character or with fixed periods for access, reflecting the specific periods where activities may conflict with vulnerable bird occurrences. As an example there is evidence that late summer and early autumn may constitute a period of potential conflict between recreational activities and the early migratory movements of birds. In order to reduce actual conflicts specific management measures for recreational activities could be designated at suitable sites in particular in this period.

There are numerous examples from around European coasts of specific management measures for particular water-based recreational activities. Such measures are often set out in local or regional codes of conduct, usually

developed with local users and user groups. The codes of conduct are sometimes also linked to bylaws, and the implementation of the management measures is often driven by safety issues rather than with the aim to minimise disturbance (Brøgger-Jensen et al. 2015).

In order for such management measures to become efficient against disturbance it is important that all coastal recreational activities are considered at the same time. As evidenced above, many or most types of recreational activities in coastal areas may disturb birds at some point. And a single disturbing element may often be sufficient to cause an effect on birds occurring at the specific site, whether it is an un-leashed dog, bait-digger, kitesurfer or a kayak.

Burger (2003) reported the success of education in reducing disturbance impacts to breeding common terns (*Sterna hirundo*), however, continual education and enforcement is necessary to maintain the effectiveness of such strategies.

Impact assessments can be a strong tool for assessing and planning for a certain activity and is legally mandatory in EU member states for a large range of projects, structures and activities as specifies in the EU Environmental Impact Assessment (EIA) Directive (2014/52/EC). Within Natura 2000 sites, it may be required to conduct an Appropriate Assessment (Art 6 in the Habitats Directive) for new activities in order to assess the potential impacts on Natura 2000-designated features (such as overwintering or breeding birds). While recreational activities on the sea are not included on the Annex I or II of the EIA Directive the principles and approach given by the EIA procedure may prove beneficial to apply in certain cases where kitesurfing appears to be conflicting with different points of view and opinions. An impact assessment carried out by an independent body, done along the principles laid out by the directive, should expose, describe and assess the actual activity against e.g. natural values, including bird occurrences, and draw up recommendations for the planning and regulating authorities.

Spatial plans may provide an overall framework for more detailed, local regulations of activities and will as such be a valuable instrument for avoiding conflicts while establishing the regulatory framework for existing and planned activities. In line with the assessment of specific projects by means of the stipulations in the EIA Directive spatial plans should likewise be assessed in compliance with the EU Directive on Strategic Environmental Assessment (SEA), Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment. If conducted in a comprehensive manner the SEA will inform the spatial planning process and help avoiding major conflicts of interests subsequent to the planning process.

5.6 Cumulative impacts and habituation

Bird disturbances are amplified when more disturbances take place simultaneously or continuously (Smit & Visser, 1992, Laursen & Holm, 2011). The responses of birds to disturbances are more prominent when raptors are present (Laursen & Rasmussen, 2002) and Linaker (2012) found that the

disturbance caused by dog-walkers with dogs off leash was intensified with the simultaneous presence of bait-diggers or kitesurfers. Furthermore, it is well documented (eg. Meltofte, 1982, Laursen et al. 2017) that hunting creates a certain stress level that results in a higher alertness and shyness towards other recreational activities.

With the increasing and intensifying recreational activities taking place in north-western European coasts it is likely that cumulative effects may become more and more prominent and should be included in future studies of the effects of recreational activities in coastal areas.

As already described in section 5.4, kitesurfers represent a small part of the overall disturbances as kitesurfing is just one out of several coastal recreational activities and should be considered as such. Hence, when assessing effects and potential cumulative effects of recreational activities kitesurfing should never be considered in isolation as all activities in the coastal areas potentially brings some kind of disturbance effect with them. An isolated assessment of kitesurfing – or any other coastal activity – will not yield the necessary information about the disturbance effects at the particular site and the possible cumulative impacts.

Facing this is the process of habituation to human disturbances that gradually develops when the disturbance is perceived by the birds as being non-lethal. With increasing habituation the effects of disturbance will be reduced as birds gradually accept the presence of the activities and demonstrate higher tolerance towards human presence. As indicated by Laursen & Holm (2011) the issue of habituation is highly complex and may vary with site and species of birds, and it may develop over rather short time or over generations of birds.

Hence, there is very little research done on habituation and it is highly challenging to quantify habituation as a mechanism at play simultaneously with cumulation of effects from disturbance.

As the access points and launching sites for kitesurfing are relatively well defined due to the limited availability of suitable access and launching sites the actual number of kitesurfing areas is limited as well and thus rather well defined. If human movements and activities are limited to well-defined paths and areas the resulting disturbance effects are likely to be smaller due to habituation.

Thus, cumulative effects and habituation are likely to present themselves as two opposing processes though with different initiators. Cumulative effects may be initiated when several disturbing activities take place simultaneously and consecutively and habituation may be initiated at the same time and place if the activities are carried out in a predictable manner that does not stress and harm the birds.

6 Conclusions and recommendations

6.1 Conclusion

6.1.1 General conclusions

When seen in isolation, kitesurfing can be a disturbance factor for birds at the specific site and time where it is being carried out. However, an important perspective to bring forward when making an overall or generalised assessment of the disturbance of kitesurfing on birds is the limited number and extent of the sites where kitesurfing is carried out and the restricted periods when kitesurfing can be conducted.

Thus, the answer that may be given to the basic question *Does kitesurfing disturb birds?* must indeed be split in two:

1 On a specific site and time where birds and kitesurfers are found together the answer is yes – with the addition: Any human activity that takes place where birds occur is likely to disturb birds. The magnitude of the disturbance depends completely on the actual circumstances and cannot be transferred from one case to another.

2 On a broader temporal and spatial scale the answer is more complex. Compared to other and more widespread and frequent coastal zone recreational activities the disturbance effects from kitesurfing may be insignificant due to the infrequency of kitesurfing in general.

The fact that kitesurfing belongs to one of the less frequent recreational activities in the coastal areas of north-western Europe has seldom been brought to light in the existing studies that have focused on single sites. Conclusions from single site studies dealing with a local disturbance at a given time have no general validity.

It should also be stressed that the present review – and indeed the consulted studies – has made no attempt to assess the disturbance effects in the light of

the presence of natural enemies to birds, such as birds of prey and carnivore mammals. With a rapidly growing population of white-tailed sea eagle in north-western Europe (the breeding population in Denmark has grown from a handful of pairs in 2000 to more than 80 breeding pairs in 2016 (Skelmose et al. 2017)) the stress caused among coastal birds by the eagles have increased significantly.

Nor has the review tried to assess the disturbance effects in comparison to hunting in coastal areas. The disturbance effects of hunting in coastal areas are assessed in countless studies and reviews, but the cumulative effect of the stress applied to birds when being hunted may be considerable.

Another potential flaw in the existing studies is exposed when it is demonstrated that a given area holds birds before and after a kitesurfing event but no or few birds during the event. A number of reasons related to wind, water depths, tidal effects etc can explain why a given area is suitable for birds under one set of conditions and suitable for kitesurfing under another set.

In general, there is a major lack of empirical evidence that demonstrates the actual disturbance effect, when seen in connection with other recreational activities, that take place in the same area. The many studies that have looked at kitesurfing in isolation do not allow to make detailed conclusions on the effect of kitesurfing as one of several recreational activities in coastal regions. To single out kitesurfing as a major cause of disturbance to birds is not justified on the grounds of the findings in the majority of the studies consulted for this review.

6.1.2 Where are the main risks for conflicts

The following major risks for conflicts with birds have been identified:

- Kitesurfing near high tide roosting sites for birds where migratory birds are highly concentrated and can occur in very large numbers,
- Prolonged kitesurfing near major and extensive feeding sites, in particular during the winter months (where kitesurfing frequency is much reduced due to reduced daylight and challenging winter weather conditions),
- Late summer and early autumn, where the first pulse of migratory birds pass through northwest European coastal regions towards their wintering quarter may be the period over the course of a year where there is greatest risk for conflicts between vulnerable bird occurrences and kitesurfing and other recreational activities.
- There are no indications that the kite itself is regarded as a bird of prey – and thereby as a threat – by the birds. It remains plausible that disturbance is caused by simple factors such as movement, speed and visual volume.

6.1.3 When can kitesurfing take place

The review has retrieved the following major findings concerning the requirements for kitesurfing:

- Kitesurfing is severely restricted in terms of time and space as to where and how frequent it can be conducted,
- The demand for specific weather conditions and water levels give kitesurfing more limitations than most coastal activities in terms of when it can be carried out,
- The specific requirements for accessing the shore with the rather bulky equipment and for preparing the kite with the 20-24 m lines limit the number of suitable access and launching sites,
- Kitesurfing takes place at water levels that under many circumstances reduce the potential impact on the most significant breeding and resting/feeding bird sites, in particular in the Wadden Sea area, as the required water levels are found sufficiently far from the shore or from tidal/mudflats and breeding sites to avoid major disturbance situations,
- The space required for kitesurfing may be less than projected as kitesurfing most often takes place within a certain polygon rather than by means of long unidirectional excursions along the coast like motor boating, kayaking/canoing etc. This reduces the impact even in situations with many kitesurfers at the same place,
- The requirements for certain water depths and for a certain minimum wind speed limit the possibility for kitesurfers to enter areas with shallow or calm water, which in most cases are the preferred habitats for resting and feeding birds. Large parts of eg. the Wadden Sea and lagoons and lakes along the coast are not accessible due to these constraints
- Cold winter weather and reduced daylight cause a significantly reduced activity during winter.

6.1.4 What are the disturbance effects from kitesurfing when compared to other recreational activities

The review has retrieved the following major findings concerning kitesurfing as a factor (out of several) in the recreational pressure in coastal regions:

- Kitesurfing can disturb birds, like other coastal recreational activities conducted where birds are present. Disturbance can take place at the launching site and on open water, but fewer birds are found at the water depth where kitesurfing most frequently takes places than on shallow water or exposed sand and mudflats,

- In general the more wind exposure on open water the less birds will rest and feed in the area, and the more suitable will it be for kitesurfing – and the other way around. This fact reduces conflicts between birds and kitesurfing in many places,

- The majority of studies done on the effects of kitesurfing on birds conclude that kitesurfing disturbs birds but conclude so without including the effects of other types of recreational activities or isolating the effects of kitesurfing from the effects of other activities,

- Studies of the effects of kitesurfing on birds when kitesurfing is the only ongoing recreational activity will inevitably lead to the – premature – conclusion that kitesurfers disturb birds. The consequence of conducting such studies is that kitesurfing is given as the cause of disturbance even if it overwhelmingly likely that any human activity at the same time and place will cause disturbances of birds,

- The disturbance effects of kitesurfing are comparable to windsurfing.

- More widespread and common recreational activities such as dog walkers are likely to disturb more than kitesurfing across temporal and spatial scales.

- Due to the highly specific local conditions in terms of weather/wind, occurrences of birds, topography, recreational activities etc it remains unrealistic and impossible to generalise findings from a single study to other sites and circumstances. The large number of variable parameters makes it extremely challenging to design a study setup that allows for a broader use of the findings and conclusions.

- Other generally unknown factors to consider when assessing the disturbance from recreational activities are habituation, cumulative effects and synergistic effects. Cumulative effects are effects from various sources of disturbance that add onto each other and thus increase the resulting response from birds. Habituation and synergistic effects may act opposing to each other and at different times. Few of the consulted studies reported on indications of habituation and cumulative and synergistic effects. Without doubt these factors should be tested in far more details as they may significantly change the expected response patterns to disturbance.

6.2 Recommendations for further studies

6.2.1 Study methodology

The majority of studies consulted for this review suffer from a number of common flaws that make it difficult, if not impossible, to accurately assess the effects on birds from kitesurfing. The most widespread methodological problem is that studies typically are conducted as a kind of before-and-after comparisons

which in almost all cases inevitably lead to the conclusion that kitesurfing scares birds away or that birds were more numerous before or after kitesurfing etc.

Some studies also observe that birds will utilize the areas that kitesurfers are using, when there is no surfing going on. Again, this observation can lead to the flawed conclusion that kitesurfing keeps birds away from preferred grounds, and while this may indeed be the case in some situations it is equally likely that the area due to wind and weather conditions is not suitable for birds when useful for kitesurfing, and indeed the other way around. With the kitesurfers' specific requirements for features such as wind and water depths it remains a plausible possibility that in many cases the same area will be used alternating by birds and by kitesurfers with reduced or no overlap in temporal or spatial usage.

It is obviously very challenging to set up a study design that will provide an unbiased picture of the actual disturbance effects of kitesurfing, where factors such as birds present, other recreational activities (ongoing as well as recent), weather (wind), water depth, area usage by birds etc can be controlled in the study setup. Nevertheless there are major advantages to get if a study is designed with these variables in mind and with sufficient time at hand to map the complex combinations of these variables.

6.2.2 Short- and long-term effects of kitesurfing

The review has first of all revealed a significant gap in the specific knowledge about the actual disturbance patterns that result from kitesurfing. There is a rather notable need to undertake studies that aims at establishing short-term and long-term effects of kitesurfing on bird populations, with the specific purpose of building a solid picture of the explicit circumstances that may lead to conflicts between kitesurfing and bird occurrences.

Long-term effects of disturbances are notoriously difficult to study in more detail due to the many factors involved when assessing population pressures and measuring the physiological response. Models that describe aspects of bird population viability have been developed many times over the recent decades (typically termed PVA, Population Viability Analysis, see eg. Horswill et al. 2016 and O'Brien et al. 2016) but most models are compromised by the immense amount of parameters that are needed for the model to become operational. For basics models the simplistic approach to map population characteristics and essential population factors leave the models too vulnerable to flawed input data.

6.2.3 GIS-mapping of kitesurfing sites

In order to be more precise about the actual location of suitable kitesurfing sites it can be suggested to make a GIS-based mapping of sites that match the physical/topographical requirements as well as accessibility (access roads, parking spaces) along the Northwest European coastline. Though it may be a significant task to conduct such a mapping exercise it would constitute a major tool for conservation planning in coastal areas and potentially help avoiding

conflicts between kitesurfing and conservation interests as well as legal requirements to protect bird species. Currently there is a lot of focus on spatial planning in coastal areas for climate adaptation purposes and it can be argued that planning for recreational activities should be an integrated part of the spatial planning in coastal regions due to the massive recreational values and nature conservation values of Northwest European coasts.

6.2.4 Buffer zones

The areas that can be affected by disturbance from recreational activities are species-specific and site-specific and any Codes of Conducts and management measures such as buffer zones need to reflect this. It is inappropriate to set general buffer distances since responses to disturbance vary between bird species and between individuals of the same species (Blumstein et al. 2003, Beale & Monaghan 2004). The ecology of the species and the site specific features must be taken in to account when identifying potential disturbance and measures that aim at countering the effects of disturbance.

Zones prohibiting kitesurfing only would be an inadequate conservation measure as other recreational activities cause disturbance to birds. In order to minimise disturbance of birds in important coastal sites or at sensitive times a year, management measures such as zoning would have to consider all potential disturbing activities e.g. dog walking, sailing, kayaking, bait-digging etc.

6.2.5 Site-specific impact assessments

Perhaps the most important conclusion that can be drawn from the present review is that it is impossible to generalise about the potential impacts from kitesurfing. So rather than exploiting the lack of site- and area-specific knowledge by issuing general bans on kitesurfing it may be useful to undertake site-specific assessments of possible conflicts between birds and kitesurfing as an impact assessment is likely to reveal and pinpoint the actual areas of conflicts – if any. Based on the findings in an impact assessment it is then possible to establish specific and targeted regulations and measures including buffer zones that may serve to allow for a preservation of the bird fauna as well as provide access to recreational activities under certain rules.

An impact assessment must obviously also include an assessment of all activities in the specific place so that a thorough understanding of the recreational activities and their combined effects on the bird fauna present can be revealed and discussed. This may lead to broader measures in order to regulate the recreational traffic or it may result in an area-specific Code of Conduct that should include all recreational activities.

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