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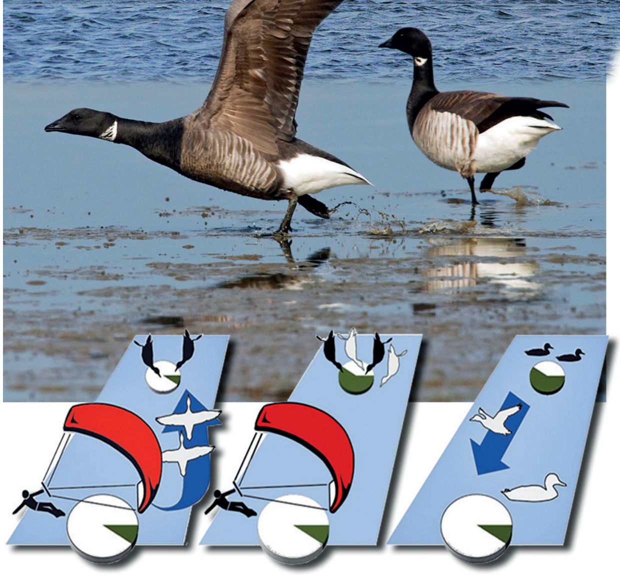

Thorsten Krüger

On the effects of kitesurfing on waterbirds – a review

Niedersachsen

Contents

Cover: The large photo of the collage shows a kite surfer outside the zone designated for the pursuit of his sport on the other side of the Königshafen on Sylt heading towards the high tide roost of waterbirds and waders on the island of Uthörn in the Wadden Sea National Park, causing them to flee. Among them are Brant Geese and Common Shelducks, Eurasian Curlews, Bar-tailed Godwits, European Golden Plovers, Grey Plovers and Dunlins. (Photo: Hans-Ulrich Rösner)

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1 Introduction

The end of the 1990s saw the advent of a new kind of sport: kitesurfing. Despite similarities to windsurfing in terms of locomotion, it had entirely different origins and was in fact completely separate (HAPGOOD 2014). The board on which the kite surfer stands has only short fins and is pulled by a kite at a distance of 20-30 m, which means surfing is still possible in very shallow waters and in light wind. In the right conditions, it is possible to achieve higher speeds than in windsurfing, daring jumps (up to 10 m high and 40 m in length) can be performed and in general kitesurfing was soon seen as an exciting new challenge, requiring a high level of technical skill.

At that time, the new extreme sport quickly attracted many devotees around the world and in recent years it has become a very popular sport, as can be seen in the rapid increase in the number of kite surfers (www.sportkiten.com). Although the number of practitioners in Germany is not exactly known, it is currently estimated to be around 10,000 with 800,000 (http://kiteboarding-kitesurfen.de/) to millions (www.kitesurfersblog.com/kitesurfing/) active worldwide.

Since kitesurfing can often be practiced at the same locations as windsurfing – in coastal waters and on large lakes – it was not long before observations were being reported recalling those which had led to discussions about windsurfing as early as the 1980s (DNR 1981, TAAPKEN 1982, MATHEWS 1982, LNV-SH 1983, HÜBNER & PUTZER 1985). Observations from multiple locations reported that kitesurfing was proving a considerable source of disturbance especially for staging birds, jeopardizing the future of staging/breeding areas coinciding with highly frequented kitesurfing spots (e.g. BERG 2003, TIND & AGGER 2003).

This kind of outcome has long been documented with respect to windsurfing (KELLER 1995, SÜDBECK & SPITZNAGEL 2001) and is irrefutable, occasioning many coastal regions to ban or seasonally/locally limit the sport. With kitesurfing, in view of the lack of focused studies, further insight has thus far been sought in publications on disturbances caused by windsurfing (HÜBNER & PUTZER 1985, DIETRICH & KOEPFF 1986, BLEW & SÜDBECK 1996, DIERSCHKE 1998, SÜDBECK & SPITZNAGEL 2001) and kite flying (HELLWIG & HELLWIG 1993). This practice, though tried and tested, is easy to discredit and any conclusions reached are often called into question.

However, Germany is not the only country debating the “if”, “where” and “how much” of kitesurfing within or close to important bird habitats. Discussions like this are being held around the globe wherever kitesurfing is practiced. According to VISTAD (2013) important bird habitats, which often have the additional status of a national park, a Special Protection Area, etc., can be defined as socio-ecological systems (SES). These can be characterized as areas where every human activity will have an impact of some sort on the natural environment, but these impacts are not necessarily injurious with respect to the conservation goals. It very much depends on how vulnerable/robust the systems and different bird populations are, and on which societal values and guidance the management is to be based.

So far, all studies on the effects of kitesurfing on birds are unpublished reports spread out among different nations and considered "grey" literature. The aim of this paper is to summarize these reports and to develop a general synopsis of the following topic: the reactions of waterbirds to kitesurfing and its effects. This was felt necessary as kite surfers tend to underrate the disturbance effects they cause as marginal or non-existent.

Kite surfers would like to pursue their activities without restrictions (e.g. online petition "Legalize kitesurfing on lakes in Saxony", https://weact.campact.de/petitions/kitesurfen-in-sachsen/). Instead, to reduce disturbance effects they would prefer to rely on voluntary self-control and appeals, which are generally viewed as problematic in individual sports and are invariably ineffective (STEINGRUBE & SCHEIBE 2007).

Additionally, demands for expansions of designated kitesurfing zones are being made, presenting the argument of support for tourism or business promotion (e.g. online petition "No general ban on kitesurfing in the Wadden Sea", https://weact.campact.de/petitions/kein-generelles-verbot-fur-das-kiten-im-wattenmeer/), or even, as recently in the case of the City of Emden, that of attracting more students and thus securing the continued existence of the university. These encroachments call for reliable and resilient data and information to be placed at the disposal of environmental protection agencies and nature conservation organizations if they are adequately to meet the demands of a comprehensive protection of valuable habitats.

In addition, this report evaluates observations of interactions between kite surfers and birds, considering aspects such as distances between the two, and proposes recommendations on possible buffer zones between bird habitats and kitesurfing areas (kite spots, kitesurfing zones). Important for the success of the discussion as a whole is to avoid seeing kitesurfing as a positive or negative recreational activity, and instead to consider it dispassionately, simply as another use of nature, which it undeniably represents. From this neutral standpoint, the potentially negative effects of kitesurfing on protected natural resources can be objectively evaluated.

Figure 1: Kitesurfing is becoming increasingly popular. Weather conditions permitting, surf spots can become very crowded, especially during world cup events, as pictured above (St. Peter-Ording, Germany 2015). (Photo: U. Walz / blickwinkel.de)

2 General conditions for kitesurfing

Kitesurfing is an all-year-round sport but is not recommended for beginners in temperatures below 10°C, which makes it more of a summer activity in more northerly latitudes. Whether or not kitesurfing is possible depends on wind conditions (wind direction and wind speed) and the skill levels of the surfers. Ideal wind conditions are steady side-shore or side-on-shore winds. In on-shore winds, although kitesurfing is still possible, designated kitesurfing zones quickly become overcrowded as all kite surfers move parallel to the coast. Most kite surfers stay within 500 m of the coast (maximum 1,000 m). Kitesurfing in deep waters far from the access point requires skill, strength and endurance and is comparatively dangerous.

The range of wind speeds suitable for kitesurfing has increased with the recent advancements in materials used. Lightwind kites and appropriate boards enable kite surfers to go out in wind speeds as low as 10 knots (3 Bft). While winds > 40 knots (8 Bft) can only be tackled by experts, beginners usually start in winds of 12-27 knots (4-6 Bft; www.sportspy.net/wind-wetter-beim-kitesurfen/). ANDRETZKE et al. (2011) observed that kite surfers off the island of Norderney, Germany, were particularly active in winds starting at 12 knots (4 Bft). While kitesurfing in coastal waters can be restricted by tidal ranges, no such limitation applies to lakes.

3 The concept of “disturbance” in ecology

In ecology “disturbance” is generally defined as any external influence that negatively affects the energy and/or time budget of an animal. REICHHOLF (2001) states that a disturbance interferes with or modifies other (vital) activities like foraging, food intake, comfort behaviour, breeding, feeding young or other activities related to reproduction, as well as the processes involved in growth or roosting phases. Disturbances can be caused by other animals (larger animals, predators), by environmental conditions (floods, storms, fires, etc.) and by humans.

“Disturbance” is an ambiguous term which can refer either to the cause of the interference, the reaction to it or the entire event (HOCKIN et al. 1992, BANKS & REHFISCH 2005, LE CORRE et al. 2013). STOCK et al. (1994) therefore suggests that research oriented in nature conservation should speak of “disturbance stimulus”, “reactions” to it and resulting “consequences”. “Disturbance effect” refers to the immediate reaction and the ensuing consequences. The occurrence of a disturbance stimulus and the resulting consequence are called the “disturbance event”. These terms are dispassionate and non-judgmental; the term “disturbance” is used only in the evaluative assessment of a stimulus (STOCK et al. 2002, KOMENDA-ZEHNDER & BRUDERER 2002).

The relevance of a disturbance stimulus depends on its duration, intensity, frequency (of occurrence) and temporal distribution (time of day, season). The reactions to disturbance stimuli depend on previous experiences of the affected individuals. Reactions can be:

- physiological, e.g. increasing heart rate or energy costs
- behavioural, e.g. change of behaviour (becoming alert, fleeing, etc.)
- ecological, e.g. disappearance or absence of vulnerable species in disturbed areas that would otherwise be suitable habitats.

Shyness is not a natural trait in animals, it is the result of experiences generating familiarity or fear of humans. Sensitivity to stimuli is therefore locally and temporally diverse and cannot be assumed to be similar or identical in different situations and regions. This sensitivity is not hereditary; its extent generally depends on experience and the ability to learn (REICHHOLF 2001).

Whenever animals with certain characteristics (morphological, behavioural) are more likely to survive and reproduce, evolutionary adaptation is at work. We differentiate between phylogenetic adaptation via selection of genetic traits and adaptive modifications in response to the experience of individuals. These experiences can be passed on (INGOLD et al. 1996). Habituation requires the ability to learn and a sufficiently long lifespan (time in which to “learn”). Other factors that facilitate habituation are:

- frequent, reoccurring disturbance stimulus without negative impacts
- in particular places and/or
- at particular times.

A reduction in or lack of reaction to a disturbance stimulus precedes a habituation, but does not necessarily mean adaptation has taken place (INGOLD et al. 1996).
A disturbance stimulus has to be considered as severe when the resulting change in behaviour entails negative consequences for the energetic budget or body condition and culminates in diminishing fitness of offspring. The reduced fitness of many individuals of a population must be prejudicial to the fitness of the population as a whole (STOCK et al. 2014).
Disturbance stimuli that have negative impacts that cannot be compensated for can be classified as true disturbances and need to be averted by environmental protection measures (Fig. 2; STOCK et al. 1994).
Disturbance stimuli can be segregated into visual and acoustic stimuli. Another important consideration is the intensity and the potential temporal overlap and accumulation of stimuli. The intensity of disturbance effects can be categorized as follows on the basis of reactions:

- increased alertness (= distraction from other activities or interruption of resting phases)
- evasive reaction (when spatially possible and undisturbed zones are accessible)
- escape reaction; leaving area (breeding, roosting or feeding site) resulting in absence from or abandonment of the site
- complete desertion, the most severe disturbance effect, as it entails the loss of habitat and cannot be compensated for.

The intensity of a disturbance also varies with the distance of the prey from the stimulus, animals reacting differently according to whether a predator is 1,000 m or 10 m away. The distance between the point at which a prey begins to flee and the approaching predator is known as the flight initiation distance (FID; HEDIGER 1934). Synonyms are: flight distance, flush distance, escape distance, fleeing distance. In birds, the response modes include not only taking flight, but also running, swimming and diving to safety (WESTON et al. 2012).

The decision of an animal whether or not to flee when e.g. a predator violates their specific flight distance results from a trade-off between risk management and energy costs: fleeing burns up (a lot of) calories. But the risks of remaining increase with decreasing distance from the predator (Fig. 3). Further, the costs of fleeing are greater from a foraging area of high quality than they are from a low quality area, as the energetic costs of missed feeding opportunities have to be added to the costs of fleeing (YDENBERG & DILL 1986, BLUMSTEIN 2003, COOPER & FREDERICK 2007, COOPER & BLUMSTEIN 2015).

Vigilance is a state of alertness that promotes the detection of relevant stimuli. Alert behaviours vary between bird species, but often include a change of posture to monitor the disturbance stimulus/predator (e.g. by raising the head, PULLIAM 1973) and communication with conspecifics via alarm calling or pursuit-deterrent signaling, as in the tail movements of rails (Rallidae; WOODLAND et al. 1980, ALVAREZ 1993, RANDLER 2016) and the wing raising und wing beating in avocets (Recurvirostridae; (HAMILTON 1975, DIETRICH & KOEPFF 1986). The alert distance (AD) is the distance at which a prey responds overtly to the stimulus/predator and it is always equal to or greater than the FID (FERNÁNDEZ-JURICIC 2001, BLUMSTEIN et al. 2005, CÁRDENAS et al. 2005, COOPER & BLUMSTEIN 2015; Fig. 4).

The definition of two other distances is essential:

1) The detection distance (DD) represents the distance at which a stimulus is first detected by the bird but causes no reaction. Detection is usually visual but can be acoustic as in the case of motorized vehicles/boats or sounds made by approaching predators (WESTON et al. 2012).
2) Physiological initiation distance (PID) represents the distance from a stimulus at which birds react on a physiological level e.g. by increased heart rate (GABRIELSEN 1987, HÜPPOP & HAGEN 1990, PLATTEEUW & HENKENS 1997, ELY et al. 1999) or release of stress hormones (STURKIE 1976).

Birds can detect disturbance stimuli without appearing vigilant, thus detection distances are always greater, or at least as great as, ADs (LIMA & BEDNEKOFF 1999); PIDs will normally be greater than ADs (NIMON et al. 1996). The starting distance (SD) represents the beginning of an observation when the bird appears to be completely undisturbed and the stimulus/predator (e.g. person walking) begins to approach (COOPER & BLUMSTEIN 2015).

In the evaluation of the effects of kitesurfing, FIDs are highly significant as they can be observed and measured easily and objectively. Measuring ADs is more difficult as the corresponding behaviour is not always visible/audible (GUAY et al. 2013), the more so as the observers are usually at a distance in order not to be a disturbance themselves.

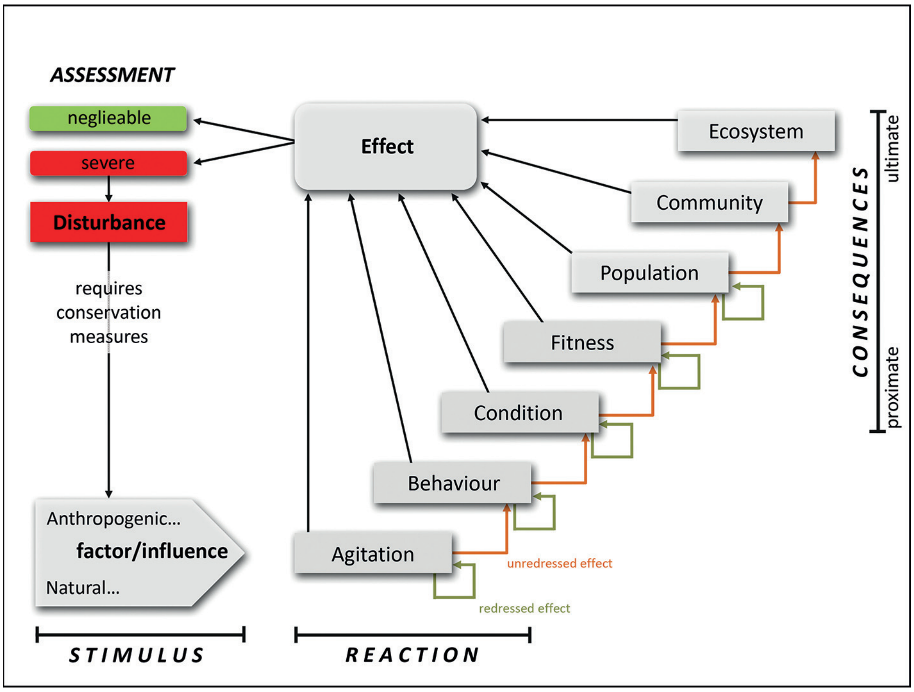


Figure 2: Disturbance model after STOCK et al. (1994): natural and anthropological stimuli have different effects on different levels, ranging from the individual to the ecosystem. Stimuli that have negative consequences (impacts) that cannot be compensated for can be classified as true disturbances.

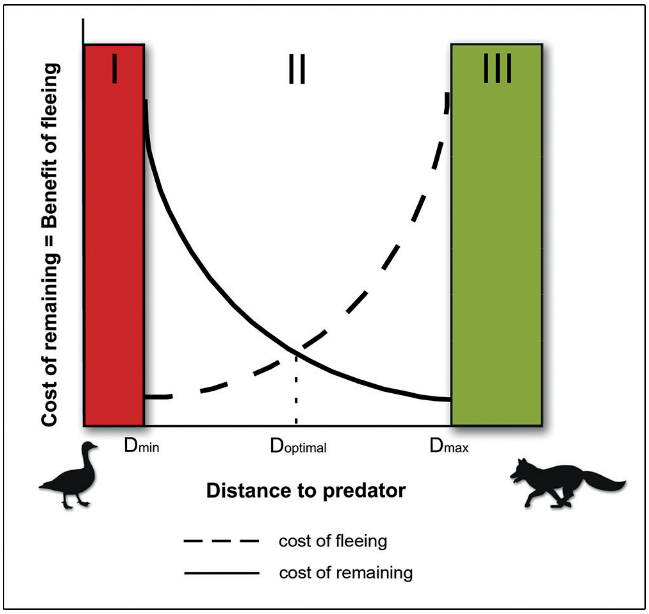


Figure 3: Economic model of flight initiation distance (modification of YDENBERG & DILL, 1986). The cost of remaining (which is congruent with the benefit of flight; solid line) reduces as the distance to an approaching predator increases, whereas the cost of fleeing (broken line) increases with distance from an approaching predator. The intersection between these two functions defines the cost-minimizing optimal flight initiation distance ($D_{optimal}$). Species have two critical distances (D_{min} and D_{max}) which create three zones: Zone I: animals will always respond to threats detected in this zone; Zone II: animals will optimize their escape dynamically as a function of the benefits and cost of flight; Zone III: animals will not respond to predatory stimuli from this zone by fleeing (adapted from BLUMSTEIN 2003).

4 Disturbance of roosting or foraging waterbirds

There are numerous detailed studies on anthropogenic disturbances of birds in general and of waterbirds in particular; in addition there are a number of useful synopses (e.g. PLATTEEUW & HENKENS 1997, ROBINSON & POLLITT 1992, HELLDIN 2004, KRIJGSVELD et al. 2008, LE CORRE et al. 2009, BORGMANN 2012, WESTON et al. 2012).

Individual papers include, for example, studies on the impact of boating, windsurfing and other water sport activities (overviews: YORK 1994, KELLER 1995, MADSEN 1998), hunting of wildfowl (MADSEN 1995, MADSEN & FOX 1995), coastal development (HOCKIN et al. 1992), air traffic (KOMENDA-ZEHNDER & BRUDERER 2002) and exercising dogs on beaches (MILLER et al. 2001, BANKS & BRYANT 2007, SCHWARZ 2010, GOMPPER 2014). The negative effects of these activities are abundantly documented. Disturbances caused by recreational activities of whatever nature are generally classified as a serious threat to waterbirds, particularly since many recreational activities may still be increasing in intensity and distribution (WARD 1990, CAYFORD 1993, GILL 2007).

4.1 Factors and processes that influence the behavioural responses to disturbance stimuli

There are various factors influencing the reaction of birds to disturbance stimuli. Birds – not least waterbirds – often react to humans as they would react to predators (GILL et al. 1996, BEALE & MONAGHAN 2004a) and in many situations, a disturbance stimulus caused by humans has a far greater effect than that caused by natural factors (KIRBY et al. 1993). BOAG & LEWIN (1980), for example, found that ducks reacted more strongly to a mockup in the form of a human than to one of a falcon or to glittering strips of aluminum fluttering in the wind.

The behaviour of animals is determined by their individual ability to judge risks (LIMA & DILL 1990); consequently, waterbirds show behavioural responses to human actions they determine to be dangerous (FIRD & DILL 2002). They raise their heads, run, swim or dive away from danger or take flight (BLUMSTEIN et al. 2003, Fig. 5).

Flock size can influence the behaviour of an individual, since the birds evaluate the behaviour of their conspecifics as an index of the predation risk (STANKOWICH & BLUMSTEIN 2005). Thus, in the case of larger flocks, "chain/avalanche reactions" can occur, for example, when single individuals flying up from the edge of the flock cause the whole flock to take flight. The FID of the whole flock is in this case determined by the shyest individual (Fig. 6). Generally, the FID of waterbirds increases with increasing flock size, since the likelihood of the presence of particularly shy birds increases too (BATTEN 1977, OWENS 1977, GRIEG-SMITH 1981, DIETRICH & KOEPFF 1986, SPILLING et al. 1999, MORI et al. 2001, LAURSEN et al. 2005, VAN RIJN et al. 2006, KAHLERT 2006). But sometimes the opposite can be true as well (e.g. BATTEN 1977, LILEY & FEARNLEY 2012).

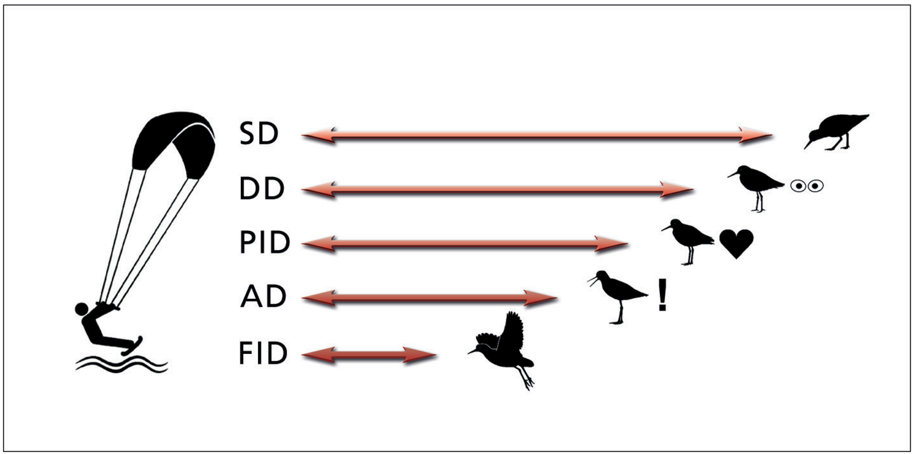


Figure 4: Visual representation of the starting distance (SD), detection distance (DD), physiological initiation distance (PID), alert distance (AD) and flight initiation distance (FID). Presented to illustrate a conceptual framework; distances are not to scale (adapted from WESTON et al. 2012, termini modified according to COOPER & BLUMSTEIN 2015).

The species composition of flocks (single-species or mixed-species flocks) also influences the FID. Individuals of skittish species taking flight can infect less sensitive species with alarm and provoke them into taking flight too (METCALFE 1984, KOEPFF & DIETRICH 1986, MORI et al. 2001). Alarm calls of other species alone can cause escape reactions in Sandpipers (*Calidris* spec.; LEGER & NELSON 1982) and Brant Geese (*Branta bernicla*; OWENS 1977).

The ability of waterbirds to estimate danger is based on a trade-off between on the one hand tolerating a source of disturbance (predator) and thereby risking injury or death, and on the other hand avoiding the source of disturbance, abandoning foraging and thereby accepting an increased risk of undernourishment (STILLMAN & GOSS-CUSTARD 2002, BLUMSTEIN 2003, Fig. 3). This means that healthy birds in good physical condition probably react faster and more susceptible to disturbance stimuli because they can better afford the energy necessary for fleeing (BEALE & MONAGHAN 2004b).

Under ideal conditions with enough food available, birds can compensate for disturbance effects by feeding at different times or locations. Under worse conditions (in winter) and with limited food resources Barnacle Geese (*Branta leucopsis*) and Greater White-fronted Geese (*Anser albifrons*) move closer to roads and tolerate disturbance stimuli – albeit reluctantly and without becoming habituated (KRUCKENBERG et al. 1998).

Owing to the high variability (severity, frequency and length) or the co-occurrence of multiple disturbance stimuli, the effect of single sources of disturbances on bird populations is difficult to quantify (CAYFORD 1993) but well studied in terms of birds' distribution and breeding success (CARNEY & SYDEMAN 1999, FINNEY et al. 2005). Severe impacts are most likely to be found in breeding birds. However, consequences are hard to identify, especially in migrating birds, as "cause and effect" are likely to be spatially and temporally distant from each other (STOCK 1994).

The responses of wintering waterbirds, too, are hard to quantify as they vary between locations, activities and species (e.g. TUIT et al. 1984, TAYLOR et al. 2005; Fig. 6). The sensitivity of species also depends on factors such as:

Figure 5: Geese (here: Barnacle Geese) are good model organisms for studying reactions to disturbance stimuli.

When undisturbed they are occupied with foraging. Aside from some individuals that are on guard, most birds in the flock are feeding. (Photo: Hans Glader/ birdimagency.com)

When a source of disturbance approaches the geese's specific detection or alert distance (DD or AD), the birds stop feeding, crane their necks and keep guard with great vigilance. (Photo: Thorsten Krüger / thorsten-krueger.com)

If the source of disturbance continues to approach, the birds closest to it will take flight and potentially cause birds further away to take flight too. Depending on the severity of the disturbance all birds might take flight at once in a mass flight. This occasionally causes thousands of birds to fly up en masse. (Photo: Thorsten Krüger / thorsten-krueger.com)

- the season (e.g. GOSS-CUSTARD & VERBOVEN 1993, SPILLING 1998, FRID & DILL 2002, HOLMES et al. 2005, BREGNBALLE et al. 2009, BURGER et al. 2010)
- the age of the bird (KOCH & PATON 2014)
- the time of day or state of tide (e.g. BURGER & GOCHFELD 1991, KLEIN 1993, GOSS-CUSTARD & VERBOVEN 1993)
- the weather (e.g. KERSTEN 1975, KOEPFF & DIETRICH 1986)
- the location along the migration route (KRUCKENBERG et al. 2008)
- the habitat inventory and use (e.g. LAFFERTY 2001, CUTTS et al. 2009)
- the type/source of disturbance (e.g. KOMENDA-ZEHNDER & BRUDERER 2002, REES et al. 2005, PEASE et al. 2005, KRIJGSVELD et al. 2008, LETHLEAN et al. 2017)
- its size, speed and approach angle (e.g. BURGER & GOCHFELD 1981, KOEPFF & DIETRICH 1986, AGNESS et al. 2008, 2013, BURGER et al. 2010, COOPER & BLUMSTEIN 2015, LETHLEAN et al. 2017)
- the group size of approaching humans/predators (e.g. BURGER & GOCHFELD 1991, FRID & DILL 2002, GEIST et al. 2005, KOCH & PATON 2014)
- the previous disturbance stimuli in the area (e.g. CAYFORD 1993, LAFFERTY 2001, REES et al. 2005)
- the hunting pressure (e.g. OWENS 1977, GERDES & REEPMEYER 1983, MADSEN 1988, WILLE 2000).

Additionally, habituation can take place in individuals when disturbances occur frequently (without posing threats). These individuals then exhibit a decrease in FIDs (see above; HOCKIN et al. 1992, MADSEN & BOERTMANN 2008; Fig. 6). Such habituation can be observed in protected areas with a hunting ban along highly frequented paths/trails (“national park effect”; BEZZEL 1995, BERGMANN & WILLE 2001, BELLEBAUM 2001) or at beaches with highly frequented piers (WEBB & BLUMSTEIN 2005), where disturbance stimuli occur at predictable locations or are associated with predictable movements. At only a short distance from these areas or structures, however, the birds again show “normal“, greater FIDs.

4.2 Implications and consequences of repeated disturbances

Repeated disturbance stimuli can lead to the avoidance of a suitable and even optimal feeding and roosting site causing birds to move to suboptimal areas that are less or not at all disturbed. Their previous site is thus rendered unavailable to them by the disturbances; it is “blocked” (MEILE 1991, BAUER et al. 1992, MÜLLER et al. 1996, PEASE et al. 2005, PETERS & OTIS 2007, Fig. 7). In the al-

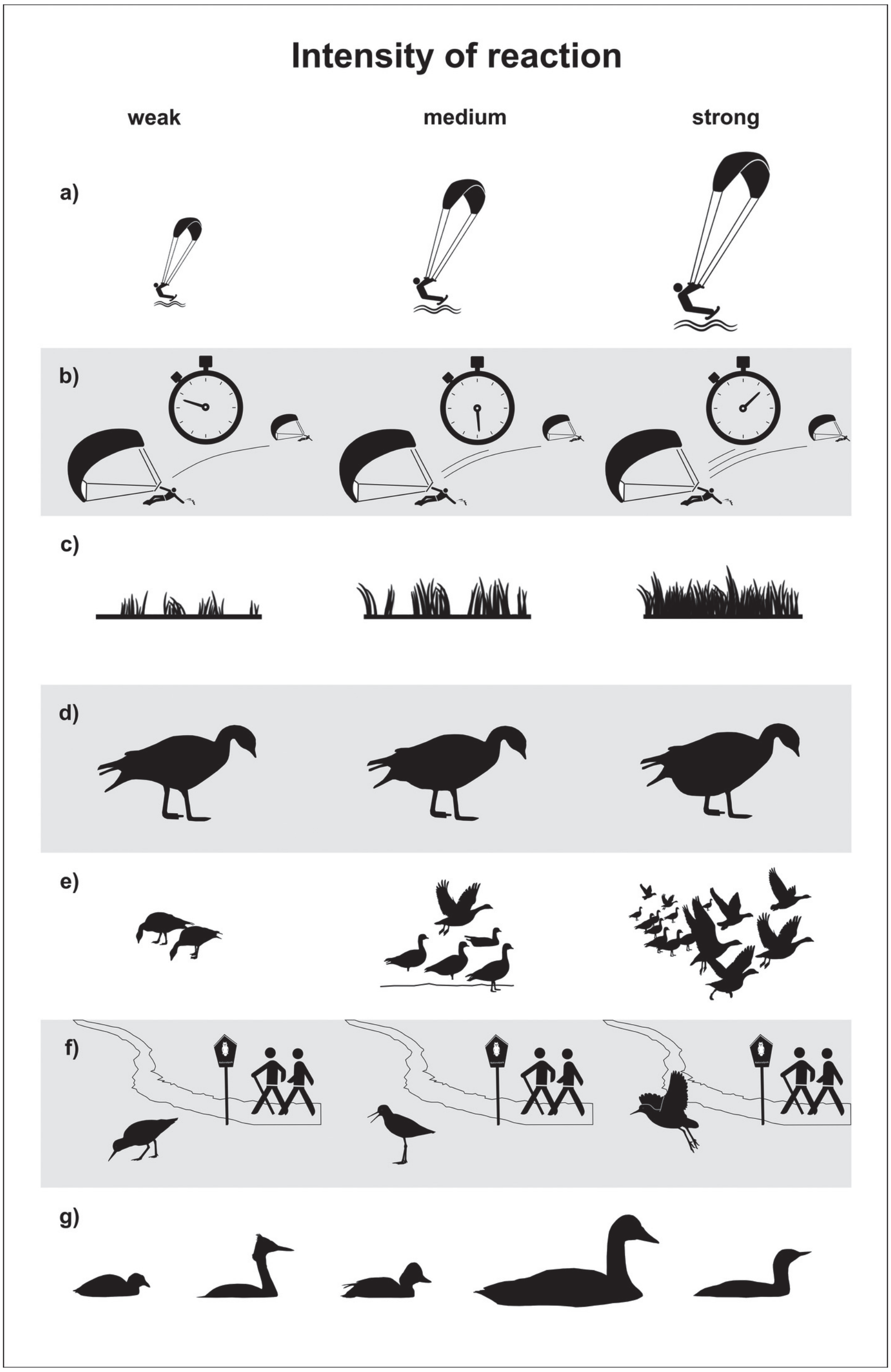


Figure 6: A bird’s individual reaction to a disturbance stimulus depends on various factors and processes. These include:
a) distance between the bird and the source of disturbance: the closer the source, the stronger the reaction
b) ground speed of the approaching source of disturbance: the faster, the stronger the reaction
c) food availability: the better in space and time and quality, the sooner the bird can take flight
d) body condition: the better the bird is fed, the sooner it can afford to take flight
e) flock size: usually, birds in larger flocks are less tolerant of disturbance stimuli
f) habituation (a process; from right to left in figure): bird learns that hikers stay on designated paths (predictability) and pose no threat
g) species-specific sensitivity: Common Coots (left) are less sensitive, whereas Loons (right) react very strongly to disturbance stimuli in their environment.

ternative sites the bird density consequently increases, leading to an escalation in antagonistic behaviour (rivalry and competition) and thus to inflated demands in the amount of energy and time required for foraging and feeding (GOSS-CUSTARD 1980, CAYFORD 1993).

The high energy costs occasioned by disturbances have to be compensated for by an increase in the time invested in foraging or by increasing food intake per time unit. Otherwise, a deterioration of the body condition is unavoidable and can lead to death (PLATTEEUW & HENKENS 1997, GOSS-CUSTARD et al. 2006).

Repeated anthropogenic (recreational) disturbances in roosting areas or during foraging are disquieting as they can have negative long-term effects on entire populations (Fig. 9). The building up of energy reserves via lipid deposition is *the* most important activity of staging birds and is necessary for successful migration. Disturbances force birds to spend energy and reconvert lipid deposits when they try to evade the source of disturbance by taking flight (GOSS-CUSTARD et al. 2006).
If the birds arrive at the breeding area in poor physical condition, they may no longer be able to breed or successfully raise their young. Thus reduced feeding (= reduced lipid and protein) and increased occurrences of disturbances during migration and at wintering habitats have a delayed negative effect at the breeding site (= carry-over effect; MADSEN 1995, GOSS-CUSTARD et al. 2002, 2006, TOMBRE et al. 2004, DRENT et al. 2007). Models by GOSS-CUSTARD et al. (2006) show no negative consequences in terms of fitness in wintering Eurasian Oystercatchers (*Haematopus ostralegus*) flushed 1-1.5 times an hour when food resources are plenty and the weather is mild. This threshold of 1-1.5 sinks to 0.2-0.5 disturbances per hour when food sources are diminished and weather conditions are harsh.

Flying is the most energy consuming method of displacement in vertebrate animals; it is generally 12 times more costly than basic metabolic rates (TUCKER 1973, WARD & ANDREWS 1993). SCHILPEROORD & SCHILPEROORD-HUISMAN (1984) found that Pink-footed Geese (*Anser brachyrhynchus*) have to invest an additional 1.5-2 min in feeding to compensate for every minute of extra flight caused by disturbance stimuli. According to them, this amounts to 150 kg of additional food for 8,000 Pink-footed Geese that have been disturbed for 10 min.

Brant Geese reduce their foraging activities by 10 % in the first 20 min after the occurrence of a disturbance stimulus and therefore need to extend their focus on foraging for up to 280 additional minutes at the cost of roosting, preening, etc. (BERGMANN et al. 1994). A study by OWNES (1977) shows that Brant Geese that are in the air seven times longer due to disturbance stimuli lose 11.7 % of potential feeding time daily.

GRÉMILLET & SCHMID (1993, cited in PLATTEEUW & HENKENS 1997) calculate that Great Cormorants (*Phalacrocorax carbo*) need 23 g of additional food (fish) to compensate for a 30 min disturbance. American Coots (*Fulica americana*) need an additional 10.5 kcal/day (111.4 kcal/day for undisturbed activities) when disturbance stimuli occur 4 times per hour (SCHUMMER & EDDLEMAN 2003). KORSCHGEN et al. (1985) estimate that daily energy requirements of Canvasbacks (*Aythya valisineria*) at Lake Onalaska (USA) rise by 75 kcal/day (basic energy requirement: 400 kcal) for every additional hour of flight due to disturbance. This translates to an additional intake of 23 g (dry weight) of wild celery (*Vallisneria americana*).

These data show that disturbances are very costly for roosting or foraging waterbirds in terms of energy requirements and that negative consequences are likely if the extra costs cannot be compensated for (Fig. 2, 9).

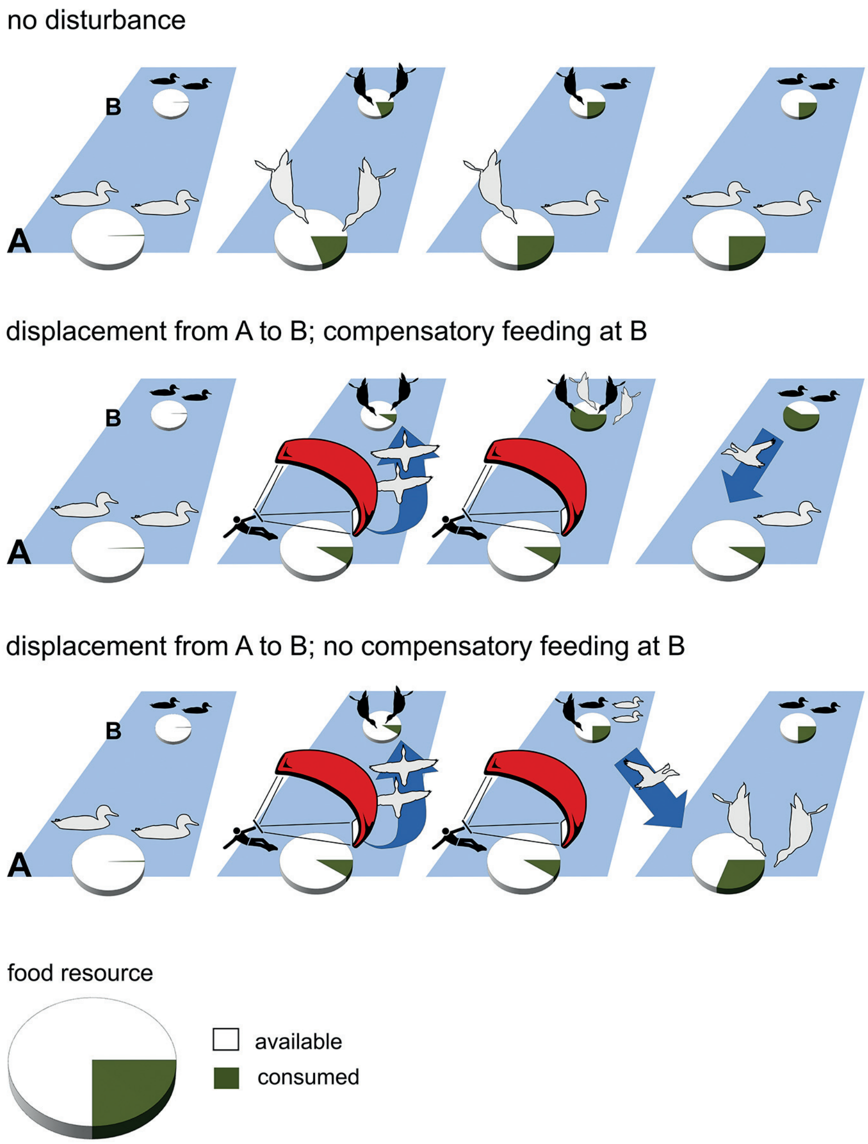


Figure 7: Consequences of repeated displacement of waterbirds from a feeding site (A) to an alternative site (B) on the availability of food resources. Two examples are illustrated:
- with compensatory feeding at alternative site (B): food resources at (B) are heavily overexploited partly as a result of enhanced intra-specific competition, food sources at (A) are underexploited.
- without compensatory feeding at (B): food resources at (B) are exploited normally, food resources at (A) are overexploited (from PLATTEEUW & HENKENS 1997).

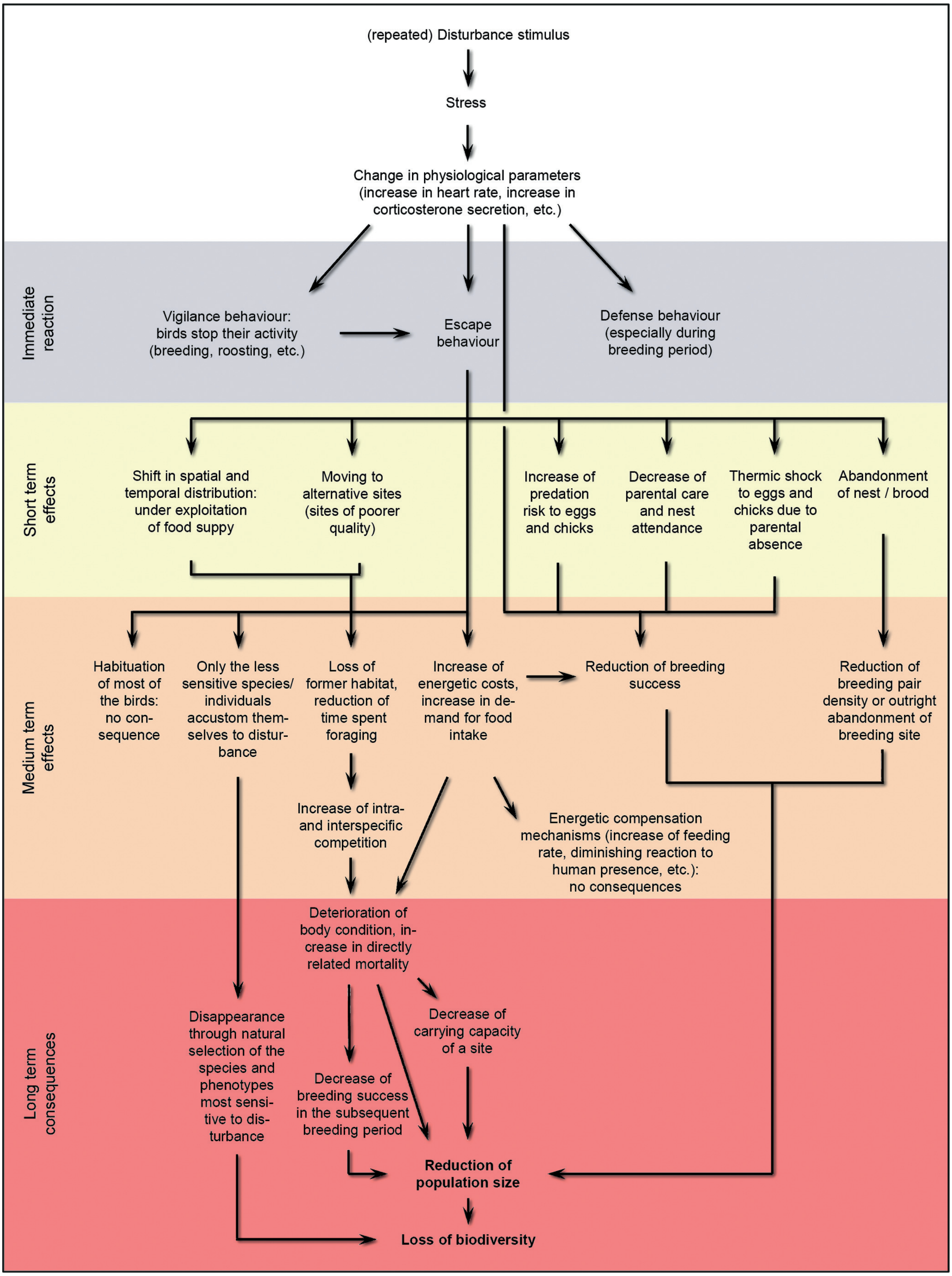


Figure 9: Main theoretical reactions to disturbance stimuli as well as effects and consequences of disturbance events for birds (from LE CORRE et al. 2009, modified)

5 Towards a quantitative assessment of the disturbance impact on birds and sites

In order to quantify the effects and impacts of anthropogenic disturbance of birds, one needs to know the number of birds affected and the length of time the birds are being denied the site through disturbance stimuli. Usually this is estimated on the basis of a comparison of the number of birds present before the disturbance stimulus with the number of birds remaining in the area during/immediately after the disturbance event. The duration of disturbance depends on both the number of individual disturbance stimuli and the duration of each (BLEW & SÜDBECK 1996, PLATTEEUW & HENKENS 1997).

PLATTEEUW & HENKENS (1997) suggested that a better estimate of the impacts on certain habitats could be achieved by additionally incorporating the size of the disturbed surface area. To do that, the distance at which bird species present at the site react to a disturbance stimulus has to be known (= disturbance / effect distance, the distance within which behavioural changes due to disturbance effects begin to occur, i.e. from AD onward; cf. Fig. 4). Several studies have ascertained effect distances, usually coinciding with FIDs (Fig. 4), either through direct observations (PUTZER 1983, DIETRICH & KOEPFF 1986) or through experimental disturbance stimuli controlled by the researchers themselves (BIEMANNS 1987, PLATTEEUW & BEEKMANN 1994, BLUMSTEIN 2006). Effect distances (d) can be considered as the radius of an imaginary circle drawn round a bird within which no disturbance is tolerated, but alternatively also serves as the radius of the imaginary circle round a stationary source of disturbance (e.g. boat/kite) within which no birds (of a particular species) will remain (Fig. 10). Usually, however, recreational watercraft (e.g. kite surfers) will be moving at a velocity of v [m/s], thus sweeping clear a surface area [m^2] of $2 \cdot v \cdot d + \pi \cdot d^2$ each second (Fig. 10). Any bird within the disturbance distance will be driven away from this belt of water for at least the time it takes for the watercraft to cross the area. The duration of the disturbance is lengthened further by the time interval between disappearance of the source of disturbance and the return of the birds to their original site and behaviour (= recuperation time). This time lag will have to be estimated in the field (PLATTEEUW & HENKENS 1997).

6 Literature review: effects of kitesurfing on waterbirds

The present state of knowledge about the impact on birds of this fairly young recreational activity of kitesurfing is relatively elementary. Nevertheless, the few studies available allow us to make general statements about its impacts on roosting, migrating and breeding birds. These studies obviate the necessity for analogies drawn from windsurfing and traditional kite flying, thus adding weight to our conclusions.

Form a conservation standpoint it matters little whether birds identify the kite surfers as “watercraft with humans” or as “suspicious flying object, possibly a raptor”. What is decisive is the resulting disturbance effect, and this is probably governed by a combination of factors. First of all, kitesurfing is an anthropogenic dis-

Figure 8: Waders like Red Knots, Grey Plovers and Dunlins use the Wadden Sea as a stop-over site to replenish their energy reserves. In spring they have come a long way from the shores of western Africa and still have a long way ahead of them to their breeding habitats in the Arctic. Every disturbance at their staging sites is very costly. (Photo: Mellumrat)

turbance with humans being widely visible and identifiable as such – different, for example, from disturbances caused by cars, which birds do not necessarily associate with humans at all (cf. McLEOD et al. 2013). Secondly, the equipment used in kitesurfing administers an optical stimulus as a moving watercraft on one hand and a flying object on the other. Additionally, shadows and silhouettes and gaudily coloured kites affect areas greater than the area actually used. Moreover, kitesurfing can also produce acoustic disturbance stimuli when kites hit the water surface with a loud and sudden percussion (SMITH 2004, DAVENPORT & DAVENPORT 2006).

Also contributing to the disturbance effect of kitesurfing are the high-speed movement and sudden, unpredictable changes in direction involved. It is important to remember that these disturbances occur in open surroundings, not normally associated with the vertical and horizontal movement of anthropogenic objects on the water surface. Kiteboards, more than other watercraft, are able to enter shallow waters with ease – areas often adjacent to breeding habitats and of great importance as roosting and feeding sites. The studies that have been carried out so far are presented below subdivided according to the habitats in which the investigations took place. Thereby

- the respective goals and scopes of the studies are briefly described,
- the species or groups of species focused on as roosting, breeding and / or migrating birds are named,
- the methods used are briefly sketched,
- the most important results are summarized
- and finally the most important conclusions *drawn by the authors* for each site are reiterated.

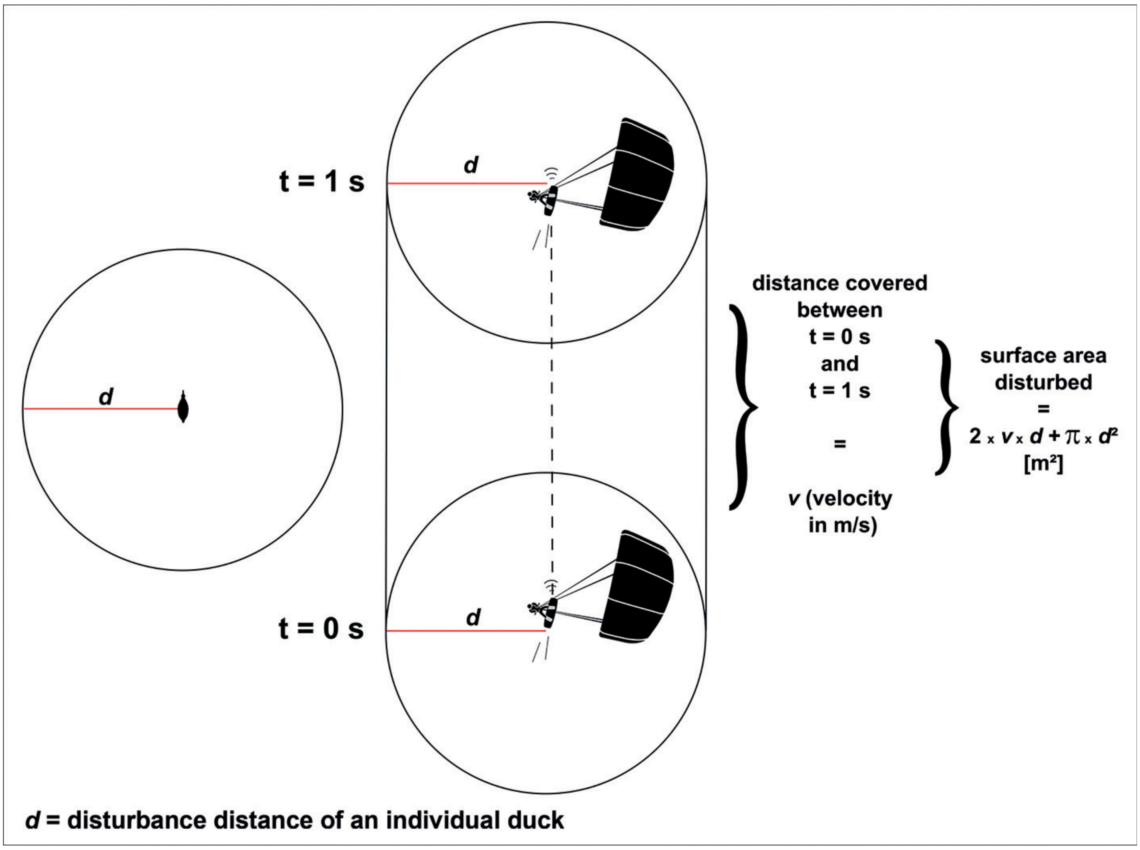


Figure 10: Relationship between the distance at which a bird responds to disturbance stimuli (d), kite surfer speed (v) and the surface area disturbed by a kite surfer per unit of time (from PLATTEEUW & HENKENS 1997, modified).

The spectrum of species considered in this work, explanation of terms

In this work, different collective terms for birds are used. The term **"waterbird"** does not represent a sharp, systematically and taxonomically derived bird group. In this group species or groups of species not necessarily related to each other are lumped according to their preferred habitat (so-called guilds, ecological groups). Waterbirds live on or around water and have webbed feet as a special adaptation to their habitat. Further they have bills and legs adapted to feeding in water and the ability to dive from the surface or the air into water. Among typical waterbirds are swans, geese, ducks, loons, grebes, pelicans and cormorants as well as a few species of rails, such as the Common Coot, or the family of the penguins.

"Waders" or **"shorebirds"** in contrast form a closely related bird group (within the order of Charadriiformes) consisting of several families which as a common morphological characteristic usually have long legs (for wading) and are found as limicoline birds predominantly in semiaquatic habitats. Typical waders breeding in Europe are, for example, Northern Lapwings, Black-tailed Godwits, Eurasian Oystercatchers and Pied Avocets. In this work waders, too, are subsumed under "waterbirds" although there is usually a clear distinction between the two groups (also linguistically, i.e. "waterbirds" and "shorebirds" or "Wasservögel" and "Watvögel" in German). The gulls, which systematically belong with waders, terns and auks to the order of Charadriiformes, are also included in waterbirds in this paper.

"Waterbird" is thus a very broad collective term which relates to a mixture of ecological-physiological and systematic-taxonomic criteria and refers to any species that inhabits or depends on bodies of water or wetland areas. Besides conservational aspects this has practical applications: the different groups within waterbirds often occur side by side in the same habitat and can be counted by ornithologists in one procedure. For example, the International Waterbird Census (IWC) takes place in 150 countries across the world, whereby the numbers of the respective species are monitored along coasts or at inland wetlands. National coordinators work with a network of ornithologists to provide waterbird counts to the IWC.

The term **"breeding bird"** represents a status classification, indicating that a species is reproducing at a certain site (area) – as opposed to occurring temporarily as a **"visitor"** at the site (e.g. as a passage migrant or vagrant). There are more than a few species in Europe which occur at the same time and site in different guises, as both breeding bird and migrant (e.g. Great Crested Grebe, Common Shelduck, Eurasian Curlew); other species are exclusively migrants breeding in Northern Europe or as far afield for example as Siberia (e.g. Tundra Swan, Common Scoter, Red Knot).

"Roosting" is, in turn, a (general) term that refers to a particular set of behaviours that a bird exhibits at a particular site. These are sleeping, resting, preening and associated comfort activities. Birds at the coastline, for example, regularly roost at certain sites when the intertidal mudflats are covered and thus no longer available for foraging – so-called high tide roosts. Roosts (being independent from the tidal cycle) are often called roosting sites, staging sites or stop-over sites. So a Sanderling (a breeding bird of the tundra zone of Northern Europe and Siberia) which is present at an autumn roosting site is thus a roosting bird belonging to the group of waders (often considered as waterbirds, see above) and possessing the status of a visitor at the site, which it has reached as a migratory bird.

6.1 Coastal habitats – intertidal mudflats, sandflats, beaches and salt marshes


The Effect of Kite Surfing on Wader Roosts at West Kirby, Dee Estuary

Richard Smith
(Dee Estuary Voluntary Warden)

SMITH, R. (2004): The Effect of Kite Surfing on Wader Roosts at West Kirby, Dee Estuary. – Report, 8 pages, www.deeestuary.co.uk/decgks.htm

Scope of study

The Dee Estuary southwest of Liverpool (England) is one of the most important wetlands for birds in Western Europe and for this reason it is a Ramsar site designated under the Convention on Wetlands of International Importance especially as Waterfowl Habitat and it has been declared a Special Protection Area under the terms of the EC Birds Directive. 11 waterbird species, which use the area as a stop-over site on migration, have been recorded in internationally important numbers at the Dee Estuary and a further eight species in nationally important numbers. Despite a massive increase in beach use by local people and tourists bird numbers have increased since 1990, a development which is thought to be the result of voluntary wardening. Two traditional high tide roosts for waterbirds are West Kirby Shore and a nearby tiny island, Little Eye.

However, since the summer 2002 kite surfers have been using West Kirby with its large area of shallow water sheltered from the relatively large waves of the Irish Sea. Up to twelve kite surfers have been seen regularly at every high tide, wind and weather permitting. Their arrival in the area has coincided with a marked decline in the numbers of Common Redshanks (*Tringa totanus*) and Eurasian Oystercatchers in particular.

Species/groups studied

Waterbirds, especially waders, gulls and terns as visitors on migration

Methods

Results from 91 counts of nine wader species from 2002/2003 (Sept. 20 – Mar. 23; kite surfers regularly present) are compared with counts from the previous season (2001/2002; no kitesurfing). All disturbance events were observed and documented.

Results

- Inventories of Common Redshanks and Eurasian Oystercatchers show relatively consistent numbers over the previous 16 years (1986/1987 – 2001/2002). Maximum and average counts of both species rapidly decreased in 2002/2003 (cf. Fig. 11). Figures for Eurasian

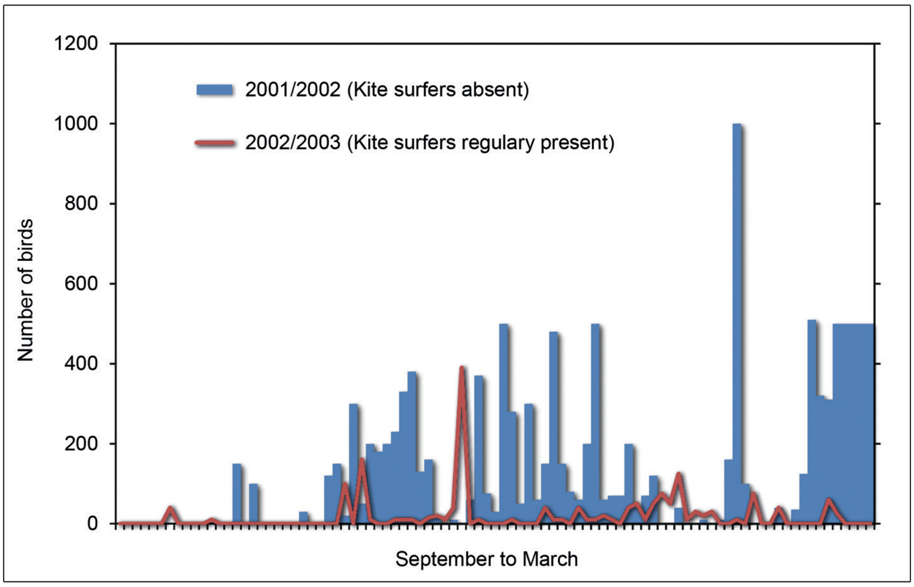


Figure 11: Numbers of Common Redshanks counted at West Kirby Shore on the same dates between September and March 2001/02 (no kite surfers present) and between September and March 2002/03 (kite surfers regularly present; data taken from SMITH 2004)

Figure 12: A flock of roosting Common Redshanks in heightened awareness and on guard (Photo: Graham Eaton / rspb-images.com)

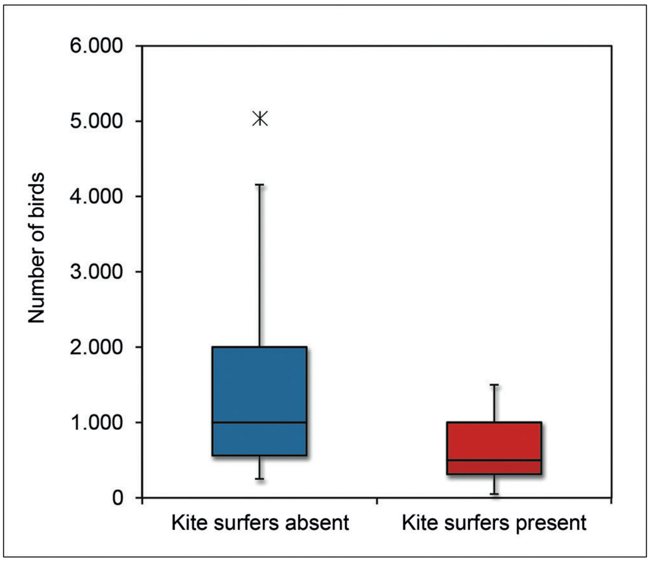


Figure 13: Numbers of Eurasian Oystercatchers at "Little Eye" (resting site) during 2002/2003 with kite surfers present (left) and kite surfers absent (right). Box = lower quartile, median, upper quartile; whiskers = range; star = outlier (data taken from SMITH 2004)

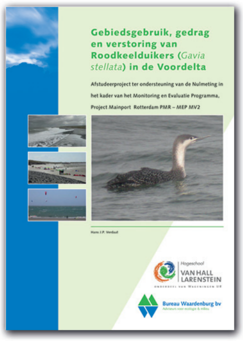
Oystercatcher on Little Eye 2002/2003 were 43 % of those from 2001/2002, for Common Redshank at West Kirby 2002/2003 figures were 14 % of the 2001/2002 results.

- The presence of kite surfers resulted in a decrease in the number of Eurasian Oystercatchers (mean number of birds with kite surfers present = 445, mean number of birds with no kite surfers = 1,065; Fig. 13) and Common Redshanks.
- The roost on Little Eye has frequently been disturbed, often resulting in complete abandonment of the island by the birds.
- The potential for disturbance of all the waders, gulls and terns at West Kirby and Little Eye is huge. A kite surfer who chooses to sail along the high tide roost (e.g. along the edge of the sand bank between West Kirby and Red Rocks) and back is very likely to clear the whole roost.
- Severe disturbances also occurred while kite surfers were flying their kites on the beach, waiting for the tides.

Figure 14: During the winter of 2002/2003 more Eurasian Oystercatchers were counted at the high tide roost "Little Eye" on days without kite surfers present than on days when kitesurfing occurred. (Photo: Menno van Duijin / agami.nl)

Conclusions

The arrival of kite surfers at West Kirby is clearly connected to a significant drop in the number of roosting Eurasian Oystercatchers and Common Redshanks. Kitesurfing is a major source of bird disturbance and has the potential to become an even greater one. Restriction of the area within which the kite surfers operate must be seriously considered to prevent negative impact on the important wader, tern and gull roost. A close season from September to March should be considered.



VERDAAT, H. J. P. (2006): Gebiedsgebruik, gedrag en verstoring van Roodkeelduikers (*Gavia stellata*) in de Voordelta. – Afstudeerproject ter ondersteuning van de Nulmeting in het kader van het Monitoring en Evaluatie Programma, Project Mainport Rotterdam PMR – MEP MV2. Rapport, Hogeschool Van Hall – Larenstein u. Bureau Waardenburg, Culemborg.

Scope of study

Voordelta is an area of coastal waters between the island of Schuowen-Duiveland, Brouwersdam and the island of Goereee-Overflakkee southwest of Rotterdam (The Netherlands). The occurrence, distribution and behaviour of Red-throated Loons (*Gavia stellata*) were studied as part of a Master thesis and the effects of human disturbance were determined. The area is a part of the larger "Voordelta", which is a wintering site for important numbers of loons and which belongs to the set of Dutch "Natura 2000" sites. There are two "surfing zones" (kitesurfing and windsurfing) within the area studied.

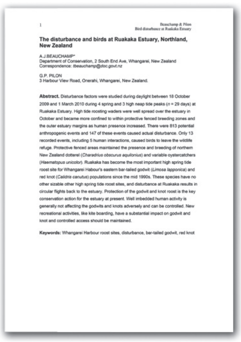
Figure 15: VERDAAT's (2006) study focused on Red-throated Loons. This species breeds in northern Europe and winters mainly in the southern North Sea. Red-throated Loons are generally very shy when confronted with anthropogenic disturbances at sea. (Photo: Udo Schlottmann / birdimagency.com)

Species/ groups studied
Red-throated Loons as winter visitors

Methods
Red-throated Loons were counted systematically between Feb. 20 and Apr. 20 2006 at 18 selected sites; flight movements were also recorded. Additionally, systematic observations of behaviour and reactions to disturbance stimuli were made. This coincided with Project Mainport Rotterdam (PMR), whereby ship-based counts and aerial counts of the species in the same area were conducted.

Results
- Especially close to the shore (≤ 2,000 m) kitesurfing and windsurfing represented disturbance stimuli for the loons, which took alarm and flew out of the area.
- There were fewer Red-throated Loons in the surfing zone at Brouwersdam than in adjacent areas without surfing activity.
- On days when surfers were present in the surfing zones the number of Red-throated Loons was much smaller (including complete absence of birds) than on days when no surfing occurred.
- Red-throated Loons generally took flight when surfing activity (kitesurfing or windsurfing) came within 1,000-2,000 m of them. The occasional individual tolerated activity at distances down to 500 m.
- The relative increase in flying Red-throated Loons (as opposed to resting Loons) in the course of the morning coincides with the increase of surfing activities and is probably a result of them.
- Disturbances were more severe (effect distance and reaction to the stimulus increased, Fig. 4) when surfers left the designated surfing zones.
- When surfing coincided with other disturbance stimuli, e.g. initiated by passing ships, the disturbance effects increased.

Conclusions
In order effectively to protect wintering Red-throated Loons, designated surfing areas need improved signposting. This might dissuade surfers from crossing into other areas. Any violations should always be met by a fine.



1 Beauchamp & Pilon
Bird disturbance at Ruakaka Estuary

The disturbance and birds at Ruakaka Estuary, Northland, New Zealand

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Abstract. Disturbance factors were studied during daylight between 18 October 2009 and 1 March 2010 during 4 spring and 3 high neap tide peaks (*n* = 29 days) at Ruakaka Estuary. High tide roosting waders were well spread over the estuary in October and became more confined to within protective fenced breeding zones and the outer estuary margins as human presence increased. There were 813 potential anthropogenic events and 147 of these events caused actual disturbance. Only 13 recorded events, including 5 human interactions, caused birds to leave the wildlife refuge. Protective fenced areas maintained the presence and breeding of northern New Zealand dotterel (*Charadrius obscurus aquilonius*) and variable oystercatchers (*Haematopus unicolor*). Ruakaka has become the most important high spring tide roost site for Whangarei Habour's eastern bar-tailed godwit (*Limosa lapponica*) and red knot (*Calidris canutus*) populations since the mid 1990s. These species have no other sizable other high spring tide roost sites, and disturbance at Ruakaka results in circular flights back to the estuary. Protection of the godwit and knot roost is the key conservation action for the estuary at present. Well imbedded human activity is generally not affecting the godwits and knots adversely and can be controlled. New recreational activities, like kite boarding, have a substantial impact on godwit and knot and controlled access should be maintained.

Keywords: Whangarei Harbour roost sites, disturbance, bar-tailed godwit, red knot

BEAUCHAMP, A. J. (2009): Distribution, disturbance and bird movement during a spring tide and kite surfing period at Ruakaka Estuary, 10-15 March 2009. Unpublished report, 16 pages, Northland Conservancy, Department of Conservation, Whangarei, New Zealand.

Scope of study
Ruakaka Estuary is a small (83.3 ha) open river estuary southeast of Whangarei (Northland, New Zealand) that was gazetted as a Wildlife Refuge, under the New Zealand Wildlife Act of 1953. Challengingly, three sides are bordered by urban development. There is a racecourse 1,800 m north of the estuary mouth and a "motor camp" on the southern side, furthermore the number of beach visitors is high. Nevertheless the refuge is of great importance as a breeding site for Variable Oystercatchers (*Haematopus unicolor*) and Red-breasted Plovers (*Charadrius obscurus aquilonius*). Moreover, it is a summer roost at very high tide (≥ 2.7 m) for Bar-tailed Godwits (*Limosa lapponica*) and Red Knots (*Calidris canutus*), which normally stay in the area of Whangarei Harbor.

Kite surfers began using the area in 2005, which is generally only possible for them when easterly winds occur and from just before high tide to c. three hours after that tide. In 2008 concerns grew that kitesurfing could have greater disturbance effects on birds than the traditional (recreational) activities in the area. It was observed that the time windows for the utilization of the sandbanks as a roosting site by Palearctic waders and of the adjacent water surface by kite surfers almost completely overlapped. In February 2009 a video taken during a spring high tide showed disturbance of roosting Bar-tailed Godwits and Red Knot there by kite surfers at rates of at least 12 times per hour and kept large numbers of the c. 3,000 birds in the air when they should have been roosting. The aims of the study were, i.a. to confirm the diurnal tide height at which waders use Ruakaka Estuary, to define the species that are being affected by the various disturbance sources and to define which of these were responsible for birds leaving the wildlife area.

Figure 16: Ruakaka estuary is an important staging site (above the high tide line), especially for Bar-tailed Godwits. (Photo: Thorsten Krüger / thorsten-krueger.com)

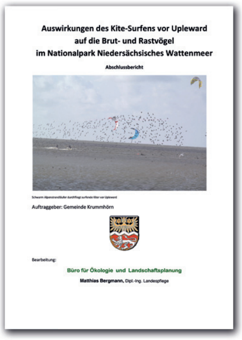
Species/groups studied
Waterbirds as breeding birds and visitors on migration

Methods
From Mar. 10-15 2009, in each case at morning during high tide, bird species frequenting the area and the number of people and their activities in different sections of the area were observed for several hours (4.2, 4.35, 4.1, 7.2 and 7.35).

Results

- 52 anthropogenic and 17 natural (other birds, wave movements) disturbance stimuli were recorded on five observation days. Even though kitesurfing was only possible twice (Mar. 14 and 15) for a few hours in the afternoon owing to bad weather, it was the second most frequently observed source of disturbance in total (11 times). The primary source of disturbance was beach walkers (31 times).
- The zones most at risk from kitesurfing are the "Northern side", the "Southern spit" and the "Island". The most important species observed in those areas are: Bar-tailed Godwit, Red Knot, Variable Oystercatcher and Pied Cormorant (*Phalacrocorax varius*). Large numbers of South Island Oystercatchers (*Haematopus finschi*) occur during autumn and winter.
- Severe disturbance events caused by kitesurfing: 40 out of 54 Variable Oystercatchers were flushed when kite surfers entered the estuary from the sea. The birds moved 500 m up the refuge. 51 Red Knots and White-fronted Terns (*Sterna striata*) using a sand bank were flushed and moved to the "motor camp" area.
- The only Pied Cormorants present on Mar. 15 left the wildlife reserve when kite surfers appeared.
- An Australian Gannet (*Morus serrator*) entered the estuary on Mar. 15 after high tide and had trouble getting out again through 12 kites that were present at the face of the estuary.
- Kitesurfing activity appears to have driven away Variable Oystercatchers from feeding sites on the outskirts of the estuary.
- Bar-tailed Godwits were roosting on the spit and the island from Mar. 10-14 (when no kitesurfing activity was observed in the area) and in the "motor camp" area on Mar. 15 (kitesurfing activity in the estuary).

Conclusions
The (limited) data suggests that kitesurfing displaces shags which roost in the outer estuary from the estuary, and that all birds on the outer estuary can be displaced. The timing of kitesurfing activity appears to be in direct conflict with the presence of Palearctic waders in Ruakaka Wildlife Reserve. Kite boarding has the potential to displace birds from the estuary roosting sites during important periods of the birds lifecycle and should be banned when tides equal or exceed 2.7 m between September and April. Consideration should be given to a total ban of the activity within the confines and the margins of the estuary. The data may be insufficient to indicate that kitesurfing is more of a threat than other sources of disturbance to the quality of the Ruakaka Wildlife Reserve. Thus, further data should be collected on this and other activities.



BERGMANN, M. (2010): Auswirkungen des Kite-Surfens vor Upleward auf die Brut- und Rastvögel im Nationalpark Niedersächsisches Wattenmeer. – Abschlussbericht i. A. der Gemeinde Krummhörn, 66 pages, Büro für Ökologie und Landschaftsplanung, Aurich.

Scope of study
The aim of the study was to evaluate the newly established kitesurfing zone in the Ems estuary in Upleward north of Emden (Lower Saxony, Germany) and its effect on birds in the Nationalpark Niedersächsisches Wattenmeer (Wadden Sea National Park). However, a scientific determination of FIDs for different species did not form part of this study. Kitesurfing was allowed for all surfers in a designated kitesurfing zone after registering at the local kitesurfing school (Fig. 17). The kitesurfing zone lies in the "Intermediate Zone" of the National Park (where access of areas off the trails is allowed between Aug. 1 and Mar. 30) and roughly 700 m from a high tide roost. Windsurfing is also allowed in this zone and has occurred there regularly for many years. Windsurfers often pass close to the roosts.

Species/groups studied
Waterbirds as breeding birds and visitors on migration

Methods
Observations of the behaviour of breeding and staging birds on 14 days (à 6 hours) between September 2009 and June 2010 when kite surfers were present. Recording of disturbance effects caused by kite surfers. Additionally, bird numbers were counted before and after kitesurfing activities.

Results
- Kite surfers remained in the designated area.
- Roosting birds exhibited no flight reactions to the kite surfers 700 m away (Fig. 18).
- During a test approach, a kite surfer caused Eurasian Oystercatchers to take flight at 100 m. No other species were present at that time.
- On three occasions flying/migrating birds at low flight altitudes were disturbed by kites (2 x Barnacle Geese, 1 x Eurasian Curlew). The flocks dispersed and reassembled after passing the kite.
- Waders foraging in the mudflats tolerated kitesurfing at a distance of 200 m and only took flight when kites crashed with a loud bang.
- Foraging Dunlins (*Calidris alpina*), Red Knots and Grey

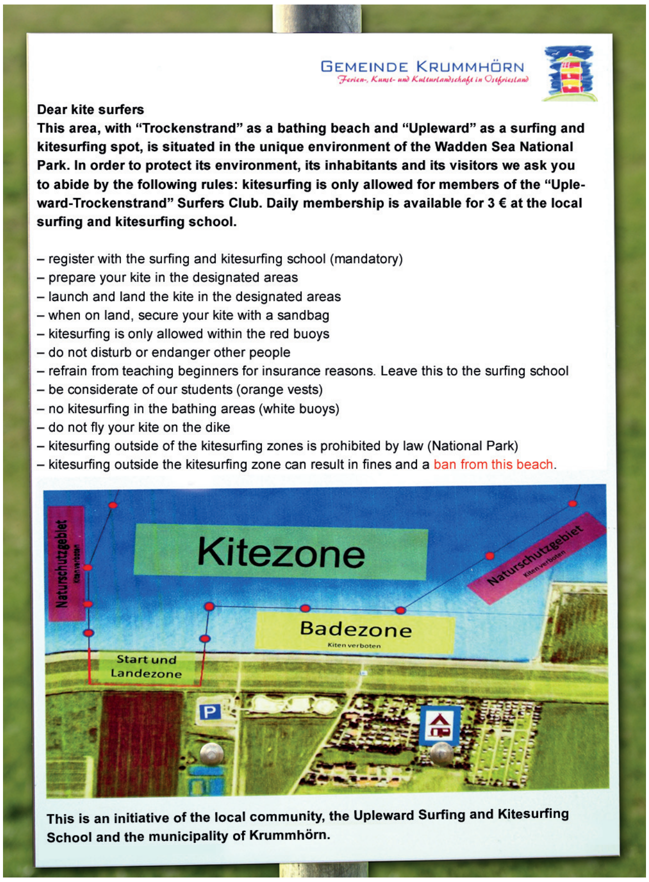
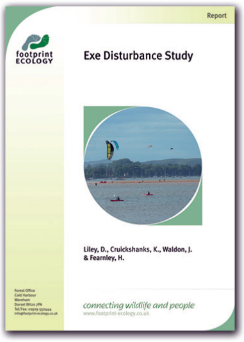


Figure 17: Rules and regulations of the designated kitesurfing zone in Upleward (Picture: Matthias Bergmann).

Figure 18: On May 18 2010 hundreds of staging Dunlins, Common Ringed Plovers, Grey Plovers and Bar-tailed Godwits were undisturbed by kite surfers 700 m off shore at "Schillbank Campen". (Photo: Matthias Bergmann)

Plovers (*Pluvialis squatarola*) tolerated an experimental approach by a kite surfer as close as 100-200 m.
- Gulls (*Larus* spec.) and Mallards (*Anas platyrhynchos*) showed the greatest tolerance of kitesurfing.
- No negative effects on breeding birds were observed. However, breeding sites are in the dunes and out of sight of kite surfers.

Conclusions
The short FIDs of the birds present may result from the absence of more sensitive birds, which stage in areas further away from the kitesurfing zone. Thus kite surfers approach only the northern tip of the long-standing high tide roost. Spatially appropriate designated kitesurfing zones can limit additional disturbances.



LILEY, D., K. CRUICKSHANKS, J. WALDON & H. FEARNLEY (2011): Exe Disturbance Study, Final report. – Commissioned by the Exe Estuary Management Partnership, 98 pages, Footprint Ecology, Wareham.

Scope of study
The Exe Estuary is on the south coast of Devon, England. It regularly supports an assemblage of at least 20,000 waterbirds, among these, for example, at least 28 % of the wintering population of Pied Avocet in Great Britain. It is designated as a Special Protection Area (SPA), Ramsar site and Site of Special Scientific Interest (SSSI). The aim of this extensive study was to evaluate the effects of disturbances caused by various recreational activities on waterbirds in the Exe Estuary. Kitesurfing began in the area over 10 years ago. On a perfect day up to 100 kite surfers can be seen on the water in the "Duck Pond" and another 50 kite surfers can be active on the seafront. Data on recreational use were collected through interviews, direct observation and route mapping using GPS devices. These data were combined with detailed ornithological fieldwork and existing bird count data to explore the extent to which disturbance is a problem for birds on the Exe.

Species/groups studied
Waterbirds as visitors on migration and wintering birds

Methods
16 different recreational activities with the potential to cause disturbances (e.g. kitesurfing, windsurfing, kayaking) were recorded in detail, partly by attaching GPS trackers to surf boards. 28 counts of people and activities on the estuary were conducted between December 2009 and April 2011). A total of 220 hours of detailed observations of foraging birds (behavioural responses, distances at which birds respond, lost feeding time, distance displaced etc.) were undertaken at nine locations, and spread over a number of months (between September 2009 and March 2010, and then from August 2010 through to March 2011). The survey effort coincided with the period of the year when wintering waterbirds were present on the estuary. Distribution patterns of birds in the estuary were recorded from 2006-2008.

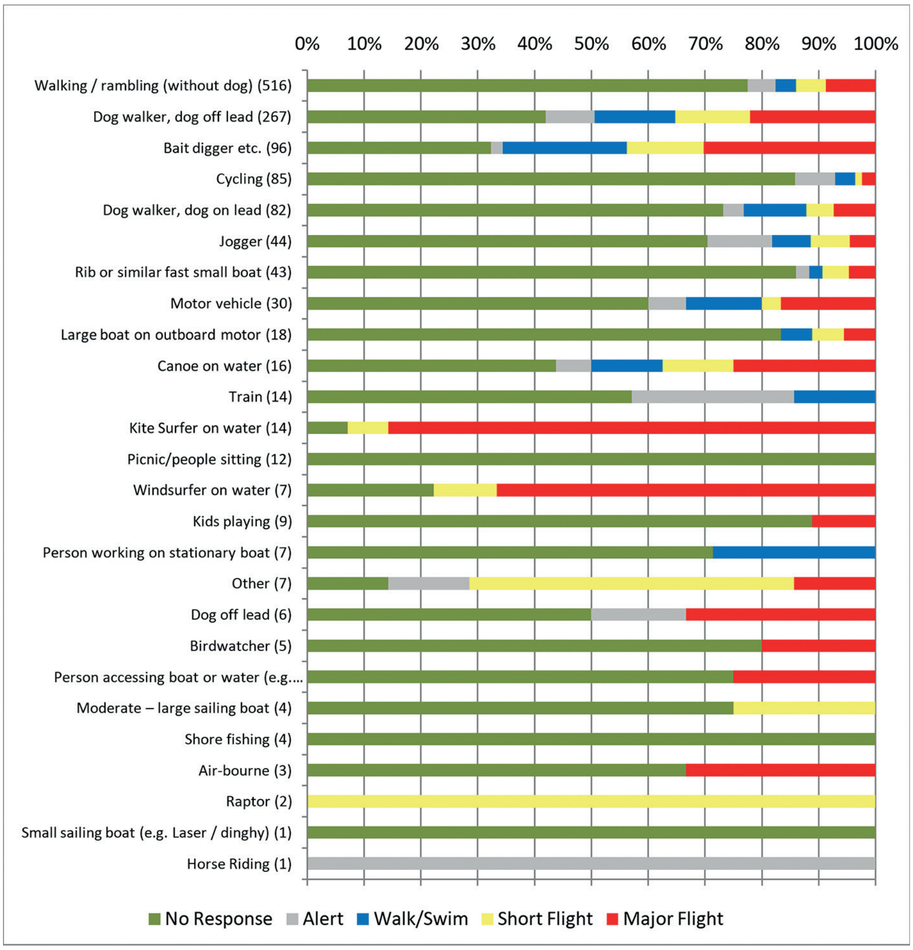


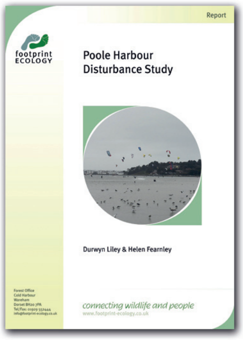
Figure 19: Behavioural responses of birds (grouped across all sites and all species) to various recreational activities in the Exe Estuary between September 2009 and March 2011. Activities are listed in order of sample size (the sample size being the number of species-specific observations, given in brackets) (from LILEY et al. 2011).

Results:

- Across all counts there were 1,299 observations of potential disturbance events (including birds of prey) involving an individual (or individuals) of a particular target species.
- Kitesurfing and windsurfing, bait digging and dogs off the lead were the four activities which resulted in the most response from the birds.
- Considering the distance, tide and location, birds were more affected by recreational activities on the mudflats and the water than on the beach.
- Bait digging on the intertidal, dog walking with dogs off lead on the intertidal, walking on the shore and intertidal, and kitesurfing were the activities which accounted for the majority of "major flights" (change of location by 50 m or more).
- About 85 % of the disturbance events caused by kitesurfing (n = 14) resulted in major flights (Fig. 19).
- Dog walkers with their dogs off lead on the intertidal caused the highest number of major flights of all the observed potential disturbance events.
- Data collected by the GPS units revealed that on average kitesurfing trips lasted 1 hour and 26 minutes and covered an average distance of 9.3 km, while the area covered was relatively small at 0.32 km^2.
- Escape behaviour triggered by a kite surfer or windsurfer around the Duck Pond during mid-tide resulted in the loss of 8 ha of mudflats as potential feeding site per trip (as opposed to 0.1 ha caused by a walker on the beach during low tide). This is the greatest loss of area recorded in the study.
- The Exe is a particularly small estuary; single disturbance events caused by kite surfers affected virtually the entire estuary.

Conclusions

Disturbance is reducing the habitat available to the birds and the numbers of birds in certain parts of the estuary are related to the levels of access. Disturbance is thus currently influencing the distribution and behaviour of birds on the Exe. In order to reduce recreational pressure and disturbance events, there is a need to consider management of access and recreational use of the estuary.



LILEY, D. & H. FEARNLEY (2012): Poole Harbour Disturbance Study. – Report for Natural England, 75 pages, Footprint Ecology, Wareham.

Scope of study

The study was conducted in order to evaluate spatial distribution, intensity and effects of various recreational activities on overwintering waterbirds in Poole Harbour (Southern England). The area is a Ramsar site and a Special Protection Area (SPA) and regularly home to 28,000 waterbirds.

Species/groups studied

Waterbirds as visitors on migration

Methods

At 15 locations bird numbers, disturbance stimuli and behavioural responses of the birds were recorded three times a month from November to February for 105 min each within a 500 m radius of the observer. Additionally, 16 paired night and day counts of birds and humans were conducted during comparable times in the tidal cycle within a 200 m radius at 13 locations around the harbour.

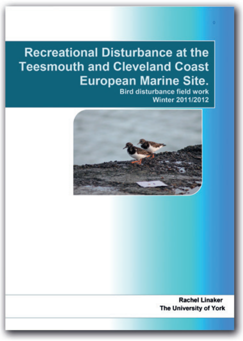
Results

- Kitesurfing was observed on 40 occasions (1 % of total recreational activities, n = 3,584). Most of the kite surfers (86 %) were recorded on the water. However, they were also a source of disturbance at the shoreline and on intertidal mudflats.

Figure 20: Sanderling proved out to be one of the species in which the proportion of events resulting in birds being flushed was highest during the Poole Harbour study (Photo: Thorsten Krüger / thorsten-krueger.com)

- In three out of four events where kitesurfing was a "potential source of disturbance" (here: all cases where birds were present and kite surfers caused a disturbance effect or were < 200 m away), the species affected reacted in the form of "major flights" (cf. LILEY et al. 2011).
- Activities on the water or the intertidal were statistically most likely to cause major flight reactions. Accordingly, the probability of watersports (i.e. kitesurfing, canoeing, personal watercraft or windsurfing) resulting in major flight was significantly higher than it was in all other groups (e.g. the foot/horse/bicycle grouping). This despite the fact that "watersports" were observed less often than other activities.
- The number of waders present at night was lower when disturbance levels were higher during the day; i.e. there was no evidence that waders were in any way "compensating" at night for the disturbance during the day.
- The behavioural responses to disturbance stimuli varied according to species (Sanderlings, Red-breasted Mergansers *Mergus serrator* and Eurasian Curlews were the three species in which the proportion of events resulting in birds being flushed was highest) and flock size (small flocks of waders were more sensitive).
- Whatever the source of disturbance, Dunlins (650 m) and Common Ringed Plovers (*Charadrius hiaticula,* 600 m) showed the largest mean flight distances, while Eurasian Oystercatchers (ca. 100 m) and Bar-tailed Godwits (60 m) showed the shortest.

Conclusions
At Poole Harbour a lone kite surfer can cover a large area and potentially disturb a number of roost sites and important feeding areas. A spatial specification for the pursuit of the sport (kitesurfing zone) on a reduced area would minimize its impacts. Ideally, access to the water for kite surfers and windsurfers would not involve walking across the mudflats or setting up kites etc. on the mudflats. There would be a single access/exit point.



LINAKER, R. (2012): Recreational Disturbance at the Teesmouth and Cleveland Coast European Marine Site. Bird Disturbance field work Winter 2011/2012. – Report commissioned by Natural England, 44 pages. University of York, York.

Scope of study
European Marine Sites (EMS) across England are under threat from recreational activities. The Teesmouth and Cleveland Coast EMS northeast of Middlesbrough (England) supports a population of over 20,000 migratory and wintering waterbirds of European importance. However, the imminent threat of recreational disturbance has the potential to affect habitat quality – kitesurfing occurs at the shore edge and waters just offshore, where the majority of birds forage – and as a consequence management of recreational disturbance may become imperative. The study was conducted to record and assess baseline data in order to increase the understanding of how wintering birds may respond to human activity and to test the efficacy of current (voluntary) management methods.

Species/groups observed
Waterbirds as wintering birds

Methods
The study took place from October 2011 to March 2012. Six study sites across the Teesmouth and Cleveland Coast EMS were surveyed, all habitats important to the waterbirds and of high public access. Numerous counts of the number of staging birds were conducted and georeferenced. Simul-

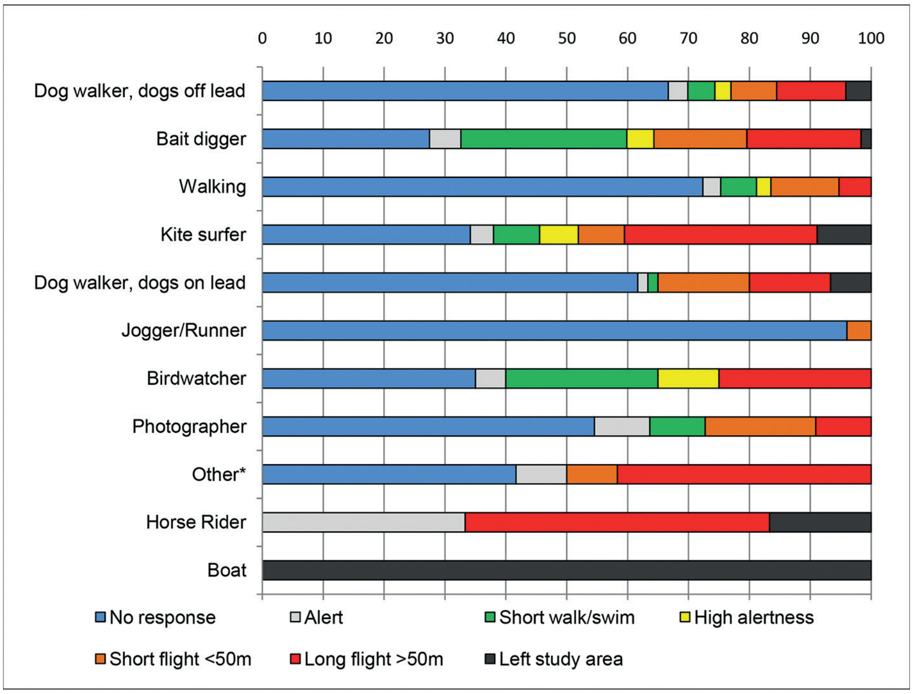


Figure 21: Behavioural responses of birds (grouped across all sites and all species) to different recreational activities at the Teesmouth and Cleveland Coast EMS from October 2011 to March 2012 (from LINAKER 2012).

taneously, all human activities, regardless of their potential as disturbance stimuli, and behavioural responses of birds were documented.

Results

- Of 1,218 recorded recreational acts, 91.1 % occurred in the presence of waterbirds and were classed as potential disturbances. Of these, the 28.2 % to which birds exhibited some form of behavioural response were regarded as actual disturbance events.
- Kitesurfing (62 times) was the fourth most frequent on the list of recreational activities, walking a dog (579 times) was most recurrent.
- The average behavioural response observed depended significantly on the type of recreational activity: activities involving boats, horse riders and kite surfers were more likely to elicit a disturbance response and tended to have a great impact resulting in a substantial proportion of birds either taking long flights (> 50 m) or leaving the site altogether.
- Accordingly, 40 % of disturbance stimuli caused by kitesurfing resulted in long flights or birds leaving the wintering site (Fig. 21).
- There was no evidence that habituation to the disturbance stimuli occurred on the Teesmouth and Cleveland Coast.

Conclusions

Although the frequency of kitesurfing was low, the impacts appear to be relatively large. Further work on the temporal and spatial spread of kitesurfing within the EMS would be helpful, and the significance of disturbance events caused by this activity requires further investigation.


Auswirkungen des Kite- und Windsurfens auf Rastvögel an der Wurster Küste im Nationalpark Niedersächsisches Wattenmeer an den Standorten Dorum-Neufeld und Wremen

Auftraggeber: Nationalpark Wattenmeer — Nationalparkverwaltung Niedersächsisches Wattenmeer

Auftragnehmer: BIOS — Gutachten für ökologische Bestandsaufnahmen, Bewertungen und Planung

Bearbeitung: Tasso Schikore & Karsten Schröder; Gunnar Siedenschnur (Erfassung); Marco Zimmermann (Erfassung); Sonja Maehder (Erfassung, Auswertung); Ole Albrecht (Wetterdatenrecherche)

Kontakt: Lindenstraße 40, D-27711 Osterholz-Scharmbeck; Telefon: 04791 502667-0; Fax: 04791 89325; E-Post: info@bios-ohz.de

Osterholz-Scharmbeck, Januar 2013

SCHIKORE, T., K. SCHRÖDER, G. SIEDENSCHNUR, M. ZIMMERMANN, S. MAEHDER & O. ALBRECHT (2013): Auswirkungen des Kite- und Windsurfens auf Rastvögel an der Wurster Küste im Nationalpark Niedersächsisches Wattenmeer an den Standorten Dorum-Neufeld und Wremen. – Gutachten i. A. der Nationalparkverwaltung Niedersächsisches Wattenmeer, 72 pages, BIOS, Osterholz-Scharmbeck.

Scope of study

In July 2010 the Wadden Sea National Park acceded to kitesurfing in four designated kitesurfing and windsurfing zones: Wremen, Dorum-Neufeld, Sahlenburg and Cuxhaven-Duhnen (Lower Saxony, Germany). These areas are heavily frequented by tourists. This study documents the behaviour of roosting birds in potentially affected areas as well as kitesurfing and windsurfing activities and their potential effect on birds throughout the year. The effectiveness of zoning was evaluated in terms of reducing disturbances. The survey was not designed as a baseline study to determine the species-specific FIDs of roosting waterbirds.

Species/groups studied

Waterbirds as visitors on migration

Methods

Waterbirds inside two kitesurfing and windsurfing zones (380 ha, 920 ha) were counted on 21 days between February and November 2011. Observations started three hours before high tide and ended two hours after high tide. Data on windsurfing and kitesurfing as well as all other recreational activities were collected. Distances to sources of disturbances were measured by laser.

Results

- On observation dates with kite surfers and windsurfers present, there were no roosting populations of any noteworthy size present.
- On all observation dates, all kite surfers remained in the designated zones with highest densities close to the point of entry and within a radius of 1,000 m. Some windsurfers were noted also in areas outside of the designated zones.
- No disturbance effects on roosting birds triggered by surfing activity were observed. The distances between roosting sites and surfing zones appear to be adequate (Fig. 22).
- The distance between surfing zones and breeding sites is also appropriate.
- Four disturbance events caused by kite surfers were observed in the "Recreation Zones" of the National Park with the access point, groynes and land reclamation areas.
- Observed FIDs were: Mallard = 250-280 m, 300 m; Eurasian Oystercatcher = 150-200 m; Black-headed Gull (*Larus ridibundus*) = 280-300 m; Mew Gull (*L. canus*) = 280-300 m.
- In the reactions to disturbances, no differences were observed between those caused by kite surfers and those by windsurfers.
- Swimming birds were observed to use kitesurfing zones when no surfing activities were going on (mostly in non-summer months).

Conclusions

The greatest potential for disturbances caused by kite surfing and windsurfing was observed when these activities took place within 400 m of waterbirds. At high tide roosts (in the study areas mostly in parts with only narrow expanses of foreland) disturbance stimuli were caused by other activities, such as walking with or without a dog, camping, cycling and kayaking. Windsurfers outside the designated surfing zones caused isolated disturbances of a high tide roost. No disturbance effects by kite surfers and windsurfers are to be feared if activities take place at distances of 500 m or more. The extent of one kitesurfing and surfing zone in Wremen was changed in response to the findings of this study and the number of disturbance events was reduced to a minimum.

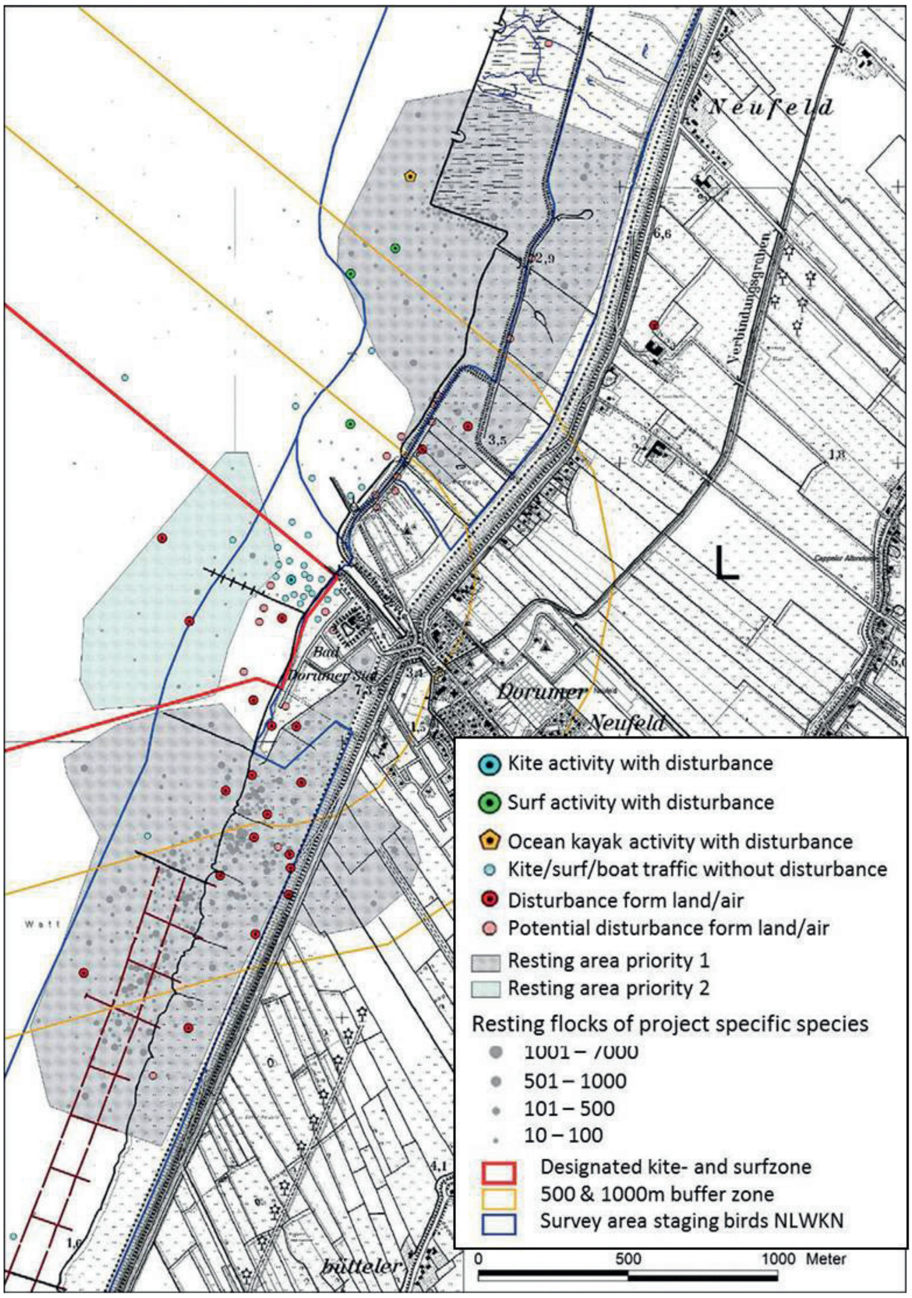


Figure 22: The potential of disturbances caused by kitesurfing can be reduced by establishing designated kitesurfing zones like the ones in Dorum-Neufeld, where the number of disturbance events is high in consequence of recreational zones and harbour activities. The surfing zones have to be clearly marked and the distance from roosting/breeding sites has to be sufficient (SCHIKORE et al. 2013).

VERBEEK, R. G. & K. L. KRIJGSVELD (2013): Kitesurfen in de Delta en verstoring van vogels en zeehonden – Onderbouwing van locaties waar kitesurfen via het Beheerplan kann worden toegestaan. – Einrapport in opdracht van Rijkswaterstaat dienst Zeeland, 105 pages, Bureau Waardenburg, Culemborg.

Scope of study
The number of kite surfers observed in the Delta area southwest of Rotterdam (The Netherlands) has been increasing since the 1990s. Some areas have become more popular with kite surfers than others. In the course of time it became obvious that kitesurfing can cause severe disturbance of birds. As part of the development of a new management plan for this Natura 2000 site ("Deltawateren"), therefore, an evaluation was to be made as to where kitesurfing could be allowed in the future without jeopardizing the conservation objectives of the area or species concerned. To this end, a literature review of the effects of kitesurfing on waterbirds was conducted and effect distances and buffer zones were derived.

Species/groups studied
-

Methods
This being a literature review, no data was collected and no experiments were conducted. From a compilation of literature available at this time, sites were identified within the Delta area where kitesurfing would be unproblematic and others where it should be banned. The review included only studies where effects caused by kitesurfing were actually observed in the field. At the time, only six studies fit the criteria (SMITH 2004, VAN RIJN et al. 2006, VERDAAT 2006, ANDRETZKE et al. 2010, JANSEN 2011, LILEY et al. 2011). The results of these publications are summarized in this review.

Results / Conclusions
- All studies summarized agree that disturbance effects and impacts on birds caused by kitesurfing are severe and that the presence of kite surfers can drive away large proportions of the birds present at a site.
- FIDs described varied between 200 m and 2,000 m.
- ADs (as opposed to FIDs) were established only for Tundra Swans. They lay between 1,000 and 1,400 m.
- The authors conclude that in view of the species present in the Delta area, a buffer zone of 700 m should be sufficient to minimize the disturbance effects of a kitesurfing zone. Beyond this distance the majority of the species would not be disturbed.
- However, for some species at some locations, the 700 m gap could potentially cause a reduction of foraging time.
- A distance of 700 m should be large enough to shield breeding birds from disturbance stimuli.
- The monitoring of disturbance stimuli and their effects in the Delta area is necessary and could lead to administrative adjustments.

BLÜML, V, A. DEGEN, D. FRANK & A. SCHÖNHEIM (2013): Auswirkungen des Kitesurfens an den Standorten Dornumersiel und Neuharlingersiel auf Rastvögel im Nationalpark Niedersächsisches Wattenmeer – Avifaunistische Begleituntersuchung 2012-2013. – Gutachten i. A. der Nationalparkverwaltung Niedersächsisches Wattenmeer, 46 pages, BMS-Umweltplanung, Osnabrück.

Scope of study
After previous studies at three other sites of the Lower Saxon part of the Wadden Sea National Park (Germany), disturbance effects on birds caused by kitesurfing were also to be evaluated at Dornumersiel and Neuharlingersiel. An evaluation as to if and how kitesurfing affects the quality of high tide roosts in these areas of the National Park was to determine if the established kitesurfing zones are effective. Otherwise suggestions for a new delimitation of the kitesurfing zones were to be made. Kitesurfing activities are restricted to three hours before to three hours after high tide, which is when under normal weather conditions intertidal mudflats are completely covered.

Species/groups studied
Waterbirds as visitors on migration

Methods
Both sites were monitored 24 times between 5.5 hours before and 0.5 hours after high tide from April to October 2012-2013. Monitoring included bird counts, a con-

tinuous recording of disturbance effects and respective behavioural responses of the birds at the two kitesurfing zones (80 and 70 ha).

Results

- 47 disturbance events were observed at Dornumersiel and 63 at Neuharlingersiel that resulted in swimming away, taking flight or, in the case of flying/migrating birds, changing direction.
- Out of these disturbance events 28 and 39 can be attributed to kitesurfing (Fig. 23). They affected 27 and 42 flocks, comprising an average number of 14 and 20 individuals, and a maximum number of 78 and 200 individuals respectively.
- The average number of birds per disturbance event affected by kitesurfing was considerably smaller than that affected by other sources of disturbance (e.g. windsurfing).
- Regularly occurring recreational activities are responsible for an elevated base line of disturbance events. Kitesurfing often co-occurred with other activities (e.g. walkers) causing cumulative disturbance effects.
- Species most affected were Brant Geese, Common Eiders (*Somateria mollissima*), waders and gulls.
- Distances of 20-200 m were observed between kite surfers/windsurfers and affected individual birds. Almost half of the birds reacted at distances between 100 m and 200 m by taking flight.
- Small flocks and individual birds occasionally exhibited habituation towards kite surfers and other sources of disturbance, not being affected until they got relatively close.

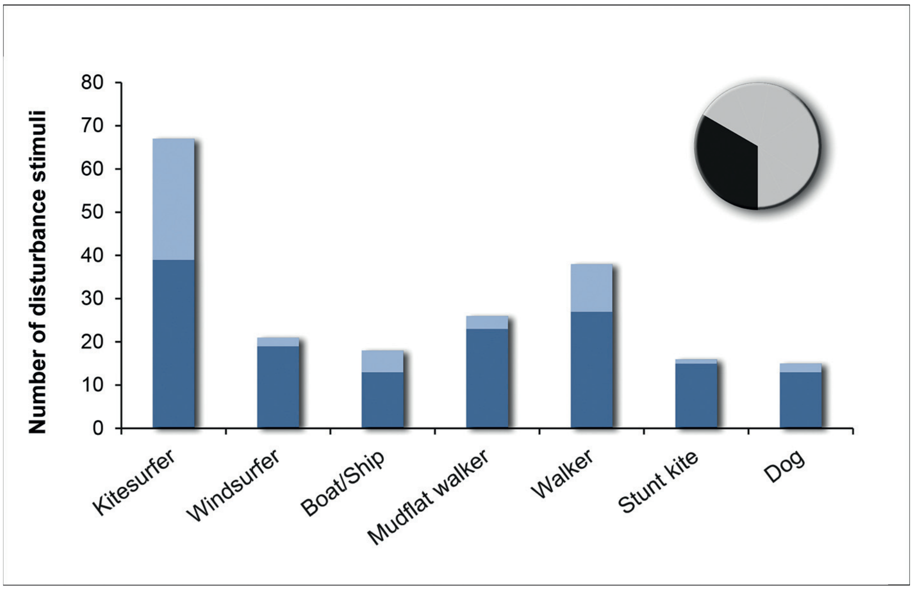
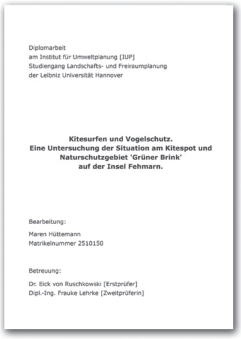


Figure 23: Number of disturbance events affecting birds per recreational activity. Observations were registered for 6 hours in the course of 24 observation periods at Neuharlingersiel (dark blue) and Dornumersiel (light blue). Pie chart: percentage of disturbance events caused by kitesurfing (black) out of total number of disturbance events (data provided by V. BLÜML, in lit.).

Figure 24: Brant Geese were most affected by disturbance events caused by kite surfers at Dornumersiel and Neuharlingersiel. According to consultants, kitesurfing zones should be closed until the migration of this species is over. (Photo: Jiří Bohdal / naturfoto.cz)

Conclusions

Kite surfers were responsible for a third of all recorded disturbance stimuli, contributing significantly to the overall “disturbance situation” (Fig. 23). It is important to restrict kitesurfing activities to three hours before and one hour after high tide. Expanding this window (e.g. to four hours before/after high tide) would be to sanction frequent disturbance stimuli as intertidal mudflats are accessible during that time. Seasonal aspects should be taken into account in managing kitesurfing activities; this could help minimize conflicts. For example, extremely low bird numbers were recorded within the kitesurfing zones and their surroundings in June, which could justify relaxing constraints on kitesurfing. On the other hand, more restrictive rules or even closures of kitesurfing zones should be in force until migrating/staging Brant Geese leave the area in mid-May.


Diplomarbeit
am Institut für Umweltplanung [IUP]
Studiengang Landschafts- und Freiraumplanung
der Leibniz Universität Hannover

**Kitesurfen und Vogelschutz.
Eine Untersuchung der Situation am Kitespot und
Naturschutzgebiet 'Grüner Brink'
auf der Insel Fehmarn.**

Bearbeitung:

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Matrikelnummer 2510150

Betreuung:

Dr. Eick von Ruschkowski [Erstprüfer]
Dipl.-Ing. Frauke Lehrke [Zweitprüferin]

HÜTTEMANN, M. (2013): Kitesurfen und Vogelschutz. Eine Untersuchung der Situation am Kitespot und Naturschutzgebiet „Grüner Brink" auf der Insel Fehmarn. Dipl.arb. am Institut für Umweltplanung (IUP), Leibniz Univ. Hannover, 155 pages, Hannover.

Scope of study

"Grüner Brink" is a nature reserve on the northern coast of the island of Fehmarn (Schleswig-Holstein, Germany) bordering areas much in demand by tourism such as recreational beaches and kitesurfing/windsurfing zones in the east. Kitesurfing is popular in the area, which is visited by up to 37 kite surfers simultaneously and frequented by up to 100 kite surfers per day. In 2012, weather conditions were favorable for kitesurfing on 103 days. In 1995, 1,600-2,000 people used the beach daily. The nature reserve, which is also a designated Special Protection Area (SPA), is 2.5 km long and 180 m wide and features shallow water areas of the Baltic Sea, mudflats, sand bars, sandy and rocky beaches with primary dunes, a lagoon and shallow pools on the beaches, where terns, gulls and waders breed. The aim of this study was to evaluate the effects of kitesurfing on the spatial distribution and behaviour of breeding and staging birds.

Species/groups studied

Waterbirds as breeding birds and visitors on migration

Methods

Observations of birds were conducted on eleven days (June 9-21 2012) in three stages (7:30-10:30 a.m., 2:00-5:00 p.m. and 8:00-9:00 p.m.) for a total of 43 hours. Two sites were visited alternately, one near the lagoon within the nature reserve and one on the beach 300 m to 550 m away from the designated kitesurfing zone. From there, all visible birds in the "study area" were georeferenced and behavioural observations were carried out. Kite surfers were present for only five out of 109 mapping runs. Thus, the sample is quite small with regard to kitesurfing.

Results

- Kite surfers remained in the designated kitesurfing zone only when other beachgoers or large numbers of windsurfers were present. The area most used is within and north of the swimming/bathing zone. When swimmers are present, kite surfers also use areas close to/ within the nature reserve.
- Generally, none of the user groups followed the guidelines and spatial restrictions of the area.
- General recreational use (swimming, hiking, walking dogs, tourist service) caused most (22 out of 24) disturbance events.
- Only one case of fleeing due to kitesurfing activities was registered. Two Common Shelducks took flight when a kite crashed with a bang. Four other similar crashes triggered no behavioural reactions.
- Kite surfers generally do not pose a threat and birds feel safe in their presence. The author repeatedly asserts "birds do not see the kites as a threat". These general statements were put into perspective when the author, on request, communicated the distances involved between birds and kite surfers.
- Thus, pictures provided by the author show that roosting or foraging Common Shelducks, Common Ringed Plovers and Dunlins were not disturbed by kite surfers at a distance of 150 m (M. HÜTTEMANN, in lit.). This is in accordance with similar studies of these species.
- The species studied exhibited a variety of reactions to kite surfers. Gulls and terns showed the shortest FIDs.
- Common Shelducks were observed expanding their areas of use towards kite surfers or flying towards them before changing direction just before reaching the kite surfers.
- Owing to the high frequency of recreational activities (for more than 50 % of the observation time birds were being influenced by anthropogenic activities) and their spatial expansion, spatial competition occurs between birds and people, especially on mudflats.
- This also applies to kite surfers.
- Irrespective of sample size and species-specific sensitivities, birds (all species and individuals observed) used more or less the same total area when humans were absent altogether as they did when kite surfers [how many? how far away?] were present (Fig. 26).
- Some species presented clearly different spatial distribution within this area when kite surfers were present. Eurasian Oystercatchers and Dunlins, for example, roosted and foraged in much smaller numbers or not at all (Fig. 26). However, this could equally well be the result of other (environmental) factors.
- Highest densities of birds coincided with lowest anthropogenic activity. The areas preferred by birds were mudflats and high tide lines close to the inlet of the lagoon.

Conclusions

Human activity should be banned from mudflats and the sand strip. The majority of problems result from ambiguous, illegible, misplaced or missing markers for the nature reserve and/or guidelines for its use. Trail markers are inadequate. The dialogue between all parties involved should be intensified. A clear management plan needs to be developed in which wildlife conservation is non-negotiable.

Figure 25: Foraging Common Shelducks and Common Ringed Plovers are not affected by kite surfers 150 m away. (Photo: Maren Hüttemann)

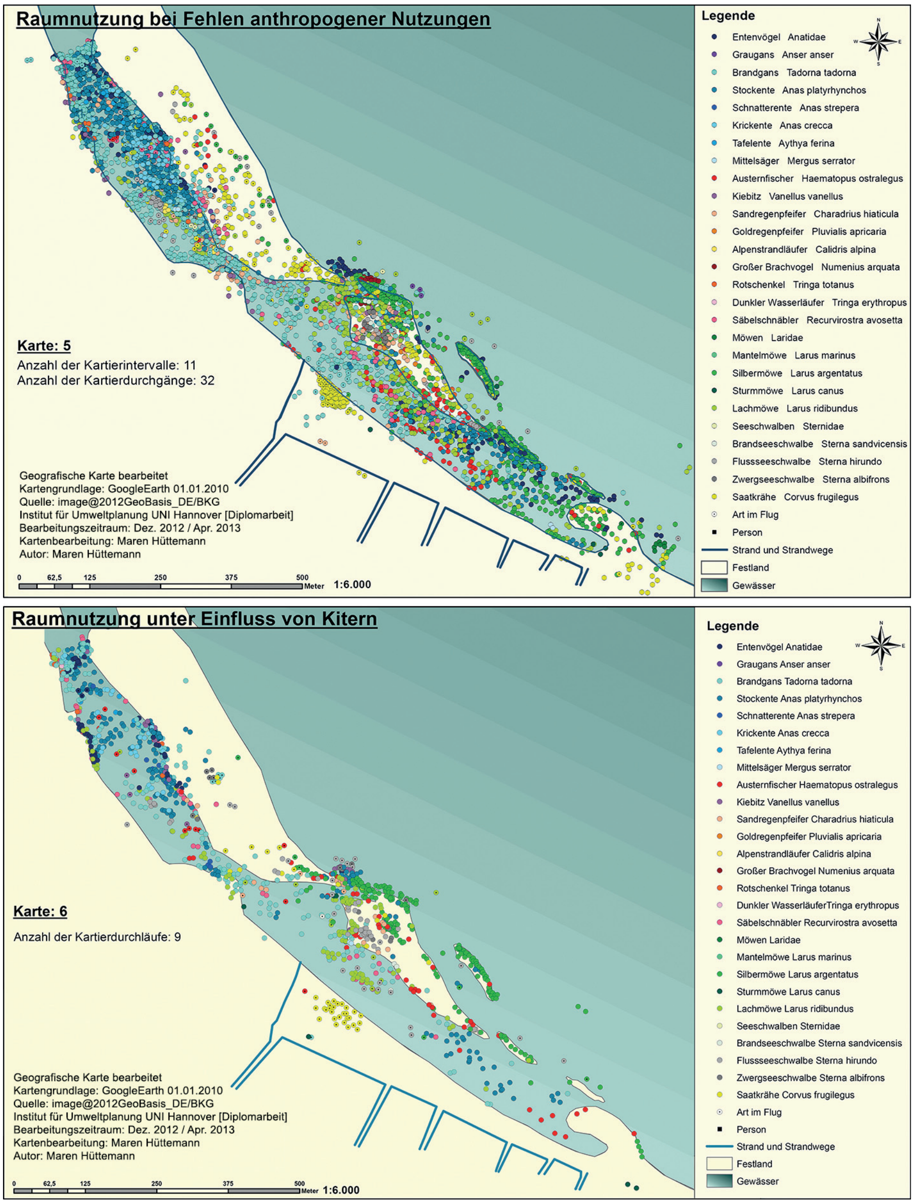
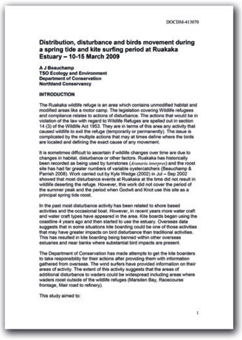


Figure 26: Spatial distribution of waterbirds at "Grüner Brink" without human presence (top) and with kite surfers present (bottom). Different colored dots signify different species. The total area used by birds hardly differs; however, certain species show clearly different patterns within the area according to whether disturbances are present or not. Note the difference in sample size (top: 32 georeferenced tracks through the area, bottom: 6 georeferenced tracks) and the synoptic presentation disregarding the chronological succession of disturbance events and the distance between kite surfers and birds (from: HÜTTEMANN 2013).


DOCDM-413070

Distribution, disturbance and birds movement during a spring tide and kite surfing period at Ruakaka Estuary – 10-15 March 2009

A J Beauchamp
TSO Ecology and Environment
Department of Conservation
Northland Conservancy

INTRODUCTION

The Ruakaka wildlife refuge is an area which contains unmodified habitat and modified areas like a motor camp. The legislation covering Wildlife refugees and compliance relates to actions of disturbance. The actions that would be in violation of the law with regard to Wildlife Refuges are spelled out in section 14 (3) of the Wildlife Act 1953. They are in terms of this area any activity that caused wildlife to exit the refuge (temporarily or permanently). The issue is complicated by the multiple actions that may at times define where the birds are located and defining the exact cause of any movement.

It is sometimes difficult to ascertain if wildlife changes over time are due to changes in habitat, disturbance or other factors. Ruakaka has historically been recorded as being used by turnstones (*Arenaria interpres*) and the roost site has had far greater numbers of variable oystercatchers (Beauchamp & Parrish 2008). Work carried out by Kyle Wedge (2002) in Jul – Sep 2002 showed that most disturbance events at Ruakaka at the time did not result in wildlife deserting the refuge. However, this work did not cover the period of the summer peak and the period when Godwit and Knot use this site as a principal spring tide roost.

In the past most disturbance activity has been related to shore based activities and the occasional boat. However, in recent years more water craft and water craft types have appeared in the area. Kite boards began using the coastline 4 years ago and then started to use the estuary. Overseas data suggests that in some situations kite boarding could be one of those activities that may have greater impacts on bird disturbance than traditional activities. This has resulted in kite boarding being banned within other overseas estuaries and near banks where substantial bird impacts are present.

The Department of Conservation has made attempts to get the kite boarders to take responsibility for their actions after providing them with information gathered from overseas. The wind surfers have provided information on their areas of activity. The extent of this activity suggests that the areas of additional disturbance to waders could be widespread including areas where waders roost outside of the wildlife refuges (Marsden Bay, Racecourse frontage, Mair road to refinery).

This study aimed to:

1

BEAUCHAMP, A. J. & G. P. PILON (year not given): Distribution, disturbance and birds movement during a spring tide and kite surfing period at Ruakaka Estuary (Northland, New Zealand) – Submitted for publication at Notornis.

Scope of study
This is a follow-up study on observations in Ruakaka Estuary (New Zealand) from March 2009. It encompasses the summer months of the southern hemisphere and the observation effort has been increased correspondingly. Just before the start of observations in October, local kite surfers reacted to results from the previous study and called for a voluntary, self-imposed ban on kitesurfing when Bar-tailed Godwits are present at certain states of the tide (Fig. 27).

Species/groups studied
Waterbirds as breeding birds and as visitors on migration

Methods
Between Oct. 18 2009 and Mar. 1 2010, observations were conducted on consecutive days during incoming tides until highest spring tides, in each case in the morning and in the early afternoon. Additionally, observations were conducted during neap tides from mid-January to mid-February (effort: 105 hours of observation on 29 days). These dates were chosen in advance in order to illustrate the periods before, during and after the summer high season of beach use in the area. Bird counts were conducted during the two hours before and two hours after low tide. All human activities and birds were registered and all "actual disturbances" (here: bird moves evasively more than 2 m) and "potential disturbances" (here: birds become alert or move less than 2 m) were evaluated. The purpose of this study was to evaluate all recreational activities. Therefore, it took place independently from weather conditions suitable for kitesurfing (easterly winds).

Results
- There were 813 potential anthropogenic disturbance events and 147 of these caused actual disturbance.

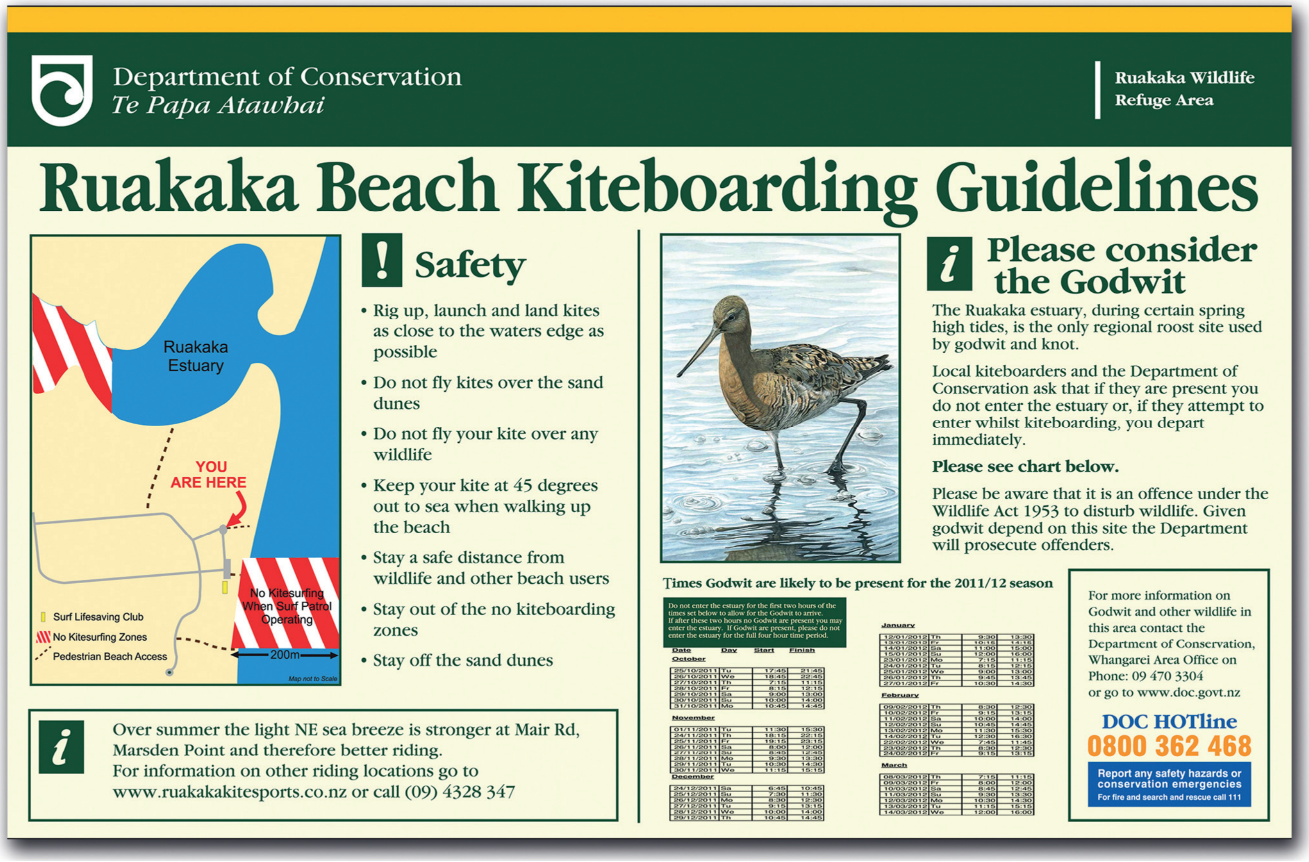
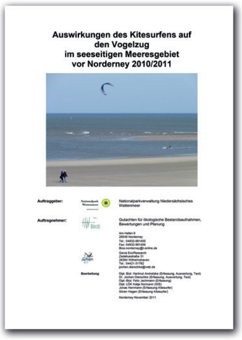


Figure 27: Minimizing disturbances through voluntary self-monitoring. This sign (summer season 2011/2012) is an appeal not to use certain areas during times provided in a chart (lower right corner). Two hours later, if Bar-tailed Godwits are still absent, kitesurfing is in order, otherwise the estuary should not be entered.

- There were only 13 events that resulted in birds leaving the estuary, of which five were caused by humans.
- Because the study was conducted regardless of weather conditions, species-specific responses to kitesurfing could only be observed three times. Most disturbance stimuli were elicited by walkers (88), boat traffic (37), kayakers (6), swimmers and dogs (5 each).
- There were five fenced areas for roosting and breeding birds. Without these fences in the "motor camp" and along the southern shoreline, even the most tolerant staging birds would have been absent from these areas at high tide.
- Ruakaka estuary is the most important high tide roost for Bar-tailed Godwits and Red Knots in the Whangarei Harbour area. Flushed birds usually circle back as there are no alternative sites for roosting close by.

Conclusions
Protection of the Bar-tailed Godwit and Red Knot roost is the key conservation concern for the estuary at present. Well integrated human activity is generally not adversely affecting the Bar-tailed Godwits and Red Knots and can be controlled. New recreational activities, like kitesurfing, have a substantial impact on godwits and knots and controlled access should be maintained.

6.2 Open sea


Auswirkungen des Kitesurfens auf den Vogelzug im seeseitigen Meeresgebiet vor Norderney 2010/2011

ANDRETZKE, H., J. DIERSCHKE, F. JACHMANN, K. NORMANN, J. HERRMANN & S. HAGEN (2011): Auswirkungen des Kitesurfens auf den Vogelzug im seeseitigen Meeresgebiet vor Norderney 2010/2011. – Bericht i. A. der Nationalparkverwaltung Niedersächsisches Wattenmeer, 49 pages, BIOS Norderney & Gavia Eco Research, Norderney.

Scope of study
In 2011, eight kitesurfing zones in the Lower Saxon part of the Wadden Sea National Park (Germany) were approved with five more pending approval. Four of these were seaward of the East Frisian Islands. Effects of kitesurfing on birds were evaluated as part of the approval process. The study was conducted on the island of Norderney and for reasons of comparison on the island of Baltrum.

Species/groups studied
Seabirds and coastal birds on migration

Methods
Observations of migrating birds passing Norderney and kite surfers during autumn 2010 and spring 2011. The aim of this study was to find answers to the following questions: what is the frequency of usage of the proposed kitesurfing zones during migration? Where are the most heavily used areas? What are the distances between kite surfers and migrating birds? What potential conflicts are there? What is the potential severity of disturbances of migrating birds by kite surfers?

Results
- Because kite surfers primarily frequent areas close to the beach (< 250 m; Fig. 28) and are very seldom further away from the beach than 1,250 m, conflicts between kite surfers and migrating birds might potentially arise especially in autumn. At that period the median of the distance classes between migrating


Figure 28: Kitesurfing was limited primarily to a strip 250 m wide parallel to the seaward coastline of the East Frisian islands Norderney and Baltrum. Encounters between migrating birds and kite surfers are therefore probably rare. However, these European Herring Gulls roosting on the groyne are evidently not disturbed by the two kite surfers close by (Norderney, April 2011). (Photo: Jochen Dierschke)

seabirds/shorebirds and the beach/island is 1,000 m (spring: 2,000 m).

- Out of nine species for which data are available from autumn 2010, only Red-throated Loons showed considerable reactions to kite surfers. A change of course (of 90°) was initiated when sources of disturbance were 500 m away. A flock of 32 Common Eiders changed direction 1,400 m away from a kite surfer (Fig. 29).
- 12 encounters between kite surfers and migrating birds were observed in the spring of 2011. Four encounters resulted in a horizontal change of direction (three times < 90° and once > 90°).These changes were initiated 100 m and 200 m away from the source of disturbance.
- Observations on Baltrum were conducted to provide a reference data set. 42 encounters were observed in October of 2011 with 9 changes of direction mostly in Brant Geese. Brant Geese often reacted by vertical adjustments initiated 100-150 m away from the source of disturbance.
- Some species, such as Sandwich Terns (*Sterna sandvicensis*), appear to be indifferent to kite surfers.

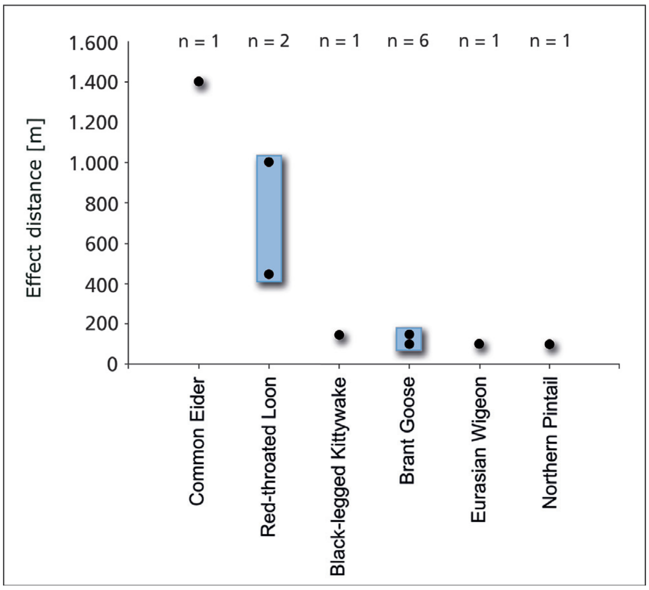


Figure 29: Distances between kite surfers and those bird species (individuals and flocks) that showed reactions (e.g. change of direction) to kite surfers while migrating past the islands of Norderney and Baltrum in the autumn of 2010. Boxes indicate the range (according to data from ANDRETZKE et al. 2011).

Conclusions

On migration Red-throated Loons and Common Eiders could be more susceptible to disturbance stimuli produced by kite surfers than are, for example, Brant Geese (minimal change of direction) or gulls and terns (no reaction). Spatial and temporal activities of kite surfers and migrating birds rarely coincide and this limits the number of potential interactions. It is considered to be uncritical if a 1,000 m wide kitesurfing zone were to be established off a certain section of the beach of Norderney. Results from this study might not be applicable to other areas as kitesurfing conditions and migration routes vary.

6.3 Lakes

VAN RIJN, S. H. M., K. L. KRIJGSVELD & R. C. W. STRUCKER (2006): Gedrag van vogels tijdens een kitesurfevenement in de Grevelingen. – Eindrapport in opdracht van Rijkswaterstaat Zeeland, 37 pages, Bureau Waardenburg, Culemborg.

Scope of study

Effects of kitesurfing on birds were studied during a kitesurfing event on Nov. 4 2006 (“Downwinder Grevelingenmeer 2006”, cf. www.youtube.com/watch?=rLs8iH3-Unl). Between 11:30 a.m. and 2:30 p.m. a group of 15 kite surfers, accompanied by boats (Rijkswaterstaat, police, coast guard), used a route from Brouwersdam, across the entire Grevelingenmeer, to Grevelingendam. Grevelingenmeer is an area southwest of Rotterdam (The Netherlands) and is separated from the North Sea by the Brouwersdam. It is an internationally important stop-over site for nine species and is part of the Dutch set of “Natura 2000” areas.

Species/groups studied

Waterbirds as visitors on migration

Methods

Bird counts, the spatial distribution of the birds and behavioural responses (taking flight/swimming away) to kite surfers were conducted at six different locations along the route of the kite surfers. In order to register reactions of birds on open water, observations were also made from a boat. To be able to compare these observations, bird counts and distributions were also recorded one day before and one and two days after the event.

Results

- Almost all birds present on open water (grebes, mergansers, ducks) took flight when the group of kite surfers approached (Fig. 30).
- The first individuals took flight long before the kite surfers appeared/passed. FIDs of flocks on open water varied between 500 m (smaller flocks) and 1,000 m (larger flocks).
- The reactions observed were massive. Flocks fleeing from the large group of kite surfers caused other birds, far removed from the disturbance, to take flight as well ("avalanche effect").
- Most species escaped by flying; Great Crested Grebes and Black-necked Grebes (*Podiceps nigricollis*) moved away by swimming or diving, or in the case of quickly approaching kite suffers also by flying.
- FIDs: Red-breasted Merganser > 500 m, Common Goldeneye c. 500 m, Great Crested Grebe 200-500 m.
- Kite surfers passed a high tide roost (waders, ducks) at a distance of 200 m. Almost all of the 10,000 individuals took flight.
- Several hours after the event, less than 25 % of the birds had returned.
- 30 % of Dunlins and Grey Plovers came back after 30-45 min, Brant Geese came back after 60 min, Red Knots and Bar-tailed Godwits did not come back at all.
- Out of the duck species, only 10 % of Eurasian Wigeons (*Anas penelope*) came back. Northern Pintails (*A. acuta*), Northern Shoveler (*A. clypeata*), Mallards and Greater Scaups (*Aythya marila*) did not come back.
- Noticeably lower counts of resting birds were registered not only on the day after (Fig. 31), but also two days after the event.
- Kite surfers used a route 1.5 km wide. Allowing FIDs of 1,000 m for birds on open water, a total area of 50 km^2 was disturbed, equivalent to 7,500 ha of open water. As the Grevelingenmeer encompasses 14,000 ha, this means that half of the area was vacated by waterbirds.

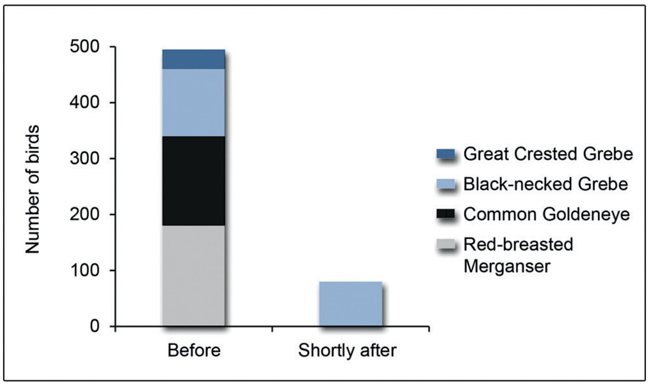
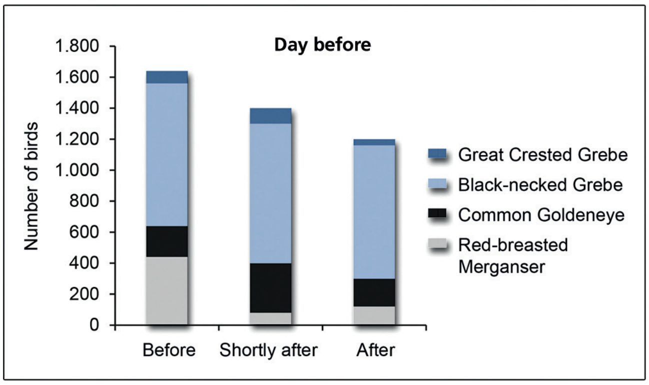


Figure 30: Numbers of birds counted on open water (within the route used by kite surfers, northwestern part of Grevelingenmeer) on the day of the event just before (left) and immediately after (right) kite surfers passed (from VAN RIJN 2006).



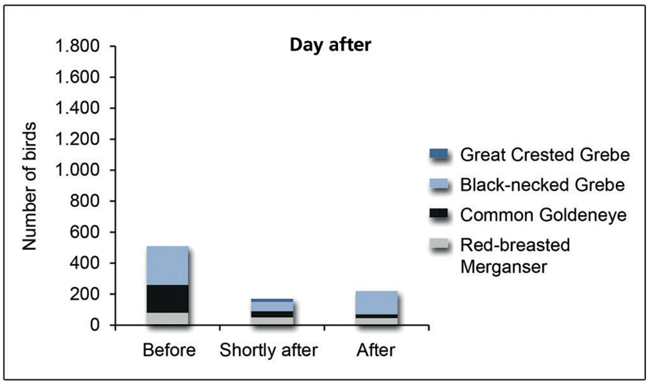
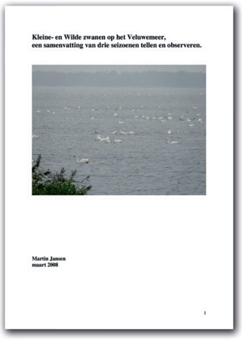


Figure 31: Numbers of birds counted on open water (within the route used by kite surfers, southeastern part of Grevelingenmeer) on the day before the event (left) and the day after the event (right). Counts were timed according to the event and took place at the same time of day each day (from VAN RIJN 2006).



JANSEN, M. (2008): Kleine en Wilde zwanen op het Veluwemeer, een samenvatting van drie seizoenen tellen en observeren – Rapport, 18 pages.

Scope of study
The author conducted a thorough evaluation of the use of Veluwemeer (southwest of Zwolle, The Netherlands) by Nordic swans in his own interest. The Veluwemeer is part of the Veluwerandmeren, an area with multiple lakes. It is a staging and wintering site of international importance for waterbirds as well as a key site for roughly 2,500 Tundra Swans in the Netherlands each winter (cf. REES 2006). The Nordic swans mostly use Veluwemeer as a feeding and roosting site, some parts are used as night roosts. The Veluwerandmeren area as a whole is part of the Dutch set of "Natura 2000" areas.

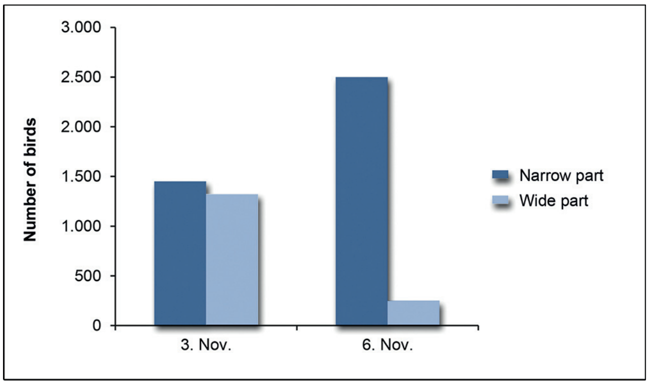


Figure 32: Spatial distribution of Tundra Swans at the narrow part (dark blue) and the wide part (light blue) of Veluwemeer on different days. No kite surfers were observed on Nov 3rd, on Nov 6th kite surfers were present at the wide part of the lake (from JANSEN 2008).

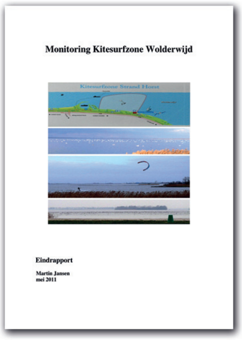
Species/groups studied
Mainly Tundra Swan; Mute Swan (*Cygnus olor*) and Whooper Swan (*C. cygnus*) when present

Methods
Swans were counted on a total of 19 days between mid-October and mid-February 2005/2006, 2006/2007 and 2007/2008. Behaviour, presence of colour-ringed birds and spatial distribution were recorded at seven defined sites. Simultaneously, water level, available food sources and all disturbance events were noted.

Results
- Kite surfers strongly affected the spatial distribution of Tundra Swans. On days without kite surfers present, Tundra Swans dispersed themselves evenly in both the wide and the narrow parts of Veluwemeer to forage. On days with kitesurfing activities in the wide part of the lake, the spatial distribution of Tundra Swans was completely different – almost all birds moved to the narrow part of the lake (Fig. 32). This was possible because of the favorable water level in the area.
- When kitesurfing coincided with high water levels unfavorable for Tundra Swans at Veluwemeer, no spatial evasion was possible and the swans then moved to other roosting sites.
- In successions of disturbance stimuli caused by kite surfers and windsurfers Tundra Swans moved to the night roosts, where they remained until dusk. From there they moved back to the feeding sites.
- Disturbances by kite surfers were so severe that Tundra Swans were visibly affected even at the night roosts too. One night roost in particular (Polsmatendam) was greatly affected as it was adjacent to a dike where kite surfers were flying their kites. This resulted in the abandonment of the roost (KRIJGSVELD et al. 2008).

Conclusions
Thorough monitoring is essential for such an important area and future studies on Tundra Swans in this area, including their ecology, will be conducted by the Vogelbeschermingswacht Noord-Veluwe. The results of this study were communicated to kite surfers along with suggestions as to how to reduce disturbances. This is already starting to have an effect.

Figure 33: Small flocks of Tundra Swans roosting on open water at Veluwerandmeren reacted to kite surfers at a flight initiation distance of 700 m. (Photo: Buiten Beeld /alamy.com)



JANSEN, M. (2011) Monitoring Kitesurfzone Wolderwijd. Eindrapport – In opdracht van de Provincie Flevoland en Province Gelderland. 26 pages, Elburg.

Scope of study
The use of and adherence to a designated kitesurfing zone at Wolderwijd (southwest of Zwolle, The Netherlands) was studied for three years (2008-2010). Included was an evaluation of the effects of kitesurfing on breeding and staging birds. Lake Wolderwijd is part of the Veluwerandmeren area, which as a whole is part of the Dutch "Natura 2000" habitats. Kitesurfing regulations include keeping kites a minimum distance of 500 m from staging birds (including birds outside of kitesurfing zones) from Oct. 1 to Apr. 1.

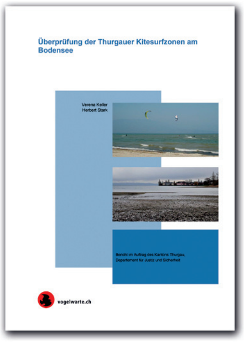
Species/groups studied
Waterbirds as visitors on migration, waterbirds and birds associated with reed bed habitats as breeding birds

Figure 34: Common Goldeneyes are among the shiest species (FID: 650 m) observed reacting to kite surfers at Wolderwijd. (Photo: Glenn Bartley / birdimagency.com)

Methods
Seasonal occurrence and spatial distribution of birds was studied in depth. Additionally, a host of other data was accumulated: how often do disturbances/displacements caused by kite surfers occur, do those disturbances also occur outside of designated kitesurfing zones, do disturbances through causes other than kitesurfing also occur, how severe is the problem of bird displacement through kitesurfing, do bird populations move to another, more peaceful area of the lake and lastly, is the 500 m buffer zone effective?

Results
- Kite surfers were present, making use of the entire kitesurfing zone, on 47.4 % of the observation days (n = 76).
- All birds of all species present within the kitesurfing zone were displaced on 39.5 % of days (= 30 days).
- Tundra Swans, Gadwalls (*Anas strepera*), Common Goldeneyes, Northern Pintails, Eurasian Wigeons, Northern Shovelers, Smews (*Mergellus albellus*), Common Mergansers (*Mergus merganser*) and foraging Common Pochards and Tufted Ducks (*Aythya fuligula*) were displaced entirely when a kite surfer took to the water.
- Only minor reactions were observed in Great Crested Grebes and Eurasian Coots, which mostly swam away.
- FIDs could be determined for several species: Tundra Swan: 700 m, Common Goldeneye: 650 m, Gadwall: 550 m. FIDs similar to Gadwalls' were observed in Eurasian Wigeons, Northern Pintails, Northern Shovelers, Smews and Common Mergansers.
- The special directive to kite surfers instructing them to keep at least 500 m away from birds was ignored. Kite surfers crossed the 500 m buffer zone into flocks of staging waterbirds.
- Kitesurfing was regularly observed outside of designated kitesurfing zones.

Conclusions
A buffer zone of 500 m is not effective enough. The current guidelines are not enough to meet preservation goals for Common Goldeneyes, Smews and Northern Shovelers in the Special Protection Area (SPA).



KELLER, V. & H. STARK (2012): Überprüfung der Thurgauer Kitesurfzonen am Bodensee. – Gutachten i. A. des Kantons Thurgau, 20 pages, Schweizerische Vogelwarte, Sempach.

Scope of study

The canton of Thurgau (Switzerland) established two designated kitesurfing zones on Lake Constance. The presence of important numbers of waterbirds in these areas gave rise to concerns. In 2010 the kitesurfing zones were approved for a further two years, until 2012, and a compatibility study with respect to the demands of bird conservation was commissioned. The study focused on (1) the importance of the kitesurfing zones for birds (2) the evaluation of impacts of kitesurfing on birds (literature review, observations) (3) re-examination of the boundaries of kitesurfing zones at Lake Constance with recommendations.

Species/groups studied

Waterbirds as breeding birds and as visitors on migration

Methods

Bird count data from the past 10 years (winter 2001/02 till 2010/11) were analyzed to evaluate the importance of areas of the lake used as kitesurfing zones. The most important shore sections were identified with the help of local expertise. The authors of the study were given advance notification of kitesurfing activity only three times, therefore only a small amount of data (measurement of distances between kite surfers and birds) could be collected from October 2011 to July 2012.

Results

- When several kite surfers were present simultaneously, they availed themselves of an area much bigger than the designated kitesurfing zones.
- In some instances, kite surfers moved far outside the borders of kitesurfing zones even when only a few kite surfers were present.
- Hardly any waterbirds could be observed when kite surfers were present. If Eurasian Coots were in the area, they congregated in groups (Fig. 35) and gave kite surfers a wide berth.
- On days without kitesurfing activities, however, up to 600 individuals of various species were present within kitesurfing zones.

Conclusions

Observations at Berlingen showed that kite surfers use an extensive area and cause severe disturbances on days with good weather conditions (for their sports). Restricting points of entry/exit is an essential part of managing kitesurfing at Lake Constance. The access point at the kitesurfing zone in Münsterlingen is on a relatively pristine natural beach. This beach is of great importance to bird populations, especially outside the breeding season. In view of the importance of this area and the severe impacts of even a single kite surfer, the authors recommend abolishing this kitesurfing zone.

Figure 35: In the face of danger (e.g. presence of predators like White-tailed Eagle), Eurasian Coots congregate in large flocks. This counter-predator behaviour was observed on Lake Constance in response to approaching kite surfers (Photo: A. Hartl / blickwinkel.de)

7 Synthesis

7.1 Material

This report embraces 17 studies from 5 countries worldwide 12 of which relate the effects on birds in coastal habitats (with estuaries, tidal mudflats, salt marshes and beaches – 9 x North Sea, 2 x South Pacific, 1 x Baltic Sea), one study describes the impacts of kitesurfing on birds migrating across the open sea (1 x North Sea) and four were conducted at sizable lakes (Table 1). It is clear from this selection alone that the results obtained in one place are not always applicable to other habitats and the species occurring in them. And in any case, as regards the transferability of results pertaining to disturbance effects on the one hand and sensitivities of birds on the other, the cautionary remarks made in Section 4.1 apply in full.

Further, the reports were designed differently. The majority of them are purely descriptive-analytical works that summarize the observations made in a particular area, compare the findings with data on bird occurrences, and interpret them. Some of these studies included simultaneous systematic and extensive observations (e.g. GPS tracking) of kitesurfing activities, bird movements and bird behaviour. There are also a few studies which were designed to be experimental, confronting birds with controlled disturbance stimuli. And lastly there is a literature review, which comes to conclusions on the basis of six reports available at the time of writing.

Even with studies of similar design, the comparability of the results is obscure by the fact that they are only similar, but not identical. This variation in methods is surprising as HILL et al. (1997) define the basic requirements for ecological studies of disturbances and several exemplary studies and standard methods have been published since then (RODGERS & SMITH 1997, BLUMSTEIN 2003, 2006, GILL 2007, SUFFOLK COAST AND HEATHES et al. 2012, WESTON et al. 2012).

Against this background, the challenges are, on the one hand, from the multitude of information contained in the various studies to sift out those results which seem to be transferable, while at the same time robust, and

Table 1: Basic information on the studies reviewed in this paper on the effects of kitesurfing on waterbirds (cf. chapter 6).

Study	Country	Habitat	Protection status of the study area*	Observation effort (days)**	Kitesurfing zones designated or regulations in force?	Study developed to focus on kitesurfing?	Experimental study (with control group)?	Specification of effect distances?	Number of species observed
Smith (2004)	GB	coastal	Ramsar, SPA, SAC, SSSI	182	no	yes	no	no	9
Verdaat (2006)	NL	coastal	SPA, SAC	34	yes	no	no	yes	1
Beauchamp (2009)	NZ	coastal	Wildlife Refuge	5	no	no	no	no	17
Bergmann (2010)	D	coastal	SPA, SAC, NP (EZ, ZZ)	28	yes	yes	partially	yes	>20
Liley et al. (2011)	GB	coastal	Ramsar, SPA, SAC, SSSI	238	no	no	no	no	>20
Liley & Fearnley (2012)	GB	coastal	Ramsar, SPA	28	no	no	no	no	>20
Linaker (2012)	GB	coastal	Ramsar, SPA, EMS	?	no	no	no	no	>20
Schikore et al. (2013)	D	coastal	SPA, SAC, NP (EZ, ZZ)	21	yes	yes	no	yes	>20
Verbeek & Krijksveld (2013)	NL	coastal	partially SPA	-	yes	yes	no	yes	>20
Blüml et al. (2013)	D	coastal	SPA, SAC, NP (EZ, ZZ)	24	yes	yes	no	yes	>20
Hüttemann (2013)	D	coastal	SPA, SAC, NSG	11	yes	yes	no	no	>20
Beuachamp & Pilon (subm.)	NZ	coastal	Wildlife Refuge	29	no	no	no	(yes)	17
Andretzke et al. (2011)	D	island, offshore	SPA, SAC, NP (EZ, ZZ)	59	no	yes	no	yes	>20
van Rijn et al. (2006)	NL	lake	N 2000	3	no	yes	yes	yes	>20
Jansen (2008)	NL	lake	N 2000	57	no	no	no	no	2
Jansen (2011)	NL	lake	N 2000	76	yes	yes	no	yes	15
Keller & Stark (2012)	CH	lake	partially BLN, WVZV	7	yes	yes	no	no	>20

* Ramsar = Ramsar site (according to Ramsar Convention), SPA = Special Protection Area (under the EC Birds Directive), SAC = Special Area of Conservation (under the EC Habitats Directive), SSSI = Site of Special Scientific Interest, NP = national park, EZ = recreation zone, ZZ = intermediate zone, EMS = European Marine Site, NSG = protected nature reserve, N 2000 = Natura 2000 (SPA and/or SAC), BLN = inventory of habitats and natural monuments of national importance, WVZV = water bird and migratory bird reserve

** Observation effort not including observations from previous years on the other hand to interpret even the extreme data in terms of the conflict potential.

7.2 General statements on the effects of kitesurfing on waterbirds

The results of the studies presented are consistent in many respects and can be summarized as follows with regard to the effects of kitesurfing on birds and bird habitats:

- Generally speaking and compared to other sources of human disturbances, water-based recreational activities and especially kitesurfing tended to produce rather powerful disturbance stimuli. Kitesurfing tended to have a considerable impact on birds with a substantial proportion of birds either taking long flights or leaving the site altogether.
- At any specific site on days with kitesurfing activities almost always significantly fewer staging birds were present (or in many cases none at all) than on days without kite surfers. Findings of a similar nature often emerge from long-term observation periods, when the introduction of kitesurfing in an area coincided with marked decreases in average waterbird numbers. These are indirect but clear indications of disturbance effects caused by kitesurfing, which influence both the spatial and temporal distribution of birds.
- Systematic Before-After-Counts proved that significantly more birds were always present before kitesurfing got under way at a particular site than during or shortly after the activities (if there were any birds left at all). This is a consequence of their observed reactions to the disturbance stimuli produced by kitesurfing.
- This also applies to tidal feeding areas on mudflats, where bird numbers naturally shrank as the water level rose and were therefore often empty before kitesurfing activities started; any remaining birds were then displaced by kitesurfing.
- Like any other source of disturbance, kitesurfing had different effects on different species. Some species were more susceptible to stimuli caused by kite surfers (large FIDs) while others were more tolerant of kitesurfing activity, even in close proximity.
- Disturbance distances, species-specific and individual sensitivities etc. notwithstanding, kitesurfing had the potential to drive away all roosting or feeding birds from an area.
- Depending on the location of roosting and feeding sites even a single kite surfer could cause this effect.
- Only a fraction of the birds (species and individuals) which flew off in response to the disturbance stimulus returned to the roost or feeding site after kitesurfing activity had ceased. Very often, even a day after the disturbance event, local bird numbers were not as high as they had been before.
- Effect distances and disturbance effects were particularly great when kite surfers moved outside the zones designated for kitesurfing.
- Kitesurfing in designated zones also had adverse effects on the spatial distribution of birds beyond the borders of these zones depending on the species-specific ADs and FIDs of the birds present in adjacent areas.
- Irrespective of effect distances, species-specific and individual sensitivities, kitesurfing not only disturbed staging or foraging birds, but also flying/migrating birds. They usually reacted by flying around or flying over the surfer. Sometimes shy species even significantly changed heading or the direction of migration.
- Through its disturbance effect, kitesurfing led to a reduction of both time and space available for foraging/feeding birds. In coastal habitats this effect was all the greater inasmuch as time and space for many species (e.g. waders) is naturally limited by the tidal cycle already.
- When in addition to kitesurfing other disturbance stimuli caused by other recreational activities occurred in an area, the disturbance effects aggregated and then usually became considerable.
- However, in many areas the disturbance level caused by other recreational activities (windsurfing, boat traffic, walkers, etc.) was already so high that the stimuli caused by kitesurfing seemed to elicit much weaker reactions. In such cases effects were seldom (or not at all) measurable since few if any birds still remained (Fig. 36).
- Habituation towards kitesurfing was not found. This is explained by the very nature of kitesurfing as a source of disturbance (quick movements, sudden changes of direction, no fixed routes, high speed; Table 2) and also by the fact that staging birds especially are often only present for a short period of time (high turnover) at roosts and feeding sites (e.g. HOCKIN et al. 1992, REES et al. 2005).
- At least those studies conducted in Lower Saxony provide little evidence of negative effects of kitesurfing on breeding birds of coastal habitats. This was due to either the high disturbance level of other human activities in those habitats leading to low densities of breeding birds or a complete lack of all but possibly the least sensitive breeding birds close to kitesurfing zones in the first place. But it could equally well be an indication that the buffer zones defined in the study areas between kitesurfing zones and breeding bird habitats were effective. However, in other countries it was explicitly claimed that kitesurfing activities (including accessing the beach or the shore, walking along the beach and across the mudflats to open water, kite already aloft on the beach and waiting for the tide, etc.) had effects on the breeding birds of the beaches and dunes. This has led locally to temporary bans on kitesurfing (e.g. at Cape Cod National Seashore, southwest of Boston, USA; CAPE COD NATIONAL SEAHORE 2011, CAPE COD NATIONAL SEASHORE & THE NATIONAL PARK SERVICE 2015) or the publication of best practice guidelines or rules of conduct (e.g. ENVIRONMENT CANADA 2012, Fig. 37).

7.3 Species-specific alert and flight initiation distances

In advance of a discussion of ADs and FIDs, it has to be stated that not all of the studies described here specifically aimed to determine these distances. Most studies did not plan on collecting this data, rather they noted them when possible, and results are thus based on a small sample size. Additionally, in view of the high speeds usually observed in kitesurfing activities, cross bearings (measurement of the distance of the observer from the bird and from the surfer, each along with the angle to the observer) are fraught with some degree of

Figure 36: Walkers cause Brant Geese to leave the area (left). No impacts can be observed when a kite surfer passes the same area shortly after (right) as no more birds are present. (Upleward 2010; Photo: Matthias Bergmann)

uncertainty. In view of this, the results obtained basically provide approximations, which seen as a whole, however, do produce a recognizable picture.

In addition to the above-mentioned aspects influencing the sensitivity of bird species and individuals (chapter 4, Fig. 6), the ADs and FIDs established are also dependent on the size and location of kitesurfing zones. Kitesurfing zones abutting roosting sites at just one end cause different disturbances than those running the whole length of a roost.

From Fig. 38 it becomes apparent that bird species differ not only in their specific FIDs, but also in their sensitivities towards active kite surfers (BLUMSTEIN et al. 2003, BLUMSTEIN et al. 2005). The most susceptible among the studied species, the Red-throated Loons, normally showed FIDs of 1,000 to 2,000 m, with FIDs of 500 m in isolated cases. This is in accordance with FIDs from other studies describing effects of shipping traffic on Red-throated Loons as well as Black-throated Loons (*Gavia arctica*), Common Scoters and Velvet Scoters (*Melanitta fusca*); all of which mostly showed FIDs greater than 1,000 m (BELLEBAUM et al. 2006, SCHWEMMER et al. 2011, DIERSCHKE et al. 2012; appendix).

The FIDs of Tundra Swans were on average 700 m, their ADs however 1,000 to 1,400 m. The FIDs of Common Goldeneye (640 m), Gadwall (550 m) and Red-breasted Merganser (> 500 m) were also relatively large. The FIDs of Great Crested Grebes ranged from 200-500 m. When grebes, ducks and mergansers formed mixed flocks, the FIDs of larger flocks were 1,000 m while those of smaller flocks were 500 m. In Black-headed Gulls and Common Gulls, taking flight was recorded at 280-300 m, whereas waders tended to take flight generally at about 100-200 m. This is evidence that the FIDs of birds confronted with kitesurfing on open water (open sea, lakes) are greater than those of birds inhabiting (semi-)terrestrial roosting sites or foraging in intertidal mudflats.

7.4 How does kitesurfing compare with other sources of disturbance?

The disturbance effect caused by a watercraft depends on its type. In this context it is possible to differentiate between human powered, motorized and wind-driven watercraft, and these can be classified as boats (e.g. canoe, kayak, rowing boat, motor boat, jet ski, speed boat, dinghy, sailing boat), ships (e.g. fishing vessel, research vessel, catamaran, ferry, freighter) and others (e.g. jet ski, windsurfer, kite surfer).

Initiation of escape is considered to result from a complex assessment of risk and aspects of a stimulus. Some aspects, such as speed, shape/visibility or noise, are predetermined by the type of the watercraft, thus permitting general statements on their potential disturbance effects. MATHEWS (1982) made a first attempt to classify the different water-based recreational activities and types of watercraft involved in them and arranged them according to their disturbance effects (in descending order of severity):

1) Activities with fast movements on the water surface *and* loud sounds (e.g. driving speed boats, jet skis and other motorized boats)
2) Activities with movements on the water surface but without sound emission (e.g. sailing, rowing, windsurfing)
3) Activities with limited movement on the water surface or low sound emission (e.g. swimming, wading)
4) Activities predominately restricted to the waterside (e.g. fishing, hiking, traffic)

This classification has been employed by many (e.g. KORSCHGEN & DAHLGREN 1992) and, although it is in its way still valid, today a more differentiated characterization based on, for example, the unpredictability of the route, is required. KRIJGSVELD et al. (2008) developed a catalogue and classification of disturbance effects caused by different recreational activities. First, they categorized activities according to the kind of space they occupy: air, water or land. Within these groupings, "fault" points were then given for characteristics of the activity

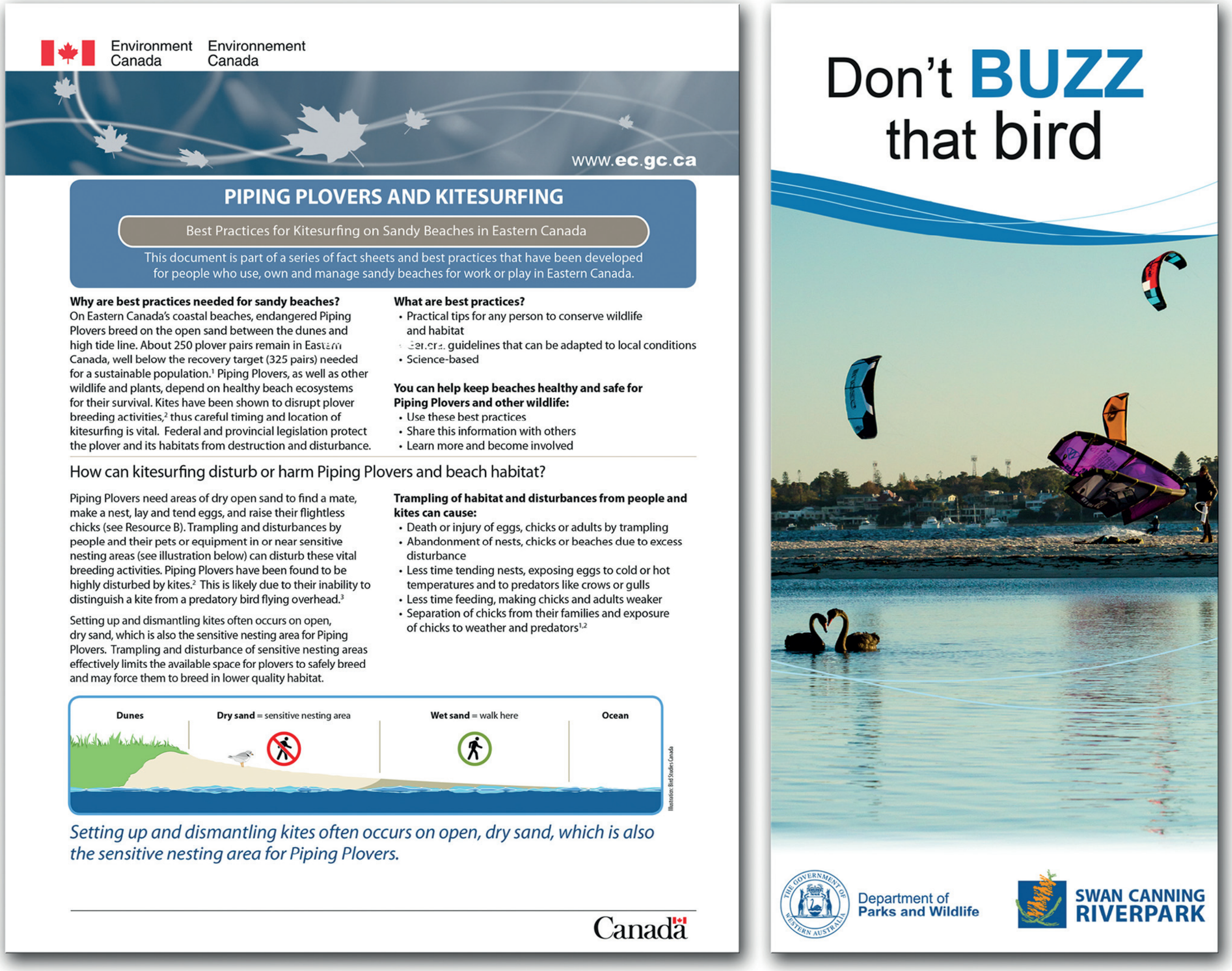


Figure 37: In areas without designated kitesurfing zones or regulated access/exit points, kitesurfing poses a threat to breeding waders such as Oystercatchers, *Charadrius*-plovers and terns. In Canada, best practice guidelines have been devised for Piping Plover (*Charadrius melodus*) habitats (left, ENVIRONMENT CANADA 2012) and Point Walter Spit in Australia produced a brochure with information and guidelines on how to minimize disturbances (right, DEPARTMENT OF PARKS AND WILDLIFE & BIRDLIFE WESTERN AUSTRALIA).

(noise, unpredictability, velocity, presence and visibility). The score increased with increasing disturbance effect on birds (for details see KRIJGSVELD et al. 2008; Table 2). Among watercraft dependent recreational activities, kitesurfing takes third place, after speedboating and jet skiing but one place ahead of windsurfing in terms of disturbance effects on (water) birds (KRIJGSVELD et al. 2008).

Comparisons of the disturbance effects of different watercraft can also be made by reference to the FIDs associated with them. KOEPFF & DIETRICH (1986), for example, studied the effects of windsurfing and kayaking on birds at Jade Bay in Germany. They found that five out of six waterbird species had significantly more pronounced reactions to windsurfing than to kayaking. In some cases the FIDs caused by

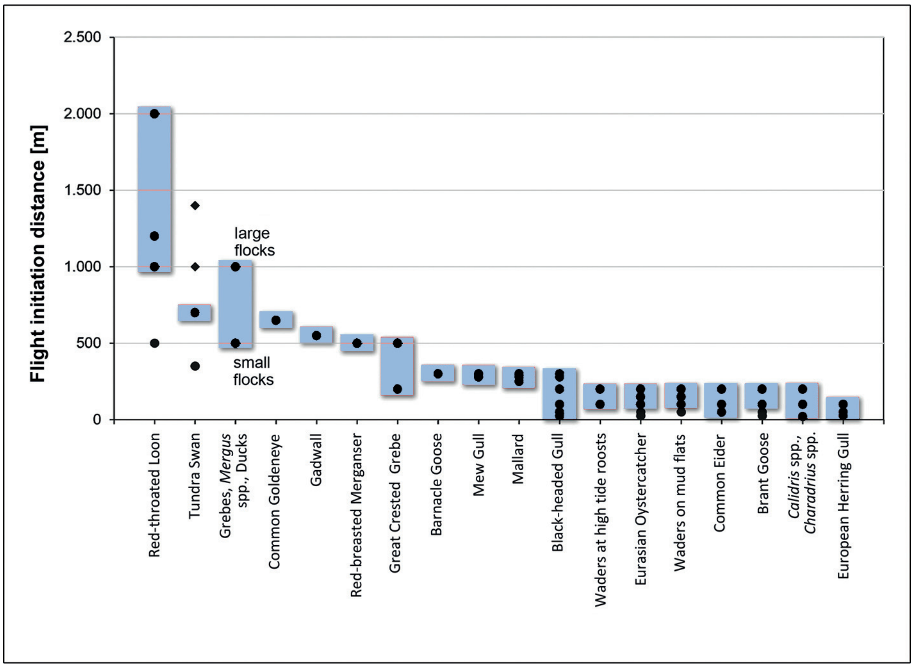


Figure 38: Overview of species-/family-specific flight initiation distances from kite surfers, collected in various habitats. According to the authors data symbols outside of blue boxes (range) signify outliers (Red-throated Loon) or alert distance (Tundra Swan) (Source: studies described in chapter 6).

windsurfers were twice as large as the ones caused by kayakers; thus windsurfers clearly represent a greater source of disturbance.

KELLER (1992) compiled published FIDs of waterbirds in relation to types of watercraft. In Denmark, MADSEN (1998) found generally stronger disturbance effects on birds through windsurfers than through fishing vessels, motorboats and sailing boats, a consecution confirmed by KAHLERT (1994) in his studies on breeding Red-breasted Mergansers. Studies on Common Terns *Sterna hirundo* (BURGER 1998) showed that personal watercraft such as jet skis and waverunners as sources of disturbance caused stronger reactions than motorboats. RAVENCROFT et al. (2007) confirmed this in looking at speedboats in the Stour-Orwell estuary in England.

Any comparison of the FIDs associated with kitesurfing (Fig. 38) with values from other studies (of other types) published in the literature (see appendix) has to be regarded with caution as these results were obtained in different ways with different observation effort. Thus, FIDs in response to walkers (overview: McLEOD et al. 2013) usually derive from controlled, standardized experiments (based on the method described by BLUMSTEIN 2003), where one (or more) people approach a single bird or a flock at a constant speed and the moment of taking flight, or the FID, can be measured with great precision (e.g. BLUMSTEIN 2003, 2006, MØLLER 2008, BREGNBALLE et al. 2009, GLOVER et al. 2011). Similar statements can be made for data concerning ships (e.g. BELLEBAUM et al. 2006, SCHWEMMER et al. 2011). Less reliably, figures supported by only small sample sizes usually trace back to chance observations, possibly resulting in FIDs (considerably) too low by virtue of an irregular approach. Even comparison of FIDs themselves can be challenging as some studies report minimum distances whereas others report maximum distances or a range. Some stud-

Table 2: The disturbance effect (right column) is the sum of points given for each of the following characteristics: sound emission (noise), unpredictability, velocity, duration of presence in an area and visibility. Higher values indicate stronger disturbance effects. Low total numbers do not mean activities are not causing potentially severe disturbances (from KRIJGSVELD et al. 2008; numbers written in italics = values had to be modified; this has no effect on the order within the group as presented by the authors).

Recreational activity	**Noise[1]**	**Unpredictability[2]**	**Velocity[3]**	**Presence[4]**	**Visibility[5]**	**Disturbance effect**
Air						
Helicopter	4	2	2	0	2	**10**
Sports aircraft	3	2	2	0	2	**9**
Paraglider*	2	3	1	1	2	**9**
Hot-air balloon	1	3	1	1	2	**8**
Zeppelin	1	2	1	1	2	**7**
Sailplane	0		1	0	2	**5**
Water						
Speedboat	3	3	1	1	1	**9**
Water scooter / Jet ski	3	3	1	1	1	**9**
Kite surfer	*1*	3	1	1	2	8
Windsurfer	*1*	3	1	1	1	7
Motorboat	2	0	1	1	1	**5**
Sailing boat	0	*1*	0	1	*2*	4
Rowing boat	0	1	0	1	1	**3**
Canoe	0	1	0	1	1	**3**
Land						
Dog	0	4	0	1	0	**5**
Birdwatcher	0	3	0	1	0	**4**
Car	1	0	1	1	0	**3**
Walker	0	1	0	1	0	**2**
Horse rider	0	1	0	1	0	**2**
Cyclist	0	0	0	1	0	**1**

[1] combination of sound emission and range
[2] values increase with unpredictability of routes and abrupt appearance of source of disturbance
[3] average velocity towards or past a fixed point
[4] combination of speed and "no fixed route"
[5] combination of size and height of the sources of disturbance and the openness of habitat (water)
* alludes to motorized paragliders, unmotorized paragliders are scored as a 6.

ies report means, with and without standard deviations, some with 90 %, others with 95 % or 98 % confidence intervals and yet others report FIDs as medians rather than means.

Taking these aspects into account, data on species-specific FIDs caused by kitesurfing and other (mostly water-based) recreational activities can be consolidated and plotted (Fig. 39). These graphs (Fig. 39) bring to view the severity of disturbances caused by kitesurfing as compared to other activities. Kitesurfing as a source of disturbance is only surpassed by the disturbances caused by motorized, fast-moving watercraft emitting noise (e.g. speed boats, jet skis). Ferries and similar fast moving, big ships or catamarans have similar impacts; however, they are not recreational activities.

The combination of the theoretical ranking of strengths of disturbances caused by watercraft established by KRIJGSVELD et al. (2008) and the data derived from studies summarized in this report (chapter 6) leads to the following grading: speed boats and jet skis > kite surfers > windsurfers > small boats, motor boats and sailing boats > rowing boats, canoes and kayaks.

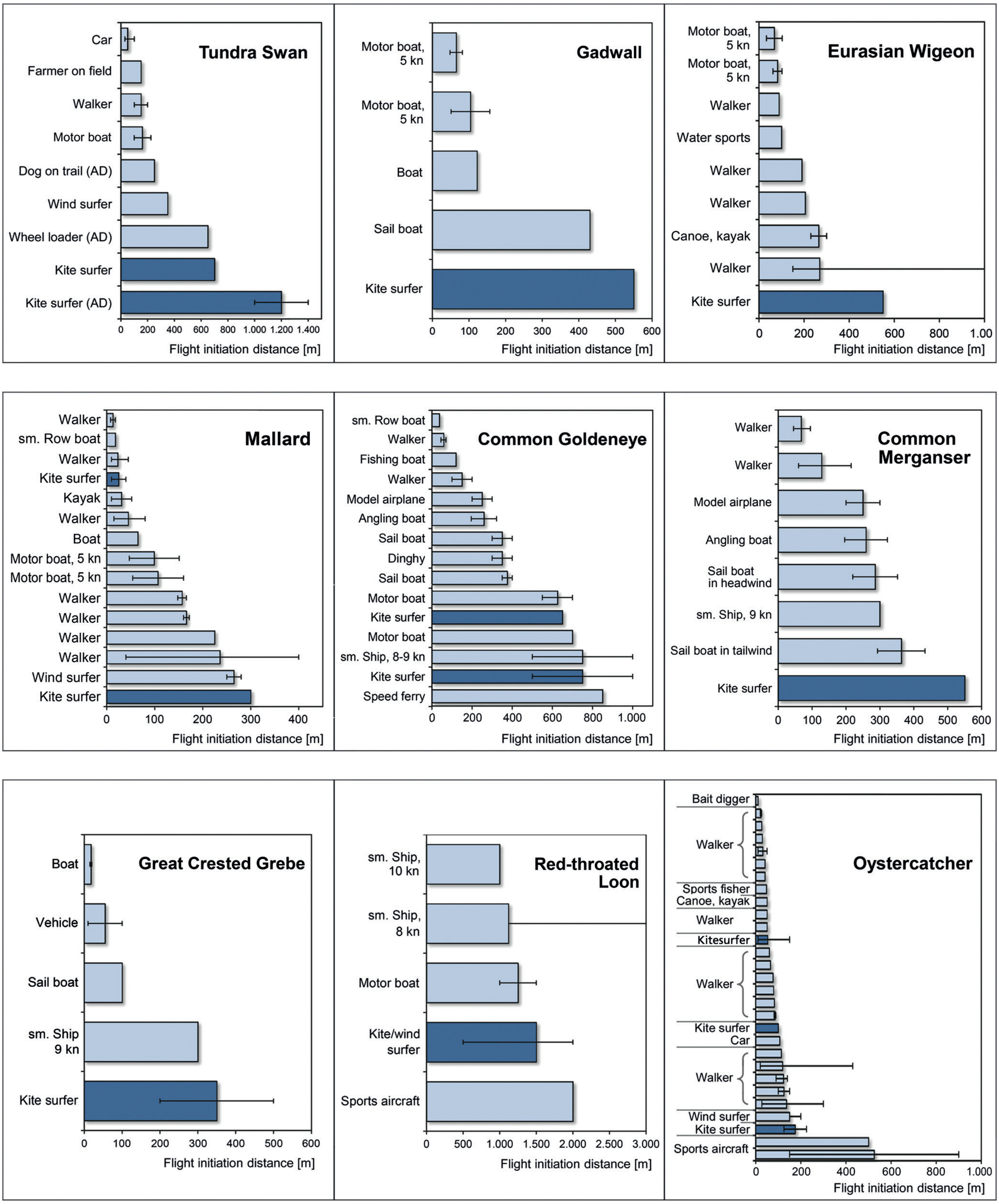


Figure 39: Published flight initiation distances (means) of non-breeding waterbirds and shorebirds in reaction to different anthropogenic sources of disturbances (AD = alert distance, see text and appendix for more details)

Species-specific FIDs aside, kitesurfing appears to elicit two distinct effects: birds encountering kite surfers on open waters (lakes, open sea) react more strongly than birds roosting on beaches or mudflats. This impression is supported by the greater FIDs of water birds compared to waders, and the greater FIDs of ducks and geese in open water as opposed to roosts. In this context SMIT & VISSER (1993) and DAVIDSON & ROTHWELL (1993) have in the past both theorized that sources of disturbance approaching from (or on) water result in stronger reactions in birds than those of terrestrial origin.

According to DEAR et al. (2014) Eurasian Coots, Western Swamphens (*Porphyrio porphyrio*) and Dusky Moorhens (*Gallinula tenebrosa*) exhibit increasing FIDs with increasing distance from the water's edge when responding to approaching predators (humans). This is plausible since for these species, open water represents a safe environment generally bypassed by humans. Conversely, have roosting waterbirds recognized that kite surfers on land pose no threat to them and so adjust their FIDs to distances shorter than those applied to kite surfers on water (working hypothesis)?

7.5 Buffer zones

Establishing sufficiently large protection zones around (open water habitats) and facing (shore areas and shallow water) valuable bird habitats at lakes or at coastal high tide roosts is the only way to secure undisturbed staging and feeding sites for waterbirds. An extra buffer zone between an important bird habitat (which are often protected) and an area of recreational activity is an essential tool in conservation management for minimizing or even eliminating human disturbances of waterbirds (e.g. ERWIN 1989, KELLER 1992, 2001, RODGERS & SMITH 1995, 1997, RODGERS & SCHWIKERT 2002, DÖPFNER & BAUER 2008).

In order to allow "normal behaviour" in the birds, the width of a buffer zone must be at least the distance at which human activities no longer cause any behavioural changes. To determine from what distance birds show no changes in heart rate or behaviour requires elaborate investigations. More often than not, these are impracticable (KELLER 1992).

Technically the most appropriate parameter to use in designing buffer zones is the alarm distance (AD), (FERNÁNDEZ-JURICIC et al. 2001, 2005, RUDDOCK & WHITFIELD 2007). At this distance, there are already significant behavioural responses to stimuli – for example in foraging or feeding, in roosting, performing comfort behaviours, displaying or breeding – by interrupting or putting an end to them. Thus, encroaching on the AD has a fundamental effect on birds. At the same time, AD is determinable by behavioural observation without the need for elaborate experimental setups or instruments (which are necessary to determine physiological initiation distances).

However, disturbance events are often too far from the observers or influenced too much by extraneous disturbance stimuli to allow confidence in recognizing and assessing alert behaviour (AVOCET RESEARCH ASSOCIATES 2009). KOCH & PATON (2014), for example, in a study on foraging waders described serious difficulties in differentiating between natural respites and true alert behaviour. Additionally, how correctly vigilance behaviour is identified also depends on how experienced observers are (GUAY et al. 2013), and birds in nests can be totally concealed from researchers determining the AD (e.g. GONZÁLEZ et al. 2006).

If the only data available for particular species or groups of species are FIDs (preferably from the area in question), these must in all cases be enlarged (KELLER 1992, BENTRUP 2008; Fig. 40). FERNÁNDEZ-JURICIC et al. (2001) showed that in four bird species in parks (House Sparrow *Passer domesticus*, Common Blackbird *Turdus merula*, Common Wood Pigeon *Columba palumbus* and Eurasian Magpie *Pica pica*) ADs were on average 1.5 times greater than prior estimates of FIDs in the same parks. However, this ratio can only be generalized or transferred to other species (or groups of species) to a limited extent. TAKEKAWA et al. (2008) determined the ratio between AD and FID (here: swim away / take flight) in Greater Scaups and Surf Scoters (*Melanitta perspicillata*) in response to an approaching ferry at 1.1 / 1.6 and 1.9 / 6.9 respectively. In Tundra Swans the ADs recorded by JANSEN (2008, 2011) were respectively 1.7 times or twice the FID (chapter 6.3).

On the assumption that the core zone of a protected area is only shielded effectively from disturbance if for any bird at any point within it the nearest edge is always beyond its FID, FOX & MADSEN (1997) established that protected areas need to be at least three times as wide as the FID of the most sensitive species occurring. Since FIDs are subject to a wide scattering even within species (chapter 4), this variability should also be taken into account when establishing buffer zones (LAURSEN et al. 2005) as the data reported may be based on observations of more tolerant individuals.

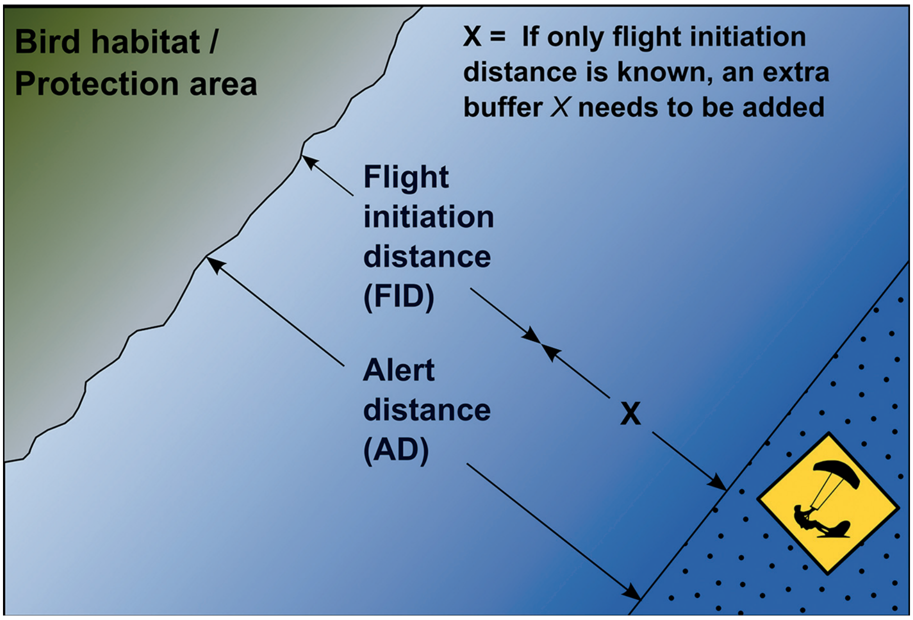


Figure 40: To dimension buffers between kitesurfing zones and valuable habitats for waterbirds the AD of the most sensitive species (or group of species) in the area has to be taken as a basis. If its AD is not known but the FID is, then this + an extra buffer "X" should be taken (see text for more details).

According to LAURSEN et al. (2005), presupposing a statistically normal distribution of the available FID data, by adding to the mean FID twice the standard deviation, sufficient allowance can be made for the variability to achieve a 98 % protection of all flocks. RODGERS & SCHWIKERT (2002) considered that suitable species-specific minimum buffers zones could be determined according to the following formula: upper limit of the 95 % confidence interval of the mean FID + one standard deviation + a further constant of 40 m to minimize the arousal of vigilance behaviour. Instead of adding 40 m, KOCH & PATON (2014) doubled the sum of "the 95 % confidence interval of the mean FID + one standard deviation". However, data like this including standard deviation – which is in any case materially affected by sample size – are not available from all areas.

Whatever the method used, the guiding principal must be to keep extra buffer zones (*"X"* in Fig. 40) at a size that forestalls any possibility of serious disturbance effects or allowing an approach to within a distance (at least AD) which initiates PID (precautionary principle, Fig. 40). The dimensioning of these extra zones needs to be based on the behavioural responses observed in the most sensitive species occurring in the area under review (RODGERS & SCHWIKERT 2002). This ensures that effects are minimized for all other species as well. Local factors such as mean flock sizes, visibility of sources of disturbance (can be restricted by geomorphology or vegetation) and seasonal aspects also need to be taken into account (BREGNBALLE et al. 2009, KOCH & PATON 2014).

Therefore, with kitesurfing zones on the coastline – although at first glance buffer zones of 500 m at roosting and feedings sites may appear sufficient to prevent any disturbance effects for most species (Fig. 38) – it has to be remembered that along with waders and gulls these almost always harbour bird species of the open water as well (especially geese and ducks), at least some of which have visibly much larger FIDs (Fig. 38, 39). VERBEEK & KRIJGSVELD (2013) suggested 700 m as an adequate buffer size between valuable bird habitats and kitesurfing zones at the coast, but with the reservation that at this distance for some species feeding and resting sites are lost.

Bearing in mind the behaviour of other species occurring especially on the seaward side of the Wadden Sea Islands, such as Red-throated Loons and Common Scoter, and other duck species often present at high tide roosts, buffer zones of 700 m cannot be advocated for all locations. For in VERDAAT (2006) Red-throated Loons took flight mostly at a distance of 1,000-2,000 m when they were confronted with kite surfers. No data is available for Common Scoters' response to kitesurfing, but their FID in response to other sources of disturbance is similar to that of Red-throated Loons (cf. appendix). Duck species in large multi-species flocks at Grevelingenmeer took flight when kite surfers approached to a distance of 1,000 m (VAN RIJN et al. 2006).

8 Conclusions

The results of studies on the disturbance effects of kitesurfing presented here indicate clearly the need to protect valuable waterbird habitats. The data show that unregulated kitesurfing activity will eventually severely and negatively affect the state of bird habitats and the species and communities occurring in them. Accordingly, in many places kitesurfing has already been prohibited completely or restricted to definite zones far enough removed from valuable bird habitats, where the sport is governed by further regulations. Technically speaking, this is an indispensable requirement of nature conservation, especially in coastal habitats (BURGER 1981, KOEPFF & DIETRICH 1986, PFISTER et al. 1992, KOFFIJBERG et al. 2003, BURGER et al. 2004, NAVEDO & HERRERA 2012).

According to the assembled data, in areas which are not only of special importance for waterbirds, but arising from this have also acquired legal protection status (national parks, EU-Special Protection Areas, etc.), kitesurfing should be prohibited. The results and conclusions of the studies are so unequivocal and unanimous that case-by-case assessments in nature reserves of potential disturbance effects caused by kitesurfing and of the dimension of the disturbances are in principal wholly superfluous. And in any case, protected areas are by no means recreational parks and as a rule, this becomes immediately clear with a glance at the legal requirements to which these areas are subject.

Where case-by-case assessments are necessary, however – in taking stock of the local spatial distribution of birds and the whereabouts of sites that may be of interest to kite surfers – is in areas such as

- large conservation areas with differentiated zones and locally different levels of pre-existing impact from other recreational activities
- valuable habitats without legal protection status, e.g. many Important Bird Areas (IBA) in Germany (SUDFELDT et al. 2002)
- many ("only") regionally important breeding and staging areas in Lower Saxony (KRÜGER et al. 2013).

The purpose of these assessments is to determine whether kitesurfing needs to be prohibited in the inter-

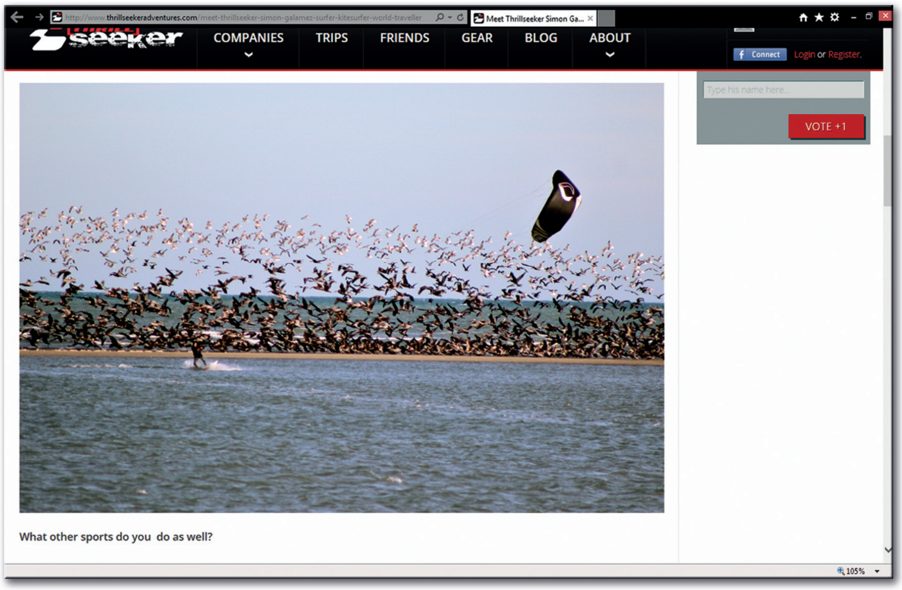


Figure 41: An example of lack of awareness of the problem: on their website thrillseekeradventures.com ("How do you want to get your thrills today") a profile which includes this photo presents a kite surfer as a figurehead for the company. It is highly probable that the roosting gulls and pelicans have been startled by the kite surfer.

ests of bird protection or whether it can be regarded as acceptable or even as unobjectionable with the establishment of a buffer zone.

There is furthermore no generally applicable procedure for dimensioning minimum distances (buffers) between the kitesurfing zones and valuable roosting or feeding sites (or other important habitats). The distances are determined by the local species inventory, the functions of the area for these species (breeding area, roosting area, wintering area) and the sensitivity of the species to kitesurfing (current knowledge, see Fig. 38).

Eventually, this will require further investigations into disturbance ecology, with preferably – outside protected areas – a more experimental approach: in order to obtain standardized results, disturbance stimuli have to be caused under experimental conditions permitting increased control over parameters such as target species, time, site, area, weather conditions, tide, etc.. As opposed to direct observations in uncontrolled situations, this approach would yield more precise results on effect distances of kitesurfing and would allow comparisons between data sets (WESTON et al. 2012).

But relatively little is known (in the different areas) about kitesurfing or about the kite surfers themselves. GILCHRIST (2008, cited in NEWING et al. 2011), using a technique derived from the social sciences, put together a catalogue of 28 questions (“Kitesurfing and the environment“) which went online on the British Kitesurfing Association (BKSA) webpage. Between September 2nd and October 15th 2008 kite surfers were able to answer these questions anonymously (cf. NEWING et al. 2011). VISTAD (2013) published interviews with 6 (kite) surfers operating in Lista (Norway) and described the location requirements, wind and waves favorable to kite surfers and tracked the preferred areas with GPS.

Questionnaires and interviews like these would improve our knowledge at other locations as well: the motivation of kite surfers, how intensively they pursue their hobby, memberships in associations or surf schools, spatial and temporal patterns of activity, and, most importantly, their awareness of their role as a source of disturbance in an ecosystem in relation to other recreational activities (BEAUCHAMP 2001, GLOVER et al. 2011, LE CORRE et al. 2013). This kind of information is of great importance for the discussion and also discloses issues on which nature conservation has to become even more familiar in the future if it is to win appreciation of and broad acceptance for its goals.

For occasionally, kite surfers lack an awareness of the negative effects and consequences kitesurfing can have on birds, even if they see that the birds react to their activities (cf. KLEIN 1993, LE CORRE et al. 2013). The kitesurfing community often reacts with incomprehension, outrage and opposition (“Kitesurfing is not a crime“) to bans on kitesurfing imposed for reasons of nature and species protection. Numerous blog entries in the worldwide web indicate clearly that kite surfers see their sport as a green, clean sport, which produces no exhaust gases, and that they feel very much in touch with the nature, wind and weather through their outdoor pursuits.

Birds taking to the air are seen rather as a symbol of freedom or as a spectacular part of the scenery, but not as the result of a disturbance possibly caused by kitesurfing (Fig. 41). The fact that birds need undisturbed areas for resting and roosting, that they don’t fly just for fun and that in terms of energy taking flight is costly (even very costly under certain circumstances) is not common knowledge. There are no grounds whatsoever to presuppose kite surfers ignorant or indifferent to the protection of birds. Rather, an urgent need for the exchange of a great deal of information has become apparent and talks have become a pressing matter.

9 Acknowledgements

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10 Summary

Krüger, T. (2016): On the effects of kitesurfing on waterbirds – a review. Inform.d. Naturschutz Niedersachs. 36: 3-64.

Kitesurfing is a relatively new recreational activity that emerged internationally at the end of the 1990s and was introduced at many European locations for the first time in the early 2000s. Very soon it became obvious that for birds kitesurfing could create a disturbance stimulus as severe as or even more severe than windsurfing. Yet to date there are but few studies on the effects and impacts of the new sport. This paper provides an overall view of the various studies and their results and aims to give a synoptic account of bird reactions to kitesurfing. Since kite surfers themselves tend to underestimate the impact of their sport, nature conservationists are in great need of reliable data.

The material gathered for the evaluation includes 17 studies from five countries (England, Germany, Netherlands, New Zealand, Switzerland), twelve of which describe the effects of kitesurfing on birds in coastal habitats, one study highlights the reactions of migrating birds over the open sea and four studies refer to large inland waters. Ten of the 17 studies were conducted explicitly in order to investigate the effects of disturbance caused by kitesurfing. The seven remaining studies referred to the whole range of human disturbance stimuli occurring at a study site, among which kitesurfing is only one of the sources. Almost all the studies are unpublished, so-called grey literature, while one study has been submitted to a journal for publication and was kindly made available in advance.

Not surprisingly, the material is very heterogeneous, especially since the methods for recording and measuring the

disturbance stimuli differ between studies. Thus, the task at hand was to extract the universal or at least generally applicable findings from the multitude of information gathered from the different studies. Additionally, the extreme data presented in the studies needed to be interpreted to evaluate the potential of conflicts between kitesurfing and water birds.

The findings of the studies regarding reactions of birds to kitesurfing and effects of disturbance on birds and bird habitats can be summarized as follows:

- Compared to other types of man-made disturbances, water sports and especially kitesurfing tended to present rather powerful disturbance stimuli. It tended to have a considerable impact on birds with a substantial proportion of birds either taking long flights or leaving a site altogether.
- On days with kitesurfing activities at a specific site almost always significantly fewer birds were present (in many cases none at all) than on days without kite surfers. This is indirect but clear evidence of a reaction to the disturbance stimuli caused by kitesurfing, which influences both the spatial and temporal distribution of birds.
- Systematic Before-After-Counts proved that at any particular site there were always significantly more birds present before than during or shortly after kitesurfing activities (if there were any birds left at all). This accords with the observed reactions to the disturbance stimuli of kitesurfing.
- This also applies to tidal feeding areas in mudflats, where bird numbers naturally dwindled with rising water level and had therefore often already disappeared before kitesurfing activities started; any remaining birds were then displaced by kitesurfing.
- Disturbance distances, species-specific and individual sensitivities etc. notwithstanding, kitesurfing always had the potential to drive away all roosting or feeding birds from an area.
- At some locations all it took to cause this effect was a single kite surfer surfing in areas intensively used for resting and feeding.
- Only a fraction of the birds (species and individuals) flying off in response to a disturbance stimulus returned to the roost or the feeding area after the kitesurfing activity had ended. Very often, even a day after the disturbance event, local bird numbers were not as high as they had been before.
- Reactions to disturbance stimuli were particularly strong when kite surfers were active outside the zones designated for kitesurfing.
- Depending on the species-specific ADs and FIDs of the birds present in adjacent areas, kitesurfing in designated zones had adverse effects on the spatial distribution of birds even beyond the borders of these zones.
- Effect distances, species-specific and individual sensitivities aside, kitesurfing disturbed not only resting or feeding birds, but also flying/migrating birds. They usually reacted by flying around or flying over the surfer. Sometimes shy species even significantly changed heading or the direction of migration.
- For foraging birds kitesurfing led to a reduction of both time available for foraging and space for feeding through its disturbance effect. In coastal habitats this effect was all the greater in that time and area for many species (e.g. shorebirds) is already limited naturally by the tide.
- When several other disturbance stimuli caused by other recreational activities occurred in an area in addition to kitesurfing, the effect of the disturbances was cumulative and usually considerable.
- However, in many areas the disturbance level caused by other recreational activities (windsurfing, boat traffic, walkers, etc.) was already so high that the reaction to disturbance stimuli caused by kitesurfing was less evident. In such cases effects were seldom (or not at all) measurable because there were no birds or only a few birds still present.
- Habituation towards kitesurfing was not found. This is explained by the quality of the disturbance source "kitesurfing" itself (quick movements, sudden changes of direction, no fixed routes, high speed) and also by the fact that especially staging birds are often only present for a short period of time (high turnover) at roosts and feeding sites.
- The data from the studies presented suggest that birds of open waters (open sea, lakes) react at greater FIDs in the face of kite surfers than birds occupying (semi-)terrestrial roosts or foraging in tidal mudflats.
- Studies like those conducted in Lower Saxony produced but little evidence of negative effects of kitesurfing on breeding birds of coastal habitats. This was due to either the high level of disturbance stimuli through other human activities in those habitats causing low densities of breeding birds, or a complete lack of sensitive breeding birds close to kitesurfing zones in the first place. These habitats hosted only a small number of less susceptible breeding birds. On the other hand this could be an indication that the buffer zones defined in the study areas between kitesurfing zones and breeding bird habitats were having the desired effect. However, in other countries it is generally accepted that kitesurfing activities (starting with accessing the beach or the shore, walking along the beach and across the mudflats to open water, kite already in the air on the beach and waiting for the tide etc.) have definite effects on the breeding birds of the beaches and dunes. This has led to temporary bans on kitesurfing at such sites or the publication of best practice guidelines or rules of conduct.
- With respect to the disturbance effect of kiteboarding as compared with other water-related recreational activities (watercraft only) the data show that the disturbing effect of kitesurfing is only surpassed by motorized, fast-moving boats producing loud noise.

The following grading emerges: speedboats and jet skis > kite surfer > windsurfer > small vessels, motorboats, and sailboats > rowing boats, canoes, and kayaks.

The results of the studies on the effects of disturbance of kitesurfing compiled in this work clearly demonstrate a requirement for the protection of important water bird habitats. The data provide strong evidence that the unregulated pursuit of kitesurfing will significantly affect the conservation status of any bird habitat, its species, and communities. For this reason, kitesurfing has been banned at many sites already or limited to distinct, sufficiently remote zones. At these surfing spots the pursuit of the sport is subject to regulations. From a conservation perspective, this is imperative, especially in coastal habitats.

Keywords: kitesurfing, disturbance stimuli, behavioural response, flight initiation distance (FID), buffer zones, kitesurfing zones

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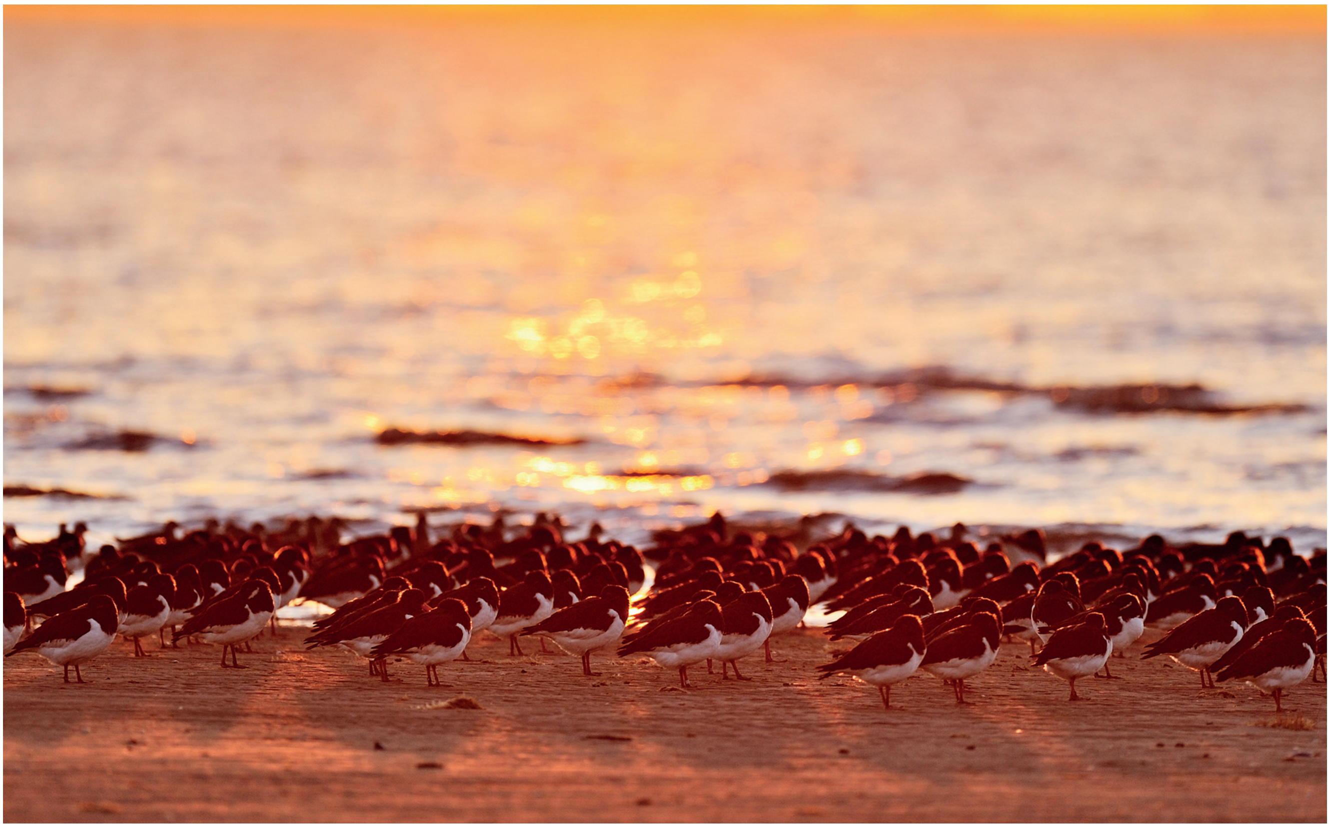

Figure 42: Undisturbed roosting and feeding sites are of fundamental importance for migratory birds like the Eurasian Oystercatcher.
(Photo: David Tipling / naturepl.com)

Appendix

Compilation of flight initiation distances of waterbirds (selection) in reaction to anthropogenic disturbance stimuli
Mean values in brackets = not given in source; calculated by means of min and max, AD = alert distance, SD = standard deviation, * = median, ** = standard error (SE); n = sample size, FID = flight initiation distance

Species	Flight initiation distance min	max	mean	SD	n	Source of disturbance	Notes	Source
Tundra Swan *Cygnus bewickii*	30	100	**50**			car		own data
			150		1	farmer in field	effect: retreating	MORITZ (2009)
	59	224	**160**			sm. motor boat, 5 kn	FID greater when foraging than when resting	MORI et al. (2001)
			250 AD		1	15 dogs (sleigh dogs)		MORITZ (2009)
			350			windsurfer	multiple times at 350 m	JANSEN (2009)
			600 AD		1	wheel loader, levelling works	reaction time 30 s	MORITZ (2009)
			700		1	kite surfer	birds could only see kite	JANSEN (2009)
			700			kite surfer		JANSEN (2009)
	1,000 AD	1,400 AD	**(1,200)** AD		2	kite surfer		JANSEN (2009)
Barnacle Goose *Branta leucopsis*	40		**(250)**			walkers	usually at 250-300 m	LEITO & RENNO (1983)
			300		>12	walkers		LAURSEN & RASMUSSEN (2002)
	500	3,000	**(1,750)**			helicopter	low altitude flight	LEIT & RENNO (1983)
Brant Goose *Branta bernicla*	20					walkers	in particular area (Leigh)	OWENS (1977)
			<50			train	no disturbance at 50 m	OWENS (1977)
	15	120	**69**		6	walkers		BLÜML et al. (2013) & in lit.
	58	152	**105**			walkers	mudflats in delta-area	SMIT & VISSER (1993)
	80	200	**126**		3	walkers with dog		BLÜML et al. (2013) & in lit.
	200				3	walkers	seagrass bed; 2nd approach FID 600 m, 3rd approach FID 800 m	OWENS (1977)
	150	500				walkers	150 m in area without hunting, 500 m in area with hunting	OWENS (1977)
	60	350	**185**	85	22	walkers	salt marsh; depending on flock size	OWENS (1977)
			300			windsurfer		KÜSTERS & VON RADEN (1986)
	130	1,000	**319**		31	walkers		LAURSEN et al. (2005)
		1,500				small airplane	at <500 m altitude	OWENS (1977)
Greylag Goose *Anser anser*			**230**	14**	7	walkers	single species flocks, autumn	BREGNBALLE et al. (2009)
			350		>12	walkers		LAURSEN & RASMUSSEN (2002)
			628			small airplane		LENSINK et al. (2007)
Common Shelduck *Tadorna tadorna*	30	40	**35**		2	walkers		BLÜML et al. (2013) & in lit.
			102			walkers		SPAANS et al. (1996)
	80	180	**130**	60	6	tourist vessel, fixed route		DIETRICH & KOEPFF (1986)
	99	197	**148**			walkers	mudflats in delta-area	SMIT & VISSER (1993)
			200			tourist vessel, fixed route	moulting birds	DIETRICH & KOEPFF (1986)
		500	**220**	84	5	canoe, kayak		KOEPFF & DIETRICH (1986)
	55	700	**225**		102	walkers		LAURSEN et al. (2005)
			230		>12	walkers		LAURSEN & RASMUSSEN (2002)
	200	300	**250**			walkers	mudflats in Wadden Sea	SMIT & VISSER (1993)
			275	135	5	windsurfer		KOEPFF & DIETRICH (1986)
	150	400	**(275)**			windsurfer		SCHIKORE et al. (2013)
		200				ship traffic	during moult	NIEHLS (1998)

Species	Flight initiation distance min	max	mean	SD	n	Source of disturbance	Notes	Source
Gadwall *Anas strepera*			**65**	17		motor boat, 5 kn	single species flocks	MORI et al. (2001)
			107	53		motor boat, 5 kn	mixed flocks	MORI et al. (2001)
			122		11	boats		GFN (2013)
			430			sailing boat		VOS (1986)
			550			kite surfer		JANSEN (2009, 2011)
Eurasian Wigeon *Anas penelope*		200	**40**		9	punt		MADSEN (1998)
			68	35		motor boat	single species flocks	MORI et al. (2001)
			82	20		motor boat	mixed flocks	MORI et al. (2001)
			89			walker		SPAANS et al. (1996)
	100					water sport		BATTEN (1977)
			190	9*	32	walker		BREGNBALLE et al. (2009)
			205	9*	26	walker	single species flocks, autumn	BREGNBALLE et al. (2009)
		400	**210**		8	fishing vessel		MADSEN (1998)
	230	300	**(265)**		3	canoe, kayak		KOEPFF & DIETRICH (1986)
	150	1,000	**269**	42		walker		LAURSEN et al. (2005)
		600	**530**		4	windsurfer		MADSEN (1998)
			550			kite surfer	similar to A. strepera	JANSEN (2011)
Eurasian Teal *Anas crecca*			**90**		2	boats		GFN (2013)
			156	11**	25	walker	single species flocks, autumn	BREGNBALLE et al. (2009)
			166	5**	88	walker		BREGNBALLE et al. (2009)
			190		>12	walker		LAURSEN & RASMUSSEN (2002)
	80	450	**197**			walker		LAURSEN et al. (2005)
Mallard *Anas platyrhynchos*			**13**	5	3	walker		WESTON et al. (2012)
			18			sm. rowing boat		AVOCETT RES. ASSOCIATES (2009)
	10	55	**(23)**		26	walker	late winter	SELL (1991)
	10	52	**31**	5**	20	kayak	urban park/lake	AVOCET RES ASS (2005)
	15	80	**(45)**		14	walker	autumn	SELL (1991)
			65		5	boats		GFN (2013)
			99	53		motor boat, 5 kn	single species flocks	MORI et al. (2001)
			107	52		motor boat, 5 kn	mixed flocks	MORI et al. (2001)
			157	9**		walker	single species flocks, spring	BREGNBALLE et al. (2009)
			166	6**		walker	single species flocks, autumn	BREGNBALLE et al. (2009)
			225		>12	walker		LAURSEN & RASMUSSEN (2002)
	60	400	**236**			walker		LAURSEN et al. (2005)
	250	280	**(265)**			windsurfer		SCHIKORE et al. (2013)
			300		1	kite surfer	AD, FID at 280 m	SCHIKORE et al. (2013)
Northern Pintail *Anas acuta*			**116**			walker		SPAANS et al. (1996)
	100	500	**294**	31		walker		LAURSEN et al. (2005)
			550			kite surfer	similar to A. strepera	JANSEN (2011)
Northern Shoveler *Anas clypeata*	100					water sport		BATTEN (1977)
			107	38		motor boat, 5 kn	multi-species flocks	MORI et al. (2001)
			112	4		walker	on trails	TRULIO et al. (2013)
			115	64		motor boat, 5 kn	single species flocks	MORI et al. (2001)
			137	5		walker	no trails	TRULIO et al. (2013)
			350			sailing boat		VOS (1986)
			430			sailing boat		VOS (1986)
			550			kite surfer	similar to A. strepera	JANSEN (2011)
diving ducks (*Aythya*-species., Common Goldeneye, *Mergus*-species, *Melanitta*-species)			**746 939**			boat	FID in spring: 746 m, in autumn: 939 m	KNAPTON et al. (2000)

Species	Flight initiation distance			SD	n	Source of disturbance	Notes	Source
	min	max	mean					
Common Pochard *Aythya ferina*	20	5	**(35)**		53	walker	late winter	SELL (1991)
	25	100	**(58)**		54	walker	autumn	SELL (1991)
			89	35		motor boat, 5 kn	single species flocks	MORI et al. (2001)
			105	52		motor boat, 5 kn	mixed flocks	MORI et al. (2001)
			150			motor boat		VOS (1986)
			200	1		rowing boat		BATTEN (1977)
			206	1	79	shore angler		PUTZER (1985)
	200	300	**(250)**			model airplane		PUTZER (1989)
			259	63	85	boat angler		PUTZER (1985)
			286	66	38	sailing boat in headwind		PUTZER (1983)
			300			sm. boat, 9 kn		PLATTEEUW & BEEKMAN (1994)
	230	450	**(340)**		5	sailing dinghy	flock sizes 100-300	BATTEN (1977)
			363	70	53	sailing boat in tailwind		PUTZER (1983)
			400	1	?	boat race		MEILE (1991)
Tufted Duck *Aythya fuligula*	25	55	**(33)**		18	walker	recreational area; median at 30 m	SELL (1991)
			50		1	boat		GFN (2013)
			139	73		motor boat, 5 kn	mixed flocks	MORI et al. (2001)
			148	62		motor boat, 5 kn	single species flocks	MORI et al. (2001)
			200	1		rowing boat		BATTEN (1977)
			206	1	79	shore angler		PUTZER (1985)
	200	300	**(250)**			model airplane		PUTZER (1989)
			259	63	85	boat angler		PUTZER (1985)
			286	66	38	sailing boat in headwind		PUTZER (1983)
	230	450	**(340)**		5	sailing dinghy	flock sizes 100-300	BATTEN (1977)
			363	70	53	sailing boat in tailwind		PUTZER (1983)
	400				?	boat race		MEILE (1991)
Greater Scaup *Aythya marila*			**400**			sm. boat, 9 kn		PLATTEEUW & BEEKMAN (1994)
			99			sm. rowing boat	FID dependent on flock size, largest FID shown	AVOCETT RES. ASSOCIATES (2009)
			225			ferry, fixed route	AD at 330 m	TAKEKAWA et al. (2008)
			>500			sm. boat, 9 kn		PLATTEEUW & BEEKMAN (1994)
Common Eider *Somateria mollissima*			**80**		1	canoes		BLÜML et al. (2013) & in lit.
			120		52	fishing vessels, ferry (regular)		LUGERT (1988)
			130	60		tourist vessel		KOEPFF & DIETRICH (1986)
	100	200	**150**			windsurfer	surfers restricted to specific area, known disturbance stimuli	FRASER (1987)
	10	1100	**150***		132	sm. research vessel, 5-6 m, 10 kn	75 % < 450	SCHWEMMER et al. (2011)
	70	200	**157**		3	kite surfer		BLÜML et al. (2013) & in lit.
	10	1,200	**208***		154	sm. research vessel, 5-6 m, 10 kn	75 % < 450	SCHWEMMER et al. (2011)
	10	1,200	**450***		21	sm. research vessel, 5-6 m, 10 kn	95 % 200-500 m; outside navigation routes	SCHWEMMER et al. (2011)
			500		1	windsurfer	new/unusual disturbance event	FRASER (1987)
			850		16	fast ferry (sporadic)		LUGERT (1988)
			1,000		599	fast ferry, catamaran, 36 kn	>1,000 m no escape	LARSEN & LAUBERT (2005)
		1,000				ship traffic	during moult	NEHLS (1998)
Common Scoter *Melanitta nigra*	10	3,250	**804***		210	sm. research vessel, 5-6 m, 10 kn	75 % < 1,250 m	SCHWEMMER et al. (2011)
			1,000		144	fast ferry, catamaran, 36 kn	no flight > 1,000 m	LARSEN & LAUBERT (2005)
	10	2,600	**1,000***		140	sm. research vessel, 5-6 m, 10 kn	75 % < 1,400 m	SCHWEMMER et al. (2011)
	270	1,460	**1,100***		4	sm. research vessel, 8-9 kn		BELLEBAUM et al. (2006)
	100	2,500	**1,350**	790	49	research vessel, 10 kn		KAISER (2003)
			1,500			ship		DIRKSEN et al. (2005)

Species	Flight initiation distance min	max	mean	SD	n	Source of disturbance	Notes	Source
Common Goldeneye *Bucephala clangula*			**37**			sm. rowing boat		AVOCETT RES. ASSOCIATES (2009)
	45	70	**(59)**		17	walker	recreational area; mean at 60 m	SELL (1991)
			120			fishing vessel		LUGERT (1988)
	100	200	**150**			walker		HUME (1976)
	200	300	**(250)**			model airplane		PUTZER (1989)
			259	63	85	fishing vessel		PUTZER (1985)
	300	400	**(350)**			sailing dinghy		BATTEN (1977)
	300	400	**(350)**			dinghy		EDINGTON (1980)
	350	400	**(375)**		>1	sailing boat		HUME (1976)
	550	700	**(625)**			power boat		BATTEN (1977)
	550	700	**625**	2		power boat		BATTEN (1977)
			650			kite surfer		JANSEN (2011)
			700		1	motor boat		HUME (1976)
	500	1,000	**(750)**			sm. vessel, 8-9 kn		PLATTEEUW & BEEKMAN (1994)
	500	1,000	**(750)**			kite surfer		VAN RIJN et al. (2006)
			850			fast ferry		LUGERT (1988)
Smew *Mergellus albellus*			**100**			sailing dinghy		BATTEN (1977)
			550			kite surfer	similar to *A. strepera*	JANSEN (2011)
Common Merganser *Mergus merganser*	45	95	**(68)**		21	walker		SELL (1991)
	40	215	**(128)**			walker		BELLEBAUM et al. (2006)
	200	300	**(250)**			model airplane		PUTZER (1989)
			259	63	85	boat angler		PUTZER (1985)
			286	66	38	sailing boat in headwind		PUTZER (1983)
			>300			sm. vessel, 9 kn		PLATTEEUW & BEEKMAN (1994)
			363	70	38	sailing boat in tailwind		PUTZER (1983)
			550			kite surfer	similar to *A. strepera*	JANSEN (2011)
Red-breasted Merganser *Mergus serrator*			**28**			sm. rowing boat		AVOCETT RES. ASSOCIATES (2009)
	500	1000	**(750)**			kite surfer		VAN RIJN et al. (2006)
Great Crested Grebe *Podiceps cristatus*	15	20	**(18)**			boat		INGOLD et al. (1992)
	10	100	**55**			motor vehicle		PLATTEEUW (1995)
			70		1	bus		McLEOD et al. (2013)
			100			sailing boat		BATTEN (1977)
			300			sm. vessel, 9 kn		PLATTEEUW & BEEKMAN (1994)
	200	500	**(350)**			kite surfer		VAN RIJN et al. (2006)
Horned Grebe *Podiceps auritus*			**24**			sm. rowing boat		AVOCETT RES. ASSOCIATES (2009)
Black-necked Grebe *Podiceps nigricollis*	200	500	**(350)**			kite surfer		VAN RIJN et al. (2006)
Cormorant *Phalacrocorax carbo*			**18**		1	car		McLEOD et al. (2013)
			32	21	34	walker		BLUMSTEIN (2006)
			78	25	4	walker		McLEOD et al. (2013)
			100		2	boats		GFN (2013)
	40	200	**120**		2	kite surfer		BLÜML et al. (2013) & in lit.
	110		**140**	40	8	tourist vessel, fixed route		DIETRICH & KOEPFF (1986)
			163	53	17	sailing boat in tailwind		HÜBNER & PUTZER (1985)
			193	16**	10	walker	single species flocks, autumn	BREGNBALLE et al. (2009)
			200			model airplane		PUTZER (1989)
			203	57	43	fishing vessel		HÜBNER & PUTZER (1985)
			207	50	31	sailing boat in headwind		HÜBNER & PUTZER (1985)
			233	49	12	windsurfer		HÜBNER & PUTZER (1985)

Species	Flight initiation distance min	max	mean	SD	n	Source of disturbance	Notes	Source
Red-throated Loon *Gavia stellata*	100	2,000				sm. research vessel, transect trips, 10 kn	median = 400 m, 90 %-percentile = 1,000 m	BELLEBAUM et al. (2006)
		3,000	**1,120**			sm. research vessel, transect trips, 8 kn	38 % escaped at > 500 m	PERCIVAL (2009)
	1,000	1,500	**(1,250)**			motor boat		POOT et al. (2005)
	500	2,000	**1,500**			kite surfer and windsurfer	FID usually at 1,000-2,000 m, occasional birds at 500 m	VERDAAT (2006)
			2,000			sports aircraft		NIJLAND (1997)
Eurasian Coot *Fulica atra*			**15**	1	44	walker	AD	DEAR et al. (2014)
			19	16	10	walker		BLUMSTEIN (2006)
			23	0		walker		WESTON et al. (2012)
	40	150	**50**		5	punt		MADSEN (1998)
			50		?	sailing boat		BATTEN (1977)
			58	6**	8	walker	single species flocks, spring	BREGNBALLE et al. (2009)
			62	19	7	bus		McLEOD et al. (2013)
			68	11**	6	walker	single species flocks, autumn	BREGNBALLE et al. (2009)
			74	48	14	car		McLEOD et al. (2013)
			75	35	4	walker		McLEOD et al. (2013)
			97		1	cyclist		McLEOD et al. (2013)
			<100			sm. boat, 9 kn		PLATTEEUW & BEEKMAN (1994)
			100		2	boats		GFN (2013)
	100	200	**155**		4	fishing vessel		MADSEN (1998)
	400	500	**450**		2	windsurfer		MADSEN (1998)
Eurasian Oystercatcher *Haematopus ostralegus*			**10**			walker		SCOTT (1989) in DAVIDSON (1993)
	20	25	**23**			bait digger		SCOTT (1989) in DAVIDSON (1993)
			26	7	23	walker	one person affected 500 m^2	URFI et al. (1996)
			29	2	53	walker		FITZPATRICK & BOUCHEZ (1998)
	10	50	**31**		7	walker		BLÜML et al. (2013) & in lit.
			41		48	walker		BRETT (2012)
			41	11	33	walker		URFI et al. (1996)
			48	10	27	walker		URFI et al. (1996)
			50			angler		SCOTT (1989) in DAVIDSON (1993)
			50			canoe, kayak		KOEPFF & DIETRICH (1986)
	25	75	**(50)**			walker	sm. group on mudflats in Wadden Sea	WOLFF et al. (1982)
	10	150	**53**		8	kite surfer		BLÜML et al. (2013) & in lit.
			60	20		walker		TENSEN & VAN ZOEST (1982)
			65			walker		SPAANS et al. (1996)
			77			walker	mussel bed, 1,000 m away from waterline	GLIMMERVEEN & WENT (1984)
			79			walker	mudflats, 200-300 m away from waterline	GLIMMERVEEN & WENT (1984)
			82			walker		BLANKESTIJN et al. (1986)
	81	89	**85**			walker	mudflat in delta-area	VAN DER MEER (1985)
			100	1		kite surfer		BERGMANN (2010)
			106			car		BLANKESTIJN et al. (1986)
			113			walker	mudflat, 500-1,000 m from waterline	GLIMMERVEEN & WENT (1984)
	20	400	**119**		172	walker		LAURSEN et al. (2005)
	90	140	**123**			walker		STILLMAN & GOSS-CUSTARD (2002)
	100	150	**125**			walker		VAN DER MEER (1985)
		200	**150**			windsurfer		KOEPFF & DIETRICH (1986)
	150	200	**(175)**			kite surfer		SCHIKORE et al. (2013)
	150	250	**(200)**			walker	sm. group on mudflats in Wadden Sea	WOLFF et al. (1982)
			500			sports aircraft		BLANKESTIJN et al. (1986)
	150	900	**525**			sports aircraft		VAN DER MEER (1985)

Species	Flight initiation distance			SD	n	Source of disturbance	Notes	Source
	min	max	mean					
Grey Plover *Pluvialis squatarola*	11	48	**23**	9	41	sm. motor boat, 5 kn		RODGERS & SCHWIKERT (2002)
	9	68	**24**	10	46	jet ski, 20 kn		RODGERS & SCHWIKERT (2002)
			36	19	41	walker		BLUMSTEIN (2006)
	22	60	**39***			walker	juveniles: 95 % at 56 m	KOCH & PATON (2014)
			44	0	1	walker		GLOVER et al. (2011)
	25	134	**55***			walker	adults: 96 % at 85 m	KOCH & PATON (2014)
	50	150	**(100)**			walker	mudflats	WOLFF et al. (1982)
	50	200	**116**		4	boats	multi-species flocks	KOEPFF & DIETRICH (1986)
	106	142	**124**			walker	mudflats in delta-area	SMIT & VISSER (1993)
			125		>12	walker		LAURSEN & RASMUSSEN (2002)
	42	400	**132**		80	walker		LAURSEN et al. (2005)
			192	100	9	boats	single species flocks	KOEPFF & DIETRICH (1986)
Pied Avocet *Recurvirostra avosetta*	75	250	**113**		17	walker		LAURSEN et al. (2005)
	180	350	**(265)**			walker	mudflats in Wadden Sea	WOLFF et al. (1982)
		350				walker		KOEPFF & DIETRICH (1986)
		500				boats		KOEPFF & DIETRICH (1986)
Eurasian Curlew *Numenius arquata*	20	25	**23**			bait digger		SCOTT (1989) in DAVIDSON (1993)
			35			angler		SCOTT (1989) in DAVIDSON (1993)
			38	4	41	walker		FITZPATRICK & BOUCHEZ (1998)
			88		24	walker		BRETT (2012)
			94	22		walker		TENSEN & VAN ZOEST (1982)
			102			walker	mussel bed, 1,000 m away from waterline	GLIMMERVEEN & WENT (1984)
			140			walker	mudflats, 200-300 m away from waterline	GLIMMERVEEN & WENT (1984)
			157			walker		SPAANS et al. (1996)
			188			car		BLANKESTIJN et al. (1986)
			196			walker	mudflats, 500-1,000 m away from waterline	GLIMMERVEEN & WENT (1984)
	124	299	**211**			walker	mudflats in delta-area	SMIT & VISSER (1993)
			213			walker		BLANKESTIJN et al. (1986)
	200	250	**225**			walker		VAN DER MEER (1985)
			240			canoe, kayak		KOEPFF & DIETRICH (1986)
	100	500	**269**	136	31	boats		KOEPFF & DIETRICH (1986)
	250	300	**(275)**			windsurfer		SCHIKORE et al. (2013)
	58	650	**298**		110	walker		LAURSEN et al. (2005)
			300			boats	most susceptible shorebird	ZWARTS (1972)
	225	550	**339**			walker	mudflats	SMIT & VISSER (1993)
			350		>12	walker		LAURSEN & RASMUSSEN (2002)
			350	1		windsurfer		SCHIKORE et al. (2013)
	250	500	**(375)**			walker	mudflats	WOLFF et al. (1982)
			395			windsurfer		KOEPFF & DIETRICH (1986)
	150	900	**525**			sports aircraft		VAN DER MEER (1985)

Species	Flight initiation distance min	max	mean	SD	n	Source of disturbance	Notes	Source
Bar-tailed Godwit *Limosa lapponica*			**22**	15	196	walker		WESTON et al. (2012)
			39		23	walker		BRETT (2012)
			42	5	2	canoe		PATON et al. (2000) in WESTON et al. (2012)
			49	1	2	walker		PATON et al. (2000) in WESTON et al. (2012)
			54	8	2	boat		PATON et al. (2000) in WESTON et al. (2012)
	45	69	**60**	5	4	walker		GLOVER et al. (2011)
			72	30		walker		TENSEN & VAN ZOEST (1982)
			76			walker		SPAANS et al. (1996)
			101			walker	mudflats, 200-300 m away from waterline	GLIMMERVEEN & WENT (1984)
	88	127	**107**			walker	mudflats in delta-area	SMIT & VISSER (1993)
	100	150	**(125)**			walker		VAN DER MEER (1985)
			138			walker	mudflats, 500-1,000 m away from waterline	GLIMMERVEEN & WENT (1984)
	40	450	**156**		120	walker		LAURSEN et al. (2005)
	50	225	**(190)**			walker	most at 150-225 m	WOLFF et al. (1982)
			210			canoe, kayak		KOEPFF & DIETRICH (1986)
	150	225	**219**			walker	mudflats in Wadden Sea	SMIT & VISSER (1993)
		450	**226**	99	15	boats		KOEPFF & DIETRICH (1986)
			240			windsurfer		KOEPFF & DIETRICH (1986)
Common Redshank *Tringa totanus*	10	15	**(13)**			walker		SCOTT (1989) in DAVIDSON (1993)
	20	25	**(23)**			bait digger		SCOTT (1989) in DAVIDSON (1993)
			37	4	29	walker		FITZPATRICK & BOUCHEZ (1998)
			40			angler		SCOTT (1989) in DAVIDSON (1993)
			80			walker		SPAANS et al. (1996)
	50	150	**87**		3	kite surfer		BLÜML et al. (2013) & in lit.
			95	20		walker		TENSEN & VAN ZOEST (1982)
	40	450	**137**		73	walker		LAURSEN et al. (2005)
			200			canoe, kayak		KOEPFF & DIETRICH (1986)
	50	300	**200**			walker	mudflats in Wadden Sea	WOLFF et al. (1982)
			290			windsurfer		KOEPFF & DIETRICH (1986)
			300		24	boats	left the area at 200 m	KOEPFF & DIETRICH (1986)
Turnstone *Arenaria interpres*			**7**			walker		SCOTT (1989) in DAVIDSON (1993)
			14	6	51	walker		BLUMSTEIN (2006)
			15			bait digger		SCOTT (1989) in DAVIDSON (1993)
			15			road traffic		RODGERS & SCHWIKERT (2002)
		30	**16***			walker	juveniles: 95 % at 27 m	KOCH & PATON (2014)
	13	25	**20**			walker		BEALE & MONAGHAN (2004a)
	10	50	**30**		3	walker		BLÜML et al. (2013) & in lit.
	17	54	**30**	6	6	walker		GLOVER et al. (2011)
	9	135	**31***			walker	adults: 96 % at 52 m	KOCH & PATON (2014)
			42			walker		SPAANS et al. (1996)
	31	53	**47**			walker	mudflats in delta-area	SMIT & VISSER (1993)
	150	250	**(200)**			walker	mudflats in Wadden Sea	SMIT & VISSER (1993)
Red Knot *Calidris canutus*	8	48	**20***			walker	juveniles: 95 % at 38 m	KOCH & PATON (2014)
			21	9	8	walker		WESTON et al. (2012)
	14	110	**35***			walker	adults: 96 % at 50 m	KOCH & PATON (2014)
			220			canoe, kayak		KOEPFF & DIETRICH (1986)
	50	500	**249**	312	20	boats	short FID only when disturbance not visible	KOEPFF & DIETRICH (1986)
			280			windsurfer		KOEPFF & DIETRICH (1986)

Species	Flight initiation distance min	max	mean	SD	n	Source of disturbance	Notes	Source
Sanderling *Calidris alba*			**11**			walker	1-2 walkers	THOMAS et al. (2003)
			12		26	walker		BRETT (2012)
	5	50	**12**			walker	FID not related to flock size	ROBERTS & EVANS (1993)
			13			walker	1-2 runners	THOMAS et al. (2003)
	6	29	**13***			walker	juveniles: 95 % at 24 m	KOCH & PATON (2014)
			14	5	13	walker		RODGERS & SCHWIKERT (2002)
			15	6	39	car		RODGERS & SCHWIKERT (2002)
	12	75	**26***			walker	adults: 96 % at 39 m	KOCH & PATON (2014)
	22	39	**32**	4	5	walker		GLOVER et al. (2011)
Gulls *Larus sp.*	10	150				walker	reactions vary greatly	WOLFF et al. (1982)
	100	120		22		canoe kayak windsurfer		KOEPFF & DIETRICH (1986)
Black-headed Gull *Larus ridibundus*	20	50	**33**		9	walker		BLÜML et al. (2013) & in lit.
			52	8		walker		TENSEN & VAN ZOEST (1982)
	10	150	**57**	6	15	kite surfer		BLÜML et al. (2013) & in lit.
			60		2	boats		GFN (2013)
			64			walker		SPAANS et al. (1996)
	50	450	**116**			walker		LAURSEN et al. (2005)
	280	300	**(290)**			kite surfer		SCHIKORE et al. (2013)
Common Gull *Larus canus*	10	40	**24**		5	walker		BLÜML et al. (2013) & in lit.
			73			walker		SPAANS et al. (1996)
	280	300	**(290)**		1	kite surfer		SCHIKORE et al. (2013)
	70	350	**120**			walker		LAURSEN et al. (2005)
European Herring Gull *Larus argentatus*			**27**			walker		BLÜML et al. (2013) & in lit.
	30	60	**45**		2	kite surfer		BLÜML et al. (2013) & in lit.
			<50			kite surfer		ANDRETZKE et al. (2011)
			56			walker		SPAANS et al. (1996)
			60	12		walker		TENSEN & VAN ZOEST (1982)
			65		1	boat		GFN (2013)
Lesser-black backed Gull *Larus fuscus*			**<50**			kite surfer		ANDRETZKE et al. (2011)
Sandwich Tern *Sterna sandvicensis*			**200**	1		kite surfer		ANDRETZKE et al. (2011)
Common Tern *Sterna hirundo*			**21**	8	18	walker		WESTON et al. (2012)
	50	150	**100**			walker with dog		KRIJGSVELD et al. (2008)
Little Tern *Sternula albifrons*			**22**	8	18	walker		BLUMSTEIN (2006)
			100			walker with dog		KRIJGSVELD et al. (2008)

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