PLEASE DO NOT DISTURB!

The growing threat of seal disturbance in the United Kingdom:

Case studies from around the British coast

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Diving to safety: an alarmed seal risks serious injury

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Executive Summary

- The tourism sector contributes to an estimated 10.2% of global gross domestic product (GDP), as well as providing 10% of employment worldwide. This sector is continually expanding with the growing popularity of Ecotourism, including interest in the coastal environment, wildlife and recreational activities.
- Recreational water sports and ecotourism expansion have resulted in increasing numbers of interactions between wildlife and human (anthropogenic) activities, which have been observed to have potentially harmful consequences, such as disturbance to many species. This results in negative impacts on individual animals and populations in both the short and long term.
- Seals are vulnerable to disturbance as a result of their need to haul out on land for vital rest and to breed. If scared or disturbed by human activity, stressed seals may be flushed into the sea before they have replaced their oxygen supplies, heat and energy. This can affect their ability to successfully breed and seriously compromise their life expectancy.
- Seals have behavioural and physiological responses to human disturbance. They may become more alert and prematurely flush, stampede or tombstone into the sea resulting in site abandonment. At the same time each seal's heart, breathing rate and stress levels will have been increased.
- Case studies from around the UK have highlighted high levels of seal disturbance at sensitive haul-out sites that overlap with popular recreation and tourist destinations. These were located in Southwest England, Northwest Wales, Northeast England and Northeast Scotland.
- Causes of this disturbance include land, sea and air-based activities. For example, motorised vessels, jet-skis, kayaks, SUPs and wildlife watching tours from the sea; land-based anglers, wildlife photographers, walkers, dogs off leashes, as well as air-borne drones, light aircraft and helicopters.
- Many sites experienced disturbance incidents during the majority of observation or survey days. In Southwest England, stampedes at one site in a single survey occurred up to 10 times in just 70 minutes (1 every 7 minutes) as a result of disturbance. The maximum number of seals that stampeded into the sea in a single survey was 220. Northeast England recorded almost 700 disturbance incidents in just one month and in Northeast Scotland, two new-born pups were trampled and killed as a result of a stampede caused by human disturbance.
- The devastating impacts suffered by individual seals as a result of human disturbance cannot continue. It is essential to conserve this vital species that regulate environmental ecosystems, which local communities value, and businesses depend upon for their economic prosperity.
- Current levels of cumulative disturbance around highly sensitive seal sites cannot go uncontrolled, given that they are most likely already unsustainable and likely to escalate in the future.
- Funding for monitoring and management schemes are desperately needed to protect these globally rare and vulnerable marine mammals from human disturbance. The Seal Alliance have provided recommendations to help tackle the issue.

Recommendations

- **Provide funding for site-specific research on seal disturbance to gain scientifically robust data to assess issues in 'hot-spot' areas and inform effective mitigation and management.**

  These could include:

  - **Regular monitoring of sites of high disturbance levels to ensure compliance**
  - **Engagement and interpretation resources to raise public awareness of this issue**
  - **Clear signage in sensitive areas to educate public**
  - **Voluntary exclusion zones to prevent human activities encroaching on resting seals**
  - **Limitation advice on the number of vessels in an area at one time, along with guidelines on no-wake speeds, minimum distance of approach and duration of stay**

- **Create a national statutory code of conduct making marine wildlife disturbance a crime**
- **Require all highly sensitive seal haul out and pupping sites to be protected with local neighbourhood generated spatial zone management plans within ten years**
- **Implementation of a licensing system for commercial marine wildlife related and recreational activities to enable growth management**
- **Make it a requirement for all commercial recreational activity skippers and guides to become 'Wildlife Safe' accredited renewable annually**

Glossary

Anecdotal data	Records collected from observations that have not been made during an official survey
Anthropogenic	Caused or influenced by humans
'Best practice'	Following guidelines of responsible conduct and behaviour
Displacement	Causing seals to leave a site before naturally choosing to
Disturbance	A change in natural behaviour caused by human activity
Flushing	A seal caused to move from land into the sea prematurely
Habituation	The reduction of an instinct or natural response to a frequently repeated activity
Hauled	When a seal is on land
Haul-out	A location where a group of seals gather on land
Moulting	Annual shedding of old fur to make way for new growth
Physiological	Biological processes and body functions e.g. heart rate and oxygen storage
Pinniped	The taxonomic group to which seals, sea lions and walruses belong
Pupping	Giving birth to offspring and the period that mothers feed pups until weaned
Sensitisation	When the intensity of a response increases to repeated activity (this is the opposite to habituation)
Site Fidelity	When a seal is observed to return multiple times to the same location throughout its life
Stampeding	A sudden charge of multiple seals rushing towards the sea
Statutory	Relating to governance and law
Stimulus	An activity or event that causes a response
Systematic	Data collected through a regular and scientifically robust survey method
Tolerance	Actively choosing not to respond naturally to a negative stimulus or activity
Tombstoning	Falling or jumping from rocks at a substantial height
Vigilance	Being in a state of increased awareness and alertness

1. Introduction

The tourism sector has become a key driver of the global economy, contributing an estimated 10.2% of global gross domestic product (GDP), as well as providing 10% of employment worldwide. Recent years have seen a continual expansion of this sector and this is predicted to grow further in the future (WTTC, 2017). Ecotourism, including several types of wildlife-based experiences has become increasingly popular contributing to an estimated 40% of all tourist activities (GlobalData, 2017; Belicia & Islam, 2018). In the UK, wildlife watching has become a lucrative industry with growing demand from visitors (both resident and international) and an increase in the number of commercial operators concentrated on delivering wildlife encounters. In Scotland alone, nature-based tourism generates £1.4 billion annually with over 10% of that attributed to wildlife watching activities (Bryden *et al*., 2010). In the UK, visits to seaside and coastal regions are a large proportion of holiday trip destinations (England – 36.1%, Scotland – 21.6%, Wales – 50.9%) (GBTS, 2018), with many visitors drawn by the beautiful environment, wildlife and marine-based activities. This expanding interest in the coastal environment, wildlife and recreational activities has resulted in increasing numbers of interactions between wildlife and human (anthropogenic) activities. These interactions have been observed to have potentially harmful consequences, such as disturbance to many species, resulting in detrimental impacts on individual animals and populations on both a long and short-term basis (Moorhouse *et al*., 2015; Granquist & Nilsson, 2016; Trave *et al*., 2017).

Seal species (pinnipeds) are particularly vulnerable to anthropogenic disturbance (Kirkwood *et al*., 2003; Bearzi, 2017; Trave *et al*., 2017). The two species of seal that regularly use UK waters and terrestrial habitat, the grey seal (*Halichoerus grypus*) and the eastern Atlantic sub-species of harbour seal, also known as the common seal (*Phoca vitulina vitulina*), use mainland beaches, coves and caves as well as offshore islands and rocky outcrops to haul out to rest ,mate and moult (Leeney *et al*., 2010; SCOS, 2017). The UK is home to approximately 34% of the global population of grey seals and 5% of the world's harbour seal population, consisting of an estimated 45% of the eastern Atlantic subspecies population (JNCC, 2019). Both species are classed as a vulnerable migratory species and are protected under the international Bern Convention (1979) and other European and national legislation (Table 1).

Table 1. List of international, national and regional legislation pertaining to conservation of seals in the United Kingdom.

Legislation	Region of application	Details relating to seals
EU Habitats Directive 1992 (Annex II and V)	Europe	• Establishment and designation of Special Areas of Conservation (SACs) to protect vital habitat e.g. seal breeding sites • Grey and common seals classed as UK speciality species.
Conservation of Habitats and Species Regulations 2017	England and Wales	• Transposition of EU Habitats Directive into UK law.
Conservation (Natural Habitats &c.) Regulations 1994 and Habitats Regulations 2010	Scotland	• Transposition of EU Habitats Directive into UK law.
Conservation (Natural Habitats &c.) Regulations (Northern Ireland) 1995	Northern Ireland	• Transposition of EU Habitats Directive into UK law.
Conservation of Seals Act 1970 (COSA)	UK	• Prohibits the killing, harming or taking of pinnipeds during designated closed seasons
Wildlife and Countryside Act 1981	UK	• Mandates the implementation of Sites of Special Scientific Interest (SSSIs), where, if listed in the citation, declares any damage, disturbance or destruction to be a criminal offence
Marine (Scotland) Bill 2009	Scotland	• Specific Scottish law that amends or enhances UK laws for Scotland only
Marine (Scotland) Act 2010	Scotland	• From Marine Scotland Bill 2009 receiving Royal assent • Prohibits intentional and reckless harassment of seals at designated sites
Conservation of Seals Order (Scotland) 2007	Scotland	• Extending 'closed season' established in COSA 1970
Nature Conservation (Scotland) Act 2004	Scotland	• Increases protection measures in existing SSSIs

Specific protection measures relevant to the disturbance of seals state that it is a criminal offence to '*intentionally or recklessly damage, disturb or destroy wildlife*' within a protected site with that species listed within the citation (SSSI/SAC). Section 117 of the Marine (Scotland) Act 2010 also prohibits intentional and reckless harassment of seals at designated sites (Marine Scotland, 2014).

Seals haul out on land to breed and for essential rest periods to enable energy recuperation from foraging, digestion, oxygen supply replenishment and to regulate body temperature (Reidman, 1990). They have also been recorded to display site fidelity at haul-out locations, resulting in their presence being reliable and predictable, both temporally and spatially (Pomeroy *et al*., 2000; Dietz *et al*., 2012; Sayer *et al*., 2019). This makes them a huge asset to commercial wildlife tour operators, providing a relatively dependable marine mammal sighting for their customers. Seals can haul out for multiple hours dependent on tidal movements, individual energetic requirements and other environmental factors (Grellier *et al*., 1996; Leeney *et al*., 2010), which further increases their value to operators as they have the potential to be seen on multiple trips (Kirkwood *et al*., 2003; Curtin *et al*., 2009). However, these constant and repeated visits raise the probability of serious disturbance occurring if responsible behaviour and 'best practice' is not employed (Strong and Morris, 2010). Private recreational users (e.g. kayakers and snorkellers) and land-based activities (e.g. walkers and wildlife watchers) also seek out seal haul-outs and frequently do not have the relevant information, to conduct appropriate behaviour when viewing wildlife, subsequently causing disturbance. Understanding the impacts that anthropogenic disturbance may have on seal individual and population health is important to increase public awareness and reduce the number of incidents that can potentially occur.

2. Impacts of Disturbance

Anthropogenic disturbance has been identified to affect wild seals in a number of ways, resulting in various harmful consequences. Most studies on multiple species of pinnipeds have focused on behavioural responses to anthropogenic stimuli, measuring the occurrence and resulting effect of disturbance on an immediate and short-term basis (Suryan & Harvey, 1999, Cassini, 2001; Henry & Hammill, 2001; Boren *et al*., 2002; Engelhard *et al*., 2002; Kucey & Trites, 2006; Boren *et al*., 2008; Cowling *et al*., 2015). However, more recent studies have concentrated on the cumulative and longer-term consequences of recurring disturbance such as habituation, fitness implications and population effects (Karpovich *et al*., 2015; King *et al*., 2015; McHuron *et al*., 2017; Pirotta *et al*., 2018). These long-term effects will be explored further in section 2.1.

2.1. Behavioural

Behavioural responses to disturbance are commonly measured when seals are hauled out on land. This is when observations can be conducted more easily, and when seals are more vulnerable to disturbance. At such times, impacts can be more harmful physically, disrupt essential rest periods more dramatically and affect vital life processes such as pupping and moulting (Suryan & Harvey, 1999, Cassini, 2001; Henry & Hammill, 2001; Boren *et al*., 2002; Engelhard *et al*., 2002; Kucey & Trites, 2006; Boren *et al*., 2009; Cowling *et al*., 2015).

There are many different behavioural impacts that have been observed as a result of human disturbance that have been shown to be strongly influenced by many factors including: environmental conditions (e.g. sea state, wind direction and force), type of activity and

characteristics associated with them (e.g. motor size of vessel, group size of walkers), distance, type of approach and intensity of activity (e.g. visitor behaviour and sound levels), individual seal traits (species, age, sex, previous exposure to anthropogenic activity), location and site-specific features, and seasonal variations (breeding and moulting season). Responses of seals to disturbance can vary greatly and be short or long term (Kelly *et al*., 1988; Born *et al*., 1999; Boren *et al*., 2002; Andersen *et al*., 2012; Granquist & Sigurjonsdottir, 2014).

Increased vigilance and flushing

In terms of short-term behavioural changes, disturbance of seals is measured as a change from resting behaviour to increased vigilance or alertness associated with a predator response and stress. This includes recognised alert behaviour, such as raised heads or detection of the stimuli and movement towards the sea, as well as the flight response, causing the animal to flush into the sea to escape human presence (Frid & Dill, 2002; Holt, 2015; Cates & Acevedo-Gutiérrez, 2017). Associated physiological impacts resulting from increased vigilance is detailed in Section 2.2. When a seal is already in the sea and approached too quickly, directly or closely, the resulting vigilant behaviour is known as a crash dive, which is a sudden 'splash' dive underwater without preparation (Curtin *et al*., 2009). This can result in lack of preparation for diving, compromising appropriate oxygen storage, heart rate changes and other physiological alterations.

Figure 1. Grey seals showing behavioural responses as a result of disturbance from anthropogenic stimuli. Tombstoning and vigilant behaviour at an offshore island haul-out (left), multiple seals stampeding into the sea (right). Photos by Sue Sayer.

Habituation, tolerance and sensitisation

As a result of exposure to repeated or chronic disturbance (e.g. multiple and daily tourist vessel visits), individual seals can experience long-term behavioural alterations (Boren *et al*., 2002; Karpovich *et al*., 2015; Cates & Acevedo-Gutiérrez, 2017; Olson & Acevedo-Gutiérrez, 2017). Habituation is the diminishing of an innate response as a result of repeated exposure to a stimulus, meaning their natural behavioural responses decrease over time (Krausman *et al*., 2004). This is indicated by a reduction in alert, vigilant and flushing behaviour when human activity is present (Holcomb *et al*., 2009; Andersen *et al*., 2014). This lack of behavioural change can also be attributed to an increase in tolerance, which is when an individual animal actively chooses to respond 'unnaturally' as a trade-off to prioritise actions such as remaining with offspring. They choose to use their limited energy for a more important action, which could compromise long term survival (Bejder *et al*., 2009; Andersen *et al*., 2012; Pavez *et al*., 2015; Jansen *et al*., 2015). Both can commonly be interpreted as human presence having no perceptible effect on an animal. However, the distinction between habituation and tolerance can easily be misinterpreted and lead to inaccurate assumptions concerning the impact of disturbance on an individual animal (Bejder *et al*., 2009). The lack of

response to human activity could be perceived as an absence of potentially harmful impact, however the long-term negative consequences may have already occurred and can affect breeding success in the future. Sensitisation is a contrasting response and refers to an involuntary increase in intensity of reaction to repeated adverse stimuli (Bejder *et al*., 2009; Higham & Shelton, 2011), potentially resulting in displacement of individuals from important areas for breeding, resting and foraging (Twiss *et al*., 2012; Corral *et al*., 2018).

Figure 2. Adult male grey seal showing indications of increased tolerance to presence of anthropogenic stimulus (kayakers). Although alert and aware of stimulus, no flushing behaviour takes place even within close proximity. Photo by Malo Gardin.

Displacement and site abandonment

A direct result from sensitisation and lower tolerance levels, is a change in spatial dynamics over a long period of time. Individuals can become temporarily displaced from important and productive areas, optimal for foraging, resting and breeding (Bishop *et al*., 2015). There is also evidence of permanent abandonment of breeding sites as a result of high levels of human activity, which could have substantial impacts on reproductive success and population (Gill *et al*., 2001; Stevens & Boness, 2003; Fox, 2008; Acevedo-Gutiérrez & Cendejas-Zarelli, 2011; Jansen *et al*., 2015). These consequences not only affect seal species. Changes to apex predator distribution and populations have the potential to disrupt ecosystem functioning, biodiversity and environmental health of an area (Forbes *et al*., 2001; Kucey & Trites; Cates & Gutiérrez, 2017).

2.2. Physiological

Behavioural responses in research have been used to indicate potential impacts on an animal's energy expenditure. However, these observations cannot accurately measure the physiological alterations that occur as a result of anthropogenic disturbance (Beale & Monaghan, 2004; Dyck & Baydack, 2004; Harding *et al*., 2005; Karpovich *et al*., 2015; McHuron *et al*., 2017). When displaying vigilant or anti-predatory behaviour (similar responses observed as a result of human disturbance), a seal's natural physiological response is the rapid mobilization of energy in preparation to respond to a threat, also known as the 'fight or flight' response (McMahon *et al*., 2005; Erbe, 2012; Karpovich *et al*., 2015). During this, physiological processes not required for immediate survival are suppressed, utilising energy stores that may be required for longer term processes such as breeding (Buchanan, 2000). Stampeding and flushing of seals into the water also disrupts essential resting periods, resulting in a need to 'repay' energetic debts during subsequent haul-out periods to ensure sufficient energy stores are available for vital foraging activity, breeding success and survival.

However, in the event of chronic disturbance, this recovery is disrupted repeatedly, having the potential to causes long-term harm to individual animals (Karpovich *et al*., 2015) and their subsequent offspring. There is limited research into the true extent of physiological impacts of disturbance on seals and more is urgently needed to assess species-specific responses to mitigate harm.

3. Disturbance case studies around the UK

Previous research has highlighted the need to monitor and assess seal disturbance on a site-specific basis (Strong & Morris, 2010; Granquist & Sigurjonsdottir, 2014). Disturbance has been recorded in a large number of areas around the UK's coastline and has been recognised as an issue by multiple non-governmental organisations (NGOs), local experts and researchers. To explore this further, four case studies from around the UK have been compiled to provide more detailed analysis of site-specific factors regarding seal disturbance as a result of human activity (Figure 3). These sites have been routinely monitored by NGOs, providing a thorough study of disturbance levels in recent years.

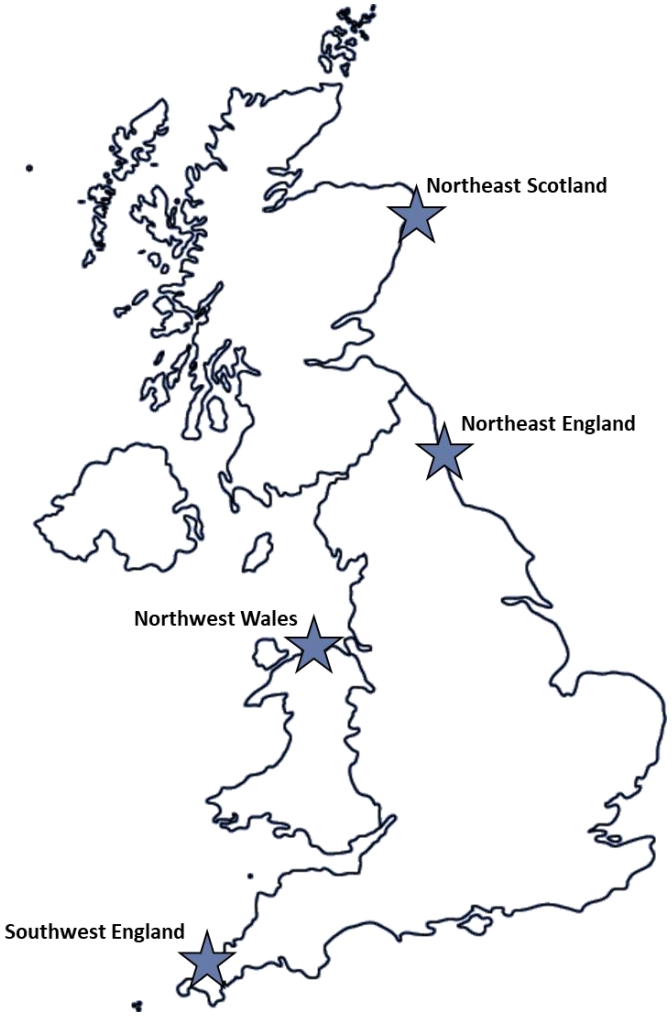

Figure 3. Map of United Kingdom with locations of seal disturbance case study areas: Southwest England; Northwest Wales; Northeast England; Northeast Scotland.

3.1. Southwest England (Cornwall Seal Group Research Trust)

Site Information

Two different haul-out sites for seals within a very popular tourist destination in Cornwall for locals and tourists: West Cornwall mainland and West Cornwall offshore. Sites can be used at most tidal states but with only minimal use one to two hours around high tide.

1. West Cornwall mainland: Intertidal beach site below 45m cliffs on SW coast path. Within 100m of summer car park and 400m of winter car park. Land owned and managed by National Trust. No public access to the beach (access exemption from Countryside and Rights of Way Act 2000), but viewable from clifftop. Designated as Site of Special Scientific Interest (SSSI) with grey seals listed as a feature in the citation (criminal offence to damage, destroy or disturb seals). Very popular tourist destination in Cornwall for locals and tourists.
2. West Cornwall offshore: Offshore Island 400m off headland. Rocky intertidal substrate used by seals to haul out during low tide. Lighthouse owned and managed by Trinity House and only accessible by boat or helicopter. No landing without permission from Trinity House.

Seal Activity

Species – Atlantic grey seals and occasional sightings of common seals

1. West Cornwall mainland:
   - Used by seals throughout the year to haul out with pupping and mating observed during breeding season.
   - October – April: Peak numbers of seals present during breeding and moulting season with a maximum of 500 seals recorded on a single day.
   - August – December (mostly September to November in recent years): New-born pups observed but not an official pupping beach.
   - May – September: Lower numbers of hauled out seals but site still used. This is a new use of the site only recorded since 2014.

2. West Cornwall offshore:
   - Seals observed to haul out throughout the year but mostly present in the spring and summer.
   - May – October: Maximum of approximately 56 seals recorded to haul out on island on a single day.

Human Activity

1. West Cornwall mainland

Land based:
Regular and constant walkers on the clifftop coast path above the haul-out site during all daylight hours with maximum of 62 people recorded to be observing seals at one time. This area is a very popular tourist destination all year round, with thousands of visitors per day during peak season (spring/summer/school holidays).

Sea based:
Infrequent private recreational vessels and activity (e.g. kayaks, paddleboards and snorkellers) and passing motorised vessels.

Air based:
Regular (up to 3/hr) low flying aircraft (helicopters and small planes) are observed to pass over haul-out site on most days. Occasional but increasing drone activity also recorded although this is prohibited on all National Trust owned land without a licence.

2. West Cornwall offshore

Sea based:
Regular visits from multiple commercial tripper boats from St Ives (between 1-20 visits per day) from April to October. Regular (1-2 visits per day) from private recreational vessels and activity (e.g. kayaks, paddleboards and snorkellers) launching from nearby beach. Infrequent activity from outdoor activity providers (kayak tours and jet skis). Maximum of 13 sea craft (tripper boat, jet skis, kayaks, SUPs) observed on a single survey.

Air based:
Regular (up to 3/hr) low flying aircraft (helicopters and small planes) are observed to pass over island. When Trinity House is conducting routine maintenance work on the island, multiple helicopter landings are made daily sometimes for several weeks. Infrequent drone activity also observed.

Interactions, disturbance and observed impacts

Disturbance of hauled out seals has been recorded as a response to smell, sound and sight of multiple and cumulative anthropogenic sources.

1. West Cornwall mainland

Frequent disturbance results from clifftop onlookers or their dogs being heard and seen by seals, but occasionally people descend the cliff path and access beach including those carrying out seal rescues. Regular stampedes cause by airborne helicopters and fixed wing aircraft including jets. Occasional kayak and recreational boat disturbance from those approaching too close. Stampedes are recorded to have occurred up to 10 times in just 70 minutes (1 every 7 minutes) as a result of disturbance from land, sea and air sources, as well as the occasional natural source (e.g. seals disturbing themselves, seals being disturbed by birds and rockfalls). The maximum number of seals stampeded into the sea observed during a single survey was 220.

At mid to high tide stampedes occur over shingle, but at low tide a 50m boulder beach is exposed, increasing the risk of greater injury. Individual seals have been observed to cut bellies, rip out claws, have ‘road rash’ grazes, poo themselves and even tombstone in panic off boulders up to 10m high risking serious injury or death. Pregnant females have also been seen stampeding over the boulder beach at low tide, causing concern for reproductive success and injury to unborn pups.

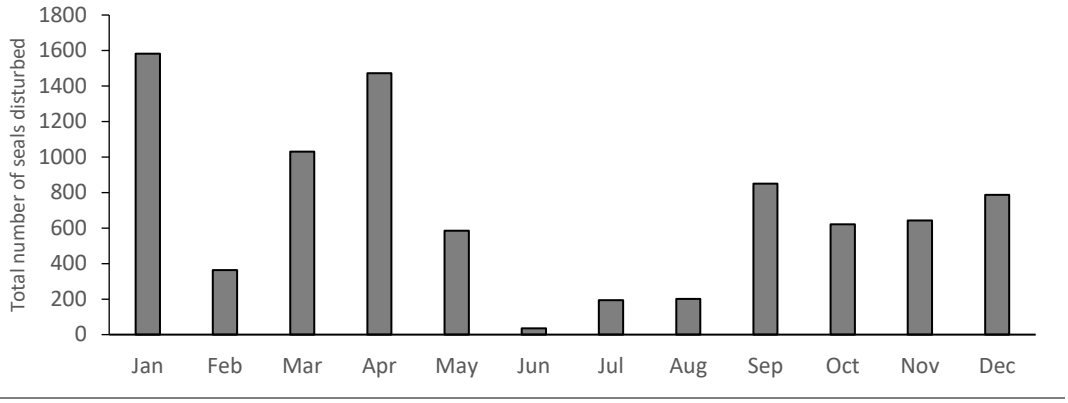

Figure 4. Monthly total number of seals flushed into the sea as a result of anthropogenic disturbance at West Cornwall mainland West Cornwall between 2011-2018. Site was systematically surveyed twice a week. Data provided by CSGRT.

The number of seals disturbed into the sea, caused by human activity has almost doubled over the last seven years (Figure 5).

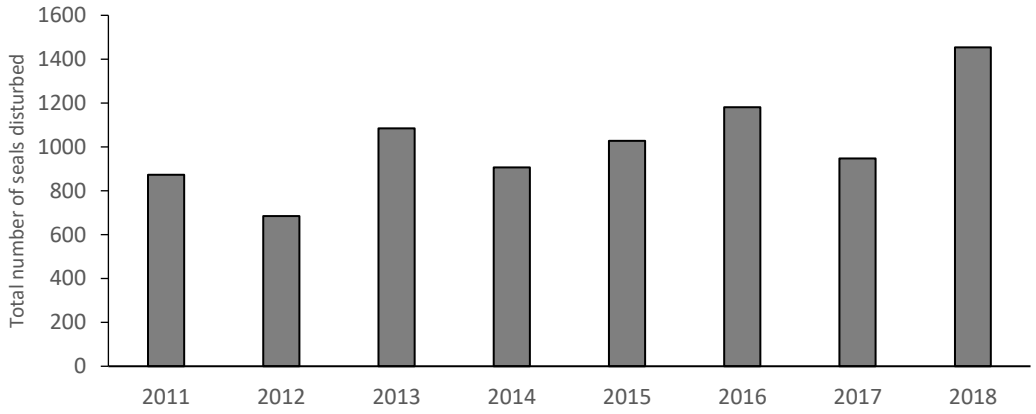

Figure 5. Annual total number of seals disturbed into the sea at West Cornwall mainland, West Cornwall from 2011 to 2018. Site was systematically surveyed twice a week. Data provided by CSGRT.

2. West Cornwall offshore

Problems observed from disturbance include: Frequent 'flushing'(stampeding) behaviour resulting from tripper boats operating out of St Ives. Regular incidents of seals rushing over rocks towards the sea, occasionally tombstoning from positions above high tide (even at low water) or even falling from substantial heights in desperation to get to the sea caused by airborne helicopters. Vigilant behaviour has also been recorded. Occasional kayak, SUP, recreational or fishing boat disturbance from approaching too close. Some incidents of feeding of wild seals from members of the public observed near West Cornwall offshore.

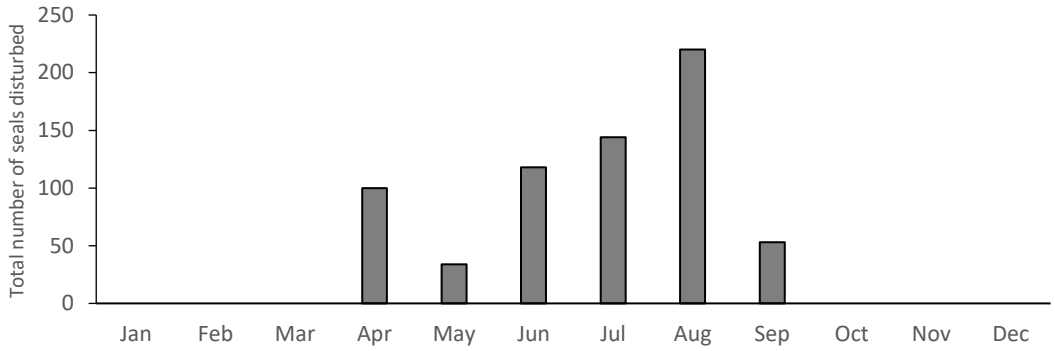

Figure 6. Monthly total number of seals disturbed into the sea as a result of anthropogenic disturbance on West Cornwall offshore, West Cornwall, West Cornwall between 2011-2018. Site was systematically surveyed twice a week. Data provided by CSGRT.

The largest number of seals disturbed into the sea at West Cornwall offshore was in 2012 and reduced in the following years. However, numbers have doubled over the last three years (Figure 7).

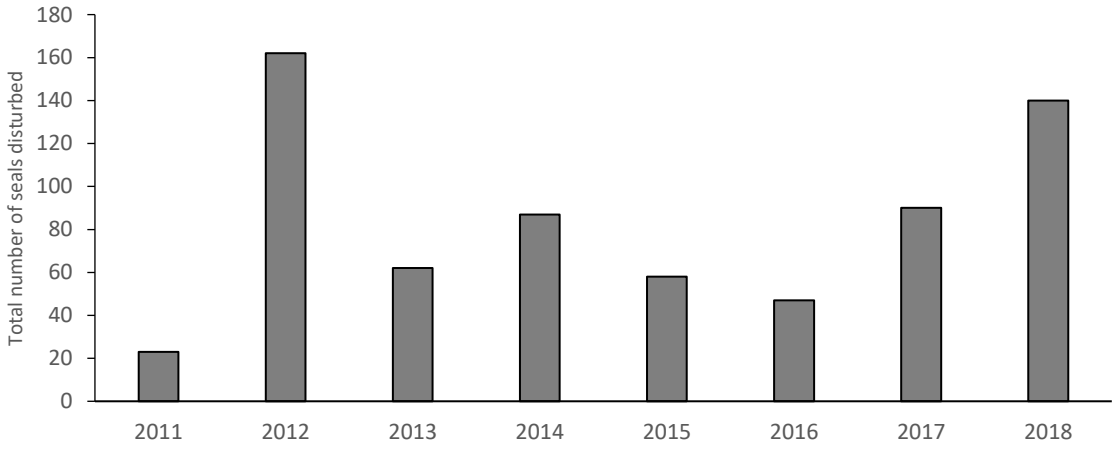

Figure 7. Annual total number of seals disturbed into the sea at West Cornwall offshore, West Cornwall, from 2011 to 2018. Site was systematically surveyed twice a week. Data provided by CSGRT.

Current Conservation Actions and Results

The Cornwall Marine and Coastal Code was set up in 2013, a consortium of both statutory agencies and NGOs specialising in marine disturbance. A telephone hotline was established for volunteer surveyors and members of the public to report disturbance incidents. Training of community-based volunteers on how to respond to and record disturbance has also been undertaken, as well as distribution of informative leaflets on disturbance impacts and best practice wildlife watching. Key improvements that have resulted from working with landowners include positive signage, collecting evidence to follow up disturbance incidents (by CSGRT, NT, Natural England and Police) and long-term volunteers from local communities 'policing' activity.

1. West Cornwall mainland
    - SSSI designation of site, providing additional statutory protection and closed coastal access
    - Regular systematic twice weekly surveys of seals have provided data and evidence of disturbance incidents and trends
    - Engagement, communication and work with landowner to reduce the problem, including 'Whisper for wildlife' signs on low fence at clifftop, 'No access' sign with explanation at top of cliff access path, 'You are entering/exiting a sensitive wildlife site' signs along the coast path
    - Correspondence with RNAS Culdrose; Bristows Search and Rescue, Coastguard, Western Airlines, Skybus and Air Ambulance before and after disturbance incidents
    - Reporting drone use to National Trust staff who log activity and will speak to pilots as flying is banned on NT land without a licence
    - Advice sheet provided for those contacting CSGRT for organised trips of large groups (e.g. schools, colleges, universities) to see seals. CSGRT do not organise public trips to see the seals.
    - Educational talks for range of community marine and other stakeholder groups
    - CSGRT volunteer presence during surveys on clifftop talking to people before and after disturbance incidents.
    - A trial of Wildlife Information Rangers was undertaken a few years ago but without dedicated coordination and resource support the scheme ended. Given the right support, this scheme could be reinstated.

2. West Cornwall offshore
    - Regular systematic twice weekly surveys of seals have provided data and evidence of disturbance incidents and trends.
    - 'No landing' sign erected by Trinity House on island.
    - Correspondence to RNAS Culdrose; Bristows Search and Rescue, Coastguard, Western Airlines, Skybus and Air Ambulance before and after disturbance incidents.
    - WiSe accredited training and Amazing Marine Life 'training' sessions for St Ives commercial operators.
    - Educational talks for range of community marine and other stakeholder groups.

With further successful conservation action and effective management implementation, seal disturbance levels are predicted to stabilise or decline as awareness spreads and peer pressure for best practice gains critical mass. However, without this, seals will continue to be injured during disturbance incidents with some individual seals and potentially all of them abandoning these haul-out sites. Further action such as implementation of voluntary or enforced exclusion zones or minimum approach distance markers have potential to prevent frequency and extremity of disturbance and engagement of all operators and stakeholders in the area is important to ensure consistent 'best practice'.

3.2. Northwest Wales (North Wales Seal Group)

Site Information

Sheltered north facing inlet enclosed on 3 sides by steep cliffs ranging from around 200ft to 460ft in height. Small rocky beach with access via steep incline path on the lowest cliff. Maximum tidal range 30ft sometimes leaving very little beach to haul out on. No special legislation. Voluntary Marine Code of Conduct in place. Close to busy tourist destination and residential area. Easily accessed on foot: 5-10 minute walk from car parking. Wheelchair accessible.

Seal Activity

Species – Atlantic grey seals and occasional sightings of common seals

- Seals present all year round
- April – August: lower number of seals present spending majority of time in the water
- September – December (breeding and pupping season and beginning of annual moult): peak number of seals hauling with frequent mating behaviour observed. First grey seal pups born in early September (for last two years), though previously recorded to start in October.
- January – April (moulting season): numbers steadily decline until most disperse.

Rescues performed: 3 known successful pup rescues at North Wales mainland beach since 2015 (2 grey and 1 common).

Human Activity

Local area attracts tourists year-round with fairly small changes in numbers. Highest tourist numbers coincide with school holidays. Land activity constant throughout year. Water activity continues during all seasons, with greatest numbers during spring, summer and autumn.

Land based:
Large numbers of public gather on lower cliff edge above the seal beach. Public presence all year round, including walkers, families, dog walkers and wildlife watchers. Frequent (several times a week) angling activity both from the beach and surrounding lower reaches of the cliff. Coastguard training takes place on the surrounding cliffs (rope training etc.) and down on the beach itself. Bouldering and climbing activity occurs frequently during spring, summer and autumn on the cliffs above the beach, but often it is on the actual beach itself. Public swimming and tombstoning activity from the beach and surrounding rocks is present in peak tourist seasons and increases in summer and during school holidays.

Sea based:
Multiple recreational vessels (e.g. jet skis, motorboats, kayaks and sailing boats) are frequent (daily) in the area during spring, summer and autumn, and occasionally during winter. Proximity to the haul-out is variable according to tides, however, vessels will often come into the bay itself with kayaks, in particular landing on the beach. Commercial tripper boat operators come into the bay frequently during spring, summer and autumn with peaks at weekend and summer holidays, specifically to observe the seals. Lobster boats enter the bay of North Wales mainland to drop and retrieve pots throughout the year. Most frequently (2 to 3 times a week) in March to October. All have been observed to adhere to the voluntary Marine Code of Conduct, implemented in 2017.

Air based:
During Coastguard training, helicopter lands on area of flat ground near to the cliff edge above the beach, having flown in over the beach rather than above the higher cliffs. Drone use observed all through the year but is sporadic and infrequent.

Interactions, disturbance and observed impacts

Public Presence - when large numbers of people are going to and from the cliffs above the beach to observe the seals, seal response depends on the behaviour of those people. If there is excess noise (e.g. loud voices, screaming children, barking dogs etc.), approximately one quarter to a third of seals stop their current behaviour and demonstrate an alert response. A handful of those will then move slowly towards the water. Several times a week there are incidents of dogs running down the path onto the beach. This promotes a more extreme reaction, with most of the seals present showing an alert response, and more than half stampeding into the sea where they remain until the dogs are called back up the path. The seals in the water often do not haul out again immediately. All remaining seals have been observed to stay in an alert stressed status for a period of time after an incident like this, sometimes for up to an hour.

Angling - when angling is occurring from the lower reaches of the cliffs as opposed to the beach itself, seals in the vicinity demonstrate an alert response and stop their current behaviour until the perceived disturbance is removed. When angling occurs from the beach itself, most animals stampede into the water as the angler(s) approaches down the path, with just a handful remaining behind rocks and along the foot of the cliffs. Maximum numbers of seals observed being disturbed into the sea in a single incident is approximately 60. Disturbed animals have been observed to be temporarily displaced from the site for several hours. Once returned to the beach, they remain alert and vigilant for approximately an hour.

Coastguard training - some flushing of seals on the beach in response to low level helicopter flying directly overhead when coming to land. Highest estimated number of seals recorded disturbed in a single incident is 20 seals out of an initial count of 78, though the remaining seals mostly demonstrated an alert response. The impact of Coastguard personnel training on the cliffs and accessing the beach is similar to angling observations on the beach already described.

Bouldering/Climbing - results in similar impact to angling on the beach already described above.

Swimming/Tombstoning – high numbers of seals stampede into the sea when people are present on the beach. Observations have shown all hauled seals to flush from the beach as a result of this. As the beach is a recognised breeding site (acknowledged by Natural Resources Wales), there are likely to be heavily pregnant females needing to access the beach to rest and conserve energy as summer progresses. This may have implications on subsequent reproductive success. Occasionally there have been incidents of people throwing rocks at the seals, and the recommended action is to contact the rural crime team of the North Wales Police by phoning 101.

Sea based - hauled out seals appear tolerant of motor vessels coming into the bay with no change in behaviour. However, occasionally small numbers will demonstrate an alert response. There have been several incidents of seals flushing from the beach when kayaks approached very close to shore and/or landed. In each of these observed incidents, between one quarter and one third of hauled out seals stampeded into the sea, with those remaining on the beach all demonstrating alert responses. The majority of flushed seals remain in the water until the kayak leaves the bay and remain alert for approximately one hour after the incident.

Drones - have a severe impact with many of the seals present flushing into the sea and remaining there long after the drone has gone. Maximum number of 34 (out of 36) seals observed to flush. Further monitoring of seal response is required a more accurate assessment of the negative impact of drones.

Current Conservation Actions and Results

Multiple actions have been taken since North Wales Seal Group was established in 2017, around the same time that North Wales Wildlife Trust began carrying out seal counts during breeding season including:

- Introduction of voluntary Marine Code of Conduct (MCC), which has been circulated widely amongst recreational and commercial water users through specific launch areas (harbourmaster), water sports venues and clubs, and on relevant and local social media sites.
- Improved signage courtesy of North Wales Wildlife Trust close to the access point to the seal beach.
- For the past two years, small temporary STOP signs have been placed at the top of the path during pupping and moulting, but these are removed during the summer months
- A number of small finger post 'seal viewing' signs were placed along the cliff edge and path above the beach in 2017.
- Communication of information, advice and spreading awareness by North Wales Seal Group, through social media platforms.
- Promotion of North Wales Seal Group, and the subject of seal conservation, amongst relevant bodies/authorities/organisations in order to establish links and build communications.

Based on anecdotal data from 2014 – 2017 and data from NWSG 2017 to present (2-3 observation days/week during Jan – Sept, daily observations from Sept – Dec), it would appear that there has been a drop in the number of people accessing the beach, particularly noticeable during the breeding and moulting seasons when the STOP signs are present. This would suggest that the improved signage has helped, though longer term monitoring of this is necessary to confirm this trend.

There has also been less intrusion into the bay from recreational water users, with many of these vessels choosing to skirt right past the mouth of the bay without stopping. Observation does suggest that the voluntary MCC has helped to improve the situation of access to North Wales mainland from the sea. This requires longer term monitoring to fully understand the trend. However, many recreational vessel users, particularly kayaks are more likely to launch independently from a beach rather than from a specific site, therefore may not be aware of the Marine Code of Conduct. There have been increased visitor numbers due to the seals being promoted as a 'must see' attraction by local tourism bodies and various public platforms.

Further conservation and management action are needed with an increasing number of visitors through publicity/promotion of the area. Given a lack of educational material available to maintain public awareness at North Wales mainland and with an increasingly indifferent attitude to current warning signage, it is predicted that current activity levels will have a detrimental impact upon the area, including increasing encroachment and disturbance of seals. The danger being that disturbance could return to previous levels, or probably increase with larger numbers of visitors.

3.3. Northeast England (St Mary's Seal Watch)

Site Information

A small inter tidal rocky island accessible by a short causeway. It sits within the Northumberland Shore Site of Special Scientific Interest (SSSI), the Northumbria Coast Special Protected Area (SPA), the Northumbria Coast Ramsar and a Marine Conservation Zone (MCZ), which makes up part of the surrounding Local Nature Reserve (LNR) designated 1992.

Seal Activity

Species – Atlantic grey seals

- April – May: Peak number of seals present hauled out on rocks surrounding the island.
- Before 2014, seals were only seen on Tyne and Wear offshore sporadically and infrequently. Anecdotal records show seals on the island increasing to approximately six during May (peak juvenile moult season). In 2018, the largest haul-out count showed an estimated increase of over 14 times the pre-2014 records.
- Over 2,000 seals sightings were recorded throughout 2018 with variations in spatial use of the island throughout the year.
- Not a breeding site.

Human Activity

The are many types of anthropogenic activities that occur at the island as the area attracts many visitors (Table 1.)

Table 2. Types of anthropogenic activity observed at Tyne and Wear offshore. Number and frequency of activity also detailed. Site surveyed during 70 observation days between 1st April and 31st August 2016. Data provided by St Mary's Seal Watch (SMSW).

Type of Activity	Frequency	X per day	Length of activity	Number taking part
Visitors	daily	continuous	all day	420 per hour peak
Diving	daily	x2	2 hours	x3
Dive School	2x week	x1	4 hours	up to 25
Swimming	3 x week	x1	2 hours	up to 12 per group
Photography	daily	x3	2 hours	x3
Sea Angling	min 2 x week	x1	6 hours	x4
Kayak	daily	x2	0.5 hours	x4
Paddle boarding	2 x weekly	x1	0.5 hours	x4
Jet skis	3 x per week	x2	0.5 hours	x6
Drones	Daily	x3	0.5 hour	x1

Interactions, disturbance and observed impacts

Seals have been observed to be disturbed as a result of physical approaches, either directly or indirectly by both terrestrial and marine activity sources. There have also been adverse reactions from seals caused by noise associated with human activities. The majority of disturbance incidents have been observed to be caused by land-based visitors to the island, with the highest rate occurring within the month of May (Figure 8).

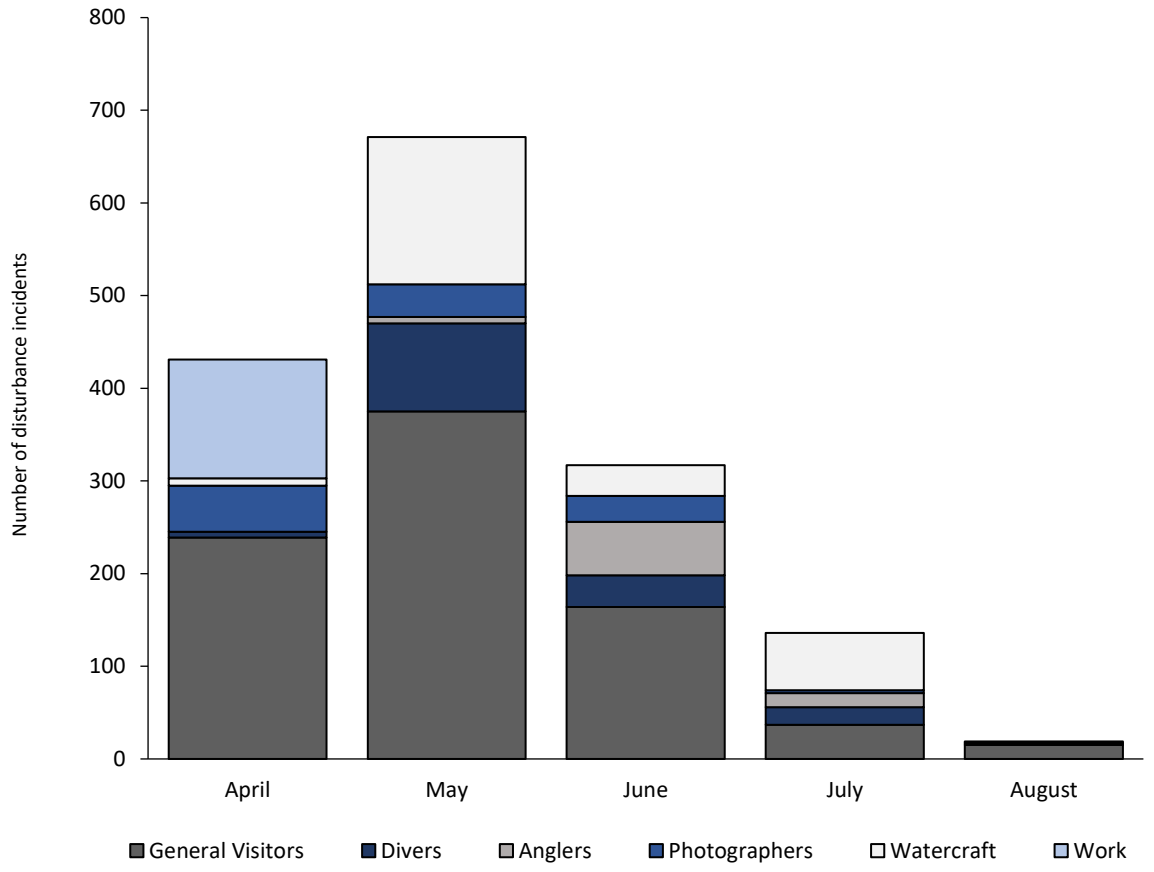

Figure 8. Number of Level 3 (flushing) disturbance incidents at Tyne and Wear offshore, northeast England and the type of anthropogenic activity that caused it (April – August 2016). Site surveyed during 70 observation days between 1st April and 31st August 2016. Data provided by St Mary's Seal Watch.

Due to the rocky substrate, steep cliffs and large tidal range of the haul-out site, seals that have hauled out closer to high tide are liable to tombstoning from great heights onto rocks when fleeing from disturbance. This has the potential to cause substantial injury (Figure 9).

Figure 9. A juvenile grey seal disturbed on the island, causing it to flee to the sea by tombstoning off the rocks, which very likely resulted in injury. Photo by Sal Bennett.

Current Conservation Actions and Results

- Zoning of public activities allowing the seals and birds more space. Since 2014 SMSW has advised that a zoned area is the only way to seriously reduce disturbance levels. Volunteers have encouraged visitors to respect an area of the reserve heavily used by seals (and birds). In 2017 the local authority put up signs requesting visitors to avoid wildlife sensitive areas. Temporary restrictions put in place by North Tyneside Council on access points leading directly from the lighthouse compound to the rocks used by seals has seen a further reduction in footfall onto the haul-out.
- Direct engagement with visitors. The work of SMSW focuses on providing volunteer wardens on site, using friendly, trained well informed SMSW volunteers. In 2015, SMSW held its first Volunteer Training Day and has held a minimum of one a year since to recruit a growing team of "Seal/Wildlife Wardens" from the local community.
- Education and raising awareness by encouraging best practice responsible wildlife watching through information provision and facilities. SMSW provides binoculars and telescopes at selected locations for visitors to observe the wildlife without causing a disturbance. Information explaining the impact of disturbance, how to avoid it and general interpretation of the island's wildlife is located around the viewing areas.
- Using social media as a way of reaching a wider audience, SMSW soon developed a considerable public profile gaining essential support from the local community. SMSW now has over 5,000 followers on its Facebook page.
- Engaging with local authorities to raise the profile of the nature reserve and the issues of disturbance present within it. Attempts have been challenging but progress is being made.

Founders of SMSW recognised the pattern of adverse behaviour and believed that the low numbers and short stay of the seals was a direct result of excessive disturbance to an important habitat i.e. on their haul-out site. SMSW began keeping seal activity records and proactively trying to reduce disturbance levels. Being on site to engage directly with visitors was the most immediate way to reduce disturbance and raise awareness both of seal behaviour, biology etc but also the importance of conserving and protecting the wildlife habitats of a completely neglected nature reserve. Reduction of footfall onto the rocks and encroachment upon and around the shoreline has reduced disturbance levels. As disturbance levels decreased, seal numbers at the site increased. The length of time individual seals hauled out for also increased. Without effective management and support from the local authority and landowners, the wildlife habitats in the area are predicted to be subjected to uncontrolled visitor pressures, resulting in higher levels of seal disturbance and resulting harm.

3.4. Northeast Scotland (Ythan Seal Watch)

Site Information

This seal haul-out is located on the Ythan Estuary, a large area of sandy beach surrounded by a substantial dune system. The seals are located on Forvie National Nature Reserve which is managed by Scottish Natural Heritage. It is ssituated within various designated areas including; National Nature Reserve (NNR), Special Protection Area (SPA) for migratory and wading bird species, Special Area of Conservation and within the Ythan Estuary & Meikle Loch Site of Special Scientific Interest (SSSI). It is also designated as an official seal haul-out site under The Protection of Seals Amendment Order (2017) by Marine Scotland (Figure 10), making it a crime to harass the animals anywhere in the area of beach they are on. This carries a penalty of a £5,000 fine or up to six months in prison.

During the bird breeding season (April - August) the spit is closed to the public due to a Schedule 1 breeding protection order for Little Terns. At present between August and March, the public have unsupervised access to the haul-out. Under seal management laws, the Seal Licence, the river fisheries are permitted to shoot a maximum of three grey seals that are beyond a certain point upriver. They have used this licence on two occasions in 2017-2018.

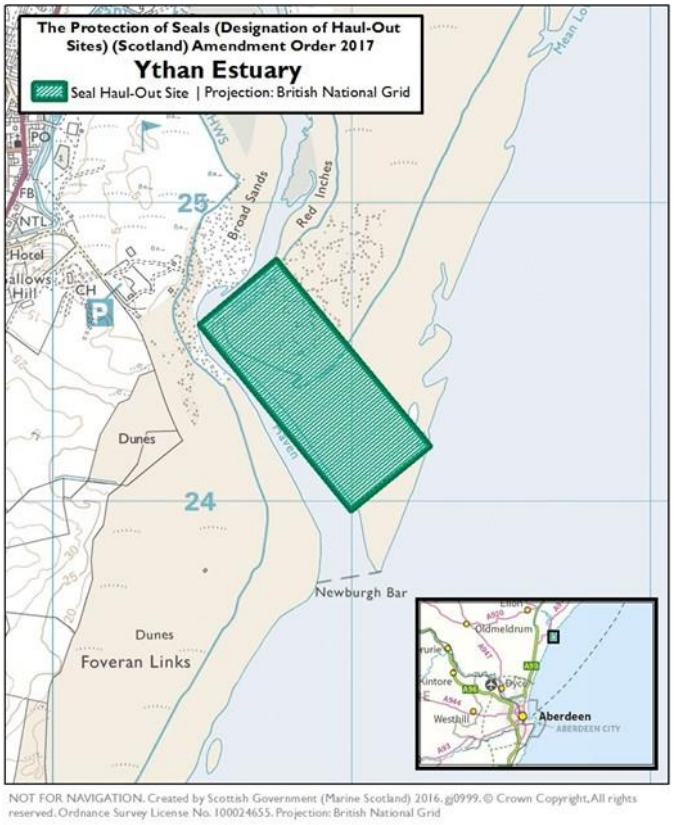

Figure 10. Map of showing location of designated seal haul-out site at the Ythan Estuary, where it is a criminal offence to intentionally or recklessly harass seals (Marine Scotland, 2016).

Seal Activity

Species – Atlantic grey seals and common seals

- One of the largest grey seal mainland haul-outs in the British Isles, with an estimated 3000 seals recorded to haul out together during peak season.
- Has been an established haul-out site for ten years.
- Seals present all year round with peak number in winter and early spring (coinciding with the annual moulting season).
- Recorded pupping activity.

Human Activity

Land based:
The nature reserve receives over 35,000 visitors each year to view wildlife and use walking routes throughout the area. Seals can be viewed from a beach on the opposite side of the river without disturbing the seals, however the seal beach is accessible by walkers, viewable from points along dune trails. It is a popular area for walkers, dogwalkers and horse riders. Many dogs have been observed as off the lead around the seals. There is a barrier fence in place to deter visitors from approaching the seals.

Sea based: There is a large commercial fishing operation offshore (including bottom trawling for prawn/*Nethrops* industry) and bycatch of seals has been suggested (but not proven) to be a reason for the seals being attracted to the estuary, away from the fisheries activity.

Air based:
There is frequent drone activity that has been observed to come in close proximity to film the hauled-out seals. Visitors fly drones over the haul-out from the viewing beach on the opposite side of the estuary.

Interactions, disturbance and observed impacts

When recording disturbance at the estuary commenced in 2016, there would be no seals left on the haul-out, as a result of disturbance. The beach would be over-run with visitors to the point the seals were driven offshore and unable to access the beach. Closing off this site, this season (2017/2018) has resulted in disturbance incidents reducing to 2-3 incidents per day at the weekends, which are the busiest periods of the week.

The busiest time for seal disturbance in the 2017/18 season was during the Christmas/New Year holidays. Large stampedes of seals were frequently witnessed and can occur even from passive viewing as well as direct approaches from the public (Figure 11). These stampedes have resulted in grey seal pup deaths in the past. Visitors, including unsupervised children, were observed to be approaching adult seals on the beach, as well as walkers with dogs off the lead, walking through the seal haul-out (Figure 12), posing a danger to the seals, the public and their dogs.

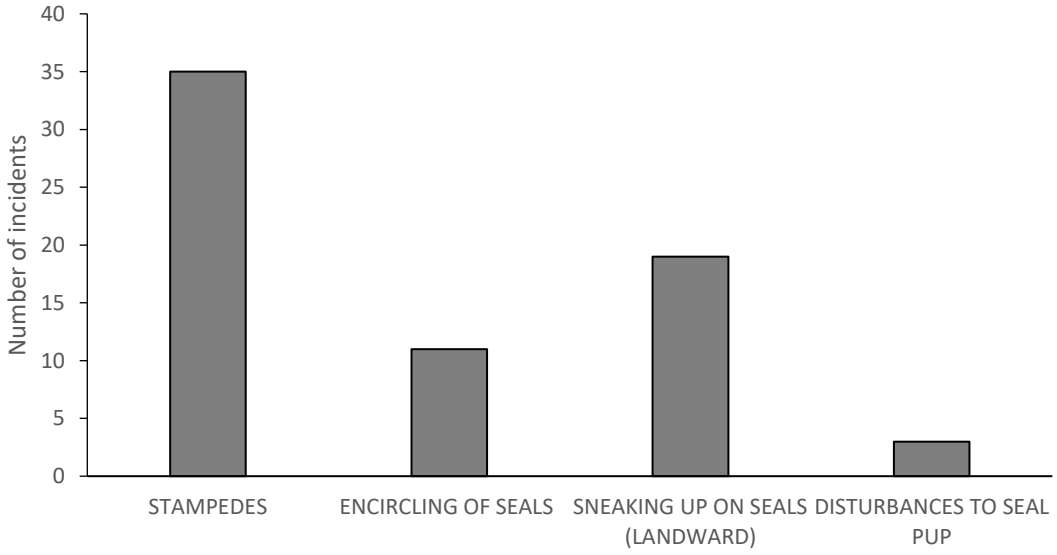

Figure 11. Number of disturbance incidents and type of disturbance observed at Ythan Estuary, northeast Scotland recorded twice a week (usually weekends) between 1st April 2017 and 19th August 2018. Data provided by Ythan Seal Watch (YSW).

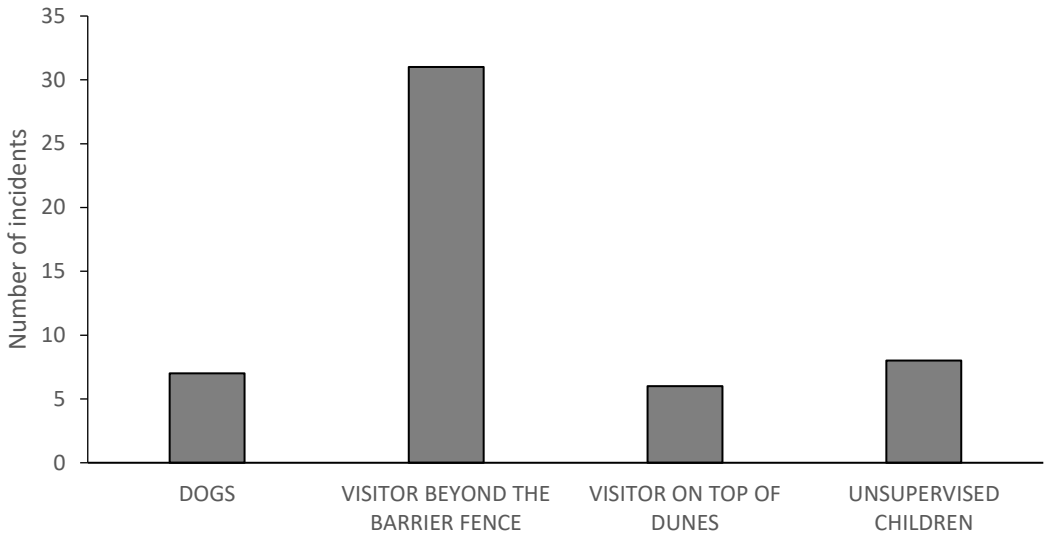

Figure 12. Number of disturbance incidents and the cause of the disturbance observed at Ythan Estuary, northeast Scotland recorded twice a week (usually weekends) between 1st April 2017 and 19th August 2018. Data provided by Ythan Seal Watch.

Drones have been observed flying close to the seals, resulting in vigilant behaviour and large numbers of seals flushed/stampeded into the water. This has caused problems with injury, pup abandonment and on two occasions pup mortality. Larger numbers of seals will clearly look in the direction of the source of the disturbance. The stampedes can completely empty the haul-out and are worse when the visitor is at an elevated height on the dunes behind the seals.

Young seals have been observed to haul-out on the public beach opposite the main haul-out in the early spring during their first moult. Visitors have tried to put children on the seals for photographs. We have become aware of seals appearing on the busy beach on the other side of the estuary where there are large number of visitors and greater public access. The only seals/human interaction we are seeing an increase in, is people attempting to feed the seals.

Current Conservation Actions and Results

As a designated official seal haul-out site under The Protection of Seals Amendment Order (2017) by Marine Scotland, it is a criminal offence to intentionally or recklessly harass or disturb the seal whilst they are hauled out to moult, rest and breed on the site. Visitor conduct around the seals is subject to the standards set in the harassment guide issued by Marine Scotland.

- Temporary closures of the area (April – August) during the Tern breeding season.
- Engagement and education of school and youth groups to educate pupils about seal safety and disturbance. Visiting schools in Aberdeenshire and Aberdeen City to explain the importance of safety around seals and also the impact that disturbance has on a seal's wellbeing.
- Barrier fence to keep visitors at the bottom of the dunes
- Signage and interpretation to inform visitors of appropriate behaviour, legal warnings and any active area closures.
- Volunteers positioned on both approaches to the seal beach to speak to visitors before going into the designated haul-out area.

YSW is recommending that a further fence be established on the perimeter of the designated site located between the Ternery and the dunes at the back of the haul-out. This fence should have signs

on both approaches advising of possible prosecution if seals are approached and disturbed. Warnings of potential prosecution would be an important deterrent as well as facilitating any legal proceedings over any suspected intentional/reckless harassment of the haul-out. This fence would provide a clear demarcation for visitors before they get to the seals to advise the visitor that they are entering a designated seal site and, if they choose to, that they risk prosecution if the seals are disturbed. These signs are already placed in the reserve in the carpark. On speaking with visitors after disturbances, the current location of the fence is causing confusion as its seen as a viewpoint. There should also be a reporting system made clear by the relevant authorities to visitors so they can report disturbance incidents. Information should be provided by the authorities advising the public on how to do so.

4. Potential Solutions and Management

Although statutory protection measures are in place for areas where seals haul out around the UK, few of them specifically cover seals. Protection for seals is only provided at a small number of specific sites such as SSSIs, SACs (with seals listed as a feature in the citation) and designated seal breeding sites. There is concern over a clear definition of what behaviour constitutes 'intentional or reckless harassment' or disturbance (Marine Scotland, 2014). As a result of this limited protection, there is a need for implementation of further protective measures, including introduction of voluntary codes, with additional education and awareness campaigns for both commercial operators and the general public. Some sites currently have these in place (e.g. Marine Code of Conduct in North Wales, Cornwall Marine and Coastal Code, Pembrokeshire Marine Code) and there are training courses available nationwide that provide accreditation for 'wildlife safe operators' (e.g. The WiSe Scheme – a national 'best practice' training and accreditation scheme for operators). However, the voluntary nature of these codes and training courses, requiring reliance on the compliance of operators without any obligation or enforcement, limits the ability and success of reducing disturbance (Scarpaci *et al*., 2004; Johnson & Acevedo-Gutiérrez, 2007; Curtin *et al*., 2009; Hoover-Miller *et al*., 2013). The drive to introduce these codes and their application in place has relied on local community volunteers. The promotion of these codes and guidelines is also needed to reach private vessel users.

Education for appropriate land-based seal watching is also essential to reduce incidents occurring as a result of walkers or other visitors to popular seal watching areas. Engagement with landowners to produce strategies and effective interpretation (e.g. signage, barriers, visitor centres and rangers), as well as wider education of the public, is key to avoiding land-based disturbance (Cassini *et al*., 2004; Strong & Morris, 2010; Granquist & Sigurjonsdottir, 2014; Granquist & Nilsson, 2016).

It is vital that management solutions aimed at reducing seal disturbance are assessed on a site-specific basis. Each haul-out site comprises of several different features that affect the potential for disturbance, the cause and resulting impact, including access, types of human activity in the area, seasonal variations in both seal and human presence (e.g. breeding seasons and peak tourist seasons), and features of the haul-out site (e.g. mainland beach, offshore rocks) (Cassini *et al*., 2004; Curtin *et al*., 2009; Young, 2009; Granquist & Sigurjonsdottir, 2014; Young *et al*., 2014). Any protective measures, or management plans implemented, should consider all these factors, as well as engage all interested parties and local community stakeholders in order to be effective.

5. Summary and Recommendations

Having reviewed case studies from four different locations around the UK coast, there is compelling evidence that human activity is having a considerably negative impact on wild seals and their behaviour. The presence of a variety of different commercial and recreational activities on land, sea and air have resulted in incidents of serious and escalating seal disturbance incidents. As the tourism industry continues to expand, particularly in coastal areas, as well as the growing interest and economic value in wildlife-based activities, it is expected that the already high level of disturbance rates will increase without effective management of sensitive wildlife areas. In addition to detrimental effects on wildlife and the environment (disruption to ecosystem functioning and decreased biodiversity), there could be a negative economic impact on the businesses relying on wildlife sightings and those members of the public who enjoy visiting the area to see the animals.

It is recommended that systematic monitoring of important habitat for seals is developed and conducted to accurately assess the extent of disturbance and the main contributing factors. This can inform future management implementation and maximise the potential to successfully reduce wildlife disturbance. Currently, the monitoring and recording of disturbance for many areas in the UK, including the four case studies in this report, operates through voluntary citizen science projects and organisations. Although this has provided important and informative records, introduction of standardised systematic survey protocols will contribute more accurate and robust data to better quantify and identify the disturbance issue at each site. However, adequate funding for these projects is seriously lacking and desperately needed to enable the training of volunteer surveyors and the acquisition of appropriate survey equipment.

If disturbance monitoring is successfully in place, the research obtained from it will provide stakeholders in all areas with accurate information. This can be used to gain the support needed to develop and implement effective management, with the aim of successfully reducing wildlife disturbance. Without this, there is a strong possibility that disturbance levels of seals will increase, resulting in negative impacts on the species, the wider marine environment, as well as on local communities of people and tourism-based economies.

6. References

Acevedo-Gutiérrez, A. and Cendejas-Zarelli, S., 2011. Nocturnal haul-out patterns of harbor seals (Phoca vitulina) related to airborne noise levels in Bellingham, Washington, USA. *Aquatic Mammals*, *37*(2), p.167.

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M. and Miller, L.A., 2014. Disturbance-induced responses of VHF and satellite tagged harbour seals. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *24*(5), pp.712-723.

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M. and Miller, L.A., 2012. Behavioural responses of harbour seals to human-induced disturbances. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *22*(1), pp.113-121.

Beale, C.M. and Monaghan, P., 2004. Human disturbance: people as predation-free predators? *Journal of applied ecology*, *41*(2), pp.335-343.

Bearzi, M., 2017. Impacts of marine mammal tourism. In *Ecotourism's Promise and Peril* (pp. 73-96). Springer, Cham.

Bejder, L., Samuels, A., Whitehead, H., Finn, H. and Allen, S., 2009. Impact assessment research: use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. *Marine Ecology Progress Series*, *395*, pp.177-185.

Belicia, T. and Islam, M., 2018. Towards a Decommodified Wildlife Tourism: Why Market Environmentalism Is Not Enough for Conservation. *Societies*, *8*(3), p.59.

Bishop, A., Pomeroy, P. and Twiss, S.D., 2015. Breeding male grey seals exhibit similar activity budgets across varying exposures to human activity. *Marine Ecology Progress Series*, *527*, pp.247-259.

Boren, L.J., Gemmell, N. and Barton, K., 2009. The role and presence of a guide: preliminary findings from swim with seal programs and land-based seal viewing in New Zealand. *Tourism in Marine Environments*, *5*(2-3), pp.187-199.

Boren, L.J., Gemmell, N.J. and Barton, K.J., 2002. Tourist disturbance on New Zealand fur seals (Arctophalus forsteri). *Australian Mammalogy*, *24*(1), pp.85-96.

Born, E.W., Riget, F.F., Dietz, R. and Andriashek, D., 1999. Escape responses of hauled out ringed seals (Phoca hispida) to aircraft disturbance. *Polar Biology*, *21*(3), pp.171-178.

Bryden, D.M., Westbrook, S.R., Burns, B., Taylor, W.A. & Anderson, S. (2010) Assessing the Economic Impacts of Nature Based Tourism in Scotland. Scottish Natural Heritage Commissioned Report No. 398.

Buchanan, K.L., 2000. Stress and the evolution of condition-dependent signals. *Trends in Ecology & Evolution*, *15*(4), pp.156-160.

Cassini, M.H., 2001. Aggression between females of the southern fur seal (Arctocephalus australis) in Uruguay. *Mammal Review*, *31*(2), pp.169-172.

Cassini, M.H., Szteren, D. and Fernández-Juricic, E., 2004. Fence effects on the behavioural responses of South American fur seals to tourist approaches. *Journal of Ethology*, *22*(2), pp.127-133.

Cates, K. and Acevedo-Gutiérrez, A., 2017. Harbor seal (Phoca vitulina) tolerance to vessels under different levels of boat traffic. *Aquatic Mammals*, *43*(2), p.193.

Corral, C.T., Szteren, D. and Cassini, M.H., 2018. Short-and long-term changes in the intensity of responses of pinnipeds to tourist approaches in Cabo Polonio, Uruguay. *Applied Animal Behaviour Science*, *201*, pp.111-116.

Cowling, M., Kirkwood, R., Boren, L., Sutherland, D. and Scarpaci, C., 2015. The effects of vessel approaches on the New Zealand fur seal (Arctocephalus forsteri) in the Bay of Plenty, New Zealand. *Marine Mammal Science*, *31*(2), pp.501-519.

Curtin, S., Richards, S. and Westcott, S., 2009. Tourism and grey seals in south Devon: management strategies, voluntary controls and tourists' perceptions of disturbance. *Current Issues in Tourism*, *12*(1), pp.59-81.

Dietz, R., Teilmann, J., Andersen, S.M., Rigét, F. and Olsen, M.T., 2012. Movements and site fidelity of harbour seals (Phoca vitulina) in Kattegat, Denmark, with implications for the epidemiology of the phocine distemper virus. *ICES Journal of Marine Science*, *70*(1), pp.186-195.

Dyck, M.G. and Baydack, R.K., 2004. Vigilance behaviour of polar bears (Ursus maritimus) in the context of wildlife-viewing activities at Churchill, Manitoba, Canada. *Biological Conservation*, *116*(3), pp.343-350.

Engelhard, G.H., Baarspul, A.N., Broekman, M., Creuwels, J.C. and Reijnders, P.J., 2002. Human disturbance, nursing behaviour, and lactational pup growth in a declining southern elephant seal (Mirounga leonina) population. *Canadian Journal of Zoology*, *80*(11), pp.1876-1886.

Erbe, C., 2012. Effects of underwater noise on marine mammals. In Popper, A. N., Hawkins & A. (Eds.) *The effects of noise on aquatic life* (pp. 17-22). Springer, New York, NY.

Forbes, B.C., Ebersole, J.J. and Strandberg, B., 2001. Anthropogenic disturbance and patch dynamics in circumpolar arctic ecosystems. *Conservation Biology*, *15*(4), pp.954-969.

Fox, K. S. 2008. *Harbor seal behavioral response to boaters at Bair Island refuge*. Thesis, San Jose State University, San Jose, California, USA

Frid, A. and Dill, L., 2002. Human-caused disturbance stimuli as a form of predation risk. *Conservation Ecology*, *6*(1).

GBTS, 2018. The GB Tourist: 2017 Annual Report. *Commissioned Report by Visit Scotland, Visit Wales and Visit England.*

Gill, J.A., Norris, K. and Sutherland, W.J., 2001. Why behavioural responses may not reflect the population consequences of human disturbance. *Biological Conservation*, *97*(2), pp.265-268.
GlobalData, 2017. *Top Trends in Sustainable Tourism: An analysis of the key trends in sustainable tourism and the business opportunities they create for the travel and tourism industry*. Commissioned Report.
Granquist, S.M. and Nilsson, P.Å., 2016. Who's watching whom? –an interdisciplinary approach to the study of seal-watching tourism in Iceland. *Journal of cleaner production*, *111*, pp.471-478.
Granquist, S.M. and Sigurjonsdottir, H., 2014. The effect of land-based seal watching tourism on the haul-out behaviour of harbour seals (Phoca vitulina) in Iceland. *Applied Animal Behaviour Science*, *156*, pp.85-93.
Grellier, K., Thompson, P.M. and Corpe, H.M., 1996. The effect of weather conditions on harbour seal (Phoca vitulina) haulout behaviour in the Moray Firth, northeast Scotland. *Canadian Journal of Zoology*, *74*(10), pp.1806-1811.
Harding, K.C., Fujiwara, M., Axberg, Y. and Härkönen, T., 2005. Mass-dependent energetics and survival in Harbour Seal pups. *Functional Ecology*, *19*(1), pp.129-135.
Henry, E. and Hammill, M.O., 2001. Impact of small boats on the haulout activity of harbour seals (Phoca vitulina) in Metis Bay, Saint Lawrence Estuary, Quebec, Canada. *Aquatic Mammals*, *27*(2), pp.140-148.
Higham, J.E.S. and Shelton, E.J., 2011. Tourism and wildlife habituation: reduced population fitness or cessation of impact? *Tourism Management*, *32*(6), pp.1290-1298.
Holcomb, K., Young, J.K. and Gerber, L.R., 2009. The influence of human disturbance on California sea lions during the breeding season. *Animal Conservation*, *12*(6), pp.592-598.
Holt, A. 2015. Identifying the effects of anthropogenic disturbance on the breeding behaviour of female grey seals (Halichoerus grypus), at a mainland UK colony., Durham theses, Durham University. Available at Durham E-Theses Online: http://etheses.dur.ac.uk/11373/
Hoover-Miller, A., Bishop, A., Prewitt, J., Conlon, S., Jezierski, C. and Armato, P., 2013. Efficacy of voluntary mitigation in reducing harbor seal disturbance. *The Journal of Wildlife Management*, *77*(4), pp.689-700.
Jansen, J.K., Brady, G.M., Ver Hoef, J.M. and Boveng, P.L., 2015. Spatially estimating disturbance of harbor seals (Phoca vitulina). *PloS one*, *10*(7), p.e0129798.
JNCC, 2018. *1365 Harbour seal, Phoca vitulina.* Available: http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?FeatureIntCode=S1365 [Accessed on 1/4/2019]
Johnson, A. and Acevedo-Gutiérrez, A., 2007. Regulation compliance by vessels and disturbance of harbour seals (Phoca vitulina). *Canadian Journal of Zoology*, *85*(2), pp.290-294.
Karpovich, S.A., Skinner, J.P., Mondragon, J.E. and Blundell, G.M., 2015. Combined physiological and behavioral observations to assess the influence of vessel encounters on harbor seals in glacial fjords of southeast Alaska. *Journal of experimental marine biology and ecology*, *473*, pp.110-120.
Kelly, B.P., Burns, J.J. and Quakenbush, L.T., 1988. Responses of ringed seals (Phoca hispida) to noise disturbance. *Port and ocean engineering under arctic conditions*, *2*, pp.27-38.
King, S.L., Schick, R.S., Donovan, C., Booth, C.G., Burgman, M., Thomas, L. and Harwood, J., 2015. An interim framework for assessing the population consequences of disturbance. *Methods in Ecology and Evolution*, *6*(10), pp.1150-1158.
Kirkwood, R., Boren, L., Shaughnessy, P., Szteren, D., Mawson, P., Hückstädt, L., Hofmeyr, G., Oosthuizen, H., Schiavini, A., Campagna, C. and Berris, M., 2003. Pinniped-focused tourism in the southern hemisphere: a review of the industry. *Marine mammals: fisheries, tourism and management issues*, pp.257-276.
Krausman, P.R., Harris, L.K., Blasch, C.L., Koenen, K.K. and Francine, J., 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. *Wildlife Monographs*, *157*(1), pp.1-41.
Kucey, L. and Trites, A.W., 2006. A review of the potential effects of disturbance on sea lions: assessing response and recovery. *Sea Lions of the World, Alaska Sea Grant Program AK-SG-06-01*.
Leeney, R.H., Broderick, A.C., Mills, C., Sayer, S., Witt, M.J. and Godley, B.J., 2010. Abundance, distribution and haul-out behaviour of grey seals (Halichoerus grypus) in Cornwall and the Isles of Scilly, UK. *Journal of the Marine Biological Association of the United Kingdom*, *90*(5), pp.1033-1040.
Marine Scotland, 2014. Guidance on the Offence of Harassment at Seal Haulout Sites. *Scottish Government.*
McHuron, E.A., Costa, D.P., Schwarz, L. and Mangel, M., 2017. State-dependent behavioural theory for assessing the fitness consequences of anthropogenic disturbance on capital and income breeders. *Methods in Ecology and Evolution*, *8*(5), pp.552-560.
McMahon, C., van den Hoff, J. and Burton, H., 2005. Handling intensity and the short-and long-term survival of elephant seals: addressing and quantifying research effects on wild animals. *AMBIO: A Journal of the Human Environment*, *34*(6), pp.426-430.
Moorhouse, T.P., Dahlsjö, C.A., Baker, S.E., D'Cruze, N.C. and Macdonald, D.W., 2015. The customer isn't always right—conservation and animal welfare implications of the increasing demand for wildlife tourism. *PloS one*, *10*(10), p.e0138939.
Olson, J.K. and Acevedo-Gutiérrez, A., 2017. Influence of human exposure on the anti-predator response of harbor seals (Phoca vitulina). *Aquatic Mammals*, *43*(6), pp.673-681.

Pavez, G., MUnoz, L., Barilari, F. and Sepúlveda, M., 2015. Variation in behavioral responses of the South American sea lion to tourism disturbance: Implications for tourism management. *Marine Mammal Science*, *31*(2), pp.427-439.
Pirotta, E., Booth, C.G., Costa, D.P., Fleishman, E., Kraus, S.D., Lusseau, D., Moretti, D., New, L.F., Schick, R.S., Schwarz, L.K. and Simmons, S.E., 2018. Understanding the population consequences of disturbance. *Ecology and Evolution*, *8*(19), pp.9934-9946.
Pomeroy, P.P., Twiss, S.D. and Redman, P., 2000. Philopatry, site fidelity and local kin associations within grey seal breeding colonies. *Ethology*, *106*(10), pp.899-919.
Riedman, M., 1990. *The pinnipeds: seals, sea lions, and walruses* (Vol. 12). Univ of California Press.
Sayer, S., Allen, R., Hawkes, L.A., Hockley, K., Jarvis, D. and Witt, M.J., 2019. Pinnipeds, people and photo identification: the implications of grey seal movements for effective management of the species. *Journal of the Marine Biological Association of the United Kingdom*, pp.1-10.
Scarpaci, C., Nugegoda, D. and Corkeron, P.J., 2004. No detectable improvement in compliance to regulations by "swim-with-dolphin" operators in Port Phillip Bay, Victoria, Australia. *Tourism in Marine Environments*, *1*(1), pp.41-48.
SCOS, 2017. Scientific Advice on Matters Related to the Management of Seal Populations: 2017. *Commissioned report by DEFRA SCOS –BP 17/05.*
Stevens, M.A. and Boness, D.J., 2003. Influences of habitat features and human disturbance on use of breeding sites by a declining population of southern fur seals (Arctocephalus australis). *Journal of Zoology*, *260*(2), pp.145-152.
Strong, P. and Morris, S.R., 2010. Grey seal (Halichoerus grypus) disturbance, ecotourism and the Pembrokeshire marine code around Ramsey Island. *Journal of Ecotourism*, *9*(2), pp.117-132.
Suryan, R.M. and Harvey, J.T., 1999. Variability in reactions of Pacific harbor seals, Phoca vitulina richardsi, to disturbance. *Fishery Bulletin*, *97*(2), pp.332-339.
Trave, C., Brunnschweiler, J., Sheaves, M., Diedrich, A. and Barnett, A., 2017. Are we killing them with kindness? Evaluation of sustainable marine wildlife tourism. *Biological conservation*, *209*, pp.211-222.
Twiss, S.D., Culloch, R. and Pomeroy, P.P., 2012. An in-field experimental test of pinniped behavioral types. *Marine Mammal Science*, *28*(3), pp. E280-E294.
WTTC, 2017. Tourism Economic Impact 2017: World. *World Travel Tourism Council*, 1,1.
Young, C. 2009. Disturbance of harbor seals by vessels in John Hopkins Inlet, Glacier Bay, AK. Thesis, San Jose State University, San Jose, California, USA.
Young, C., Gende, S.M. and Harvey, J.T., 2014. Effects of vessels on harbor seals in Glacier Bay National Park. *Tourism in Marine Environments*, *10*(1-2), pp.5-20.