Perspective

PREDATOR CONTROL ON LAND AND AT SEA: A COMPARISON AND CALL FOR COMMON STANDARDS OF ASSESSMENT

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1. Introduction

Carnivores come into conflict with humans when they cause damage to livestock, crops and other property. Examples in Europe include wolves (*Canis lupus*) taking sheep, wolverines (*Gulo gulo*) preying on semi-domestic reindeer (*Rangifer tarandus*) and brown bears (*Ursus arctos*) damaging beehives and maize (Linnell and Cretois, 2018). However, conflict is not only a land-based issue. For example, pinnipeds (seals and sea lions) come into conflict with fisheries and aquaculture sites when they damage equipment and take or injure fish. As in terrestrial settings, human-wildlife conflict in the marine environment can have significant financial repercussions and present animal welfare issues (Box 1).

As with conflicts on land, no one-size-fits-all solution is available for the marine environment. The development of seal-proof fishing technologies is an on-going process that has attempted to reduce both predation of fish and damage to nets (e.g. Varjopuro, 2011). Consumers of farmed fish are increasingly demanding that fish farms minimise harm to marine mammals and the environment. As such, there is an increasing need to ensure that methods used by fish farms to deter marine mammals from destroying equipment and killing or damaging fish are not only effective but are also humane.

Fisheries and fish farms have used both lethal control (i.e. shooting) and non-lethal methods to prevent conflict with seals (Nunny et al., 2018). An example of a non-lethal method is the use of acoustic deterrent devices to produce uncomfortable levels of sound that scare away seals (Götz and Janik, 2013). Some fish farms also use anti-predator nets to stop seals from accessing the inner cage nets where fish are kept (Northridge et al., 2013). They surround either individual cages or the entire cage system. Seal blinds

Box 1

Predator control and animal welfare

Protecting harvests and livestock is challenging and there is increasing recognition that it should be done in ways that consider the welfare of both domestic animals and predators (Nunny, 2020). Animal welfare encompasses "the physical and mental state of an animal in relation to the conditions in which it lives and dies" (OIE, 2018). It considers how an animal copes with its environment and whether it is able to achieve its needs and wants (Broom, 1991; Dawkins, 2012).

The term 'humane' is often taken to mean without causing pain, suffering and distress, particularly in relation to killing methods (Sharp and Saunders, 2011). An assessment of animal welfare can include determining the humaneness of methods used to prevent conflict with wildlife.

Quantifying animal welfare can be done using scoring systems such as The Five Domains model, which comprises four physical/functional areas ('nutrition', 'environment', 'health' and 'behaviour') and a fifth 'mental' domain representing the animal's affective experience (Mellor, 2016). This type of model can be used to assess the overall welfare status of an animal as it takes into consideration both positive and negative elements in each of the domains.

are another non-lethal deterrent and are used to hide dead fish that have accumulated at the bottom of cage nets from seals approaching from underneath (Coram et al., 2014). The seal blind comprises an area of thicker material at the base of the net, making it stiffer and harder for seals to deform and access the fish within.

Conflict with wildlife can vary seasonally with availability of prey and changes in animal physiologies and behaviours. It is therefore necessary to consider seasonally appropriate tools to reduce conflicts. For example, there is evidence that conflict with large carnivores on land is greater under specific circumstances, such as when natural food resources are scarce and, for bears, when they are in hyperphagia – a period of intense caloric demand before hibernation (Artelle et al., 2016). Similarly, peak depredation by grey seals (*Halichoerus grypus*) at fish farms occurs after the breeding season when adult seals are recovering from fasting (Northridge et al., 2013).

Although there may be areas of common ground where sharing of data and experience could be useful, it appears that those managing conflict situations at sea rarely turn to terrestrial experts for help or advice. To encourage such knowledge-sharing, a workshop entitled *Predator controls: lessons from land to sea* was convened at the World Marine Mammal Conference in Barcelona, Spain in December 2019. Here, we summarise the most important topics addressed by a series of keynote speakers, their proposals and recommendations, and present the most relevant conclusions of the workshop.

2. Main topics and recommendations

The workshop's main aim was to bring together experts in human-wildlife conflict scenarios on land with those who deal with analogous conflicts at sea. The workshop was convened by Laetitia Nunny (Wild Animal Welfare) and Mark Simmonds (Humane Society International). It was attended by 39 participants from 14 countries in Europe, Asia and North America, the majority of whom work with or study marine mammals. Mark Simmonds facilitated the event and provided an introduction to the topic and an overview of the issues to be discussed. He noted that, on the marine side, the workshop would focus on issues with seals around fish farms, although there are many other conflicts between marine mammals and people such as dolphins interacting with fisheries (e.g. Butterworth and Simmonds, 2017).

Grey seals on Bardsey Island, North Wales, UK.
(Photo: Mark P. Simmonds)

Carlos Bautista (Institute of Nature Conservation, Polish Academy of Sciences) spoke about conflicts on land related to large carnivore damage, with a special focus on mitigation techniques. His talk was divided into two main parts. First he evaluated current programmes to compensate and prevent damage caused by brown bears, wolves, lynx (*Lynx lynx*) and wolverines in 27 European countries and the factors related to the economic costs of these programmes. He highlighted large differences in compensation costs between countries and species. Costs tend to be higher when husbandry practices are not adapted to the presence of predators, national economic wealth is high and effective prevention practices such as electric fences and livestock guarding dogs are not a prerequisite to receive compensation. He also noted that most European countries pay compensation on an ongoing basis but only half of them subsidise preventive measures regularly. He warned that an approach based on compensation rather than prevention can perpetuate conflicts, instead of mitigating them (Bautista et al., 2019).

Brown bear in the Catalan Pyrenees, Spain.
(Photo: Generalitat de Catalunya)

In the second part of his presentation, Bautista gave an overview of the available literature on the effectiveness of lethal predator control in comparison with non-lethal techniques to prevent wildlife damage and related conflicts. Lethal control programmes for large carnivores are not always effective at preventing damage (van Eeden et al., 2018; Artelle et al., 2016). Some may even be counterproductive, resulting in an increase in damage (e.g. Fernández-Gil et al., 2016). Furthermore, predator removal may compromise the long-term viability of the predator's population (e.g. Lennox et al., 2018) and so, depending on the species involved, might be contrary to conservation needs (Haber, 1996). Accordingly, Bautista asserted his support for the widely held recommendation that effective conflict mitigation should move away from predator removal and focus on damage prevention programmes that help to adapt husbandry practices to the presence of large carnivores.

Diederik van Liere (Institute for Coexistence with Wildlife) highlighted the notion that, in order to understand the origins of problems, it is necessary to look at local learning and how an individual animal adapts and develops its choice of prey species and killing strategies. He illustrated this with reference to the large differences between neighbouring wolf packs in their selection of livestock as prey regardless of abundance (Meriggi et al., 1996). In other wolf research, it has also been shown that prey preference cannot be fully explained by abundance (e.g. Imbert et al., 2016). Additional explanations for prey choice relate to learning and include developing hunting skills and learning from parents or other group members (e.g. Imbert et al., 2016). Experiences related to prey and habitat are transmitted and generally accepted as instrumental in preparing the next generation to efficiently survive in a habitat similar to the one in which they were reared (e.g. Davis and Stamps, 2004). If transmission of skills and prey choice is instrumental to survival, then it can be assumed that problematic prey choice and habitat preference will also be transferred and maintained across generations.

The development of foraging routines in wolves is recognized from their use of specific travel routes within their territories, linked to successful past hunting experience (Mech and Boitani, 2003). This might explain the observation that the same sheep farms are repeatedly attacked (e.g. van Liere et al., 2013). To solve such problems, van Liere therefore recommended deterring predators at the moment they are detected on travel routes. This can be done by placing sensors on the route that immediately activate deterrents, such as recordings of shouting humans, pepper spray or lights.

In addition, signals that predators may use to predict that there is a reward to be gained need to be removed or disrupted. Conflict can be reduced by moving reinforcing stimuli away from predators' travel routes, e.g. by relocating fish farms when there is problematic predation by seals, or relocating livestock in the case of terrestrial predators, and by negatively rewarding the different elements of hunting behaviour (chasing, biting, consuming) that are in themselves reinforcing. The chances that predators will detect the new site depend on several factors including the senses they use to locate potential prey and what (if any) management actions have been taken to obscure tell-tale signs. For instance, up-wind location of a flock of sheep and the presence of goats increase the chance of wolf attacks because of the wolf's use of sound and smell (van Liere et al., 2013).

It was noted by workshop attendees that the same issues related to learning and routines may apply to seals in the marine environment. It might therefore be possible, for example, to disrupt individual seals that behave in predictable ways around fish farms or fishing nets. Some research has been carried out on 'rogue' seals that seemingly specialise on feeding on salmon in rivers or raiding salmon traps (Graham et al., 2011; Königson et al., 2013). Perhaps their routines and learning experiences can be disrupted to prevent conflict, such as by disturbing or masking the currents that swimming fish produce. Using propellers or other means to change water flow may interfere with the ability of seals to use their whiskers to hydro-dynamically track fish (Schulte-Pelkum et al., 2007). Further research is needed on this aspect.

Beehives protected by electric fence in Poland.
(Photo: Carpathian Brown Bear Project)

Santiago Palazón (Fauna and Flora Service, Generalitat de Catalunya) described practical methods used to prevent damage by wolves and bears in the Catalan Pyrenees in Spain. He highlighted the claim that non-lethal methods of protecting livestock are more effective than killing carnivores. In Catalonia, there is a focus on building coexistence between large predators and people through education and long-term action plans which include working alongside all interested stakeholders (e.g. PirosLife, 2018). Improving living conditions for shepherds is a key component of this and includes building mountain cabins and supplying them with materials. As predators are legally protected in the area, since 2007 compensation has been paid to livestock owners and beekeepers for any damage caused.

Various damage prevention methods have been used in Catalonia. Beehives are protected using several electrified wires combined with metal fences, which are often partly buried to prevent bears from digging under them. Sheep and goats are protected through a combination of measures: grouping smaller flocks together into one bigger flock, employing shepherds to stay with the livestock 24 hours a day for four to five months during summer, installing electric fences for protection at night and using livestock guarding dogs (Palazón, 2017). Flocks without protection are seven times more likely to be attacked than flocks protected using this multifaceted system (PirosLife Team, 2019). However, cows and horses are not brought into enclosures at night but are left to graze freely in mountain pastures.

Palazón compared beehives and night-time livestock enclosures to aquaculture sites as they are all focus points that attract large predators and where protection measures can be implemented. He noted that it is much more difficult to record and quantify losses due to predators in the sea and, in some cases, to identify the species responsible for causing the damage.

Canadian fish farms have a long history of developing and trying different means to deter pinnipeds from accessing fish held in net pens. Some of the methods reviewed by Andrew Trites (University of British Colombia) during the workshop include acoustic deterrence and harassment, types of netting, low-voltage electric wires, anti-predator nets and lethal and non-lethal removals. For the most part, these methods have been developed and shared among individual fish farms and have not been scientifically

Steller sea lions (*Eumetopias jubatus*) in British Columbia, Canada. *(Photo: Andrew Trites)*

evaluated. Broader acceptance and use of proven mitigation methods that meet international expectations of animal welfare standards can be achieved through collaborative studies involving scientists and fish farm personnel.

Trites presented a framework for evaluating the effectiveness and impact of different mitigation measures on animal welfare based on a model for assessing the welfare implications of control methods for a range of terrestrial invasive animals (Sharp and Saunders, 2011). The assessment process consists of two parts. Part A categorises the overall impact of a control method on welfare as either extreme, severe, moderate, mild or no impact and combines it with the duration of the impact to give a humaneness score from 1 (most humane) to 8 (least humane). This is the only relevant score for non-lethal control methods. For lethal control methods, Part B of the assessment combines the intensity of suffering experienced before the animal becomes insensible (no suffering, mild suffering, moderate suffering, severe suffering or extreme suffering) with the duration of suffering to give a score from A (most humane) to H (least humane). Humaneness scores for lethal methods are determined by combining the result from Part A with the result from Part B so that welfare prior to killing is considered as well as how the animal is killed. The most humane method would score 1A and the least humane 8H.

Trites noted that scoring the different methods used at Canadian fish farms by degree of effectiveness and their impact on animal welfare is a promising means to quantify the combined effectiveness and humaneness of methods used to deter marine mammals from fish farm sites. Such an approach is also a promising means to establish global standards for use of anti-predator technologies at sea.

3. Main conclusions

The workshop ended with an expert panel, a question and answer session and a final discussion from which the following conclusions were derived:

1. Whilst there appears to be little transfer of anti-predator technologies between land and sea, people who farm and fish have common issues including ensuring the effectiveness of the measures deployed. This warrants a formal assessment of the common issues and solutions and a proper assessment of their welfare implications.

2. The welfare implications of conflict mitigation methods concerned many attending the workshop. How control methods impact predator welfare depends on the method used and how it is applied.
3. Standard protocols to assess the welfare and effectiveness of conflict mitigation techniques need to be developed and endorsed by the international community and could apply equally to land and sea situations. The approach used by Sharp and Saunders (2011) was noted as promising, as is the welfare assessment tool developed by the International Whaling Commission (Nicol et al., 2020).
4. Reducing conflict requires a thorough understanding of the situation, including socio-economic aspects, determining whether the conflict is limited to individual problem animals or is more pervasive and evaluating how the problem at the site has developed. In addition, it is necessary to determine whether the conflict is more prevalent at a particular time of year, in a particular location or under certain ecological conditions or geopolitical circumstances.

Conflict resolution requires gathering as much information as possible about the conflict in order to take appropriate actions and is an area where marine experts can learn from the experiences of terrestrial experts and vice versa. For this reason, providing platforms to marine and terrestrial experts to exchange knowledge and experience can benefit the conservation and welfare of wild predators on land and in the sea.

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[1] An extended list of references pertinent to this article is available at: https://wildanimalwelfare.com/2020/09/04/carnivore-damage-prevention-news-full-reference-list/

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