Introduction

Hunting, trapping, fishing, and whaling can all impact wild animal welfare. They are undertaken for a variety of reasons including:

- For food and other products, such as fur, either as part of a subsistence or commercial hunt;
- To stop wild animals from competing with humans for a resource (competition may be proven or perceived);
- To control wild animals around livestock/crops;
- To prevent carnivores from posing a physical threat;
- As a form of population control or culling, for example pest or invasive species control or to prevent the spread of disease;
- For recreation/sport;
- For cultural reasons (Hampton et al., 2016; Hampton and Hyndman, 2019; Feber et al., 2020; Nunny, 2020).

When assessing the welfare of an animal during a hunting, trapping, fishing, or whaling event, the time to death (TTD) can be measured but it is generally considered more appropriate to measure the time to insensibility or time to irreversible unconsciousness (TIU) (Nunny, 2020). Animals that are killed in a manner that causes them to lose consciousness instantaneously so that they become insensible to pain and distress, therefore, do not experience any negative welfare after loss of consciousness (Broom, 1999). If the animal does not experience poor welfare just before the start of the killing procedure, such a death can be considered ‘humane’. Sharp and Saunders (2011) recommend an assessment method based on Mellor and Reid’s Five Domains Model, which can be used to assess the effects on welfare of a hunting or trapping method by considering the severity of any poor welfare before death and the duration of the poor welfare as well as the killing method itself (if death is the ultimate goal and, in some cases, e.g. catch-and-release fishing, it may not be).
Hunting and trapping

We hunt animals on land, on ice, at sea, and in the air. We hunt them from solid ground and from moving vehicles including helicopters, motor vehicles, and boats. We use firearms, harpoons, bows and arrows, or we catch them in traps or nets which either kill them or hold them until we can despatch them. We pursue them with dogs or birds of prey and we lure them with decoys. Depending on the species being hunted and the country where the hunt is taking place, legislation and codes of practice will differ and with them the methods used. Here, some methods and their welfare implications are described.

Hunting methods

Firearms, including centrefire and rimfire rifles, shotguns, and pistols, are one of the most widely used methods for culling wildlife and for commercial harvesting (Hampton et al., 2021). Wildlife regulations may specify which bullet weights and calibres should be used for targeting particular species, but these can vary between countries, for example see Nunny et al. (2018) for the range of firearms and ammunition used throughout Europe to kill seals. Other factors which can differ and which can impact welfare outcomes include the distances from which animals are shot and the area of the animal's body that is targeted (Hampton et al., 2021). These disparities may affect the welfare outcome for the individual animal. An assessment of feral camel (Camelus dromedarius) management in Australia, for example, determined that when camels were shot in the chest the outcome was less humane than when they were shot in the head (Hampton et al., 2016).

Bullets kill either by causing trauma to the central nervous system which leads to irreversible unconsciousness, or by causing fatal haemorrhage, when major blood vessels are impacted, or when major organs are lethally damaged (Stokke et al., 2018; Hampton et al., 2021). Most bullets used in hunting are designed to expand upon impact (Stokke et al., 2018) and although kinetic energy (determined by velocity and mass of a bullet) influences the likelihood of killing or injuring an animal, it is how a bullet behaves, including fragmentation, that can be more relevant for determining animal welfare outcomes (Hampton et al., 2021).

It is argued that killing an animal with a firearm allows it to carry out normal behaviours up until the moment of death, meaning that it has the potential to experience positive welfare until the last moment (Gamborg et al., 2020). When deer are undisturbed before being shot and killed instantly they have lower cortisol levels (a stress indicator) than deer killed after trauma (Gentsch et al., 2018).

Trauma could include pursuit of the animal before the shot is taken. Hunts which involve chasing an animal, on horseback and/or with dogs, mean that a target animal may experience negative welfare for hours or even days depending on how long it is pursued (Jones and Draper, 2018). Bateson and Bradshaw (1997) found that red deer (Cervus elaphus) hunted with dogs were chased for an average of 19 km and for a mean duration of 3.12 hours. These long hunts led to several physiological outcomes including high concentrations of cortisol and the authors concluded that red deer are not well-adapted to cope with the activity levels required during a hunt with hounds, and that long hunts lead to extreme exhaustion.

A report carried out for the UK government found that stalking was preferable to chasing a deer with dogs in terms of animal welfare (Burns et al., 2000). The same report also found that when a fox is caught and killed by hounds it “seriously compromises the welfare of the fox”. The digging out of foxes from their dens was also considered to seriously impact welfare as the fox has no escape and the process can take a considerable time. The UK has subsequently banned hunting with dogs (Hunting Act, 2004) but the practice is still common in other countries, e.g.
in Australia hunting dogs are used to track and restrain feral pigs (*Sus scrofa*), which are then killed with a large knife (Orr et al., 2019).

Other hunting methods may be species-specific such as the use of a club or hakapik (a club with a metal ferrule which has a spike on one side) for killing young harp seals (*Pagophilus groenlandicus*) (Daoust and Caraguel, 2012). The animal is struck on the head with the club or blunt part of the hakapik, checked to make sure that it has been properly stunned by palpat ing the skull to ensure that it has been crushed, and then bled out to ensure death. Although this method of killing has been controversial, the sealer is, in theory, able to check the seal’s state of consciousness instantly, whereas for seals which are shot from a distance on the ice there may be some delay before they are checked. Checking is even harder if the seal is shot in water, and Daoust and Caraguel (2012) found that shooting a seal in water meant a 30% risk of a poor welfare outcome, whereas for a seal shot on the ice there was only a 2.6% chance. The location of the hunt may, therefore, be as important as the method used in some circumstances.

Hunting methods which are considered traditional, or which are undertaken by indigenous people, are often not scrutinised scientifically for their impacts on animal welfare (Hampton and Hyndman, 2019). No animal-based welfare studies have been published regarding dugong (*Dugong dugon*) hunting in Australia, for example, despite concerns about welfare outcomes, because one of the killing methods includes drowning (Hampton and Hyndman, 2019) – which is generally considered to have severely negative welfare consequences (Ludders et al., 1999).

### Trapping

Worldwide, tens of millions of animals are trapped legally each year and an unknown number are trapped illegally (Iossa et al., 2007). Killing traps aim to render the animal unconscious and kill it, whereas restraining traps hold the animal until the trapper checks the trap and kills or releases it. As many traps were developed by trappers to capture furbearers, the main aim of the trap was to capture the animal without damaging the pelt. Welfare was at best a secondary consideration.

Leghold traps are prohibited in many countries including throughout the European Union (European Communities, 1991) but are legal in Canada and many states of USA (Iossa et al., 2007). In Australia they may be combined with toxins which are applied to the trap jaws to kill the animals once trapped (Meek et al., 2019). This practice can have negative welfare implications depending on the toxin used. Strychnine, for example, intoxicates the animal while it is still conscious and is considered an inhumane poison due to the severe welfare impacts (Sharp and Saunders, 2011). It has been banned in many countries, e.g. New Zealand and the UK.

The 1999 Agreement on International Humane Trapping Standards (AIHTS) banned steel-jawed leghold traps in the European Union, Canada and Russia (European Communities, 1998). The AIHTS have been criticised for not reflecting the latest trapping technology, for omitting commonly used traps and commonly trapped species, and for not including assessments to ensure that animal welfare is properly protected (Proulx et al., 2020). The TIUs given in the AIHTS are, in some cases, considered to be too long and could be reduced for many species if new technology and materials were implemented.

The International Organization for Standardization (ISO) standards 10990-4 1999 (“Methods for testing killing-trap systems used on land or underwater”) can be used to evaluate traps for animal welfare, capture efficiency, selectivity, and user safety (ISO, 1999). Tests are carried out with anaesthetised animals, although they also recommend testing on conscious animals as the effects of trap forces can vary. Few traps have actually been tested according to ISO standards and how traps perform in experimental testing circumstances can be different to how they perform in the field (Iossa et al., 2007).
Due to their indiscriminate nature, cable snares are prohibited in many places including most central African nations, but Noss (1997) found that they were regularly in use in the Central African Republic and that foot snares had clear welfare consequences. Over one-third of animals caught escaped from the snare injured, often with a severed limb. The animals that did not escape would fight to free themselves, often breaking the captured limb and dying of shock, blood loss, exhaustion, and starvation.

How a trap impacts welfare will, in part, depend on how often the trap is checked by the hunter. The legal requirement for checking leg-hold jaw traps used for trapping dingoes (*Canis lupus dingo*) and wild dogs (*Canis lupus familiaris*) in Victoria, Australia, is only every three days, whereas the international recommendation for checking soft-jaw traps in research projects is daily, and many researchers check more frequently (Hampton and Hyndman, 2019). There are no legal requirements regarding trap and snare checking times in Canada, and in the USA times vary according to state, often exceeding 24 hours, leading to the recommendation that all killing traps, including those certified as ‘humane’, should be monitored frequently, ideally every 12 hours (Proulx and Rodtka, 2019).

**Trophy hunting**

Trophy hunting often involves the use of methods which are less likely to result in a quick death for the target animal, e.g. bows and arrows, and many trophy hunters are not expert shots (Jones and Draper, 2018). As part of the animal’s body (often the head) will be retained as a trophy, this area is not targeted to avoid damaging it, meaning that the weapon and/or target area is not necessarily chosen with the aim of minimising negative welfare consequences. The killing of Cecil the Zimbabwean lion (*Panthera leo*) by a trophy hunter in 2015 sparked intense public interest because he was part of an ongoing research project and had been lured out of a national park to an area where hunting was permitted. Cecil was initially shot and wounded with a bow and arrow before being killed many hours later.

The practice of canned hunting, where animals are bred to be shot by trophy hunters, raises several concerns including the poor conditions in which they are kept (Feber et al., 2020) and the hand-rearing of cubs so that the mothers will be ready to breed again in a short period of time (Jones and Draper, 2018). Tourists are sometimes allowed to interact with these cubs – an activity which also has negative welfare consequences (Hunter et al., 2012).

When animals are bred and raised to be hunted, their welfare at other points of their lives needs to be considered (not just the moment when they are hunted). In the UK, over 40 million pheasants (*Phasianus colchicus*) are bred and released to be hunted each year (Feber et al., 2020). Although welfare guidelines for their rearing are available (DEFRA, 2010), these birds are susceptible to starvation, disease, predation, and roadkill (Feber et al., 2020).

**Wounding**

If an animal is not killed outright but is wounded by a shot, for example, then its welfare will be negatively impacted to some degree and for some duration. A seriously wounded animal could die relatively quickly (after a few minutes or hours) whereas an animal with a less serious wound could live for several days or weeks (Fox et al., 2005) in pain and with difficulties carrying out necessary behaviours such as foraging. The animal may also suffer sickness, discomfort, and psychological effects. Welfare may be very poor before the animal finally succumbs (Broom, 1999). It is, therefore, important that hunters are able to determine when an animal has been wounded, so that they can locate it and humanely kill it. Stokke et al. (2018) proposed a way...
Hunting, fishing, and whaling

to assess animal welfare outcomes in the field during the hunting of terrestrial mammals based on body mass and flight distance. Such wounding thresholds may be affected by factors such as terrain, weather conditions and animal stress levels.

Aebischer et al. (2014) assessed wounding of deer shot with rifles. Of 2,281 first shots, 4.5% resulted in a clean miss, 88.8% resulted in the deer being killed instantly and 6.7% wounded the deer. Of the wounded animals, 81.7% were killed with a subsequent shot and 18.3% escaped. The authors, therefore, estimated wounding rates of 1–12%, although a worst-case scenario (where apparently missed animals were actually wounded) would give wounding rates of 3–17%. Bow hunting has been associated with high rates of wounding and increases the risk of a slow and painful death (Gamborg et al., 2020). In two white-tailed deer (*Odocoileus virginianus*) hunts in the USA, there was an 18% wounding rate for animals shot with modern compound bows or crossbows (Pedersen et al., 2008) and a 50% wounding rate for those shot using traditional archery equipment (recurve and longbows) (Ditchkoff et al., 1998).

**Hunter skill level**

Wounding and other negative welfare outcomes tend to be more common in recreational hunts, whereas professional culling techniques usually have very low nonfatal wounding rates (Hampton and Hyndman, 2019). However, Caudell et al. (2009) found that many people involved in wildlife management using firearms are not adequately trained.

Accuracy (how closely a projectile strikes to a target) and precision (the closeness of shots to each other) are important and can be affected by the stability of the shooting platform and the hunter’s position (Hampton et al., 2021), and a number of best practice recommendations have been made, including regular hunter training (for example by Aesbischer et al., 2014). In Denmark and Norway, crippling rates of pink-footed geese (*Anser brachyrhynchus*) were reduced thanks to awareness campaigns and appropriate hunter training (Clausen et al., 2017).

**Effects on non-target animals**

To prevent young animals from being orphaned and starving, close seasons are imposed at particular times of year for certain species (Nunny, 2020). However, there are many examples of animals not being protected, e.g. in England and Wales there is currently no close season for hares (*Lepus europaeus*) meaning that young hares (leverets) can starve to death if their mothers are killed (Butterworth et al., 2017a). A close season is being considered by the British government (DEFRA, 2021).

The removal of an individual animal from a social group or population can have welfare consequences for other animals. For example, the killing of a male lion may lead to other males replacing him, often with the accompanying infanticide of cubs (Whitman et al., 2004), whilst the removal of a matriarch African elephant (*Loxodonta africana*) can have consequences for the rest of her group because she influences their social knowledge (McComb et al., 2001).

The welfare of domestic animals used in hunts also deserves consideration. In Australia, there is a lack of information regarding the health and welfare of hunting dogs (Orr et al., 2019). Many are trained using aversive training techniques such as electric shock collars which can increase anxiety and aggression, reduce motivation, and create other conditions (Australian Veterinary Association, 2014). Orr et al. (2019) expressed concern over the health of hunting dogs due to their poor living conditions and because they are exposed to diseases and parasites, injuries sustained during the hunt and increased risk of heat exhaustion, poisoning, being hit by vehicles, snake bite, accidental shooting, and dehydration.
Humane alternatives

If the aim of the hunting or trapping is to control a pest or predator, then there are many non-lethal alternatives available such as enclosures, livestock guarding, the use of deterrents and repellents, or translocation (see Nunny, 2020 for a discussion). Fertility control reduces or eliminates the need for lethal control and may have some welfare benefits by averting the physical risks and energetic costs of pregnancy, birth, and lactation for female animals (Gamborg et al., 2020). However, it may present some welfare challenges itself, for example, when fertility control drugs are administered to deer, the animals may experience fear and pain, and, depending on the drug given, behaviours such as rutting and mating may be suppressed or unnaturally extended. These behavioural changes could lead to negative welfare or, at least, prevent the possibility of positive welfare being experienced (if mating and raising offspring are considered to be rewarding experiences).

Fishing

Do fish feel pain?

Browman et al. (2019) discuss which aquatic animals experience pain and recommend that fish welfare assessments should be based on indicators of stress, health status and behaviour specific to the situation and species. Some authors, e.g. Rose et al. (2014) have concluded that from the behavioural and neurobiological evidence, fish have limited responses to nociceptive stimuli and are unlikely to experience pain. However, other experts assert that there is evidence that fish have nociceptive systems similar to those of mammals and that the behavioural and physiological changes they exhibit following potentially painful events are indicative of a pain response (Sneddon, 2020). Fish will avoid areas where they have experienced pain demonstrating cognitive engagement including learning and memory, and an emotional response (e.g. fear) to the negative stimuli (Vila Pouca and Brown, 2017; Sneddon, 2020). The painful event may be so consuming that they cease to exhibit normal fear or antipredator responses (Sneddon, 2020).

Recreational fishing

Although some fish are harvested and killed during recreational fishing, many more are released during catch-and-release angling (Cooke and Sneddon, 2007). Fish may be released because they are not the target species, because they are undesirable in some way (sex, size, food value) or because there is a regulation in place to preserve resources. There has been a lot of debate in recent years about the consequences of catch-and-release and it is generally recognised that all caught fish will experience some level of injury and stress (Brownscombe et al., 2017).

When a fish is caught with a hook the extent of injury or tissue damage will depend on where on the body the injury is and the type of fishing gear used (Cooke and Sneddon, 2007). Most fish are hooked in the jaw/mouth area, subsequently impacting respiration (ventilation), foraging and feeding, reproduction (e.g. in the case of mouth brooding), or social interactions. Eye injuries are also common, taking place during hooking and handling. Impaired vision has been linked to mortality and may affect behaviours such as foraging, predator avoidance and finding a mate.

Landing is a key moment regarding welfare outcomes as fish can be exposed to air and can be injured by the landing gear, handling by the angler, or from contact with other surfaces (e.g. boat, shore) (Brownscombe et al., 2017). Bluegill (Lepomis macrochirus) that were kept in a land-
Hunting, fishing, and whaling

ing net for 30 seconds had increased fin abrasion compared to fish that were angled and held out of the water but which were not netted (Barthel et al., 2003). Scale and mucous loss also increased for netted fish, as did mortality rates post-treatment.

Lure type, size, and the number of hooks used all influence fish injury and handling time for dehooking indicating that lure choice is important for ensuring improved animal welfare outcomes (Clarke et al., 2021). Dehooking time depends on the number of hooks and the location of the hook on the fish’s body. Hooks left in place in a released fish may subsequently be expelled or may remain embedded in the oesophagus, gut or throat leading to lesions and infections (Cooke and Sneddon, 2007). Further research is needed so that advice can be given to anglers about whether to remove or leave hooks.

Angler experience, knowledge, and skill can all impact fish welfare outcomes. When an angler is unprepared in terms of tools (including hook type, landing gear, unhooking tools) and knowledge then the fish is more likely to experience stress and injury (Brownscombe et al., 2017).

Killing methods

If a fish is bleeding, injured, deeply hooked, hooked in a vital organ, severely exhausted, or if the hook cannot be removed without causing significant damage, then experts recommend that the fish should be killed using a method which minimises stress and suffering prior to unconsciousness (Davie and Kopf, 2006). Davie and Kopf (2006) recommend percussive stunning of the cranium to cause immediate death or unconsciousness, followed by pithing, exsanguination, or decapitation to prevent the fish from recovering consciousness. They recommend bleeding-out for active fish such as Salmonidae which require high concentrations of oxygen, and suggest that pithing (only after stunning) may be more appropriate for less active fish, e.g. catfish (Ictaluridae), which can survive for longer with poor blood flow to the brain. Pithing (or spiking) involves inserting a rod into the cranial cavity to destroy the central nervous tissues. Bleeding-out without prior stunning can lead to fish showing aversive behaviour and results in a slow death (Robb and Kestin, 2002).

Other killing methods which are considered unacceptable on welfare grounds include hypothermia (through the use of ice slurries) and asphyxia (death caused by lack of oxygen) (Davie and Kopf, 2006). Fish placed in ice slurries or exposed to air die from hypoxia (oxygen deficiency). In higher ambient air temperatures, fish die more quickly and with increased stress levels, whereas fish in ice slurries die more slowly but with a lower physiological stress response. Hypoxic-tolerant fish will die more slowly than active fish species. Due to the slow TTD or TIU, ice slurries and asphyxia are not considered appropriate killing methods (Davie and Kopf, 2006).

Subsistence fishing

Subsistence fishers around the world use a number of different fishing methods including hook and line, purse seine nets, gillnets, longlines, dredging, traps, pots, spears or harpoons, and even dynamite (FAO, 2015). Different fishing methods have different welfare outcomes. Not all can be reviewed here but it is noted, for example, that gillnets can cause scale, skin, and fin injuries, stress, and asphyxiation, whilst fish caught on hooks will have injuries to their mouth, throat, or gut (Veldhuizen et al., 2018; Brown and Dorey, 2019). Fish caught at depth may exhibit pressure injuries, and greater capture depth and longer fishing duration results in more injuries.
across a range of gear types (Veldhuizen et al., 2018). The use of explosives not only has welfare consequences but severe environmental impacts as all fish and many other organisms in a 15–20 m radius are killed or injured and habitat, e.g. coral reef, is completely destroyed (Slade and Kalangahe, 2015).

Diggles et al. (2011) assert that for many subsistence fishers it would be financially, logistically, and even culturally impossible to adapt traditional fishing methods to take animal welfare into account.

Bycatch

Bycatch, whereby non-target species are caught incidentally by fishers, is recognised as a major problem in commercial fisheries but it also takes place in subsistence or artisanal fisheries and often at alarmingly high levels. For example, artisanal fisheries based at the port of Salaverry, Peru take approximately 2,412 small cetaceans as bycatch each year (Mangel et al., 2010), as well as leatherback turtles (Dermochelys coriacea) which are either released alive or are landed for human consumption (Alfaro-Shigueto et al., 2007).

The welfare consequences for bycaught animals may be severe with most bycaught dolphins asphyxiating and experiencing a period of extreme stress before they succumb (Dolman and Moore, 2017). Animals which escape or are released from nets may be injured and/or effected by stress leading to behavioural changes and physiological costs which can impact their welfare and survival. Bycaught loggerhead turtles (Caretta caretta) have been recorded as suffering from decompression sickness evidenced by gas embolisation (GE) after being caught in trawls and gillnets at depth (García-Párraga et al., 2014). Turtles with GE that are released alive, may die within hours or days of release. Non-target fish species taken as bycatch experience trauma whilst trapped in fishing gear or during hauling (Metcalfe, 2009). If the fish are released alive, their subsequent welfare and survival will depend on injuries and stress sustained when they were bycaught.

Whaling

Since 1990, people in at least 114 countries have taken one or more of at least 87 marine mammal species (Robards and Reeves, 2011). This is principally to provide food, although arguments about killing fish-eating mammals as a form of pest control prevail in many places. Japan has the largest-scale targeted takes and also takes the highest diversity of species (32).

Table 16.1 provides a summary of some of the better known cetacean hunts, outlining the species taken and the wide range of methods deployed. An idea of scale is provided by the figures for 2019 where available. Here we focus on two types of cetacean hunting that have been subject to critical scrutiny.

The International Whaling Commission (IWC) currently calculates and endorses quotas for member nations under its aboriginal subsistence whaling category and this form of whaling continued after the IWC’s international moratorium on commercial whaling came into force in 1986. Norway took out a legal objection to the moratorium and, hence, legally whales “under objection”. The IWC’s ‘Whale Killing Methods and Welfare Issues Working Group’ considers welfare, including information related to whale hunting methods, and last met in 2018 (IWC, 2018). In recent years, several whaling nations have preferred to provide relevant information to the North Atlantic Marine Mammal Commission (NAMMCO) instead. NAMMCO’s Committee on Hunting Methods was established in 1994 and it also hosts other relevant groups and publishes their reports on its website.
**Table 16.1 The better-described cetacean hunts of recent years**

<table>
<thead>
<tr>
<th>Country</th>
<th>Species</th>
<th>Killing methods</th>
<th>Notes</th>
<th>2019 take</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Bowhead whale, narwhal, beluga, harbour porpoise, white-beaked dolphin, Atlantic white-sided dolphin.</td>
<td>DARTING gun and pENTRITE grenades for the bowheads. Rifles for the smaller species.</td>
<td>Ongoing hunts.</td>
<td>4 bowheads taken. Some 1,300 others.</td>
</tr>
<tr>
<td>Faroe Islands</td>
<td>Long-finned pilot whale, bottlenose dolphin, white-beaked dolphin and Atlantic white-sided dolphin.</td>
<td>Drive hunting: animals are herded into the shallows and then killed with sharp instruments.</td>
<td>Ongoing hunts.</td>
<td>682 long-finned pilot whales and 10 Atlantic white-sided dolphins</td>
</tr>
<tr>
<td>Greenland</td>
<td>Narwhal, beluga, common minke whale, fin whale, humpback whale, bowhead whale, harphead whale, long-finned pilot whale, Atlantic white-sided dolphin, white beaked dolphin, orca, northern bottlenose whale.</td>
<td>PENTRITE grenades as primary and secondary method for the larger species and pENTRITE grenades as primary with high calibre rifles as the secondary killing method for the common minke whale, apart from the “collective” hunt for common minke whales which uses non-explosive harpoons and rifles. Other species are mainly taken with rifles of various calibre. Narwhal and beluga are hunted by harpoon from qayaqs and with rifles from small boats. In some places in northern and eastern Greenland, narwhal and beluga are also captured with nets.</td>
<td>Ongoing hunts.</td>
<td>536 narwhals, 265 beluga, 171 common minke whales, 8 fin whales, 4 humpback whales, 2,569 harbour porpoises, 285 long-finned pilot whales, 126 Atlantic white sided/white-beaked dolphins, 31 orcas, 8 northern bottlenose whales.</td>
</tr>
<tr>
<td>Iceland</td>
<td>Common minke and fin whales.</td>
<td>PENTRITE harpoon plus secondary killing methods when necessary.</td>
<td>No whaling in 2019 or 2020.</td>
<td>0 (Continued)</td>
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### Table 16.1 (Continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>Species</th>
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<th>Notes</th>
<th>2019 take</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Sei whale, common minke whale, Bryde’s whale.</td>
<td>Penthrite harpoon plus secondary killing methods as required.</td>
<td>Japan left the IWC in 2019 and after this has, to date, restricted its cetacean takes to its exclusive economic zone. 25 sei whales, 187 Bryde’s whales and 123 common minkes taken.</td>
<td></td>
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<tr>
<td></td>
<td>Baird’s beaked whale, short-finned pilot whale (‘northern’ and ‘southern’ ‘forms’), Risso’s dolphin, false killer whale, striped dolphin, bottlenose dolphin, pantropical spotted dolphin, Pacific white-sided dolphin, Dall’s porpoise (‘Dalli type’ and ‘Truei-type’), rough-toothed dolphin, melon-headed whale.</td>
<td>‘Small-type, whaling’ (i.e. smaller vessels with smaller harpoon canons), hand-harpoon, drive hunting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>Common minke whale.</td>
<td>Penthrite harpoon plus secondary killing methods when necessary.</td>
<td>Ongoing hunt. 429 taken including 2 lost.</td>
<td></td>
</tr>
</tbody>
</table>

(Continued)
Hunting, fishing, and whaling

Table 16.1 (Continued)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>St Vincent and the Grenadines</td>
<td>Humpback whales,* Atlantic spotted dolphin, short-finned pilot whale, spinner dolphin, Fraser’s dolphin, orca, false killer whale, Risso’s dolphin, rough-toothed dolphin, melon-headed whale, dwarf sperm whale, pygmy killer whale, common bottlenose dolphin, Gervais’ beaked whale, Clymene dolphin, striped dolphin, pantropical spotted dolphin.</td>
<td>Harpoons.</td>
<td>Ongoing hunts.</td>
<td>3 humpbacks taken. More than 500 from other species taken annually.</td>
</tr>
<tr>
<td>USA</td>
<td>Bowhead whale,* beluga also taken.</td>
<td>For Bowheads: Penthrite projectile (darting gun) alone; the penthrite projectile (darting gun) with a black powder shoulder gun as a backup; or black powder (darting gun) with a black powder shoulder gun as a backup.</td>
<td>Ongoing hunts.</td>
<td>36 Bowhead taken. 6 struck and lost. Figures for belugas not found.</td>
</tr>
</tbody>
</table>

* indicates that these takes are classified as Aboriginal Subsistence Whaling and are granted a quota by the IWC.

Sources: NAMMCO, 2011, 2015; Altherr and Hodgins, 2018; IWC 2018; Minamikawa, 2020; IWC, 2021; Simmonds et al., 2021; Whaling.fo, 2021.

The hunting and killing weapons used for cetaceans (alone or in combination) are (NAMMCO, 2011, 2015; Øen, 2021):

- Cold harpoons (i.e. non-explosive) delivered by harpoon gun or by hand;
- Explosive grenades delivered by harpoon gun or darting gun (only used on large cetaceans);
- Firearms – rifles and various types of ammunition;
- Lances/spears and knives;
- Nets.
Vessels are used in many hunts to get close enough to strike or shoot and, in some hunts, to drive animals to shore. Cetaceans also need to be secured, so that they do not escape or sink once struck. This explains the prevalence of various types of harpoons with barbs or toggling claws that embed in the flesh of the animals and which are typically attached to an appropriately robust rope, allowing the animal to be winched in.

The three key factors related to the humaneness of cetacean hunting are: firstly, the actions leading up to the animals being killed, particularly whether they are chased or confined, both of which can cause stress. Secondly, the actual killing method deployed linked to the time taken until the animal is deemed to have died or be insensible prior to death. TTD and Instantaneous Death Rates (IDR) are key terms in the assessments. The rapid subduing of the animal is also an issue for the hunters’ safety, given that these large animals may thrash around when struggling to escape or in their death throes. A further reason for trying to quickly render the animal immobile is that this reduces its opportunity to escape. This links to the third key attribute, the issue of “struck and lost”, which typically refers to animals that have been hit with a harpoon or shot but then lost and a similar concept applies to animals that have been otherwise captured (e.g. driven ashore as part of a drive hunt) but were then either released or escaped.

**Commercial take of large whales**

**The chase**: large-scale whaling in Norway, Iceland, and Japan in recent years has been conducted from dedicated whaling vessels or modified multi-purpose fishing vessels, all of which use a harpoon tipped with a penthrite explosive-containing grenade, which is fired from a harpoon canon.

In the Norwegian hunt, there is reported to be no chase (Øen, 2021). The boat approaches the whale and manoeuvres to strike it from the side, rather than from behind or the front, which both offer smaller targets. By contrast, Japan’s large whale hunting both chases the whale (apparently using sonar) and, also, tends to fire the harpoon from behind (NAMMCO, 2015). Both factors are bound to increase TTD and decrease IDR.

**The kill**: determining death or insensibility in mammals that can hold their breath for considerable periods of time is challenging. Additionally, reflex movements, such as the thrashing of the tail or flukes, may be exhibited for several minutes after loss of consciousness or even death. The grenade explodes when the harpoon has penetrated about 70 cm inside the whale and, in the Norwegian hunt, rifles of calibres .375 and .458 aimed at the whale’s brain are used as a secondary killing method when the animal has not been killed outright (Øen, 2021). Norwegian gunners have to pass annual shooting tests with the harpoon canon and backup rifle and, from 2006 onward, the hunt has been monitored by an electronic trip recorder and “spot controls” in harbours. Studies in Norway have shown that the range, the size of the whale, and the angle of the shot relative to the animal’s long axis all strongly influenced survival time.

The TTD data available from recent commercial hunts are in most cases far from comprehensive and, as differing methods may have been used to gain and analyse them, comparisons between hunts are difficult and may not be valid. However, here are some examples: in the Norwegian hunt, TTD data for 271 common minke whales (*Balaenoptera acutorostrata*) taken in 2011 and 2012 showed an IDR of 81.9% with an average TTD of 60 s (Øen, 2021). The median TTD for the 49 whales that were not recorded as instantly dead was 300 s, and one that had only been wounded was reshot after 20–25 minutes. Similarly, in a sample of Iceland’s minke whale hunt, 9 (69%) of 13 whales taken in 2014 and 2015 were reported instantly dead (NAMMCO, 2015). The median survival time for the 4 whales that did not die instantly was 4 minutes, with one recorded as surviving for 13 minutes. In a sample from Iceland’s fin whale (*Balaenoptera physalus*) hunt in 2014, 42
Hunting, fishing, and whaling

whales (84%) were recorded as instantaneously killed. The others (8) were re-shot with penthritegrenades, and their median survival time was 8 minutes, with the longest TTD being 15 minutes.

Data reported from Japan from 2010–2015 for sei whales (*Balaenoptera borealis*) show TTD of 2–4 minutes and an IDR of 48–60% depending on the year (NAMMCO, 2015). Data for Bryde's whales (*Balaenoptera brydei*) appear broadly similar. Information is not provided about the whales that did not instantaneously die.

**Struck and lost:** recent data on the very sensitive issue of recent struck and loss rates appears scantly, but some examples are noted in Table 16.1.

**Drive hunting in Taiji, Japan**

The chase: the animals are herded by a coordinated group of fishing vessels deploying noisecreated by fishermen banging on trumpet-shaped metal poles. This generates powerful acoustic signals (greater than 170 dB) inducing flight, escape and avoidance behaviours (Vail et al., 2020). The primary sense of cetaceans is hearing and the deployment of loud noise is likely to be highly stressful.

The kill: The animals are driven into a bay which is then closed off with a net. Previously they were killed by lances that were thrown at them but, in 2000/2001, trials were started with a “spinal lance”. This is a narrow metal blade inserted posterior to the blow hole and intended to sever the spinal cord and key blood vessels (NAMMCO, 2015; Butterworth et al., 2017b). This method is based on that used in the Faroe Islands and now seems to be the main killing method. In 2009, apparently because of adverse publicity linked to the reporting of clouds of blood in the water, the Taiji hunters modified their methods. A narrower lance/rod was used to minimise the area of the wound and a wooden plug was then inserted into the wound. This approach was criticised by the NAMMCO Expert Group which “emphasised that the process of bleeding out animals is part of the killing process and that it is a widely accepted principle both from an animal welfare point of view and from the point of view of meat quality”. Butterworth et al. (2017b) analysed this method, concluding that whilst it would cause damage to the vertebral blood vessels and the complex nets of blood vessels around the head, leading to significant haemorrhage, it would not lead to a rapid death in a large mammal of this type. The method causes paraplegia and death through trauma and gradual blood loss. An animal that is paralysed would be less of a hazard to the hunters.

Once contained at the shoreline, the dolphins are sometimes held up to five days before they are either selected for slaughter or, in the case of a small minority, sold to dolphinariums, or they are released. Those to be killed are roped around their tails and towed backwards to the killing area. Vail et al. (2020) concluded that the prolonged and strenuous chase and herding, capture, and restraining of the dolphins in Taiji can result in acute stress and injury.

Lost and released animals: individuals, including calves, are sometimes released, probably so as not to violate quotas but this process involves their rough handling further to being stressed and exhausted from the chase. Calves are unlikely to survive and this may also be true of injured and heavily stressed adults.

In many instances, these highly social and intelligent animals will be aware of the herding, captivity and killing of the other members of their groups. Butterworth et al. (2017b) concluded “from a scientific, humane and ethical perspective, the treatment of dolphins in drive hunts sharply contradicts current animal welfare standards employed in most modern and technologically advanced societies”. They also noted that ‘termination of movement’ is not a credible measure of death for a mammal, highlighting that in this instance it could be the result of severance of the spinal cord.
Consideration of these examples of cetacean hunting clearly shows effort to improve the efficiency and humaneness of whale hunting in Norway. Arguably the biggest step in this being when cold (non-explosive) harpoons were replaced with grenade harpoons in the 1980s, when IDR went from 17% to 44.8% (Øen, 2021). Other improvements followed but many would still argue that even the relative efficiency of the hunt in Norway still does not compare well with the methods used to kill farmed animals in abattoirs and clearly animals that are not killed outright or, even worse, struck and lost may have prolonged and painful deaths. Japan’s whaling activities seem less transparent; its large whale takes are less efficient and its drive hunting raises highly significant welfare concerns.

The hunts focused on here are only a small part of the full picture. Approximately 100,000 small cetaceans (all the toothed cetaceans bar the sperm whale *Physeter macrocephalus*) are intentionally killed each year worldwide (Altherr and Hodgins, 2018). In most cases, these hunts are unregulated, or even illegal and poorly documented.

**Conclusions**

Compared to farmed animals, companion animals and animals used in research, there have been relatively few independent studies assessing how animal welfare is impacted in hunting, fishing, and whaling scenarios. Many welfare issues are identified here and the killing of cetaceans, in particular, is worrying, noting that many hunts are not documented at all or only poorly. Some authors, e.g. Nunny (2020); Proulx et al. (2020), have called for the development of appropriate and widely accepted animal welfare assessment approaches which can be used in predator control, trapping, and other hunting scenarios.

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Hunting, fishing, and whaling


