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Troubled waters: A case study of cohabitation conflicts for a leopard seal, *Hydrurga leptonyx* de Blainville, 1820 (Mammalia Phocidae) in northern New Zealand

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ABSTRACT The >9.5-year residency of an adult female leopard seal, *Hydrurga leptonyx* de Blainville, 1820 (Mammalia Phocidae) in New Zealand (NZ) provided an opportunity to investigate this species in the framework of human-wildlife conflicts and management. We examined >2,000 sighting records and collated observations of this leopard seal. We qualitatively describe conflicts originating from both the humans and leopard seal's perspectives. Humans created conflicts for the leopard seal by providing misinformation about the species (and therefore negatively influencing public perception), making proposals or threats to disturb/harm, and causing inconvenience, tension, disputes, disturbance and harm to her. Conversely, the leopard seal created conflicts for humans including, causing inconveniences, tension, damage to property and disturbance. Short-term mitigation tools along with longer-term preventive strategies to reduce, mitigate and/or eliminate these conflicts are provided and we recommend that the NZ Government Authorities, who are legally mandated to protect the species, take the lead in implementing these in collaboration with stakeholders. Implementation of these tools and strategies, in a proactive rather than reactive manner, will assist with protection and management of leopard seals in all areas where they cohabitate with humans (both within NZ and internationally).

KEY WORDS Cohabitation; human-wildlife conflict; leopard seal *Hydrurga leptonyx;* marine mammal management; pinniped, urban wildlife

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INTRODUCTION

As human populations continue to expand, the frequency of interactions with wildlife in urban areas increases, as does the number of human-wildlife conflicts (Soulsbury & White, 2015). Such conflicts are multifaceted, intertwined and complex (Zimmerman et al., 2020) and in order to better manage them, whilst also preserving biodiversity, it is important to identify and understand issues that develop and escalate.

The majority of the documented human-

wildlife conflicts involve terrestrial mammals. Although pinnipeds occupy both marine and terrestrial ecosystems and have long been in conflict with humans (Heredia-Azuaje et al., 2021), conflicts with leopard seals, *Hydrurga leptonyx* de Blainville, 1820 (Mammalia Phocidae) have primarily been documented in Antarctica and are, due to the sparsity of humans in that region, relatively rare (Muir et al., 2006a). In New Zealand (NZ), leopard seal occupation overlaps significantly with human populations (Hupman et al., 2020). While leopard seals in NZ were previously classified as a 'Vagrant' species, they have recently been reclassified as 'Resident' (Hupman et al., 2020) based on *inter alia,* the species being documented in NZ; since the 1200's (Smith, 1985); year-round, in all regions (Hupman et al., 2020); at major coastal cities (LeopardSeals.org unpublished data) and; giving birth (Hupman et al., 2020; van der Linde et al., 2022a). The species has also been recognised as an important part of NZ's cultural heritage, including recognition by Iwi who have bestowed a range of names on them; *rapoka*, *pakaka*, *popoiangore* or *poipoiangori* (see Note 1).

As the number of leopard seal sightings in NZ increases, so too does the number of individuals residing in populated urban areas of the country. By default, the number which are encountered by humans has also increased. As there is an absence of large terrestrial mammalian predators (King & Forsyth, 2021) in NZ, members of the public are not frequently exposed to apex predators. Perhaps as a consequence, this has resulted in conflicts between humans/dogs and leopard seals.

As part of ongoing research by the non-profit NGO LeopardSeals.org, we present a case study of the cohabitation conflicts (hereafter referred to as conflicts) faced by an iconic adult female leopard seal, known in the NZ Leopard Seal Catalogue as HLNZ-001, or colloquially as 'Owha' (van der Linde & Visser, 2020; van der Linde et al., 2022b) (see Note 2).

We developed a framework for categorising conflict types and suggest strategies to reduce, mitigate and/or eliminate these conflicts.

MATERIAL AND METHODS

Identification and Records of HLNZ-001

HLNZ-001 was identified using unique pelage patterns and distinctive scars. For example, she exhibits a V-shaped scar posterior to the gape on the left-side of her face (Visser et al., 2022) and a crescent-shaped scar in conjunction with two parallel scars (van der Linde et al., 2022b).

Over 2,000 sightings of HLNZ-001 were recorded between 07 October 2012 (when she was recorded for the first time near Dunedin Harbour, Otago region) and 2 June 2022 (when she was recorded in the Waitematā Harbour, Auckland region), i.e., she was recorded in NZ waters for >9.5 years; van der Linde et al., 2022b). She was found in four regions during that time; from north to south; North Island (Northland, Auckland, Bay of Plenty) and South Island (Otago) (see Note 3).

Conflict framework

We used the sightings of HLNZ-001 and observations of conflicts to qualitatively categorise conflicts by origin (i.e., if a human/dog or the leopard seal caused the conflict). We defined nine conflict types and ranked them in order of general increasing severity: (1) Lack of information/misinformation; (2) accidental/incidental event; (3) inconvenience; (4) tension; (5) dispute; (6) proposal/threat to disturb/harm; (7) damage; (8) disturbance and (9) harm (Table 1; Supplemental Materials (SM) S–1). Two assessors examined all sightings of HLNZ–001 independently and categorised conflicts that occurred into one of these nine categories.

Taking into consideration the complexity of wildlife conflicts (Zimmerman et al., 2020) we used the following criteria when ranking severity; the general ranking was determined by the level of impact to the leopard seal. However, where logical, equal consideration was given to both the effects on the humans/dogs and leopard seals; nevertheless, we considered the detrimental impacts to the leopard seal as ranking higher in severity than financial impact to humans. Also, the severity ranking may have changed depending on any given scenario, for example, disturbance may have occured concurrently with and/or after harm. Likewise, overlap may have occurred between conflict types and/or multiple conflicts may have been representative of any single event, particularly as an event escalated in severity (see Note 4).

Severity increases ↓	Conflict type	Definition	Conflict origin
	Lack of information / misinformation	*Lack of information*: A lack of dissemination of knowledge. *Misinformation*: Dissemination of incorrect knowledge and/or distortion of facts and/or narratives.	H/D
	Accidental / incidental event	*Accidental*: An unintentional event caused by chance which also includes an element of carelessness, inattention or naivety. *Incidental*: A event which results from an action where precedence has shown conflict is likely to occur.	H/D & LS
	Inconvenience	An action which is troublesome or difficult and compromises comfort and/or requirements.	H/D & LS
	Tension	An action which causes mental, emotional and/or financial strain. For an animal, this may result in being on high alert or stressed, both of which may not be externally visible (noting that high tension levels would escalate to disturbance).	H/D & LS
	Dispute	An action which starts or results in a disagreement and/or argument.	H/D
	Proposal / threat to disturb / harm	*Proposal*: A request to disturb or harm. *Threat*: A statement with intent to disturb or harm, typically in retribution for an action (noting that inaction can also lead to this conflict).	H/D
	Damage	Physical harm that impairs the value, usefulness or normal function of an inanimate object.	LS
	Disturbance	An event which alters one's mental/physical function and is externally visible.	H/D & LS
	Harm	Compromised animal welfare or physical injury and/or death, including that which is deliberately inflicted.	H/D & LS

Table 1. Conflict types, in order of general increasing severity. Conflict types were categorized by origin from the human and/or dog (H/D) or the leopard seal (LS). See S-1 for further details and specific examples.

Furthermore, there may have been various levels of severity within any one conflict type (see Note 5).

Government management of conflicts

In NZ, the Government Authority legally mandated to protect marine mammals is the Department of Conservation (DOC). It was established in 1987 under the Conservation Act (see Note 6) and amongst other aspects, it is responsible for the "*provision of educational and promotional conservation information*" (see Note 7). As governments typically play a key role in wildlife conservation, including in NZ (Press et al., 1996; Towns et al., 2019), we assessed DOC's, management of conflicts specifically related to HLNZ–001.

RESULTS

Conflict types

Categories of conflicts

All nine conflicts were assigned as originating with either the human and/or dog (Figs. 1–8) or the leopard seal (Figs. 9–16) (Table 1; S–1) and there was no discrepancy amongst assessors. There was only one sighting in both the Otago and Bay of Plenty regions and neither of those involved conflicts. Instead, all conflicts were witnessed in the Northland and Auckland regions.

Lack of information/misinformation

Prior to 2015 there had been a consistent paucity of information about leopard seals in NZ, despite an increase in the number of sightings (Hupman et al., 2020) and callouts for this species (see Note 8).

There have been many examples of statements based on outdated information. For example, as of December 2022, the DOC webpage contains outdated and misleading information about leopard seals. For example, it portrays leopard seals as more aggressive than other seal species when it incorrectly states "*They are the only seals known to regularly hunt and kill warm-blooded prey, including other seals*" (see Note 9). To put this into perspective, it has long been established via scientific research, that a wide range of pinniped species regularly feed on other pinnipeds including the endemic NZ sea lion (*Phocarctos hookeri* Gray, 1844) which was first documented at least 30 years ago feeding on three species of seals (Bradshaw et al., 1998) and more than 20 years ago conducting infanticide and cannibalism (Wilkinson et al., 2000) (see Note 10).

There were instances where DOC provided misinformation to the media, which vilified leopard

seals and thereby influenced public perceptions of this species. For example, in 2018, DOC disseminated an official press release via their website, which contained a comment from a DOC Biodiversity Ranger who stated that leopard seals "… *could easily crush a person simply by rolling over*" (see Note 11). Almost to the day but a year later, that identical quote from the now DOC Senior Biodiversity Ranger, was recycled in another press release (see Note 12). In a similar fashion, another DOC ranger was quoted by Radio NZ in 2018, stating that being near the species was "*...like getting into a cage with a lion or a tiger* …" (see Note 13). In addition, in another media article, a DOC spokesperson stated, "*Apart from a human, it's probably the most dangerous mammal you are likely to encounter on New Zealand shores*" and "… *they will make a mess of your dog*". DOC statements such as these are regularly referenced by the media, resulting in misinformation being amplified and perpetuated.

Other examples of misinformation, even though they may not have a profound impact by impugning the species reputation, do influence public perception of leopard seals. For example, DOC has an official education pamphlet (see Note 14) titled "*The Seal Deal*" which focuses on the NZ fur seal (*Arctocephalus forsteri* Lesson, 1828), but also contains an isolated and incongruous reference to leopard seals stating that "*Leopard seals, pakaka, haul out infrequently on southern beaches, resting their spotted bellies in the sand*.". This statement implies that the species is found only occasionally in NZ and only on beaches and only on the South Island. This is despite leopard seals being found year-round and in all regions of the country (Hupman et al., 2020) as well as in a wide range of habitats other than beaches (LeopardSeals.org unpublished data).

Accidental/incidental event

We have records of vessels approaching (typically at fast speeds) while HLNZ–001 was swimming (Fig. 1). The skippers were apparently unaware of her presence (likely due to her low profile in the water), but the close approaches could have led to an accidental boat strike.

Methods have been used by members of the public, marinas and DOC to displace HLNZ–001 from certain areas, some of which created potential conflicts, such as incidental entanglement. For example, DOC attempted to prevent HLNZ–001 from hauling out on pontoons which she frequently used inside a marina by installing a polypropylene rope with bunting (small plastic flags), tied to a series of large buckets filled with water, along all the outer edges of a pontoon (Fig. 17). LeopardSeals.org researchers expressed concerns over the deployment of this deterrent, as it presented an entanglement and drowning risk for HLNZ–001 (see Note 15). An alternative to this deterrent was bins filled with water (i.e., no rope or bunting is used), which were successfully deployed by LeopardSeals.org in other locations with the same leopard seal (Fig. 18), however this method was not implemented by DOC. Another example of an incidental event is when HLNZ–001 ingested foreign objects (such as plastic, pieces of fender, fishing line and multiple fishhooks) or had them embedded into her (such as fishing lures and fishing hooks; Fig. 2), of which some were removed (Fig. 19).

HLNZ–001 has also accidentally (the first time she completed the action) and incidentally (subsequent times she completed the action) damaged property such as sinking dinghies when she tried to haul-out (Fig. 9). We note that this example overlaps with the conflict type 'damage' (see details below).

Inconvenience

Humans created inconveniences for HLNZ–001 such as interfering with her chosen haul-out areas (e.g., HLNZ–001's most frequently used pontoon), leading to displacement. HLNZ–001 also created inconveniences for humans such as defecation on property (Fig. 10), blocking foot-traffic areas (such as walkways; Fig. 11) and preventing the use of equipment (such as fuel docks; Fig. 12 and/or vessel support cradles; Fig. 13).

Tension

Humans created tension for HLNZ–001 when they non-physically engaged with her (e.g., flapping a towel vigorously at her face or creating noise), causing her to remain on high alert / increased wariness. They also physically made contact with HLNZ–001 (e.g., approaching her closely to take photos, Fig. 3, and using hoses to squirt her), creating a level of tension which had the ability to escalate to disturbance.

HLNZ–001 created tension for humans (e.g., when a human tripped over her, frightening both parties). HLNZ–001 non-physically engaged with humans/dogs (e.g., when she made concerted eye contact when people/dogs walked along a pontoon, Fig. 14, when she swam around a scuba diver or when she followed a person on stand-up paddleboard, Fig. 15). We also documented instances where HLNZ–001 closely approached people and this typically occurred when she was attempting to haul-out and people were nearby. During that process she repeatedly 'spy-hopped' (lifted her head and/or shoulders out of the water; Fig. 14), in order to check the suitability of the surface she wished to haul-out onto. She also physically made contact with people (e.g., nudging kayaks when people were paddling in them). Such behaviours were often mis-interpreted by members of the public as 'stalking' or 'predatory-lunging'.

Dispute

As the residency of HLNZ–001 progressed, arguments between certain members of the public regarding appropriate management increased in vehemence and resulted in complaints being filed with marinas, LeopardSeals.org and DOC. In addition, LeopardSeals.org elevated concerns with DOC over the safety of HLNZ–001 cohabitating with humans and the lack of management/mismanagement of leopard seals.

Proposal/threat to disturb/harm

A number of options to permanently displace HLNZ–001 from an Auckland marina were discussed including those which likely would have not caused disturbance/harm including using boats to move people past her when she was hauled out, movable barriers to protect her, consideration of modifying people's behaviour and providing information leaflets and signage. However, other methods which were discussed by DOC to displace HLNZ–001 included using noise (e.g., airhorn), physical contact (e.g., squirting with hot water from a hose or poking her with a stick), electric fences, deer repellent and translocation (see Note 16), all of which had the ability to cause disturbance and possibly harm (see Note 17).

LeopardSeals.org received calls from members of the public stating that if HLNZ–001 defecated on their pontoons, damaged their property or approached their dogs they would remove her from areas she inhabited either by spraying her with a hose, hitting her or shooting her (see Note 18). Threats were made by members of the public to feed HLNZ–001 fish laced with hooks and, where she was known to remove fenders, to deploy fenders embedded with razorblades (LeopardSeals.org, unpublished data). A video, by a NZ Government owned TV news channel, about HLNZ–001 playing with and also damaging equipment in a marina, prompted threats by the public to shoot HLNZ–001, i.e., "*Shoot the damned thing"* as well as suggestions as to the calibre of bullets to use including "*.50 cal. Problem solved*" and "*A .303 bullet would take care of the vandal*" (see Note 19).

There were instances that might be considered peripheral to the human-wildlife conflicts, but which were directly related to the conflict situation when humans threatened humans (LeopardSeals.org, unpublished data). These instances involved intimidation and threats from members of the public towards LeopardSeals.org researchers/volunteers due to their frustrations regarding the conflicts caused by the leopard seal.

Damage

Damage to property by HLNZ–001 caused conflict, specifically in relation to her removing, playing with, ripping and/or puncturing fenders (Fig. 16), tyres, mooring buoys, ropes (Fig. 4) and dinghies. She escalated this behaviour by sinking dinghies (Fig. 9), including those with outboard engines attached.

Disturbance

People approached HLNZ–001 and intruded within a threshold distance of her 'personal space' or 'comfort zone' causing disturbance (see Note 20).

A range of disturbances were documented, for example when: (i) people flew drones over her in close proximity (i.e., <150 metres) (see Note 21); (ii) people/dogs (on and off leads) approached her in close proximity (i.e., <20 metres; Fig. 1, 3, 6) (see Note 22); (iii) people attempted to remove her from an area using noise (e.g., air-horns and leaf

blowers), water (e.g., hoses) or barriers (e.g., marina trolleys). Disturbances to HLNZ–001 occurred when she was displaced (e.g., a vessel approached too close to her haul-out platform, and she left the area by entering the water, Fig. 7) and/or her exhibiting defensive/warning signals including avoiding, gaping, head jabbing, hissing and wicking (in order of approximate escalation, see van der Linde & Visser, 2020 for further explanations). Defensive/warning signals were frequently ignored or dismissed by the instigating person/dog and were sometimes misinterpreted as 'aggression' and subsequently reported as 'attacks'.

DOC also authorised marinas (see Note 23) to implement intervention methods, to displace HLNZ–001. Permitted intervention actions involved approaching the seal at a distance of <20 m using hazing techniques (e.g., Young et al., 2021), including light (e.g., via the use of flashlights), noise (e.g., blowing whistles and banging pot lids together) (see Note 24) and/or physical contact (e.g., spraying with water) to displace her, all of which had the ability to cause disturbance and/or harm (Young et al., 2021).

Humans and/or dogs were disturbed by HLNZ–001 when they had to cease activities due to her presence. For example, on occasion, people were asked to not directly access their vessels from marina pontoons when the leopard seal was blocking their path (Fig. 11). Although HLNZ–001 has been described as chasing (see Note 25) and attempting to bite dogs (LeopardSeals.org, unpublished data), we could not find evidence (photographs, videos, CCTV footage, first-hand accounts) to support these claims. Furthermore, from a collection of 127 leopard seal scats (van der Linde et al., 2021), of which 49 were from HLNZ–001, there was no evidence of dog remains.

Figures 1–4. Examples of cohabitation conflicts for the leopard seal HLNZ-001, caused by humans. These include (Fig. 1) potential risk of boat strike (note HLNZ-001, with a very low profile, inside the yellow circle), (Fig. 2) fishhook embedment, (Fig. 3) human approaching within 20 metres (note that in this example HLNZ-001 is exhibiting disturbance behaviour by opening her mouth and pointing her head at the intruder) and (Fig. 4) potential ingestion of foreign objects. Photographs via LeopardSeals.org (Fig. 1: Ingrid Visser, Fig. 2: Westhaven Marina, Fig. 3: Joel Fletcher, Fig. 4: Carol Jardine).

Harm

HLNZ–001 was physically harmed by humans, e.g., from hooks embedded into her flippers and mouth (Fig. 2), from kicking and beating, but also from a presumed shooting (Fig. 8) (see Note 26). Conversely, HLNZ–001 was never documented harming a human or dog.

DISCUSSION

With ever-increasing human populations and our encroachment into wildlife habitats that are displacing species into urban areas, efforts to understand human-animal interactions are becoming increasingly important (e.g., Draheim et al., 2015). In NZ we have recorded leopard seals in all major coastal cities and, in each of those locations a variety of conflicts have been documented (LeopardSeals.org unpublished data). As such, this case study is only one example of the cohabitation conflicts between humans/dogs and leopard seals nationwide. In general, NZ native wildlife are currently undergoing a biodiversity crisis in part due to pressures from human-wildlife conflicts (Department of Conservation, 2020) and yet conflicts such as those indicated herein have been largely overlooked and/or mismanaged.

Current management of conflicts involving HLNZ-001 has been largely focussed on the use of hazing techniques in an attempt to alter her behaviour or cause her to move away. While hazing can reduce undesirable behaviour of wildlife (e.g., Werner & Clark 2006), there are no clear guidelines on how to haze or the consequences of hazing leopard seals.

Research on the efficacy of hazing have produced

Figures 5–8. Examples of cohabitation conflicts for the leopard seal HLNZ-001, caused by humans/dogs. These include (Fig. 5) potential entanglement, (Fig. 6) dog approaching within 20 metres, (Fig. 7) vessel approaching too close to her haul-out and resulting in displacement and (Fig. 8) presumed shooting (wound indicated by white arrow, note the blood and mucus expelled from the wound and nostrils). Photographs via LeopardSeals.org (Fig. 5: Ingrid Visser, Fig. 6: Adrian Hill, Fig. 7: Ingrid Visser, Fig. 8: Rick Bout).

ambiguous results (Bonnell & Breck et al. 2017), and as such, there is a lack of science-based evidence to support hazing as a successful management strategy. Considering the level of conflicts occuring in NZ, further strategies are required to better manage leopard seal and human co-habitation in this region rather than relying solely on haphazard hazing.

Defining conflicts

Zimmerman et al. (2020) found that human-wildlife conflicts typically "*defy simple explanations*" which was consistent with this case study. For example, when trying to allocate any given scenario into clear-cut and/or mutually exclusive definitions, there were overlaps, although we were able to comparatively assess the conflict types using a scale of severity and document their escalation. However, we have strived to develop a system that will be useful for other pinniped human-wildlife co-habitation scenarios (Table 1). Although we prioritized the order of general severity of the conflict based on the detrimental impacts to the leopard seal as opposed to the financial impact to humans, we do however believe that equal consideration should be given to both the effects on the humans/dogs and leopard seals for real-world management scenarios, as if not addressed appropriately escalation will likely occur. Conflict types at times escalated from potential to actual and as a result consequences arose. For example, a threat to harm HLNZ–001 escalated into injuring her and as a consequence, she experienced welfare issues.

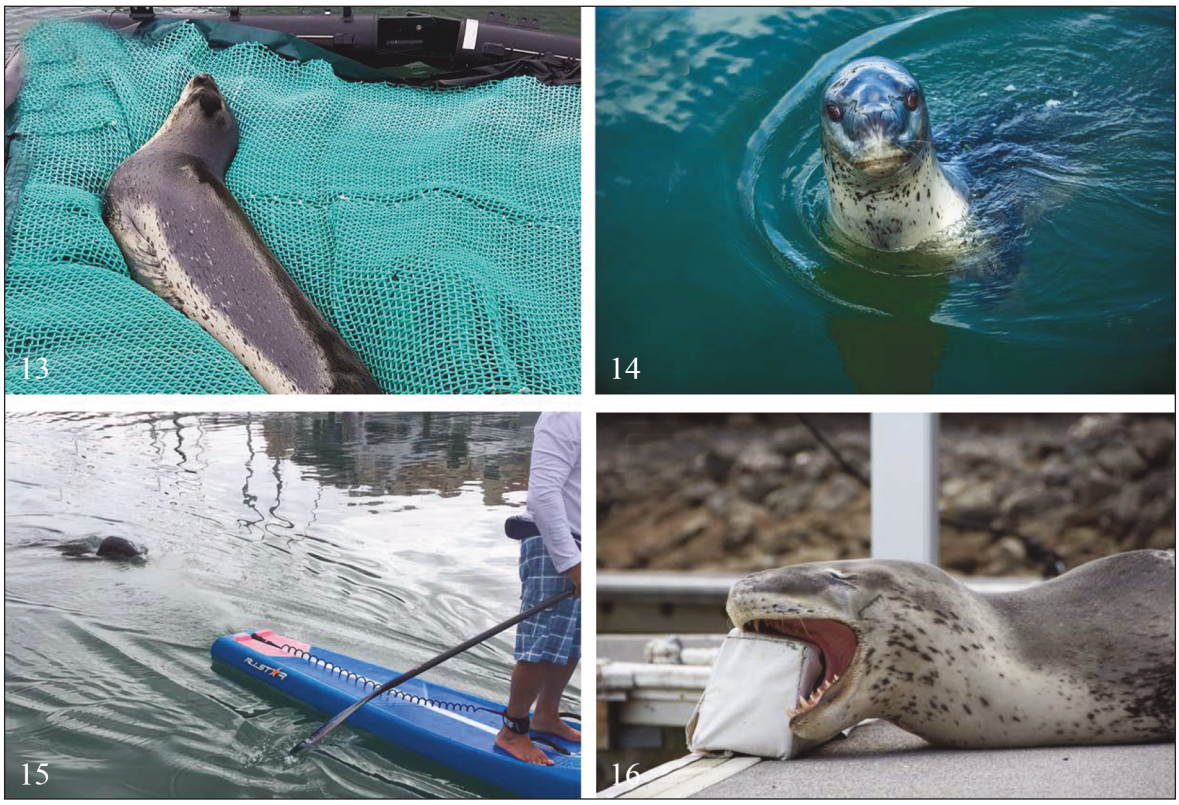
Understanding the threat

Despite humans and leopard seals interacting throughout their range for at least 200 years (Home,

Figures 9–12. Examples of cohabitation conflicts for humans, caused by HLNZ-001. These include (Fig. 9) popping inflatable boats/dinghies and sinking them, (Fig. 10) defecation on property, (Fig. 11) blocking foot-traffic and (Fig. 12) blocking access to fuel pumps. Photographs via LeopardSeals.org (Fig. 9: Logan Reilly, Fig. 10: Ingrid Visser, Fig. 11: Joel Fletcher, Fig. 12: Ingrid Visser).

1822; Smith, 1985; Gales et al., 2003), including diving and snorkelling in Antarctica for over 50 years (DeLaca et al. 1975), aggressive incidents are rare. For example, in NZ alone, there have been thousands of encounters with leopard seals (Richardson, 1844; Gray, 1873; Waite, 1909; Gales et al., 2003; Berkenbusch et al., 2013; McKinlay et al., 2014; Hupman et al., 2020) and more than 170 different leopard seals have been documented in recent years (Hupman et al., 2020), yet no attacks have been verified (LeopardSeals.org, unpublished data). Furthermore, there are no verified instances in the form of an attack in the dataset of over 2,000 records of HLNZ–001. In contrast, HLNZ–001 has been frequently and consistently impacted by humans and dogs and still the only actions/reactions she has presented are her (a) departing a location or (b) defensive warning displays/signals. She has not shown any aggression, nor been the aggressor. Her overall passive behaviour is reflected in the similar behaviour of other leopard seals around NZ who when provoked (even when injured), depart rather than defend themselves (see Note 27). This is in contrast to other wildlife species found in NZ, which have injured humans. For example, magpies (*Gymnorhina tibicen* Latham, 1802) have injured more than 100 people in NZ between 2013–2018 (Cropper, 2018) and have caused human deaths in Australia (see Note 28). These birds, at times, appear to attack with little to no provocation, other than if a person approaches their nest (Heather & Robertson, 2000; Warne et al., 2010).

However, while leopard seals in NZ waters have not been found to show aggression towards humans/dogs, it is possible that they could be a threat to health and safety. Although there has only been one report of a leopard seal killing a human (Muir



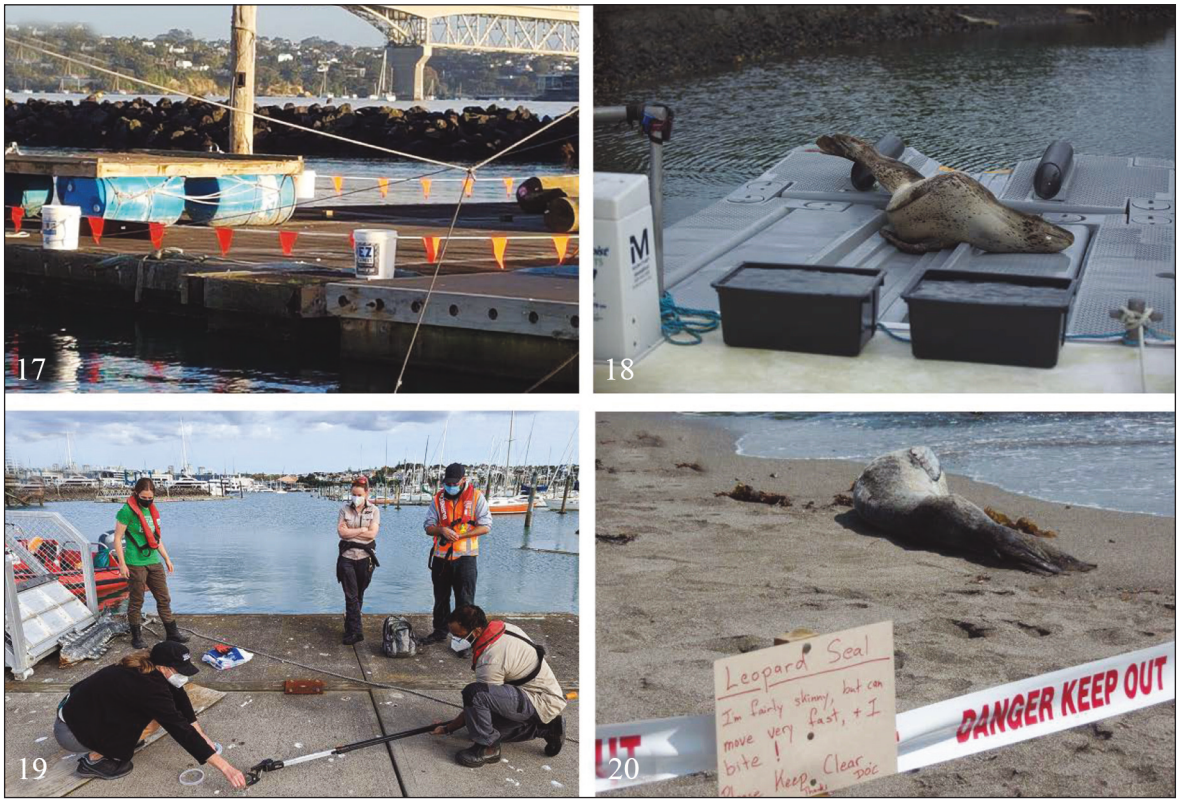
Figures 13–16. Examples of cohabitation conflicts for humans, caused by HLNZ-001. These include (Fig. 13) preventing use of equipment (in this case a floating vessel cradle comprised of pipe and net), (Fig. 14) approaching people when she is seeking a haul-out site, (Fig. 15) following people (in this case a stand-up paddleboarder) and (Fig. 16) chewing and/or removing marina fenders. Photographs via LeopardSeals.org (Fig. 13: Natalia Teller, Fig. 14: Ingrid Visser, Fig. 15: Jamie Paul, Fig. 16: Sophie Roselt).

et al., 2006a, 2006b), such an event may occur in NZ if, for example, a leopard seal mistook a human/dog as prey, or if the seal felt threatened.

Cohabitation is possible

Despite the evidence of multiple conflict types occurring, some which are deep-rooted (Madden & McQuinn, 2014; Zimmerman et al., 2020), there is potential for amicable and mutually beneficial cohabitation. Simple measures such as providing information leaflets and signage (e.g., Figs. 20, 21) can prevent conflicts occuring, and pro-active strategies such as these need to be increasingly utilised.

There have been many positive reactions to HLNZ–001's presence including people travelling specifically to view her in the same manner that people travel to see the 'Big Five' wildlife species in Africa (Caro & Riggio, 2013). Such meaningful wildlife experiences can have long-lasting positive consequences for conservation. We have observed an increase in the public wishing to assist with science projects involving HLNZ–001, including a rise in the number of dedicated citizen scientists recording the presence of HLNZ–001 and documenting her behaviour, members of the public installing 'pop-up' leopard seal information stations when she is recorded in locations with high human foot-traffic, positive media stories (including children's programs) centred on her presence and strong support for her being protected and nurtured in the marine environment. Likewise, there has been strong community rallying to provide protection of this iconic individual, particularly when threats have been made or when she has been disturbed or harmed (see Note 29). We have noted the 'journey' of one marina, which HLNZ–001 has frequented, who were originally vocal in their calls for her to be removed.



Figures 17–20. Examples of actions implemented to reduce, mitigate and/or eliminate cohabitation conflicts as well as actions taken as a result of conflicts for the leopard seal HLNZ-001. These included (Fig. 17) the Department of Conservation (DOC) deploying rope to trial an exclusion zone (note this created an entanglement hazard), (Fig. 18) LeopardSeals.org creating of an alternative exclusion zone using water-filled bins and no ropes, (Fig. 19) LeopardSeals.org and vets prepare equipment and plan to disentangle HLNZ-001 from fishing gear, (Fig. 20) DOC deployment of sign and "DANGER" tape. Photographs via LeopardSeals.org (Fig. 17: Ingrid Visser, Fig. 18: Ingrid Visser, Fig. 19: Ingrid Visser, Fig. 20: DOC).

Subsequently, they regularly reported sightings, advocated for her protection, monitored people's interactions with her on CCTV, assisted in scientific research (e.g., behavioural monitoring, Fig. 22, body condition assessment, photo identification and scat collection, Fig. 23) and assisted with concerns over her health and safety that developed (e.g., entanglements and injury monitoring). This shows that with effective communication and education (e.g., Fig. 24), human perceptions can change towards wildlife in urban environments (Soulsbury & White, 2015), thereby reducing possible conflict and increasing postive cohabitation.

In order for cohabitation to be possible, a more inclusive model of managing leopard seals is required, as this has been shown to increase the effectiveness of conservation efforts for other species (Craig et al., 2013). Research has illustrated that traditional power-based leadership (such as Government departments), when operating in isolation, can result in a loss of efficacy to conservation (Shanee et al., 2015; Black, 2019). Moreover, inaction by the authorities can have dire consequences, such as the deaths of individuals from critical populations (Shanee et al., 2015; Ten et al., 2021) including marine mammals in NZ waters (Chilvers, 2008; Visser et al., 2017; Visser & Hupman, 2019; Slooten & Dawson, 2021).

Conflict levels

By applying a three levelled conflict pyramid, Madden & McQuinn (2014) and Zimmerman et al., (2020) assessed the degree of intensity of conflicts from a human perspective. Briefly, their Level 1 was defined as 'dispute', Level 2 as 'underlying conflict', and Level 3 as 'deep-rooted conflict'. Our findings showed that the human/dog and leopard

Figures 21–24. Examples of actions implemented to reduce, mitigate and/or eliminate cohabitation conflicts as well as actions taken as a result of conflicts for the leopard seal HLNZ-001. These included (Fig. 21) LeopardSeals.org deployment of sign, (Fig. 22) LeopardSeals.org monitoring HLNZ-001's behaviour using remote cameras, (Fig. 23) LeopardSeals.org collecting scat to monitor prey types and (Fig. 24) LeopardSeals.org production of outreach/educational materials (website, social media, scientific publications, public presentations, toys, management plan). Photographs via LeopardSeals.org (Fig. 21: Ingrid Visser, Fig. 22: Rick Bout, Fig. 23: Rick Bout, Fig. 24: Ingrid Visser).

seal conflicts described herein contained elements of all three conflict levels. Zimmerman et al., (2020) recommended that conflict resolution approaches and practical solutions (strategies) are applied with urgency when wildlife conflicts reach the Level 3 stage.

Strategies required

The most sensible approach to addressing human-wildlife conflicts is to implement a combination of two different approaches: (1) short-term mitigation tools along with (2) long-term preventative strategies. Such a combination aids in reducing current problems while fostering the rapid development and implementation of innovative approaches to address future issues and eradicate conflicts (Distefano 2005). Drawing on examples from the active management of pinnipeds in urban environments internationally, alongside the conflicts described between humans/dogs and HLNZ–001 in this case study, we recommend the following, each of which contains elements of both short-term mitigation tools and long-term preventative strategies: (1) monitoring leopard seals; (2) improved education and advocacy; (3) establishment of designated safe areas for leopard seals; (4) research into and provision of effective enrichment; (5) expanded research on leopard seal occupation in NZ waters and the threats/conflicts they face; (6) establishment of a formalized stakeholder group; (7) improved legislation and definitions; and (8) effective application of the legislation for non-compliance. We provide detailed discussions for each of these recommended strategies in S-2. Implementation of these strategies will assist with the management and protection of leopard seals, not only in NZ but in all parts of their range where they cohabitate with humans.

Government management of conflicts

We acknowledge DOC occasionally implemented preventative actions in an effort to eliminate conflicts from arising, including deploying Rangers in areas where HLNZ–001 may be disturbed and/or harassed and placing signs and cordons around HLNZ-001 in urban areas. Furthermore, we recognise the important work that DOC has done for this species, perhaps the most significant being the reclassification of the Threat Status for leopard seals (Baker et al., 2019), based on the research by LeopardSeals.org (e.g., see Hupman et al., 2020). DOC's species-specific webpage (see Note 30) now includes leopard seal approach guidelines and how to report a leopard seal sighting. In addition, many DOC Rangers now email sightings directly to LeopardSeals.org (for inclusion into LeopardSeals.org's database of sightings and catalogue of individuals) or seek advice from this NGO with regards to appropriate management and/or assessment of injuries on leopard seals within their regions. Additionally, some Rangers are requesting that LeopardSeals.org advise them directly of any leopard seal sightings (e.g., at popular beaches) in order for them to proactively manage the situation rather than going via the departments own 0800 DOC HOT hotline notification system, as internal messages do not generally get passed on in a timely manner. Some DOC Rangers have facilitated the collection of deceased leopard seals for necropsies. We see these as positive steps forward in protecting this species and improving public awareness as well as supporting research of leopard seals within NZ.

Despite the above, we have identified that many of the conflicts discussed here have arisen and/or escalated in severity due to the lack of and/or mismanagement by DOC. Therefore, we strongly encourage DOC to implement a reassessment of their management strategies including *inter alia* combining short-term mitigation tools with longer-term preventive strategies, such as the eight listed above. Considering the number of leopard seal sightings in NZ has increased over time (Hupman et al., 2020), human-leopard seal interactions and conflicts will likely increase, and we recommend that DOC address them in a proactive rather than reactive way. Lastly, as there has been a trend by DOC to apply more invasive strategies (such as issuing permits to disturb/harm leopard seals or considering translocation), as opposed to low impact strategies (such as better public education or enrichment). We recommend that in the future, strategies are applied in an incremental order, and only when low impact strategies are not effective, are more invasive strategies considered.

CONCLUSIONS

While this study highlights the conflicts between

humans/dogs and one individual leopard seal, it is not an isolated case and these conflicts are inevitably going to increase as leopard seal sightings rise in human populated regions across NZ. And, whilst several strategies can be applied to reduce, mitigate and/or eliminate conflicts, to date, NZ Government departments have only used these minimally and in an *ad-hoc* fashion. Furthermore, the management/lack of management/mismanagement in isolation of, or exclusion of, other stakeholders has not been successful. As such, there is an urgent need to build the institutional capacity within NZ Government departments to address such conflicts as part of the framework of overall conservation management and planning. Concurrently, there is a need to adopt a decentralised decision-making process that involves all stakeholders, including those at a grassroots level. Herein, we have provided species-specific strategies to guide the prevention and/or management of human/dog-leopard seal conflicts. In order to increase the chances of successful conflict management, we recommend that these aforementioned strategies are applied in a proactive and consistent manner in consultation with all stakeholders. The details herein provide context for other countries where leopard seals are found in populated areas and will assist in the development of better management policies for the cohabitation and conservation of leopard seals throughout their range.

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NOTES

1 Iwi are the largest social units in Aotearoa Māori society. The term is often translated as 'tribe', or 'a confederation of tribes' and is both singular and plural in the Māori Te Reo language. The various names for leopard seals in Te Reo Māori are sourced from Richards (2008) and references therein.

2 As a result of HLNZ-001 showing long-term residence in NZ waters the local Māori hapu, Ngati Whatua ki Orakei named this female leopard seal "He owha nā ōku tūpuna" meaning treasured gift from our ancestors. The shortened version, "Owha" has become her nickname.

3 Regions are defined by DOC - see Hupman et al. (2020) for details.

4 For example, a leopard seal may swim around a dinghy with a person in it and then try to enter the boat. As that is occurring, the person may feel threatened and attempt to defend themselves by poking the leopard seal with an oar, and by mistake, injure its eye. Such a reaction may cause stress and/or long term injury, which may result in the death of the leopard seal. As such, this one event has involved several conflict types as its severity escalated: tension (leopard seal swimming around the boat), disturbance (leopard seal enters the dinghy), defence (human poking leopard seal) and harm (leopard seal incurring stress and injury, and as a result, cannot feed adequately and subsequently dies). All levels of any conflict that escalated were recognised, however when categorising such an event, the highest level of severity (i.e., harm) was used to classify the event.

5 For example, harm of a leopard seal may include lower severity incidents such as injury and higher severity incidents such as killing.

6 NZ Legislation, Conservation Act (1987) https://www.legislation.govt.nz/act/public/1987/0065/latest/DLM103610.html.

7 See bullet point 7 under the heading "What are the key functions of the Act?" https://www.doc.govt.nz/about-us/our-role/legislation/conservation-act/.

8 Pinniped callouts in NZ are defined by Boren (2008) as those where no action was taken, checks only and/or mediation.

9 DOC leopard seals webpage: https://archive.ph/mV2yE.

10 Furthermore, nearly 40 years ago, walruses (Odobenus rosmarus Linnaeus, 1758) were documented eating three species of seals (Lowry & Fay, 1984) and southern sea lions (*Otaria byronia* de Blainville, 1820) were documented eating South American fur seals (*Arctocephalus australis* Zimmermann, 1783) (Majluf, 1987).

11 Article archived at https://archive.ph/MqB1p.

12 Article archived at https://archive.ph/6x6KS#selection-943.217-943.343.

13 Article archived at https://archive.ph/9nnoA.

14 Pamphlet archived at https://archive.ph/wip/nFEGX and was recently updated in 2022.

15 The manner in which the rope and buckets were sequentially tied may have resulted in a 'sea-anchor effect'.

16 Article archived at https://archive.ph/Tmfbo.

17 Translocation would have involved sedation which has its own inherent high risks to leopard seal survival (Higgins et al., 2002) as has been demonstrated within NZ as at least two leopard seals have died during sedation and transportation (Debbie Freeman (DOC), Pers. comm. September 2022; https://archive.ph/wip/YXLNx).

18 A 2019 example is given in this article archived at https://archive.ph/jyLJg#selection-1649.1-1675.1, whilst two 2020 examples are archived at: https://archive.ph/iEr7d and https://archive.ph/wip/8E2Sg.

19 The comments can be found under the 29 Jan 2019 video https://www.youtube.com/watch?v=JUVKXlnEyaI, which was reposted by 1News, subsequent to an online article by the same news agency https://archive.ph/R48ZK.

20 Such thresholds are recognised in most species of animals (Brown & Orians, 1970) and can elicit a range of reactions when that threshold is crossed (e.g., the animal can depart, or defend itself with warning signals such as vocalisations, or defence can escalate to physical defence - however HLNZ-001 never physically defended herself).

21 Despite the NZ Marine Mammal Regulations (1992) requirement for aircraft (which includes drones) to be kept at a distance greater than 150 m. See NZ Government legislation: https://www.legislation.govt.nz/regulation/public/1992/0322/latest/whole.html#DLM168286.

22 DOC recommends when approaching a leopard seal, humans/dogs should stay "at least 20 m away": (https://archive.ph/mV2yE).

23 An example is for Westhaven Marina who was provided with a permit from DOC: permit number: 69371-MAR.

24 1News reported that a marina's "*management is frustrated with Conservation Departments advice*". The marina manager stated "*blowing whistles and bashing pot lids together, that's the approach to try and scare her away*". Video available at: https://www.youtube.com/watch?v=JUVKXlnEyaI.

25 Article archived at https://archive.ph/fgw5v.

26 It is an offence in NZ, under the Marine Mammal Protection Act (1978), to harm, harass or injure a marine mammal. DOC website:

https://archive.ph/wip/XeYuW and the NZ Government legislation: https://www.legislation.govt.nz/act/public/1978/0080/latest/whole.html#DLM25111.

27 See example at https://archive.ph/wip/YXLNx.

28 See examples at https://archive.ph/wip/qwkzV and https://archive.ph/wip/RYHzR.

29 For example, see some of the comments in response to those made about shooting her, under this video by 1News https://www.youtube.com/watch?v=JUVKXlnEyaI.

30 DOC leopard seals webpage: https://archive.ph/mV2yE.

Troubled waters: A case study of cohabitation conflicts for an urban leopard seal (*Hydrurga leptonyx* de Blainville, 1820) in northern New Zealand

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Supplemental 1 (S-1)

Table S-1. Conflict types, in order of general increasing severity, including definitions and actual or relevant hypothetical examples. Conflict types were characterised as those which originated with the human (H) and/or dog (D) or the leopard seal (LS) (*Hydrurga leptonyx* de Blainville, 1820). Abbreviations: Department of Conservation (DOC).

Conflict type (in order of increasing escalation)	Definition	Conflict originated with humans/dogs	Conflict originated with the leopard seal	Example
Lack of information / misinformation	*Lack of information*: A lack of dissemination of knowledge. *Misinformation*: Dissemination of incorrect knowledge and/or distortion of facts and/or narratives.	✓	-	H: *Lack of information* - DOC not providing members of the public (correct) biological information about leopard seals. H: *Misinformation* - DOC providing information via press releases stating that leopard seals have small teeth.
Accidental / incidental event	*Accidental*: An unintentional event caused by chance which also includes an element of carelessness, inattention or naivety.	✓	✓	H: *Accidental* - A human inadvertently encounters a leopard seal on a beach and unwittingly approaches too close.

Conflict type (in order of increasing escalation)	Definition	Conflict originated with humans/dogs	Conflict originated with the leopard seal	Example
	Incidental: A event which results from an action where precedence has shown conflict is likely to occur.			H: *Incidental* - A human unintentionally caught a leopard seal in a fishing net (it is established that fishing nets can unintentionally capture pinnipeds). LS: *Accidental/Incidental* - A leopard seal sinks a dinghy whilst attempting to haul out.
Inconvenience	An action which is troublesome or difficult and compromises comfort and/or requirements.	✓	✓	H: A member of the public can't get to their dinghy because a leopard seal is blocking their path. LS: A regularly used haul out pontoon becomes storage for construction items, reducing preferred area for resting.
Tension	An action which causes mental, emotional and/or financial strain. For an animal, this may result in being on high alert or stressed, both of which may not be externally visible (noting that high tension levels would escalate to disturbance).	✓	✓	H: Marina personnel are annoyed that a leopard seal is threatening the safety of their patrons. LS: Each time a leopard seal hauls out onto a boat ramp people gather close and it must therefore remain alert, creating stress.
Dispute	An action which starts or results in a disagreement and/or argument.	✓	-	H: Boat owners sue DOC for not managing a leopard seal which has damaged their boats.
Proposal / threat to disturb / harm	A proposal or statement with intent to disturb or harm, typically in retribution for an action	✓	-	H: A boat owner makes a request to DOC to remove a leopard seal

Conflict type (in order of increasing escalation)	Definition	Conflict originated with humans/dogs	Conflict originated with the leopard seal	Example
	(noting that inaction can also lead to this conflict).			from a marina because it punctured their boat fenders. H: A statement to the media that a leopard seal will be shot because DOC have not translocated it from a public area where children play.
Damage	Physical harm that impairs the value, usefulness or normal function of an inanimate object.	-	✓	LS: A leopard seal rips off a fender from a vessel and punctures it with its teeth.
Disturbance	An event which alters one's mental/physical function and is externally visible.	✓	✓	H: A boat owner hoses a leopard seal to remove it from their pontoon and the seal is displaced. LS: A leopard seal swims close to a beach and swimmers are instructed to leave the water.
Harm	Compromised animal welfare or physical injury and/or death, including that which is deliberately inflicted.	✓	✓	H: A human is bitten by a leopard seal (as has occurred in Antarctica). LS: A leopard seal is translocated and experiences a number of stressors from this action.

Troubled waters: A case study of cohabitation conflicts for an urban leopard seal (*Hydrurga leptonyx* de Blainville, 1820) in northern New Zealand

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Supplemental 2 (S-2)

Strategies required

Below we provide detailed discussions for each of the recommended strategies to reduce, mitigate and/or eliminate leopard seal (*Hydrurga leptonyx* de Blainville, 1820) and human/dog conflicts occurring in New Zealand (NZ), as outlined in van der Linde et al. (2022). We use examples from the presence of an adult female leopard seal (HLNZ-001) in the Auckland/Northland regions.

1. Attendance of leopard seal sightings

Background. Attendance of leopard seal sightings has been a successful method in managing human/dog and leopard seal conflicts. This has also been found for other pinnipeds, such as NZ fur seals (*Arctocephalus forsteri* Lesson, 1828), where the presence of monitoring personnel has reduced conflicts by up to two-thirds (Acevedo-Gutiérrez et al., 2010). Pro-active members of the public have endeavoured to protect HLNZ-001, despite having no authority or any equipment. In one instance, they simply drew a circle in the sand around her with a 20 m radius[1] (i.e., thereby indicating to others the space they should give the leopard seal). During such events, no offences or conflicts were documented (LeopardSeals.org, unpublished data). In contrast, there have been numerous circumstances where HLNZ-001 has hauled-out on busy dog-walking beaches and the Department of Conservation (DOC; the legally mandated NZ Government agency to protect wildlife, including leopard seals) was called by members of the public to assist, yet their management actions were either absent, limited and/or inconsistent.

Although LeopardSeals.org (non-profit NGO in NZ) endeavoured to provide monitoring and protection of HLNZ-001 when she was in high foot-traffic areas, they are a volunteer organisation and as such have limited in time and resources. In contrast, the DOC administers a budget

[1] DOC recommends when approaching a leopard seal, humans/dogs should stay "*at least 20 m away*": (https://archive.ph/mV2yE).

including ~NZ$36m for "*Conservation with the Community*"[2].

Strategy. We recommend that DOC and, where possible conservation organisations, attend leopard seal sightings in public areas in a timely manner, to prevent conflicts and better manage incidents that may occur. Attendance should include, but is not limited to, education and safety cordons for crowd control (ensuring people remain 20 m away from the leopard seal) and that dogs are kept on leads. With respect to the latter, given that zoonotic diseases can be transmitted between dogs and pinnipeds e.g., canine distemper virus has resulted in mass mortalities of pinnipeds, with dogs and wolves suspected as vectors for this morbillivirus (Beineke et al., 2015), it would be prudent to keep dogs and pinnipeds well separated (Boren, 2008).

2. <u>Improved education and advocacy</u>

Background. HLNZ-001's occupation of urban environments resulted in conflicts which led to people having negative perceptions of leopard seals, specifically of her. These cohabitation conflicts are complex and one of the central themes is that leopard seals pose a high threat to human safety. This perception may arise from the fact that in Antarctic waters, spy-hopping (a prevalent behaviour with HLNZ-001) is associated with leopard seals hunting along the ice edge (Muir et al., 2006a) and leopard seals have been noted to lunge at people in Antarctica (Muir et al., 2006b). This perception is exacerbated by the knowledge that leopard seals are large apex predators, capable of consuming a wide variety of prey species (Rogers, 2018; van der Linde et al., 2021). Furthermore, popular media typically demonizes the species as 'evil' (Litchfield, 2013) or portrays it as a 'villain' (e.g., in animated family movies such as 'Happy Feet')[3]. This leads to the reinforcement of negative perceptions about the species and as a consequence people are often afraid of them.

In NZ, this fear of leopard seals was further enhanced by the earlier lack of information, as well as misinformation, provided to members of the public, which was amplified by social and mainstream media. The absence of terrestrial apex-predators in NZ (Daniel & Baker, 1986) has perhaps created an atmosphere where sensationalism or misinformation can

[2] Department of Conservation Budget 2021 overview (archived at https://archive.ph/wip/9kUPM).

[3] See a clip where the protagonist, a young penguin called 'Mumble' is chased by the leopard seal 'Rojas'; https://www.youtube.com/watch?v=-0f67QE-HP8. Other movies have similar themes, such as 'The Penguins of Madagascar' where the lead penguin character 'Skipper' stated "*leopard seals … nature's snakes*", followed by a chase scene involving penguins pursued by three leopard seals.

prevail, or wildlife can be blamed for conflicts occurring (Dayer et al., 2019). This type of inaccurate portrayal has been documented for an extensive range of other predators, both aquatic and terrestrial (Litchfield, 2013; Bombieri et al., 2018). It has previously occurred in NZ where orca (*Orcinus orca* Linnaeus, 1758) were once considered fearsome and dangerous creatures, but with concerted efforts to educate the public, they are now considered an iconic and integral part of the marine ecosystem and powerful symbols of conservation (Visser, 2000, Orca Research Trust, unpublished data).

Given that people's perception and tolerance of predators is fundamental in the animal's protection, and these opinions are highly driven by the risks the predator poses, misinformation may be harming conservation actions for leopard seals and the potential for coexistence (Siemer et al., 2009; Bombieri et al., 2018).

Strategy. Considering this framework, it is vital that conflicts between leopard seals and humans/dogs are taken seriously and that appropriate non-escalatory management of the species and human/dog interactions is applied throughout NZ. Although we acknowledge that DOC has a duty to educate the public and to keep the wildlife safe, caution should be used when making statements about such issues. For example, the comment by a DOC Ranger in the media, that leopard seals "… *will make a mess of your dog*"[4] can create unnecessary tension.

In other regions, where cohabitation with pinnipeds occurs on a regular and long-term basis (e.g., the California sea lion *Alophus californianus* Lesson, 1828, colony at Pier 39, San Diego, which has become a major tourist attraction), signage, media and education is typically pro-active, positive and sympathetic to the animals (VanderWalde, 2007; Purdy, 2015) and cohabitation is normalized. Yet within NZ, cohabitation has seemed alien to some people, despite leopard seals having been documented from at least 800 years ago (Smith, 1985).

LeopardSeals.org was founded in 2016 and since then has strived to move towards better leopard seal and human cohabitation through education, conservation and scientific research, incorporating assistance from Iwi[5], DOC, the public and citizen scientists (van der Linde et al., 2021)[6].

[4] See example at https://archive.ph/wip/YXLNx.

[5] Iwi are the largest social units in Aotearoa Māori society. The term is often translated as 'tribe', or 'a confederation of tribes' and is both singular and plural in the Māori Te Reo language. The various names for leopard seals in Te Reo Māori are sourced from Richards (2008) and references therein.

[6] As one example, the recovery of dead leopard seals has occurred primarily due to assistance from Iwi and the public, for an example see https://archive.ph/Lfr8i.

Since outreach by LeopardSeals.org began, there have been anecdotal changes in attitude within the reports received from the public and an increase in the number of people concerned about the welfare of leopard seals in NZ waters.

In order to continue enhancing education about leopard seals, the NZ public should be provided proactive and pre-emptive information on: (1) leopard seal residency within NZ, (2) normal behavioural patterns of leopard seals in NZ (for example, as described in van der Linde & Visser, 2020)[7], (3) the absence of verified reports which describe aggressive actions or harm to humans/dogs in NZ and (4) measures people should employ when they encounter a leopard seal to keep not only themselves and their dogs safe, but also the leopard seal (van der Linde & Visser, 2020). This educational material could be via multiple means including online resources, press releases, reports and signage. Similar recommendations were made by Desmond et al. (2015) who recommended the implementation of safety around seals in NZ dog training schools and for DOC to post signs warning dog walkers to control their dogs on beaches where seals are present.

Educational materials are an important tool in creating positive perceptions, as well as decreasing fear and generating a greater understanding of certain species (Almeida et al., 2017). For example, education about pinnipeds has been shown to reduce the likelihood of lethal management for California sea lions (Schakner et al., 2019) and the use of effective signage has been shown to minimize social disputes over pinniped conflicts (VanderWalde, 2007). Therefore, it is likely that improved education and advocacy would result in the NZ public having a greater understanding of leopard seals and promote an increased willingness to cohabitate with this 'Resident' species.

Given that DOC is legally responsible for the provision of educational and promotional conservation information, we recommend that the development of such material and advocacy campaigns be done in consultation with local Iwi, various stakeholders who are affected by the leopard seal's presence and those who have the animals' welfare and best interests in mind, as well as species-specific experts familiar with leopard seals in NZ. Other pinniped conservation groups working in NZ (e.g., The NZ Sea Lion Trust)[8] and those working with other species of pinnipeds internationally [such as the Hawaiian monk seal (*Neomonachus*

[7] https://www.leopardseals.org/management-plan/

[8] https://www.sealiontrust.org.nz/

schauinslandi Matschie, 1905; Sullivan et al., 2019)[9]], should also be consulted.

Influencing human behaviour, and therefore the resultant modifications, is clearly a key component for a better cohabitation model as it can have direct impacts on biodiversity conservation. However, conservation professionals are often ill-equipped to understand and influence human behaviour (Veríssimo, 2013) and this can in turn shift peoples focus and priorities away from conservation (Black, 2019). As such, NGOs involved in conservation as well as DOC who are in charge of conservation of all NZ's flora and fauna, may benefit from receiving training on how they can influence human behaviours (Rimal & Real, 2003) and how they incorporate tolerance levels for wildlife (Zimmerman et al., 2020). Additionally, human psychology in relation to conservation (Clayton & Myers, 2009) would add to the toolbox of resources that could be applied to cohabitation conflicts. In the framework of this case study, aspects of leopard seal biology, behaviour and cohabitation (e.g., see van der Linde & Visser, 2020, for some examples) should also be part of that training. For conservation leaders, training has been shown to relate to competencies as well as improved sensitivity towards all stakeholders and helps to align employees' values and motivation (Black, 2019). Specifically, human-wildlife conflict management training has been shown to de-escalate and prevent conflicts from occurring (Osei-Owusu, 2008).

3. <u>Establishment of designated safe areas for leopard seals</u>

Background. HLNZ-001 has been documented to haul out in predictable locations, the majority of which have been within marinas. She has selected specific pontoons which she favours, however these are often also used for other purposes (e.g., ferry terminals or the storage of materials). This has led to conflicts occurring. For example, HLNZ-001 has been disturbed by people approaching too close to use a ferry service or retrieve construction equipment. Conversely, humans have had to make alternate routes around the seal, sometimes within close proximity, posing potential harm to them.

Strategy. One action to mitigate issues of safety (for humans, dogs and HLNZ-001) is to provide leopard seals with designated safe areas where they can haul-out without being disturbed or harmed. Dedicated pontoons have been provided for pinnipeds

[9] See this archived website for various publications by the National Oceanic and Atmospheric Administration, US Department of Commerce https://archive.ph/cUwiK.

in urban environments for South American sea lions (*Otaria flavescens* Shaw, 1800) who reside and interact with people at a fish market in Chile (Root-Bernstein et al., 2012) and for California sea lions (*Zalophus californianus* Gill, 1828) at a popular marina and tourist area in the USA (Purdy, 2015; Schakner et al., 2019). For HLNZ-001, the high-use areas that have been identified by LeopardSeals.org (such as marinas), would be likely locations to trial/implement such pontoons. When HLNZ-001 is on pontoons with foot access (or on land), a simple rope barrier, above the height of HLNZ-001 (so as to avoid potential entanglement) would indicate a safety margin around her. Similar ropes (at waist and chest height) have been successfully applied for seal viewing in California (VanderWalde, 2007) and by some marinas in NZ (LeopardSeals.org, unpublished data). To prevent human-wildlife conflicts, permanent fencing has also been successfully utilized for a range of pinniped species, particularly when they congregate in colonies (Gales et al., 2003; Copello et al., 2021).

4. Research into and provision of effective enrichment

Background. HLNZ-001 has been documented destroying property (including items of high monetary value such as dinghies), and such activities are likely to continue without intervention. Although we do not yet understand the driving force behind her destructive behaviours, research on captive animals has shown those who are bored, including aquatic mammals, frequently exhibit oral behaviour such as gnawing and chewing (Sweeney, 1988; Marino et al., 2019). Although stereotypical behaviours (i.e., repetitive abnormal behaviours with no apparent outward function; Mason, 1991) have not been documented in free-ranging wild animals, the mitigation techniques of providing enrichment to reduce boredom and undesirable behaviour could be trialled with HLNZ-001. There is empirical support for the efficacy of enrichment in decreasing stereotypical behaviours for captive pinnipeds who are undergoing rehabilitation (Chudeau et al., 2019). Although HLNZ-001 is a free-ranging wild animal, we have documented her playing with/in/on items. Therefore, LeopardSeals.org recommended to DOC that diversion enrichment be provided to HLNZ-001 (LeopardSeals.org unpublished data). LeopardSeals.org offered to trial/instigate such an enrichment program (van der Linde & Visser, 2020). DOC, however, decided not to provide enrichment as they believed it could encourage this leopard seal to remain in the area.

Similar diversion enrichment has been successfully provided by DOC to another wild NZ species, an alpine parrot. The kea (*Nestor notabilis* Gould, 1856) is a species known for its manipulation of objects and well recognised for its destruction of human property[10] (e.g., McLean et al., 2021; Bastos et al., 2022).

Strategy. The potential benefits of trialling diversion enrichment (i.e., reduction in damage to property) appear to outweigh the concerns that DOC has of HLNZ-001 extending her stay. Therefore, we strongly recommend that for leopard seals damaging property, DOC reconsider using diversion enrichment, in consultation with experienced researchers.

5. <u>Expanded research on leopard seal occupation in NZ waters and the threats/conflicts they face</u>

Background. Our understanding of leopard seals throughout their range is still lacking fundamental baseline information (e.g., see details of births and pups in van der Linde et al. (2022) as well as general references about the species). While we understand that leopard seals are located in all regions of NZ (Hupman et al., 2020), we are yet to determine their fine scale occurrence and movement patterns. As a consequence, we are unable to understand the relative importance and spatial distribution of key conflicts to this species. Furthermore, the data described herein only represents the cohabitation conflicts of one leopard seal in NZ waters, and preliminary data indicates that various levels of conflict may be occurring for multiple individuals (LeopardSeals.org, unpublished data).

Strategy. We recommend expanding research on leopard seal occupation in NZ waters. Further studies involving photo-identification and tracking (via the use of minimally invasive flipper or micro-satellite tags) would be useful to identify individual occurrence and movement patterns, particularly for those longer term residents of NZ such as HLNZ-001. In addition, further research on cohabitation conflicts for all leopard seals in NZ waters should be conducted.

6. <u>Establishment of a formalized stakeholder group</u>

Background. In order to improve the management of leopard seals in NZ, specifically of HLNZ-001, LeopardSeals.org developed a management plan which could be implemented by stakeholders (e.g., marinas and DOC) (van

[10] See example at https://archive.ph/d9beG#selection-3145.1593145.175.

der Linde & Visser, 2020). That plan: (1) categorises leopard seal behaviours in urban environments, (2) establishes and defines pre-emptive management strategies (and actions) to help stakeholders minimise incidents and avoid emergency situations from developing between humans and leopard seals, (3) establishes and defines reactive management actions for events involving leopard seals in NZ, thereby providing a coordinated response from all of the stakeholders and, (4) outlines intervention activities which can be used for leopard seal disruptions. However, although this management plan exists, it has yet to be endorsed by DOC, and therefore our concerns remain that HLNZ-001 (and other leopard seals) will come to further harm, or human/dog health and safety will be compromised due to a lack of action by the Government Authorities.

Strategy. We recommend that a formalised stakeholder group be established with urgency to fully engage and represent interested parties in leopard seal protection, and that such a group be responsible for approving and implementing the aforementioned management plan. This group should involve species-specific experts in consultation with groups that have completed similar work with other pinnipeds.

7. <u>Improved legislation and definitions</u>

Background. All marine mammals in NZ are protected under the Marine Mammals Protection Act (MMPA) 1978 which states that it is an offence to injure, harass or disturb a marine mammal. However, the Act itself does not provide definitions as to what constitutes the above terms. As such, there is ambiguity in relation to what constitutes injury, harassment or disturbance. While DOC provides "*simple guidelines*" for people watching seals in NZ[11], these are not supported by the legislation. For example, one of these guidelines is that people should "*stay at least 20 m away*", however there is no legislative requirement to adhere to this safe approach distance in the MMPA (1978). This is in contrast to the Australian legislative requirements such as the Biodiversity Conservation Regulation 2017[12], which states that it is illegal for a person to approach a seal closer than 10 metres in the water, 40 metres on land, or, 80 metres in the

[11] See the DOC website for leopard seals: https://archive.ph/mV2yE.

[12] https://legislation.nsw.gov.au/view/html/inforce/current/sl-2017-0432#sec.2.3

water or on land if it is a pup. Furthermore, in NZ, while members of the public are not provided with legally binding approach distances, and instead are only provided with recommended guidelines, leopard seal researchers must adhere to much stricter restrictions. For example, LeopardSeals.org researchers are legally not allowed to approach a leopard seal within 20 metres to conduct their research, however members of the public can, as long as they are not seen to injure, harass or disturb the seal.

Strategy. We recommend that DOC revises the Marine Mammal Protection Act with respect to providing definitions on what constitutes harassment and disturbance. In addition, we recommend that a 20 m approach becomes a legislative requirement.

8. <u>Effective application of the legislation for non-compliance</u>

Background. The NZ MMPA states that every person who commits an offence under the Act may receive a maximum penalty of two years imprisonment or to a fine to a maximum of $250,000[13]. While the MMPA provides provisions for sanctions for non-compliance, we are unaware of any instances where implementation of/conviction under the Act has occurred due to violations, despite significant evidence being available in some instances (including offenders admitting to the crimes; LeopardSeals.org unpublished data).

Strategy. LeopardSeals.org recommends that improved enforcement of the legislation that protects leopard seals from injury, disturbance and/or harassment should be applied with urgency.

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