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IN THIS ISSUE:

ABOUT THE JOURNAL

THE *Journal of Wildlife Rehabilitation* is designed to provide useful information to wildlife rehabilitators and others involved in the care and treatment of native wild species with the ultimate purpose of returning them to the wild. The journal is published by the International Wildlife Rehabilitation Council (IWRC), which invites your comments on this issue. Through this publication, rehabilitation courses offered online and on-site in numerous locations, and its outreach to those in the profession, the IWRC works to disseminate information and improve the quality of the care provided to wildlife.

Left:
Cranes navigate through a field of wind turbines.
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On the cover:
Brown pelican *(Pelecanus occidentalis).*
PHOTO © CUATROK77 ON FLICKR. CC BY-SA 2.0.

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EDITORIAL

Undefined Borders

As rehabilitators, we are aware that the boundaries and borders of humans are not the borders observed by wildlife. To a pigeon, a fence is a perch. A water-filled ditch is hunting ground for an otter. The wall of an old house is the sign of a possible cavity den to a raccoon.

Borders vary with species and with seasons. Forest edges are borders for spotted owls and are simultaneously the center of a cowbird's territory. Part of our job as rehabilitators is to interpret these varying definitions of borders for the public and to help people and wildlife manage potential conflicts – to prevent border wars, if you will.

Human-created borders can have a positive impact on wildlife. The Demilitarized Zone between North and South Korea is a notable example from the last century. It contains landmines, is off limits to the casual human, and has become home to thriving populations of large cats, cranes, and various otherwise threatened wildlife populations. Chernobyl, with its border of 'keep out' signs and high radiation readings, has seen an increasing population of wild denizens since the disaster.

Roads, while a pathway for humans, are a barrier for terrestrial wildlife. Animals that do not heed the border may become carrion on the side of the road or patients in the local wildlife center. Transportation departments and universities have experimented with various tunnels and land bridges to pierce this boundary, at times with good success.

Humans build borders with the intent that they endure. Many natural borders are more transitory. While human-made walls do crumble and mountain ranges last for a very, very, long time, the ocean shore, the edge of the meadow, the bank of the river are not static. And, more importantly when considering human borders, climate is not static. We know that alongside changing climates, ideal habitats for different species move over time. A wall on the border of two climates now might later dissect one.

The impacts of the proposed additions to the US/Mexico border wall on wildlife are quite unclear. The USFWS International Affairs website states "wildlife, fish, and plants do not recognize national boundaries." A wall between our countries may interfere with access to critical current resources: food, water, dens, and mates. Further, the ability to move with the changing climate may well be what separates the surviving species of the future from the extinct.

The US/Mexico border wall at the southern US border of the Pacific Crest Trail. PHOTO ©EDMOND MEINFELDER. CC BY-NC-ND 2.0.

—Kai Williams
Executive Director

Wildlife Rehabilitation in Northwest Tucson Rebuilds

TUCSON, Arizona, USA (April 23, 2017)—On the night of March 30, a fire ripped through the center, killing multiple animals and destroying structures, equipment, food and supplies that Wildlife Rehabilitation in Northwest Tucson relied on to operate.

It took 22 firefighters more than 20 minutes to extinguish the fire and another 45 minutes to search through the home for hot spots. With no hydrants in the area, firefighters had to use a water tender to battle the blaze.

Three weeks later, Wildlife Rehabilitation's training and operations continue, despite the fact that many of the surviving animals have been moved to other centers or private homes until the sanctuary is rebuilt.

The cause of the fire has not been determined and much of the damage is still visible, as volunteers aren't able to clear out the wreckage until the fire inspection is complete.

"It was devastating," volunteer Nancy Chilton said. "The loss of property was one thing, but we lost some of our education birds and other birds who were in recovery and to whom we were very attached."

The sanctuary, owned and operated by 86-year-old Janet Miller, is licensed by the Arizona Game and Fish Department. In addition to rehabbing injured animals, the center also provides education to students across Tucson about desert wildlife and the ways animals can be injured by sharing their environment with humans.

The center takes in all types of animals, many of which are birds, but also small and larger mammals, including bobcats and coyotes.

There are roughly 60 volunteers who fill two shifts a day at the center, doing everything from housekeeping duties to assisting with wound care, physical therapy and feeding the animals, Chilton said.

Once the fire inspection is complete, volunteers can begin cleaning up the structure, after which they will begin to replace equipment and restock supplies lost in the fire. The next step will be rebuilding the main room where the animals were held as well as the adjacent cages.

"This is going to be very much focused on redesigning and making the space more appropriate for the kind of work we're doing there," Chilton said. "The center was one of those things that was added onto as need increased, now we have this opportunity to start from scratch and really design the whole place so that it's a good space for the animals and it's easy for the volunteers to move around in."

In early April, Chilton set up a fundraising site with a goal of $10,000. In 18 days, it has exceeded its goal, raising more than $16,000.

"The funding is going to be very helpful, but we're going to need continued funding to get through it. The insurance from the fire should help, but as far as running the center, we're always going to depend on public help," Chilton said.

While the large volume of donations that rolled in quickly was wonderful, the outpouring of support from community members offering to help in other ways was also a welcome surprise.

"A lot of people have called and said they really want to help by either offering services or bringing us supplies," Chilton said. "We've had Girl Scouts and Boy Scouts and different groups like that who have come forward to offer their help with cleanup or with anything else where we need people. It's really encouraging."

—by Caitlin Schmidt

Reptile Rehabilitation Centre in New South Wales Prison

WINDSOR, AUSTRALIA (April 11, 2017)—From a jungle python coming off methamphetamine to an eastern brown found injured on the side of the road, staff and inmates at a prison in Sydney's west are helping give reptiles another chance at life.

The python, which cannot be named due to legal reasons, was discovered during a police raid of an ice lab and required six weeks of detoxification while housed at the Corrective Services NSW Wildlife Care Centre in Windsor.

Senior Overseer Ian Mitchell, who has been managing the centre at the John Morony Correctional Complex for the past few years, said the reptile had absorbed the drug through its skin.

Jungle carpet python (*Morelia spilota cheynei*).
PHOTO © ALFONSOPAZPHOTO. CC-BY-NC-ND 2.0 LICENSE.

"It just takes time for the drug to leave the snake's system but through our assistance, we managed to calm it down after several months and bring it back to its routine feeding patterns," Mr Mitchell said.

"We also currently house bearded dragons and blue tongue lizards seized during raids.

"Besides the reptiles associated with criminal cases, we rehabilitate venomous snakes like eastern browns and red bellies that might have been found in backyards or by the side of the road."

Minimum-security inmates from the Outer Metropolitan Multi-Purpose Correctional Centre are carefully selected to participate in the program.

They feed and clean the reptiles, except the venomous ones, as well as rid them of worms and other illnesses and occasionally

take them out of their enclosures to receive natural light.

The snakes generally feed on mice and rats while the other reptiles feed on meal worms and crickets.

Only CSNSW staff who have undergone specialist training can handle and access the venomous snakes.

The reptiles involved in court cases are put to a ballot following the completion of those legal cases so they can be re-housed at another animal-related organisation or placed with an owner with a reptile licence.

Following rehabilitation, other reptiles are handed to organisations including the RSPCA or National Parks and Wildlife Service.

Over the past year, around 40 snakes, 15 lizards, five turtles and a number of other animals have been cared for at the centre.

Outer Metropolitan Multi-Purpose Correctional Centre Governor Ivan Calder said the program allows around a dozen inmates to participate in a wide range of tasks including caring for the animals, building shelters and the opportunity of gaining a Certificate II in Animal Care.

"The program provides them with a calming environment that can assist with reducing reoffending," Mr. Calder said.

"It also allows gradual reintroduction to community contact as well as the reinforcement of the care and consideration of others, not just one's self.

"There are also improvements in group interaction and self-motivation as the program provides a goal for the participants to achieve."

At any one time there are around 250 animals, mainly birds, housed at the centre.

New Wildlife Rescue Centre in Bhutan

JIGMELING, BHUTAN (February 5, 2017)—In commemorating the birth anniversary of HRH the Gyalsey, the Department of Forest and Park Services launched the Southern Wildlife Rescue Centre at Jigmeling, Sarpang Dzongkhag.

The centre will cater to veterinary care and rehabilitation for wildlife in the southern and central part of Bhutan. This centre also functions as the breeding centre for Gharials and Marsh Crocodiles. The centre spans across nearly 15 acres and it houses three barking deer, two peacocks and one jungle fowl. The centre was established with funding support of World Bank through the IDA Project for Strengthening Regional Cooperation for Wildlife Protection in Asia. The Southern Wildlife Rescue and Rehabilitation Centre is one of the five regional centres to be operational with the first one for the western region being set up at Taba-Thimphu in 2014.

Behavioral Design

RESTON, Virginia, USA (May 3, 2017)—How a wind energy facility is designed can influence the behavior of animal predators and their prey, according to a recent study published in The Journal of Wildlife Management by researchers at the University of California, Davis, and the U.S. Geological Survey.

Scientists placed motion-activated cameras facing the entrances of 46 active desert tortoise burrows in a wind energy facility near Palm Springs, California. Video recordings showed that visits to burrows from five predators—bobcats, gray foxes, coyotes, black bears and western spotted skunks—increased closer to dirt roads, and decreased closer to wind turbines.

Habitat disturbance caused by wind energy facilities creates unique challenges and opportunities for wildlife. Although fragmented landscapes may make some large carnivores -- like cougars and bears -- more vulnerable to population decline, some small- to medium-sized animals -- like coyotes and foxes -- expand their habitat to include areas that have been changed by humans.

"These findings could be helpful in assisting managers to design future wind energy facilities with species in mind," said lead author Mickey Agha, a UC Davis graduate student studying ecology with Professor Brian Todd. "There may be benefits to adding space between turbines and increasing the number of dirt roads, to potentially provide habitat for sensitive terrestrial wildlife."

Results suggest that infrastructure associated with wind energy facilities, such as dirt roads or culverts, may create movement corridors through disturbed habitat that some animals prefer. Dirt roads may act as funnels for predators because they are potential corridors through the wind energy facility. Earlier research at the study site reported that tortoise burrows were more likely to be closer to roads than random points. Tortoises can move more easily on dirt roads and desert washes than on highly vegetated landscapes.

"There is little information on predator–prey interactions in wind energy landscapes in North America, and this study provides a foundation for learning more," said Jeffrey Lovich, USGS scientist and co-author of the study. "Further investigation of causes that underlie road and wind turbine effects, such as ground vibrations, sound emission and traffic volume could help provide a better understanding of wildlife responses to wind energy development."

The cameras did not record any predation on adult desert tortoises close to burrows. This suggests that the predators observed in the study do not often actively prey upon adult desert tortoises, but visit the sites looking for smaller prey that frequently live in desert tortoise burrows.

Oil Spill Recovery Occurs at Different Rates for Various Species

RESTON, Virginia, USA (May 2, 2017)—Thanks to a quarter-century of research and monitoring, scientists now know how different wildlife species were injured by the 1989 Exxon Valdez oil spill and how long it took for populations to recover.

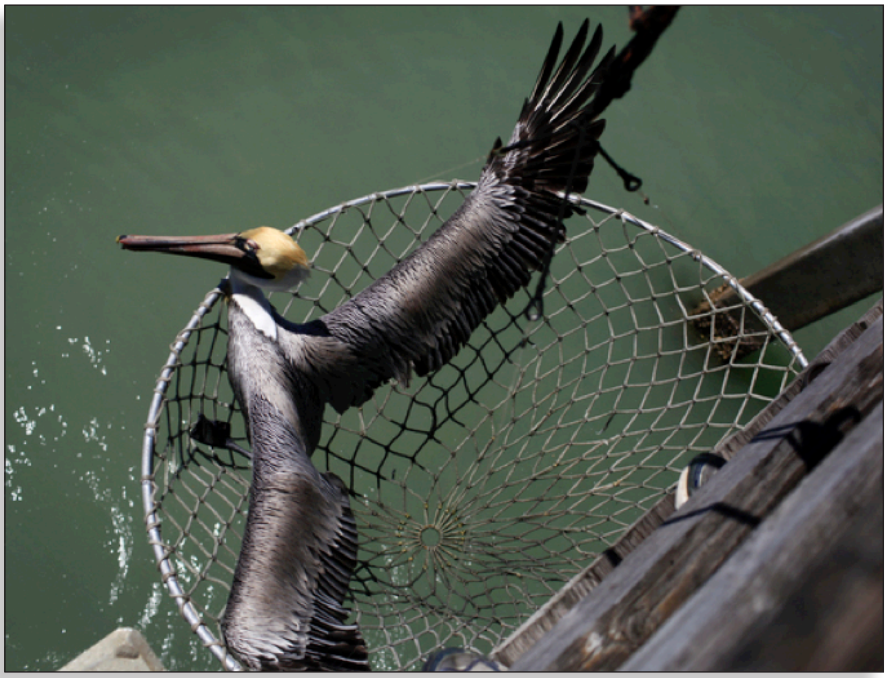
This information may have important implications when responding to other oil spills, when conducting damage assessment studies after spills and when considering the environmental risks associated with extracting and shipping oil.

"Because wildlife species in the spill area vary so much in terms of what they eat, habitats that they use, and their abilities

CONTINUED ON PAGE 32

Large birds in large numbers: a case study of brown pelicans with fishing line and hook injuries at the Naples Pier

Colleen Cosgrove



An adult brown pelican being brought up to the pier in the large nets provided at the ends of the Naples Pier in order to safely remove the hook it was caught on. (FIG. 8).

ABSTRACT: The von Arx Wildlife Hospital (vAWH), in Naples, Florida received a large increase (1,500%) in the amount of injured brown pelicans being admitted from the winter of 2012 – 2013 (n=11) to the winter of 2013-2014 (n=163). The Naples Pier was identified as the epicenter of the fishing line and hook injuries, as fishing is allowed to all visitors without requiring a permit[1]. The Conservancy of Southwest Florida (CSWF) undertook many efforts to educate and train the people of Naples to reduce the number of injuries happening. They also successfully lobbied the city council to ban treble hooks from being used at the pier, which reduced the severity of the hook injuries seen at the vAWH. The following year, in the winter of 2014-2015, the number of pelican admissions decreased by almost half (48.5%; n=84), providing compelling evidence that the measures taken by the vAWH and CSWF were likely successful in lowering the number of pelicans being injured at the Naples Pier.

KEYWORDS: brown pelican, Conservancy of Southwest Florida, fishing line, hook, Naples, *Pelecanus occidentalis*, pier, treble hook

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Statement of Problem

The brown pelican (*Pelecanus occidentalis*) is a large gregarious bird that occupies estuaries and shorelines, and they are found along the Pacific coast, from Nova Scotia to Chile, along the Atlantic coast, from North Carolina to Venezuela, and the Gulf coast.[4] Placed on the endangered species list in 1973 due to DDT contamination, they were removed from the list in 2009, and the Florida population is stable.[4] In Naples, Florida, the brown pelican has become an iconic symbol of the beach that people love to visit, but has also become the unfortunate victim of many fishing related injuries.

The Naples Pier, originally constructed in 1888, is arguably the biggest attraction on the beaches of Naples for both residents and tourists. Each year, 71% of city residents and over one million tourists visit the landmark to fish, watch wildlife, and soak up the beautiful Florida beaches[1]. Perhaps the most unique and alluring factor of the 1,000 foot pier is that the city of Naples has purchased a bulk fishing license for the pier, allowing anyone to fish from it without needing a permit.[1] Dozens of brown pelicans and other shorebirds hang around the pier and attempt to snag a fish from anglers' lines, and in the process, hundreds of birds end up entangled in fishing line or embedded with fishing hooks.

In the winter of 2013-2014, December through February, the von Arx Wildlife Hospital (vAWH) in Naples, Florida experienced a 1,500% rise in the number of injured brown pelicans from the winter before. In the winter of 2012-2013 they received 11 pelicans, and the following winter the hospital received 163 injured pelicans (fig. 1). The vAWH operates within the Conservancy of Southwest Florida (CSWF), a non-profit

J. Wildlife Rehab. 37(2): 7-12.

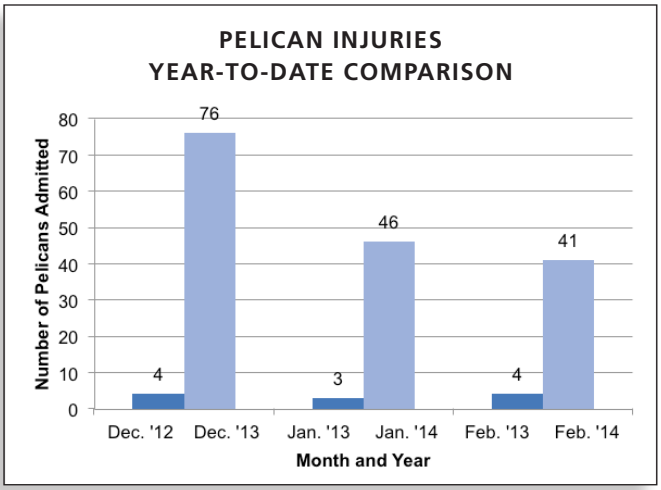

FIGURE 1. Graph depicting the increase between winters.

dedicated to protecting Southwest Florida's water, land, wildlife and future. In the previous years, the vAWH received fewer than 20 brown pelicans each winter, leaving them unprepared for the sudden influx of the large birds.

Pelicans injured by fishing line and hooks were brought to the vAWH to be rehabilitated and released back into the wild. Most pelicans were admitted with superficial hook wounds, after being hooked by accident while going for a fish on a hook or being in the wrong place at the time somebody casts their line (fig. 2) However, a portion of the birds had severe constriction wounds due to tightly wrapped fishing line, had swallowed hooks, or had extensive pouch lacerations (fig. 3). The constriction wounds often resulted in extremities becoming necrotic and, if severe enough, led to the euthanasia of the bird[2]. The swallowed hooks were taken out through manual removal with anesthesia or abdominal surgery, which then exposed the bird to post-operation risks such as infection and sepsis. Any large tears in the pelicans' pouches had to be sutured or the wounds would prevent the bird from eating as the fish would fall out of the hole[5] (fig. 4). The 1,500% increase in brown pelican admittances certainly tested the CSWF's new hospital in terms of staff, space, and resources; for example, staff had to house pelicans in any cage that would fit them, regardless of original intent, and using almost eight times more finger mullet than usual to feed the multitude of birds.

Discussion

A map was created to pinpoint the epicenter of the sudden influx of injured brown pelicans. The data used to create the map was retrieved from the vAWH database by the vAWH wildlife rehabilitators. The rescue locations were obtained for each pelican received between October 1, 2013 and October 1, 2014 (n=205). In each case, the exact rescue location was entered on to a map of Naples. The shape and color of each map point indicates whether or not the pelican was injured by fishing line and hooks, and if the bird was successfully released or not (figs. 5 and 6).

Of the 205 injured pelicans that were mapped, 75% (n=154) of them were injured by fishing line and hook, and 50.7% (n=104) of

FIGURE 2. The Naples Pier, with a brown pelican in the water.

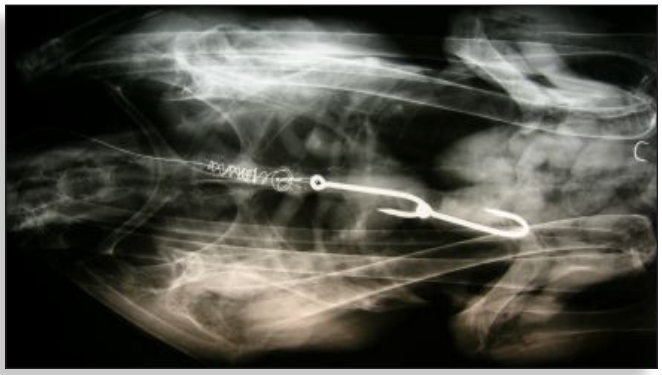

FIGURE 3. A radiograph of a brown pelican that has swallowed two fishing hooks that had to be removed surgically.

FIGURE 4. A pelican with tears in its pouch due to fishing hooks being ripped through the tissue.

the 205 pelicans were successfully rehabilitated and released back into the wild. The Naples Pier alone was the location for nearly a third (29%; n=60) of the pelicans brought in over the year, and the majority of the injured pelicans (63%; n=129) came from within a two mile radius of the Naples Pier. The majority (79%; n=102) of those 129 pelicans were injured by fishing line and hook. Except for one outlier at 31 miles, the pelicans were found within a 20 mile radius of the Naples Pier, which means that almost two-thirds (63%; n=129) of the pelicans came from only one percent (1%) of the total area. The results of this study clearly demonstrate that the Naples Pier is the epicenter of the fishing related injuries to pelicans.

Methods

Once the Naples Pier was identified as the main location for the influx of injured pelicans due to fishing line and hooks, the

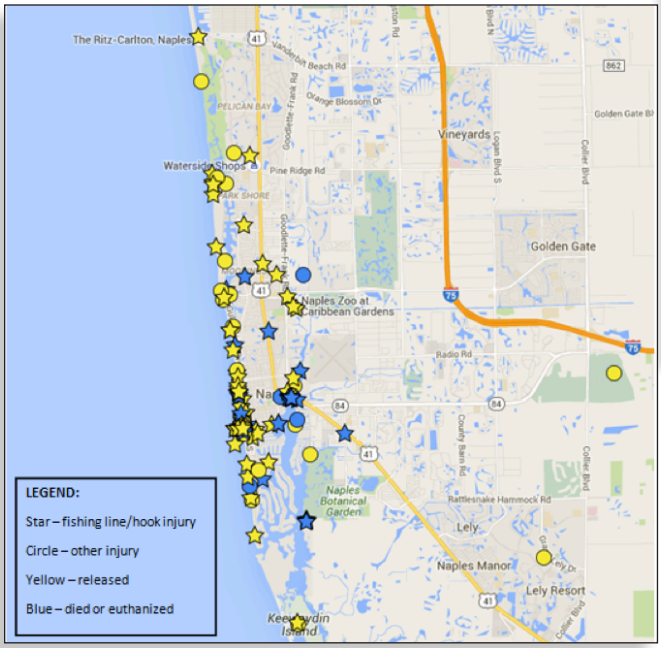

FIGURE 5. A map of Naples, Florida with the original locations of pelicans rescued in a one-year span.

FIGURE 6. An inset of the previous map, showing the large amount of pelicans injured at the Naples Pier.

FIGURE 7. The educational signs designed by the Conservancy of Southwest Florida and placed at both ends of the Naples Pier.

vAWH and the CSWF began to form a plan to reduce the number of birds being injured and brought to the wildlife hospital. In order to fix the core problem, the CSWF focused on education of both public and industry personnel, proper implementation of that education, and policy change.

According to a beach patrol specialist with the city of Naples, tourist outreach is difficult. They find that tourists rarely read signs posted on the pier concerning education or enforcement issues (personal communication, 2014). In an attempt to grab the attention of tourists, the CSWF designed and positioned large, clear, multilingual signs on either end of the pier to educate the public on the proper way to deal with a hooked pelican (fig. 7).

Large nets were placed at both ends of the pier to allow the public to reel in hooked pelicans in order to remove hooks (fig. 8, page 7). The CSWF also paid for two part-time employees to patrol the pier during tourist season, November to March, to instruct people on the safe and proper way to unhook pelicans and other shorebirds.[3] The proper way to unhook a pelican is to reel the bird in, using a net if needed, and safely cut out the hook. If the hook is deeply embedded or there is reason to believe it may have ingested a hook (a sign such as fishing line coming out of the bird's mouth), the public is encouraged to bring it to the vAWH so trained rehabilitators can assess the situation.

CSWF found other ways to reach stakeholders as well. For example, they developed and hosted workshops at the vAWH at which the director demonstrated the proper way to handle a pelican and safely remove a hook, using deceased brown pelicans with real hooks in them as training tools. Through this experience, park rangers, beach patrol officers, and interested members of the public were able to practice the skills and force needed to cut the barbs and remove hooks from the birds. Several workshops were held throughout the tourist season to in effort to accommodate all that were interested in learning how to rescue pelicans.

During the increase in pelicans admitted with hook injuries, it became apparent that one type of hook known as a treble hook was doing more damage than others. The treble hook has three barbs and is typically attached to a lure with several others (fig. 10). These hooks are more damaging because they can simultaneously hook two body parts and cause the bird to injure itself further while struggling. They are also much more dangerous and difficult to remove from a pelican's stomach, with three times as many barbs

FIGURE 9. The director of the von Arx Wildlife Hospital, Joanna Fitzgerald, using a deceased brown pelican to show eager members of the public how to correctly and safely remove a hook from the large bird.

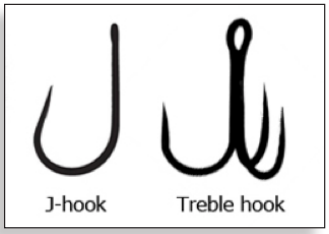

FIGURE 10. The typical J-hook used for fishing with one barb(l), compared to the treble hook, now banned from the Naples Pier.

to injure internal organs. The CSWF policy department petitioned the city of Naples to ban the use of these hooks by attending City Hall meetings and contacting officials. By April of 2014, a city ordinance was passed banning the use of treble hooks at the Naples Pier, making it the first pier in the state of Florida to have a law (the pier in Clearwater, FL has a policy against them, but not an ordinance). The fines range from a $100 citation up to a $5,000 code enforcement fine if use of the hook results in the death of a pelican.

Results

The following year, December 2014 through February 2015, the rate of injured brown pelican admissions dropped from 163 pelicans to 84 pelicans (48.5%). The vAWH has also seen an impressive decline in the presence of treble hooks, resulting in less severe hook wounds on the pelicans. Due to the success of the CSWF-funded patrols placed on the pier, the city of Naples now funds two full-time staff members to patrol the pier during tourist season. Before beginning their season, these staff members train with the rehabilitation specialists at the vAWH to learn appropriate handling and hook removal skills, as well as to recognize injuries that require veterinary assistance. In addition, CSWF created an educational video demonstrating the correct and safe way to use the nets and handle the large birds. The video uses footage from an actual rescue at the pier, and now plays on a continuous loop at the entrance to the Naples Pier.

The following winter saw similar numbers as the year before, admitting 85 injured brown pelicans in December 2015 through February 2016. The educational signs and video, in combination with the city-funded pier patrols, are teaching tourists and local fisherman how to avoid hooking pelicans, what to do when it accidentally happens, and how to safely cut the hook out of them.

The vAWH is currently undergoing a $2 million expansion of their outdoor cages and shorebird pool to accommodate the annual influx of the large birds. As the number of tourists fishing on the Naples pier continues to increase each year, the CSWF is hopeful that continued education and enforcement on the pier will reduce the number of pelicans getting injured by fishing line and hooks.

Conclusion

Since receiving the large increase (1,500%) of pelicans starting in December 2013, vAWH rehabilitators have adjusted their methods to accommodate the large influx of birds every winter. Since that first increase, the CSWF has combined educational, policy, and enforcement efforts, and the past two winters, December through February, the vAWH has received only 84 (2014-2015) and 85 (2015-2016) injured pelicans. While this number is not as low as December 2012 through February 2013 (n=11), it is still almost half as much (48.5%) as the winter of December 2013–February 2014. The continued high number of pelicans may be due to changing climates for migrating birds, increased awareness of the wildlife hospital by the public, more tourists finding injured birds, or other unknown factors. By working with the public and local government, the CSWF and vAWH were able to decrease pelican admissions, increase public awareness, lobby to ban treble hooks, and increase the patrol on the Naples pier. These achievements provide compelling evidence that the steps taken by this organization, working with its community, reduced the amount of pelicans being injured by fishing line and hooks.

About the Author

Colleen Cosgrove works as a wildlife rehabilitation specialist at the von Arx Wildlife Hospital, part of the Conservancy of Southwest Florida, where she has been helping rescue native Florida wildlife for over three years. She completed this project as a part of her graduate work with Project *Dragonfly* at Miami University in Oxford, Ohio.

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Community attitudes and practices of urban residents regarding predation by pet cats on wildlife: an international comparison

Catherine M. Hall, Nigel A. Adams, J. Stuart Bradley, Kate A. Bryant, Alisa A. Davis, et. al.

ABSTRACT: International differences in practices and attitudes regarding pet cats' interactions with wildlife were assessed by surveying citizens from at least two cities in Australia, New Zealand, the UK, the USA, China and Japan. Predictions tested were: (i) cat owners would agree less than non-cat owners that cats might threaten wildlife, (ii) cat owners value wildlife less than non-cat owners, (iii) cat owners are less accepting of cat legislation/restrictions than non-owners, and (iv) respondents from regions with high endemic biodiversity would be most concerned about pet cats threatening wildlife. Everywhere non-owners were more likely than owners to agree that pet cats killing wildlife were a problem in cities, towns and rural areas. Over 85% of respondents from all countries except China valued wildlife in cities, towns and rural areas. Non-owners advocated cat legislation more strongly than owners except in Japan. Many Australian (62%), New Zealand (51%) and Chinese owners (42%) agreed that pet cats killing wildlife in cities, towns and rural areas was a problem, while Hawaiian owners were similar to the mainland USA (20%). Thus high endemic biodiversity might contribute to attitudes in some, but not all, countries. Husbandry practices varied internationally, with predation highest where fewer cats were confined. Although the risk of wildlife population declines caused by pet cats justifies precautionary action, campaigns based on wildlife protection are unlikely to succeed outside Australia or New Zealand. Restrictions on roaming protect wildlife and benefit cat welfare, so welfare is a better rationale.

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Introduction

Cats (*Felis catus*) are widely kept as companion animals [1,2] and their popularity as pets is increasing in many countries [3,4]. For example, in Australia, the UK and New Zealand, the proportions of households with a cat are 23% [5], 26% [6] and 35% [7] respectively. Cats have been introduced to most islands and continents across the world, where as pets they are often maintained at high population densities (e.g. > 100/km2 [8,9]).

Pet ownership, including cats, confers numerous benefits to pet-owners but also creates problems for wider society. Benefits include better health and social connection of owners [10–13], as well as opportunities to teach children responsibility, respect and compassion [14–16]. The contribution of pet ownership to national economies through sales of pet food, accessories and veterinary care is also considerable (e.g. [5]). On the other hand, problems arise when cats roam without restriction. These include (i) unwanted hunting of wildlife [7,17,18], (ii) transmission of disease to humans, livestock and wildlife [19–21], (iii) potential hybridisation with native wildcats (eg. in Europe [22,23,24]), (iv) interbreeding with feral populations, and (v) nuisance to neighbours by fouling yards, harassing caged birds, fighting, spraying and jumping on cars [25,26]. Roaming cats also risk injury or death [27,28] and these events are often financially and emotionally costly to owners [29].

Given that pet cats are an important and beneficial part of many people's lives and

lifestyles, the most productive approach to ameliorate these problems is to regulate cat husbandry practices to improve cat welfare, reduce nuisance and protect wildlife, while allowing people the pleasure of owning a cat. Tagging (e.g. microchipping) would improve the return of lost and injured animals as well as helping to identify specific nuisances. Desexing (except cats approved for breeding) would reduce the incidence of unwanted kittens, hybridisation with native felids and breeding with feral cats. Likewise, restricting wandering behaviour would decrease predation of wildlife, the spread of disease and traffic accidents involving cats. Understanding the attitudes of the general population towards cat husbandry, as well as the practices of owners, allows governing authorities to create effective regulations sensitive to local situations that are more likely to be accepted, and identifies areas where targeted education may encourage compliance.

Over the last 15 years, several studies have collected data on citizens' attitudes and practices with regard to cats (both owned and feral) and proposed regulations in several countries, including Australia [30,31], the USA [32–35], the UK [36] and NZ [37]. While surveys have differed in their questions, timing of administration and sample populations, and were often geographically restricted in each country, the data suggest marked differences between nations in attitudes and practices towards cats. For example, the incidence of confinement of pet cats ranges from 35% [38], quoting data collected in 1997) to 60% [39] in mainland USA, compared to < 10% in Australia [31,40,41] or the UK [9]. The prevalence of desexing is consistently > 90% in Australian studies [31,40,42,43] and UK studies [36], compared to c. 80% in the USA [44,45] or 43% in parts of Italy [46]. Moreover, Australian citizens, including cat owners, also seem more accepting that cats may be a threat to urban wildlife than UK citizens (contrast [30] and [31] with [36]).

Given the variability across nations in how cats are treated and perceived, we sought to test if this variability was an artefact of differences in survey methodology or a true difference, and to greatly extend geographical coverage. We assessed international differences in attitudes and husbandry regarding restrictions and desexing of pet cats, as well as interactions between cats and wildlife, by administering a common survey to cat owners and non-owners in Australia, China, Japan, New Zealand, the UK and the USA. This approach allowed us to compare the attitudes of owners and non-owners in each country to questions such as the desirability of legislation, support for desexing and confinement, and the level of concern over predation by pet cats. We also assessed national variations in response to these questions. While the survey was predominantly exploratory, we also tested explicit predictions that: (i) cat owners would agree less that cats might threaten wildlife than non-cat owners, (ii) cat owners would value wildlife less than non-cat owners, (iii) respondents from Australia, China, New Zealand and the US state of Hawaii (all with high levels of endemic (distinct) wildlife biodiversity) would be more concerned about the potential impacts of pet cats on wildlife than respondents from the UK, the mainland USA and Japan, and (iv) cat owners would be less accepting of cat legislation/restrictions than non-owners. A clearer understanding of citizens' attitudes will be helpful in deciding what, if any, legislative or community education steps might be acceptable in different countries to address perceived problems of predation by pet cats on wildlife.

Materials and Methods

Ethics Statement

The Murdoch University Human Ethics Committee (permit 2012/195), the University of Sydney Human Research Ethics Committee (approval no. 15508), University of Hawaii (Manoa) Human Studies Program CHS#20333, University of Southampton Psychology Ethics Committee (Ethics ID: 5775), and University of Otago Human Ethics Committee (Approval D11/297) all approved this study. Written consent was obtained from participants via completion of the first item of the survey form, which also gave documentary evidence of consent. Participants who declined to provide consent did not proceed past the first item.

Choice of Countries and Cities

The English-speaking nations share common cultural origins despite their current social and political diversity, while Japan is a developed Asian country and China a rapidly developing one. Australia, New Zealand, China and the USA state of Hawaii all have high endemic biodiversity compared to the other countries. We controlled the possibility that attitudes within countries might vary by including at least two cities in each country, where possible across a climatic range (Table 1). In the USA the survey was distributed in two mainland cities (Los Angeles and Chicago) and the Hawaiian Islands, which have significant issues regarding conservation of endemic fauna. In Japan, respondents from Tokyo and Kanagawa were combined into the Japan Capital Area and respondents from the Japanese city of Osaka were combined with small numbers of respondents from other locations to form 'Japan Other.' The Japanese city Shizuoka was the third city from Japan. Our focus on cities reflects the increasing trend to urbanisation globally.

Administration and Design of Survey

Frame, Sampling Design and Contact Method

The survey was administered from spring to autumn in each country when cat activity and prey availability are likely to be high. Temporal effects were controlled by administering the survey in all countries within a 12 month period (Table 1).

For cities in all countries except China, invitations to participate were distributed amongst suburbs with a broad age range of citizens and a high proportion of employed people (i.e. a middle to upper-middle socio-economic demographic more likely to respond to an online survey [47]). These people are also more likely to be politically engaged and hence more vocal in any discussions regarding regulation of the husbandry of pet cats [48,49]. Within the chosen demographic in each city, 2,000 individuals were selected using simple random sampling without replacement from electoral

TABLE 1. List of participating countries and the participating cities from each country, with details of local climate, survey timing and response rates. https://doi.org/10.1371/journal.pone.0151962.t001

Country	Cities—Response rates (no. surveys returned/(no. sent—no. undeliverable)) are in parentheses	Climate	Survey Timing
Australia	Sydney (2.7%), Wollongong (5.3%)	Sydney: Warm temperate, summer highs average 27–30°C and winter highs 17–21°C	Dec 2012 – Mar 2013
		Wollongong: Oceanic, summer highs average 26°C and winter highs 17°C	
New Zealand	Auckland (6.7%), Dunedin (15.9%)	Auckland: Oceanic, summer highs average 24°C and winter highs 14°C	Nov 2012 – Feb 2013
		Dunedin: Oceanic, summer highs average 19°C and winter highs 10°C	
United States of America	Los Angeles (2.9%), Chicago (3.0%), Hawaii (6.8%)	Los Angeles: Mediterranean, summer highs average 29°C and winter highs 20°C	May–July 2013
		Chicago: Humid continental, summer highs average 29°C and winter highs 0°C	
		Hawaiian islands: Tropical, summer highs average 29–32°C and winter highs 26–28°C	
United Kingdom	Southampton (5.6%), Birmingham (2.6%)	Southampton: Oceanic, summer highs average 22°C and winter highs 8.4°C	Aug–Oct 2012
		Birmingham: Temperate maritime, summer highs average 22°C and winter highs 6.5°C	
Japan	Japan Capital Area, Shizuoka, Japan Other (36.9%)	Tokyo: temperate with four distinct seasons, summer highs average 31°C and winter highs 6°C	July–Nov 2013
		Shizuoka: temperate with four distinct seasons, summer highs average 24°C and winter highs 11°C	
China	Beijing, Harbin (47.1%)	Beijing: Humid continental, summer highs average 31°C and winter highs 2°C	July–Nov 2013
		Heilongjiang: Monsoon influenced humid continental, summer highs average 26°C and winter highs -12°C	

rolls (New Zealand, UK) or marketing databases (Australia, USA) as the sampling frame. The survey administration method was online for reasons of cost, speed of analysis, alleviating problems with deciphering handwriting, and convenience of reply for the respondents [50]. A personalised invitation letter was sent to all people selected with details of the online survey and an option for requesting a hard copy survey by mail, with a postage-paid reply envelope for its return. A reminder letter was sent two weeks later.

In Japan, 800 invitations to participate in an online survey were distributed at veterinary clinics and local shops (distribution of invitations at shops mitigated the probable bias that clients at veterinary clinics would own a pet of some kind) within suburbs matching the chosen demographic rather than mailed, because the local researchers believed that this was likely to elicit higher responses. Sakurai and Jacobson [51] reported that mailed surveys in Japan rarely exceed response rates of 20–40%, and have been declining steadily since the 1970s. No follow-up was possible in this case. The researchers in China considered it very unlikely that Chinese nationals would respond to an unsolicited online survey from an unknown source: recent Chinese surveys often use interviews [52] or distribute questionnaires to assembled groups [53]. Instead, hired surveyors approached 500 people in Beijing to complete the survey. In Harbin, 500 people known to the researchers by acquaintance, and matching the chosen middle to upper-middle socio-economic demographic, were contacted directly by email and asked to return a completed survey. The decision to use convenience samples rather than probability samples in Japan and China was a trade-off between possible aversion to the probability sample approach in those countries and the lack of consistency in approaches across all countries.

Questionnaire Design

The survey was based on that developed by Grayson, Calver and others [30] and adapted by Lilith, Calver and others [31], with the goal of determining public opinion on aspects of cat husbandry, predatory interactions between pet cats and wildlife, and legislative regulation of cat ownership. For our study additional items were added to strengthen assessment of respondents' attitudes to interactions between cats and wildlife, and to restrictions on cat ownership or husbandry. Minor changes to the wording of some items occurred between countries in order to address differences in colloquial terms. There were 77 items overall, 44 assessing opinions and 33 assessing the characteristics of respondents and, for owners, their cat husbandry practices. Items were a mix of direct questions and responses on a five-point Likert scale (Strongly agree, agree, disagree, strongly disagree, I don't know). No item in the online survey insisted on a response, because this might have led to respondents abandoning the survey [54]. However, it did cause variations in response rates for individual items. A copy of the Australian version of the survey is available from the corresponding author on request. Surveys for Japan and China were translated by the authors from those countries.

Eight key items (scored on a five-point Likert scale) were selected for individual analysis to provide insights into the attitudes

and beliefs of owners and non-owners in each country on specific issues. These were:

- There is a need for cat legislation
- All cats should be kept in at night time
- Cats should be kept on their owner's property at all times
- It is important to have wildlife in cities, towns and rural areas
- Pet cats killing wildlife in cities, towns and rural areas is a serious problem
- Pet cats on farms are harmful to wildlife
- Pet cats in nature reserves are harmful to wildlife
- Except for a cat owned by a breeder, all cats should be desexed

Further questions relating only to owners were examined to determine differences in husbandry between countries and whether or not the cats had a history of catching wildlife:

- How many cats do you currently own?
- Has this cat been desexed?
- Does this cat live:
  - Solely inside?
  - Solely outside?
  - Solely inside during the night, but free roaming during the day?
  - Inside and outside, but restricted to my property?
  - Inside and outside, but free roaming?
- Has this cat ever caught anything?

Using the Rasch measurement model[55,56], three scales were constructed based on responses to the items on attitudes and practices:

1) Restrictions, dealing with regulations on cat ownership;
2) Wildlife, considering interactions between pet cats and wildlife; and
3) Desexing, covering issues related to desexing pet cats (see below for details).

Respondents' scores on these scales were used as dependent variables indicating their attitudes.

The survey program iSurvey, from the University of Southampton, was used by respondents from Australia, New Zealand, the USA and the UK, with each country having its own customised survey and login. The Japanese survey used Survey Monkey (https://www.surveymonkey.com). Results from China were compiled manually. Any paper surveys received were entered manually.

Data Analysis

Response Rates and Representativeness of the Survey

Response rates, defined as the number of surveys completed either online or by paper divided by the number of invitations sent minus the number returned as undeliverable [57], were calculated for each city where invitations were mailed. In Japan, response rates were calculated as the number of surveys completed divided by the number of leaflets distributed, while in China they were calculated as the number of people responding divided by the number approached. Responses collected online may not be representative [50], so we tested the representativeness of the samples by: (i) comparing the proportions of cat owners in the responses for each country with recent independent assessments of the proportion of cat ownership in those countries, (ii) checking for non-response bias by comparing the responses of people responding promptly to those responding tardily to the survey, and (iii) comparing mailed and online responses. These measures apply only to our target middle to upper-middle socio-economic demographic and cannot be extrapolated beyond it.

We compared the proportions of cat owners and non-owners in the study to estimates of cat ownership in each country from data published within the last decade (Australia 23% [5]; NZ 35% [7]; UK 26% [6]; USA 30% [58]; Japan 10% [59]; China 15% [60]. We used chi-squared goodness of fit tests with continuity correction to determine whether the relative proportions of cat owners to non-owners who responded were equivalent to the relative proportions in the general population for each country.

Armstrong and Overton [61] argued that people who respond less readily to surveys, as indicated by a tardy response or a response only after prompting, are more likely to have similar attitudes to non-respondents. Therefore, if there are differences in characteristics or answers between prompt and tardy respondents non-response bias is likely, requiring a correction. We divided the respondents into early (responding within two weeks of the return of the first response) and late (responding after two weeks from the first response). This was undertaken on data for Australia, New Zealand, the UK and the USA as information on when the survey was completed was available. Those who completed a paper survey were excluded. Information on the timing of responses was unavailable from the Japanese data and not applicable to the Chinese data.

For each country separately, combining the results for cities within countries, we used a two-way chi-square contingency table with Yates' correction to determine if there was any difference between early and late respondents for i) the proportions of owners to non-owners and ii) the proportions of men to women. Secondly, we tested for differences in the average age between early and late respondents using either a two-tailed *t*-test after confirming homoscedasticity, or a two-tailed *t*-test for heteroscedastic samples. Thirdly, we used log-linear three-way contingency tables to test for associations between agreement (the proportion of respondents agreeing or strongly agreeing to an item), ownership (owners and non-owners) and promptness (whether the respondents answered early or late to the eight specific items above) in each country. Fourthly, for each country we correlated respondents' scores on the Restriction, Wildlife and Desexing scales with the length of time they took to respond (measured in days from the date of initial mailing of the invitation to participate). Correlations significant at $p < 0.05$ were interpreted as evidence of non-response bias.

We also tested for differences between online and paper surveys. There were too few paper surveys from Australia and the UK to analyse, so we analysed only respondents from New Zealand and the USA. Countries were analysed separately and

cities within countries were combined.

We used two-way chi-square contingency tables with Yates' correction to evaluate associations between whether people responded by mail or online and the relative proportion of owners and non-owners, men and women, and employment status (working, retired or unemployed). We tested for differences in age between mail and online respondents using either a two-tailed *t*-test after confirming homoscedasticity or a two-tailed *t*-test for heteroscedastic samples. We also used log-linear three-way contingency tables to test for associations between agreement (strongly agree and agree combined)/disagreement (strongly disagree and disagree combined) to the eight specific items above, owners/non-owners, and online/paper survey.

Analysis of Specific Items for All Respondents

We divided all responses simply into agree or disagree to avoid problems caused by limited responses in some of the finer categories, as well as avoiding problems of cultural differences in preferences for selecting middle or extreme values[62]. Respondents who answered "I don't know" to a particular item were excluded from analysis for that item only.

For each item, we used chi-squared homogeneity tests[63] to determine whether the proportion of agreement for owners and non-owners between cities in the same country was the same and therefore whether the data for the cities within each country could be pooled. Those respondents who did not indicate what city they were from were excluded from this analysis. We then used a Generalized Linear Model (GLM) in Statistica 12[64] to assess relationships between the predictor variables (Country, Cat ownership (i.e. cat owners and non-owners) and the Country x Cat ownership interaction) and the dependent variable of agreement with the statement. As there were only two possible answers to each question (agree/disagree), we evaluated the binomial distribution with a logit link function. For countries where the cities were homogeneous according to the previous test, the data were pooled. If not, the cities of that country were analysed separately for that item only. If the cities were considered homogeneous, data from respondents who did not indicate which city they were from were included in the totals for their country. If cities were not homogenous for an item, these respondents were excluded for that item.

Analysis of Specific Items for Cat Owners

For each of the items specific to cat owners we used chi-square contingency tables to evaluate if (i) there were any differences between cities in the same country and therefore whether data could be pooled, and (ii) whether there were any differences between countries. If cities within countries were not significantly different at the 0.05 level, respondents who answered these items but did not disclose what city they were from were included in the totals for that country. Otherwise, they were excluded. For the question 'how many cats do you currently own?' responses were divided into 1 cat, 2 cats and > 2 cats because few owners owned more than two cats.

The survey asked owners to provide information on up to four of their cats if applicable. Information for all of the cats mentioned was used in the analyses. For example, for the question "has this cat been desexed?," if an owner provided information on three cats, all three cats were recorded and contributed to the total sample size.

Construction of Rasch Scales

The Rasch measurement model was used to establish the psychometric properties of three scales (Restriction, Wildlife and Desexing) using RUMM2030[65]. This examines the fit of a set of data to a linearised uni-dimensional model, which, if the data fit the model, places survey questions and respondents' attitudes relative to one another on a single equal-interval continuum. This produces locations (scores) for each survey item and every respondent. These locations are directly comparable with each other and, since they are linearised, are more appropriate for use in common statistical tests than raw scores. Respondents scoring more highly on the Restriction scale were more supportive of cat legislation, including items such as limiting the number of cats that can be owned per household or opportunities for cats to roam. Those scoring more highly on the Wildlife scale were more likely to be concerned about negative impacts of roaming cats on wildlife, while respondents scoring more highly on the Desexing scale were more knowledgeable about desexing and cat behaviour, more supportive of desexing their own pet cats, and more supportive of requiring others to do likewise.

Analysis of the Rasch Person Locations on the Three Scales

Each of the three scales was analysed separately as a dependent variable in a nested GLM using Statistica 12 [64]. Country, City (nested within country), Cat ownership status and the Country x Cat ownership interaction were used as predictor variables to test relationships with the dependent variables. We did not extend the analysis to consider, for example, differences in responses between men and women or between people of different ages because inclusion of large numbers of variables in relation to sample size risked overfitting in statistical models. Significance levels for the tests were set at $p < 0.01$ to compensate for heteroscedasticity that could not be corrected by logarithmic transformation.[66] Respondents who did not indicate their city were excluded from these analyses. However, if city was not a significant predictor alone or in interaction, we then repeated the analyses excluding city as a predictor and included respondents who did not give a city.

Results

Representativeness of the Survey and Non-Response Bias

Characteristics of Survey Respondents

In the presentation of results that follows and in the discussion we refer simply to categories of respondent by country and by cat ownership status, without reiterating that our respondents belong to a specific middle class demographic. They cannot be considered representative of other demographics in the populations of these countries.

TABLE 2. Characteristics of respondents in each country. https://doi.org/10.1371/journal.pone.0151962.t002

City and Country	n	Male	Female	Owner	Non-owner	Mean age[1]	Early[2]	Late[3]	Online[4]	Mail[5]
Sydney	53	25	28	11	42	56±13	31	20	51	2
Wollongong	108	54	54	22	86	60±14	60	45	105	3
Unspecified	8									
Australia Total	169	79	82	34	132	59±14	91	65	156	5
Auckland	99	42	57	53	46	48±16	56	36	92	7
Dunedin	225	84	141	114	111	53±16	126	61	187	38
Unspecified	23									
New Zealand Total	347	126	203	175	164	52±16	182	97	279	45
Chicago	62	42	20	18	44	54±13	27	33	60	2
Los Angeles	61	33	28	26	35	54±14	23	35	58	3
Hawaii	140	91	48	42	98	56±14	65	56	121	18
Unspecified	19									
USA Total	282	167	101	91	182	55±14	115	24	239	23
Southampton	107	52	54	42	65	50±18	65	47	105	7
Birmingham	49	17	32	15	34	52±18	27	22	51	0
Unspecified	0									
UK Total	156	69	86	57	99	51±18	207	193	156	7
Japan Capital Area	87	32	55	17	70	28±8	N/A	N/A	N/A	N/A
Shizuoka	101	25	75	36	65	38±14	N/A	N/A	N/A	N/A
Japan Other	65	15	50	16	48	25±13	N/A	N/A	N/A	N/A
Unspecified	42									
Japan Total	295	72	181	82	190	31±13	N/A	N/A	N/A	N/A
Beijing	143	147	148	53	220	37±16	N/A	N/A	N/A	N/A
Heilongjiang	305	49	90	6	115	34±15	N/A	N/A	N/A	N/A
Unspecified	23									
China Total	471	203	245	61	350	36±15	N/A	N/A	N/A	N/A

[1]Mean ± standard error.
[2]Responded within two weeks of invitation.
[3]Responded more than two weeks after invitation.
[4]Responded online.
[5]Requested a hard copy survey and responded by mail.

There were 1720 respondents across the six countries. Most responses were from China (471–47.1% response rate) followed by New Zealand (347–11.5% response rate), Japan (295–36.9% response rate), the USA (282–5.0% response rate), Australia (169–4.3% response rate) and the UK (156–3.9% response rate). More women responded to the survey than men in all countries except the USA. On average, the respondents from Australia, the UK, New Zealand and the USA were in their 50s. Respondents from Japan and China were much younger with average ages of 31 and 36 respectively (Table 2).

Proportions of Cat Owners

In Australia, the USA and China cat owners were represented in the sample in the same proportions as expected based on ownership for the population ($p \geq 0.22$ in all cases). In New Zealand, the UK and Japan, cat owners were over-represented in the sample ($\chi^2_1 = 30.11$, $p < 0.0001$, $\chi^2_1 = 10.04$, $p = 0.002$ and $\chi^2_1 = 119.57$, $p < 0.0001$, respectively; Table 2).

Non-Response Bias

The proportions of owners and non-owners, men and women, and age categories did not vary depending on whether people responded early or late from each country ($p > 0.10$ in all cases). Similarly, agreement/disagreement with seven of the eight specific items was not associated with whether people responded early or late. The exception was 'All cats should be kept in at night time', where late cat owners in Australia were more likely to agree ($G^2_2 = 6.32$, $p = 0.042$), while late cat owners in the USA were less likely to agree ($G^2_2 = 6.2$, $p = 0.045$). These trends were borne in mind when interpreting the analysis of this item. Non-response bias was not detected in the other questions. No significant correlations were found between respondents' scores on the Restriction, Wildlife and Desexing scales and the promptness with which they responded to the survey ($r \leq 0.215$ in all cases), so there was no evidence of non-response bias in these scales.

Given the almost total absence of evidence for non-response bias for Australia, New Zealand, the UK and the USA, we assumed no non-response bias for Japan (where individual survey timing information was unavailable) and in China, which had the highest overall response rate. Undetected non-response bias may exist, but with no evidence of the direction in which this might be operating no correction was possible.

Mail Survey Respondents

Similar proportions of owners and non-owners (NZ: $\chi^2_1 = 0.01$, $p = 0.92$; USA: $\chi^2_1 = 0$, $p = 1$) and men and women (NZ: $\chi^2_1 = 0.11$; $p = 0.74$; USA: $\chi^2_1 = 0.88$, $p = 0.35$) responded online or by mail. However, there were significantly more retired people in both New Zealand and the USA who responded by mail ($p \leq 0.0001$ for both countries), with mail respondents significantly older by about 20 years in New Zealand and 10 years in the USA than online respondents ($p < 0.0001$ for both countries). Mail survey respondents from the USA were more likely to agree 'That there is a need for cat legislation' ($G^2_2 = 6.8$, $p = 0.03$) and disagree with 'It is important to have wildlife in cities, towns and rural areas' ($G^2_2 = 9.24$, $p = 0.01$). New Zealand mail survey respondents were more likely to agree that 'Except for a cat owned by a breeder, all cats should be desexed' ($G^2_2 = 8.48$, $p = 0.01$). There were no significant differences in responses for the other specific items. Online and mailed responses were pooled for analysis of specific items and development of Rasch scales.

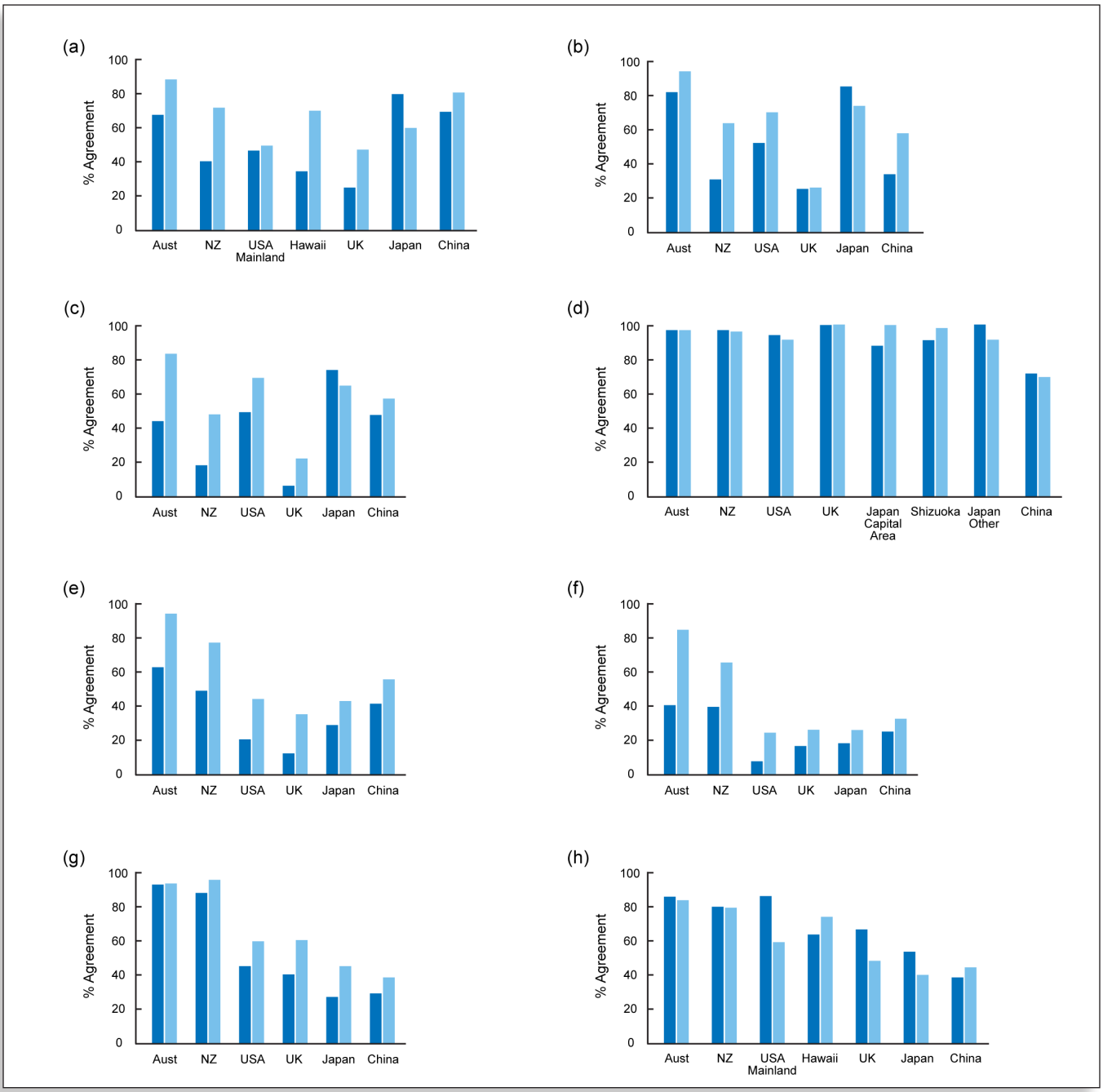

FIGURE 1. Percentage agreement of cat owners (dark blue) and non-owners (light blue) in each country to eight survey items: (a) There is a need for cat legislation (b) All cats should be kept in at night (c) Cats should be kept on owner's property at all times (d) It is important to have wildlife in cities, towns and rural areas (e) Pet cats killing wildlife in cities, towns and rural areas is a serious problem (f) Pet cats on farms are harmful to wildlife (g) Pet cats in nature reserves are harmful to wildlife (h) Except for a cat owned by a breeder, all cats should be desexed. https://doi.org/10.1371/journal.pone.0151962.g001

Responses to Specific Items for All Respondents

For most of the specific items, cities within countries were deemed homogenous with only three exceptions. For 'There is a need for cat legislation' and 'Except for a cat owned by a breeder, all cats should be desexed', Hawaii was significantly different from Los Angeles and Chicago. In these instances, Hawaii was treated as a separate country but Los Angeles and Chicago were pooled to form mainland USA (after passing the homogeneity test). The cities within Japan were all significantly different for 'It is important to have wildlife in cities, towns and rural areas' and were treated separately for this item.

There is a Need for Cat Legislation

There were significant effects for country, ownership and the country x ownership interaction (Table 3 and S1 Table). Non-owners were more supportive of the need for cat legislation than owners everywhere except in Japan (Figure 1A). Australian non-owners were the most supportive (88%) followed by Chinese non-owners (80%) and Japanese owners (79.5%). The UK respondents showed least agreement, especially cat owners (25%). The difference between cat owners and non-owners was most marked in New Zealand and Hawaii; conversely there was almost no difference in the results between owners and non-owners on the mainland USA (Figure 1A).

All Cats Should be Kept in at Night Time

There were again significant effects for country, ownership and the country x ownership interaction (Table 3 and S1 Table). Generally, owners were less supportive than non-owners, except in Japan where owners were more supportive and in the UK, where owners and non-owners had similarly low agreement (Figure 1B). Agreement was highest in Australia, followed closely by Japan with over 80% agreement from all Australian respondents and Japanese owners. Support was lowest in the UK, with respondents showing less than 30% agreement irrespective of cat ownership.

Cats Should be Kept On Their Owner's Property At All Times

There were significant effects for country, ownership and the country x ownership interaction (Table 3 and S1 Table). Owners were generally less supportive than non-owners except in Japan, where this was reversed (Figure 1C). Australian non-owners were the only group that showed above 80% agreement, while lowest agreement was for New Zealand owners (18.6%), and both owners (6.9%) and non-owners (22.7%) in the UK.

Although both this item and the previous one consider restricting cat wandering behaviour, confining cats to their owners' properties at all times was less popular amongst the majority of respondents, with the exception of owners and non-owners from the USA and Chinese non-owners where responses stayed approximately the same. The differences between cat owners and non-owners were also much stronger for this item except in the USA and Japan, where the differences remained about the same (Figure 1C).

It Is Important to Have Wildlife in Cities, Towns and Rural Areas

There was a significant effect of country but no effect of ownership or the country x ownership interaction (Table 3 and S1 Table). Support for the retention of wildlife in settled areas was very high and, irrespective of cat ownership, attracted over 85% agreement in all countries except China, where only approximately 65% of respondents agreed (Figure 1D).

Pet Cats Killing Wildlife in Cities, Towns and Rural Areas is a Serious Problem

There were significant effects for country and ownership, but no significant effect of country x ownership interaction (Table 3 and S1 Table). Non-owners were more supportive than owners in all countries, although in Australia 62% of owners agreed (Figure 1E). Overall, support for this item was highest in Australia followed by New Zealand and least in the UK, where only 12% of owners and 38% of non-owners agreed.

Pet Cats On Farms are Harmful to Wildlife

There were significant effects for country, ownership and country x ownership interaction (Table 3 and S1 Table). In all countries, owners were less likely to agree than non-owners, especially in Australia and New Zealand (Figure 1F). However, all respondents from Australia and New Zealand, regardless of ownership, were more likely to agree with this item than respondents from any other country. Support was lowest from cat owners in the USA (8%). With the exception of owners and non-owners from the UK, support for this item was consistently lower than for 'Pet cats killing wildlife in cities, towns and rural areas is a serious problem' and 'Pet cats in nature reserves are harmful to wildlife.'

Pet Cats in Nature Reserves are Harmful to Wildlife

There were significant effects for country and ownership, but not for the country x ownership interaction (Table 3 and S1 Table). Owners were less likely to agree with this item than non-owners (Figure 1G). Support was very high in Australia and New Zealand, with more than 88% of owners and non-owners in each country agreeing that pet cats in nature reserves are harmful to wildlife. The USA and the UK formed a second group with support c. 40% for this item for owners and 60% for non-owners, with Japan and China forming a third group with support c. 30% for owners and 40% for non-owners. For owners and non-owners from Australia, New Zealand, the UK and the USA, support for this item was consistently higher than for 'Pet cats killing wildlife in cities, towns and rural areas is a serious problem' and 'Pet cats on farms are harmful to wildlife.'

Except for a Cat Owned by a Breeder, All Cats Should Be Desexed

There were significant effects of country, ownership and country x ownership interaction (Table 3 and S1 Table). In each country agreement was generally higher for this item from cat owners, with the exception of Hawaii and China, where non-owners were more supportive (Figure 1H). Levels of support were highest among cat

TABLE 3. Results of analysis of specific survey questions. Cities within countries are combined, unless responses were shown to differ between cities. https://doi.org/10.1371/journal.pone.0151962.t003

Question	Countries	GLM result				Interpretation
			Wald Chi-square	d.f.	Sig.	
There is a need for cat legislation	Australia, New Zealand, UK, USA Mainland, Hawaii, Japan, China	Intercept	36.696	1	<0.001	Non-owners were more supportive of the need for cat legislation than owners everywhere except in Japan.
		Country	81.173	6	<0.001	
		Ownership	23.061	1	<0.001	
		Country*Ownership	35.790	6	<0.001	
All cats should be kept in at night time	Australia, New Zealand, UK, USA, Japan, China	Intercept	37.651	1	<0.001	Owners were less supportive than non-owners, except in Japan where owners were more supportive and in the UK, where owners and non-owners had similarly low agreement.
		Country	142.813	5	<0.001	
		Ownership	16.112	1	<0.001	
		Country*Ownership	25.651	5	<0.001	
Cats should be kept on their owner's property at all times	Australia, New Zealand, UK, USA, Japan, China	(Intercept)	2.07	1	0.150	Owners were generally less supportive than non-owners except in Japan, where this was reversed.
		Country	130.148	5	<0.001	
		Ownership	35.159	1	<0.001	
		Country*Ownership	31.005	5	<0.001	
It is important to have wildlife in cities, towns and rural areas	Australia, New Zealand, UK, USA, Japan Capital Area, Shizuoka, Japan Other, China	(Intercept)	0.000	1	0.997	Support for retaining wildlife in settled areas attracted strong agreement irrespective of cat ownership.
		Country	75.670	7	<0.001	
		Ownership	0.000	1	0.999	
		Country*Ownership	2.945	7	0.890	
Pet cats killing wildlife in cities, towns and rural areas is a serious problem	Australia, New Zealand, UK, USA, Japan, China	(Intercept)	0.946	1	0.331	Non-owners were more supportive than owners in all countries, although in Australia 62% of owners agreed.
		Country	123.967	5	<0.001	
		Ownership	55.927	1	<0.001	
		Country*Ownership	10.002	5	0.075	
Pet cats on farms are harmful to wildlife	Australia, New Zealand, UK, USA, Japan, China	(Intercept)	80.946	1	<0.001	In all countries, owners were less likely to agree than non-owners although all respondents from Australia and New Zealand, regardless of ownership, were more likely to agree than respondents elsewhere.
		Country	113.130	5	<0.001	
		Ownership	33.847	1	<0.001	
		Country*Ownership	11.461	5	0.043	
Pet cats in nature reserves are harmful to wildlife	Australia, New Zealand, UK, USA, Japan, China	(Intercept)	52.070	1	<0.001	Owners were less likely to agree with this item than non-owners. Support was very high in Australia and New Zealand, weaker in the USA and the UK, and lowest in Japan and China.
		Country	187.618	5	<0.001	
		Ownership	10.929	1	<0.001	
		Country*Ownership	2.409	5	0.790	
Except for a cat owned by a breeder, all cats should be desexed	Australia, New Zealand, UK, USA Mainland, Hawaii, Japan, China	(Intercept)	80.082	1	<0.001	In each country agreement was generally higher for this item from cat owners, excepting Hawaii and China, where non-owners were more supportive.
		Country	113.569	6	<0.001	
		Ownership	4.486	1	0.034	
		Country*Ownership	14.884	6	0.021	

owners from Australia, New Zealand and the mainland USA, and lower for UK non-owners, Japan and China.

Responses to Specific Questions for Cat Owners

How Many Cats do You Currently Own?

The number of cats owned by households varied significantly between countries ($\chi^2_{10} = 92.99$, $p < 0.0001$). With the exception of Japan, the largest ownership category was single-cat households (Figure 2A). In China, the proportion of single-cat households was especially high (80%) compared to other countries, with New Zealand next (64%). In the USA, the number of households with only one cat (44%) was only slightly higher than the number of households with two cats (40%). In Australia, New Zealand and the UK there was a drop of at least 25% between one and two cat households. China had a 73% drop between one- and two-cat households. China and Japan had more 'more-than-two-cats' households than two-cat households (Figure 2A). Households in the UK were the least likely to have more than two cats (8%). Japan was unusual in that most households (51%) had more than two cats followed by single-cat households (32%) and then households with only two cats (17%) (Figure 2A). Some cat owners in Japan owned very high numbers of cats. Ten households (13%) reported owning 10 or more cats with the highest number being 99 and the next highest 27. Although the 99 could be an error, it might indicate a person claiming ownership of a cat colony.

Does this Cat Live...?

This question targeted whether cats were kept either solely inside, solely outside, inside at night but free roaming during the day, inside and outside but restricted to the owner's property, or inside and outside but free roaming. There was a significant association between confinement and countries ($\chi^2_{32} = 453.6$, $p < 0.0001$). This item was also highly variable within countries, with Australia divided into Sydney and Wollongong, the USA into mainland USA and Hawaii, and Japan divided into Shizuoka and Japan Rest. Cats in Sydney (53%), the mainland USA (66%) and both locations in Japan (75%) were most likely to be kept solely inside (Figure 2B).

Although Sydney and Wollongong were significantly different from each other, cat owners in Wollongong still favoured restricting their cats' wandering behaviour either by keeping them in at night (34%), or by restricting them to their property (29%). However, owners in Wollongong were more likely to let their cats be inside and outside but free roaming (20%) than owners in Sydney (8%). Cat owners in New Zealand and the UK reported similar patterns: most cats were "free roaming inside and outside" (67% and 64% respectively), followed by cats kept in at night (14% and 23% respectively). On the mainland USA, cat owners favoured restrictions by keeping their cats solely inside (66%), inside and outside but restricted to their property (19%) or inside at night but free roaming during the day (8%). However, in Hawaii, although cats were predominantly kept solely inside (56%), 20% "were free roaming inside and outside". In Japan most cats were kept solely inside (75%), but the second option preferred by Japan Rest was for cats to be inside and outside but free roaming (14%), compared to inside and outside but restricted to their property in Shizuoka (11%). China showed the least variance. Although 32% of cat owners preferred to keep their cats solely inside, even their lowest two preferences of "inside at night but free roaming during the day" (12%) and "free roaming inside and outside" (12%) were more popular than the second preference in Shizuoka, which was "inside and outside but restricted to owner's property" (Figure 2B).

Has this Cat Been Desexed?

There was a significant difference between countries in the proportion of cats desexed ($\chi^2_7 = 284.4$, $p < 0.0001$), and high levels of variability between cities in China and Japan. Shizuoka was separated from the other Japanese localities, which were all combined into Japan Rest. Beijing and Harbin were considered separately. In general, desexing rates were very high (over 94% in Australia, New Zealand, the USA, the UK and Shizuoka (Figure 2C)). Japan Rest had lower desexing rates than Shizuoka (83% and 99% respectively). China had much lower desexing rates than the other countries (43% in Beijing and 0% in Harbin (Figure 2C)).

Has this Cat Ever Caught any Vertebrate Prey?

There was a significant difference between countries in the proportion of cats that had been known to catch prey at least once in their lives ($\chi^2_6 = 124.1$, $p < 0.0001$). The highest proportions were in the UK (82%) and New Zealand (79%), followed by Hawaii (67%; Figure 2D). Respondents from Japan (32%) and the USA Mainland (38%) reported the lowest proportion of cats that were known to catch prey.

Analysis of the Rasch Person Locations for Three Scales

Overall conclusions about the scales' internal consistency and reliability are provided. All but two items (R14 and R16) in the Restrictions scale showed good fit to the model and these were deleted from the final scale as they are measuring a different variable. The Person Separation Index (an index of reliability) was high at 0.856, indicating that this scale provides valid and reliable person measures. To obtain good fit to the Rasch model, one item (W11) was deleted from the Wildlife scale, and two items (S5 and S9) from the Desexing scale. Both scales had lower reliability than the Restriction scale (0.589 and 0.605, respectively). They would benefit from a greater range of items to improve their reliability: at present the items are too homogeneous, relative to the respondents. Analysis of a combination of all three scales (with items S5, S9, R14 and R16 deleted) showed they may, for particular research contexts, be considered as a single scale representing attitudes to cat care and control. The Person Separation for the combined scale was high at 0.847. Using the person locations from each of the three scales separately, traditional statistical techniques were carried out as follows.

With a significance level of 0.01, cities within countries gave consistent results for all scales (Restriction: $F_{(8,1525)} = 1.94$, $p = 0.050$), Desexing: ($F_{(8,1476)} = 1.32$, $p = 0.226$), Wildlife: ($F_{(8,1485)} =$

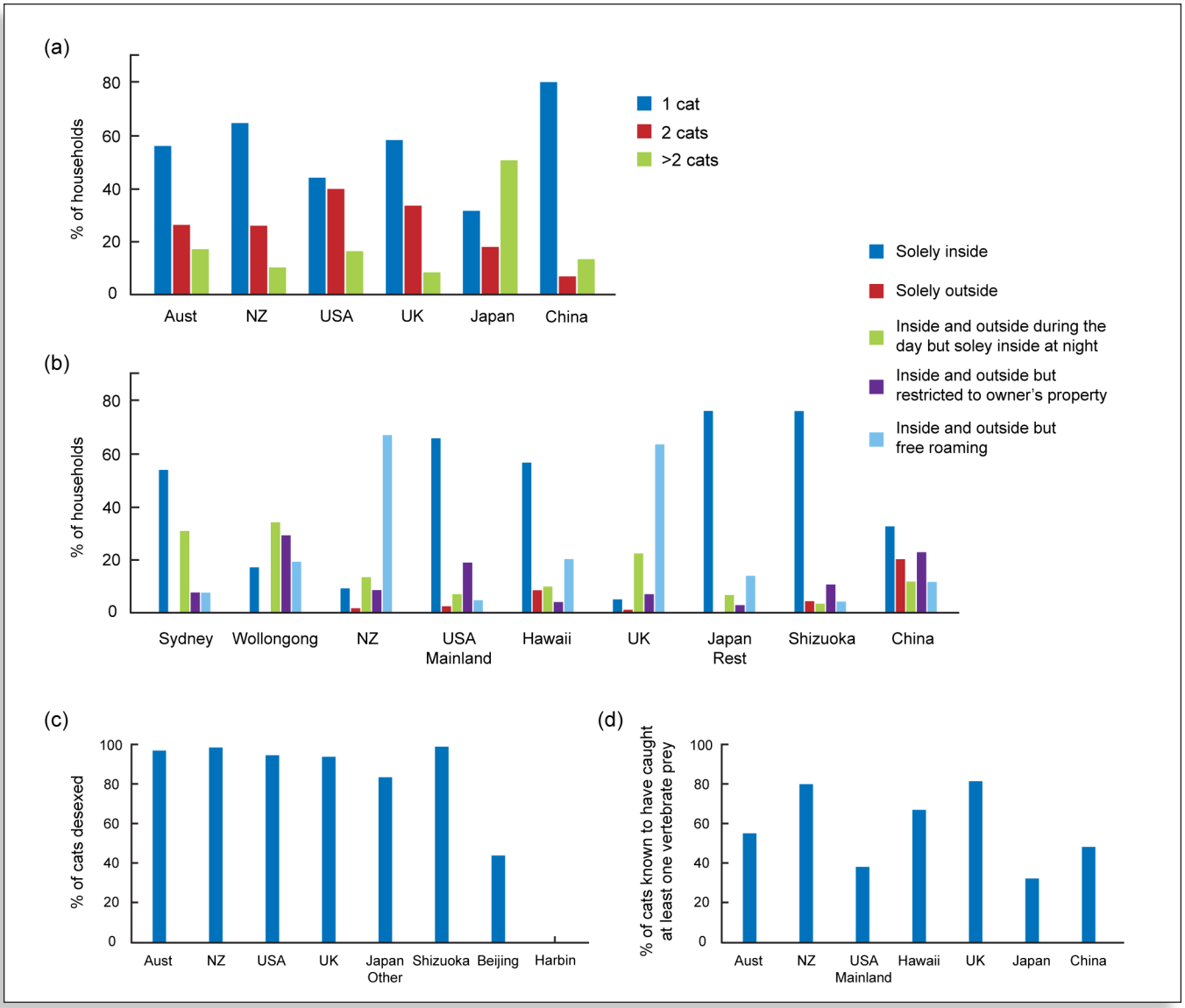

FIGURE 2. Cat husbandry practices in different countries. (a) Percentage of households that own one, two or more than two cats. (b) Percentage of cats kept in different conditions of confinement. (c) Percentage of desexed cats. (d) Percentage of cats that have ever caught vertebrate prey. https://doi.org/10.1371/journal.pone.0151962.g002

2.24, $p = 0.022$). Therefore analyses were repeated without cities nested within country as a predictor and respondents who did not indicate a city were included.

On the Restriction scale, there were significant effects for country ($F_{(5,1599)} = 20.43$, $p < 0.001$), ownership ($F_{(1,1599)} = 208.53$, $p < 0.001$) and the country x ownership interaction ($F_{(5,1599)} = 7.53$, $p < 0.001$). In each country non-owners were more supportive of restrictions than owners. This was especially so in Australia, but much less so in Japan. Australian non-owners were more supportive of restrictions on cats than non-owners from other countries, and the same was true for Australian owners compared to owners elsewhere. Support for restrictions was lowest in the UK. The significant country x ownership interaction was driven strongly by the contrast between Japan, where there was only a very small difference in the opinions of owners and non-owners, and Australia, where there was a large difference between owners and non-owners (Figure 3A and S2 Table).

On the Desexing scale, there were significant effects for country ($F_{(5,1547} = 11.42$, $p < 0.001$), ownership ($F_{(1,1547)} = 9.97$, $p = 0.002$) and the country x ownership interaction ($F_{(5,1547)} = 4.93$, $p = 0.003$). Owners were more supportive of desexing than non-owners except in China, where non-owners tended to be more supportive. Support for desexing was highest in Australia and lowest in China (Figure 3B and S2 Table).

On the Wildlife scale there were significant effects of country ($F_{(5,1555)} = 45.13$, $p < 0.001$), ownership ($F_{(5,1555)} = 109.26$, $p < 0.001$) and the country x ownership interaction ($F_{(5,1555)} = 5.25$, $p < 0.001$). In each country non-owners showed higher scores than owners. This difference was especially marked in Australia and New Zealand, but much less in China and Japan. Internationally, Australian and New Zealand non-owners had the highest scores compared to other non-owners, and the same was true for owners

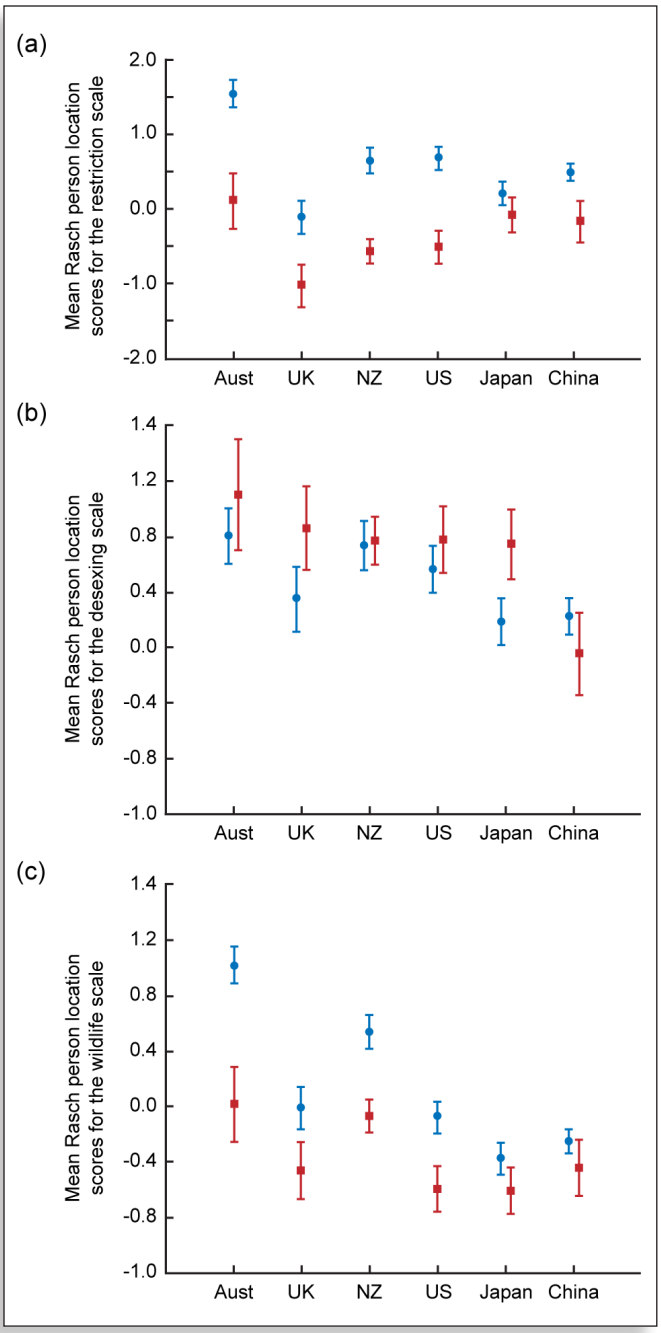

FIGURE 3. Mean Rasch person location scores, ± 95% confidence limits, for owners (red) and non-owners (blue) on (a) the restriction scale (b) the desexing scale (c) the wildlife scale.
https://doi.org/10.1371/journal.pone.0151962.g003

(see Figure 3C and S2 Table).

Discussion

Tests of Specific Predictions

Our predictions that cat owners would be less accepting of statements implying that cats threaten wildlife than non-owners and be less accepting of cat regulation were largely fulfilled. In all countries non-owners were more likely than owners to believe that pet cats killing wildlife were a problem in a range of locales, while legislation was supported most strongly by non-owners everywhere except in Japan. We have no specific evidence of why owners were less likely to believe that pet cats killing wildlife was a problem. Where the predominant practice of owners was to confine their pets at all times, this belief likely rests on the sound premise that confined cats cannot hunt wildlife, although wildlife protection need not be the motivation for confinement. In other cases, owners presumably believed that predation by pet cats was an insignificant factor in determining the distribution and abundance of prey species. Alternatively, they chose to value the convenience of their pets over wildlife. However, the prediction that owners valued wildlife less than non-owners was not supported. Significant differences between countries were identified, offering partial support for the prediction that respondents from Australia, New Zealand, China and the US state of Hawaii (all with high endemic wildlife biodiversity) would be more concerned about impacts of pet cats on wildlife than respondents from elsewhere. Even large proportions of Australian (62%), New Zealand (51%) and Chinese owners (42%) agreed that pet cats killing wildlife in cities, towns and rural areas was a problem (although Hawaii matched the mainland USA). Hawaiian non-owners, though, were more supportive of cat legislation and desexing pet cats than non-owners on the mainland USA. Overall, the pattern of responses seems to be determined by a complex of historical and cultural conditions.

International Differences in Attitudes to Cats and Wildlife

Marked national differences occurred in responses to individual questions and in the analyses of the Rasch scales. These have implications for any attempts to regulate cat ownership in each country. We discuss these in the context of research in different countries that has attempted to quantify any impacts of pet cats on wildlife. We did not extend the analysis to consider, for example, differences in responses between men and women or between people of different ages because inclusion of large numbers of variables in relation to sample size risked overfitting in statistical models. However, these variables may also have an influence.

Australia

The popularity of cats as pets in Australia is declining, with the pet cat population estimated at 2.93 million in 1994 and 2.35 million in 2009. The percentage of households owning a cat declined from 24.6% to 22.8% over the same period [5]. The second highest reason for Australians not owning a cat (after dislike of cats) is concern about wildlife [67,68]. Thus it was unsurprising that Australian owners and non-owners scored highly on the wildlife Rasch scale and were likely to believe that pet cats are harmful to wildlife in cities, towns and rural areas and nature reserves. Most Australian non-owners (85%) were also likely to believe that pet cats are harmful to wildlife on farms, but not owners (41%).

Australians have a special preference for their native fauna compared to citizens from the UK, the USA, India and South Africa[69]. Feral predators such as cats and foxes (*Vulpes vulpes*) are accepted as significant threats to Australian fauna [70,71], with feral cats now assessed as endangering more threatened and near threatened Australian mammalian taxa than any other factor [72].

Concern about predation by feral cats on wildlife is manifested in significant paintings by contemporary artists and in museum displays, with some extending to predation by pet cats. Such sustained messages in varied media are reflected in high concern by both owners and non-owners that predation by pet cats on wildlife in cities, towns and rural areas endangers wildlife. Such concerns are at least 25 years old [73,74].

Research on the effects of pet cats on wildlife populations in Australia has resulted in more ambiguity than popular opinion would suggest. Urban habitats provide important refuges for threatened species that are vulnerable to cat predation, including a legless skink (*Delma impar*) in suburban Canberra [75] and the eastern barred bandicoot (*Perameles gunnii*) in Hamilton, Victoria [17]. However, in the case of the eastern barred bandicoot traffic was even more of a threat than predation by cats [17]. Barratt [76] and Grayson, Calver and others [77] concluded that pet cats kill mainly common vertebrates that persist in cities despite predation, although they acknowledged that problems may be more severe near remnant vegetation or on urban fringes. Thus, while pet cats may depress some prey populations, they are also a convenient scapegoat for more intractable causes of wildlife decline [67,78,79].

New Zealand

Cats are popular household pets in New Zealand, with 35% of households owning at least one [80]. These cats co-exist with a predominantly endemic native fauna, although in urban areas nearly half of bird species and most individuals are exotic [81]. With the exception of bats, there are no native mammals. New Zealand respondents were concerned that their fondness for cats could impact their native wildlife, leading to them having the second highest score on the wildlife scale and high agreement that pet cats are a serious problem for wildlife in cities, towns and rural areas, and in nature reserves. Non-owners were also likely to believe that pet cats are a serious problem on farms. This is consistent with popular cultural messages related to responsible pet ownership such as Crew [82], a children's story recounting the fate of the Stephen's Island wren (*Xenicus lyalli*) at the claws of the lighthouse keeper's cat.

Whether cat husbandry should be regulated to protect wildlife proved more contentious. Although support for legislation amongst non-owners was high (70%), support from cat owners was substantially lower (40%) and New Zealand owners scored the second lowest on the restriction scale after UK owners.

Despite the ambivalence of owners towards restrictions, there is evidence that predation by pet cats in New Zealand is likely to be additive (increasing the overall mortality) rather than compensatory (removing individuals that would otherwise die from other causes) for at least some species of New Zealand birds, with urban populations likely being sinks replenished from source habitats with less predation [7]. A New Zealand study also provides the most comprehensive record of predation by one pet cat over its lifetime: in 17 years, the desexed female brought home 558 prey, including mice, rats, rabbits, hares, weasels and birds [83]. The author did not believe that this predation had negative effects on the local wildlife.

USA

Few respondents in the USA considered pet cats a threat to wildlife in cities, towns and rural areas or on farms, but about half considered pet cats a threat in nature reserves. American respondents also scored the lowest of the western countries on the wildlife scale, although it may be that given the high incidence of confinement in the USA respondents had in mind that cats were not a threat because they were likely to be indoors. Respondents were ambivalent about the need for legislation regulating ownership and husbandry of pet cats, perhaps reflecting strong community divisions on the issue (see [34] for coverage of these issues as related to managing colonies of feral or semi-feral cats). On the one hand, conservation groups advocate regulations to enhance cat welfare, reduce public nuisance and protect wildlife (e.g. [38,84]), while on the other hand lobby groups such as the Cat Fanciers' Association resist regulations they perceive as unreasonable, even offering the support of a legislative committee (http://www.cfainc.org/Legislative/LegislativeGroup.aspx). The primary motivation for much existing legislation appears to be the reduction of public nuisance (e.g. [85]). Within Hawaii, where many of the cats are free-roaming, there is strong potential for interaction with feral cat colonies as well as opportunities to depredate native wildlife, including endangered species. Thus conservation of Hawaii's unique fauna may be important in shaping attitudes there.

Wildlife mortality from pet cats in the continental USA is estimated at 684 million birds and 1,249 million mammals annually [18], while the American Bird Conservancy [86] estimated that 500 million to one billion birds are killed each year by pet cats. As an example of effects at the level of a single species, Balogh, Ryder and others [87] determined that predation accounted for 79% of mortalities of post-fledging grey catbirds (*Dumatella carolinensis*), with 47% of these mortalities caused by domestic cats (not necessarily pets). While they acknowledged that they could not determine if this mortality was compensatory or additive, the successful development of collar-worn predation deterrents by USA businesses [88–90] shows that many cat owners in the USA wish to curtail their cats' hunting behaviour.

UK

Respondents from the UK were the least supportive of introducing legislation and scored lowest on the restrictions scale. They were unlikely to believe that pet cats are harmful to wildlife in towns, cities and rural areas or farms, and only 61% of non-owners and 41% of cat owners believed that pet cats are harmful to wildlife in reserves. However, the UK had the highest proportion of cats known to have hunted vertebrate prey on at least one occasion, probably because most cats are kept either inside or outside but free roaming (64%), or only confined at night (23%). Requiring owners to restrict wandering behaviour by either keeping their cats in at night or keeping them confined to their owner's property was very unpopular amongst both cat owners and non-owners.

Requiring owners to desex their cats was only supported by about 66% of owners, although the actual desexing rate was very high (93%). These results are in close accord with independent findings that UK cat owners from two small rural communities disagree that cats harm wildlife populations and are unsupportive of most cat management actions other than neutering [91]. The similarity of attitudes to those from the urban populations we surveyed suggests a characteristic position for UK citizens irrespective of place of residence. Historically, there is a strong tradition in the UK of keeping farm cats to control vermin, so responses are consistent with this view of the function of cats.

UK responses are consistent with the finding that UK citizens respond even more positively than people elsewhere to felids as symbols of nature [69]. They also match the official message from bodies such as the Royal Society for the Protection of Birds (RSPB) that '… there is no scientific evidence that predation by cats in gardens is having any impact on bird populations UK-wide. This may be surprising, but many millions of birds die naturally every year, mainly through starvation, disease, or other forms of predation. There is evidence that cats tend to take weak or sickly birds.' However, there is acknowledgment that: 'Cat predation can be a problem where housing is next to scarce habitats such as heathland, and could potentially be most damaging to species with a restricted range (such as cirl buntings) or species dependent on a fragmented habitat (such as Dartford warblers on heathland)' [92].

Studies of predation by pet cats in the UK have moved from estimates of nationwide losses based on extrapolations from local or regional mortality (e.g.[3,93]) to assessments of population risk that support the conclusion that at least some populations are affected by cat predation [9,36,94], sublethal effects from cat presence [95], or cats mediating the effects of other predators [96]. However, the attitudes expressed by our UK respondents and the RSPB position endorse the opinion that 'Management of the predation behavior of urban cat populations in the UK is likely to be challenging and achieving this would require considerable engagement with cat owners'[36 pg. 1].

Japan

Japan was the only country where owners were more supportive of restrictions than non-owners. The cultural issues underlying this may be complex, because welfare issues such as reducing the incidence of cats being hit by cars or getting lost apply in urban environments elsewhere. Certainly, cats are very popular in Japan, with the phenomenon of 'cat cafés' where people engage directly with cats without owning them being '… a significant retail phenomenon throughout Japan, and in particular Tokyo' [97]. The prevailing views seem well-expressed in an online guide to keeping pets:

Cat owners are required by municipal authorities "to keep the cat in such a manner so as it won't disturb other citizens." Three basic principles of keeping cats:

- Keep your cat in a house.
- Use a collar marked with address and name of the owner.
- Have your cat sterilized.[98]

Japan scored the lowest on the wildlife scale and respondents were unlikely to believe that cats were harmful to wildlife in any situation, although it may be that this was based on the assumption that cats were kept mainly indoors. The number of cats in Japan reported to have killed vertebrate fauna was the lowest across all countries, probably because most were confined. This may result from a high incidence of apartment living.

Studies of predation by pet cats in Japan are limited, although feral cats on offshore islands are significant predators of birds [99]. Research concentrates on stray (unowned) domestic cats in urban areas [100].

China

China's biodiversity includes approximately 10% of known species (animal and plant), which is greater than Europe or North America [101]. Culturally, the Chinese have a long history of adopting a utilitarian approach to their biota, seeing them as resources first and other values second [102]. Infrastructures for sustainable use of natural resources and biodiversity conservation are still developing, but often include many staff and cover extensive geographic areas [101,103,104]. Long-standing cultural perspectives and changing regulatory approaches may underpin the views of Chinese respondents. Furthermore, China's size and diversity can lead to substantial regional differences in attitudes and regulations [103], emphasising that our results are restricted to the particular urban populations we surveyed.

While approximately 70% of owners and 80% of non-owners in China agreed that there was a need for cat legislation, their scores on the restriction scale were similar to New Zealand, the USA and Japan. Perhaps the Chinese respondents did feel that there should be cat legislation, but not in the areas addressed in the survey. Animal welfare organisations are recent in China, with Animals Asia founded in 1998 and the Chinese Animal Protection Network (CAPN) commencing in 2004. They oppose eating cat and dog meat and support trap-neuter-return (TNR) programs to control cat numbers [105,106]. Possibly, these are priority areas for legislation in the minds of Chinese citizens. While most Chinese respondents felt that wildlife is important in towns, cities and rural areas, they did not score highly on the wildlife scale. Chinese respondents were more likely than those from the UK, the USA and Japan to believe that pet cats endanger wildlife in cities, towns and rural areas, but less likely than people in these countries to believe they might affect wildlife in nature reserves.

International Differences in Cat Husbandry Practices

In most countries there is a link between the number of cats per household and the manner in which they are kept (e.g. solely inside, solely outside etc.). In Japan and the USA where respondents were most likely to keep their cats solely inside, households were more likely to have multiple cats. In New Zealand and the UK, where most cats had free access inside and outside all the time, households were more likely to have only one cat. It may be that in households where cats are not permitted outside and

therefore do not have contact with other animals, owners have multiple cats to keep each other company when no people are home. However, in China the majority of households had only one cat regardless of how they were kept. Lepczyk, Mertig and others [32] found a positive relationship between the number of people living at a residence and the number of cats in Michigan, USA, and suggested that larger residences are more likely to have children who own pets. This trend may occur elsewhere, but it would not account for the very high numbers of cats in many households in Japan.

Whether cats were allowed outside or not may also be related to urban density and perhaps to the likelihood of cats encountering dogs, traffic or other urban disturbances, or predators such as red foxes *Vulpes vulpes* or coyotes *Canis latrans* that enter cities or urban fringes. In Australia, significantly more cats were kept inside in Sydney, the larger city, than Wollongong. Similarly, in the USA cats in the large, mainland cities of Chicago and Los Angeles were more likely to be confined than those in Hawaii. Climate is not a factor, because Wollongong and Sydney have similar climates while Chicago and Los Angeles are very different (Table 1). Ironically for wildlife protection, while the less dense cities provide more urban gardens offering shelter and food for wildlife, the lower incidence of cat confinement may provide more opportunities for pet cats to encounter wildlife.

Of all the English-speaking countries in the survey, respondents in the USA were the most likely to keep their cats solely indoors (mainland USA 66%, Hawaii 56%). High rates of confinement between 30% and 60% are also reported in other North American studies (e.g. [39,45,107]). Given that the American Veterinary Medical Association, the Humane Society of the USA [108], the American Association of Feline Practitioners [109], the American Bird Conservancy [38,45,84,86] and the Wildlife Society [110] support home confinement of pet cats in urban and suburban areas, professional endorsement of the practice may be important in its acceptance. Rochlitz [108] and the American Association of Feline Practitioners [109] also support enriching the indoor environment for cats. We found the highest incidence of confinement in Japan, possibly as a result of high urban densities, apartment living, regulation, and advice on responsible pet ownership [98].

Predictably, there is an association between how pet cats live (solely inside, solely outside, etc.) and whether they have ever been known to catch vertebrate prey. New Zealand and the UK, where cats were most likely to be free-roaming, recorded the most cats that have brought prey home at least once. Records of cats hunting were lowest in the mainland USA and Japan, where cats are predominantly kept inside. In Australia, Hawaii and China, partial confinement is more popular, so many cats have access outside at least some of the time. Although these cats may not hunt regularly, they still returned some prey.

There were high desexing rates of cats in all countries except China. Chinese respondents scored very low on the desexing scale and support for desexing cats that are not owned by breeders was also low. Only 43% of cats in Beijing and no cats in Harbin were desexed. These figures may reflect people considering they 'own' colony cats, or a cultural aversion to desexing. Considering that 45% of Chinese cats in our sample were allowed to wander away from their owner's property at least some of the time, there are likely to be many unwanted kittens.

Despite widespread desexing of cats in countries other than China, the proportion of people who agreed with the item 'except for a cat owned by a breeder, all cats should be desexed' was much lower than the actual desexing rate amongst respondents' cats. For example, Japanese respondents were unlikely to agree that all cats should be desexed, but desexing rates were still high (91%). Even though cat owners choose to desex their pets, they are less likely to agree that everyone should be required to do so, despite being more supportive of compulsory desexing than non-owners (except in China).

Overall, the pattern of practices varies considerably across countries in response to a complex of environmental conditions and cultural attitudes, which we have described but not explained.

Representativeness of the Survey

Despite the low response rates, there was little detectable evidence of survey bias. New Zealand, Japan and the UK were the only countries where cat-owners were over-represented in the survey compared to estimates in the general population, although this does assume that the published figures for cat ownership are accurate. In the case of Japan, the disparity may be an artefact of distributing questionnaires through veterinary clinics and local shops. This may also be a reason why the mean ages of Japanese respondents were much younger than those reported in other countries and could mean that the survey missed an older demographic. The possibility that cat owners were more strongly motivated to contribute could also be a factor in Japan and elsewhere.

Further support for the representativeness of the survey comes from the broad similarity of our findings with others conducted in similar communities. For example, our findings about the reluctance of UK cat owners to take any action other than desexing their pets agrees closely with studies by McDonald, Maclean and others [91] and Thomas, Fellowes and others [36]. In Australia, which has had multiple surveys of attitudes toward cats this century, our finding that 62% of owners accepted that cats killing wildlife were a problem in cities, towns and rural areas was similar to findings of 50% in Grayson, Calver and others [30] and 63% in Lilith, Calver and others [31], both for a similar demographic. In New Zealand, our results are similar to those from New Zealand market research company UMR Research's 2013 survey on public attitudes toward cats in New Zealand [111]. For example, after being prompted with figures on the number of native birds killed by cats in New Zealand, 54% of UMR respondents supported some form of control that would reduce the future population of cats (*cf.* 55% of all respondents in our survey agreeing, without prompting, that some form of cat legislation was necessary). In the UMR survey 62% of respondents believed that all pet cats should be desexed, while in our study nearly 80% of all New Zealand respondents

supported the less restrictive position that, with the exception of licensed breeders, all pet cats should be desexed.

There were significant differences in the demographics of people who responded by mail or online in New Zealand and the USA, as well as differences in their responses to some questions. Mail respondents were older and more likely to be retired in both countries. Thus it was worthwhile to offer a mail survey alternative as opposed to providing only an online option, because otherwise we would have missed a significant portion of the older demographic. The variations in responses to some questions in mailed responses relative to internet responses reinforce the importance of offering the option of a mailed response.

Overall, although we have no detectable evidence of non-response bias, we believe the most likely biases in our data are: (i) over-representation of affluent people in the Western countries (an acknowledged issue with internet surveys, although such affluent people may be more likely to enter social debate or have political influence [69]; (ii) despite the offer of a mailed response to those invited to respond online, possible under-representation of older people; (iii) over-representation of responsible cat owners, as suggested by the high rates of desexing in their animals. Moreover, our results cannot be claimed to be representative of rural populations, or of socio-economic groups within cities other than our target demographic.

Implications for Wildlife Conservation

Empirical research from Australia [17], New Zealand [7], the USA [32] and the UK [36] has established that predation by pet cats threatens at least some elements of urban or rural wildlife. While uncertainty remains regarding the risk to populations of particular species in specific localities, a precautionary approach to cat ownership and husbandry is justified while research is undertaken [112,113]. Our chosen middle class demographic represents people most likely to be politically engaged and therefore potentially willing to engage in debate over cat husbandry [69]. Therefore their views are significant.

Of the nationalities we surveyed, Australians are most likely to accept a wildlife-based rationale for restrictions on cat ownership. Most owners and non-owners accept that pet cats may endanger wildlife (irrespective of whether or not the proposition is true), and are more accepting of measures to restrict cats in the interests of wildlife protection. Elsewhere, with the possible exception of New Zealand, arguing for restrictions on cats to protect wildlife may be counterproductive. This is especially true of the UK, where even non-owners are likely to discount cat predation as a threat to wildlife, legislation is unwanted, and there is very little support for confinement of pet cats.

Welfare arguments addressing responsible cat ownership represent an alternative approach to protect wildlife in countries other than Australia (and possibly New Zealand) where cat owners are unlikely to accept legislation based on wildlife protection, but may be more responsive to arguments based on cat welfare. This is the approach advocated by the American Bird Conservancy [84,86]. Welfare-based arguments appeal to the cat-loving citizens of the UK, where even the concept of cat cafes is subject to careful welfare scrutiny [114]. While not enhancing cat welfare, predation deterrents may also appeal to owners concerned about the welfare of prey. Bells, pounce protectors, battery-powered alarms and colourful collar covers all reduce predation by cats significantly for different groups of vertebrate prey [88–90,115–119], but do not stop all hunting. They could be promoted to reduce hunting success, especially if owners can be reassured that properly fitted safety collars are low-risk[120]. However, support for them is modest amongst owners in the UK [36], while in New Zealand the UMR Research's 2013 survey on public attitudes toward cats in New Zealand reported only 42% support for requiring all cats to wear a bell on their collar [111].

The most effective way to protect wildlife from the potential impact of pet cats and to improve cat welfare by reducing the risk of road accident trauma and fighting is to restrict cats to their owners' properties, ideally within runs so that some of the garden is safe from cat activity. Most cats in our study from Australia (Sydney), mainland USA, Hawaii and Japan were kept inside only, as were a third of cats from China. It is unclear whether this was done for reasons of cat welfare or wildlife protection, although the views of American, Japanese and Chinese owners on the impacts of cats on wildlife suggest that the motive was cat welfare. Fewer than 10% of New Zealand or UK owners confined their cats. Welfare campaigns highlighting the risks to roaming cats might increase the acceptability of confinement in the UK and New Zealand, especially if accompanied by advice on environmental enrichment requirements for indoor cats [108,121], and the use of leash training and outdoor enclosures.

Of course, regulating pet cats will not be a panacea for wildlife protection. Although in some instances pet cats may pose a significant threat to local wildlife (e.g. [7,36]), this is additive to many other impacts from anthropogenic mortality sources such as collisions with cars and other forms of transport, collisions with structures and windows (for birds), electrocution, pollution and over-hunting [17,122–126]. The primary threat to wildlife near human dwellings is often habitat loss and fragmentation [77,127,128], while the decline in the average garden size and desire for houses with larger floor areas in many countries provide fewer resources for wildlife in urban areas [7,129,130,131]. The substantial populations of unowned cats roaming in cities, sometimes fed deliberately by people, may also be a significant wildlife protection issue requiring unique approaches [4,37,80,132]. Nevertheless, reducing the threat from pet cats will benefit some species and can be done while enhancing cat welfare. It is therefore an immediate and effective action that should be undertaken together with, not instead of, investigation of some of the more intractable causes of wildlife decline.

Supplemental and Supporting Information

S1 TABLE. Raw data underpinning the analysis of specific survey questions reported in Table 3. There is a separate spreadsheet for each question. 0 = agreement with the question, 1 = disagreement with the question.

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S2 TABLE. Raw data underpinning the analysis of Rasch location scores reported in Fig 3. There is a separate spreadsheet for each question. 0 = agreement with the question, 1 = disagreement with the question.

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Competing Interests

The authors have declared that no competing interests exist.

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CONTINUED FROM PAGE 6

to rebound after a drop in numbers, researchers saw huge differences in how long it took for populations to recover," said Dan Esler, a Research Wildlife Biologist with the U.S. Geological Survey and lead author of a recently released paper on the subject. "Some species were barely affected, others such as bald eagles, rebounded quickly, and other species took much longer to recover, such as sea otters."

Oiled Sea Otter *(Enhydra lutris)*.

In addition to differences in the time required for full recovery, USGS and collaborators from the U.S. Fish and Wildlife Service, Oregon State University, and the North Gulf Oceanic Society identified ecological factors that affected the degree of injury:

- Species that foraged on invertebrates that occur in or on contaminated sediments were more likely to be affected by the oil spill than those that fed on fish or zooplankton in the water column. Species with low reproductive rates, such as orcas, have limited capacity to recover; in fact, orcas still have not returned to pre-spill numbers.
- Some population changes that were not related to the oil spill; for example, two species of seabirds, pigeon guillemots and marbled murrelets, may have been affected by oil exposure, but long-term analyses showed declines in numbers before and after the spill, probably related primarily to changing ocean conditions.

The USGS has previously led long-term studies of sea otters and harlequin ducks, two species that showed lack of recovery for over two decades after the spill. USGS Research Wildlife Biologist Dan Monson, noted "Sea otters were exposed to lingering oil in beach sediments long after shorelines appeared clean and oil exposure affected survival rates and population growth until at least the mid-2000s."

The paper reviewing scientific studies of wildlife recovery, entitled "Timelines and mechanisms of wildlife population recovery following the Exxon Valdez oil spill" is available in the journal Deep Sea Research II, as part of a special issue focused on sources of ecological variability in the Gulf of Alaska.

EU Recognizes Need for Arctic Oiled Wildlife Response

STRASBOURG, FRANCE (March 16, 2017)—The European Parliament Resolution, "*An integrated EU policy for the Arctic (2016/2228 [INI])*, recommends all Arctic states develop oiled wildlife response plans. In wording suggested by Sea Alarm, point 28 reads:

> Calls for the development of oiled wildlife response plans, in accordance with defined good practice, in all Arctic states, including an effective assessment of vulnerable species at risk, as well as feasible prevention and response strategies to ensure their protection;

"By including it in their policy report, the Members of the European Parliament (MEPs) have made a strong statement that preventing impacts on Arctic wildlife and being prepared to respond to affected animals is important to the European Union."

Writing further, the Sea Alarm representative notes:

> ..."that a response to oiled wildlife is difficult under Arctic conditions where severe weather, pack ice, long periods of low light and remote locations make finding, capturing, and treating impacted animals challenging. However, wildlife may be the most important resource that is at risk from oil spills in the Arctic. So far little has been done to discuss this issue and to agree on response options (monitoring, euthanasia, rescue, public communication) that a spiller or a responsible government could consider in order to deal with animal welfare and public concerns under these conditions. Developing integrated and area specific wildlife response plans is the way forward and should go hand in hand with R&D investments and training of specialised wildlife response staff. Acknowledging these issues and developing national and international strategies will be necessary to ensure the best possible outcome for wildlife in the event of an oil spill."

Amanda Autumn Margraves

SEP 9 1981—MAY 13, 2017

BY LLOYD BROWN

On the evening of Saturday, May 13th I lost a close friend and the wildlife rehabilitation community lost one of our own

Amanda Autumn Margraves was always meant to be a rehabber, she just didn't always know what to call it. She had a passion for animals and went to the University of Michigan, where she was studying Pre-Vet, when she found an injured squirrel. Like many people who have such experiences, she spent almost a whole day trying to find out what could be done to help it. When she finally found a rehabber and learned what wildlife rehab is all about, She was hooked. She continued on at U of Michigan and got her bachelors degree in zoology. But from then on, she was a rehabber.

After college, she got a job at the Flynt River Aquarium, in Albany, Georgia. While there, she became Georgia State permitted rehabber. She was the only rehabber in her area so she took in everything. While there she also volunteered with the rescue efforts of seabirds from the Deepwater Horizon oil spill that affected the coastal birds along the Gulf of Mexico.

She then went to Belize where she worked at Belize Bird Rescue and Wildtracks. She loved Belize and even after she moved on, she would go back as often as she could.

After that, she landed the job of Director of Rehab at the Florida Keys Wild Bird Center.

I had begun my rehab life at the Keys Bird Center working under their founder Laura Quinn. I lived and worked there for two years before moving on to work on a dolphin rescue project and eventually started my own place. Mine is the next rehab center to the north of the Keys bird center, so, I maintained close ties with them. When I heard that they were getting in a new rehabber, I made a trip down to meet her and introduce myself. That was when I met Amanda. That was in 2011 and over the next several years we stayed friends and rehab neighbors. If I had a water bird I would send it down to her. If she had a large bird of prey or a mammal, she would send it to me. During her four years there, she became a legend and was beloved by the Keys community. She was known as someone who would show up at any hour of the day or night (sometimes in her pajamas and slippers) to rescue any animal in peril. Everybody loved her and she had a cult-like following of fans who thought she was a saint and would follow her every move on social media. Many of these fans were people had witnessed her rescuing animals and some had only heard about her and wanted to know her.

In September of 2015, she came to work with me and live at my center (Wildlife Rescue of Dade County) in the south end of Miami-Dade County. For twenty plus years, I had been running the center on my own and the addition of another experienced and legally permitted rehabber made an amazing difference.

Unfortunately, despite the many people who loved her, she fought a terrible, personal battle with depression. People who didn't really know her only saw the animal rescuing super-hero, wonder woman who would quickly put her own life in danger to rescue any animal. Few saw the struggles she had to fight to save her own life every day. She lived and worked at my center for a year and a half and so I saw the highs and the lows.

When I would see her in her deep depression, I would put her to work caring for babies. This could usually bring a smile to her face right through the tears.

Nothing could fight away her depression like a baby fox or otter that needed a bottle.

Sadly on that particular night, I was on duty at my fire rescue job and so I could not be there to fight off the demons when they came for her and convinced her to take her own life. Her last text to me was that I was running low on raccoon milk and I need to order more. So right up to her end, she was thinking of what had to be done to take care of our babies.

She worked at Wildlife Rescue for a year before she got hired to at Zoo Miami where she worked in the Amazon/South America section.

To me, Amanda was not just a rehabber. She was my partner and friend.

Amanda was born in Michigan and was 35 years old.

TAIL END

"This work-life balance stuff is for the birds!"

Red Squirrel *(Sciurus vulgaris).*

INSTRUCTIONS FOR AUTHORS

POLICY Original manuscripts on a variety of wildlife rehabilitation topics (e.g., husbandry and veterinary medicine) are welcomed. Manuscripts that address related topics such as facility administration, public relations, law, and education are invited as well.

Associate editors and anonymous reviewers, appropriate to the subject matter, evaluate each submitted manuscript. Concurrent submission to other peer-reviewed journals will preclude publication in the *Journal of Wildlife Rehabilitation* (JWR). The International Wildlife Rehabilitation Council (IWRC) retains copyright on all original articles published in the JWR but, upon request, will grant permission to reprint articles with credit given to the IWRC–JWR.

SUBMISSIONS All submissions should be accompanied by a cover letter stating the intent of the author(s) to submit the manuscript exclusively for publication in the JWR. Electronic submissions are required; hard-copy manuscripts are not accepted. The manuscript file should be attached to the submission letter (which can be the body of your email) and sent to:

Kieran Lindsey, Editor
jwr.editor@theiwrc.org

MANUSCRIPT Manuscripts should be MS Word documents in either PC or MAC platform (*no PDF files*).

Manuscript should be typed in Times Roman, 12 pt., double-spaced throughout with one-inch margins.

Include the name of each author. Specify the corresponding author and provide affiliation, complete mailing address, and email address. The affiliation for all authors should be included in a brief (maximum of 100 words) biography for each that reflects professional experience related to rehabilitation or to the manuscript subject matter rather than personal information. Biographies may be edited due to space limitations.

Include an abstract that does not exceed 175 words and choose several (up to 14) key words.

Templates have been developed for the following submission categories: case study, technique (including diets), research, and literature review; authors may request a copy of one, or all, of these templates from the editor (jwr.editor@theiwrc.org) before developing a manuscript for submission to the JWR.

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