Pennsylvania One Health Task Force

Recommendations on the Management of Domestic Cats (*Felis catus*)

Executive Summary

One Health is the concept that domestic animal, wildlife, human, and ecosystem health are interrelated. The Free-Roaming Cats Subcommittee of the Pennsylvania One Health Task Force investigated the impacts of free-roaming domestic cats (*Felis catus*) on One Health in the Commonwealth. The Subcommittee identified health risks associated with domestic cats, evaluated current policies, and suggested management solutions for a healthier Commonwealth. The findings and recommendations of the Subcommittee are presented in this document.

The Subcommittee identified a host of human, domestic animal, and wildlife health risks associated with free-roaming domestic cats, including pathogen transmission and wildlife depredation. For example, Pennsylvania has the highest number of rabid domestic cats among all states, and domestic cats disproportionately expose more people to rabies than other sources. Domestic cats are also the definitive host for the parasite *Toxoplasma gondii*, which may be transmitted to any bird or mammal, including people and livestock, via contaminated cat feces, resulting in the disease toxoplasmosis. In addition to rabies and toxoplasmosis, cats also transmit several other significant diseases and parasites (e.g., toxicariasis) to humans, pets, agricultural animals, and wildlife. Free-roaming domestic cats are also invasive predators that kill a wide variety of native wildlife and contribute to population declines of at-risk species. Therefore, due to the risks to humans, domestic animals, and wildlife, free-roaming domestic cats are a One Health risk in Pennsylvania.

Under the current legal and policy frameworks of the Commonwealth, domestic cats are not regulated within a single agency, and not all domestic cats are included under existing regulations. Domestic cats are addressed under titles regarding agriculture (Title 3) and crimes and offenses (Title 18) in existing state law. Domestic cats are further addressed by regulations regarding agriculture (Title 7), conservation and natural resources (Title 17), health and safety (Title 28), and recreation (Title 58). A domestic cat that is outside of a person's home is not consistently recognized as either a "domestic animal" or a "cat." Under existing laws and regulations, such animals are not required to be vaccinated for rabies and are not subject to any official control.

To better facilitate healthy outcomes for domestic animals, wildlife, and people, the Free-roaming Cats Subcommittee recommends fourteen management and educational solutions. These recommendations are intended to minimize the transmission of infectious diseases, prevent potentially deadly conflicts between domestic cats and wildlife, and foster longer, healthier lives for the Commonwealth's residents, including people and animals. The Subcommittee believes these recommendations are achievable because of successes with similar management of other domestic animals (e.g., dogs). With the number of free-roaming domestic cats from households, on farms, and in feral populations, it will be especially important to educate all interested parties about their responsibilities regarding critical health risks from free-roaming domestic cats and to collaborate with them in any management strategies.

Effective management of domestic cats, including rabies prevention and control, can be challenging, but this challenge is not insurmountable. A failure to address the free-roaming domestic cat issue will continue to expose humans, domestic animals, and wildlife in the Commonwealth to significant health and safety risks.

Glossary

At-large: An animal on public property or private property without the property owner's consent; does not apply to an animal under a person's direct control (e.g., on a leash) or wildlife

Domestic animal: A member of a companion animal species (e.g., domestic cat) or livestock

Domestic cat: A member of the species *Felis catus*

Feral: A domestic animal that lives in a wild state

Free-roaming: Not under the direct control of a person, such as by leash or enclosure

Game species: Animals that may be legally hunted, as authorized by state or federal law

Invasive species: A non-native species whose introduction does or is likely to cause harm to the economy, environment, or human health

Non-game species: Animals that may not be legally hunted for sport or commercial purpose

One Health: A collaborative, multi-sectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—which seeks to achieve optimal health outcomes by recognizing the interconnection between people, animals, plants, and their shared environment

Post-exposure prophylaxis (PEP): Any preventative medical treatment administered after exposure to a pathogen to prevent infection

Zoonotic: Capable of transmission from animals to people

Background and Purpose

The Pennsylvania One Health Task Force was established in 2018 under the Animal Health Commission of the Pennsylvania Department of Agriculture. The task force is an interdisciplinary group of federal, state, and academic stakeholders, as well as members of the public, working together to achieve positive outcomes for human, animal, plant, and ecosystem health in Pennsylvania. In 2019 the task force identified a need to evaluate One Health risks associated with domestic cats (*Felis catus*) in Pennsylvania and to identify management solutions that may be implemented to improve the health of Pennsylvania's people, animals, plants, and ecosystems. Consequently, the task force established the Free-roaming Cats Subcommittee in December 2019 to achieve this task. This report represents the findings of that subcommittee.

Domestic Cats and Human Health

Domestic cats may transmit a variety of zoonotic pathogens of public health concern both directly and indirectly, and the likelihood of such transmission is associated with domestic cat behavior (Gerhold and Jessup 2013; Lepczyk et al. 2015; Lappin et al. 2019). For example, free-roaming domestic cats are nearly three times more likely to be infected with parasites than indoor-only domestic cats (Chalkowski et al. 2019). Without preventive medical care and vaccinations, domestic cats may transmit zoonotic pathogens from wildlife or other free-roaming domestic animals to humans. Feline intestinal parasites, *Giardia*, *Salmonella*, *Bartonella henselae* (cat scratch disease), *Rickettsia typhi* (murine typhus), and *Yersinia pestis* (plague) are just a few of the many domestic cat-transmitted zoonotic pathogens of concern (Lepczyk et al. 2015, CDC 2019a). Below, we further consider three additional and highly important zoonotic diseases of concern and their relevance in Pennsylvania.

Rabies

Rabies is caused by infection with a virus of the genus *Lyssavirus* and may be transmitted among mammals through direct contact with saliva or nervous tissue (CDC 2019b). Rabies is nearly 100% fatal once symptoms arise and is responsible for over 59,000 human deaths worldwide (Hampson et al. 2015). In the United States wildlife account for a majority of all rabid animals, but domestic cats are the most frequently documented rabid domestic animal in the U.S. and disproportionately expose more people to the virus than wildlife (Roebling et al. 2014; Ma et al. 2020). The risk of human exposure to rabies by free-roaming domestic cats is a public health concern in Pennsylvania (Campagnolo et al. 2014). The number of rabid domestic cats in Pennsylvania has surpassed rabid domestic dogs (*Canis familiaris)* since 1983, and Pennsylvania has the highest number of rabid domestic cats annually among all states in the country (Campagnolo et al. 2014; Ma et al. 2020). Between 1982 and 2011, domestic cats accounted for 29% of all rabid animals with reported human exposures, second only to raccoons (*Procyon lotor*), and 87% of rabid domestic cats were associated with a human exposure (Campagnolo et al. 2014). Consequently, physicians in Pennsylvania routinely recommend rabies immunization for all people who work closely with domestic cats of unknown origin (e.g., veterinarians, animal shelter personnel).

Domestic cat exposures account for an estimated 16% of all administered post-exposure prophylaxis (PEP) to people (Christian et al. 2009). Although the cost of PEP varies (typically from about $1,200 to $6,500), a course of rabies immunoglobulin and four doses of vaccine given over a two-week period averages about $3,800, not including costs for hospital treatment or wound care (CDC 2019c). One study found that among 65 of Pennsylvania's counties, PEP was most frequently administered due to domestic cat exposure, and owned domestic cats were less likely to be current on rabies vaccinations than owned domestic dogs (Moore et al. 2000). In 2020 domestic cats accounted for 87% of all confirmed rabid

domestic animals in Pennsylvania (PADOA 2021), and this disparity between domestic cats and other domestic animals has been attributed to fewer domestic cat vaccination and leash laws, as well as the relatively high likelihood for domestic cats to be free-roaming (CDC 2017; PADOA 2021).

Toxoplasmosis

Toxoplasmosis is caused by infection with the parasite *Toxoplasma gondii*. This protozoan parasite relies on felines, including domestic cats, to complete its life cycle (Fig. 1). Following reproduction in a feline gut, the parasite is excreted via feces into the environment, where it may infect any bird or mammal, including humans, directly (via feline-excreted oocyst) or indirectly (in the uterus or through consumption of infected tissues). A single domestic cat may excrete up to hundreds of millions of oocysts into the environment, and these oocysts remain infectious for months to years, contaminating, for example, soil, sandboxes, or water (Dubey 1996; Lélu et al. 2012). In Bensalem, Pennsylvania, Dubey et al. (2009) observed that approximately 20% of domestic cats had been infected with *T. gondii*.

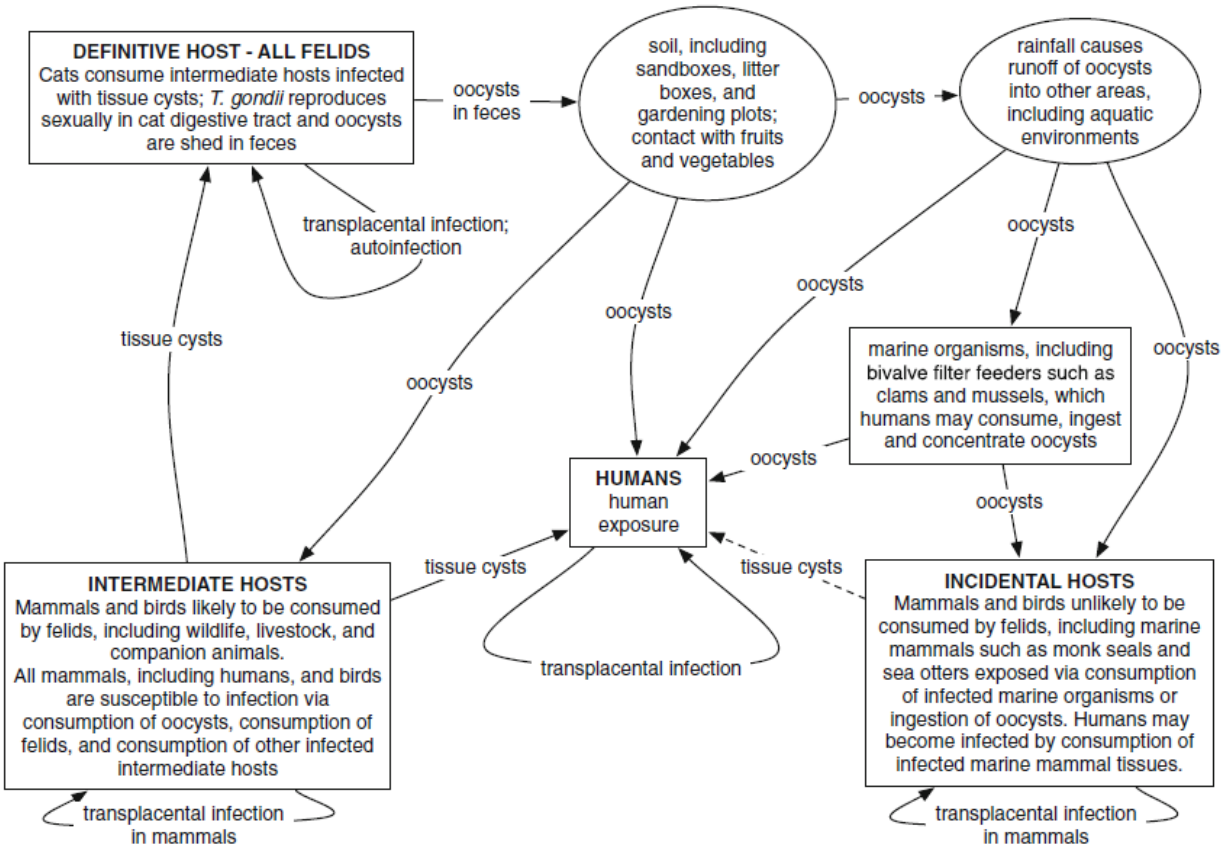

Figure 1. Life cycle of *Toxoplasma gondii* and transmission in humans, domestic animals, wildlife, and the environment (Aguirre et al. 2019).

Consequences of infection in people vary widely but may include miscarriage, fetal deformity, blindness, deafness, organ failure, and death (Aguirre et al. 2019). *T. gondii* in tissues and milk of domestic animals present important risks to human consumers, and toxoplasmosis is the second leading cause of death among foodborne illnesses in the United States (Scallan et al. 2011). Over one million people are infected with *T. gondii* annually in the US, and the Centers for Disease Control and Prevention lists toxoplasmosis among the top five neglected parasitic diseases (Jones and Holland 2010; CDC 2020).

Between 2001 and 2019 the Pennsylvania Department of Health recorded at least 842 human cases of toxoplasmosis (PADOH 2020).

Toxocariasis (Roundworms)

Toxocariasis is caused by infection with parasitic nematodes (roundworms) of the genus *Toxocara*, of which *Toxocara cati* is the most common species found in domestic cats. *T. cati* reproduces in the feline intestinal tract and is then excreted via feces into the environment, where the parasite's eggs, like *T. gondii* oocysts, may remain viable for months to years (Glickman and Schantz 1981). Human infection occurs following ingestion of these eggs from contaminated environments, such as sandboxes, gardens, or water (Despommier 2003). Once infected, parasitic larvae penetrate the intestine and migrate through internal organs, resulting in severe local reactions called visceral larval migrans or ocular larval migrans when the larvae are in the eye (Jones et al. 2008). Preventing the indiscriminate deposition of cat feces, especially in gardens and in play areas used by children, is critical to prevent human exposures (Despommier 2003).

Infection prevalence among domestic cats varies globally but may be as high as 91% (Fisher 2003). One study in Montgomery County, Pennsylvania, found *Toxocara* eggs in 100% of sites sampled and 97% of individual soil samples among parks (Stek 2018). Lucio-Forster et al. (2016) found that approximately 7% of pet domestic cats in Pennsylvania from 2011-2014 were actively excreting *T. cati* eggs. The Centers for Disease Control and Prevention lists toxocariasis, in addition to toxoplasmosis, among the top five neglected parasitic diseases in the U.S. (CDC 2020).

Domestic Cats and Domestic Animal Health

When free-roaming, domestic cats are themselves at an increased risk of exposure to a variety of environmental dangers. In a retrospective study over a 10-year period, Olsen and Allen (2001) observed that trauma was the most frequently observed cause of sudden death and was experienced exclusively by domestic cats that were free-roaming. Chalkowksi et al. (2019) found that domestic cats with outdoor access were 2.77 times more likely to be infected with parasites than their indoor-only counterparts. Similarly, free-roaming domestic cats are at an increased risk of exposure to novel sources of diseases, such as feline immunodeficiency virus, feline infectious peritonitis, and feline leukemia virus (e.g., Burling et al. 2017).

Free-roaming domestic cats may also put the health of other domestic animals at risk, such as through predation or the transmission of fungi, bacteria, and viruses. As a predator, domestic cats have long been known to have the capacity to kill certain domestic animals, such as poultry (Fisher 1909). For example, Borroto-Paéz and Reyes Pérez (2018) reported that a single free-roaming domestic cat killed 46 chickens on one farm over a four-night period. Indirectly, domestic cats may spread vectors of certain pathogens or infectious parasites that contaminate the environment. For example, infested domestic cats may introduce fleas or enteric parasites into poultry houses (Axtell 1999; Bermudez and Stewart-Brown 2008). Consequently, biosecurity protocols (e.g., building-specific footwear) are increasingly recommended (e.g., Robertson 2020). However, the trend toward raising livestock outside of secure buildings may increase the likelihood of domestic cat-livestock interactions, either directly or indirectly.

Domestic cat-transmitted *Toxoplasma gondii* is particularly problematic for livestock. Domestic cats in or around agricultural settings may contaminate local environments (i.e., soil and water) with *T. gondii* oocysts, which can infect birds and mammals (Fig. 1). Domestic pigs, sheep, and goats are particularly

susceptible to clinical toxoplasmosis, which can result in miscarriages, inhibited growth, and death (Aguirre et al. 2019). *T. gondii* was isolated in 19.4% of chicken samples in a study from local markets and farms in Ohio, Maryland, and Massachusetts, and domestic pig infection rates in the U.S. have exceeded 92% in some cases (Dubey 2009; Ying et al. 2017). Over 50% of goats from U.S. grocery stores tested positive for *T. gondii*, and *T. gondii* may also be transmitted in unpasteurized goat's milk and cheese (Dubey et al. 2011; Dubey et al. 2014). Economic losses from *T. gondii* infection of sheep in Australia have been estimated at nearly AU$10 million (Legge et al. 2020).

Domestic Cats and Wildlife Health

Domestic cats are among the world's most harmful invasive species, and predation by free-roaming domestic cats on wildlife can lead to continental-scale losses of populations and species (Lowe et al. 2000; Woinarski et al. 2015). Domestic cats have contributed to the extinction of 63 species in the wild and are major predators of native wildlife globally (Table 2; Doherty et al. 2016). At-large domestic cats in the Americas are a non-native, invasive predator introduced by European settlers less than 500 years ago (Lipinski et al. 2008). In the United States and Canada, for example, domestic cats are the top source of direct, human-caused mortality to birds and are a leading cause of wildlife intakes at wildlife rehabilitation hospitals across the United States (Loss et al. 2015; Loyd et al. 2017). Wildlife treated for domestic cat attacks are disproportionately less likely to survive, including an approximately 80% fatality rate among birds (McRuer et al. 2017; Loyd et al. 2017). Predation by domestic cats on wildlife can be a major limiting factor for survival in both urban and rural environments and may lead to population declines or extirpations (Lepczyk et al. 2003; Hawkins et al. 2004; Balogh et al. 2011; Loss and Marra 2017).

Table 1. National domestic cat-caused bird, mammal, and reptile mortalities

Country	**Wildlife Taxon**	**Annual Predation Estimate**	**Source**
Australia	Birds	377 million	Woinarski et al. 2017
Australia	Mammals	1.14 billion	Murphy et al. 2019
Australia	Reptiles	649 million	Woinarski et al. 2018
Canada	Birds	200 million	Blancher 2013
China	Birds	1.10-3.88 billion	Li et al. 2021
China	Mammals	1.83-7.98 billion	Li et al. 2021
China	Reptiles	0.59-3.39 billion	Li et al. 2021
United States	Birds	2.4 billion	Loss et al. 2013
United States	Mammals	12.3 billion	Loss et al. 2013

In addition to direct predation, domestic cats also impact wildlife health indirectly. Free-roaming domestic cats may compete with native wildlife for scarce resources, and predation can result in cascading effects that modify ecosystem dynamics (George 1974; Hawkins et al. 2004; Medina et al. 2014; Széles et al. 2018). The mere presence of a domestic cat in the environment has also been shown to negatively affect prey reproductive success through fear effects (Bonnington et al. 2013). Domestic cats may also transmit parasites and disease-causing pathogens (e.g., Bartonellosis, Feline Immunodeficiency Virus, Feline Leukemia Virus) to vulnerable wildlife species (Rodgers and Baldwin 1990; Luria et al. 2004; Riley et al. 2004; Gerhold and Jessup 2013; Chiu et al. 2019).

Toxoplasmosis is among the diseases that may be transmitted to wildlife by domestic cats (Fig. 1). A single domestic cat may excrete hundreds of millions of infectious oocysts, which can persist in the

environment for months to years, moving through terrestrial, freshwater, and marine ecosystems and causing large-scale environmental contamination (Tenter et al. 2000; Conrad et al. 2005; Dabritz et al. 2007; Gotteland et al. 2014; Lepczyk et al. 2020). *T. gondii* may infect virtually all birds and mammals that inadvertently ingest oocysts, predators or scavengers that consume infected tissues, or through vertical transmission and can result in a variety of sub-lethal impacts and mortality (Fig. 1; Aguirre et al. 2019). *T. gondii* infections have been identified in a wide variety of Pennsylvania game and non-game species, as well as wildlife found in Pennsylvania but studied elsewhere (Table 2; Cox et al. 2017). While all felines may contribute *T. gondii* oocysts to the environment, the far greater population of domestic cats and studies of infection prevalence in Pennsylvania and regionally suggest domestic cats play a major role in parasite transmission (Dubey et al. 2002; Lilly and Wortham 2013; Ballash et al. 2015; Dubey et al. 2015.

Table 2. Select examples of *Toxoplasma gondii* infection among wildlife in Pennsylvania.

Species	**Source(s)**
American Black Bear (*Ursus americanus*)	Briscoe et al. (1993); Dubey et al. (2004); Dubey et al. (2015)
Bobcat (*Lynx rufus*)	Mucker et al. (2006); Dubey et al. (2015)
Canada Goose (*Branta canadensis*)	Dubey et al. (2014)
Coyote (*Canis latrans*)	Dubey et al. (2014)
Fisher (*Martes pennanti*)	Larkin et al. (2011)
Red Fox (*Vulpes vulpes*)	Dubey et al. (2014)
White-tailed Deer (*Odocoileus virginianus*)	Dubey et al. (2014); Dubey et al. (2020)

Existing Legal Framework

The legal standing of domestic cats (*Felis catus*) in Pennsylvania is determined both by state laws (Pennsylvania Consolidated Statutes) issued by the legislature and state regulations (Pennsylvania Code) issued by state agencies. Current laws and regulations are summarized below.

Pennsylvania Consolidated Statutes

Title 3 Agriculture

Domestic cats are classified as an “animal” and, when maintained in captivity, a “domestic animal” (§2303). The Department of Agriculture is authorized to regulate “the keeping and handling of domestic animals to exclude or contain dangerous transmissible diseases and hazardous substances and to protect the environment” (§2305). The Department of Agriculture is also authorized to impose requirements, including fees, regarding domestic animal identification (§2311). The Department of Agriculture is specifically prohibited from establishing “depopulation incentive payments for cats and dogs” (§2332).

Title 18 Crimes and Offenses

Domestic cats are classified as a “domestic animal” (§5531). Domestic cats, like other animals, are protected from a variety of harms, including neglect (§5532), cruelty (§5533), and aggravated cruelty (§5534). Skinning or exchanging a domestic cat pelt, for money or otherwise, is also prohibited (§5546). The provisions of Subchapter B (beginning with §5531) do not apply to activities authorized under 34 Pa.C.S. (relating to game), to the killing of a cat by the owner in accordance with the Animal Destruction Method Authorization Law or a cat “found pursuing, wounding or killing a domestic animal or domestic fowl” (§5561).

Pennsylvania Code

Title 7 Agriculture

As it pertains to rabies, domestic cats are classified as a "cat" when the domestic cat "spends part of a 24-hour day in a residence inhabited by a human being" (§16.1). For the purposes of §16.21-§16.25, a "cat" includes all domestic cats regardless of any residential status (§16.1). All domestic cats suspected of having been exposed to rabies will be quarantined by the Department of Agriculture (§16.22) and shall be kept under observation if the animal has exposed a person (§16.23). A general quarantine order may be enacted by the Department of Agriculture, at which time the movement of animals may be restricted and domestic cats running at large may be captured and contained or euthanized (§16.25). All "cats" (excluding those that do not spend part of a 24-hr day in a human-inhabited residence) must be vaccinated for rabies (§16.41) and remain current through revaccination (§16.43). All "cats" over the age of 3 months brought into the Commonwealth must possess a certificate of rabies vaccination (§16.46). State-licensed private or breeding kennels and State-licensed nonprofit kennels may apply for certification to administer rabies vaccinations (§16.61) and, once certified, must adhere to guidelines regarding administration and records (§16.63). Once a "cat" has been removed from a kennel, it must be revaccinated (§16.64).

Title 17 Conservation and Natural Resources

A "pet" is classified as "a dog, cat or other animal that has been domesticated" (§11.201). An owner, keeper, or handler of a pet in a state park must keep the pet leashed and attended, prevent property or resource damage, and pick up the pet's feces, among other requirements (§11.212).

Title 28 Health and Safety

A health care practitioner or health care facility is required to report observed or suspected animal bites and certain diseases, infections, and conditions, among which some (e.g., toxoplasmosis) are associated with domestic cats (§27.21a).

Title 58 Recreation

A domestic cat may not be released into the wild (§137.1).

Management Solutions

As presented above, free-roaming domestic cats have a significant impact on the health of people, domestic animals, wildlife, and ecosystem health. Management solutions, such as reduced interactions between domestic cats and wildlife and increased domestic cat vaccination rates, can help to mitigate these risks. Effective management solutions to decrease health risks associated with free-roaming domestic cats will begin with engagement of the public, health professionals, and policy makers.

Such interventions have been successful in reducing One Health risks associated with other domestic animals. For example, whereas domestic dogs used to be a major rabies vector in the United States, including over 8,000 confirmed rabid dogs annually, the implementation of mandatory rabies vaccinations and at-large dog control resulted in the elimination of the canine rabies virus variant in the United States and a precipitous decline in the annual number of rabid dogs to only 63 cases in the United States in 2018 (Roebling et al. 2014; Ma et al. 2020).

The management and educational recommendations presented below represent a suite of alternatives to reduce One Health risks associated with free-roaming domestic cats in Pennsylvania. The

implementation of these recommendations, or any interventions, should consider the interests of a broad diversity of stakeholders, including but not limited to human, domestic animal, and wildlife health and welfare interests. Such interventions will also require collaborative, multi-disciplinary approaches, as are typically integral to the field of One Health, that foster open communication and mutual trust.

Management Recommendations

1. Revise statutory and regulatory definitions to facilitate increased and effective management interventions for *Felis catus*.
2. Per recommendation by the American Veterinary Medical Association, require that all domestic cats 3 months of age or older, except where medical exemptions apply, be currently vaccinated for rabies (AVMA 2021).
3. Encourage domestic cat owners to keep their domestic cats under their direct control (e.g., indoors, in an enclosure, or on a leash).
4. Encourage all domestic cats be identified, such as by microchip or collar-mounted tag.
5. Encourage the sterilization of all domestic cats not intended for breeding.
6. Identify and implement effective strategies that consider the perspectives of public, domestic animal, and wildlife health priorities, as well as agricultural and pet owner interests, to reduce free-roaming domestic cat populations.
7. Develop consistent Commonwealth-wide authorities, procedures, and protections for property owners to safely and humanely remove unwanted free-roaming domestic cats from their property.
8. Develop consistent Commonwealth-wide procedures and responsibilities associated with free-roaming domestic cat management programs and actions, including the finding and care of a free-roaming domestic cat.

Educational Recommendations

1. Distribute science-based information to the public regarding human disease risks, including but not limited to rabies, toxoplasmosis, and roundworms, associated with free-roaming domestic cats.
2. Distribute science-based information to agricultural producers regarding food safety concerns, including but not limited to toxoplasmosis, associated with free-roaming domestic cats.
3. Distribute science-based information to the public regarding domestic animal health risks, including but not limited to pets and livestock, associated with free-roaming domestic cats.
4. Distribute science-based information to the public regarding wildlife and ecosystem health risks associated with free-roaming domestic cats.
5. Distribute science-based information to the public regarding the need for regular veterinary care of domestic cats, including but not limited to current rabies vaccinations and parasite control.
6. Distribute information to the public regarding appropriate One Health management solutions for domestic cats, e.g. keeping domestic cats under an owners control.

Conclusion

Pennsylvania has the opportunity to become a leader in One Health risk mitigation by effectively addressing human, domestic animal, and wildlife health and welfare concerns associated with free-roaming domestic cats. With the large number of free-roaming domestic cats in households, on farms, and in feral populations, management challenges are vast, but not insurmountable. Indeed, a model for effective management (i.e., dog control) already exists. The management and educational recommendations presented above can remediate the One Health impacts of free-roaming domestic cats and foster a healthier and safer Commonwealth for all.

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