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EAR TIPS TO EAR TAGS
Marking and identifying cats treated with non-surgical fertility control

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Current approaches: Trap–neuter–return (TNR) introduced a humane means of managing free-roaming and feral ('community') cats; it also necessitated a method of marking and identifying these cats as sterilized. Although multiple identification methods have been studied or attempted in the field, ear tipping (or, less commonly, ear notching) has proven to be the best option and is used internationally. However, ear tipping must be performed under general anesthesia, and it conveys only binary information: yes, a cat has gone through a TNR program (and is sterilized); or, no, a cat has not gone through a TNR program (and may or may not be sterilized).

Future requirements: Future non-surgical feline fertility control options will require an alternative to ear tipping for identifying community cats, one that does not require anesthesia in order to mark the animal as treated. Long-term contraceptives (vs permanent sterilants) will also require a marker that can denote the time when a cat was last treated.

Objectives and progress: To address this need, the Alliance for Contraception in Cats & Dogs is working with an interdisciplinary team from Cornell University, USA, to develop an effective, humane marking method. Their focus is a new generation of ear tag. The prototype design uses different shapes and materials, and a different application process, than tags used to date. The objective is to minimize tag weight, application discomfort, and likelihood of blood loss and infection, while simultaneously allowing for coding of information, including treatment time period.

Introduction

Trap–neuter–return (TNR), the roots of which extend to 1950s England, introduced a new method to manage unowned, free-roaming or feral cat populations (hereafter referred to as 'community cats') without lethal means, one that has since spread to multiple countries around the globe.[1] The advent of TNR created a challenge, however: identifying treated animals. Visual identification is needed to avoid repeat trapping and surgery; in addition, it ideally protects a cat from being trapped and euthanized. It has the potential, as well, to enhance community acceptance of cats through residents' knowledge that a female will never deliver a litter of kittens under the porch, and her male counterpart will not share his trademark odor with the neighborhood.

Visual identification is needed to avoid repeat trapping and surgery (or euthanasia), and has the potential to enhance community acceptance of cats.

Ear tipping (or, less often, notching) followed the introduction of TNR to allow permanent identification of a community cat as sterilized.[1] Alternative identification methods such as tattooing, ear markers, collars and microchipping have also been explored. TNR experts note, however, that they all have shortcomings when used in community cats, related to visibility, safety, likelihood of infection and durability.[2]

Although ear tipping has become the current standard for identifying animals that have undergone TNR, the protocol is not without difficulties and detractors. A cat missing the top of the ear due to mites, frostbite or infection can be mistaken as a cat with an ear tip, particularly when viewed from a distance. Some oppose ear tipping due to its aesthetic implications or perceived mutilation;[1] this may be particularly true for cats found as unowned 'strays' or sterilized through a subsidized TNR program, but which have potential to be adopted into homes as pets. As discussed below, ear tipping also precludes a key added-value aspect of non-surgical fertility control: the ability to treat animals without using general anesthesia.

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'How do you know that the cat has been treated?'

This is among the most common questions asked about non-surgical fertility control. Whether a permanent sterilant or long-term contraceptive, non-surgical options present a new challenge for marking a treated animal, and particularly a community cat. The features that make non-surgical options a 'game changer' for community cats – no general anesthesia, field application capabilities, no postoperative recovery period – essentially preclude ear tipping. Moreover, a tipped ear reveals only binary information: 'yes' or 'no' to treatment. In order to offer optimal value, multi-year contraception, along with rabies vaccination and boosters, requires conveying information about when and what treatment was performed. A mark with more than binary information also facilitates a more nuanced understanding of the population dynamics of community cats, thereby adding further value to efforts to humanely reduce their numbers. Moreover, it is important that this information can be conveyed from a distance, without needing to re-trap a cat – as is the case with ear tipping.

Recognizing both need and opportunity, the Alliance for Contraception in Cats & Dogs (ACC&D) spearheaded a 'flagship initiative' to develop an alternative means to mark and identify animals that have undergone non-surgical fertility control. The ideal mechanism would need to fulfill multiple requirements, including (but not limited to) humane application, visibility from a reasonable distance, lack of interference with normal behavior, ease of application, and affordability for communities with limited resources (see box below). Several stages of research and brainstorming with experts from across disciplines and around the world led the ACC&D to propose a 'better' ear tag. Since the project was formally launched in early 2013, it has become increasingly clear that such a tag could offer value not just for community cats sterilized without surgery, but also for cats that have gone through 'traditional' TNR programs and for small wildlife species. This initiative, currently in the design and prototype development phase, is a true interdisciplinary effort to create a tiny object and achieve a big goal. The process thus far, as well as planned next steps, are discussed in the following sections.

Alliance for Contraception in Cats & Dogs

This article is part of a Special Issue of the *Journal of Feline Medicine and Surgery* (2015, Volume 17, pages 737–834) dedicated to 'Non-surgical feline fertility control' and coordinated by the Alliance for Contraception in Cats & Dogs (ACC&D). The ACC&D is a catalyst to advance new methods of non-surgical fertility control to save the lives of cats and dogs, expand options for pet owners, and improve animal welfare. Serving as a trusted resource for scientific and educational information, the ACC&D brings together key stakeholders to advance humane sterilization options that are faster, easier and more accessible than surgery.

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Non-surgical options present a new challenge for marking a treated animal, particularly a community cat.

Parameters for a feline identification marker

- **Visibility at moderate distances** At a minimum, the marker should be visible at 12–15 feet (3.5–4.5 m) from the cat. Ideally, it would be visible at 25 feet (7 m). The more information conveyed without handling the animal, the more useful the mark.
- **Easy-to-retrieve information** Basic information should be retrieved by vision alone, potentially with binoculars if at a distance.
- **Capacity to convey information** The marker must convey information required to avoid retreating a cat that has undergone non-surgical sterilization and identify the retreatment timeframe for a contraceptive. Ideally, it would also convey vaccination status and information useful to population dynamics research.
- **Humane for the animal** The marker must be humane for the animal at all times, from application (any discomfort must be brief and controlled) and through the duration of wear or use. This means minimizing the risk of infection, irritation and pain.
- **Permanence** The marker must persist for 3 years minimum. Ideally, it would last the lifetime of a sterilized animal; an alterable marker may be required for a long-term contraceptive.
- **No impact on behavior** The marker should have no negative impact on eating, hiding, playing or other normal feline behaviors.
- **Simple application process** The marker should require minimal training to apply safely and effectively.
- **Minimal time to administer** Ideally, it should take under 5 secs to apply the marker, increasing efficiency and minimizing stress to the cat. Any marker requiring over 10 mins to apply would not be feasible.
- **Low cost** The cost of the marker, application equipment and any information retrieval equipment should be affordable to communities and agencies with limited financial resources.

The ACC&D has spearheaded a 'flagship initiative' to develop an alternative means to identify animals that have undergone non-surgical fertility control.

Current marking and identification methods

When marking and identification methods used for companion, wildlife and livestock species are viewed as a whole (see box on the right), there are a lot of options! Several marking methods besides ear tipping have been used, or at least evaluated, for cats, as discussed below.

Permanent and temporary methods of identification used across species

- Photographic identification
- Collaring
- Leg bands
- Iris and retinal scanning
- Paint
- Beetroot juice (temporary dye)
- Freeze branding
- Hot branding
- DNA profiling
- Microchipping
- Ear tipping
- Ear notching
- Tattoos
- Ear studs
- Ear tags
- Visible implant elastomer (VIE) tags

Neck collars

Collars with tags are often recommended for owned cats to provide visual identification if an animal becomes lost. Their potential for community cats is less clear. A collar's comparatively large surface area offers a canvas for colors or patterns that identify individual cats or feline cohorts. Adding numbers, barcoding or tags can communicate still more information. While standard cat collars are inexpensive, radio or global positioning system (GPS) collars are also options; the former have been used to track and monitor cats.[3] Precedent for collar use comes from the field of wildlife biology; radio- and GPS-enabled collars have been used widely to track and monitor wildlife species.

However, veterinarians and cat owners often express concern about collar safety: the potential for a collar to strangle an animal, catch on a cat's forelimb or mouth, or become embedded if attached too snugly. A small number of studies have explored whether or not these fears are corroborated by data. One study, which compared three types of adjustable nylon collars on owned cats (plastic buckle, breakaway plastic buckle safety, and elastic stretch safety) found that 3.3% of 538 participating cats got a collar stuck in their mouth, caught a forelimb in the collar, or caught the collar on another object.[4] A second study found that two of 34 cats fitted with radio tracking collars died soon after application due to collar strangulation.[3]

A third study surveyed veterinarians, cat owners from the general public, and members of a cat shelter and welfare organization about collar incidents, collar injuries requiring veterinary treatment or collar-related deaths.[5] Interviews with 107 veterinarians revealed an average rate of one collar injury observed every 2.3 years of veterinary practice. Collar incidents (defined as snagging a collar or catching a paw in the collar) were noted by relatively large numbers of cat owners (63% of those from the welfare society and 27% of the general public), but reports of injury requiring veterinary attention was much less common (6% and 3% for the two groups, respectively), and death rarer still (2% and 0%, respectively). Vehicular accidents and fighting were much more commonly reported reasons for veterinary care and cause of death.

Whether the risks of collars outweigh the benefits is both subjective and debatable. However, long-term collar retention and durability have unarguable and significant implications for community cats. Although Lord et al found that 72.7% of cats wore collars for the 6 month study, approximately one-third lost a collar at some point and required reapplication by owners.[4] This loss rate could undermine efforts to effectively identify and monitor community cats.

Further considerations for use of collars on community cats include:

- **Ease of removal or transfer by humans.** Particularly in areas where 'proof' of sterilization and vaccination can be a literal lifesaver, there are ample reports of people transferring collars from treated to untreated animals (K Coladarci, 2013, personal communication). While it is possible to use a design and materials to make removal (or loss) less likely, it is unclear how this could be accomplished while simultaneously minimizing the collar's potential to cause physical discomfort or harm.
- **Material durability.** Lord et al found that 36.1% of the 388 owned cats completing the study had a frayed collar after 6 months.[4] The 'wear and tear' on collars belonging to community cats may be substantially greater.
- **Ability to mark growing animals.** Juvenile wildlife are sometimes fitted with collars that can accommodate growth. It is unclear if this could be safely done with cats, and if the degree of growth could be accurately predicted.

Tattoos

Tattoos have long been used to identify ownership of cats, as well as dogs and other species.[6] Tattoos on the ear, abdomen or inner thigh are often used to denote sterilization status of pet animals; ear tattoos were used as a method of marking cats in Danish TNR programs as far back as the 1970s.[1]

There are concerns about the discomfort of tattooing if performed without anesthesia.[6] Tattoos also offer limited visibility, especially from a distance; observing abdominal or inner thigh tattoos requires handling the animal and potentially even shaving the fur. Faded ink reduces visibility still further. Particularly for unsocialized cats, trapping would be required to view an ear tattoo.[2] Consequently, it has been recommended that an identification tattoo must be used in combination with 'visible' methods of identification.[6]

Despite these limitations of traditional tattooing, there may be potential for a 'better' tattoo that could add value to non-surgical fertility control. A tattoo pen designed for rabbits or an adapted needle-free jet injector may cause less pain and stress. While these alone would not address the challenge of visibility, it remains to be seen if iridescent, fluorescent or fade-resistant ink could enhance the ability to identify cats from a distance and over time.

Microchipping and RFID

Microchips are radio-frequency identification (RFID) devices that are commonly used by shelters and owners to identify the owners of lost cats and dogs. They are 'passive', meaning that the tag receives power from the tag reader. There are three microchip frequencies in the United States; one of these, 134.2 kHz, is the ISO (International Standards Organization) standard and the primary frequency used worldwide. In the frequency band of 120–140 kHz, the range for passive detection is typically 10 cm.[7]

For pets and socialized animals, a 10 cm read range and 'invisible' identification can be extremely valuable. However, microchips are, on their own and with current read range, not adequate for community cats.

There are several potential ways to extend the read range of RFID chips for animal identification. Placement outside the body would reduce interference. High frequency (13.56 MHz) and ultra-high frequency (UHF, 900 MHz) passive tags have larger read ranges (exceeding 1 m); in 2010, the US Department of Agriculture approved a passive UHF RFID tag for tracking cattle through the Animal Identification Number (AIN) system.[8] Surface acoustic wave (SAW) RFID technology tags work in the microwave range and reflect back the incoming signal rather than relying on an integrated circuit. SAW RFID tags can provide a larger range with less power than traditional RFID tags; they can also provide information about temperature and relative location, which might be useful in differentiating individuals when a scanner sends a signal towards a group of animals.[9,10] There are unfortunately drawbacks to more powerful RFID chips, however, including a larger size and greater cost.

Freeze branding

Freeze branding was developed as an alternative to hot branding to mark and identify livestock and horses,[6] and it continues to be used primarily for this purpose. A metal branding iron is supercooled, often in either liquid nitrogen or a dry ice–alcohol combination, and applied to an animal's skin. This alters the cells that produce hair pigment, resulting in the regrowth of white hair that offers stark contrast on dark-haired animals. Longer application of the iron can permanently destroy hair-producing cells, resulting in a bald spot that more closely resembles a hot brand; this approach can be used for animals with blonder hair or fur.[6] Although used primarily for large animal species, the technique has been used on smaller animals. Only one published study reports freeze branding a (dark-haired) cat – doing so successfully, particularly when the brand was held to the skin for 10 secs[11] – but there is anecdotal evidence of current use to mark the ear or flank of hunting dogs.[12,13]

There is evidence in ruminant species that freeze branding causes less discomfort than hot branding.[14] An Italian study comparing freeze branding and ear tagging in free-roaming dogs observed that animals did not react to freeze branding of the ear (whereas tag application did cause some dogs to show signs of discomfort), and in fact displayed more stress from human handling than the procedure itself.[15,16] Even so, the canine study recognized the potential for freeze branding to cause pain, and the American Veterinary Medical Association notes that it is believed to be more painful than ear notching, ear tagging or tattooing.[14]

For marking community cats, the shortcomings and limitations of freeze branding arguably outweigh the benefits. In addition to welfare concerns, the tanks of coolant needed for the procedure are relatively impractical for field use. The time required to perform freeze branding also makes it impractical for field use, and especially for marking cats that are not anesthetized (the Italian canine study reported that freeze branding required up to 10 mins per dog).[15] Given a cat's size, it would be difficult to create a mark conveying more than the fact that the cat had been treated once (not unlike ear tipping). There are also questions about whether the permanent and highly visible mark created by freeze branding could compromise a free-roaming cat's chances of being adopted as a pet.

Ear markers

Ear tags, bands and studs have all been considered as ways to identify cats, both community and pet cats. They have the advantage of being easily visible from a distance, and they can be customized by shape or color-coding to communicate additional information such as year treated or type of treatment administered.

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Tags and bands

Ear tags and bands are a common mechanism for individual or group identification among livestock, laboratory animals and wildlife species, including prick-eared animals such as foxes and coyotes. Ear tagging has been used in canine sterilization and vaccination programs in Turkey[17] and Romania (S Turetta, 2013, personal communication), as well as in a study in Italy comparing the efficacy and welfare implications of ear tags and freeze branding.[15,16] In the Turkish and Romanian programs, dogs are tagged while anesthetized; in Italy, dogs were manually restrained.

There is no tag recommended for cats at this time. One informal study tried marking cats on the ear margin using a band. In addition to including an individual cat identification and contact phone number, the band was color-coded to correspond with the color of the rabies tag used that particular year (J K Levy, 2013, personal communication). The tag was appreciated for its ability to convey the year in which a cat was sterilized, and some persons who did not see the cat's ear tip noticed the colored tag. Unfortunately, the rate of irritation or infection at the site of the tag was considered too high to continue their use, plus a portion did not stay in the ear (J K Levy, 2013, personal communication). Leading organizations familiar with feline health or sterilization of community animals cite tags' ability to fall off or become snagged, to tear the ear or cause other injury, and to cause infection.[2,6,18] Consequently, these organizations recommend ear tipping (or notching) for community animals undergoing surgical sterilization.

Studs

In 1997, Frank Andrews, then director of Los Angeles County's Department of Animal Care and Control, designed a variety of feline ear studs (Figure 1). The stud was 8 mm at its widest point and designed as a hexagon with smooth, rounded corners. This non-circular design was intended to encourage gentle rotation of the stud when the cat scratched its ear. Studs marketed commercially were engraved with identification and telephone numbers. They were promoted as a method to identify lost cats that offered greater retention and reliability than a collar. One Californian veterinarian applied these studs to several dozen cats across the spectrum of indoor and outdoor, long-haired and short-haired individuals (E Wexler-Mitchell, 2013, personal communication).

Figure 1 **Feline ear studs developed by Frank Andrews, then director of Los Angeles County's Department of Animal Care and Control, in 1997. The right-hand stud design, which included telephone and individual identification numbers, was briefly marketed commercially. The studs are 8 mm at the widest point.** *Studs courtesy of Joan Miller, The Cat Fanciers' Association*

- **The good news:** All cats participating in the informal study tolerated initial placement without problems, and no cat suffered catching the stud or having it tear the ear. One cat wore its stud for over 10 years. Cats that ventured outdoors seemed to have no greater rate of infection than indoor-only animals.
- **The bad:** An estimated 40% of cats developed infections at the site of the stud. These problems were delayed, sometimes by months. Infections were attributed to a stud that was unable to freely rotate and, as a result, crusting developed between the ear and stud or the ear and stud backing. Cleaning by owners seemed to offer the best chance of preventing problems. Short-haired cats may have had a lower rate of infection, but overall it was 'impossible to predict which cats would not have problems' with the studs.
- **The conclusion:** While the stud was a 'great concept', this particular design 'didn't work reliably enough to use long term' (E Wexler-Mitchell, 2013, personal communication).

Ear markers – hurdles to be overcome

At present, the American Association of Feline Practitioners and Alley Cat Allies, among others, cite the infection, loss and tearing risks of ear markers for cats and discourage their use. Based on results of designs to date, this concern is warranted. And yet, there is no indication that the potential for any of these ear-marking mechanisms has been fully explored. It may be that marker geometry, material and placement can profoundly affect the likelihood of complications and how well the tag serves the purpose intended.

What now?

None of the methods described above is, in its current form, optimally suited to mark and identify community cats sterilized or contracepted without surgery. In order for non-surgical fertility control methods to offer optimal value and impact, this needs to change!

In early 2013, the ACC&D sponsored an InnoCentive Brainstorm Challenge to crowd-source marking and identification ideas from around the world. Participants were presented with the challenge and marking requirements, and encouraged to submit their ideas. Suggestions streamed in, with 74 individuals proposing a total of 99 solutions. Ideas fell into such categories as electronic marking, collars, tattoos, fur removal and/or alteration, physical banding and ear tagging. Among the more creative (if not eminently practical) ideas were the attachment of a fiber optic 'hair', chip-less RFID 'ink', needle-free jet injector (as an alternative to traditional tattooing), facial recognition software, magnetic ear markers, olfactory markers, microdermal piercing, visible implant fluorescent elastomer tags (currently used in aquatic species), and an as-yet-untried ear 'wrap' design applied with a gel solution offering analgesic, antibiotic and antiseptic properties.

Research on existing identification methods, combined with creative InnoCentive Brainstorm Challenge ideas, formed the basis of an ACC&D scientific think tank in the spring of 2013. This two-day event sought to identify the most promising near-term and long-term methods to mark cats and dogs treated with a non-surgical sterilant. Towards this end, the organization convened experts from diverse fields, each invited for his or her ability to contribute varied and valuable insights on the challenge. Experts in wildlife biology, dog and cat reproductive biology, software and database design, invention and innovation, and animal identification technologies such as radio-frequency identification joined individuals experienced in vaccination and sterilization initiatives of free-roaming cats and dogs.

A new approach to an ear marker rose as the top contender. Participants concluded that none of ear tags, bands or studs has been pushed to reach its full potential for humane application, communication of information, ongoing comfort, durability and minimization of infection. This is particularly true for cats (and dogs), but it arguably applies to wildlife and livestock species as well. Although some advances have taken place, ear tags available today use a limited selection of materials, including hard plastic, flexible polyurethane, aluminum, stainless steel, brass, Monel (nickel–copper alloy) and plated steel. Participants recommended exploring new shapes and materials to limit the pressure the tag exerts on the ear and maximize retention, while at the same time allowing for coding of information and minimizing the risk of infection. Participants also advised on the need to consider new methods of applying a marker to the ear that minimizes pain, potential for blood loss and potential for infection.

An acrylic prototype ear marker is being investigated for its potential for humane application, communication of information, ongoing comfort, durability and minimization of infection.

Figure 2 **Very early prototype ear markers. Markers are 2–3 cm at their widest point. Layering of two colors and shapes would permit coding and visual identification of additional information, such as timing of both contraceptive and rabies vaccines. Colors will be determined based on a project study at Cornell University investigating optimal colors for viewing at a distance.** *Photographs courtesy of Eloïse Cucui/ Cornell University College of Veterinary Medicine*

In 2014, the Atkinson Center for a Sustainable Future at Cornell University, USA, generously funded a project to carry an ear marker from a concept to a prototype. The project is focusing initially on an ear marker for free-roaming dogs internationally; the second phase will target cats. Faculty and students from Cornell University's College of Veterinary Medicine, College of Human Ecology Fiber Science & Apparel Design and College of Engineering partnered with the ACC&D to form an interdisciplinary team equipped to approach the project from key perspectives and areas of expertise. Body jewelry company Kaos Softwear (Portland, Oregon, USA) is also providing guidance on materials and applicator optimization.

The team evaluated multiple polyester and acrylic fabrics for their texture, weight, flexibility, breathability, antibacterial properties, time to fading in direct sunlight, durability, resistance to tearing and cost. Solution-dyed acrylic fabric (in which color pigments are put into a polymer solution before the fiber is created, thus becoming contained within the fiber's physical structure) was determined to offer the greatest potential due to its weight, breathability, color-fastness and durability.

The team also evaluated different application methods with the goal of minimizing discomfort associated with application, likelihood of infection and damage to the ear. A price-tagging 'gun' has shown most promise on the ears of cadaver cats and dogs donated to Cornell University College of Veterinary Medicine. A 14 gauge needle, the size used to insert a microchip, creates a lesion less than 1 mm in diameter through which a fastener is threaded. Moreover, the needle is replaceable and the applicator is quiet, thus reducing stress to animals. Nylon is traditionally used

We look forward to a time when a soft colorful ear tag will be an essential bit of 'kitty bling', marking each individual cat as important, cared for and protected.

for commercial tagging, although an alternative polymer could be used to increase the fastener's strength and durability. A study on the use of nylon barbs in guinea pig ears found minimal damage at the insertion site, as well as low tag loss rates.[19]

Very early prototype designs are depicted in Figure 2.

Where next?

Following development of a prototype marker, the team will trial the marker under closely monitored conditions, paying particular attention to any signs of discomfort or irritation, any incidents of catching the marker on an object or during play, and any interference with normal behavior. Prototype design feedback from persons with expertise in the field will also be carefully considered. After any necessary refinements, we will determine the best way to test the new markers in a field environment.

In addition to marker design and trialing in the target species, there are questions about a potential market for a dare-we-say 'better' ear tag: is it possible that such a marker will appeal to wildlife biologists? To those who raise small, or even large, species of livestock? Could a new market help offset the cost of developing and producing ear tags for community cats, such that the product could be distributed at a nominal cost? These questions – and more – are currently being considered and explored.

Figure 3 The ACC&D's vision of improving animal welfare by reducing populations of homeless cats and dogs requires a new approach to marking and identifying those that have undergone non-surgical fertility control. Progress is being made!

In the meantime, we look forward to a time when a soft colorful ear tag will be an essential bit of 'kitty bling', marking each individual cat as important, cared for and protected (Figure 3).

KEY POINTS

- Ear tipping (or, alternatively and less commonly, ear notching) is currently the predominant means of marking and identifying cats that have gone through a trap–neuter–return (TNR) program. Visual identification is needed to avoid repeat trapping and surgery; in addition, it ideally protects a cat from being trapped and euthanized.
- Alternative approaches have been considered to mark and identify sterilized and vaccinated community cats, including neck collars, microchipping and RFID, freeze branding, ear tags and ear studs. Although these approaches have specific strengths relative to ear tipping, their undesirable consequences have precluded widespread use.
- Future non-surgical fertility control options will require an alternative to ear tipping for marking and identifying cats. Application should not require anesthesia, and the marker itself should be capable of conveying the time when the cat was treated.
- The ACC&D is working with an interdisciplinary team from Cornell University to develop a new ear marker design. The prototype design uses different shapes and materials, and a different application process, than markers used to date. The objective is to minimize marker weight, application discomfort, and likelihood of blood loss and infection, while simultaneously allowing for coding of information, including date of treatment.

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Conflict of interest

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