The Link Between Consumer Flea and Tick Control and Effluent Aquatic Toxicity

Stephanie Hughes, PE

November 2021

BACWA BAY AREA CLEAN WATER AGENCIES

Introduction to Your Speaker

Stephanie Hughes is a registered professional Chemical Engineer with more than 25 years of experience in chemical fate and transport, water quality, and regulatory compliance.

Stephanie provides consulting services and technical support to California local government agencies and is a Senior Lecturer in Environmental Science at Santa Clara University.

Organizations involved in this project

- Bay Area Clean Water Agencies (BACWA)
- City of Palo Alto
- San Francisco Estuary Institute
- San Francisco Dept of Environment
- San Francisco Public Utilities Commission

Today's Outline

- Scientific Evidence for:
  - Transport of indoor flea control chemicals to the sewer
  - Effluents exceeding toxicity thresholds
  - Impacts to potable reuse and municipal climate adaptation plans
- Flea and Tick Control Alternatives
- Public Outreach Messages and Challenges
- Next Steps

After attending this session, you will:

1. Understand the public health and environmental concerns of indoor flea and tick control
2. Understand the pathways of indoor flea control to the sewer and subsequent discharge to water bodies
3. Have the confidence to speak with colleagues, peers, and animal care professionals about this ubiquitous topic
4. Consider having your agency engage with BACWA and NACWA as we present these messages nationally

Who is BACWA?

BACWA
BAY AREA
CLEAN WATER
AGENCIES

A collaborative entity of 55 wastewater treatment plants and sewer collection system agencies serving 7.1 million San Francisco Bay Area residents

BACWA seeks to be proactive on pesticides

BACWA
BAY AREA
CLEAN WATER
AGENCIES

- Science & monitoring partnerships – collaborating with the San Francisco Estuary Institute and CA Department of Pesticide Regulation (DPR)
- Regulatory engagement – communicating with U.S. EPA and DPR as pesticides are registered or in review for re-registration
- Safer alternatives – identifying alternatives and communicating this to consumers, pest control operators, and other stakeholders

*"Conventional **wastewater treatment technologies are generally ineffective at removing pesticides from wastewater**, with high removal efficiency only observed in the case of highly hydrophobic compounds, such as pyrethroids. **Aquatic life reference values can be exceeded in undiluted effluents**. For example, seven compounds, including three pyrethroids, carbaryl, fipronil and its sulfone degradate, and imidacloprid, were detected in treated wastewater effluent at levels exceeding U.S. Environmental Protection Agency (US EPA) aquatic life benchmarks for chronic exposure to invertebrates."*

Sutton et al. (2019). "*Occurrence and Sources of Pesticides to Urban Wastewater and the Environment*" in Goh et al.; Pesticides in Surface Water: Monitoring, Modeling, Risk Assessment, and Management ACS Symposium Series; American Chemical Society: Washington, DC, 2019.

Pesticide discharges to the sewer can harm the environment and be costly

- Potential for pesticides to cause or contribute to wastewater treatment process interference
- Adverse impacts to receiving waters
- Permit compliance issues
- Exposing POTWs to the potential for third party lawsuits under the Federal Clean Water Act (CWA).
- Degradation of recycled water quality and/or ability to reuse biosolids

Numerous agencies are actively engaged in recycled water projects – for both non-potable and potable demands

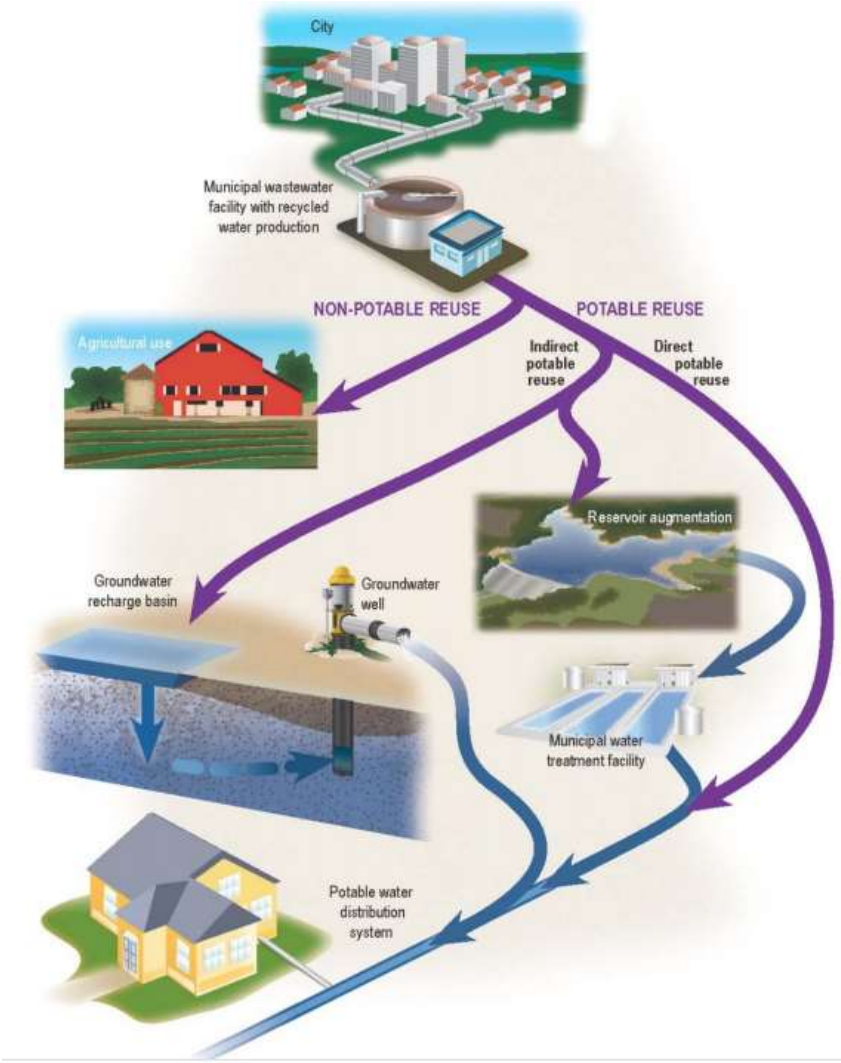


Image source:
http://bawsca.org/uploads/userfiles/files/WATER%20RECYCLING%20AND%20POTABLE%20REUSE_Final_7_12_17.pdf

Figure 2-1. Planned and constructed IPR and DPR projects in the United States as of 2017

US EPA Office of Water (2017). Potable Reuse Compendium

At issue is the resulting reverse osmosis concentrate

- RO concentrate could contain pesticides at concentrations that will prevent its discharge to surface water.
  - Either increasing cost or preventing potable reuse
- Modifying uses of persistent pesticides to avoid sewer discharges may be the best (and perhaps only) means to allow society to access this future water supply.

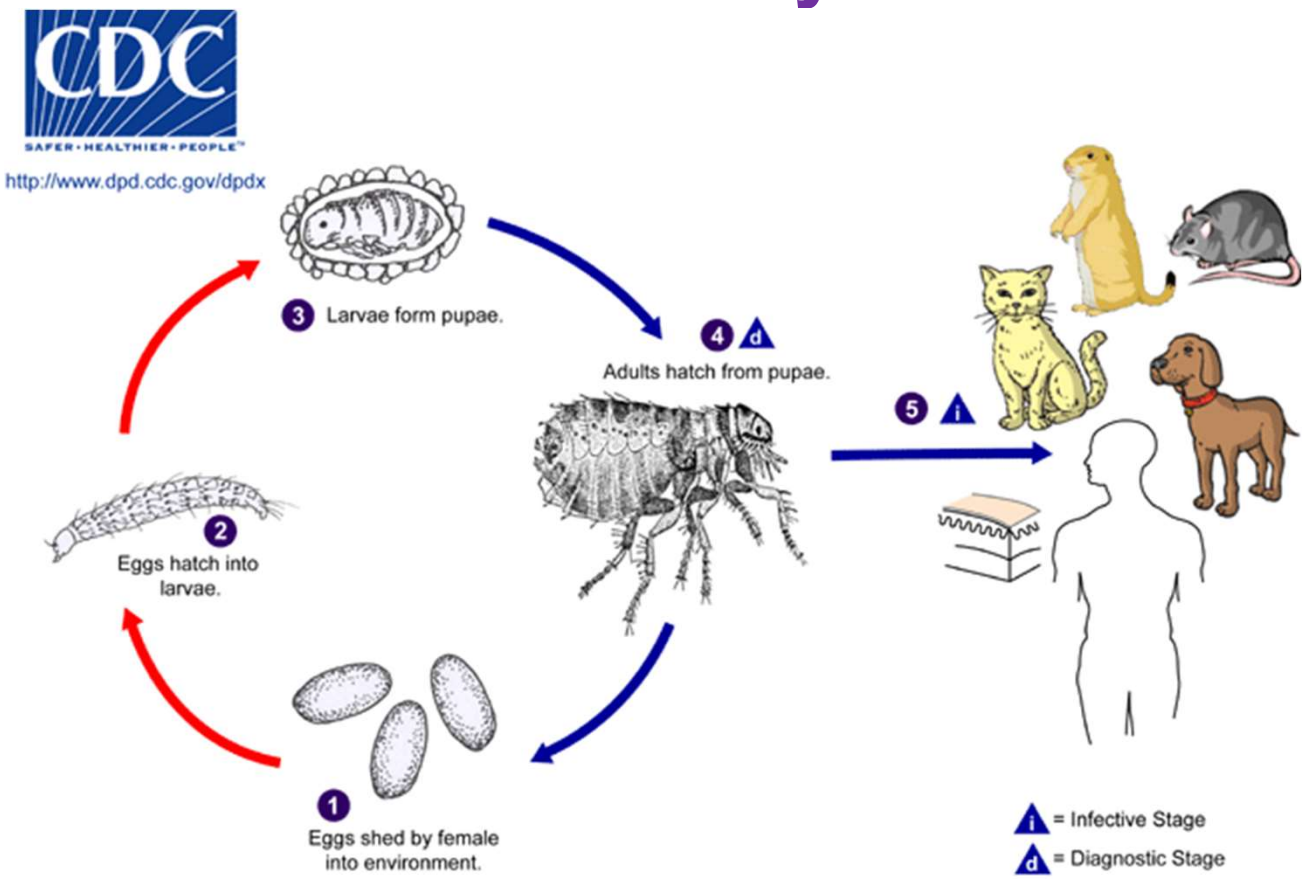
POTW Pesticides Conundrum

- 100s of pesticides used & discharged
- Many pass through sewage treatment plants
- Some toxic as low as ng/L
- Aquatic toxicity in California surface waters usually linked to current pesticides
- POTW treatment changes unrealistic
  - So many pesticides, such low concentrations!
- State law prohibits local pesticide regulation (so a POTW can't ban a pesticide use even if it is creating toxicity for the wastewater effluent)

Our Concerns Specific to Flea and Tick Control

- *Pesticides from common flea and tick control products are reaching the sewer systems.*
- *Pesticide concentrations subsequently discharged into San Francisco Bay can exceed toxicity thresholds for aquatic invertebrates.*

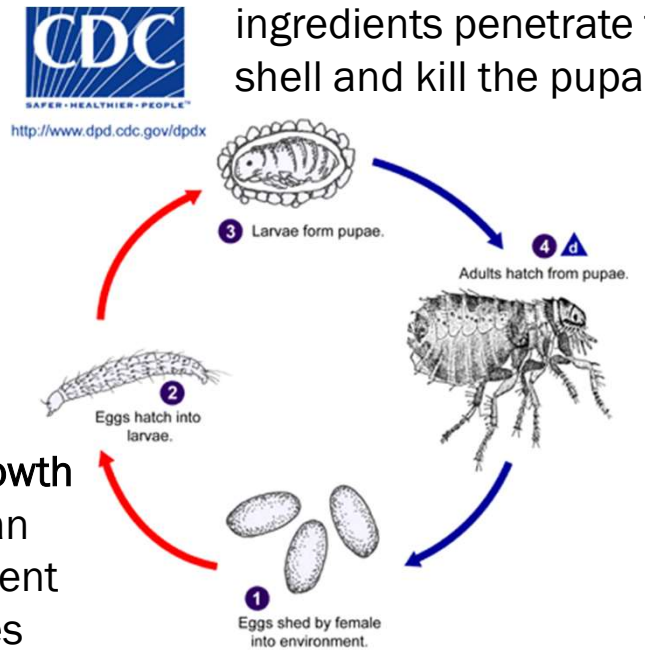
The Flea Cycle



https://www.pesticideresearch.com/site/?page_id=2933

So if you were looking to kill the fleas in this cycle, you might seek…

To my knowledge, **no** active ingredients penetrate the shell and kill the pupae



An "adulticide" - an active ingredient that kills the adults

An "insect growth regulator" – an active ingredient that minimizes number or viability of eggs or larvae

Chemical Families of Active Ingredients

- Adulticide
  - Neonicotinoids (*imidacloprid*)
  - Organophosphorus
  - Oxadiazine
  - Pyrazoles (*fipronil*)
  - Pyrethroids
  - Spinosyn, macrocyclic lactone
  - Isoxazolines (new)
- Insect growth regulator
  - Benzoylurea
  - Juvenile hormone mimics

Pesticides of concern are those that exhibit aquatic toxicity and persist in the environment

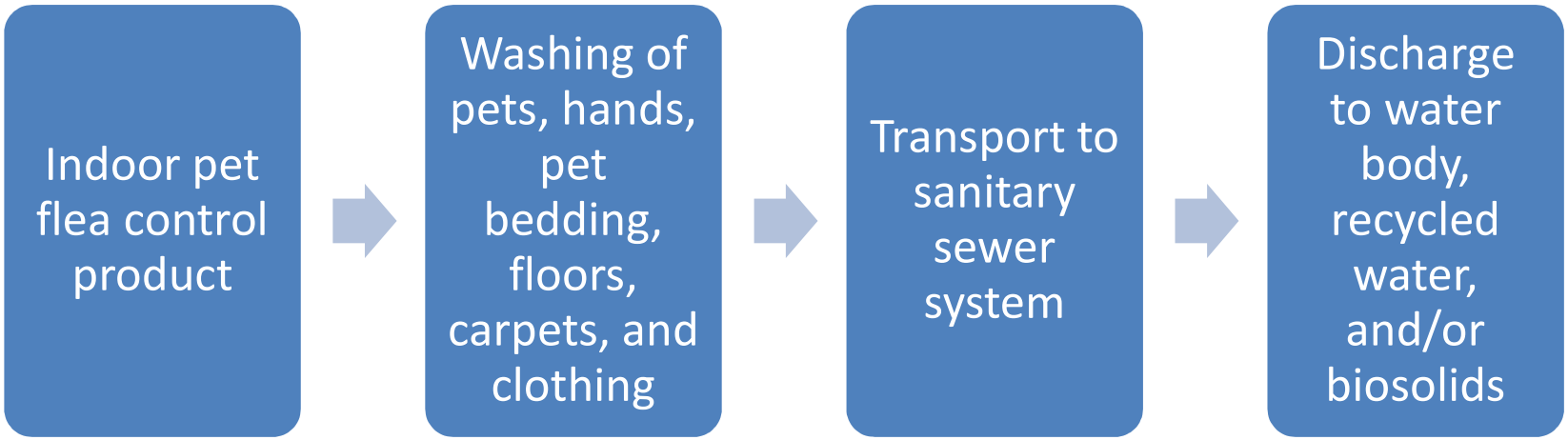
- Bifenthrin
- Deltamethrin
- Fipronil *
- Imidacloprid *
- Indoxacarb
- Permethrin

*** Uses of fipronil and imidacloprid are currently under review by the California Department of Pesticide Regulation due to possible health risks posed to adults and children.**

Which indoor-use products contain pesticides of concern?

- Topicals
  - Collars
  - Spot treatments
- Shampoos and dusts
- House sprays and foggers

How Pet Treatments Travel to Sewer Systems and San Francisco Bay



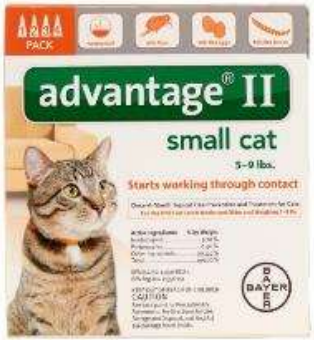
How Collars Work

- Work topically on the fur/skin
  - Requires direct contact with the adult flea, eggs or larvae
- Majority only include an “adulticide” as the active ingredient
  - Though some studies indicate that the pet dander is larvecidal
- Typically last 6-8 months
- The active ingredient permeates slowly out of the collar over time
  - Collars may release the active ingredient during storage so that when it is first applied to the pet, it initially exposes the pet to a large initial dose of the active ingredient.

"Long-Acting Control of Ectoparasites: A Review of Collar Technologies for Companion Animals," Witchey-Lakshmanan, L., Advanced Drug Delivery Reviews, 1999, Vol 38, pp 113–122.

How (Most) Topicals Work

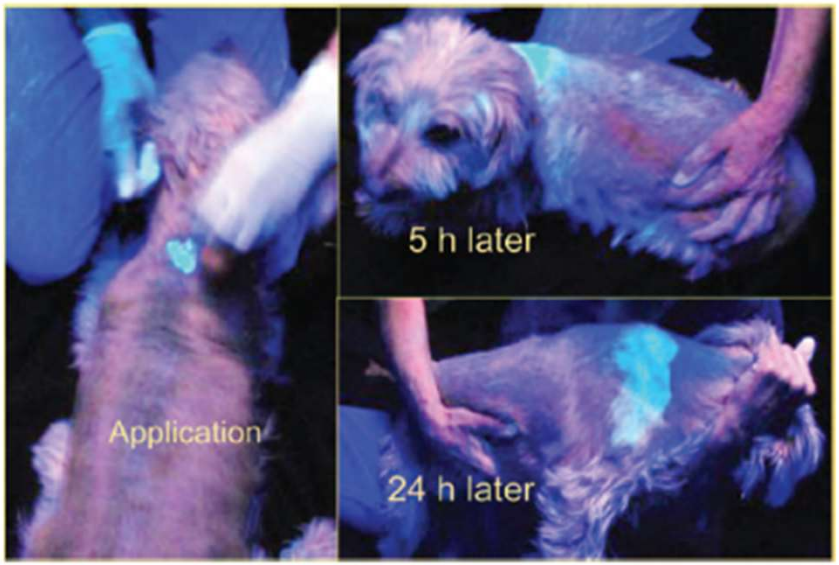
- Work topically on the fur/skin (with one exception)
  - Requires direct contact with the adult flea, eggs or larvae
- All include an adulticide
  - Many blend 2 or 3 active ingredients so as to also act as an insect growth regulator
- According to manufacturers they “don’t wash off”



Revolution is the one topical treatment that works systemically

- It is a product that is **applied topically** but breaks the skin/blood barrier and **works as a systemic (akin to oral medications)**
- Some % of the active ingredient remains on the skin/ fur (and has topical / contact impact)
- Because it is a systemic treatment it is considered a pharmaceutical rather than a pesticide and is regulated by FDA instead of EPA and requires a prescription

Topical treatments do not remain on the pet



Researchers incorporated a fluorescent dye into the spot treatment to photograph the spread.

Fig. 3. Handling of a dog treated with Frontline® containing 1% Tinopal® CBS-X fluorescent tracer revealed contamination of hands during routine application and handling of a treated dog (color figure available online).

"Fate and Distribution of Fipronil on Companion Animals and in Their Indoor Residences Following Spot-On Flea Treatments," Bigelow Dyk, M., et al., J. of Env Science and Health, Part B, 2012, Vol 47, pp 913-924.

Spot-on Products

- Product labels state “waterproof” once dry
- Common product includes 9.1% Fipronil
- Recommended frequency of application 30 days

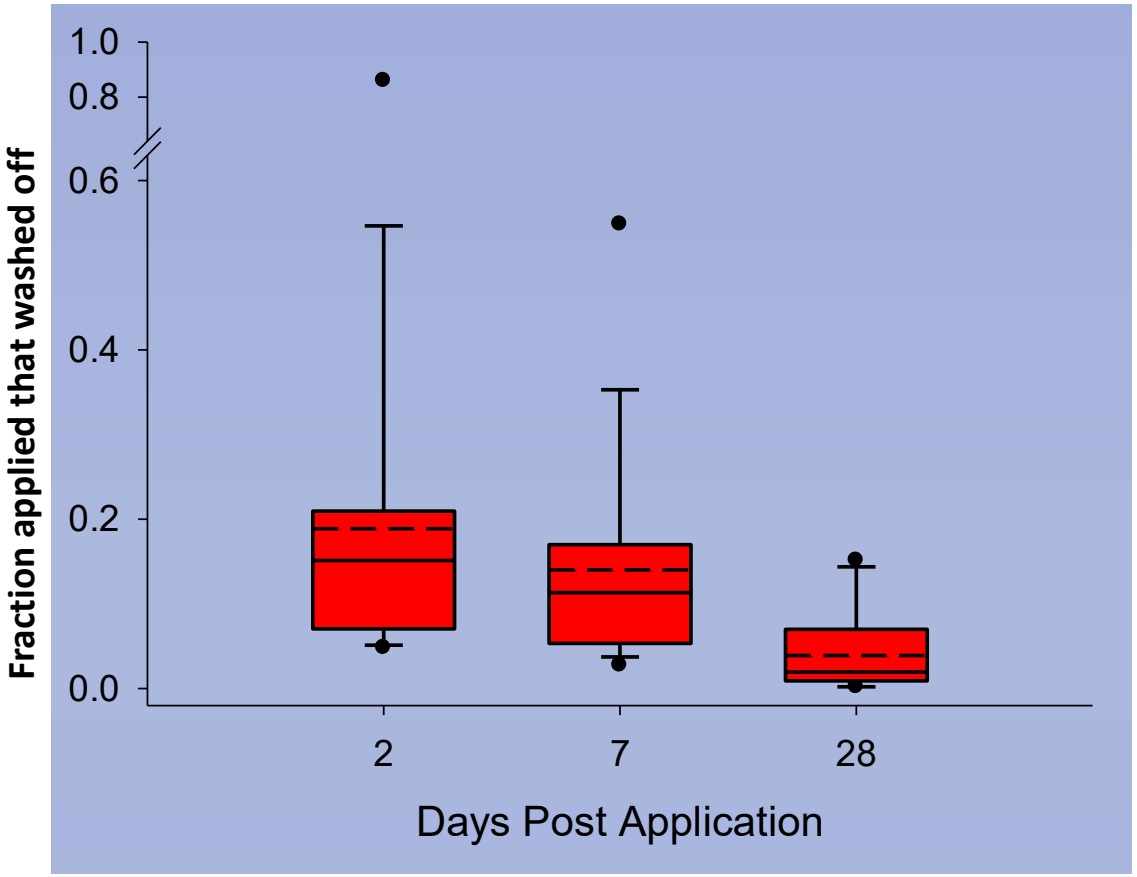
DPR conducted a study in which they washed volunteer dogs 2, 7, or 28 days post application.

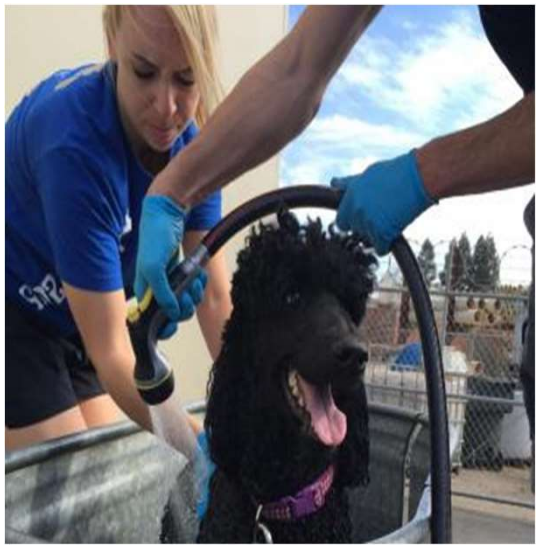
Teerlink, J., J Hernandez, R Budd. 2017. Fipronil washoff to municipal wastewater from dogs treated with spot-on products. Sci Total Environ 599-600: 960-966.

Slide source: California DPR

DPR Study: Fipronil Washes Off Pets

Wash-off continues for at least 28 days





Teerlink, J., J Hernandez, R Budd. 2017. Fipronil washoff to municipal wastewater from dogs treated with spot-on products. Sci Total Environ 599-600: 960-966.

Fipronil washoff to municipal wastewater from dogs treated with spot-on products

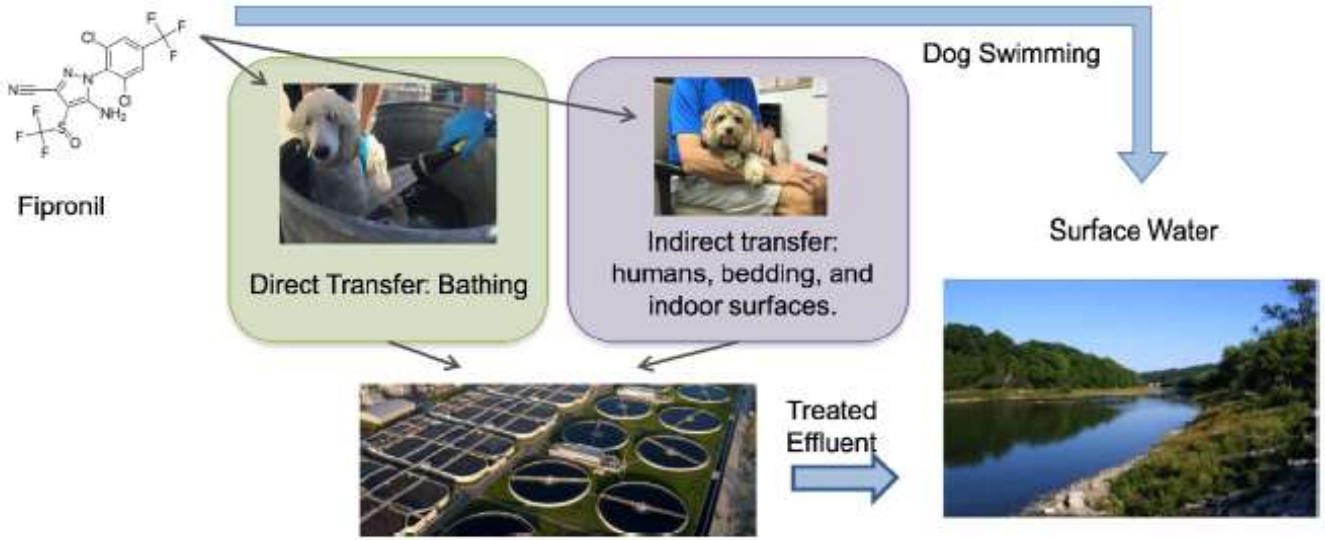
Jennifer Teerlink [a,*], Jorge Hernandez [b], Robert Budd [a]

[a] Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, CA 95812, USA
[b] California Department of Food and Agriculture, Sacramento, CA 95812, USA

HIGHLIGHTS

- Pathway for pesticide spot-on products to wastewater catchment confirmed.
- Total mass of fiproles measured in rinsate ranged from 3.6–230.6 mg per dog.
- Fipronil spot-on products a source to wastewater influent.
- Fipronil measurable to at least 28 days post application.

GRAPHICAL ABSTRACT



Evidence for fogger residue transfer to people

In 1990, the California Department of Food and Agriculture published a dermal contact study presenting findings regarding the transfer of residue to people and their clothing following a chlorpyrifos/allethrin fogger treatment in carpeted rooms.

Ross, J., T. Thongsinthusak, H.R. Fong, S. Margetich, R. Krieger, California Department of Food and Agriculture, "Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated from Indoor Fogger Use: An Interim Report," Chemosphere, Vol.20, Nos.3/4, pp 349-360, 1990.

Evidence for fogger residue transfer to people

METHOD:

- The rooms were all located in a new hotel so as to eliminate background pesticide residue and to provide repeatability from room to room.
- Foggers were set up per label instructions and activated for 2 hours followed by room ventilation.
- Participants later conducted a standardized exercise routine in specific locations in the room.
- Shirts, tights, gloves and socks were subsequently collected for analysis.

Ross, J., T. Thongsinthusak, H.R. Fong, S. Margetich, R. Krieger, California Department of Food and Agriculture, "Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated from Indoor Fogger Use: An Interim Report," Chemosphere, Vol.20, Nos.3/4, pp 349-360, 1990.

Evidence for fogger residue transfer to people

RESULTS:

- Both allethrin and chlorpyrifos were detected in <u>all</u> exposed clothing samples
- When the volunteer participants showered, the residue on their heads and other bare skin transferred to the sewer

Ross, J., T. Thongsinthusak, H.R. Fong, S. Margetich, R. Krieger, California Department of Food and Agriculture, "Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated from Indoor Fogger Use: An Interim Report," Chemosphere, Vol.20, Nos.3/4, pp 349-360, 1990.

In-House Foggers vs. Crack-and-Crevice Sprays

- UC Riverside study sought to understand human health consequences of indoor insecticidal treatments, comparing a fogger, a perimeter spray, crack-and-crevice sprays, and spot sprays.
- Each application produced a surface residue
- Fogger applications resulted in highest chemical residue
- Crack-and-crevice and spot applications deposited high levels of pesticide directly at the target site

Regulatory Toxicology and Pharmacology 58 (2010) 189–195

Contents lists available at ScienceDirect

Regulatory Toxicology and Pharmacology

journal homepage: www.elsevier.com/locate/yrtph

Deposition and spatial distribution of insecticides following fogger, perimeter sprays, spot sprays, and crack-and-crevice applications for treatment and control of indoor pests

James J. Keenan [a], John H. Ross [b], Vincent Sell [c], Helen M. Vega [a], Robert I. Krieger [a,*]

[a] Personal Chemical Exposure Program, Department of Entomology, University of California, Riverside, CA 92521, United States
[b] Gem Quality Risk, Inc. 5233 Marimore, Carmichael, CA 95608, United States
[c] Washburn & Sons, 807 Center Street, Riverside, CA 92507, United States

"Crack-and-crevice application…appears to be the most effective application type when one is trying to decrease potential exposure and maintain efficacy of treatment."

Palo Alto Sewershed Sampling

- Routine Monthly Sampling
  - 10 sub-sewershed laterals
  - Influent
  - Effluent
- Additional Sampling Sites
  - Laundromat
  - Pest Control Operator (PCO)
  - Groomer

(24-hour time-weighted composites)

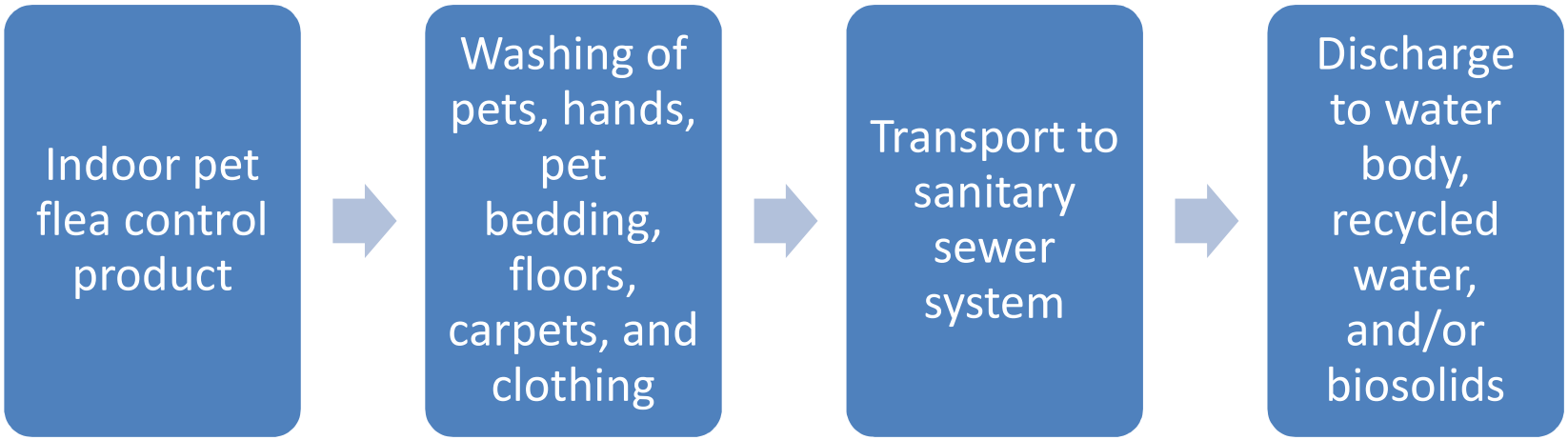
Slide source: California DPR

Results at Groomer Sites

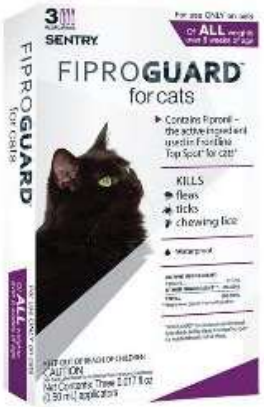
- Confirms pet use products enter wastewater catchment
- Additional residues may be introduced through:
  - Laundering pet bedding and human clothes
  - Human showering, hand washing, excretion
  - Cleaning indoor surfaces

Slide source: California DPR

How Pet Treatments Travel to Sewer Systems and San Francisco Bay



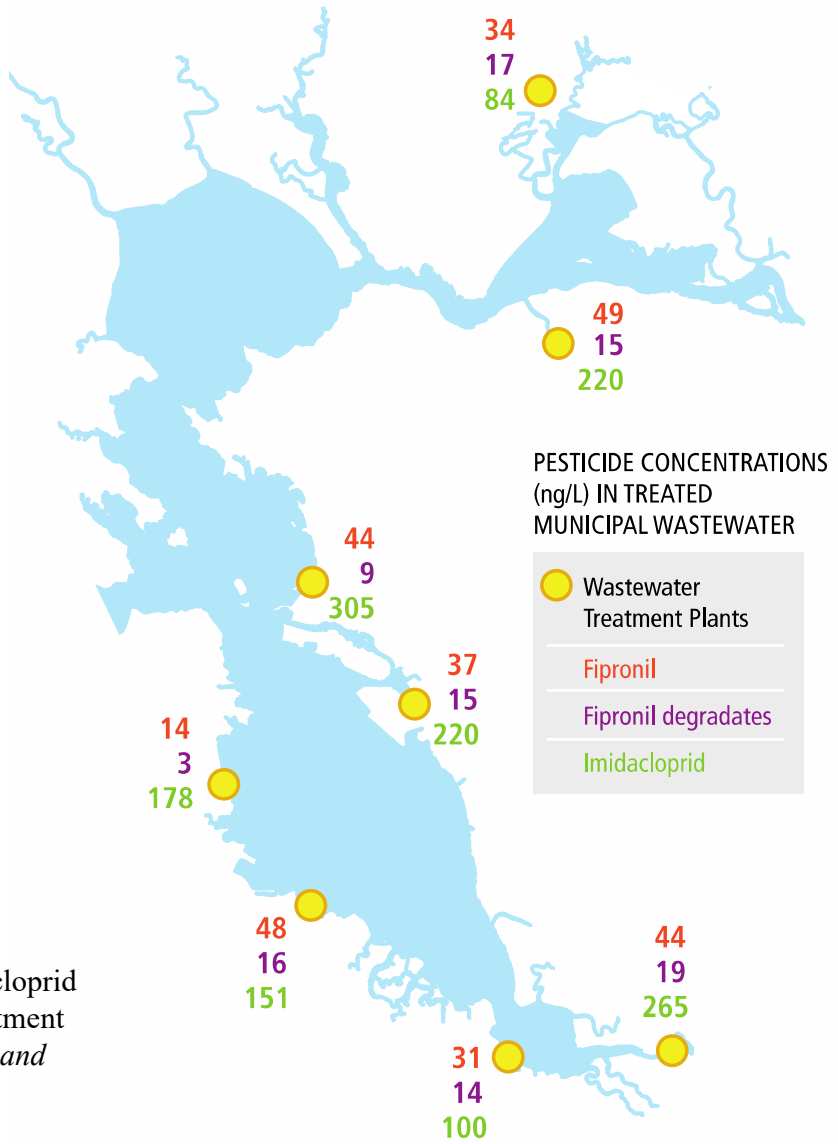
Focus on Imidacloprid and Fipronil



Focus on Imidacloprid and Fipronil

- Common “spot on” topical treatments
- Imidacloprid, fipronil and degradates found in wastewater effluent sometimes at concentrations exceeding toxicity thresholds for sensitive aquatic organisms.
- California’s Dept of Pesticide Regulation is:
  - Evaluating exposure risk in the home
  - Considering **significant** mitigation measures for **fipronil** to reduce consumer and child exposure

We have evidence that pyrethroids, fipronil and imidacloprid pass through wastewater treatment at concentrations > toxicity thresholds for sensitive organisms



Sadaria, A.M. et al. 2017. Passage of Fiproles and Imidacloprid from Urban Pest Control Uses Through Wastewater Treatment Plants in Northern California. *Environmental Toxicology and Chemistry*. 36 (6), 1473-1482.

Summary of Our Concerns

- Pesticide active ingredients:
  - transport around the home
  - wash off (contrary to product labels)
  - observed in wastewater effluent and waterbodies
    - sometimes at concentrations toxic to sensitive aquatic species

- These active ingredients (or their transformation products) exhibit aquatic toxicity and persist in the environment:
  - Bifenthrin
  - Deltamethrin
  - Fipronil *
  - Imidacloprid *
  - Indoxacarb
  - Permethrin

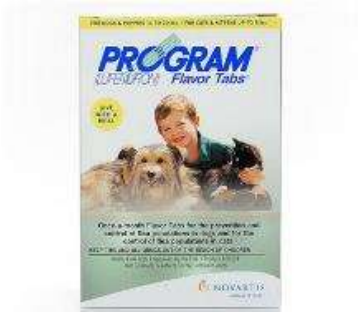
* DPR is evaluating public health impact


Questions?

What about alternatives for flea control?

On-Pet Controls: Oral Medications

- Systemic
  - Requires adult flea to bite the animal
- Active ingredient in most are adulticides
  - The active ingredient in Program is an insect growth regulator
- Typically monthly or quarterly doses
- Although rare, adverse reactions can include vomiting, lethargy
- Prescription rather than OTC (therefore regulated by FDA, not EPA)



What about effectiveness of systemics versus topicals?

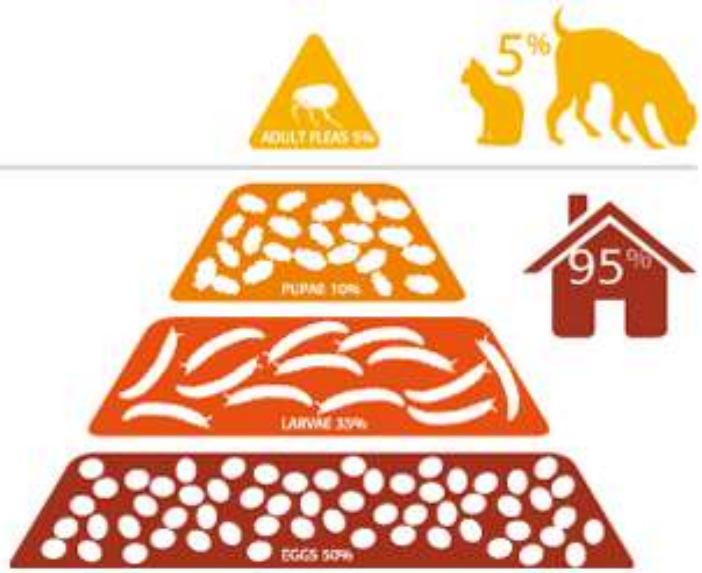
- Might systemics be more effective?
  - More accurate application method
  - More direct approach (flea bites animal rather than happens upon the topical application)
  - The active ingredient is within the pet's bloodstream rather than being licked off or diluted around the home

"In this study systemically acting insecticides such as nitenpyram, and the topically applied but systemically active insecticide selamectin, were ***more effective*** *in interfering with flea blood feeding* ***than were imidacloprid and fipronil.****"*

"Flea blood feeding patterns in cats treated with oral nitenpyram and the topical insecticides imidacloprid, fipronil and selamectin," McCoy, c., et al., Veterinary Parasitology, Vol. 156, pp 293-301, 2008.

Let's look at the flea cycle another way… The Flea Pyramid

- Adult fleas only account for **5%** of the total flea population.
- The other **95%** are the **eggs, larvae and pupae** that remain hidden in carpets, furniture, dog bedding and the garden, waiting to develop and jump onto the dog.



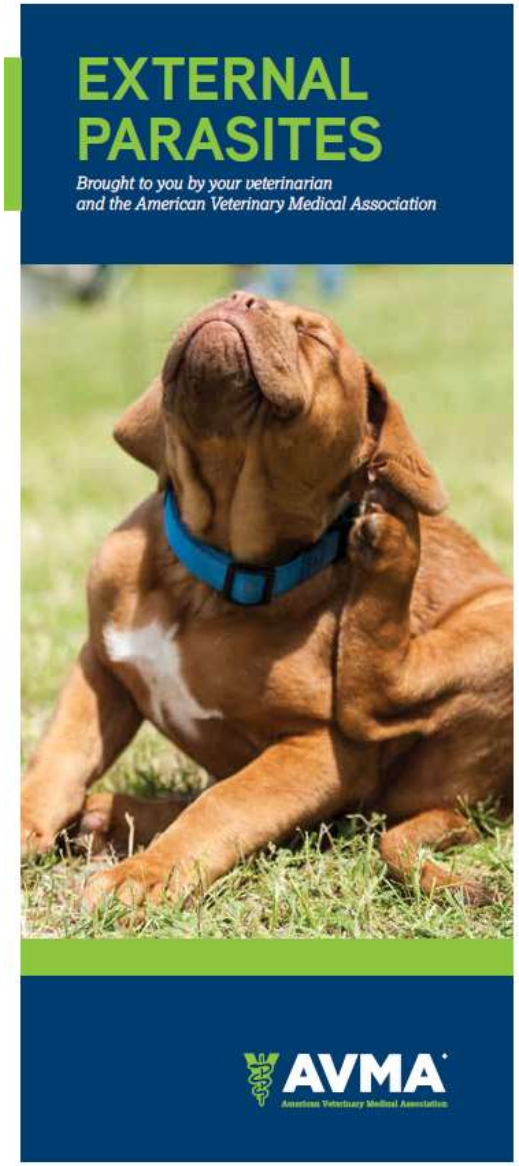
The majority of the flea cycle is the "environmental reservoir" within and throughout your home.

http://www.allcreaturesvet.biz/fleas.html

AVMA outreach materials highlight this issue

"Because much of the flea's life cycle is spent off of your pet, ***treating only your pet will not eliminate the problem****. If you kill the adult fleas and do not kill the eggs, larvae and pupae, your pet will become reinfested when these fleas become adults and the cycle will start all over again. Therefore, in addition to treating your pet,* ***reduce the flea population in your house by thoroughly cleaning your pet's sleeping quarters and vacuuming floors and furniture that your pet comes in contact with frequently. Careful and regular vacuuming/ cleaning of the pet's living area helps to remove and kill flea eggs, larvae, and pupae****."*

American Veterinary Medical Association, "External Parasites" brochure from AVMA web site, January 2016.



BACWA's Outreach Messages

Most Important: mechanical controls (vacuuming, bed washing)
Avoid: topical collars and spot products
Avoid: fipronil, indoxacarb, imidacloprid, bifenthrin, deltamethrin, and permethrin
Consider: talking to your vet about oral medication

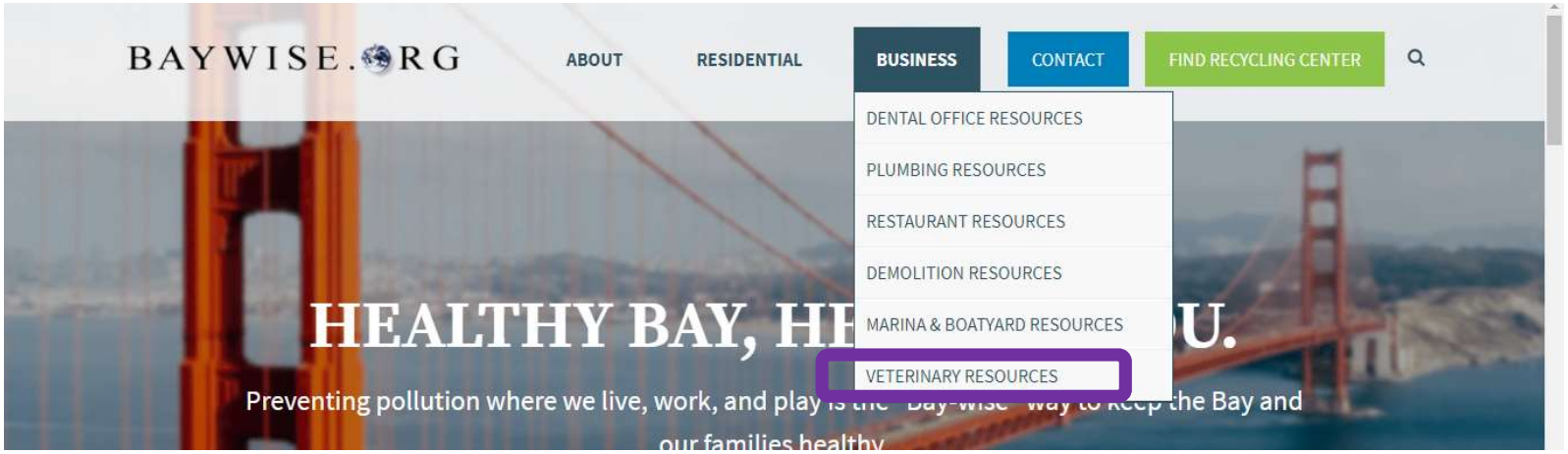
As for ticks…prevention is the key

- If possible, **keep your dog's coat short**
- **Try to keep out of the brush.** Seek to walk in the center of trails and use shorter leashes.
- **Thoroughly inspect your pet** after walks before ticks have time to attach. Pay particular attention to the nose, mouth, eyes, ears (inside too), around tails and under the collar.
- **Seek to create a tick-free zone in your yard**, controlling brush or tall grass. Consider providing a 3-foot wide barrier (e.g., wood chips or gravel) between lawns and wooded areas to restrict tick movement. Keep play and deck equipment away from yard edges. Keep outside areas neat to discourage rodents or other wildlife

BACWA's Outreach Efforts

- Outreach to California Veterinary Medical Association (VMA)
- Outreach to county-level VMAs
  - Provide newsletter articles
  - Presentation availablefor monthly meetings
- Social media campaigns
- Educational web pages

Web site is www.baywise.org: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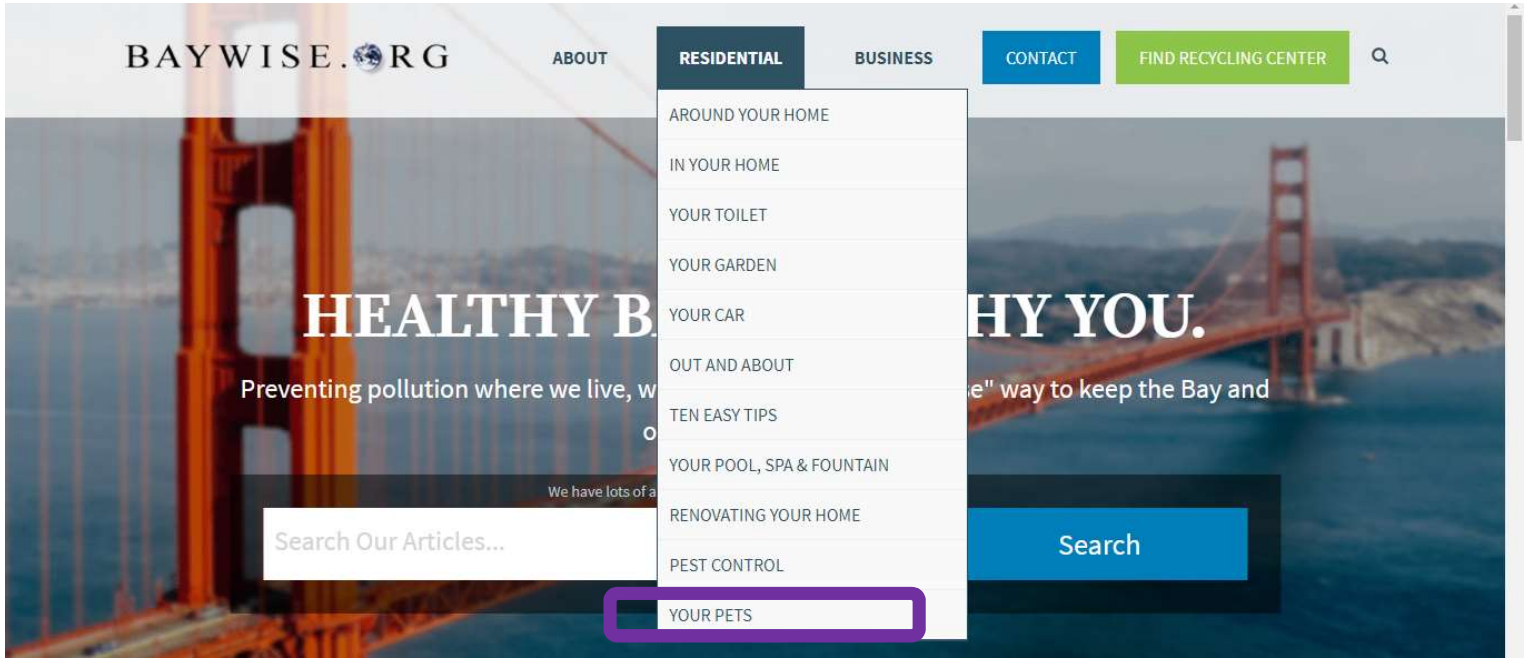
MARINA & BOATYARD RESOURCES
VETERINARY RESOURCES
HEALTHY BAY, HE
U.
Preventing pollution where we live, work, and play is the "Bay-Wise" way to keep the Bay and
our families healthy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OUT AND ABOUT
TEN EASY TIPS
YOUR POOL, SPA & FOUNTAIN
RENOVATING YOUR HOME
PEST CONTROL
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Preventing pollution where we live, w
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VETERINARY RESOURCES

Help Pet Owners Avoid Exposure to Toxic Chemicals in Topical Flea & Tick Control Products

Indoor Pet Flea and Tick Treatments Leading to Environmental and Public Health Concerns

To avoid exposing pets, their owners and Bay Area waterways to toxic pesticides, members of the Bay Area Clean Water Agencies (BACWA) are encouraging professionals to recommend their clients to use oral medications to control fleas and ticks, and to discourage the use of topical treatments.

There is increasing evidence that pesticides from external flea and tick control products including spot-on treatments, collars, indoor foggers and sprays are finding their way into our local waterways, sometimes at concentrations above toxicity thresholds for aquatic species. The California Department of Pesticide Regulation (DPR) is also currently reviewing uses of fipronil and imidacloprid, the active ingredients in most spot-on topical treatments, due to possible human health risks.

"Dog and cat flea treatments

Web pages for pet owners:

YOUR PETS

Flea and Tick Control

Products commonly used to treat fleas and ticks, including spot-on treatments, collars, sprays, and foggers, contain toxic pesticides that can easily spread around your home. Toxic pesticides from these treatments can also end up in our local waterways when you: wash your pet; wash bedding, clothing, floors, carpets or upholstery that comes into contact with your pet; and neglect to dispose of pet waste in the trash.

To avoid exposing your pets, family and Bay Area waterways to toxic pesticides, **please speak to your vet about using oral medications to control fleas and ticks**, and review our recommendations for keeping your pets safe.

- **How to Keep Your Pets Free of Fleas and Ticks**
- **Important Facts about Toxic Chemicals in Certain Flea and Tick Control Products**

"Dog and cat flea treatments suspected of polluting San Francisco Bay" by Paul Rogers, San Jose Mercury News, published November 7, 2017"

Sample newsletter article

SANTA CLARA VALLEY VETERINARY MEDICAL ASSOCIATION

NEWSLETTER
JULY 2018

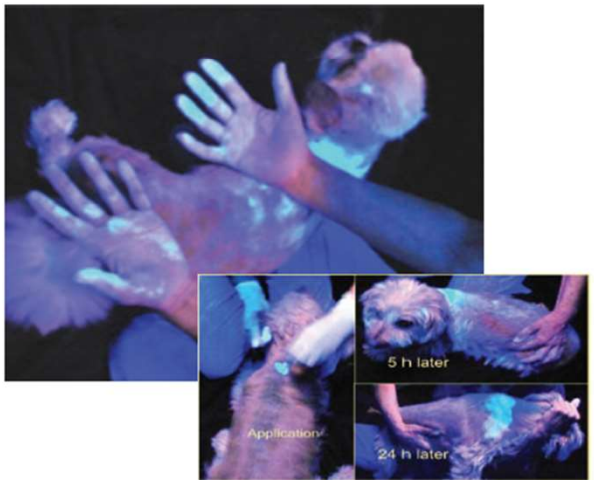
Stephanie Hughes, Consulting Water Quality Engineer and Lecturer of Environmental Science, Santa Clara University, submitted the following article.

Help Pet Owners Avoid Exposure to the Toxic Chemicals in Topical Flea & Tick Control Products

Indoor Flea and Tick Treatments Leading to Environmental and Public Health Concerns

To avoid exposing pets, their owners, and Bay Area waterways to toxic pesticides, members of the Bay Area Clean Water Agencies (BACWA) are urging veterinarians and other animal care professionals to recommend their clients to use oral medications for fleas and tick control, and to discourage the use of topical treatments.

There is increasing evidence that pesticides from flea and tick control products such as spot-on treatments, collars, indoor foggers and sprays are finding their way into our local waterways, sometimes at concentrations above toxicity thresholds for aquatic species. The California Department of Pesticide Regulation (DPR) is also currently reviewing uses of fipronil and imidacloprid, the active ingredient in many common spot-on topicals, due to possible human health risks.



Public Outreach Challenges

- Flea products change every year
  - Some products are pulled from the marketplace
  - New products emerge
- Simpler for consumers to buy topicals at box-stores rather than seek a prescription (for orals) from their vet
- Companion animals are a lucrative pharmaceutical market

The Lucrative Market of Companion Animals

- "many similarities between the human health and animal health industries."
- "The global companion animal market is an important segment of the animal health market. It has higher profitability, less price sensitivity and a higher growth rate than livestock."
- A $7 billion industry (2015), growing at 6-7% a year
- **The single MOST common companion animal pharmaceuticals are for fleas/ticks.**

Sources: Pharmaceutical challenges in veterinary product development, Imran Ahmed and Kasra Kasraian (Pfizer), Advanced Drug Delivery Reviews 54 (2002) 871–882.
And http://www.prnewswire.com/news-releases/packaged-facts-pet-medications-market-returns-to-form-with-sales-forecast-to-reach-7-billion-in-2015-300163409.html

Our efforts have caught the attention of the national association, the American Veterinary Medical Association

- BACWA reps met with AVMA reps beginning in January 2021
- Initially met with skepticism but the AVMA now appears receptive to our messages
- AVMA appears interested in collaborating with the National Association of Clean Water Agencies (NACWA) and BACWA
  - It would be helpful if the AVMA hears that water agencies in other regions of the country are raising this issue with their veterinary associations

Our AVMA contact recently recommended two additional national entities to approach:

- American Animal Hospital Association (AAHA)
- Humane Society of United States (HSUS)

Summary

- Scientific evidence shows that ingredients from indoor flea treatments are transported around the home (and wash off)
- Fipronil and imidacloprid are seen throughout a wastewater service area, as well as the final treated effluent, and waterways; they are toxic to aquatic organisms
  - Are being evaluated by DPR due to human health risk
- On-pet products only target about 5% of the flea cycle
- Alternatives include thorough house cleaning and oral medications
- BACWA will continue consumer and vet outreach in the SF Bay Area
- BACWA and NACWA are hoping to partner with the AVMA
- BACWA and NACWA also plan to reach out to the AAHA and HSUS

Seeking support from Pacific Northwest agencies

- Mirror our messages in your communities
  - Consistent messaging is important
- Seeking to expand our outreach team to provide NACWA with additional support throughout the country
  - Add resources and staff time to support this at a national level
  - Support on-going AVMA communication
  - Initiate the AAHA and/or HSUS communication

Thank you for your attention!

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BACWA
BAY AREA
CLEAN WATER
AGENCIES