**COMPARING ANTIBIOTIC RESISTANCE IN FREE-RANGING VS. CAPTIVE AFRICAN WILD HERBIVORES**. J Wildl Dis (2023) 59 (2): 224–233. Lucie Brisson; Alexandre Caron; Christine Mazuy-Cruchadet; Emmanuelle Gilot-Fromont; Alexis Lécu; Bourgarel Mathieu; Thierry Petit; Delphine Sergentet.

Abstract: Antimicrobial resistance (AMR) is a critical challenge of the 21st century for public and animal health. The role of host biodiversity and the environment in the evolution and transmission of resistant bacteria between populations and species, and specifically at the wildlife-livestock-human interface, needs to be further investigated. We evaluated the AMR of commensal Escherichia coli in three mammalian herbivore species—impala (Aepyceros melampus), greater kudu (Tragelaphus strepsiceros), and plains zebra (Equus quagga)—targeting populations living under two conditions: captivity (French zoos) and free ranging (natural and private parks in Zimbabwe). From 137 fecal samples from these three host species, 328 E. coli isolates were isolated. We measured the AMR of each isolate against eight antibiotics, and we assessed the presence of AMR genes and mobile genetic element class 1 integrons (int1). **Isolates obtained from captive hosts had a higher probability of being resistant than those obtained from free-ranging hosts** (odds ratio, 293.8; confidence interval, 10–94,000). This statistically higher proportion of AMR bacteria in zoos than in natural parks was **especially observed for bacteria resistant to amoxicillin.** The percentage of int1 detection was higher when isolates were obtained from captive hosts, particularly captive impalas. Ninety percent of bacterial isolates with genes involved in antibiotic resistance also had the int1 gene. The sul1, sul2, blaTEM, and stra genes were found in 14, 19, 0, and 31%, respectively, of E. coli with respective antibiotic resistance. Finally, plains zebra carried AMR significantly more often than the other species.

Background:

* Antibiotic use is the main driver of AMR spread worldwide
* AMR transmission from direct contact between hosts or indirect from environmental contamination/pollution; exact mechanisms largely unknown
* Class 1 integrons (int1) are central actors in genetic transmission of AMR

Methods: isolated 328 e.coli isolates from 137 fecal samples from three ungulate species (impala, greater kudu, plains zebra) both captive and free-ranging, and measured AMR of each isolate against 8 antibiotics

* Doxy, streptomycin, spiramycin, TMS, ceftazidime, amoxi, chloramphenicol, ciprofloxacin
* *Escherichia coli* = aerobic and facultative anaerobic gram negative bacteria of commensal flora of endothermic animals; easily isolated and good organism to study AMR of commensal flora

Key Points:

* *E.coli* isolated from 64% of samples - relatively low yield, perhaps due to freezing right away
* 24% resistant to at least one antibiotic and 28% had int1 gene
  + Among those resistant to one antibiotic 37% were multiresistant (MR)
  + 90% of the bacterial isolates with AMR had int1 gene
* **Most frequent resistance was amoxi 53%** > streptomycin 37% > ceftazidime 28% > TMS 25%
  + Similar to previous E. coli AMR studies in wildlife with common resistance to tetracyclines, beta-lactams, streptomycin, TMS
* **Isolates from captive animals had higher probability of AMR than free-ranging animals**
  + **Especially for bacteria resistant to amoxicillin**
  + int1 gene more commonly detected in isolates from captive hosts
  + In zoo animals, resistant patterns match antibiotics used in establishments
    - Exception: resistance against spiramycin (rarely used) in impalas in zoos
  + Suspect from close contact with humans (direct care staff contact, antibiotic residues in environment) and artificial management (frequent abx treatments)
* Number of multiresistant bacteria was also higher in captivity
* Plains zebra had AMR more often than impala or greater kudu
  + Monogastric, strict grazer compared to ruminant generalist (browser/grazer)
* sul1 gene found in 14%, and sul2 gene found in 19% of TMS resistant bacteria
* stra gene found in 31% of streptomycin resistant bacteria
* blaTEM gene not found in any beta-lactam resistant bacteria

**HEALTH ASSESSMENT OF FREE-RANGING CHELONIANS IN AN URBAN SECTION OF THE BRONX RIVER, NEW YORK, USA.** Journal of Wildlife Diseases, 55(2), 2019, pp. 352–362.Andrea C. Aplasca, Valorie Titus, Robert J. Ossiboff, Lisa Murphy, Tracie A. Seimon, Karen Ingerman, William E. Moser, Paul P. Calle, and John M. Sykes IV.

Abstract: The Bronx River in Bronx, New York, US spans an area of significant human development and has been subject to historic and ongoing industrial contamination. We evaluated the health of free ranging native common snapping turtles (Chelydra serpentina) and nonnative invasive red-eared sliders (Trachemys scripta) in a segment of the Bronx River between May and July 2012. In 18 snapping turtles and nine sliders, complete physical examinations were performed, ectoparasites collected, and blood was analyzed for contaminants (mercury, thallium, cadmium, arsenic, lead, selenium, oxychlordane, alpha-chlordane, dieldrin, DDD, DDE, polychlorinated biphenyls). Complete blood counts and the presence of hemoparasites were determined in 16 snapping turtles and nine sliders. Swabs of the choana and cloaca were screened for ranavirus, adenovirus, herpesvirus, and Mycoplasma spp. by PCR in 39 snapping turtles and 28 sliders. Both turtle species exhibited bioaccumulation of various environmental contaminants, particularly organochlorines and polychlorinated biphenyls. Molecular screening revealed a unique herpesvirus in each species. A Mycoplasma sp. previously isolated from emydid turtles was detected in red-eared sliders while a unique Mycoplasma sp. was identified in common snapping turtles. Ranaviruses and adenoviruses were not detected. Our study established a baseline health assessment to which future data can be compared. Moreover, it served to expand the knowledge and patterns of health markers, environmental contaminants, and microorganisms of free ranging chelonians.

Background

* Chelonians are effective biomonitors for environmental contamination; absorb contaminants through various routes (ingestion, skin, deposition in body fat) and occupy high trophic levels within their ecosystem
* OCs and PCBs accumulate in hepatic and adipose tissue
  + OC in turtles: conjunctivitis, otitis media, aural abscesses, lower lysozyme activity, abnormal sexual development
  + PCB in turtles: developmental deformities in snappers, feminization and male-to-female sex shifts in RES
* Lead circulates in erythrocytes for extended periods and is stored in long-term in bone
  + Lead in turtles: decreased enzymes of heme in RBCs and decrease in Hgb, prolonged righting reflex times
* Cadmium, selenium, arsenic, thallium accumulate in hepatic, renal and other tissues
  + Other heavy metals in turtles: compromised reproduction, decreased metabolic rates, and toxic effects on GIT and neuro systems

Methods: Complete health assessments (PE, ectoparasites, blood for heavy metals/pollutants, CBC with hemoparasite eval, choanal swab viral screening) performed on free-ranging common snappers (n=18) and RES (n=9) over one summer season to establish baseline health data

Key Points:

* PE: Abnormalities consistent with trauma or congenital deformity
* Parasites: Hemoparasites (hemogregarina sp) and leeches were greater in snappers > RES
* **Heavy metals: lead and selenium were detected in all turtles (higher in snappers)**
  + Mercury not detected in any turtles despite being detected in river water
* Hematology: generally consistent with other chelonians
  + PCV higher in snappers even though they had with higher hemoparasites, leeches, and blood lead levels
* **Environmental contaminants: OC and PCBs detected in both snappers and RES**
  + OC =organochlorines (oxychlordane, alphachlordane, dieldrin, DDD, DDE)
    - **Oxychlordane detected in all snappers** and 50% of RES at lower ranges
    - Alphachlordane in 47% snappers and 56% RES at similar ranges
    - Dieldrin detected in both species in similar ranges
    - DDD in low amount of snappers (no RES), DDE in some RES (no snappers)
  + PCB = polychlorinated biphenyls detected in 60% snappers and 50% RES
    - One RES with highest PCB level had lowest PCV and TS
* **Viral screen (choanal swabs): herpes and mycoplasma detected in both snappers and RES**
  + **No ranavirus of adenovirus detected**
  + Herpesvirus detected in both species: 26% snappers and 11% RES (P>0.2)
    - Novel Trachemys herpesvirus 1 in RES
    - Novel Chelydra herpesvirus 1 detected in snappers
    - Detected in healthy and diseased animals; thus unknown significance here
  + Mycoplasma detected in both species: 36% snappers > 7% RES (P<0.01)
    - Mycoplasma sp in RES similar to previously detected in other emydids; considered commensal, can cause URI in box turtles, unknown significance here
    - Novel mycoplasma sp detected in common snapper

PREVALENCE OF ANTICOAGULANT RODENTICIDES IN FECES OF WILD RED FOXES (VULPES VULPES) IN NORWAY

Kristin Opdal Seljetun,1,2,7 Elin Eliassen,3 Knut Madslien,4 Hildegunn Viljugrein,4 Vigdis Vindenes,3,5 Elisabeth Leere Øiestad,3,6 and Lars Moe1

ABSTRACT: High occurrence of anticoagulant rodenticides (ARs) in wildlife is a rising concern, with numerous reports of secondary exposure through predation. Because of widespread distribution of the red fox (Vulpes vulpes), they may act as sentinels for small mammal-hunting predators in rural, suburban, and urban areas. No AR surveillance in wild mammals with analyses of residues in feces has been conducted throughout a single country. We collected 163 fecal samples from presumed healthy red foxes from 18 out of 19 counties in Norway. The foxes were shot during regular hunting between January and December 2016 and samples collected directly after death. Fecal samples were analyzed for six ARs: brodifacoum, bromadiolone, coumatetralyl, difenacoum, difethialone, and flocoumafen. We detected ARs in 54% (75/139) of the animals. Brodifacoum was most frequently detected (46%; 64/139), followed by coumatetralyl (17%; 23/139), bromadiolone (16%; 22/139), difenacoum (5%; 7/139),

difethialone (1%; 2/139), and flocoumafen (1%; 2/139). More than one substance was detected in 40% (30/75) of the positive foxes, and 7% (5/75) of these animals were exposed to four different ARs. There were no statistically significant seasonal, age, or sex differences in foxes after exposure to one AR compound. We found a significant difference in occurrence of brodifacoum and coumatetralyl in foxes from different geographical areas. These findings demonstrate fecal analyses as a valuable method of detecting AR exposure in red foxes. We suggest using direct fecal sampling with analyses as a method to evaluate the occurrence of ARs in live endangered wildlife in connection with radio tagging or collaring operations.

* Second generation anticoagulant rodenticides (because mice and brown rats became immune to first generation): brodifacoum, bromadiolone, difenacoum, difethialone, and flocoumafen
  + Higher toxicity compared to first generation, prolonged liver half life; cauda mortality after several days
* Predators are at risk during those days for secondary or even tertiary exposure
* Small amount of rodenticides can cause sublethal effects
  + Reduce sperm mortality, increased embryonic mortality, cause teratogenic effects, neonatal death
* M&M: collected fecal samples (163) from red foxes shot by hunters in 2016- these samples represented 18 out of 19 counties in Norway
* Results: At least 1 AR was detected in 54% of samples- Brodifacoum most frequent and was found in 46% significantly more than other ARs
* No significant seasonal differences in exposure to 1 AR, season was significant in multiple ARs detected: more common in autumn compared to spring and winter
* No significant differences in AR exposure between sexes or age groups, or area (suburban, urban, rural- i.e. no significant difference in comparison to human density)
* Suspect exposure came from rodent ingestion (rodents that ingest ar’s are slow with abnormal activity and easily caught)
* Foxes also consume invertebrates: who have been found to be contaminated with with AR (roaches, beetles, gastropods); suspect due to multiple exposures to contaminated prey over time
* Found that fecal analysis to be a valuable method for evaluating AR exposure in wildlife

HAIR, WHOLE BLOOD, AND BLOOD-SOAKED CELLULOSE PAPER- BASED RISK ASSESSMENT OF MERCURY CONCENTRATIONS IN STRANDED CALIFORNIA PINNIPEDS

Elizabeth A. McHuron,1,7 J. Margaret Castellini,2 Carlos A. Rios,3 James Berner,4 Frances M. D. Gulland,3,5 Denise J. Greig,6 and Todd M. O’Hara2

ABSTRACT: Mercury (Hg) poses a health risk to wildlife populations and has been documented at relatively high concentrations in many marine mammals, including wild-caught pinnipeds along the central California, US coast. We measured total Hg concentrations ([THg]) in hair and blood of live-stranded harbor seals (HS; Phoca vitulina), California sea lions (CSL; Zalophus californianus), and northern elephant seals (NES; Mirounga angustirostris) in California to quantify species, temporal, and spatial variability in [THg] and assess the relationships between [THg] measured by different methods (blood vs. filter paper) and in different matrices (blood vs. hair). We compared [THg] with toxicologic thresholds of concern to aid in identification of at-risk individuals or groups and better understand how the use of different methods and matrices affects assumed toxicologic risk. There was a wide range of [THg] in blood (,0.01–1.13 lg/g) and hair (0.45–81.98 lg/g), and NES had higher [THg] compared with HS and CSL. All three species had individuals with [THg] that exceeded the lower threshold for one or both matrices, but only HS pups had [THg] exceeding upper thresholds. Spatial differences in [THg] were detected, with higher concentrations in HS pups from areas surrounding San Francisco Bay, but differences were dependent on sampling year and matrix. The relationship between [THg] in blood and filter paper (r2 1⁄40.98) was strong, and differences had little influence on comparisons with toxicologic thresholds. Blood and hair [THg] were generally in agreement (r21⁄40.72), but large mismatches for a few seals underscore the importance of combined sampling in adverse effects studies where accurate assessment of Hg exposure is crucial. The wide range of [THg] in stranded HS pups that exceeded published thresholds of concern makes them a promising candidate for adverse effects studies, particularly because different matrices represent Hg exposure across key developmental stages.

* Adverse effect from Hg exposure include: neurologic, immunologic, and reproductive impairment
* Measured THg in blood and hair: strong positive relationship between tHg in blood and FP (filter paper)
* Total Hg concentration in hair was a moderately good predictor of blood in HS pups
  + The inclusion of lanugo vs adult coat did not improve this relationship
* Northern Elephant seals had higher blood THg compared with HS and CSL- although HS had the highest maximum THg across all species
* HS had concentrations that exceeded the upper threshold
* 2008 seals had higher concentrations compared to all other years- pups that stranded in San Francisco Bay and surrounding counties in 2008 had significantly great THg than wild caught pups samples the same year and geographic region
* Documented a large increase in THg in whiskers of HS pups between mid and late gestation (think to be due to increased fetal blood flow)
* Stranded animals may have reflected the range but not the average THg exposure in wild populations
* HS pups are promising candidates because they are a key cohort of concern and exhibit a wide range of THg

*JWD* 2021 57(3):590-600

[**POSTRELEASE SURVIVAL OF CALIFORNIA BROWN PELICANS (*PELECANUS OCCIDENTALIS CALIFORNICUS*) FOLLOWING OILING AND REHABILITATION AFTER THE REFUGIO OIL SPILL**](https://doi.org/10.7589/jwd-d-20-00171)

Fiorello CV, Jodice PGR, Lamb J, Satgé Y, Mills K, Ziccardi M

**ABSTRACT:**

Oil spills represent a continued threat to marine wildlife. Although the public expects, and the State of California, US requires, oiled animals to be rescued for rehabilitation and release, scientists have questioned the welfare and conservation value of capture and rehabilitation of oiled wildlife, based on poor postrelease survival documented in the few available studies. In May 2015, Plains Pipeline 901 spilled >100,000 gallons of oil near Refugio State Beach, California. Many California Brown Pelicans (*Pelecanus occidentalis californicus*) were oiled; capture and rehabilitation efforts began within 1 d. Ultimately, 65 live birds were captured, including 50 pelicans. Forty-six pelicans survived and were released. Of these, 12 adults (six male, six female) were fitted with solar-powered GPS satellite Platform Terminal Transmitters (PTT) and released in June 2015. In early July, we captured eight adult (three male, four female, one unknown), unoiled pelicans from the Ventura, California area. These control birds were similarly instrumented and released immediately. At 6 mo after release, PTTs from nine of 12 oiled pelicans and six of eight control pelicans were still transmitting; at 1 yr, those numbers decreased to two of 12 and two of eight, respectively. Survival analysis revealed no difference in survival between oiled and control birds. Although our sample size is limited, these data demonstrate that most oiled and rehabilitated pelicans can survive for 6 mo following release, and some individuals can survive over 1 yr.

**Background:**

* Long term post-release studies for rehabilitation of oiled wildlife are rare
  + Exception – penguins, tend to do well
* Plains Pipeline 901 spill – pelicans monitored for post release survival for 1 year
  + 46 pelicans survived and were released – 12 fitted with transmitters
  + CBC, serum chemistry, fibrinogen, EPH performed on rehab birds
  + 8 unoiled pelicans captured and used as controls, also fitted with transmitters

**Key Points:**

* Oiled and released birds survived an average of 251 + 93.7 days vs. 240.3 + 85.6 days for controls
* No significant difference in survival between oiled and control birds at either 6 mo or 1 yr
  + Survival rates in both groups ~75% at 6 mo
* Limitations: difficult to determine mortality definitively using transmitters
* Oiled and rehabbed birds had higher TP
* Control birds had higher eosinophil counts

**TLDR:** Brown pelicans that were oiled during Refugio oil spill and captured, cleaned, rehabilitated, and instrumented with PTT satellite tags did not have higher mortality in year following release

**Related Articles:** *None on the current ACZM reading list*

*JWD* 2018 54(2):315-328

[**AN EXPERIMENTAL STUDY OF THE EFFECTS OF CHEMICALLY DISPERSED OIL ON FEATHER STRUCTURE AND WATERPROOFING IN COMMON MURRES (*URIA AALGE*)**](https://doi.org/10.7589/2017-01-016)

Whitmer ER, Elias BA, Harvey DJ, Ziccardi MH

**ABSTRACT:** Following an oil spill in the marine environment, chemical dispersants, which increase oil droplet formation and distribution into the water column, are assumed to provide a net benefit to seabirds by reducing the risk of exposure to oil on the water surface. However, few data are available regarding acute, external impacts of exposure to dispersed oil. We evaluated the effects of known concentrations of dispersant and crude oil in artificial seawater on live Common Murres ( Uria aalge). Waterproofing and microscopic feather geometry were evaluated over time and compared to pre-exposure values. Birds exposed to a high concentration of dispersant experienced an immediate, life-threatening loss of waterproofing and buoyancy, both of which resolved within 2 d. Birds exposed to oil, or a dispersant and oil mixture, experienced dose-dependent waterproofing impairment without resolution over 2 d. Alterations in feather geometry were observed in oil-exposed or dispersant- and oil-exposed birds and were associated with increased odds of waterproofing impairment compared to control birds. At a given contaminant concentration, there were no significant differences in waterproofing between oil-exposed and dispersant- and oil-exposed birds. We found that acute, external effects of oil and dispersed oil exposure are comparable and dose-dependent. Our results also indicate that a zero-risk assumption should not be used when seabirds are present within the dispersant application zone.

**Background:**

* Oil exposure disrupts avian insulation and buoyancy
* Chemical dispersants are applied to oil spills to facilitate containment and resolution
  + Reduces surface oil
  + Increases availability of petroleum to water-borne bacteria for biodegredation
  + Decreases shoreline habitat contamination
* This study exposed wild murres to different concentrations/mixtures of dispersant and crude oil
  + Evaluated waterproofing and feather geometry

**Key Points:**

* Exposure to high concentration dispersant creates immediate, life-threatening loss of insulation and buoyancy
  + Did not affect feather geometry
  + Effects resolved within 2 days out of water
* Effects of oil exposure were dose-dependent changes in waterproofing and feather geometry
  + Feathers became more clumped
  + No recovery was noted in the 2-day experiment
* The oil-dispersant mixture had similar effects to oil alone

**TLDR:** Both oil and dispersant alone can significantly affect a common murre’s waterproofing

**Related Articles:**

Orla E. Osborne, Megan M.C. Willie, and Patrick D. O’Hara. 2022. The effects of oil spill dispersant use on marine birds: a review of scientific literature and identification of information gaps. *Environmental Reviews*. 31(2): 243-255

**ANTIBIOTIC RESISTANT BACTERIA IN WILDLIFE: PERSPECTIVES ON TRENDS, ACQUISITION AND DISSEMINATION, DATA GAPS, AND FUTURE DIRECTIONS**  
Andrew M. Ramey1,2 and Christina A. Ahlstrom1

Journal of Wildlife Diseases, 56(1), 2020, pp. 1–15 DOI: 10.7589/2019-04-099

**Abstract:**

The proliferation of antibiotic-resistant bacteria in the environment has potential negative economic and health consequences. Thus, previous investigations have targeted wild animals to understand the occurrence of antibiotic resistance in diverse environmental sources. In this critical review and synthesis, we summarized important concepts learned through the sampling of wildlife for antibiotic-resistant indicator bacteria. These concepts are helpful for understanding dissemination of resistance through environmental pathways and helping to guide future research efforts. Our review begins by briefly introducing antibiotic resistance as it pertains to bacteria harbored in environmental sources such as wild animals. Next, we differentiate wildlife from other animals in the context of how diverse taxa provide different information on antibiotic resistance in the environment. In the third section of our review, we identify representative research and seminal works that illustrate important associations between the occurrence of antibiotic-resistant bacteria in wildlife and anthropogenic inputs into the environment. For example, we highlight numerous investigations that support the premise that anthropogenic inputs into the environment drive the occurrence of antibiotic resistance in bacteria harbored by free-ranging wildlife. Additionally, we summarize previous research demonstrating foraging as a mechanism by which wildlife may be exposed to anthropogenic antibiotic resistance contamination in the environment. In the fourth section of our review, we summarize molecular evidence for the acquisition and dissemination of resistance among bacteria harbored by wildlife. In the fifth section, we identify what we believe to be important data gaps and potential future directions that other researchers may find useful toward the development of efficient, informative, and impactful investigations of antibiotic-resistant bacteria in wildlife. Finally, we conclude our review by highlighting the need to move from surveys that simply identify antibiotic-resistant bacteria in wildlife toward hypothesis-driven investigations that: 1) identify point sources of antibiotic resistance; 2) provide information on risk to human and animal health; 3) identify interventions that may interrupt environmentally mediated pathways of antibiotic resistance acquisition and transmission; and 4) evaluate whether management practices are leading to desirable outcomes.

*Key words:* Antibiotic, antimicrobial, determinant, resistance, resistant, wildlife

**Background:**

* Selection pressures driving antibiotic resistance have changed considerably within the last century
* Contamination of the environment with antibiotic resistance contamination and drivers of resistance such as antibiotic residues, heavy metals, and biocides has become extensive, resulting from activities such as antibiotic use, agricultural production, solid waste disposal, and wastewater management
* Antibiotic resistance in the environment is pertinent to both human and domestic animal health because the environmental resistome may contribute to the emergence and proliferation of pathogens that are difficult or impossible to treat.

**Key points:**

* Cross-sectional studies provide extensive evidence for associations between the prevalence of antibiotic-resistant bacteria in wildlife and habitat use, foraging strategy, and anthropogenic inputs into the environment
* Antibiotic-resistant bacteria are exchanged between humans and wildlife, presumably via environmental pathways, although specific transmission routes have yet to be elucidated.
* Additional inference regarding acquisition, maintenance, and spread of antibiotic-resistant bacteria harbored by wildlife can be obtained with genetic data
* Important data gaps include better assessment of the applicability of wildlife to serve as sentinels of a community-relevant environmental resistome, the utility of wildlife in source attribution studies, and the role of wildlife in the dissemination of resistance through environmentally mediated pathways
* In the absence of environmental sampling, researchers are encouraged to report results regarding the prevalence of antibiotic-resistant bacteria in wildlife in context of the overlap of habitat use with local human populations and the anthropogenic inputs into the environment

**Takeaway:**

Need to move from surveys that identify antibiotic-resistant bacteria in wildlife toward investigations that employ One Health approaches to 1) identify point sources of antibiotic resistance, 2) provide information on risk to human and animal health, 3) identify interventions that may interrupt environmentally mediated pathways of antibiotic resistance acquisition, and 3) evaluate whether management practices are leading to desirable outcomes.

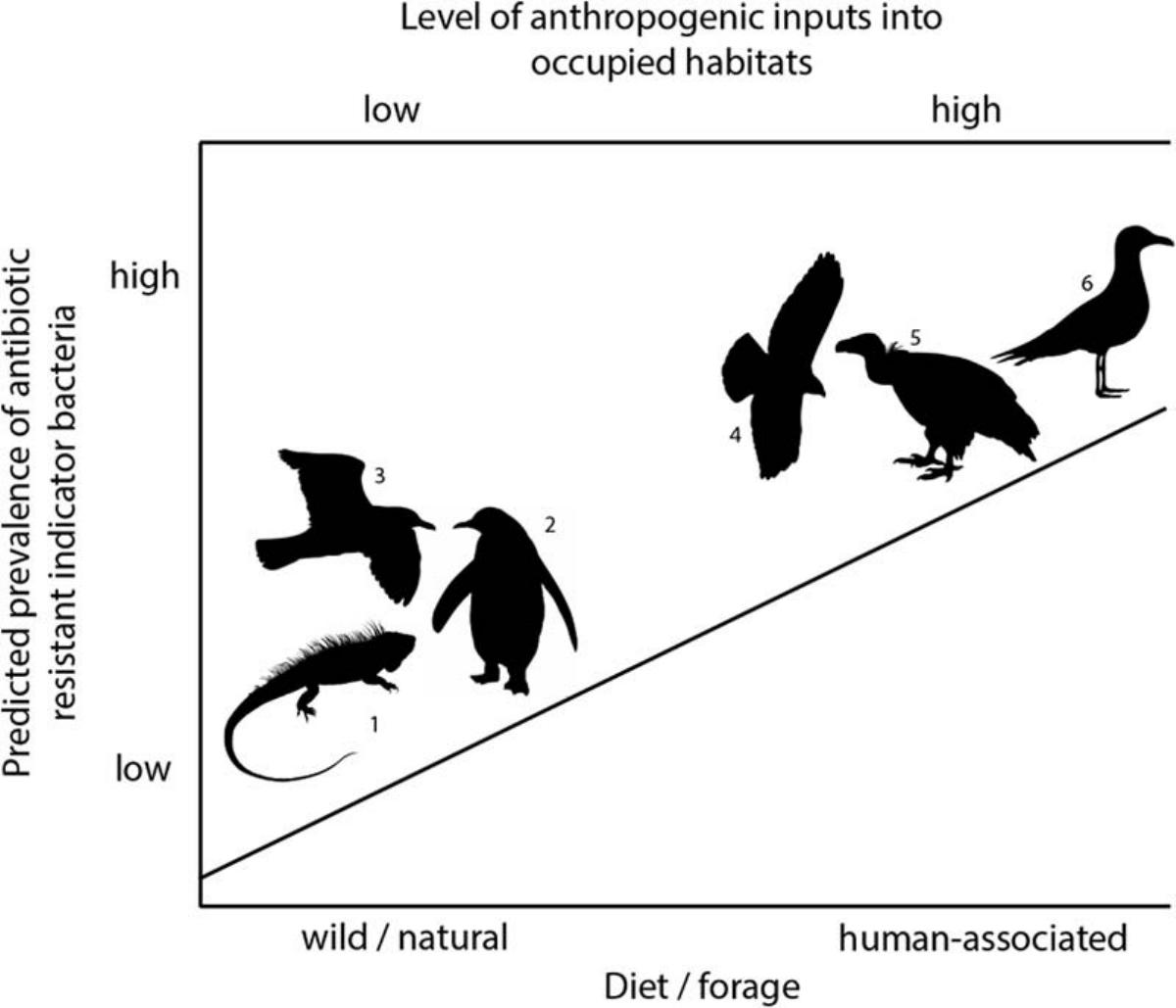


Figure 1. Generalized predicted prevalence of antibiotic-resistant indicator bacteria among wildlife relative to anthropogenic inputs into the environment and diet/foraging habits. Example taxa highlighted in this review are depicted with silhouettes: 1reptiles inhabiting remote Galapagos Islands (see Thaller et al. 2010; Wheeler et al. 2012); 2Antarctic penguins (see Bonnedahl et al. 2008; Rahman et al. 2008); 3marine-feeding gulls (see Vittecoq et al. 2017; Ramey et al. 2018); 4birds of prey, including those feeding on peridomestic animals (see Pinto et al. 2010; Radhouani et al. 2010, 2012; Molina-López et al. 2011, 2015; Guenther et al. 2012; Ahlstrom et al. 2018); 5avian scavengers of livestock carcasses (see Mora et al. 2014; Sulzner et al. 2014; Casas-Díaz et al. 2016; Blanco 2018); 6landfill-foraging gulls (see Bonnedahl et al. 2009; Hernandez et al. 2013; Bonnedahl et al. 2015; Dolejska et al. 2015; Atterby et al. 2016; Migura-Garcia et al. 2017; Ahlstrom et al. 2019a).

**EVALUATION OF THE EFFECT OF HYDRATED LIME ON THE SCAVENGING OF FERAL SWINE (SUS SCROFA) CARCASSES AND IMPLICATIONS FOR MANAGING CARCASS-BASED TRANSMISSION OF AFRICAN SWINE FEVER VIRUS**Courtney F. Bowden, James Grinolds, Gregory Franckowiak, Lorna McCallister, Joseph  
Halseth, Matthew Cleland, Travis Guerrant, Michael Bodenchuk, Robert Miknis, Michael C. Marlow, and Vienna R. Brown. Journal of Wildlife Diseases, 59(1), 2023, pp. 49–60. DOI: 10.7589/JWD-D-22-00061

**Abstract:**

African swine fever (ASF) is a devastating hemorrhagic disease marked by extensive morbidity and mortality in infected swine. The recent global movement of African swine fever virus (ASFV) in domestic and wild swine (Sus scrofa) populations has initiated preparedness and response planning activities within many ASF-free countries. Within the US, feral swine are of utmost concern because they are susceptible to infection, are wide-spread, and are known to interact with domestic swine populations. African swine fever virus is particularly hardy and can remain viable in contaminated carcasses for weeks to months; therefore, carcass-based transmission plays an important role in the epidemiology of ASF. Proper disposal of ASF-infected carcasses has been demonstrated to be paramount to curbing an ASF outbreak in wild boar in Europe; preparedness efforts in the US anticipate carcass management being an essential component of control if an introduction were to occur. Due to environmental conditions, geographic features, or limited personnel, immediately removing every carcass from the landscape may not be viable. Hydrated lime converts to calcium carbonate, forming a sterile crust that may be used to minimize pathogen amplification. Any disturbance by scavenging animals to the sterile crust would nullify the effect of the hydrated lime; therefore, this pilot project aimed to evaluate the behavior of scavenging animals relative to hydrated lime-covered feral swine carcasses on the landscape. At two of the three study sites, hydrated lime-treated carcasses were scavenged less frequently compared to the control carcasses. Additionally, the median time to scavenging was 1 d and 6 d for control versus hydrated lime-treated carcasses, respectively. While results of this study are preliminary, hydrated lime may be used to deter carcass disruption via scavenging in the event that the carcass cannot be immediately removed from the landscape.

*Key words:* African swine fever virus, carcass management, feral swine, foreign animal disease,

hydrated lime, scavenging.

**Background:**

* African swine fever (ASF) is one of the most deleterious diseases at the domestic livestock-wildlife interface with a case fatality rate of nearly 100%
  + Large, double-stranded DNA virus; genus *Asfivirus,* family *Asfarviridae*
  + Highly stable in the environment
  + Infects domestic and wild members of the Suidae family
* 2018, ASFV began to spread through central and western Europe, Asia, and the Caribbean. Prior to this outbreak, virus was limited to Africa and Eastern Europe.
* US does not have native wild boar but has populations of invasive feral swine in most states (est. > 6 million animals). Feral swine are known to interact with domestic livestock.
* Carcass-based ASFV transmission is known to be an important source for new infections; removing infected carcasses is an important means of control
* Hydrated lime (calcium hydroxide) creates a sterile “crust” on the surface of carcasses; when exposed to air it absorbs carbon dioxide and releases water, hardening to form a crust of calcium carbonate
  + Lime has been applied to human remains, animal carcasses, and abattoir waste to reduce pathogen load and dispersal.

**Key points:**

* Study design: 3 study sites (Louisiana, Missouri, Texas), 5 paired hydrated lime-treated carcasses and control carcasses at each site, trail cameras used to monitor carcass scavenging for 10 days
* No difference in frequency in which paired carcasses were scavenged in Louisiana; however, control carcasses were scavenged at a higher frequency than hydrated lime-treated carcasses in Missouri and Texas (P < 0.05)
* No difference in survival probabilities between two treatments; however, the median survival time for control carcasses was 1d compared to 6d for hydrated lime-treated carcasses (P = 0.06)
* Feral swine were not observed making direct contact with carcasses, but they were observed at all three study sites; this could result in spread of ASFV through contaminated environment if disease were introduced into the US
* Scavenging could help to reduce pathogen burden by contributing to carcass breakdown; if feral swine carcasses were left on the landscape indefinitely, the use of hydrated lime may negate the benefits of scavenging
* Use of hydrated lime may prevent translocation of ASFV-contaminated carcass materials by scavengers in the interim between carcass detection and carcass removal

**Takeaway:**

Applying hydrated lime (calcium hydroxide) to feral swine carcasses may reduce scavenging behavior and delay onset of scavenging, which may prevent spread of ASFV by scavengers in the interim between carcass detection and carcass removal.

**Blood Lead and Zinc Levels and Their Impact on Health of Free-living Small Carnivores in Taiwan, Republic of China.** Liu C-C, Chi C-H, Yen S-C, Liu J-N, Ju Y-T, Kang C-L, Chang C-H, Yu P-H. Journal of Wildlife Diseases. 2020. 56(1): 157-166.

Abstract: Lead and zinc are recognized as the most widespread trace metals in nature and can, at high levels, compromise the health of wildlife and their habitat. Because of their position in a higher trophic level, wild carnivores can be valuable biological indicator species of trace-metal contamination in the environment. We assessed blood lead and zinc concentrations of four small carnivore species native to Taiwan, the small Indian civet (*Viverricula indica*), the masked palm civet (*Paguma larvata*), the ferret badger (*Melogale moschata*), and the crab-eating mongoose (*Herpestes urva*), from urban and rural areas (Yangmingshan National Park, Xiuguluan River bank, and Da-an River bank). Blood samples were acquired from the anterior vena cava under general anesthesia, and lead and zinc concentrations, hematology, and serum biochemistry results were then obtained. Blood lead levels were significantly higher in ferret badgers in the Yangmingshan area. Although lead concentrations were comparable with those in humans and cats with lead toxicosis, there was no hematological or biochemical evidence that animal health was compromised. Blood zinc levels were within an acceptable range in all four species tested. Overall, we found significant differences in blood lead and zinc levels among four species of carnivores living in areas with different levels of land development in Taiwan. Anthropogenic pollution, mining history, and volcanic activities in Yangmingshan National Park may contribute to significantly high blood lead levels in ferret badgers in this area. Our results provided information about the potential impact of land development on wildlife and may be beneficial to wildlife conservation, public health, and environmental health in Taiwan.

Background

* Free-living wild animals are common model organisms to investigate trace-metal pollution and consequences to the wider ecosystem. Predators typically experience greater biomagnification of pollutants like trace-metals as they are at the highest trophic level.
* Small Indian Civet, Masked Palm Civet, Ferret Badger, and Crab-eating Mongoose are all native Taiwanese carnivores occupying different niches as well as different habitats representing different levels of human activity.

Goal of Study

* Compare blood zinc and lead concentrations in animals from the same habitat but different ecological niches, and animals from different habitats that represent different levels/types of human activity.
* Examine impact of trace-metal exposure on hematology and biochemistry in these same wild animals

KEY POINTS

* Ferret badgers from the Yangmingshan National Park (YNP; most human activity) region had significantly higher blood lead but lower blood zinc levels than those from Da-an River Bank (DRB; industrial region) and Xiuguluan River Bank (XRB; most remote).
* Crab-eating mongoose from the XRB had significantly higher blood lead and zinc levels than those from DRB.
* No significant differences in location noted for either of the Civet species.
* In the YNP, ferret badgers had significantly higher blood lead levels and lower blood zinc levels than masked palm civets and small Indian civets.
* Food and water are two important sources of trace-metal exposure in wildlife
* Ferret badgers consume significant amounts of earthworms. Earthworms concentrate heave metals due to diet consumption in soil. Alternatively, Civets eat fruit-eating birds and rodents – there is little heavy metals in the herbivorous diets of these prey species. This may explain the differences in lead and zinc levels.
* Clin Path Features of Lead Poisoning – microcytic/hypochromic anemia, presence of nRBC’s, basophilic stippling, and elevated liver enzymes. **NOTE: In Ferret Badgers, only elevated hemoglobin values seen at lead levels that would cause the above clin path features in a dog.**
* Zinc levels in all animals were far below range that would be considered toxic in dogs.

**Care of Oiled Wildlife.** Tseng F, Ziccardi M. From, “Medical Management of Wildlife Species: A Guide for Practitioners.” 2019. Chapter 6. pp 75-84.

Background

* **Petroleum**
  + Crude oil or refined product incidentally in the environment. Toxic components (ex: polcyclic aromatic hydrocarbons, or PAH’s) lead to oiling of wildlife and external + internal impacts
  + Exposure routes: Inhalation, consumption, or directly coating/contact
* **Birds**
  + Seabirds, waterfowl, shorebirds largely affected by oil spills.
  + Obligate aquatic birds have poorer survival rates during rehabilitation than those with semiterrestrial lifestyle.
  + Birds that nest, roost, or feed in groups, particularly if a generalized diet, are more likely to survive rehabilitation (less stressed in captivity).
  + External Effects
    - Oiled feathers lose waterproofing + insulating properties = loss of buoyancy + subsequent hypothermia = can’t engage with environment normally + increased BMR due to heat loss = loss of body fat, then muscle wasting = death.
    - Volatile fuels can cause skin + corneal burns.
  + Internal Effects
    - Ingestion: Irritation + erosion of GI mucosa, liver toxicity and reduced function of the liver or hemochromatosis and liver impairment, oxidative damage and hemolytic anemia, impaired renal function + dehydration -> elevated UA + visceral gout, reproductive failure
    - Inhalation: Lesions in upper or lower resp tract
* **Marine Mammals**
  + Furred Mammals (Otters, polar bears, fur seals) – disrupted fur, inability to maintain normal temperature and buoyancy = hypothermia and excessive grooming leading to ingestion of oil material and similar internal effects as seen in birds
  + Thick Blubber Layer Mammals (Manatees, cetaceans, true seals) – Less vulnerable to external effects of oiling. Ingestion can occur most likely via feeding behavior. Inhalation of volatile fumes injures resp tract, particularly in deep-diving mammals because they have explosive inhalation at air-water interface.
* **Other Mammals**
  + Scavengers on shorelines typically (beaver, river otter, muskrat), less is known about impacts of oil exposure.
  + Mink studied as model for oil-exposed sea otters. Mink receiving low level bunker C fuel oil incurred adrenal hypertrophy, reduced reproductive success, and decreased RBC’s with elevated total WBC counts.
* **Reptiles & Amphibians**
  + Sea Turtles particularly sensitive – experience increased egg mortality, developmental defects, and direct mortality – impacts skin, GI, resp tracts, immune system, and salt glands
  + Less known about amphibians. Tadpoles exposed to oil unable to metamorphose.
* Rehabilitation (large oiling event with large numbers of animals)
  + Recommend: Stabilize immediately at field site (birds) or at primary care facility (mammals). Specifically, assess temperature first and either heat or cool the individual right away. Birds are often gavage fed oral electrolytes immediately.
  + After full PE and potentially bloodwork, categorize into humane euthanasia, extensive care, and minor impact/co-housed groups.
  + Need good ventilation (10-15 air exchanges/hour) to reduce petroleum fumes, and reduce risk of resp disease in immunosuppressed animals (most animals oiled are immunosuppressed).
  + Appropriate housing needed – aquatic birds like loons, grebes, alcids, and sea ducks need “net bottomed” caging (for anatomy and to allow feces/urates to drop through).
  + Typically dehydrated + malnourished so start with gavage feeding (crystalloids + critical care) and can transition slowly to whole food/normal diet.
* Medical Considerations
  + All animals that die or are euthanized should undergo necropsy with full documentation, and sampling for histopathology and petroleum hydrocarbon analysis.
  + **Wash animals AFTER stabilizing them, particularly in birds (**unless quick wash needed for volatile compounds, 5 mins or less and completely dry them afterwards), (some mammals, sea turtles may be able to tolerate full washing immediately). It will likely take numerous baths to fully clean oiled wildlife and can be too stressful for unstable animals.
  + Dolphins following Deepwater Horizon spill had increased incidence of moderate to severe lung disease, adrenal hormone imbalances, and decreased survival.
  + Can consider prophylactic antibiotics and antifungal medications and should have access to oxygen cages/supplementation. Fungal resp disease often seen in oil spill response.
  + Avoid petroleum-based ointments in birds with skin burns to reduce further disruption of waterproofing.
  + Can use bismuth subsalicylate to manage vomiting/diarrhea or charcoal/kaolin slurry to adsorb petroleum (unclear efficacy).
  + Oiled birds – recheck PCV/TS q2-3 days to assess general recovery. Mammals + Sea turtles – recheck full CBC/Chem. This information can be used to decide on readiness for full bathing or moving to next stage in rehab process.
* Wash/Rinse/Drying Procedures
  + **Birds stabilized for ~48 hours prior to wash: need to have alert mentation and normalization of blood parameters.**
  + When washing, move through multiple tubs with birds – as one tub becomes oily, then move to the next until water no longer becomes oily during cleaning.
  + Use toothbrush to clean head and around eyes.
  + Water should be 2-5 grains hardness, if softer will not rinse detergent well enough, if harder will form calcium carbonate crystals in feathers/fur and further reduce waterproofing.

KEY POINTS

* Stabilize animals prior to de-oiling/washing them unless it is a volatile compound, particularly on the cornea or skin.

Oiled wildlife often experience hypothermia, dehydration, and malnutrition. These issues need to be managed to achieve successful rehabilitation