**EVALUATION OF BONE MINERALIZATION BY COMPUTED TOMOGRAPHY IN WILD AND CAPTIVE EUROPEAN COMMON SPADEFOOTS (*PELOBATES FUSCUS*), IN RELATION TO EXPOSURE TO ULTRAVIOLET B RADIATION AND DIETARY SUPPLEMENTS**

**van Zijll Langhout** M, Struijk RPJH, Könning T, van Zuilen D, Horvath K, van Bolhuis H, Maarschalkerweerd R, Verstappen F.

J Zoo Wildl Med. **2017** Sep;48(3):748-756.

**Taxa:** Amphibia → Anura → Mesobatrachia (suborder) → Pelobatidae

**Topic:** Radiology, Nutrition

**Comments:** Prospective study comparing captive to wild settings.

**Abstract*:*** Captive rearing programs have been initiated to save the European common spadefoot (Pelobates fuscus), a toad species in the family of Pelobatidae, from extinction in The Netherlands. Evaluating whether this species needs ultraviolet B (UVB) radiation and/or dietary supplementation for healthy bone development is crucial for its captive management and related conservation efforts. The bone mineralization in the femurs and the thickest part of the parietal bone of the skulls of European common spadefoots (n = 51) was measured in Hounsfield units (HUs) by computed tomography. One group, containing adults (n = 8) and juveniles (n = 13), was reared at ARTIS Amsterdam Royal Zoo without UVB exposure. During their terrestrial lifetime, these specimens received a vitamin-mineral supplement. Another group, containing adults (n = 8) and juveniles (n = 10), was reared and kept in an outdoor breeding facility in Münster, Germany, with permanent access to natural UVB light, without vitamin-mineral supplementation. The HUs in the ARTIS and Münster specimens were compared with those in wild specimens (n = 12). No significant difference was found between the HUs in the femurs of both ARTIS and Münster adults and wild adults (P = 0.537; P = 0.181). The HUs in the skulls of both captive-adult groups were significantly higher than in the skulls of wild specimens (P = 0.020; P = 0.005). The HUs in the femurs of the adult ARTIS animals were significantly higher than the HUs in the femurs of the adult Münster animals (P = 0.007). The absence of UVB radiation did not seem to have a negative effect on the bone development in the terrestrial stage. This suggests that this nocturnal, subterrestrial amphibian was able to extract sufficient vitamin D3 from its diet and did not rely heavily on photobiosynthesis through UVB exposure.

* Calcium metabolism requires correct volume and bioavailability
  + Uptake from GI requires vitamin D3 and its derivatives
  + Many species synthesize vitamin D3 in skin after UVB radiation
  + Vitamin D3 is transported to liver and hydroxylated to calcidiol (25-hydroxycholecalciferol)
  + Transported to kidneys and hydroxylated to calcitriol (1,25-dihydroxycholecalciferol)
  + Calcitriol is active, hormonal form and is responsible for maintaining Ca homeostasis (uptake from GI and release from kidneys into blood
* In amphibians, Ca is actively transported across the skin, and water can be an important source
  + Store calcium carbonate in paravertebral lime sacs to be mobilized during periods of high demand
* Nutritional metabolic bone disease (NMBD) is caused by lack of vitamin D3, Ca, and/or P
  + Hypervitaminosis A may be a contributing factor.
  + Clinical signs: mandibular deformity, abnormal posture, scoliosis, reluctance to move, long bone fractures, tetany, SC edema, and gastric, rectal, or cloacal prolapse
  + Radiographic abnormalities: abnormally shaped, radiolucent mandibles; thin cortices of the long bones,; overall loss of bone mineralization; pathologic fractures
* European common spadefoot (ECS) is in decline and reintroduction programs are in place
  + Adults are nocturnal and spend most of the time underground
  + Larva and metamorphs bask during aquatic phase
* Whole body CT scans of 5 groups of ECS and Hounsfield units measured on femoral diaphysis and caudal parietal bone
  + Juveniles with no UVB and dietary supplementation
  + Adults with no UVB and dietary supplementation
  + Juveniles with natural UVB and no dietary supplementation
  + Adults with natural UVB and no dietary supplementation
  + Wild adults collected within 2 days of death
* Skulls of captive adults higher HUs than wild
* Adults with dietary supplementation and no UVB had higher HUs than adults with UVB and no dietary supplementation
* Juveniles with UVB and no dietary supplementation were higher HUs than those with no UVB and dietary supplementation
* ECS extract sufficient vitamin D3 from its diet and does not rely heavily on UVB photobiosynthesis
  + Similar to findings in other nocturnal frogs (great barred frogs and red-eyed tree frogs)
* ECS larvae and juveniles appear more dependent on access to UVB radiation for the synthesis of vitamin D
* Dietary Ca:P for most species is 2:1 to 1:1
  + Dusting crickets can increase Ca:P for up to 5.5 hours after dusting
  + Gut loading crickets can also improve Ca:P ratio

**Conclusion:** CT is a practical tool for assessing bone mineralization in European common toads, and European common toad adults are not dependent on UVB for vitamin D3 and juveniles are more dependent on access to UVB radiation.

**GEOGRAPHIC AND INDIVIDUAL DETERMINANTS OF IMPORTANT AMPHIBIAN PATHOGENS IN HELLBENDERS (CRYPTOBRANCHUS ALLEGANIENSIS) IN TENNESSEE AND ARKANSAS, USA.**

Hardman RH, Sutton WB, Irwin KJ, McGinnity D, Reinsch SD, Freake M, Colclough P, Miller BT, Da Silva Neto JG, Souza M, Fitzpatrick B.

Journal of Wildlife Diseases. 2020 Oct;56(4):803-14.

**Abstract:** Wildlife diseases are a major threat for species conservation and there is a growing need to implement disease surveillance programs to protect species of concern. Globally, amphibian populations have suffered considerable losses from disease, particularly from chytrid fungi (Batrachochytrium dendrobatidis [Bd] and Batrachochytrium salamandrivorans [Bsal]) and ranavirus. Hellbenders (Cryptobranchus alleganiensis) are large riverine salamanders historically found throughout several watersheds of the eastern and midwestern US. Populations of both subspecies (Ozark hellbender, Cryptobranchus alleganiensis bishopi; eastern hellbender, Cryptobranchus alleganiensis alleganiensis) have experienced precipitous declines over at least the past five decades, and emerging pathogens are hypothesized to play a role. We surveyed Ozark hellbender populations in Arkansas (AR) and eastern hellbender populations in Middle Tennessee (MTN) and East Tennessee (ETN) for both chytrid fungi and ranavirus from swabs and tail tissue, respectively, from 2011 to 2017. Overall, we detected Bd on hellbenders from nine out of 15 rivers, with total prevalence of 26.7% (54/ 202) that varied regionally (AR: 33%, 28/86; MTN: 11%, 4/36; ETN: 28%, 22/80). Ranavirus prevalence (9.0%, 18/200) was comparatively lower than Bd, with less regional variation in prevalence (AR: 6%, 5/ 85; MTN: 11%, 4/36; ETN: 10%, 8/79). We did not detect Bsal in any hellbender populations. We detected a significant negative correlation between body condition score and probability of ranavirus infection (β=–0.13, SE=0.06, 95% confidence interval: –0.24, –0.02). Evaluation of infection load of positive individuals revealed different trends than prevalence alone for both ranavirus and Bd, with MTN having a significantly greater average ranaviral load than both other regions. We documented a variety of lesions that likely have multiple etiologies on hellbenders located within all geographic regions. Our data represent a multiyear pathogen dataset across several regions of C. alleganiensis, and we emphasize the need for continued pathogen surveillance.

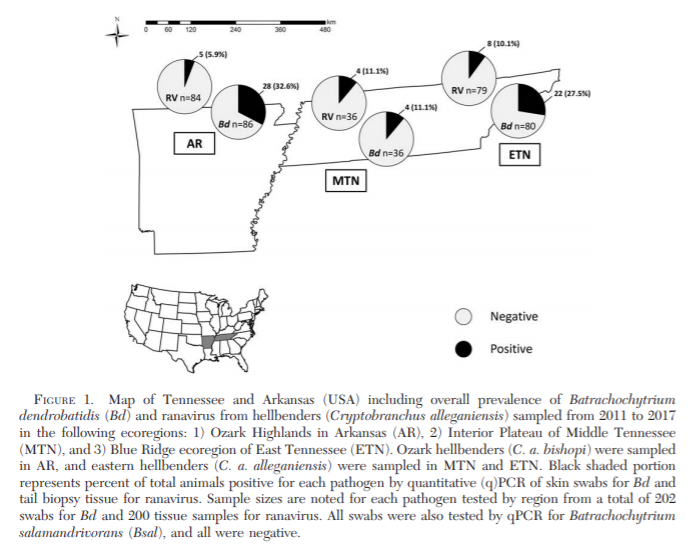
**Background:**

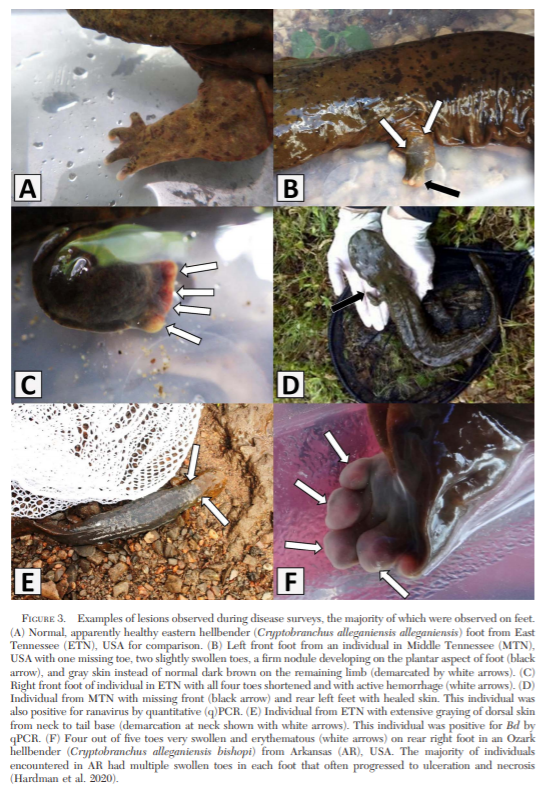
* *Batrachochytrium dendrobatidis* is associated with amphibian mass mortality and extinctions
* *Batrachochytrium salamandrivorans* is highly lethal to salamanders
* Hellbender = fully aquatic salamander with declining populations
  + Reported Bd mortalities in captive individuals (50% mortality in a head start program)
* Ranavirus causes vascular and epithelial damage
  + Chinese giant salamander with ranavirus often have swollen digits and necrosis

**Key Points:**

* Bd and ranavirus were found in all regions (Bd > ranavirus)
  + No Bsal
* No correlation with lesions and Bd zoospore load
* Some recaptured individuals had cleared Bd
* Toe lesions were seen in many hellbenders, including some associated with a spike in ranavirus prevalence
* Ranavirus correlated with lower BCS
* Highest ranavirus load in middle TN

**Conclusions:** Bd and ranavirus are found in hellbender habitats. Wild hellbenders commonly have toe lesions.





Watters, Jessa L., et al. "Seasonality in Batrachochytrium dendrobatidis detection in amphibians in central Oklahoma, USA." *Journal of Zoo and Wildlife Medicine* 50.2 (2019): 492-497.

Abstract: Chytridiomycosis, an infectious disease caused by the fungus Batrachochytrium dendrobatidis (chytrid or Bd), has not been well studied in Oklahoma. This is of particular concern regarding the connection between seasonality and chytrid infection. To further investigate this connection, chytrid prevalence and infection load were **quantified within amphibians in central Oklahoma from March to October**, across two sites in Oklahoma Co. and two sites in Cleveland Co. The results show a trend between seasonality and chytrid, **with spring and fall showing higher prevalence** and **summer showing lower prevalence, which coincides closely with the preferred chytrid growth temperatures**. Additionally, periods of high rainfall in May 2015 are linked to increased chytrid prevalence, as has been suggested by other research. Additionally, species exhibiting high chytrid prevalence follow the results of previous studies: Blanchard’s cricket frog (Acris blanchardi), American bullfrog (Rana catesbeiana), and southern leopard frog (Rana sphenocephala).

**Introduction:**

-   *Bd* may do well at cooler T˚, maximal growth 17-20˚C, dies at T˚> 26-30˚

o   Amphibian immune system weakened at cooler temperaturesl

**M+M:** Sampled different amphibian species (qPCR, skin swabs) at 2 sites in Cleveland and Oklahoma counties (n=246) during different seasons

**Results/Discussion:**

-   No amphibians had visible signs of Bd

-   Overall 42% prevalence

-   Prevalence was highest in the **fall**, followed by spring.

o   In all species

o   Across sampling sites

o   Coincided w/ temps at which *Bd* exhibits maximum growth

-   Highest prevalence in species *A. blanchardi*

**Take-home:**

-   Strong **pattern of seasonality** associated with presence and prevalence of *Bd****.* Increased during cooler months, decreased during warmer months**

Rumschlag, S. L., & Boone, M. D. (2020). Lethal and sublethal amphibian host responses to batrachochytrium dendrobatidis exposure are determined by the additive influence of host resource availability. *The Journal of Wildlife Diseases*, *56*(2), 338-349.

Abstract: Host species may differ in their responses to pathogen exposures based on host energy reserves, which could be important for long-term trends in host population growth. Batrachochytrium dendrobatidis (BD) is a pathogen associated with amphibian population declines but also occurs without causing mass mortalities. The impact of BD in populations without associated declines is not well understood, and food abundance could play a role in determining the magnitude of its effects. We exposed American toad (Anaxyrus americanus), northern leopard frog (Lithobates pipiens), and cricket frog (Acris blanchardi) metamorphs to BD under low or high food treatments. Overall, anuran species responded differently to BD exposure and the combined effect of BD exposure and food abundance was additive. American toad survival was lowered by BD exposure and low food availability. Based on these results, we developed a population model for American toads to estimate how reductions in survival could influence population growth. We found that BD could reduce population growth by 14% with high food availability and 21% with low food availability. In contrast, survival of northern leopard frogs was high across all treatments, but their growth was negatively impacted by the additive effects of BD exposure and low food availability. Cricket frog growth and survival were unaffected by BD exposure, suggesting that this species is not sensitive to the effects of this pathogen in terms of growth and survival across environments of different quality in the time period examined. Our results showed that low food availability additively increased the species-specific lethal and sublethal impacts of BD on hosts, which could have implications for long-term host population dynamics.

**Introduction:**

* Impacts of pathogens in the absence of mass mortality is understudied in dz ecology.
* Food availability could be important predictor of effects of pathogen exposures on host growth and survival in amphibians.
  + Mounting immune response is energetically costly. Especially during metamorphosis.
  + Slow growth rates due to restricted resources are assoc with later times to reproduction, decreased fecundity, decreased survival.
  + High resource availability may result in tolerance or resistance to pathogens.
  + Physiological stress of pathogen exposure under conditions of low resource availability could magnify the risk of slow growth rates and low survival.

**M+M:** Determine influence of host resource availability and BD exposure on growth and survival of three temperate amphibian hosts (Am toad, N leopard frog/NLF, Blanchard’s cricket frog/CF). Collected egg masses, hatched tadpoles. Assigned to mesocosms, manipulated exposure to BD (presence or absence) and food abundance (low or high). Euthanized 10 anurans of each spp that had been exposed to BD (5 high food, 5 low food) and send swabs for PCR testing.

**Results/Discussion:**

* PCR results – High BD infection prevalence 2 wk post exposure.
  + Am toads – 100% in high and low fed groups.
  + N LF – 60% high food, 80% low food.
  + CF – 100% high food, 75% low food.
* All Am toads that died during the experiment had active BD infections. Most died within 24 days. Group with less food died sooner.
* Only 1 BD exposed CF died.
* No NLF died.
* Survival of NLF and CF was high and not influenced by treatment groups/food abundance.
* High food abundance significantly increased the growth of all groups. NLF - Slowest growth rates with BD exposure and low food abundance.
* Food availability can influence the impact of BD exposure on host growth and survival through additive effects, these effects vary across species.

**Takeaways:**

* American toads and NLF exposed to BD and low food had the lowest survival or growth outcomes.
* Effects of BD exposure and low food on survival could have neg consequences for population growth rates of Am toads.
* Cricket frog growth and survival was unaffected. Population trajectories may still be affected by BD in natural populations.

Causes of mortality in captive Panamanian golden frogs (*Atelopus zeteki*) at the Maryland zoo in Baltimore, 2001–2013.

Eustace, R., Wack, A., Mangus, L. and Bronson, E.

*Journal of Zoo and Wildlife Medicine*, 2018;49(2):324-334.

Abstract: The Maryland Zoo in Baltimore is home to the largest captive assurance population of the critically endangered Panamanian golden frog (Atelopus zeteki). With the ongoing extinction that is occurring worldwide in amphibians, the need for amphibian captive assurance populations is growing, and few mortality reviews on amphibian species exist. Necropsy and histopathologic examination of animals that die in captivity can help identify population-level disease problems, direct research needs in amphibian medicine and husbandry, and improve the success of captive breeding programs. **This study reviews postmortem findings from 406 frogs, greater than 1 yr of age, which died in this population from 2001 to 2013**. Frogs were categorized by age and sex, and the cause of mortality was determined. **Dermatitis associated with filamentous-type fungal organisms was the most common cause of mortality in both age and sex categories** **and accounted for one-third of frog deaths in this study** (36.0%; n ¼ 146 out of 406 frogs). Other major causes of mortality included renal disease, gastrointestinal disease, septicemia, and a previously undescribed myopathy condition associated with a tetany syndrome. Increased mortality of frogs occurred during the breeding season, highlighting the need for further research into methods to minimize mortality during this time

**Background**

* Panamanian golden frog: critically endangered
  + mass extinction crisis with *Batrachochytrium dendrobatidis* (*Bd*) major driver
  + Sexual maturity 3 yr old
  + Oogenesis in August, amplexus by males in Oct, majority of eggs laid Nov-May

**Key Points**

* Mean age at time of death 4 yr (1-11.7); young frogs > middle-aged > older; females > males
* Avg yearly mortality 8% (0.5-26.2%)
  + Majority occurred during repro season Nov-May (highest Dec-Feb)
* Dermatitis: most common cause of disease
  + Hyperkeratosis, ulcers, acanthosis, necrosis
  + Most frequently associated with saprophytic filamentous fungi (subclass Zygomycetes) or fungal-like water molds Oomycota (*Saprolegnia* spp.)
  + No evidence of *Bd*
  + 1/3 bacterial and fungal mixed; rarely bacterial alone
* Renal lesions common, less common cause of death
  + Hydrocoelom and/or lymphedema
  + Degenerative tubular changes, interstitial nephritis (lymphoplasmacytic), tubular proteinosis, glomerulonephropathy, often multiple concurrent lesions
  + Rarely infectious agents associated
  + Subacute > chronic
  + Polycystic nephropathy in young frogs from the same clutch with renal MBD
* GI disease
  + Mycotic enteritis > parasitism, nonspecific enteritis, SI obstruction, pancreatitis, perforated gastric ulcer, esophagitis
  + Parasites were common but not as cause of death: nematodes (rhabditoid or oxyurid), commensal protozoa (ciliates, opalinids, flagellates)
  + Lung nematodes infrequent (genus *Rhabdias*)
  + Gastroliths - no associated clinical signs
* Sepsis: gram-negative bacteria in 1+ organs
  + Dermatitis common comorbidity, often no gross findings
  + Males > females
* “Tetany syndrome” - middle-aged females during repro season
  + Rhabdomyolysis, majority acute or subacute
  + Species specific in PFGs, hind limbs rigid and fixed in extension or held dorsally over the back, lack righting reflex
  + Often with poor nutritional condition, stressed metabolic state, or suboptimal environmental conditions
  + Early aggressive treatment with supplemental dextrose/feedings, calcium gluconate, MgCl, and Vit B complex
* Less common causes of death: poor nutritional condition (often comorbidity), respiratory disease (young frogs - bacterial pneumonia), trauma, liver disease, mycobacteriosis
* No cases of ranavirus, testing in a subset was negative
* Many multifactorial (dermatitis + renal disease/resp/GI)

**Conclusions**

* Mycotic dermatitis most common cause of mortality in Panamanian golden frogs of all ages and sexes
  + Often renal lesions as comorbid finding (all ages, rarely infectious)
* Lymphedema or hydrocoelom common gross finding (with skin or renal disease)
* Reproductive sease was a period of increased mortality
* No *Bd* or ranavirus found in this captive population
  + Often affects tadpoles and metamorph frogs (younger than this study pop) - possibly underreported
* Nematodes were common but rarely caused disease

Mycobacteriosis in a zoo population of Chinese gliding frogs (*Rhacophorus dennysi*) due to *Mycobacterium marinum*.

Milnes, E.L., Delnatte, P., Lentini, A., May, K., Ma, J., Jamieson, F.B., Slavic, D. and Smith, D.A.

*Journal of Herpetological Medicine and Surgery*, 2020;30(1):14-20.

**Abstract:**

Mycobacteriosis was implicated in the deaths of eight Chinese gliding frogs (Rhacophorus dennysi) in a zoo population over a 3 yr period. Clinical signs included nonhealing skin lesions, cloacal prolapse, hind limb weakness, weight loss, and sudden death**.** Abnormalities on postmortem were proliferative or ulcerative skin lesions in four of eight, pneumonia in three of eight, and gall bladder empyema in two of eight cases. All eight clinical cases had multisystemic granulomas containing acid-fast bacilli. Tissues most commonly affected were lung (seven of eight), liver (six of eight), kidney (six of eight), spleen (five of eight), and heart (five of eight). The remaining eight clinically normal frogs in the population were euthanized: eight of eight had granulomatous lesions, with acid-fast bacilli in three of eight cases. A mycobacterial species was cultured from four of the clinical cases by the Public Health Ontario Laboratory and was initially misidentified as Mycobacterium tuberculosis complex by a commercial lineprobe assay (GenoType Mycobacterium CM, Hain Lifesciences, Nehren, Germany). Further diagnostic testing using 16S rRNA gene sequencing ultimately identified the mycobacterial species as Mycobacterium marinum. The correct identification of mycobacterial species is essential in epidemiological investigations at zoological facilities, and in assessing health risks to staff and to other animals in the zoo population.

**Background**

* Mycobacteriosis in captive amphibians: most commonly *M marinum, M fortuitum, M ulcerans, M xenopi* (Nontuberculous mycobacteria), likely endemic in many zoo exhibits
  + *M marinum* environmental opportunist (not an obligate pathogen), ubiquitous in aquatic environments
    - Potential zoonotic risks in immunocompromised or with pre-existing skin lesions
  + *M tuberculosis* complex group - never been isolated from an amphibian host
  + Ulcerative-to granulomatous dermatitis commonly reported
  + Gold standard: granulomatous lesions and/or acid-fast bacteria on histo + identification of mycobacterial species by molecular techniques
    - Antemortem diagnosis by endoscopy and biopsy or rads, touch impressions showing acid-fast bacteria in the cytoplasm of phagocytic cells

**Key Points**

* 8 clinical cases of mycobacteriosis over a 3 yr period in a founder population and offspring
  + Antemortem: proliferative skin lesions or cutaneous ulcers, chronic weight loss, hind limb weakness, cloacal prolapse, and found dead
  + Necropsy: skin lesions, granulomatous pneumonia, gallbladder empyema, acid-fast bacteria on Ziehl-Neelsen in all cases
* 8 clinically normal frogs euthanized
  + All had granulomatous lesions consistent with mycobacteriosis
  + 3/8 had acid fast bacteria on histo
* Isolates incorrectly identified as *M tuberculosis* complex group on GenoType *Mycobacterium* CM commercial line-probe assay
  + Sequencing of 16S rRNA gene confirmed *M marinum* had cross-reacted with the GenoType *M* CM line-probe assay (false positive for *M tuberculosis* complex group)

**Conclusions**

* Mycobacteriosis is a differential diagnosis for sick amphibians
  + *M marinum* was cause of death in a captive population of Chinese gliding frogs
* Cross reaction of *M marinum* with line-probe assay for *M tuberculosis* complex group
  + Follow-up with sequencing

**Infestation by Chiggers (Hannemania sp.) of Miranda's White-lipped Frog (Leptodactylus macrosternum) from a Semiarid, Neotropic Region of Brazil**

JWD 2018 54(2) 397–399

**Abstract:**

We identified Miranda’s white-lipped frog (Leptodactylus macrosternum) as a new host for chiggers (Hannemania sp.). A total of 57 larvae of Hannemania sp. were found on 31 frogs examined from a semiarid region of northeastern Brazil.

**Summary:**

* Intro
  + Mites and chiggers
    - promote injuries and skin deformations in hosts
    - high infestation levels -negative impact on host fitness, decreasing immune resistance due to stress, death
    - common frog mites and chiggers - Amblyomma spp., Ornithodoros spp. Hannemania spp.
  + genus Hannemania
    - larvae of chigger are intradermal parasites - only larval stages are parasitic
    - found parasitizing amphibians throughout Americas
    - non-larval stages - free living, commonly found in leaf litter
    - pustules associated with parasite = characteristic of genus Hannemania, due to host reaction to ectoparasites
  + objective - describe infestation by larvae of chigger Hannemania sp. infecting Miranda’s white-lipped frogs, analyze parasitologic parameters (prevalence and intensity of infection) and relationship between SVL and parasite intensity
* M+M – 31 Miranda’s white-lipped frogs collected from Brazil, euthanized, SVL measured, parasites collected
* Results/discussion:
  + 42% prevalence overall
  + males had higher prevalence than females
  + no relationship between SVL and intensity of infection
  + males – ectoparasites only in ventral legs
  + females – parasites on both dorsal and ventral legs

**POSTMORTEM FINDINGS IN EIGHT SPECIES OF CAPTIVE CAECILIAN (AMPHIBIA: GYMNOPHIONA) OVER A TEN-YEAR PERIOD**

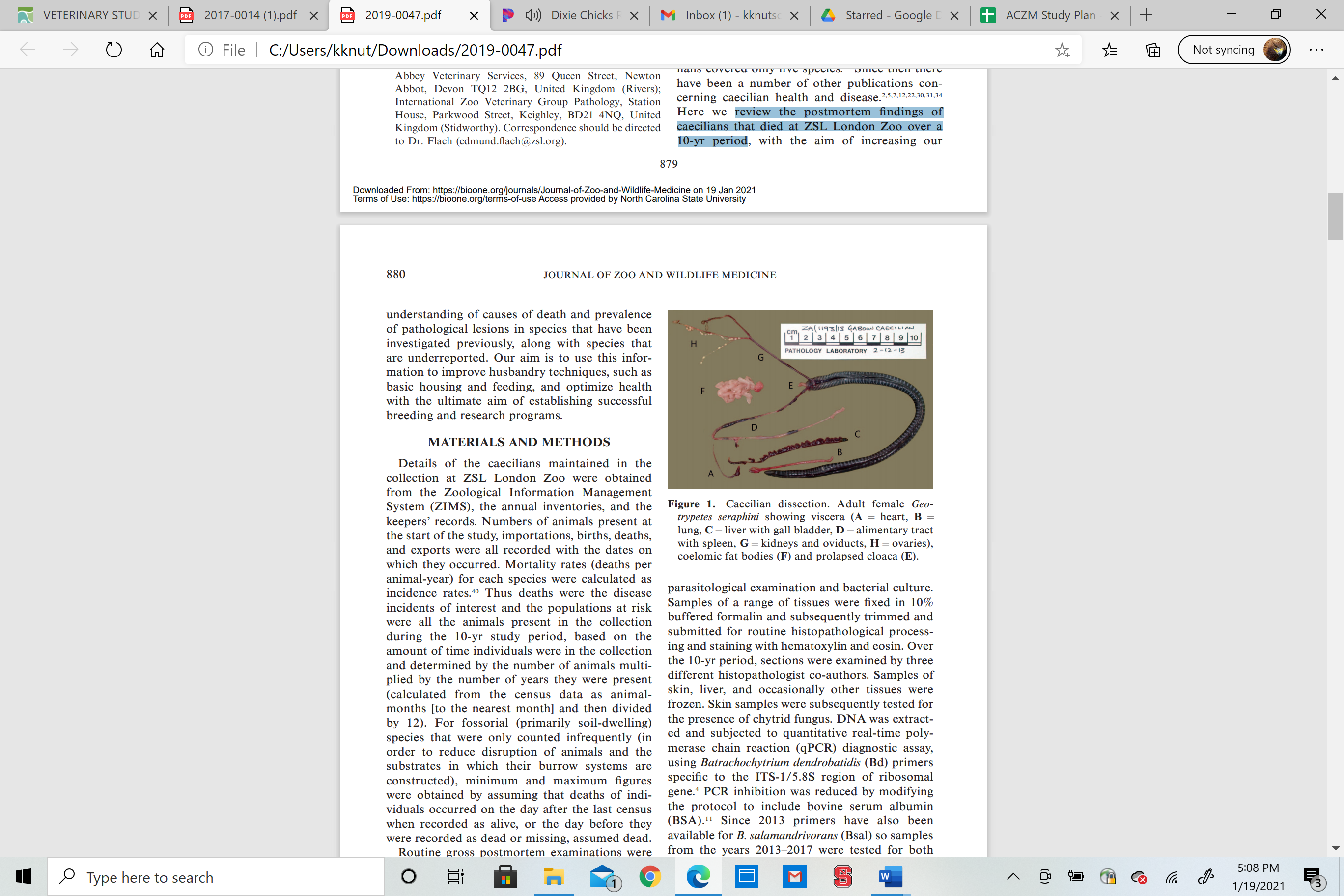
JZWM 2020 50(4) 879-890

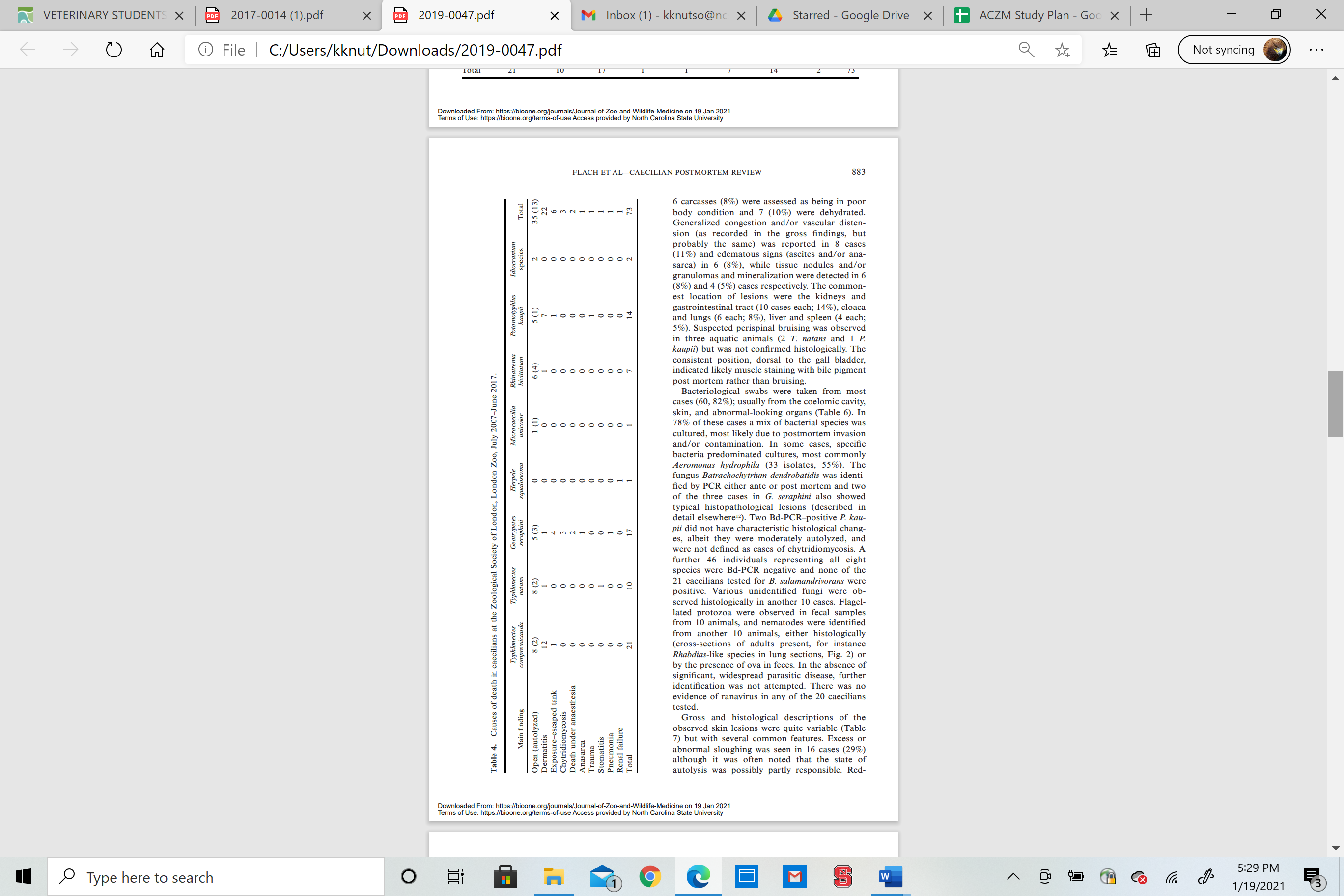
**Abstract:**

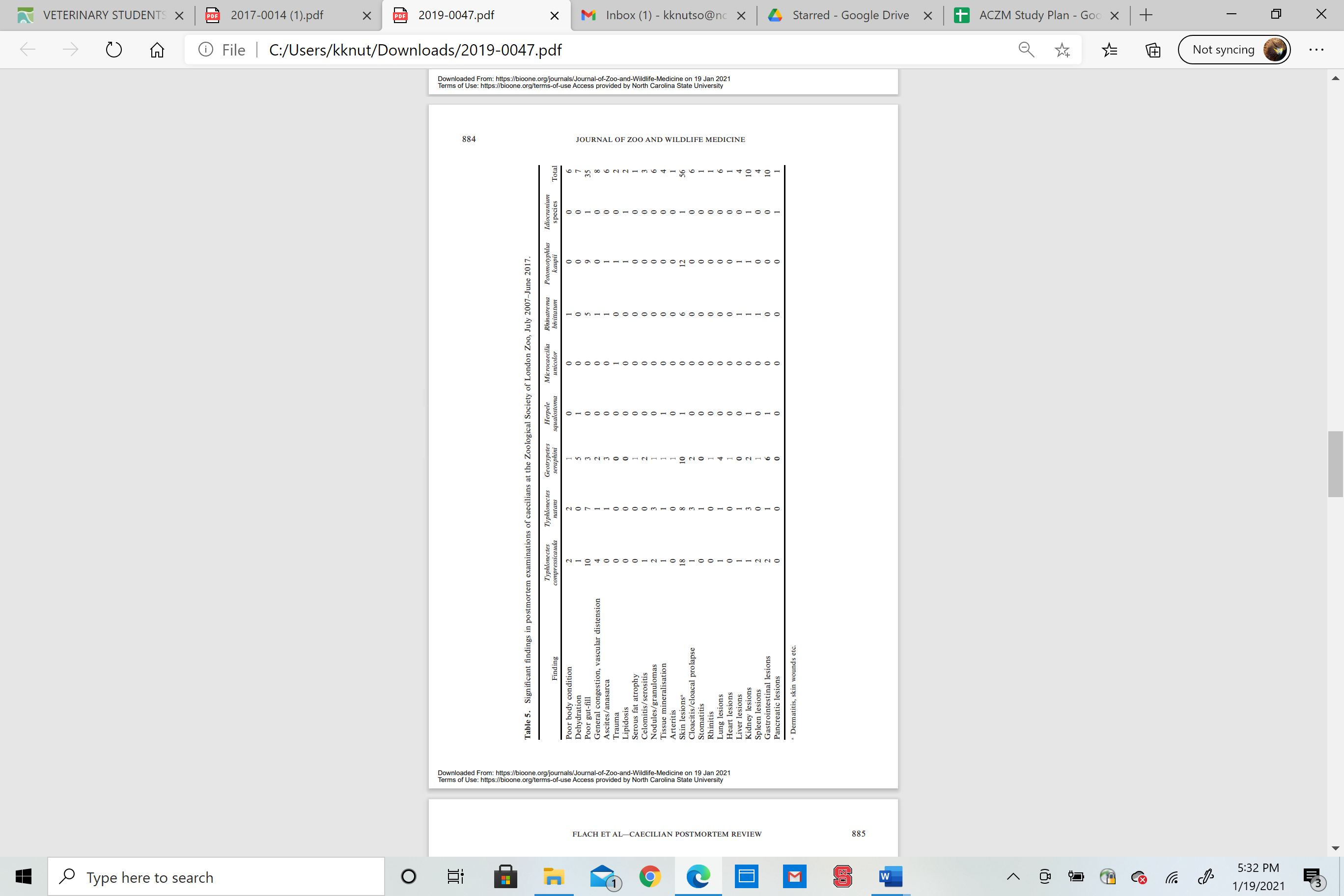
Between July 2007 and June 2017 there were 86 deaths in the populations of eight caecilian species at the Zoological Society of London (ZSL) London Zoo. The mortality rate (deaths per animal-year at risk) ranged from 0.03 in the Congo caecilian (Herpele squalostoma) to 0.85 in Kaup’s caecilian (Potomotyphlus kaupii). **Among the 73 individuals examined postmortem, no cause of death or primary diagnosis could be established in 35 cases, but of the others the most common cause of death was dermatitis (22 cases).** When all significant pathological findings were considered, skin lesions of varying types were again the commonest (56 cases), particularly among the aquatic species: Typhlonectes compressicauda (18 out of 21 cases), T. natans (8/10) and P. kaupii (12/14). Other **common findings were poor gut-fill (35 cases), kidney and gastrointestinal lesions (10 cases each), generalized congestion (8 cases) and poor body condition (6 cases).** This review adds to the growing body of knowledge regarding the presentations and causes of disease in captive caecilians.

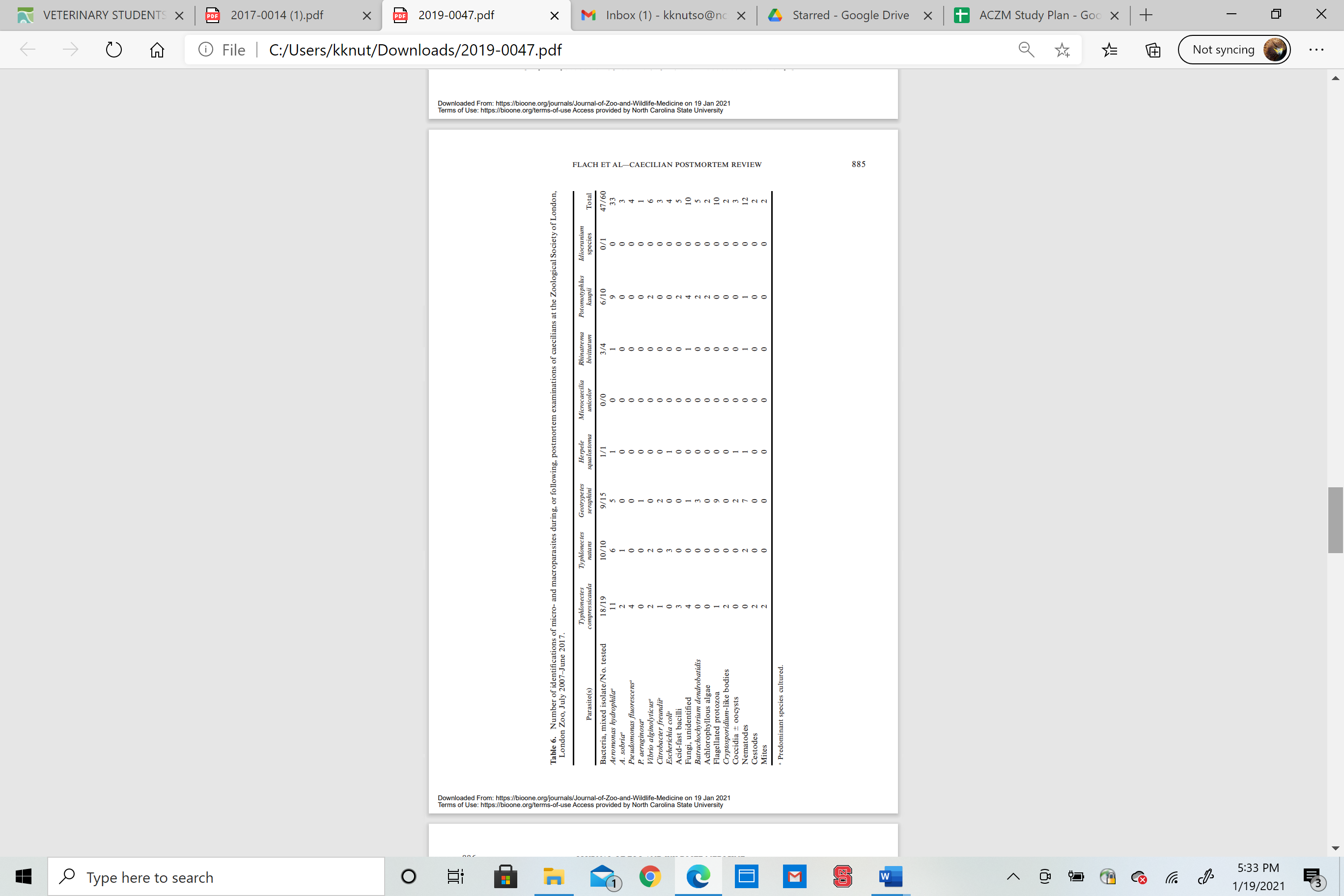
**Summary:**

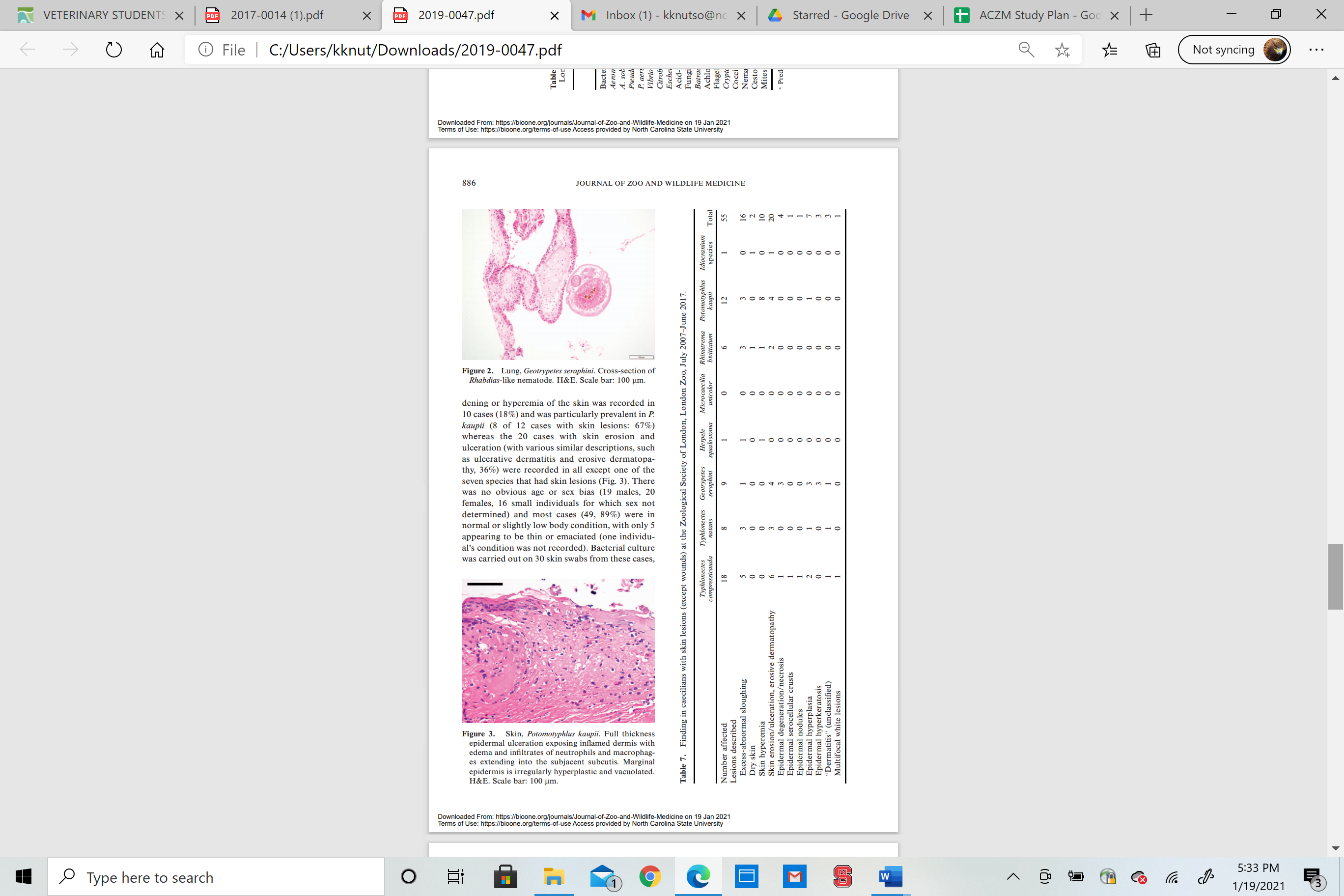
* Objective: review postmortem findings of caecilians that died at London Zoo over 10-yr period
* M+M – retrospective of caecilian deaths and necropsy results over 10 yr period at London Zoo
* Results/discussion:
  + species in lowest mortality rate category generally considered to be more dedicated burrowers that spend the least time on the surface
  + P. kaupii, R. bivitattum, and Idiocranium species - much higher mortality rate than others
  + **high prevalence of dermatitis and other skin lesions** among these cases
    - damage to skin reduces ability to maintain water and electrolyte balance
    - affected 3 aquatic sp. mainly – cause unknown, may be related to water quality
    - chytrid fungus Batrachochytrium dendrobatidis responsible for skin lesions and mortality in 3 G. seraphini, detected by PCR in 2 P. kaupii w/ no histo lesions
    - environmental Mycobacterium sp. may be associated with skin lesions in amphibians but only present in low numbers in 20% of skin smears
  + poor gut-fill common (35 cases; 48%)
  + cloacal inflammation and prolapse may be linked to direct trauma, irritation, and infection and linked to dermatitis in 2 aquatic Typhlonectes sp.
    - 2 cases - G. seraphini assoc w/ intestinal impaction w/ ingested coir substrate
  + generalized congestion and/or vascular distension reported in 8 cases (11%)
  + edematous conditions – 6 cases (8%)
    - 4 examined – 3 had renal pathology, 1 had acute skin ulcer
  + Aeromonas hydrophyla – commonly cultured bacteria (33 isolates, 55%)
  + common location of lesions - kidneys and GI tract (10 cases each; 14%), cloaca and lungs (6 each; 8%), liver and spleen (4 each; 5%)











Siddons, Spencer R., Marin C. Bray, and Catherine L. Searle. "Higher infection prevalence in amphibians inhabiting human-made compared to natural wetlands." *Journal of Wildlife Diseases* 56.4 (2020): 823-836.

ABSTRACT: It is unclear how suitable human-made wetlands are for supporting wildlife and how they impact wildlife disease risk. Natural wetlands (those that were created without human actions) can support more diverse and resilient communities that are at lower risk of disease outbreaks. **We compared frog community composition and infection with the pathogenic fungus Batrachochytrium dendrobatidis (Bd) between human-made and natural wetlands in Tippecanoe County, Indiana, US**. We conducted visual encounter surveys of frog communities and quantified Bd infection prevalence at four natural and five human-made wetlands. Water parameters associated with human practices (e.g., pH, salinity) and surrounding land use were also compared across sites. **We found higher Bd infection prevalence at human-made sites than at natural sites, with monthly differences showing highest infection in spring and fall, and decreasing infection with increasing water temperature. However, we found no differences between human-made and natural sites regarding amphibian community composition, water quality, or surrounding land use.** **Further, we found frog density increased with distance to nearest roads among both human-made and natural sites.** These findings might suggest that human-made wetlands can support frog communities similar to natural wetlands, but pose a greater risk of Bd infection.

Intro

* The fungal pathogen Batrachochytrium dendrobatidis (Bd) causes chytridiomycosis, which poses a great risk to amphibian populations around the world
* Anthropogenic practices can influence Bd infection dynamics
  + Pesticides, changes in water quality and temp, habitat destruction etc.
* This study examines the frog community composition, density, water quality, and infection with Bd between human-made and natural wetlands in Tippecanoe, Indiana

M&M

* 9 sites were sampled, 3-6 times throughout one year
  + 5 human made (HM), 4 natural (NAT)
  + qPCR for Bd performed on 20 frogs per site per instance
  + species composition, density, and water quality were also measured

Results

* Mean Bd infection prevalence was 33% (118/361) across all samples, with five of seven species having at least one infected individual
* Infection prevalence was highest in American bullfrogs and green frogs, two species that are suspected reservoirs for Bd
* The mean prevalence of Bd infection was higher at HM (38%) than at NAT(24%)
* Bd infection rates higher in spring and fall
* Infection rate decreased with increasing water temp
* No differences between HM and NAT sites regarding species composition, water quality, or surrounding land use
* Frog density increased with distance to nearest roads among both HM and NAT sites.
* **Takeaway:** Human-made wetlands can play a role in sustaining frog communities, but could pose a greater risk for Bd infection than natural wetlands.

Mosher, Brittany A., et al. "Estimating occurrence, prevalence, and detection of amphibian pathogens: insights from occupancy models." *Journal of wildlife diseases* 55.3 (2019): 563-575.

ABSTRACT: Understanding the distribution of pathogens across landscapes and their prevalence within host populations is a common aim of wildlife managers. Despite the need for unbiased estimates of pathogen occurrence and prevalence for planning effective management interventions, many researchers fail to account for imperfect pathogen detection. Instead raw data are often reported, which may lead to ineffective, or even detrimental, management actions. **We illustrate the utility of occupancy models for generating unbiased estimates of disease parameters by 1) providing a written tutorial describing how to fit these models in Program PRESENCE and 2) presenting a case study with the pathogen ranavirus**. We analyzed ranavirus detection data from a wildlife refuge (Maryland, US) using occupancy modeling, which yields unbiased estimates of pathogen occurrence and prevalence. **We found ranavirus prevalence was underestimated by up to 30% if imperfect pathogen detection was ignored.** The unbiased estimate of ranavirus prevalence in larval wood frog (Lithobates sylvaticus; 0.73) populations was higher than in larval spotted salamander (Ambystoma maculatum; 0.56) populations**. In addition, the odds of detecting ranavirus in tail samples were 6.7 times higher than detecting ranavirus in liver samples. Therefore, tail samples presented a nonlethal sampling method for ranavirus that may be able to detect early (nonsystemic) infections.**

Intro

* Emerging infectious disease (EID) in wildlife populations are an increasing threat to biodiversity
* Understanding prevalence and spatial distribution are key for effective management
* All detection methods are imperfect to some extent, and this must be considered when inferences on prevalence are to be used for management strategies
* Occupancy models allow for estimation of pathogen occurrence while explicitly accounting for imperfect and variable detection probabilities
* Goal: to illustrate an analytical framework for estimation of unbiased pathogen parameters of a wildlife disease

M&M

* Use of an occupancy model to evaluate prevalence of ranavirus in a refuge in Maryland
* Sampled 22 randomly selected wetlands
* Animals euthanized, tissues sampled from liver and tail for ranavirus PCR
* By accounting for the rate of false negative within the statistics a more accurate estimation of occurrence and prevalence could be generated

Results

* Ranavirus prevalence was underestimated by up to 30% if imperfect pathogen detection was ignored
* Noeffect of pH on ranaviruus occurrence
* The odds of detecting ranavirus in tail samples were 6.7 times higher than detecting ranavirus in liver samples
* **Takeaway:** Occupancy models account for detection probability and therefore give a more accurate assessment of prevalence and occurrence of disease. Tail clips may be a useful, nonlethal method of ranavirus detection