

Understanding Stress in Hospitalized Raptors: Implications for Rehabilitation Practices and Wildlife Welfare

Introduction

University of Missouri Raptor Rehabilitation Project:

- Creates exotic medicine experience for veterinary students
- Provides world-class medical care to sick and injured raptors
- Educates the public on birds of prey and their role in the environment

Stress is necessary to handle, confine, and treat sick and injured animals, but can be fatal to wildlife.

- Corticosterone and heterophil : lymphocyte ratio increase in times of stress, causing immunosuppression and negatively affecting the patients' health outcomes
- Considerable time and effort is expended to treat the birds' injuries or illnesses *and* prevent further harm due to the stress of being hospitalized

Limited evidence-based research has been conducted to investigate stress in hospitalized birds and its impact on patient welfare.

- A 2024 study investigating the impact of hospital noise on Tropical Screech Owls attempted to mimic the stressors of hospitalization on healthy, rehabilitated owls¹
 - Findings: fecal corticosterone and blood bacterial killing ability changed when exposed to hospital noise, but blood corticosterone and H:L ratio did not
 - Limitations: subjects were healthy, they were subjected to noise stimuli alone, and they were all the same species
- In a 2012 review study, Cook determined that fecal and feather corticosterone provide a minimally invasive, time-integrated assessment of stress in birds, while blood corticosterone serves as a short-term assessment²

Our study aims to build upon this knowledge by assessing similar parameters in birds of prey that are sick or injured during their hospitalization.

- **Hypothesis:** Markers of stress will increase during the course of hospitalization, demonstrating the raptors' physiological response to rehabilitation practices and informing future care strategies.



Figure 1. Patients at the MU Raptor Rehabilitation Project range from 100 gram kestrels to 6.4 kilogram eagles.

Methods

Sample Collection and Processing:

- Feces:** Collected daily
Corticosterone extracted from dried feces
- Blood:** Collected at intake and discharge
Blood smears prepared for heterophil : lymphocyte ratio
Corticosterone extracted from serum
- Feathers:** Collected when dropped and at death
Corticosterone extracted from cleaned, minced feather rachis and veins
- Disease Severity Score:** Collected daily
Based on visual examination and assessment during treatments
Utilized parameters in Figure 3

ELISA: Arbor Assays DetectX® Corticosterone Multi-Format ELISA Kits

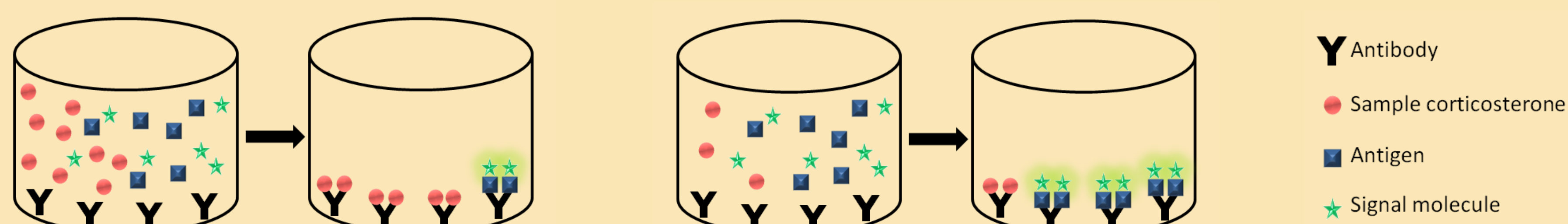
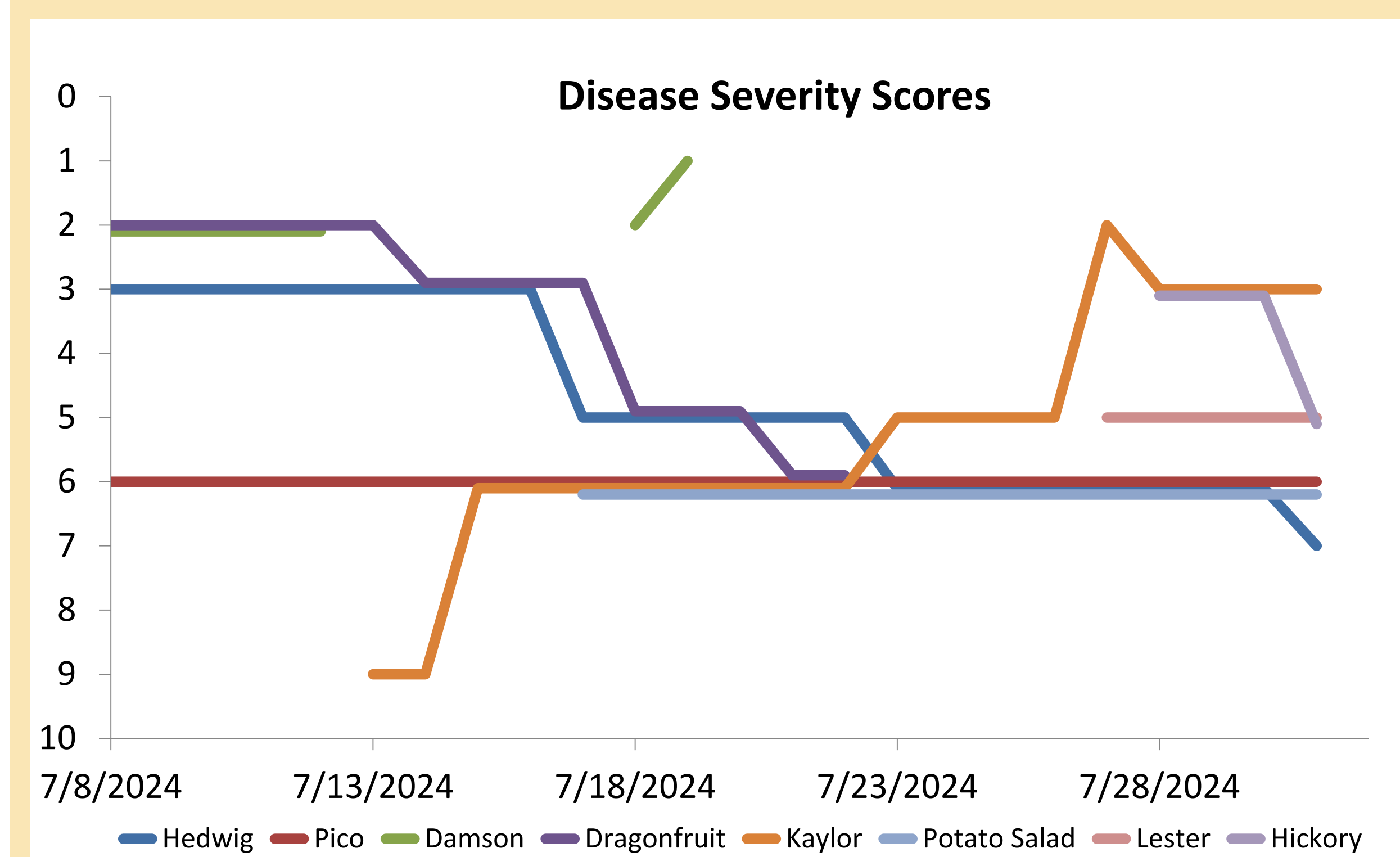


Figure 2. Competitive ELISA: Corticosterone in the sample competitively inhibits antigen binding, and subsequent signal detection. Therefore, wells with lower signal detection (left) have higher sample corticosterone concentrations than those with high signal detection (right).

Results and Discussion



Score	Mentation	Severity	Regionality
1	BAR	Apparently Healthy	Systemic
2	BAR	Non-life threatening	Local
3	BAR to QAR	Non-life threatening	Regional
4	BAR to QAR	Non-life threatening	Systemic
5	BAR to QAR	Life threatening	Local
6	BAR to QAR	Life threatening	Regional
7	QAR	Life threatening	Systemic
8	Dull	Life threatening	Systemic
9	Obtunded	Life threatening	Systemic
10	Comatose	Life threatening	Systemic

Figure 3. Daily assessments of the severity of the patients' injury or illness were performed to contextualize the health status of the patient at the time of various sample collections (left). Disease Severity is scored on a 1-10 scale based on mentation status, severity of their diagnosis and the regionality of their combined ailments (right).

White Blood Cell Counts

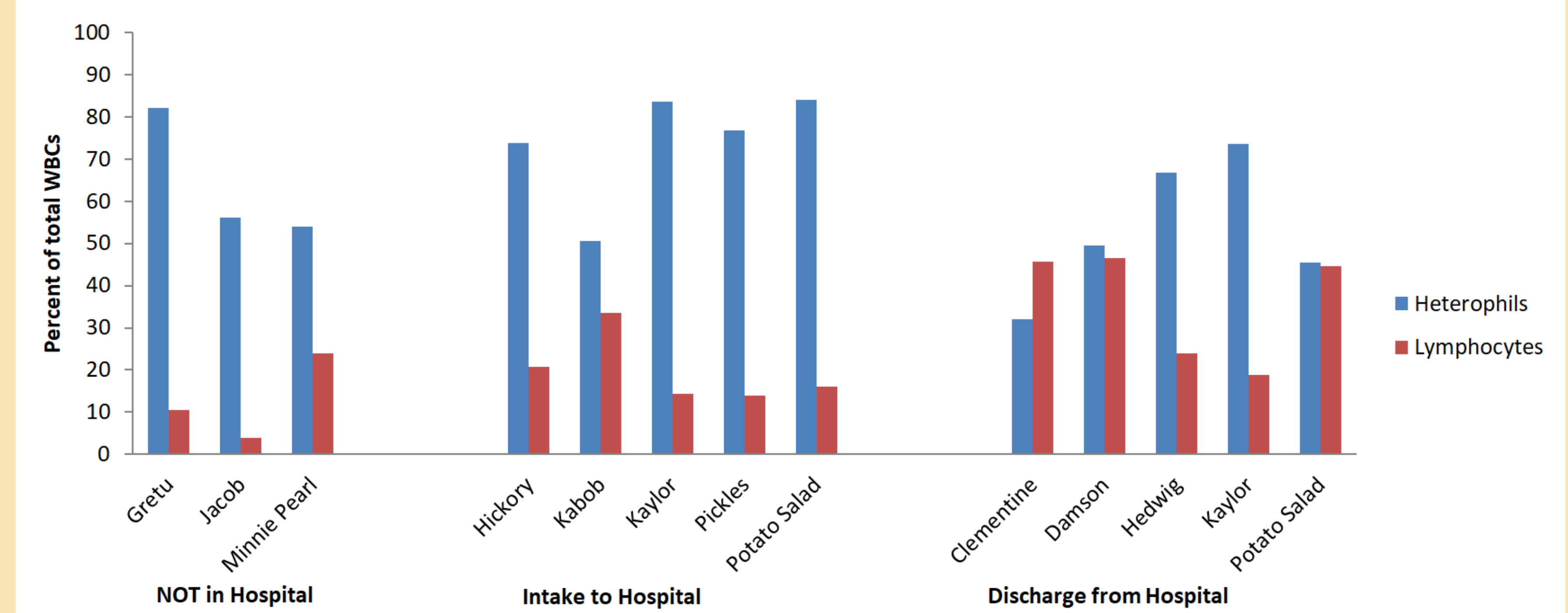


Figure 4. H:L ratios from education birds residing outside of the hospital, injured birds at intake to the hospital, and recovered birds on discharge from the hospital suggest major changes in immune function during hospitalization.

Hedwig – Juvenile Barred Owl

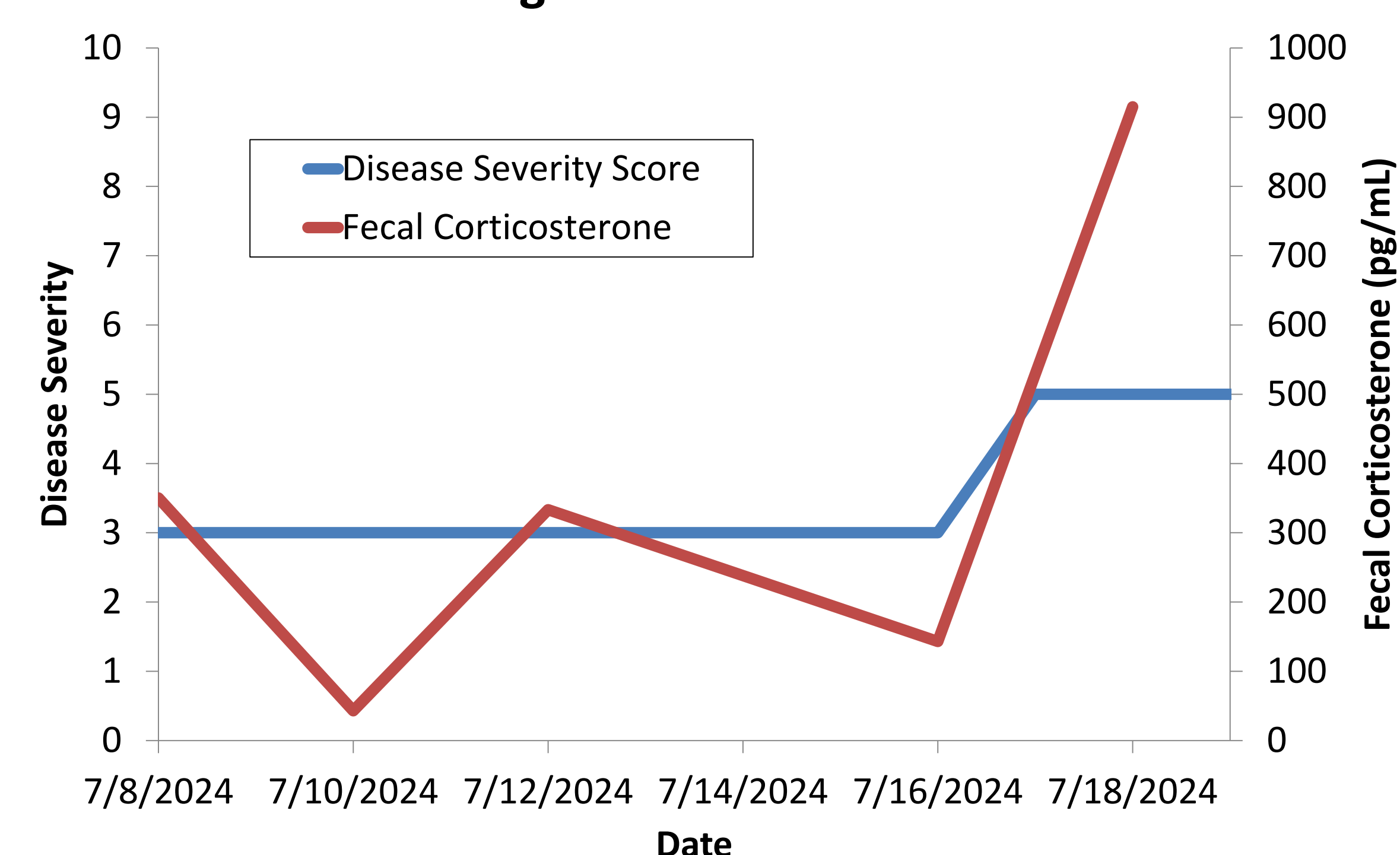


Figure 5. Comparison of disease severity with fecal corticosterone in one patient reveals a spike in corticosterone immediately after a major health event. In this case, on day 61 of hospitalization, the patient underwent an external fixator removal and enucleation. Patient was painful post-operatively, which could be contributing to the increased corticosterone reflected in her fecal samples.

Discussion:

- Disease severity varied widely from relatively healthy to unstable
- Heterophil : Lymphocyte ratios of birds on intake (4.32) more closely resembled that of birds outside of the hospital (8.16) than birds on discharge (2.12).
- This suggests immunosuppression and changes in immune function due to the stress of hospitalization.
- In our preliminary data, increases in fecal corticosterone can be correlated with major medical events, such as surgeries, providing insight into the stress patients experience during the course of their hospitalization
- Moving forward, we plan to run more ELISAs to assess corticosterone levels in feces, feather, and blood

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¹Barbosa-Moyano, H.; et al. Adreno-immunological response to healthcare facility noise during rehabilitation of Tropical Screech Owls, *Global Ecology and Conservation*, 2024, 50, <https://doi.org/10.1016/j.gecco.2024.e02845>.

²Cook, N.J. Review: Minimally invasive sampling media and the measurement of corticosteroids as biomarkers of stress in animals, *Can. J. Anim. Sci.*, 2012, 92, <http://doi.org/10.4141/cjas2012-045>