3.8 WILLIAMS, C.M.*; CHICK, W.D.; SINCLAIR, B.J.; University of Western Ontario; *cwilli67@uwo.ca*
Multiple trade-offs among life-history and metabolic traits mitigate the impacts of overwintering microclimate on the fitness of Fall Webworm across its native range.
The impact of the environment on distinct physiological and ecological traits, and across life-stages, can result in trade-offs that combine to determine the fitness of individuals and thus population dynamics. We examined the role of local adaptation and plasticity in modifying the life-history and physiological characteristics of a widespread, generalist pest species *Hyphantria cunea*, Lepidoptera: Arctiidae) from the centre (Columbus, OH [CO]) or northern periphery (Ottawa, ON [OT]) of their range, in response to overwintering microclimate conditions approximating the collection sites (northern or southern treatments), in a reciprocal common garden design. Populations differed in the majority of life-history and metabolic traits, but this differentiation did not appear to be adaptive. Diapause entry was advanced in CO compared to OT populations, which had negative effects on adult size, but larger pupal size in CO pupae compensated for this effect. Pupae facultatively suppressed their metabolism at warm, energetically demanding southern temperatures, which more than compensated for the increased energetic demands of warmer winters, as pupae from the warm southern treatment actually had more energy reserves remaining at the end of winter than did the cooler northern treatment. This species thus has a large repertoire of genotypic and plastic changes to life-history and metabolic traits that render them relatively insensitive to changes in their overwintering thermal environment.

27.1 WILLIAMS, T.M.*; WOLFE, L.L.; DAVIS, T.R.; KENDALL, T.; RICHTER, B.; ELKAIM, G.; WILMERS, C.; Univ. of California, Santa Cruz, Colorado Parks and Wildlife, Fort Collins; *williams@biology.ucsc.edu*
Energetics and Mechanics of Mountain Lions: A step by step analysis for carnivore conservation
As one of North America's largest terrestrial carnivores, the mountain lion (*Puma concolor*) places extraordinary demands on habitats and prey resources. As a result, conflicts with human activities can occur but have been difficult to predict. We developed a new "smart" collar incorporating physiological attributes of the animal, GPS and accelerometers to monitor movements, behavior and energetics of free-ranging lions in the Santa Cruz Mountains. Collars were calibrated on three adult lions (mass = 65.7 kg) trained to wear the collar in a natural enclosure and while walking on a treadmill. Oxygen consumption (VO_2) was determined by open-flow respirometry from rest to 7 $km.hr^{-1}$ and correlated to gait. The data were then used to assign behavioral and energetic signatures to collar signals. VO_2 ($mlO_2.kg^{-1}.min^{-1}$) increased linearly with walking speed ($m.s^{-1}$) according to VO_2 = 8.71 + 10.12speed (r^2=0.96). Net transport costs and gait transition speeds of mountain lions were as predicted for quadrupeds. Conversely, total energetic costs for both rest and activity were 71% higher than predicted for domestic mammals, following the trend for elevated metabolism in large carnivores. Tests with collared, free-ranging lions demonstrated peak energy expenditure during dawn and dusk for lone females while those with kittens maintained constant hunting/energetic demands throughout the day. This integrative wildlife monitoring approach provides new insights regarding optimal foraging by a large carnivore, and demonstrates the importance of species-specific physiological traits when developing conservation plans.

103.2 WILLIAMS IV, R.*; NEUBARTH, N. L.; HALE, M. E.; Univ. of Chicago; *rwilliams@uchicago.edu*
Characterizing sensory nerve fiber responses to pectoral fin ray bending
While the roles of fins in actinopterygian locomotion have been studied in depth, little is known of how they receive sensory feedback from interactions with the physical environment. We selected the bluegill (*Lepomis macrochirus*), a species that uses its pectoral fins extensively during swimming, as a model organism for the exploration of pectoral fin somatosensation. Previously we demonstrated that the sensory nerves innervating the pectoral fins of bluegills are capable of conveying mechanosensory feedback in response to fin bending, using extracellular physiological recordings in a fictive fin preparation. In this study we examine the responses of these nerves to sinusoidal and step-and-hold bending of the fin rays. Activity recorded in response to these stimuli show that sensory nerve fibers respond to the magnitude and the velocity of the bending movement. Additionally, we used spike-sorting analyses to examine the responses of individual afferents to aspects of fin ray bending. These data suggest that there are multiple types of mechanosensory neurons responsive to fin ray bending and that these populations of neurons may communicate different properties of the bending stimulus. The feedback provided by these neurons may allow the pectoral fins to act as mechanical sensors as well as propulsors.

19.1 WILSHIN, Simon; HAYNES, G. Clark; REEVE, Michelle; REVZEN, Shai; SPENCE, Andrew J.*; Royal Veterinary College, University of Pennsylvania; *aspence@rvc.ac.uk*
How is dog gait affected by natural rough terrain?
In nature legged animals depend on locomotion over uneven terrain for survival and reproduction. One way in which animals may optimize their locomotor behaviour for this task is by adjusting the relative timing of their leg recirculation, or gait. Therefore, we asked how the relative leg timing of quadrupeds changes during locomotion over natural, uneven terrain, and compared this to our idealised notions of the walk, trot and gallop. Five male dogs of shoulder height 522.0 ± 62.6 mm (mean ± s.d.) and body mass 20.0 ± 2.5 kg (mean ± s.d.) were trialled at nominal walk, trot, and gallop speeds over flat and uneven terrain. Mean perturbation size on uneven terrain was 54.8 ± 44.6 mm versus 4.2 ± 3.1 mm on flat. Dogs were fitted with a wirelessly synchronized suite of five sensors, comprised of Global Position System and inertial measurement units. One device was attached to the proximal-most segment of each leg, and a fifth on the midline of the back at the front legs. Raw sensor data were used to compute animal speed, position, and a continuous estimate of leg phases. The centroids of relative leg phase (averaged across time within each stride), describing the gait used by the dog on each terrain at each nominal gait speed, were significantly different on the rough terrain (linear mixed-model; n=5 dogs, $p<0.05$). At walking speeds on the rough terrain, dog gait moves towards the trot. Averages and distances between gaits in relative leg phase space do not account for the dynamical and geometric structure of these phase variables, however. Theoretical developments required to handle these data will be discussed. To explain why we observe these changes in dog gait, we propose experiments in a physical model, the robot XRL.