**CFS History**

The Concord Field Station was acquired and transformed into a research institution during 1962-1963. Ernst Mayr (then Director of the Museum of Comparative Zoology) and Charles P. Lyman (Curator in Mammology and Associate Professor of Anatomy at the Harvard Medical School) desired a field station associated with the Estabrook Woods. Harvard had previously purchased the Estabrook land from the Pickman family to use for ecological studies. Named for a very prominent Concord family, Estabrook Woods was the subject of many of Henry Thoreau journal entries and essays.

In the early 1950s, a Nike Missile site was built where CFS lies today (one of ~40 sites around Boston). The Nike program (named for the Greek goddess of victory) was developed during the first decade of the Cold War. It aimed to protect industrial centers from aircraft attacks by placing surface-to-air missile centers around large cities. But, by the late 1950s, the Soviet Union has shifted the nature of their military strategy away from bomber force to Intercontinental Ballistic Missiles (ICBMs). This reduced the need for the Nike missile bases and they were closed down in the early 1960s. The land was sold back to the Pickman family.

With the help of a grant from the Nature Conservancy, Harvard purchased the land and facilities from the Pickman family and began transforming the barracks into offices, animal rooms, and an environmental physiology laboratory (which boasted a Wang 700 Series programming calculator). Dr. Lyman served as Acting Director from 1963-69. When Professor C. Richard Taylor was awarded tenure in 1969, he was offered office space either in BioLabs or at CFS. He became the first director of CFS. In 1970, a grant from the Ford Foundation allowed for renovation of the missile bunkers. These new spaces were used to grow plants and house insects and lizards. A library and herbarium were built in the new laboratory area above the northern-most bunker.

The Concord Field Station has been the site of many research studies. Early laboratory work studied environmental physiology, insect development, and biological rhythms and behaviour. Field studies investigated plant life history strategies (Dr. Otto Solbrig, 1972), resource allocation in plant populations (Abrahamson 1973), and vocalizations in warblers (Lein, 1973). Local wasp, fungi beetle, and dragonfly species were also researched at the field station. The facilities included a live surgery room, which was used by a local orthopedic surgeon to study hip loading.

Dr. Taylor was the first investigator to train animals to run on a treadmill. He was interested in studying the effect of animal size on energetics. Along with his master’s student, Roger Kram, he built (and the field station continues to house) the first treadmill made with a force plate. Because the data they recorded was very noisy, they decided not to patent the design; today many companies make similar models.

Dick Taylor served as director of CFS until Dr. Andrew Biewener took over the position in 1999. The wind tunnel housed in the laboratory building over the bunkers was built shortly after. Dr. Stacey Combes joined the Field Station in 2008.

**Biewener Lab Information**

The Biewener lab works on a variety of projects concerned with the biomechanics, neuromuscular function, and control of animal movement to address the following questions:

* What features of the musculoskeletal system reflect the demands for powered flight versus those for economical movement over ground?
* How do animals maneuver in their environment and stabilize in response to perturbations?
* How does size affect animal design and performance?
* How can biological systems inform robotics design?

Our work examines how musculoskeletal design requirements vary across locomotor modes and conditions, as well as diverse species. Our goal is to understand general principles that govern the biomechanical and physiological design of vertebrate neuro-musculoskeletal systems. Limb and body dynamics of whole animal movement are analyzed in relation to the dynamics of neuromuscular, tendon and skeletal function.

**Combes Lab Information**

Our research focuses on the physical interaction between flying insects and their environment, and on how physiology, morphology and behavior contribute to the performance of ecologically relevant flight behaviors. We strive to link the worlds of lab-based insect flight biomechanics and field-based insect flight ecology to understand the physical foundation of diverse, natural flight behaviors. Projects in the lab explore topics such as phylogenetic patterns and mechanical consequences of wing flexibility, physical mechanisms of flight control via abdominal and leg movements, turbulence in natural environments and its effects on insect flight stability, and the role of flight performance in aerial predator-prey and competitive interactions.

**Cetacean Bunker Information**

The Mammalogy department moved the whale and fluid collection to CFS during the mid-1980s. They also set up a preparation facility in one of the bunkers in order to clean specimen for the collections and exhibits. The first bunker used to house the whale collection, some oversize vertebrate paleontology fossils, and fossil corals that had been taken off of exhibit in the museum. In 1999, the vertebrate and coral fossils were transferred to bunker 3 in order to make more room for the expanding whale collection. The bunker currently houses the entire cetacean (whales, dolphins, and porpoises) collection except for those specimen displayed in the museum.

All specimens were collected after they washed up onto the beaches already dead.  The Mammalogy staff work closely with Marine Mammal Stranding Networks in the New England area to recover carcasses. The stranding network is the first on the scene and, if the animal is still alive, they try to push it back out to sea. If the animal is dead they take body measurements, sex, and tissue samples and then call the Mammalogy department, which decides if they have the time and space for the specimen. Most of the preparation work is done on the beach. The carcass is cut up with very large knives. The skin, organs, and blubber are removed from the skeleton and buried in a large hole on the beach using a backhoe. The extracted skeleton is transported to CFS on several flatbed trailers. Large bones are left outside to be cleaned by nature (bugs, weather, bacteria, and, sometime, green manure). Smaller bones are cleaned in the beetle (dermestid) colony. The Mammalogy department has a permit to keep marine mammal material (which is otherwise illegal) from National Marine Fisheries.

The Mammalogy department has about 85,000 specimens in their scientific (non-exhibit) collection. Scientists use these in order to understand the morphology, ecology, and genetics of various species. Almost all data in field guides/textbooks on animals comes from studying scientific collections. This is why it is so vital that the department records as much information as possible about each specimen it prepares.

Interesting stories about the collection: There is a young right whale that had a fishnet injury to its right humerus. The rope got tangled around the animal’s flipper for such a long time that the bone actually grew around the rope, leaving a deep gash in the bone. Documentation like this can help set guidelines for fishing equipment. There is also a young sperm whale with a congenital jaw deformity (curled lower jaw preventing the mouth from closing fully). This is, apparently, fairly common and did not affect the feeding or longevity of the whale.

**Animals Currently housed at CFS**

* Emu (*Dromaius novaehollandiae*)
	+ Native to Australia
	+ Eats vegetation, seeds, and insects.
	+ Second largest bird (after ostrich) – flightless – can sprint at 50km/hr (31mph)
	+ Bone remodeling through development (Russ Main)
* African pygmy goats (*Capra hircus*)
	+ Originally from West Africa
	+ Eat greens and grains.
	+ Were imported into the US from European zoos in the 1950s.
	+ Are used at CFS to study in vivo muscle and tendon function, obstacle navigation, and muscle function in jumping.
* Jerboa (*Jaculus jaculus*)
	+ Native to Africa and the Middle East.
	+ Eats seeds and grains.
	+ Can leap up to several meters in single bound. When a female mates with a male, he will immediately kick the male out of her burrow/nest. One to four pups are born at a time.
	+ Used to study convergent evolution of bipedal hopping and foot-sand interactions.
* Cockatiels (*Nymphicus hollandicus*)
	+ Endemic to Australia.
	+ Eat grass seeds, nuts, berries, and grain.
	+ Second most popular cage bird after the Budgerigar.
	+ Used at CFS to study bird flight and navigation around obstacles.
* Lovebirds (*Agapornis*)
	+ Native to Africa (8 of 9 species) and Madagascar (Grey-headed lovebird).
	+ Eat fruit, vegetables, grasses, and seeds..
	+ Live up to 10-15 years.
	+ Used at CFS to study bird flight and navigation around obstacles.
* African Grey Parrots (*Psittacus erithacus*)
	+ Found in rainforest of West and Central Africa.
	+ Eat palm nuts, seeds, fruits, leaves, and snails.
	+ Lives up to 50 years in captivity.
	+ Have been shown to associate human words with meaning and to apply abstract concepts (shape, color, number). One bird was recorded as having a vocabulary of over 950 words
	+ Will be used to study perturbation and stability during flight (with electronics carried on bird’s back)
* Dragonflies
	+ Predominantly: *Libellula cyanea*, *Sympetrum rubicundulum*
	+ Occasionally: *Libellula semifasciata*, *Plathemis lydia*
	+ Captured from the surrounding area and moved into greenhouse.
	+ Eat small flying insects.
	+ Used to study prey capture mechanisms and wing structure.
* Bumblebees (*Bombus impatiens*)
	+ Ordered from online.
	+ Used for flying in wind tunnel as well as for studying wing structural properties and their influence on flight
* Mosquitos (*Aedes aegypti*)
	+ Used for studying wing kinematics and flight acoustics.
	+ Fed sheep’s blood.

**Animals previously studied at CFS**

* Lion cubs
	+ Energetics
* Red kangaroos
	+ Terry Dawson – animals were donated to the Washington zoo after using them
* Coyotes, wolves, dogs
	+ Does domestication influence energetics?
* Chimpanzees
	+ Cost of bipedal versus quadrupedal locomotion
* Horses (juveniles) and ostriches
	+ Cost of locomotion/energetics of quadrupedal versus bipedal runners
* Llamas
	+ Were not used for a study
* Cheetah and goat
	+ Influence of limb conformation on energetic cost of locomotion
* Elephant shrews
	+ Fuzz’s student – used xray and force plates
* Pronghorn antelope
* Various goats and pigs
	+ Fuzz and Andrew Carroll looked at using x-ray.

**FURTHER READING**

Nike missile info:

<http://alpha.fdu.edu/~bender/N-view.html>

CFS info:

<http://www.biology.ucsd.edu/labs/woodruff/pubs/25.pdf>

<http://sarzha.com/writing/fieldstation.pdf>