ENERGY CONSERVATION IN ZOOLOGICAL PARKS

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As the human population increases, so does the pressure to exploit virgin areas of the Earth for natural resources. This exploitation, whether it be for food, energy, building materials, etc., is having alarming side effects on the planet. Thousands of acres of Tropical rain forests are lost every day. Whole ecosystems are imperiled when accidents occur during the transportation of petroleum products. As the destruction of natural habitats continues, the primary purpose of the worlds zoological institutions is changing from one of pure entertainment to that of last refuge for many endangered animal species. These institutions can no longer replenish animal stocks by going to the wild; in some cases that "wild" no longer exists. The replication of an animal's natural environment is critical not only to the survival of that individual animal but to the species as a whole. The closer one can duplicate an animal's natural environment, the more likely that animal will breed to produce new generations. The duplication of an animals' environment requires the use of energy, and depending on the location of the zoological institution, these specialized micro climates must be maintained year round regardless of exterior weather conditions. The majority of buildings and their respective energy-using systems at zoological institutions are over 15 years of age, predating most energy conservation practices. In most cases, this aging building stock is updated with little regard to the energy impact of the retrofit, burdening the institution with high energy costs. It is the improvement of energy efficiency in this older building stock that this paper addresses.

The research was approached on two fronts, an overall view of energy use of zoos and a specific view of energy use at a local zoo. To determine energy use in zoos, a survey was developed that addressed types of energy used, gross square footage of animal facilities, age of facilities, energy-using systems, etc. The survey included questions concerning the use of alternative energies and types of alternative energy systems used. Twenty-one percent (21%) of zoos surveyed responded (31 out of 147). Most zoos utilize the type of energy that is readily available in their region of the country, usually electricity or gas. Though energy conservation was not a high priority, most respondents stated that they were aware of it and when possible improved the energy efficiency of buildings at their institutions. Methods of energy conservation and energy management varied from weatherizing buildings to direct gas purchasing. The sun was the source of most alternative energy production. The survey also asked respondents about their total average daily water use. Twenty-three institutions responded to the question, with the lowest water use being 200 gallons per day and the highest being 550,000 gallons per day. The total water use indicated by these 23 institutions came to 3,711,804 gallons per day.

For a more detailed look at specific energy use at a zoo, a local institution was approached to determine their interest in having buildings analyzed to improve energy efficiency. Energy audits of their buildings were not a high priority, but having an analysis performed on buildings that were mechanically not functioning properly did appeal to them. The building audit attempted to determine causes of the problem, with the recommended solutions incorporating energy efficient techniques.

To date, two studies have been completed, *Environmental Analysis of the Perching Bird House* and *Lighting Study at The Tropic World Of Primates Exhibit.* A third study, an environmental analysis of the Reptile House is currently underway. Each study addresses four topics; the ideal environment for the animal, the condition of existing building systems, the compatibility of the ideal environment with the existing systems and the incorporation of new energy saving technologies.

Determining the ideal environmental conditions in which to maintain these animals consisted of literature searches into the physiology of each group of animals and the local climatic conditions where they originate. Animal curators from other zoological institutions were consulted for information on husbandry techniques. An energy audit was conducted with emphasis on the operating condition of the energy using systems. The animal's micro climate requirements were compared with the capabilities of the energy using systems and recommendations were made on achieving this environment while conserving energy use. Finally, energy saving alternatives were researched for possible incorporation into the exhibit. The following is a brief description of each project, including building age and mechanical systems, current environmental problems, and recommended solutions.

The Perching Bird House and the Reptile House are among the original buildings at this institution, both being built in the early 1930's. Both buildings are one story masonry buildings, with large portions of roof area consisting of skylights. Both buildings rely on a constant volume, single zone air distribution system along with a perimeter radiant heat system.

The Perching Bird House (PBH) had problems ranging from uneven distribution of heat during the winter months to overheating during the summer. This situation created dry stagnant air throughout the year. Birds are able to handle various climactic conditions, but have a low tolerance to stagnant air, which increases the incidence of lung sack infection. Recommendations included replacement of an existing air supply motor with a properly sized, high efficiency unit, enlargement of supply registers, and air balancing and cleaning. To reduce heat gain during summer months, an evaporative cooling system consisting of a fogging machine was recommended with an added benefit of increasing needed humidity during winter months. To date, a new high efficiency supply motor has been installed and the air distribution system has been balanced and cleaned.

The Reptile House's (RH) mechanical systems were not able to maintain a constant interior temperature, especially during extreme low and high outdoor temperatures. Reptiles and amphibians, being cold blooded animals, cannot regulate their body temperatures and instead rely on the surrounding environment to heat or cool themselves. The majority of animals maintained in this exhibit are from tropical areas with stable temperatures. The recommended temperature for maintaining these animals is a narrow range between 80°F and 82°F. Because this temperature with the accompanying humidity levels are uncomfortable for the viewing public, a separate conditioning system for the animals was recommended. The system would consist of a radiant hot water system. Two polybutylene tubes, one located below gravel level and one placed beneath a foil shield above the screen top would be installed in each glass cage. This sandwich affect creates a micro environment capable of maintaining the required temperature. Other recommendations include waste heat recovery from the existing heating plant flue and adding insulation to all attic areas. The analysis of the Reptile House is currently being conducted, with the final report to be completed in the next months.

The Tropic World of Primates Exhibit (TW) was experiencing low light levels. Built in 1973, TW contains an exhibit of each of the three tropical rain forest regions of the world. All exhibits utilize the concept of total immersion, replicating the look and exhibiting the animals of Africa, Asia, and South America. This concept requires that all mechanical and lighting systems that are visible to the viewing public be camouflaged. TW measures 450 feet long by 125 feet wide and rises 45 feet above ground level. The building's long dimension runs east/west and skylights are located only on the north facing slope of the gambrel roof. All lighting for this exhibit comes from skylights or is reflected off the ceiling from light fixtures hidden in the side walls. Light levels were extremely low, averaging less than 20 lumens per square foot. Low light levels were believed to be contributing to behavior problems among the primates and the poor growth rates of the exhibit's plants. Because the total immersion

concept does not allow the addition of light fixtures that would be visible to the public, simply adding lights to the interior was not possible. Several alternative methods of increasing light levels were studied including the transportation of sunlight into the interior through the use of light tubes. Recommendations for the exhibit areas included adding new skylights and installing reflectors to bounce sunlight into the building. Replacement of all standard fluorescent tubes with electronic ballasts and full spectrum tubes were recommended for off-exhibit animal holding areas.

As mentioned, the recommended retrofits are currently being installed. Upon the complete installation of all recommendations, pre-retrofit fuel bills, both gas and electric, will be compared to post retrofit bills adjusted for degree days.

As each animal has its specific environmental requirements so do the buildings used to house them. With unlimited funds or disregard for energy conservation, any type of environment can be recreated and maintained. The challenge comes in providing an animal with its required microclimate while maintaining suitable environmental conditions for the viewing public in an energy efficient manner. This research attempts to maintain animals in good health and comfort, in an energy efficient environment, while enhancing the mission of increasing public education and awareness of the animal kingdom. We have encountered a diversity of environmental requirements during these studies and look forward to further challenges as we continue working with captive animals and their man-made environments.