edly in both color and size from the captive-laid eggs described here.

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SERUM ESTRADIOL-17β AND TESTOSTERONE LEVELS IN GREAT HORNED OWLS (*Bubo virginianus*)

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Reproductive hormone levels of raptors have been studied in the American Kestrel (*Falco sparverius*) (Rehder et al., Steroids 43(4):371–383, 1984). This study was designed to provide information about estradiol-17β and testosterone levels in the Great Horned Owl (*Bubo virginianus*) and also to determine the effect of the presence of both male and female on the other sex during the breeding season.

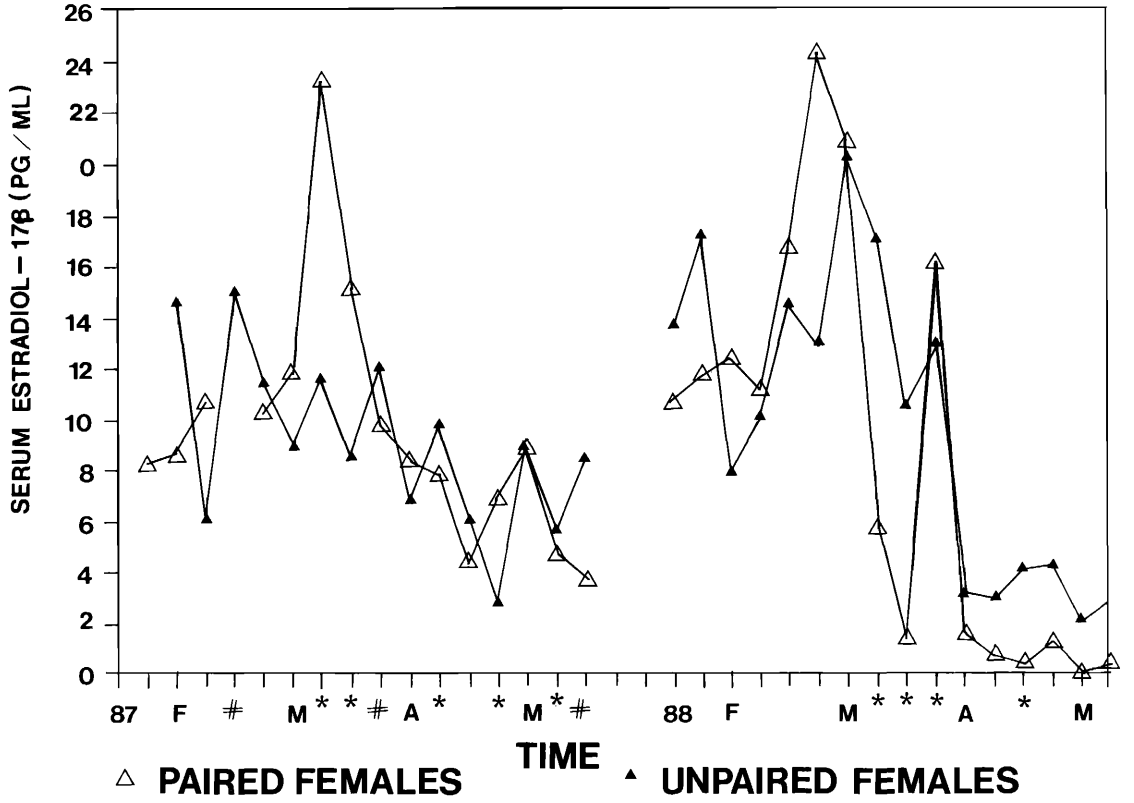

Figure 1. Serum estradiol-17β levels measured in paired female Great Horned Owls (N = 2) and unpaired female Great Horned Owls (N = 3 in 1987, N = 5 in 1988). Values given are mean values for each sample date in pg/ml. (nb * N = 1 paired bird, # N = 1 unpaired bird)

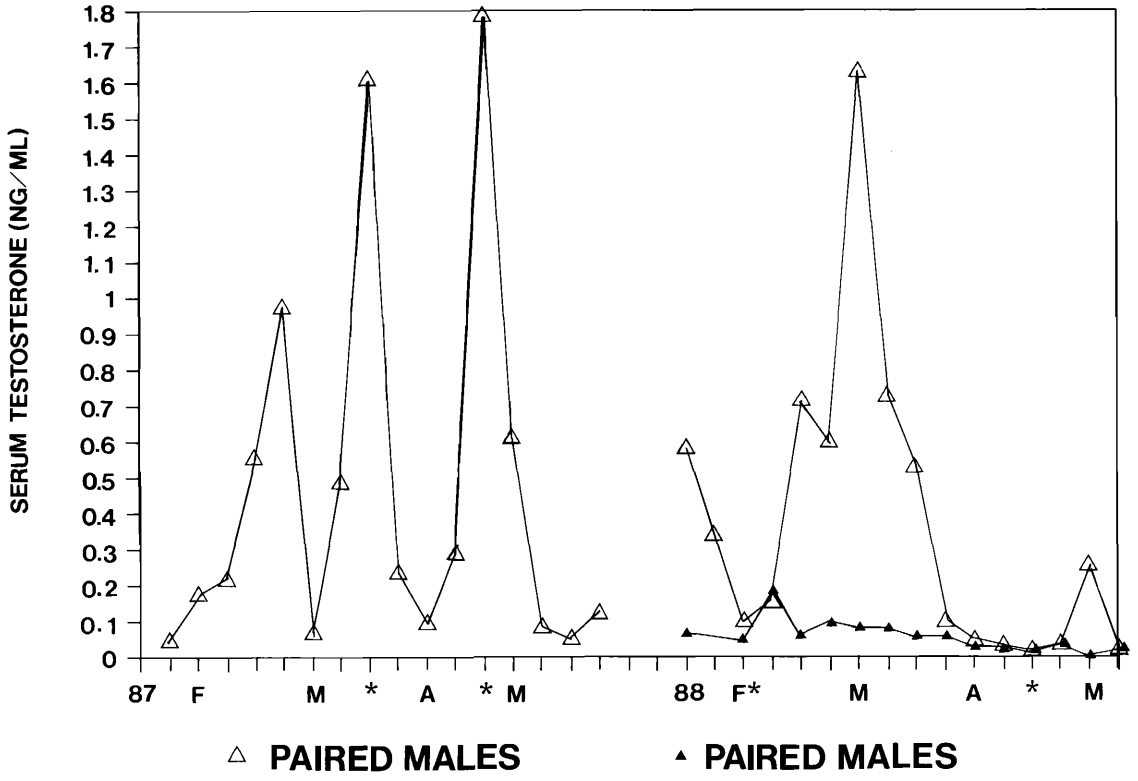

Figure 2. Serum testosterone levels measured in paired male Great Horned Owls (N = 2) and in 1 unpaired male Great Horned Owl (in 1988). Values given for paired males are mean values in ng/ml. (nb * N = 1)

A total of 11 Great Horned Owls were used in this study, 7 birds in 1987 and 10 birds in 1988, 6 of which were part of the 1987 sample group. Each bird was presented to the Calgary Zoo as injured wildlife and was medically and/or surgically treated. Birds were fully recovered from any injuries and had been part of the zoo collection for at least 2 mo prior to the beginning of the study. All birds were fed day-old chicks with vitamin/mineral supplementation (SA-37, Rogar STB, London, Ontario, N6A 4C6). The birds were all housed in outdoor enclosures and were therefore exposed to natural photoperiod and outdoor temperatures.

Each bird was laparascopically sexed then placed into 1 of 2 groups; females only or male/female pairs. Females were housed in groups of 2 or 3 and each of 2 pairs was housed separately. A single male, housed separately, was added to the study during the second year.

Blood samples were collected weekly from all birds from January to May in 1987 (N = 7) and 1988 (N = 10). Two to 3 ml were taken from the brachial vein and placed in a serum tube for centrifugation. Serum was separated and frozen, and the samples were submitted to the reproductive physiology lab at the Western College of Veterinary Medicine, Saskatoon, Saskatchewan for assay. Samples from females were analyzed for estradiol-17β by radioimmunoassay following the method of Rawlings et al. (*Theriogenology* 22:473–488, 1984). Samples from males were analyzed for testosterone by radioimmunoassay according to the method of Cook et al. (*Steroids* 40(4):369–380, 1982). Data was not obtained from all birds at all sampling dates, either due to inability to obtain a sample or due to insufficient sample size. Therefore, no statistical comparison of paired versus unpaired data was done.

During the sampling period, no copulatory behaviour was seen in any of the paired owls and no eggs were laid. One of the pairs being used in the study functioned as foster parents to nestling owls which are presented to the zoo for care. The level of individual bird's estradiol-17β peak in 1987 ranged from 12.5–23.3 pg/ml in paired females (N = 2) and from 12.2–26.5 pg/ml in unpaired females (N = 3). In 1988 individual estradiol-17β peaks in paired females (N = 2) ranged from 14–39.5 pg/ml and in unpaired females (N = 6) ranged from 21.8–32.1 pg/ml. Mean serum estradiol-17β levels in paired females peaked in early March in both 1987 and 1988. Unpaired females showed no definite peak in 1987 but did have an

elevation in serum estradiol-17β in early March of 1988 (Fig. 1). Levels of estradiol-17β in both groups appeared to be higher in 1988 compared to 1987 (Fig. 1).

In both years the peaks in estradiol-17β occurred in all individuals in mid-February to mid-March. Breeding season for Great Horned Owls is January–March while for kestrels is April–May (Bent, Life histories of North American birds of prey. Dover Publications Inc. New York, 1938).

Estradiol-17β levels measured in this study are lower than those recorded by Rehder et al. in egg-laying female American Kestrels. Estradiol-17β levels in those kestrels in February were 74.5 pg/ml. The kestrels were reproductively active (egg-laying) while owls in this study showed no reproductive behaviours and, although no reproductive activity was seen during the study, this is the period during which estradiol-17β peaks occurred in females in this study.

Testosterone levels between the paired males and one unpaired male in this study were notably different (Fig. 2). The unpaired male showed little variation from a level of 0.05–0.1 ng/ml while the paired males appeared to "cycle" at monthly intervals with mean peak serum testosterone levels of 1–2 ng/ml. Unfortunately, only 1 male was unpaired and a larger number of birds would be needed to help determine the validity of these results.

Under the conditions in this study, the levels of estradiol-17β measured in paired and unpaired female Great Horned Owls was lower than levels seen in egg laying American Kestrel females. While the female Great Horned Owls in this study did not seem to need the presence of a male to show some reproductive hormone activity, results seen with 1 unpaired male may indicate that the male may require the presence of a female to cause increases in serum testosterone. A larger sample size would be needed for confirmation.

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CHANGES IN WINTER DISTRIBUTION OF BALD EAGLES ALONG THE COLORADO RIVER IN GRAND CANYON, ARIZONA

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Distribution of wintering Bald Eagles (*Haliaeetus leucocephalus*) in the continental United States has been greatly influenced by construction and operation of dams and reservoirs (Stalmaster 1987). In contrast to reservoir-induced destruction of riverine habitats on which many wintering Bald Eagles have relied, some dams and reservoirs may harbor alternative or new food sources. Eagles may congregate below some dams in winter to feed on fish that are killed or stunned while passing through turbines, or to hunt in ice-free water immediately below other dams (Southern 1963; Spencer 1976; Steenhof 1978). Other riverine phenomena, such as salmonid spawning runs, may influence wintering Bald Eagles to congregate (Servheen 1975; Stalmaster 1976). In Glacier National Park, Montana, introduced Kokanee Salmon (*Oncorhynchus nerka*) have attracted the densest concentration of migrating Bald Eagles in the continental United States (McClelland et al. 1982).

In this study, we document how operation of Glen Canyon Dam and a run of introduced Rainbow Trout (*Salmo gairdneri*) have changed the abundance and distribution of wintering Bald Eagles along the Colorado River in Grand Canyon National Park, Arizona.

The study area encompassed a 386 km segment of the Colorado River from Glen Canyon Dam to Diamond Creek, Arizona. Completion of Glen Canyon Dam on the Colorado River near Page, Arizona, greatly altered downstream river characteristics through Grand Canyon National Park (Turner and Karpiscak 1980; Howard and Dolan 1981). Average annual maximum flows were reduced from 2438 cubic m/sec (cms) to 790 cms, and median discharge was increased to 360 cms. Average diurnal fluctuation in river stage was increased from a few centimeters to several meters; median sediment concentrations were reduced from 1500 to 7 parts per million. Average annual water temp was reduced from a range of 0.2°–28°C during