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

the pre-impoundment period (1949–1962), to a range of 5 5°–18°C during the 1963–1976 post-impoundment period (Turner and Karpiscak 1980). Completion of the dam changed the Colorado River from a turbid, seasonally variable stream supporting a native, warm-water fishery into a clear, relatively non-fluctuating stream supporting a largely non-native, cold-water fishery (Johnson and Carothers 1987).

Dominant native fishes of the pre-impoundment river, including Bonytail (*Gila elegans*), Humpback Chub (*G. cypha*), Roundtail Chub (*G. robusta*), Colorado Squawfish (*Ptychocheilus lucius*), and others, were extirpated or reduced in numbers following impoundment, and introduced Rainbow Trout and Common Carp (*Cyprinus carpio*) began to dominate the fishery after 1963 (Johnson and Carothers 1987). Trout had been introduced into several Colorado River tributaries in Grand Canyon prior to 1963, but colonization was limited in the mainstream; trout quickly colonized the river after impoundment, both from tributaries and from Arizona Game and Fish Department stocking efforts below Glen Canyon Dam (Maddux et al. 1987).

In the mid-1970s spawning Rainbow Trout were first observed in Nankoweap Creek, a small tributary to the Colorado River 110 km downstream from Glen Canyon Dam. Trout had never been introduced directly into the creek. By the mid-1980s as many as 1500 spawning Rainbow Trout were present in the lowermost 1.5 km of the creek on peak days during the spawn, which lasted from November through April (H. Maddux and D. Kubly, pers. comm.).

Nankoweap Creek is an 84.4 km^2 drainage arising on the North Rim of the Grand Canyon, flowing 14 km to its confluence with the Colorado River (Webb et al. 1987). The creek is fed by perennial springs and runoff from the Kaibab Plateau. Annual flows range from 0–1.09 cms (Johnson and Sanderson 1968), but winter flows typically range from ca. 0.05–0.20 cms.

We surveyed the study area for wintering Bald Eagles 8 times from March 1987 to April 1988 (Fig. 1). Approximately 20–25 km/d were surveyed from boats as we floated downstream on each of 5 boat surveys; 1–7 d were also spent at the mouth of Nankoweap Creek on each survey. Three rim surveys of the Nankoweap Creek area were made from a fixed point on the canyon rim within the Navajo Indian Reservation using spotting scopes. Individual eagles may have been counted more than once during downriver surveys due to the number of days of each and the fact that individual eagles could easily have flown from one survey area to the next in a day. Count data from fixed points at or near the mouth of Nankoweap Creek listed in Figure 1 were taken from the greatest number of adults or subadults seen at one time on any given day. Numbers of trout in the lowermost 0.65 km of Nankoweap Creek were counted on each visit to that site. Historical information on eagle presence in the study area was obtained from river surveys by Carothers and Aitchison (1976) and by D. H. Ellis (pers. comm.), and from helicopter surveys by the Navajo Fish and Wildlife Department (unpubl. report, Windowrock, Arizona).

The known occurrence of Bald Eagles in the study area is summarized in Figure 1. Abundance and distribution of wintering Bald Eagles along the Colorado River in Grand Canyon was unknown before 1963; however, post-impoundment winter surveys for Bald Eagles suggest that eagles were not present immediately after construction of the dam.

Wintering Bald Eagles have increased in numbers along the Colorado River in Grand Canyon, evidently in response to trout availability in Nankoweap Creek and in the river. Regulated discharge from Glen Canyon Dam apparently induced these changes. The mouth of Nankoweap Creek was a concentration point for eagle activity due to apparent ease with which eagles could forage on spawning trout in the shallow, exposed creek channel, but eagles were also found in other areas above confluence of the Little Colorado River.

Spawning trout were observed in Nankoweap Creek from December 1987–April 1988, with one or more peaks of spawning between January and March 1988. Adult trout densities ranged from 54–457 individuals in the lowermost 0.65 km of the creek, with increasing abundance of trout fry through April. Spawning trout averaged 41 cm in length (N = 30; S.E. = 1.19cm). Prey captures of live trout (no dead trout were seen during the study period) were observed (N = 7) in the lowermost 0.3 km of the creek and at the confluence of the river and the creek. Bald Eagles were present at the mouth of Nankoweap Creek only when spawning trout were present; the known peak of eagle occurrence (18 individuals in February 1988) coincided with the approximate peak of the trout spawn

Development of a concentration of wintering Bald Eagles at Nankoweap Creek in Grand Canyon is similar to the increase in eagle abundance documented at McDonald Creek in Glacier National Park, Montana (McClelland 1973). Kokanee Salmon were introduced into McDonald Creek in 1916, and annual autumn spawning eventually attracted large numbers of migrating Bald Eagles which formerly had been uncommon (McClelland 1973).

Increase in eagle abundance at Nankoweap Creek in Grand Canyon is of management concern to both the Bureau of Reclamation (which manages water released from the dam) and the National Park Service (which manages recreational use of Nankoweap Creek). Low water levels released from the dam in winter can seriously impair trout spawning (Maddux et al. 1987), and therefore the eagle prey base. The National Park Service is under steady pressure to allow greatly increased recreational fishing use of Nankoweap Creek to exploit the newly-developed trout spawn, a potential source of disturbance to the eagles (Stalmaster and Newman 1978). Bright Angel and Tapeats creeks (ca. 60 and 150 km downstream, respectively)

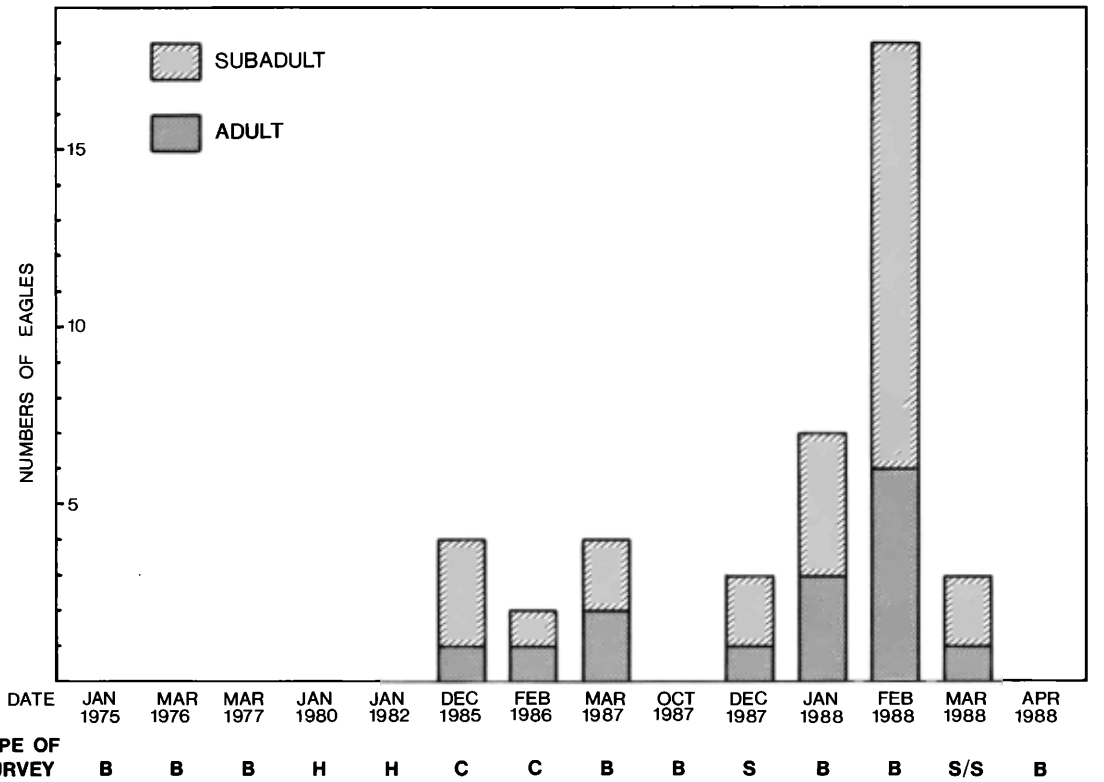

Figure 1. Occurrence of wintering Bald Eagles along the Colorado River in Grand Canyon National Park, Arizona, 1975–1988. Types of eagle surveys include: B = 18-d boat survey of entire river corridor; H = 1-d helicopter survey of upper third of study area (Glen Canyon Dam to Little Colorado River; 123 km); C = casual observations by biologists at the mouth of Nankoweap Creek; S = 1-d survey of mouth of Nankoweap Creek from canyon rim using spotting scope.

also support sizeable trout spawns along this section of river, but other factors may preclude their usefulness as alternative eagle foraging areas. Bright Angel Creek is the site of an intense recreational development, while Tapeats Creek enters the river in an extremely narrow bedrock gorge where spawning trout would be less accessible to foraging eagles.

Although the regional abundance of wintering Bald Eagles may vary annually, the 18 eagles at Nankoweap in February 1988 represented ca. 20% of the total statewide wintering population (Grubb and Kennedy 1982). Annual abundance of spawning trout at Nankoweap Creek and their accessibility to foraging eagles suggest future increases in the number of Bald Eagles there as the regional wintering population becomes aware of and habituated to this new food resource.

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EGG MEASUREMENTS FROM A NORTHERN GOSHAWK (*Accipiter gentilis gentilis*) INCLUDING ONE ABNORMALLY LARGE EGG WITH TWIN EMBRYOS

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Twin embryos are rare in the eggs of wild birds (O'Conner 1984). In captive birds the incidence of twinning has been experimentally increased in the Mallard (*Anas platyrhynchos*) by keeping the eggs at low temp prior to incubation (Batt et al. 1975) and in Domestic Chickens (*Gallus gallus*) by exposing laying females to temps inducing hypothermia (Sturkie 1946). Romanoff and Romanoff (1949) considered that double yolks were not unusual in Domestic Chickens although single yolked eggs with 2 blastoderms were very rare. We can find only 1 published account of twin embryos in the egg of a raptor, namely a Peregrine (*Falco peregrinus*) from Greenland (Pattee et al. 1984).

As part of a population study of the Northern Goshawk (*Accipiter gentilis gentilis*) in Great Britain we visited a nest on 5 May 1988 and noted 1 very large egg amongst a clutch of 3 fresh eggs. The largest egg was the dirtiest,