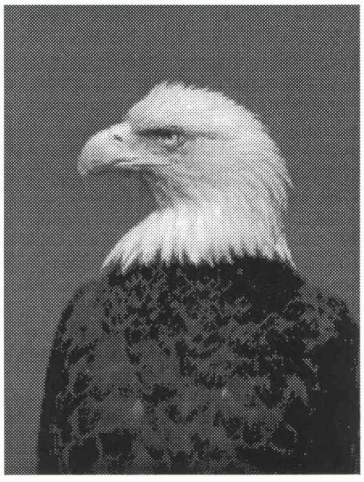
Wintering Bald Eagles in the Grand Canyon: 1993-1994

Cooperative Agreement: 8029-8-0002

Project Name: WINTER BALD EAGLE MONITORING



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December 1994

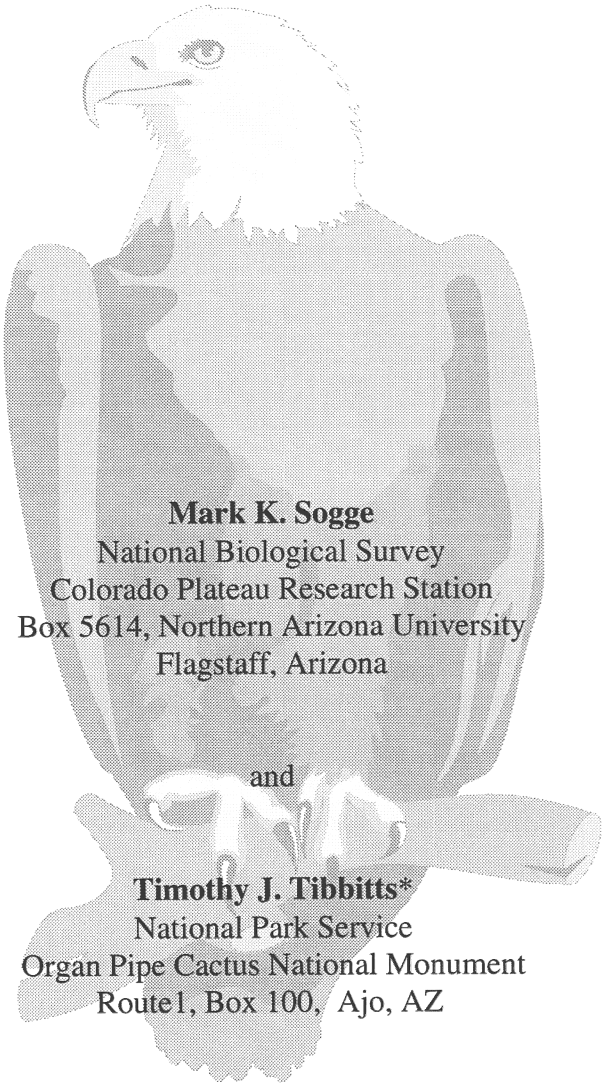

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Each winter, bald eagles (*Haliaeetus leucocephalus*) concentrate along the Colorado River corridor in the Grand Canyon, primarily in the reach from Glen Canyon Dam downstream to the confluence of the Little Colorado River. As a Federally-listed endangered species, the bald eagle is a species of special concern to Grand Canyon National Park. Previous research has documented the patterns of eagle presence and distribution in the Grand Canyon, and investigated the relationship between food supply (rainbow trout - *Oncorhynchis mykiss*) and eagle abundance, as well as the effect of water discharge rates from Glen Canyon Dam. Grand Canyon National Park, the U.S. Fish and Wildlife Service, and the Arizona Game and Fish Department recognized the need to continue monitoring the winter distribution and concentration(s) of eagles, and to monitor trout abundance at the primary eagle concentration site - Nankoweap Creek. This study was initiated in response to these monitoring needs, and was designed to: (1) continue monitoring the eagle concentration at Nankoweap Creek and in the upper Grand Canyon corridor, (2) determine if canyon rim-based eagle monitoring is feasible, and (3) gather information necessary to develop and refine a long-term eagle monitoring program.

In 1993, Nankoweap Creek was subject to many turbid, high volume flows that reduced the availability of trout. Trout were usually present and in spawning condition, but in relatively small numbers and were found in places that provided protection from bald eagles. Correspondingly, few eagles concentrated at Nankoweap in 1993; the high count of five occurred on 27 February. During 1994, Nankoweap Creek typically ran much lower and clearer. On average, there were approximately 50 trout in the creek each day, but they were hidden in undercut banks and deep pools that provided shelter from foraging bald eagles. As in 1993, few eagles concentrated at the creek during 1994; the high count of six occurred on 5 March.

During 1993 and 1994, a pair of bald eagles appeared to defend a winter feeding territory around Nankoweap Creek. Their aggressive behavior toward other eagles may have contributed to the low numbers of eagles utilizing Nankoweap Creek. Although not confirmed, there is a *possibility* that these eagles may breed in the area.

Helicopter-based surveys found that eagles continue to be present in relatively large numbers throughout the upper river corridor, even when numbers are low at Nankoweap Creek. The high counts along the river were 13 (29 December 1992) and 20 (20 January 1994). The upper river corridor is clearly an important resource for eagles migrating and wintering in Arizona, and we recommend continued helicopter-based monitoring.

Human disturbance was low in 1993, but higher 1994 when the Park did not invoke a closure of the Nankoweap area. Research-related activities had no significant effects, but hikers, anglers, and persons camping near the Nankoweap delta did cause disturbance. We recommend that the Park initiate recreation closures of lower Nankoweap Canyon and the Nankoweap delta area from 1 January through 15 March of every year.

INTRODUCTION

Bald eagles are found throughout North America from Alaska south to northern Mexico. Common breeders in Alaska and parts of Canada, bald eagles are far less common in the lower 48 United States, where they still face a variety of human-related threats (U.S. Fish and Wildlife Service 1991). Recently, the U.S. Fish and Wildlife Service [USFWS] has proposed reclassification of the bald eagle from endangered to threatended status in most of the lower 48 states, except in portions of the southwest (including Arizona) where it would retain endangered status (USFWS 1994). The Arizona Game and Fish Commission also lists the species as endangered (Arizona Game and Fish Department 1988).

During the winter, bald eagles in northern and central areas migrate to southern latitudes of North America. Although large concentrations of wintering bald eagles are rare in the Southwest, significant numbers are found scattered throughout Arizona, where state-wide eagle counts totaled 225 in 1992 (Beatty 1992) and 350 in 1994 (G. Beatty, pers. comm.). Most wintering eagles concentrate along rivers, lakes and reservoirs where preferred prey such as fish and waterfowl can be found. Many eagles also concentrate and roost in forested areas of the Coconino and Apache-Sitgreaves National Forests.

In some years, the Colorado River corridor of Grand Canyon National Park hosts one of the largest concentrations of wintering bald eagles in Arizona, and indeed the entire Southwest (Brown et al.1989, National Park Service 1992). From November through March, eagles forage for fish and waterfowl along the Colorado River in Grand Canyon National Park and Glen Canyon National Recreation Area, primarily from Glen Canyon Dam (River Mile [RM] -15.5) to the confluence of the Little Colorado River (RM 61.5). As many as 23 eagles have been observed in this stretch of river during the winter of 1991(National Park Service 1992). Bald eagles are also regularly seen by commercial, private, and research river trips from November through March. Such evidence clearly demonstrates that the river corridor is used extensively by wintering and migrating bald eagles.

Bald eagles sometimes concentrate at Colorado River tributaries where rainbow trout spawns occur. One such tributary is Nankoweap Creek(RM 52), where bald eagles have concentrated since the early-1980s (Brown et al. 1989, National Park Service 1992). Beginning in 1987, when a professional river guide saw six bald eagles at the Nankoweap Creek delta, the Grand Canyon eagle concentration has become the focus of much study. Researchers began regular monitoring of the eagles at Nankoweap in 1988 (Brown et al. 1989), when the concentration peaked at 18 eagles. In 1990 and 1991, the Canyon Environmental Studies (GCES) program funded research by the National Park Service Cooperative Park Studies Unit and Northern Arizona Univeristy. This research included extensive studies of creek morphology and flow, trout abundance, movement, morphology, and reproduction, as well as eagle abundance, foraging ecology, and human disturbances. The highest number of eagles per day was at least 26 in 1990 and 13 in 1991, and eagle numbers varied directly with the abundance of trout in Nankoweap Creek. The results of these Nankoweap research efforts have been presented in detail in Brown and Leibfried (1990), Brown and Stevens (1992), National Park Service (1992), Brown (1993), and Leibfried and Montgomery (1993).

It quickly became evident that the eagle concentration at Nankoweap Creek is a result of, and dependent upon, the spawn of rainbow trout which typically occurs from December through April. Trout were first introduced into selected tributaries within Grand Canyon National Park in the 1920s, then colonized the mainstream river (with help from introductions made upstream at Lees Ferry). Although trout were never introduced directly into Nankoweap Creek, a limited spawn was noted in Nakoweap Creek in the winter of 1977-78 (Carothers and Minckley 1981). The clear and cold river flows that resulted from the operation of Glen Canyon Dam provided ideal conditions for trout growth and survival (although successful reproduction is limited and populations are maintained by regular introductions at Less Ferry [W. Leibfried, *pers. comm.*]). By the mid-1980s as many as 1,500 trout were present in the lower 1.5 km of Nankoweap Creek during the peak spawn (Brown et al. 1989). Large numbers of trout in the shallow, clear, and slow waters of Nankoweap Creek provide an easy foraging opportunity for bald eagles, which are known for their tendency to exploit abundant, easily-procured prey (Stahlmaster 1987). Not surprisingly, the number of eagles generally peaked with the number of trout present in the creek (Brown et al. 1989, National Park Service 1992).

Even though the eagle concentration at Nankoweap Creek was in some years quite significant and received much research and management attention, it is important to note that the number of eagles at the creek accounted for fewer than one-fourth of the total number of eagles in the river corridor on any given day in 1991 (National Park Service 1992). This should be kept in mind lest the importance of the entire river corridor be overlooked.

In 1992, following the cessation of the intensive research efforts at Nankoweap Creek, Grand Canyon National Park requested that the Colorado Plateau Research Station (formerly the Cooperative Park Studies Unit) coodinate and conduct continued winter bald eagle monitoring along the river corridor and at Nankoweap Creek. Continued monitoring was suggested because of the endangered status of the bald eagle, the need for additional baseline data on abundance and distribution, the potential effect of fluctuating river flows on prey (trout) availability, and the susceptibility of eagles at Nankoweap to disturbance by human activity (National Park Service 1992). The monitoring was funded for 1993-1995 by the Bureau of Reclamation as part of the Glen Canyon Environmental Studies. This report summarizes the results of our study from 1993 and 1994. Information from our 1995 monitoring will be incorporated into the final project report, which is due to be completed in June 1995.

METHODS

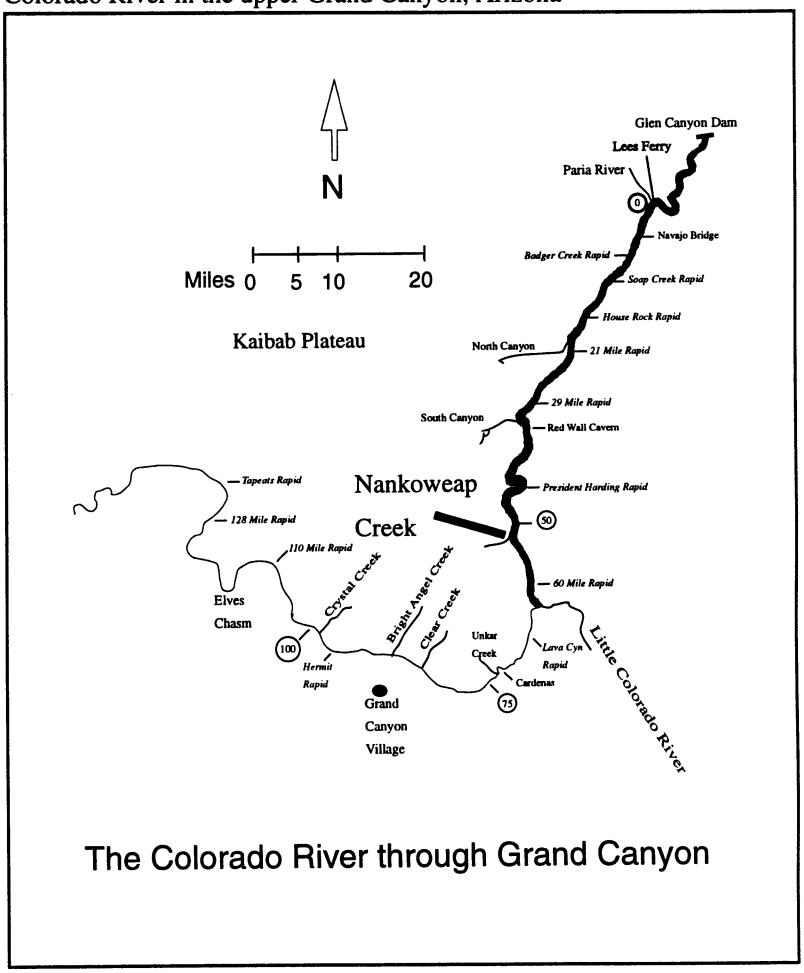
Project Coordination

This project was coordinated by the National Biological Survey Colorado Plateau Research Station, Northern Arizona University, and the USFWS Arizona Ecological Services Office in Phoenix. Principal investigators were Dr. Charles van Riper III (CPRS/NAU) and Dr. Terry May (NAU). Project leaders were Mark Sogge (Ecologist, CPRS/NAU) and Timothy Tibbitts (formerly an Endangered Species Biologist, USFWS). Bald eagle surveyors included experienced personnel hired specifically for this project (through the CPRS/NAU), as well as qualified volunteer personnel from National Parks, federal and state agencies, and Northern Arizona University.

Study Area

We monitored winter bald eagles in 1993 and 1994 along the upper Colorado River corridor within Grand Canyon National Park and Glen Canyon National Recreation Area, from Glen Canyon Dam (elevation 945 m) to the Little Colorado River (elevation 825 m: Figure 1). The water released from the dam is clear and an almost constant 9° C. Throughout the year, the water generally remains clear (with visibility often exceeding 1 m) downstream to the Little Colorado River, although sediment from the Paria River (RM 1) can cloud river flows for up to several days at a time. Weather and climate patterns for the Colorado River are summarized in Stevens (1983).

Figure 1. Location of the bald eagle monitoring study area along the Colorado River in the upper Grand Canyon, Arizona



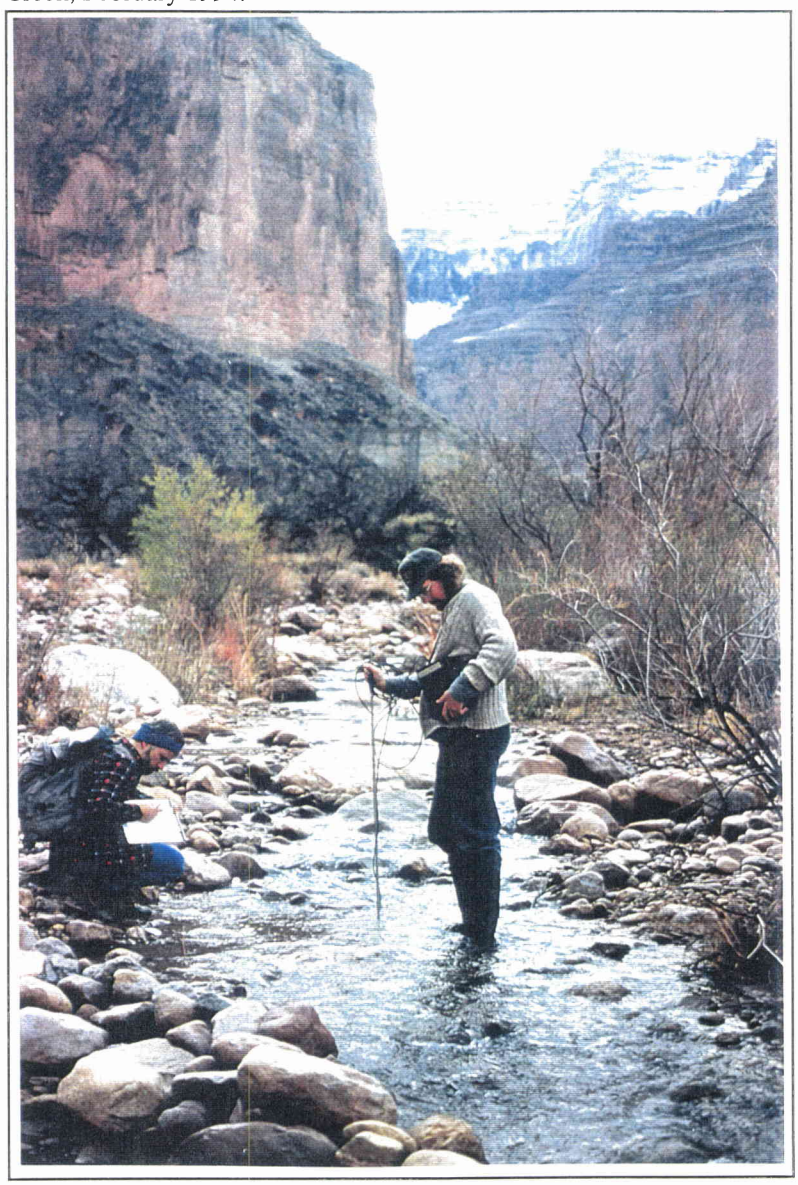
Major emphasis was placed on studying the eagles and trout in the lower 600 m of Nankoweap Creek, a small perennial tributary that enters the Colorado River at approximately RM 52 (Figure 1). The creek flows roughly 14 km from 2,900 m elevation to its confluence with the river at elevation 880 m. The creek is fed by perennial springs and runoff/snowmelt from the Kaibab Plateau, with annual flows ranging from 0-35 cubic feet per second [cfs] and winter flows from 1-6 cfs (Johnson and Sanderson 1968), typically about 1-2 cfs (Leibfried and Montgomery 1993). The lower 600 m is a narrow channel of shallow riffles and runs interspersed with small pools, with very little shrub or tree vegetation along the shores (Figure 2). Stream morphology, substrate, and physiochemical properties were described by Leibfried and Montgomery (1993).

Figure 2. Lower Nankoweap Creek as viewed from the Nankoweap Overlook, February 1994.

Stream Characteristics Data

We periodically measure stream velocity at several sites in the lower 100 m of the creek using a Marsh-McBirney current meter mounted on a standard wading rod (Figure 3). We measured stream depth and width at each cross-section site, and mutliplied these by stream velocity to obtain discharge (cfs). Nankoweap Creek temperature was taken with a small, hand-held thermometer, accurate to approximately 0.5° C. The thermometer was placed in a slow-flowing portion of the creek until the temperature reading stabilized (usually approximately one minute), after which we recorded the temperature.

Figure 3. Research crew recording creek flow data in lower Nankoweap Creek, February 1994.



Trout Numbers, Spawning and Morphology

We counted the number of trout in Nankoweap Creek at least twice weekly in 1993, and every other day during 1994. Counts were made by visual observation while walking slowly along the edge of the creek, and by using small dip-nets to slowly probe into deep pools and undercut banks. We conducted most counts at night to minimize disturbance to bald eagles, and because fish in the creek shallows were less wary and easier to count after dark. Trout counts were stratified into three different reaches: reach 1 = creek mouth to 200 m upstream, reach 2 = 200 - 400 m, reach 3 = 400 - 600 m (Figure 2).

Each week, we used dip nets to capture up to 25 trout from each reach of the creek, and measured their standard length (SL) and total length (TL) in millimeters. In 1994, we also measured their mass in grams using an OHAUS Model CT6000-s electronic balance. All captured fish were categorized with regard to their spawning condition:

Immature = no spawning coloration, no visible eggs or sperm
Loaded = spawning coloration in male, eggs felt by palpating female
Ripe = eggs or sperm released from body when palpated
Spent = sagging abdomen in females (possibly harder to tell in males)

In order to determine the number, size, and spawning condition of trout staging in the river at the mouth of the creek, we captured fish by angling at the confluence area on two occassions in 1994. Measurements of these fish were taken as described for creek-caught fish (above).

Eagle Surveys

Helicopter surveys: We performed helicopter-based surveys of the Colorado River corridor between Glen Canyon Dam the Little Colorado River (Figure 1). This portion of the river has lower turbidity, higher productivity, and higher trout densities than the river below this point. Eagles are regularly seen in this reach during the winter, so we concentrated our surveys there. Helicopter-based surveys are commonly used to count bald eagles and other raptors, and are an efficient method for determining the distribution and number of bald eagles present along the Colorado River corridor (Stahlmaster 1987, Beatty 1992, National Park Service 1992). Helicopters allow coverage of a large area in a relatively short time, and permitted quick and effective surveys of the wintering eagle population throughout the upper river corridor.

The helicopter surveys followed the protocol used in 1991 (National Park Service 1992), and utilized the Grand Canyon National Park helicopter. We conducted two surveys per week during the last two weeks in February and the first week in March, the period of peak eagle abundance in the Grand Canyon (National Park Service 1992). The surveys were made in the mornings (usually beginning no later than 0900 hrs), when eagle numbers at Nankoweap Creek were greatest in 1990 and 1991. The helicopter started at the Little Colorado River and flew upstream to Glen Canyon Dam, 100 m above the river at a speed of approximately 90 km/hr.

Each survey included, in addition to the helicopter pilot, one primary eagle surveyor and one "navigator". The primary eagle surveyor was responsible for observing and counting the eagles while the navigator recorded information. For each eagle observed we recorded location (river mile to the nearest 0.1 mile) and time of sighting, the number, where the eagle was sighted (shore, riparian, talus, cliff, or flying), height above the river, detection distance and location relative to the helicopter, and the distance at which the eagle flushed (if it did). Each eagle was assigned to one of three age classes, for which the field characteristics are summarized below:

Adult (4 yrs or older):	head and tail primarily white; back, breast and belly dark
Subadult (1-3 yrs old):	head primarily dark; back dark with white feathers forming an upside-down triangle; white belly contrasting with dark breast; tail variable (dark to dirty white with dark tips)
Immature (<1 yr):	head and body generally dark; dark beak, back, breast and belly; tail dark

The sighting locations and associated information are being entered into ARCINFO for incorporation into the Grand Canyon National Park and GCES Geographic Information Systems.

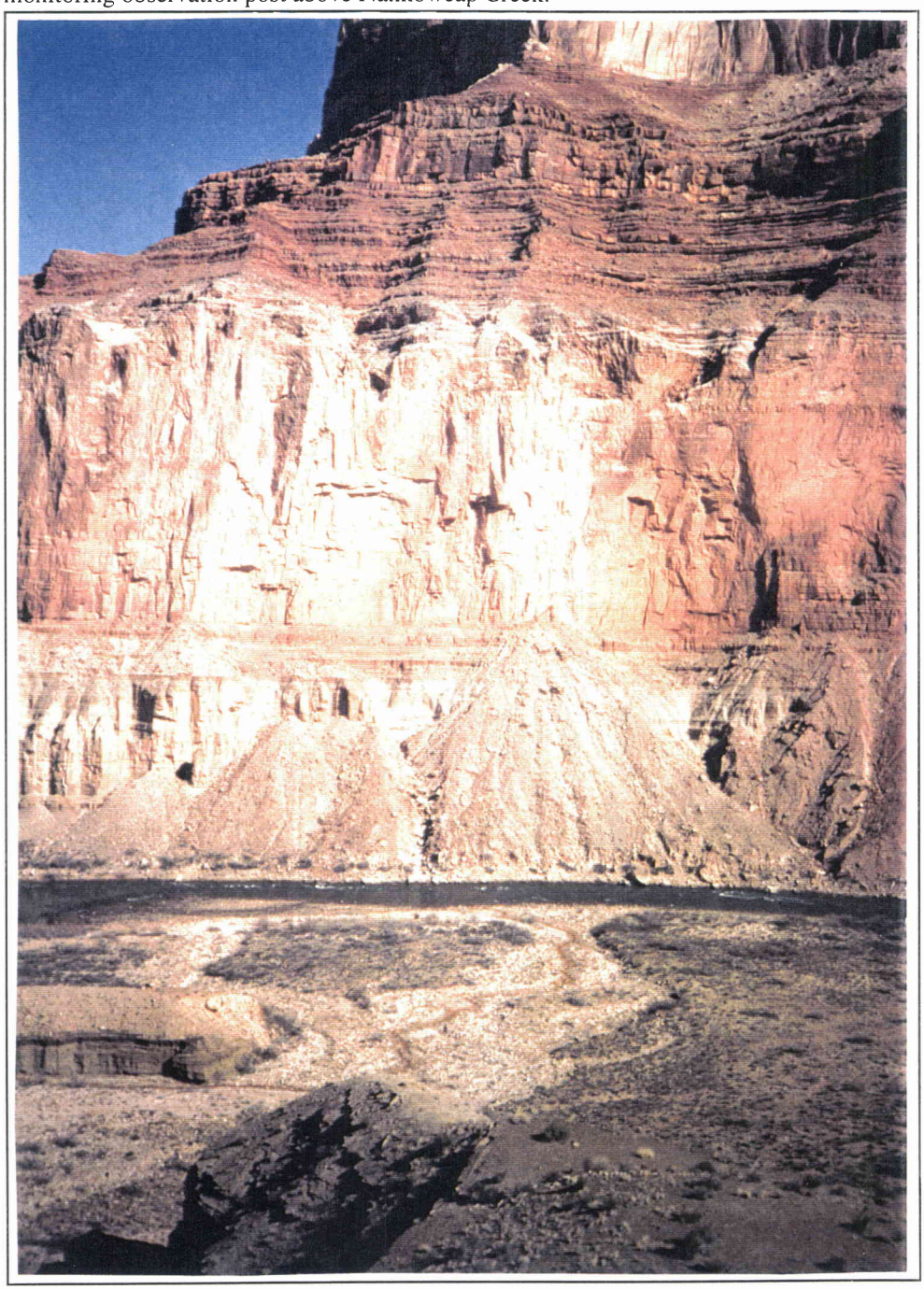
Nankoweap Creek surveys. We utilized the same observation point (OP) that was used during the 1990 and 1991 research programs. The OP is located under a small overhang in the Redwall cliff, approximately 800 m west and 100 m above the mouth of Nankoweap Creek (Figure 2). Crews of two to four persons used binoculars and spotting scopes to observe and count the number of bald eagles present in the Nankoweap delta area, including the lower 800 m of Nankoweap Creek and the entire viewshed of the observation point (Figure 4). Counts were conducted each day from 16 February through 06 March 1993, and 14 February through 07 March 1994 . Observations were made from 0700-1200 hrs in 1993, and 0700-1800 hrs in 1994.

Every hour, the surveyors recorded the total number of bald eagles simultaneously in view and marked the location of each eagle on aerial photos. Eagles were assigned to one of five plumage/age classes for which the field characteristics are summarized below:

Adult:	white head and tail; bright yellow beak and cere; body and wing feathers dark
Near-adult:	head and tail mostly white, some brown/black flecks or spots; beak and cere yellow with some dark spots; body and under wing coverts may have white flecks
Transition:	head primarily white but with dark eyeline; beak and cere dirty yellow; some white feathers on back, breast, and belly; tail dark to white with dark tips
White-belly:	head generally dark with buffy supercilliary line; beak and cere slate color; back tawny with white feathers forming an upside-down triangle on back; dark breast with contrasting whitebelly; under wing coverts tawny with white diagonal line and axillary spot
Immature:	head uniformly dark brown; eye dark; beak and cere black; body dark overall; underwing coverts tawny with white diagonal line and axillary spot; tail dark with dark tips and borders

Additional details on classifying bald eagle molts and plumages are presented by Bortolli (1984) and McCollough (1989).

Figure 4. Lower Nankoweap Creek, the Colorado River, and the canyon cliff faces and talus slopes where bald eagles often perch opposite the Nankoweap Delta. View is from the eagle monitoring observation post above Nankoweap Creek.

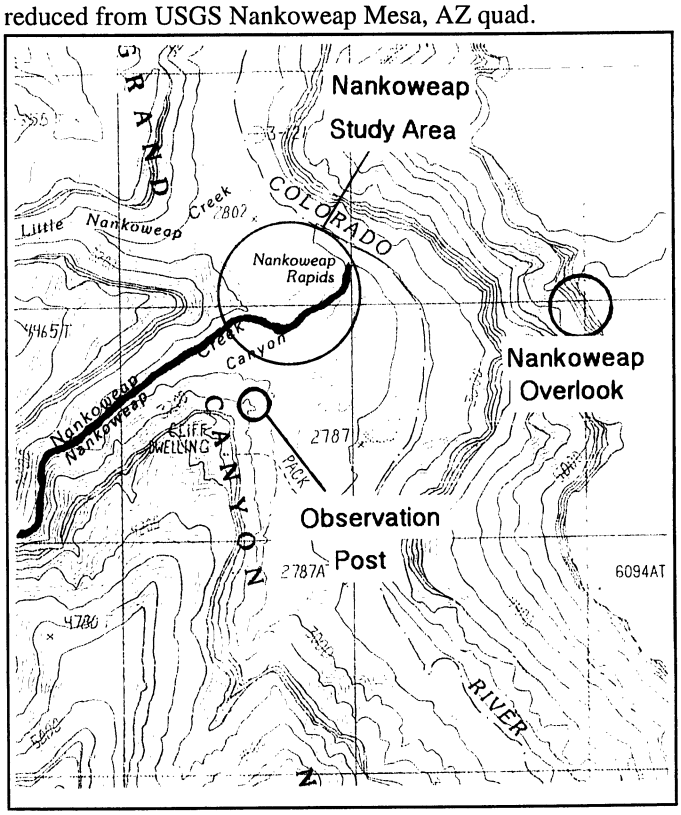


Because our study did not involve the capture and marking of individual eagles, we could not distinguish between individuals within a particular age class. In order to avoid "double-counting" any individuals that may have repeatedly moved into and out of the survey area, we tallied only the maximum number of simultaneously observed eagles in each age class. This leads to a conservative estimate of the number of eagles present each hour (or day), because subsequent observations of an eagle within one age class *could* be different eagles, but were always treated as though they were not. The total number of eagles detected each day was calculated by combining the highest hourly counts of each age class. Individuals with unique plumage characteristics were added to the daily total if they were not observed concurrently with the largest daily age group. Overall, our conservative technique may have underestimated daily eagle abundance.

We also recorded the number, location, prey type, and success of any eagle foraging attempts that were within view of the OP.

Nankoweap Overlook Surveys. We tried to count the number of bald eagles that were concentrating at Nankoweap Creek by stationing observers along the sheer canyon rim at the Nankoweap Overlook (Figure 5). Counts were conducted hourly from 0700-1200 hrs on two days during the end of February and the first week of March in 1993 (wet weather and the resultant poor road conditions precluded additional rim surveys). Observers used binoculars and high-powered spotting scopes to count the number of bald eagles that they could see from the overlook. Every hour, the surveyors recorded the number of bald eagles present (by age classes described in *Nankoweap Creek Surveys* above) and marked the location of each eagle on aerial photos of the area. Rim-based surveyors also attempted to visually determine if trout were present in lower Nankoweap Creek or in the Colorado River at the mouth of the creek.

Figure 5. Lower Nankoweap Creek, the Nankoweap overlook area, and the Nankoweap Delta observation post. Map is reduced from USGS Nankoweap Mesa, AZ quad.

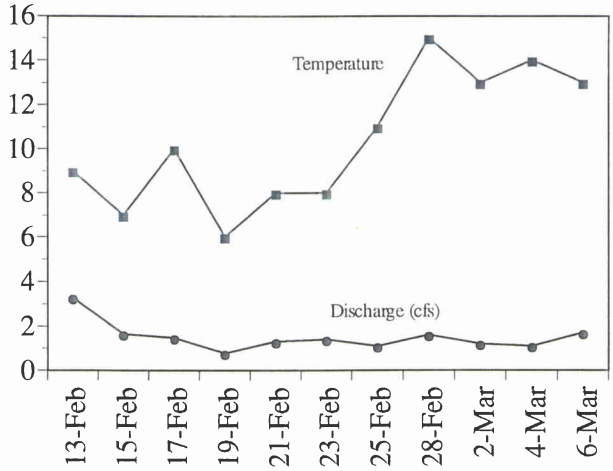


RESULTS

Physical Characteristics of Nankoweap Creek

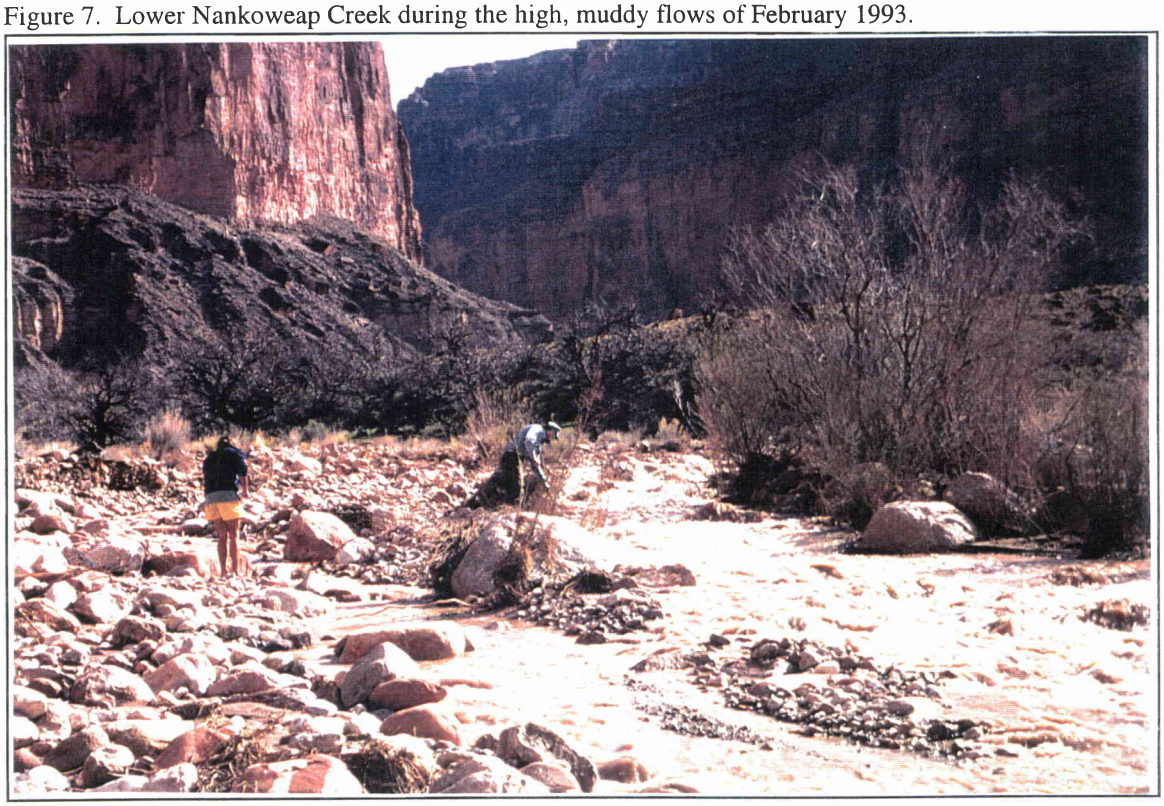
Stream flows in Nankoweap Creek varied greatly between 1993 and 1994. During 1993, winter rains and snowmelt caused repeated flash-flooding and high flows lasting up to several days. As a result the creek flows often varied widely from day to day. Flow readings taken approximately 50 m upstream of the creek mouth were greater and more varied in 1993 [7 cfs (17 Feb), 35 cfs (21 Feb), and 15 cfs (3 Mar)] than any flows in 1994, which averaged 1.5 ± 0.7 cfs (n=11 days; Figure 6).

Figure 6. Temperture (°C) and discharge (cfs) in lower Nankoweap Creek, 1994.



Due to the high discharges in 1993, the creek was often cloudy or muddy, with few days of clear water (Figure 7). The heavy flows within the main creek channel and throughout a series of braided "overtop" channels moved large amounts of cobble and large rock downstream. In contrast, 1994 was characterized by relatively clear water.

Figure 7. Lower Nankoweap Creek during the high, muddy flows of February 1993.



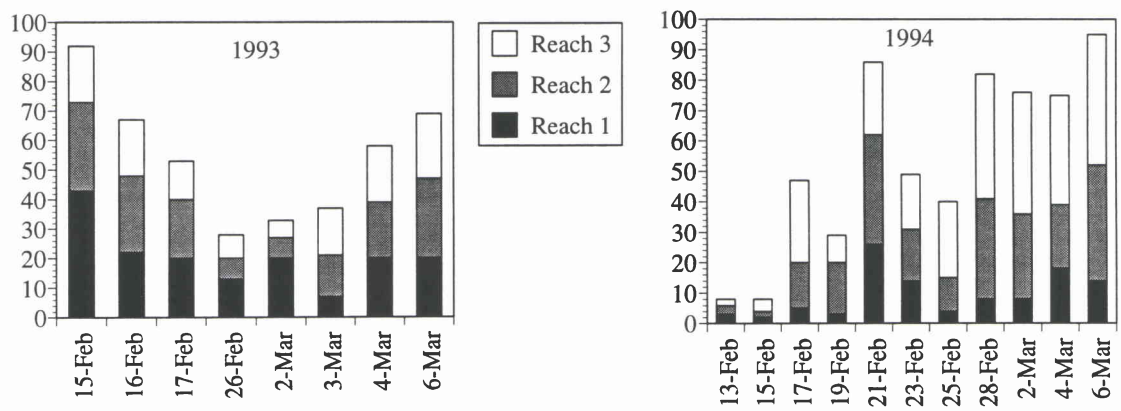
Creek temperature averaged 11 ± 1 °C (range = 10-12, n=4) in 1993 and 10 ± 3 °C (range = 6-14, n=12) in 1994. Temperatures were generally lower in the first part of February 1994, then rose thereafter (Figure 6).

In both years, reaches 1 through 3 were characterized by long stretches of shallow riffles and runs, interspersed with boulders and small pools up to about 1 m deep. These small pools usually formed below boulder areas where water cascaded into the pool and created bubbles that obscured vision into the water. The stream banks were often sufficiently undercut in the pools and riffle/run areas to provide hiding places for even the largest rainbow trout. Although substrate types were not strictly quantified during1993 and 1994, we observed that there was very little silt or gravel; cobble appeared to be the predominant substrate. There was very little emergent vegetation growing out of or alongside the creek.

Rainbow Trout in Nankoweap Creek

Numbers and distribution: We conducted eight trout counts in 1993 and 11 counts in 1994. Spawning rainbow trout were present in the lower 600 m of Nankoweap Creek on every count during both years, and averaged 55 ± 22 trout per day in 1993, and 52 ± 31 in 1994. During 1993, trout counts ranged from 28 to 98, and were lowest in late February and early March (Figure 8). However, high water and turbid conditions during this period often made counting difficult or impossible. Thus, these low counts may reflect low trout detectability rather than the actual number of trout present. This is supported by the fact that we sometimes caught "unseen" trout when we probed pools and undercut banks with nets during turbid water condition. Trout numbers varied more in 1994, starting very low and generally increasing to a high of 95 in early May (Figure 8).

Figure 8. The number of rainbow trout detected in the lower 600 m of Nankoweap Creek during 1993 and 1994

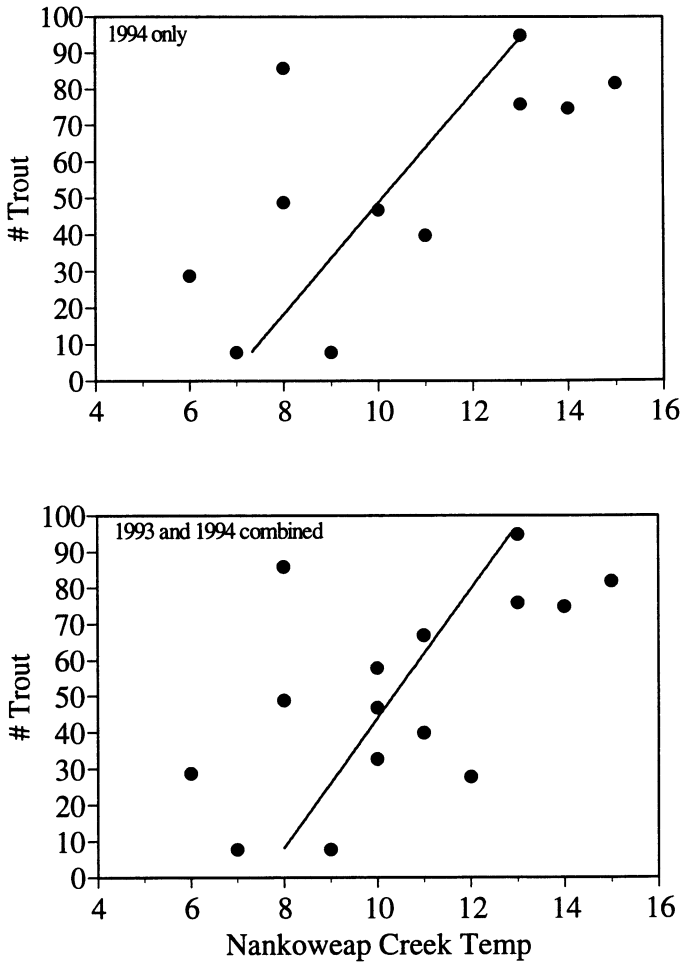


We conducted three of the trout counts during daylight hours, and from the OP regularly scanned the creek each day with spotting scopes and binoculars. We observed little trout activity or movement in shallow riffle or run areas, where trout would be most accessible to foraging eagles. At night, trout were commonly found in these shallow areas and were usually in groups of two or more.

Trout were always present in all reaches, and the proportion of fish in each reach varied daily (Figure 8). In 1993, trout counts were usually highest in Reaches 1 and 2. The pattern was different in 1994 when trout were usually least abundant in Reach 1 and most abundant in Reach 3.

Trout abundance in relation to creek temperature: We found a weak but positive correlation between creek temperature and the number of trout present for 1994 (Figure 9). The relationship was weaker when 1993 and 1994 data were combined (Figure 9), possibly because inaccuracies in some 1993 trout counts (see above) may have obscured the relationship.

Figure 9. The relationship between creek temperature (°C) and the number of trout detected in the lower 600 m of Nankoweap Creek.

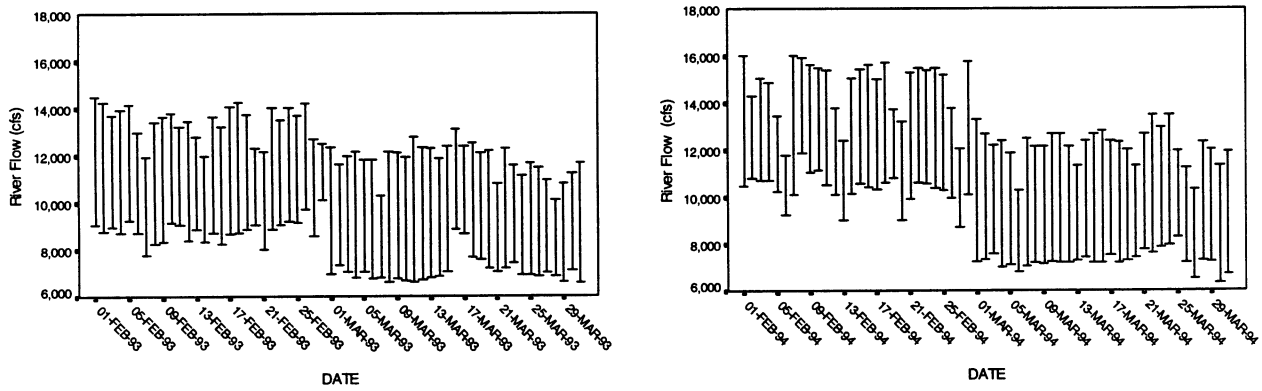


Trout abundance in relation to river flows: We investigated potential effects of Colorado River flows (minimum and maximum) on trout abundance in Nankoweap Creek by using river flow data obtained from the U.S. Bureau of Reclamation Glen Canyon Environmental Studies Office. In 1993, minimum and maximum river flows averaged approximately 8,300 and 13,400 cfs, respectively, while average flows were slightly higher in 1994 (Table 1; Figure 10).

Table 1. The mean (± one standard deviation) minimum and maximum Colorado River flows (in cubic feet per second) released from Glen Canyon Dam during February and March of 1993 and 1994.

Period	Minimum Flow (cfs)	Maximum Flow (cfs)
1993		
01 Feb - 15 Feb (pre-study)	8,705 ± 403	13,430 ± 749
16 Feb - 06 Mar (during study)	8,343 ± 1,039	12,958 ± 936
07 Mar -30 Mar (post-study)	7,114 ± 582	11,786 ± 760
1994		
01 Feb - 13 Feb (pre-study)	10,478 ± 766	14,639 ± 403
14 Feb - 07 Mar (during study)	9,228 ± 1,525	13,991 ± 1,629
08 Mar -30 Mar (post-study)	7,323 ± 428	12,216 ± 728

Figure 10. Minimum and maximum daily flows (cubic feet per second) in the Colorado River through the Grand Canyon, February and March of 1993 and 1994.



We found no significant correlation between daily mininum or maximum river flows (as measured by releases from Glen Canyon Dam) and the number of trout detected in Nankoweap Creek on the same day. This was true for 1993, 1994, and both years combined. Nankoweap Creek is appriximately 70 river miles downstream from Glen Canyon Dam, thus there could be a temporal delay between dam discharges and flow effects at the Nankoweap. To investigate this possibility, we also compared the previous days minimum and maximum dam discharge (and hence river flows) with the number of trout detected in Nankoweap Creek. There was no significant correlation in 1993, but we did find a significant inverse correlation between trout and the previous day's minimum and maximum discharge in 1993 (R^2=0.61 and 0.53, respectively; $p<0.05$). Thus, in 1994, more trout were detected in Nankoweap Creek as river flows decreased.

Trout Morphology: We captured and measured 66 trout from Nankoweap Creek in 1993, and 203 trout in 1994. In addition, we caught and measured 44 trout from the Colorado River at the mouth of Nankoweap Creek. Overall, the standard length of these trout averaged 292 ± 58 mm (range = 50 - 415, n = 317), and did not differ significantly between creek- and river-caught trout. Total length averaged 351 ± 69 mm (range = 60 - 500, n=316), and there was again no significant difference between creek- and river-caught trout. Trout mass averaged 418 ± 172 g (range = 3 - 1418, n=246), and river-caught trout were significantly heavier ($p>0.02$) than trout from the creek. Table 2 presents the morphological measurements of trout captured in the creek and river.

Table 2. Standard length, total length, and mass of rainbow trout caught in Nankoweap Creek (1993 and 1994) and the Colorado River at the mouth of Nankoweap Creek (1994).

Capture Location	Standard Length (mm) mean ± SD	range, n	Total Length (mm) mean ± SD	range, n	Mass (g) mean ± SD	range, n
River	305 ± 38	219-390, 44	370 ± 44	264-461, 44	473 ± 161	184- 909, 44
Creek - 1993	310 ± 40	212-410, 66	375 ± 44	265-486, 66	not taken	not taken
Creek - 1994	286 ± 61	62-415, 203	342 ± 73	73-500, 203	405 ± 172	3-1418, 202
Overall	292 ± 58	50-415, 317	351 ± 69	60-500, 316	418 ± 172	3-1418, 246

Gender and spawning condition: Most of the fish that we captured in the creek and river were males (Figure 11). In both years, the vast majority of fish in the creek were in spawning condition (categorized as loaded or ripe), approximately 12% were spent (post-spawning), and a few were immature (Figure 12). Virtually all fish captured in the river were in spawning condition; none were immature or showed signs of having already spawned.

Figure 11. Percentage of male and female rainbow trout captured in the Colorado River (river) and Nankoweap Creek (creek).

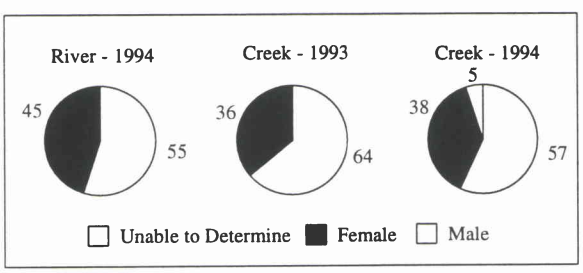
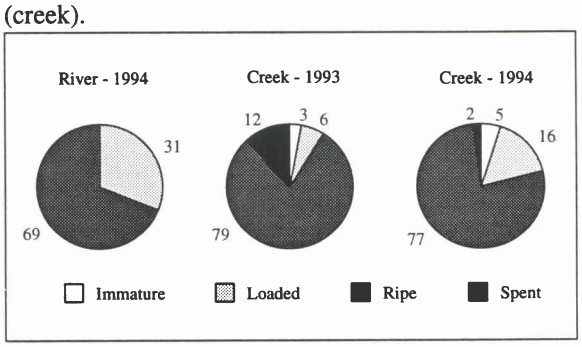


Figure 12. Spawning condition (expressed as percent of captured individuals) of rainbow trout captured in the Colorado River (river) and Nankoweap Creek (creek).



Bald Eagles at Nankoweap Creek

Abundance and age: yearly pattern. We detected bald eagles at Nankoweap Creek every day during the 1994 survey period, and every day except one in 1993 (Figure 13). The average number of eagles present each day was the same (2.6 ± 1.3) during both 1993 and 1994. The highest counts for each year were five on 27 February 1993, and six on 05 March 1994. The number of eagles present seldom exceeded three individuals in both years.

Adults were the most common age class present in both years (Figure 13). Subadults ("white-bellys") were the next most common group, but there were never more than two individuals on any one day. Subadults were present on only seven days in 1993 and three in 1994. Near-adults, "osprey" plumages, and immatures were all rarely observed, totalling no more than one individual on any day. Individuals in these plumage categories were present on only two days in 1993, and three in 1994 (Figure 13).

Bald eagle numbers in relation to creek trout population. We compared the number of eagles present at the Nankoweap Delta with the number of trout counted in Nankoweap Creek. In 1993, there was a trend for increasing number of eagles with increasing trout population in the creek (Figure 14), but the sample size was too small for robust statistical analysis. There was no significant relationship between eagle numbers and trout numbers in 1994, or with 1993 and 1994 combined (Figure 14).

Figure 13. The number of bald eagles (by age class) observed at Nankoweap Creek study area in 1993 (top) and 1994 (bottom).

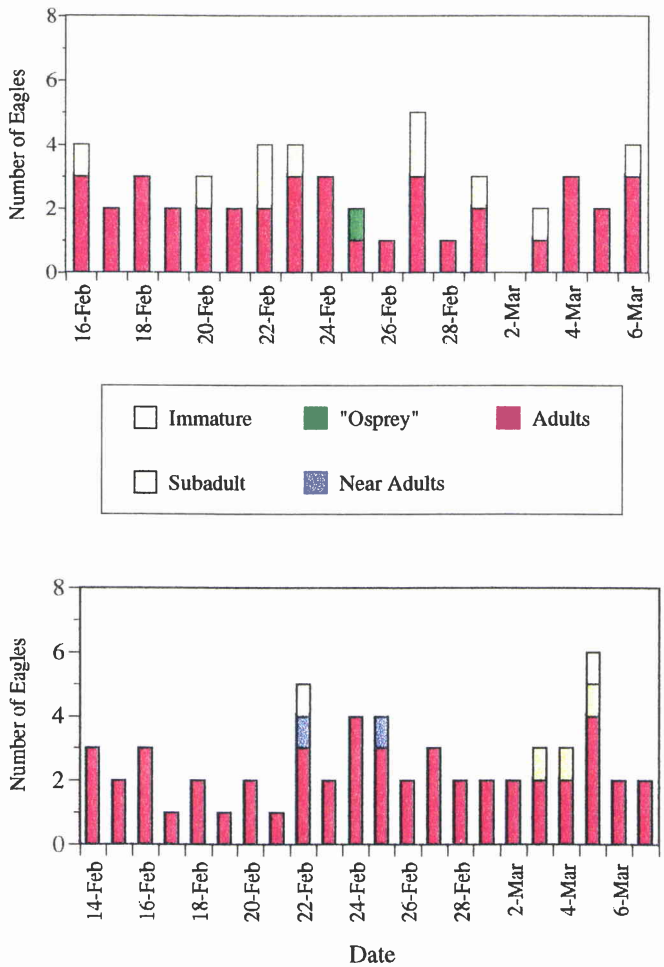
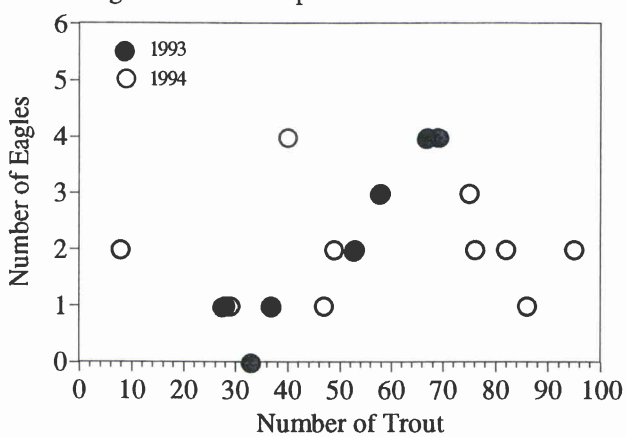
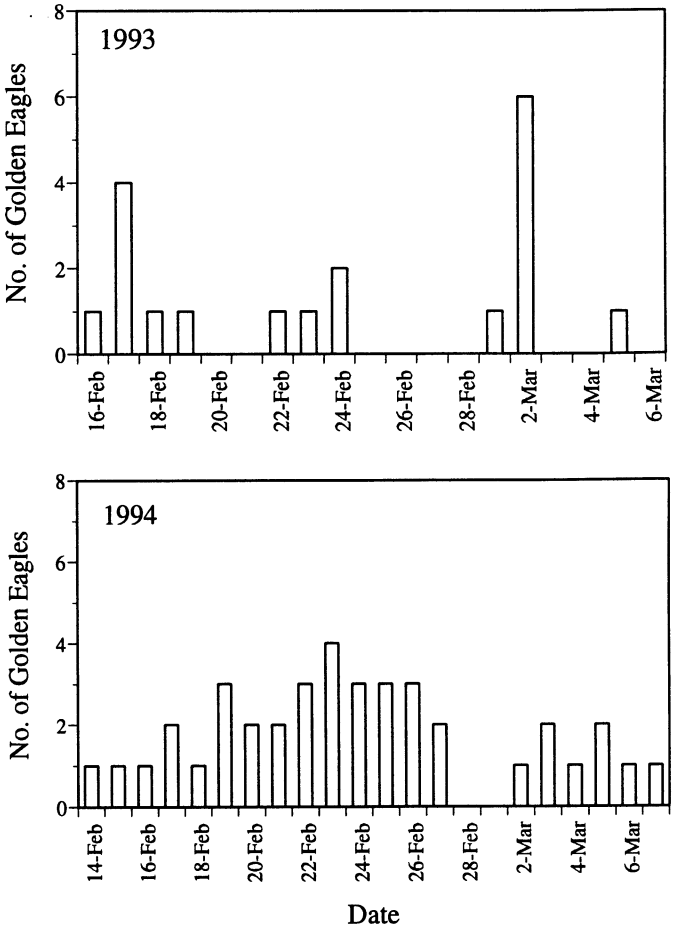


Figure 14. The relationship between the daily number of trout and bald eagles at Nankoweap Creek.



Bald eagle numbers in relation to river flows. We found no significant correlation between the number of eagles present at Nankoweap Creek and the daily minimum or maximum flow releases from Glen Canyon Dam. This was true when daily eagle numbers were compared to dam discharge (and hence river flows) of the same day, and of the previous day.

Figure 15. The number of golden eagles observed at Nankoweap Creek, 1993 and 1994.



Golden Eagles: Although monitoring golden eagles (*Aquila chrysaetos*) was not a specific objective of this project, we recorded their presence because they had to be differentiated from immature bald eagles. Golden eagles were present on 10 days in 1993, and 20 days in 1994 (Figure 15). On many days, the number of golden eagles present was equal to, or greater than, the number of bald eagles.

Bald Eagle Foraging: number, timing, success. We observed bald eagle foraging attempts on only six of the 19 days in 1993. The four foraging attempts that we saw in the creek were made by subadults on fish, and all were sucessful. Adult eagles foraged only at the river (n = 3 attempts), once capturing an unidentified shorebird. Subadults foraged at the river three times, twice unsuccessfully attempting to capture common goldeneye (*Bucephala clangula*). Overall, eagles foraged in the river more often than in the creek during 1993, even though success was lower in the river (Table 3; Figure 16) .

Figure 16. Percent bald eagle foraging success in Nankoweap Creek and the nearby Colorado River, 1993 and 1994.

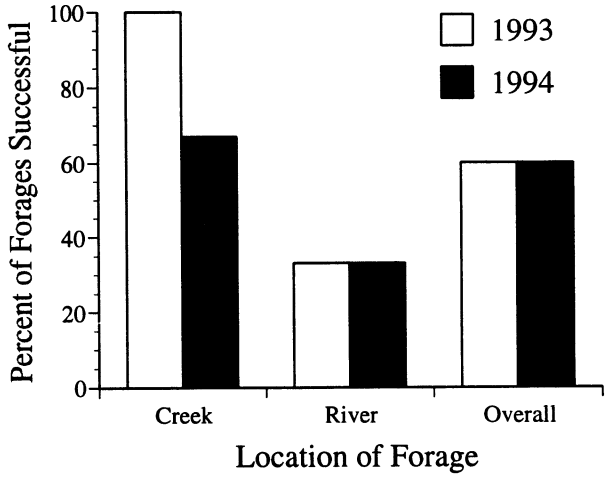


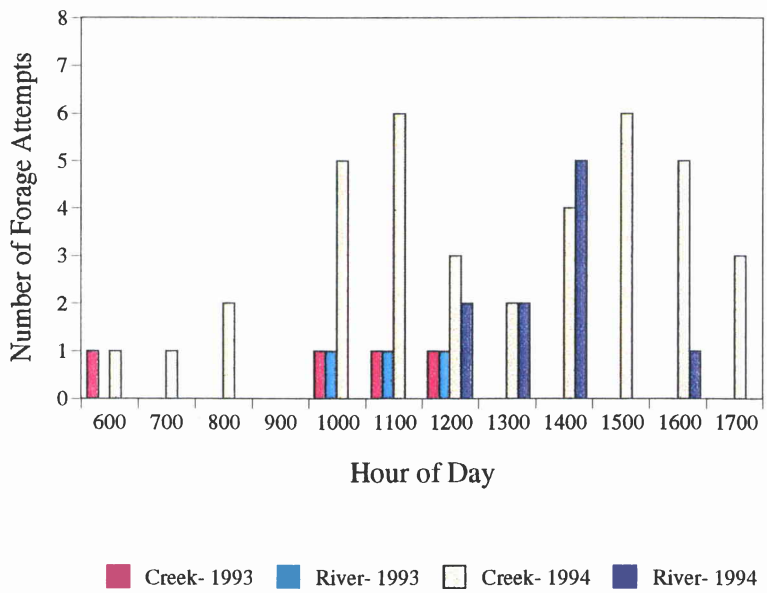
Table 3. Foraging attempts and success for bald eagles at Nankoweap Creek study area.

Location	# Forage Attempts 1993	# Forage Attempts 1994	# Successful Forages 1993	# Successful Forages 1994
Nankoweap Creek	4	39	4	26
Colorado River	6	9	2	3
TOTAL	10	48	6	29

Foraging was much more prevalent in 1994 (Table 3), occurring on 16 of 22 days. All 48 of the forage attempts were made by adult eagles. Unlike 1993, bald eagles usually foraged in the creek itself, where success was highest (Figure 16). Interestingly, 14 of the 39 creek forages were made above Reach 3. Of the nine forages at the river, seven were on fish, one was on an unidentified waterfowl, and another involved the capture of a small mammal on the talus slope.

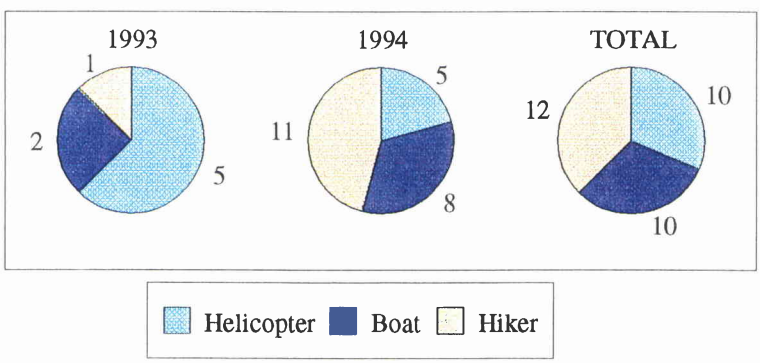
Overall foraging success was approximately 60%, and was greater in the creek than the river (Figure 16). Few forages occurred in the first few hours after sunrise; eagles usually foraged after 1000 hrs (Figure 17).

Figure 17. Timing of bald eagle forages in Nankoweap Creek and the nearby Colorado River, in 1993 and 1994.



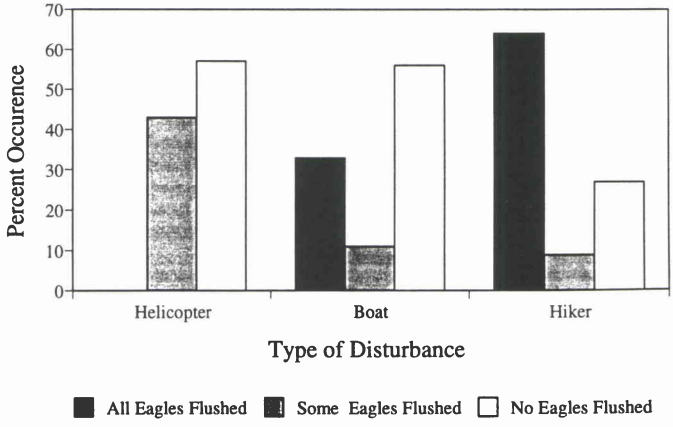
Human Disturbance: number and effects. Grand Canyon National Park instituted a closure of Nankoweap Creek in February and March 1993. We saw eight human disturbances in 1993; most were helicopters that were part of the eagle monitoring (Figure 18). In 1994, the Park did not implement a closure, and we recorded 24 disturbances; most were hikers or boaters not associated with the project (Figure 18).

Figure 18. The number of helicopter, boating, and hiking disturbances at Nankoweap Creek in 1993 and 1994.



Helicopter disturbances had the least effect on bald eagles; over half of the time when eagles were present, no eagles flushed when the helicopter flew by (Figure 19). Helicopters never flushed all of the eagles present at Nankoweap. Hiker disturbances had the greatest effect, and 67 percent of the time caused all eagles to flush from the Nankoweap delta area. Boat disturbances had an intermediate level of effect (Figure 19).

Figure 19. Effects of helicopter, boat, and hiker disturbances to bald eagles at Nankoweap Creek, expressed as the percent time that a disturbance type caused all, some, or none of the eagles present to flush.

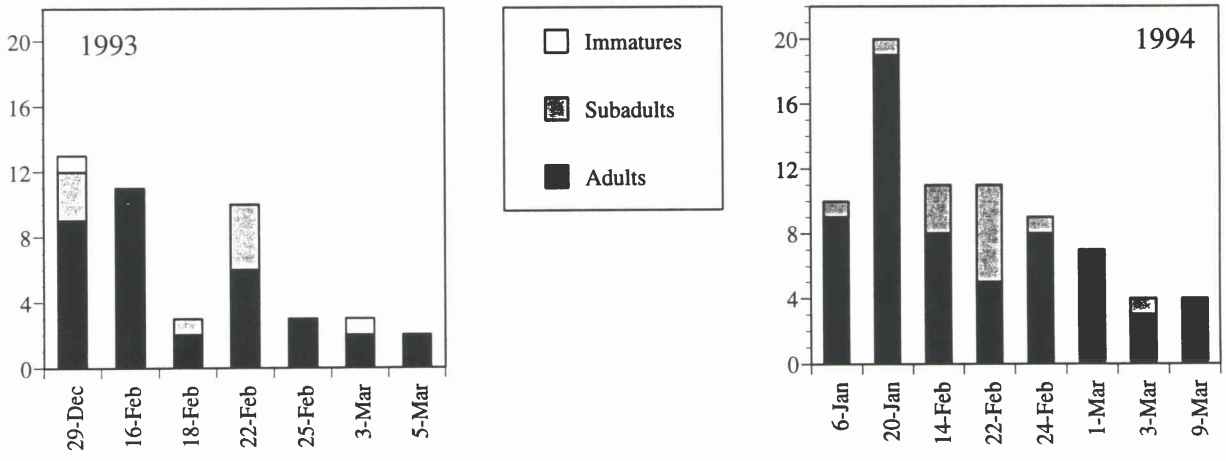


Bald Eagles Throughout Marble Canyon

Abundance and distribution. We detected bald eagles along the Colorado River corridor on each of the seven helicopter-based surveys in 1993 and the eight in 1994 (Figure 20). Eagle counts ranged between two and 13 eagles/count (mean = 6.4 ± 4.7) in winter of 1993, with the high count on 29 December 1992. Eagles were more abundant in 1994, ranging from four to 20 eagles/count (mean = 9.5 ± 5.1) with a high count on January 20. Most of the eagles we detected were adults, although other age classes were seen as well (Figure 20).

In both years, eagles were found widely distributed throughout the river corridor between Glen Canyon Dam and the Little Colorado River confluence. Most eagles were alone, although groups of two were sometimes seen. Eagles usually flushed when the helicopter approached, but landed again as soon as it passed by.

Figure 20. The number of bald eagles (by age class) detected during helicopter surveys along the Colorado River corridor in the upper Grand Canyon, 1993 and 1994.

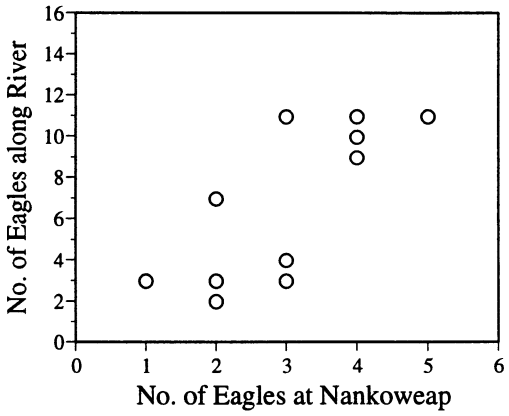


Comparison with Nankoweap abundance. On average, the eagles at Nankoweap accounted for less than half the number of eagles in the upper river corridor in 1993, and less than one third the number in 1994 (Table 4). Although there was a trend for the number of eagles at Nankoweap to increase with the number present along the upper river corridor (Figure 21), the number detected along the river corridor was not a good predictor of the number at the creek.

Table 4. The average number of eagles (± one standard deviation) detected per day during counts at Nankoweap Creek, and through the upper river corridor from Glen Canyon Dam to the Little Colorado River confluence.

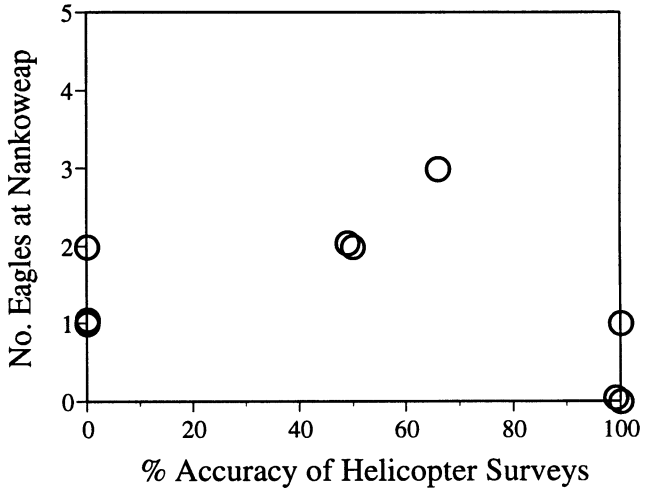
Location	1993	1994
Nankoweap Delta	2.6 ± 1.3	2.6 ± 1.3
Upper River Corridor (including Nankoweap)	6.4 ± 4.7	9.5 ± 5.1

Figure 21. The number of eagles detected on the same day at Nankoweap Creek and along the Colorado River in the upper Grand Canyon, 1993 and 1994 (combined).



Accuracy of Helicopter Counts at Nankoweap. We compared the number of eagles detected at Nankoweap by helicopter with the actual number of eagles present (based on counts by the ground-based monitoring crew). Accuracy of the helicopter counts varied from 0-100 percent, averaging 52 ± 42 % (n=9) for 1993 and 1994 combined. The accuracy of helicopter surveys was not related to the number of eagles present at the creek (Figure 22). However, there was a slight but non-significant trend for the number of eagles counted by helicopter to increase with the number of eagles present (Figure 23).

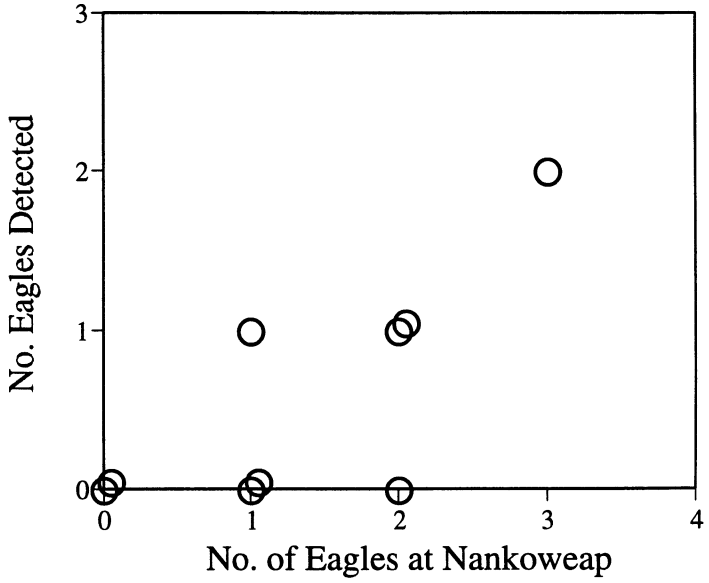
Figure 22. The relationship between the number of eagles present at the Nankoweap Delta and the relative accuracy of helicopter-based counts at the site. Data is for 1993 and 1994 combined.



Monitoring Eagles from Nankoweap Overlook

Monitoring attempts and problems. We scheduled weekly visits to the Nankoweap overlook during 1993. Due to wet and cold weather in February and March, the dirt roads leading from Hwy 89 west to the overlook were muddy and impassible. The roads would stay muddy and splippery for up to two weeks after rain or snow. This forced us to cancel most of our scheduled monitoring attempts. Despite the bad roads, we tried three times to reach the overlook by 4-wheel drive vehicle. The overlook monitoring crew vehicle turned back once, and made it to the overlook twice. On one return trip from the overlook, the vehicle got stuck overnight. Thus, access was very limited, unpredictable, and potentially hazardous.

Figure 23. The relationship between the number of eagles detected at Nankoweap Creek by helicopter surveys and the number of eagles present at the site that day.



Once the monitoring crew reached the Nankoweap overlook, they faced several difficulties in conducting the surveys. Surveyors must stand right on the edge of the cliff face, within a foot or so of the more than 1000 m drop to the talus below. The rocks along the edge are often slippery from snow, ice, or rain and footing can be treacherous. Strong winds often buffet the overlook, making observation difficult. Further, clouds and fog can shroud the rim, obscuring or eliminating the view down the the canyon bottom.

In discusing these difficulties with staff of the Resources Management Division of Grand Canyon National Park in 1993, it was decided that the lack of predictable access to the overlook and the potential hazards to the safety of the monitoring crew precluded rim-based surveys as a safe, reliable monitoring technique. We then eliminated rim-based monitoring from our activities in 1994.

Possibility of Breeding Bald Eagles at Nankoweap Delta

In both 1993 and 1994, two adult bald eagles (a male and a female, based on relative body sizes) appeared to establish themselves as residents in the Nankoweap area. The birds had especially light edgings on their wing coverts and breast feathers but were not unmistakenly identifiable as unique individuals. The pair often perched and roosted together, and established fairly predictable behavior patterns in terms of timing of movements and locations of perch and foraging sites. The two birds often flew up Nankoweap and Little Nankoweap Canyons together, and in the morning often flew down canyon to the delta area. We regularly heard them calling to each other.

The eagle pair aggressively defended the Nankoweap delta area from other eagles. Although sometimes tolerant of other eagles (particularly subadults and immatures), they were usually aggressive against golden eagles and other adult bald eagles.

Although not definitive proof, these behaviors suggest that the birds may be a mated pair. Because much of this pair's activity centered around Nankoweap Canyon and Little Nankoweap Canyon, we regularly scanned the canyon walls for nests. From our vantage point at the OP, we saw no sign of a nest (note that visibility up these canyons is very limited from the OP). In April 1994 (while conducting other research in the canyon) we surveyed (by foot) the lower 2 km of Nankoweap Canyon and again found no sign of nests. However, in June 1994 (during a willow flycatcher research trip), we observed several very large stick nests (possibly of bald eagles) high up on the cliffs in lower Little Nankoweap Canyon.

DISCUSSION

Stream Conditions

Stream conditions in 1993 and 1994 differed in many ways from than those occuring in 1990 and 1991 (National Park Service 1992). Creek discharge was generally lower in 1990 (0.9 ± 0.5 cfs; range = 0.5-1.1, n= 13) and 1991 (0.4 ± 0.3; range = 0.3 - 1.1, n=26), although one temporary high flow on 4-5 March 1991 was estimated at 20 cfs. Water clarity in 1990-91 was typically higher than during 1993, although it was similar to 1994. While the creek followed the same general channel in all years, there were almost no undercut banks and pools were generally clearer and calmer in 1990-91, with no undercut areas. Gravel, the prefered spawning substrate for trout, was a much more common substrate in 1990 and late in 1991.

The cumulative result is that due to higher creek flows, more turbid water, deeper pools and/or more undercut banks, the creek provided less spawning substrate but more protective cover for trout in 1993 and 1994 than was present in 1990 and 1991.

Trout Abundance and Availability

Trout were present and spawning in Nakoweap Creek throughout the monitoring periods of 1993 and 1994. However, average numbers present were much lower than observed in 1990 and 1991, when the trout population in the creek peaked at approximately 1,500 and 450, respectively (National Park Service 1992).

Leibfried and Montgomery (1993) found that trout were most abundant in the creek when water temperature increased to 10° C or more. Trout abundance in 1994 generally followed this same pattern, suggesting that the timing and extent of the trout spawn may be influenced by a combination of environmental factors that effect Nankoweap Creek water temperature.

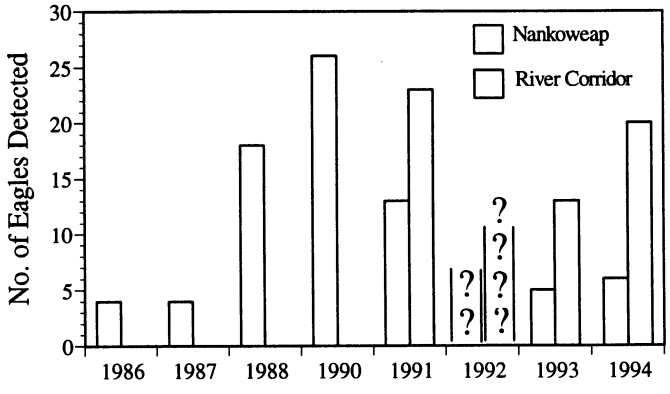
Although trout were always present in Nankoweap Creek during 1993 and 1994, we believe that they were not readily available to foraging eagles. The high creek flows (particularly during 1993), deeper pools, and undercut banks provided the trout with much more shelter and protection. Trout were never so abundant as to exceed the "protective capacity" of the creek. In other words, all of the trout could find protective shelter. This was not the case in 1990 and 1991, when there were so many trout and the creek was so shallow that during the day hundreds of trout crowded into pools and shallow areas, where their backs often projected out of the water. In contrast, we seldom saw any trout in shallow areas during the day in 1993 or 1994; most were in deeper pools or undercut banks. Only at night did we find trout in exposed shallows.

We found a significant negative correlation between Colorado River flows (in terms of Glen Canyon Dam discharge on the previous day) and the number of trout in Nankoweap Creek in 1994. Thus, more trout were present in the creek when river flows were lower. We do not believe that this is a cause-effect relationship. Rather, it appears that two independent phenomenon combined to create this correlation. First, the number of trout present in the creek increased during late February and early March, as creek temperatures rose and became more suitable for spawning (Figures 6 and 8). Second, dam discharge was lower in March than during the preceeding month, a common element of the annual discharge regime (Figure 10). The creek trout population was increasing at a time when river discharge was decreasing, resulting in a statistical correlation.

Eagle Abundance at Nankoweap

Eagle abundance at Nankoweap Creek in 1993 and 1994 was less than half that of 1990 and 1991 (Brown and Stevens 1992, National Park Service 1992). No formal eagle monitoring occurred in 1992, but observations by river guides and biologists suggests that the 1992 eagle concentration at Nankoweap was similar to that of 1993 and 1994 (Bill Leibfried, *pers. comm.*). Combining this information with data presented by Brown et al. (1989), it becomes clear that the magnitude of the eagle concentration at Nankoweap Creek can vary greatly from year to year (Figure 24). In fact, in some years there are so few eagles that no true "concentration" occurs.

Figure 24. The highest number of bald eagles observed each year at Nankoweap Creek and along the Colorado River corridor in the upper Grand Canyon, 1986-1994. Note that in 1992, no ground-based surveys were conducted at Nankoweap. In 1992, only one late-season helicopter survey was conducted along the river corridor. No river corridor aerial surveys were conducted pre-1991.



Eagle abundance at Nankoweap Creek is not simply a function of the magnitude of the state-wide wintering eagle population. Arizona Game& Fish mid-winter eagle counts found more eagles wintering in Arizona during 1993 and 1994 than in previous years (G. Beatty, *pers. comm.*), in contrast to the pattern observed at Nankoweap.

The driving force behind the eagle concentration at Nankoweap appears to be the number and availability of trout in the creek. Wintering bald eagles are opportunistic foragers - they concentrate where prey availabiltiy is high and energy expenditure to procure prey is low (Stahlmaster 1987). When trout are abundant in Nankoweap Creek, eagles moving through the area find the trout spawn and congregate to forage on the easily available prey. When trout numbers are low (below the "protective capacity" of the creek), there is little to attract and hold eagles in the area. Colorado River flows (minimum and maximum flows) showed no correlation with eagle abundance.

Patterns of eagle foraging attempts in Nankoweap Creek support the concept that a prey abundance and availibility threshold determines the nature of the eagle concentation. In 1990 and 1991, when trout were very abundant and easily available in the creek (eagles could often simply wade into the creek and step onto a trout), eagles made 624 and 230 foraging events, respectively (Brown and Stevens 1993). In 1993, high, turbid water and low trout numbers resulted in low prey abundance and availability. This is reflected in the extremely low number of forages (n=4) in 1993, even though trout and eagles were present almost daily. In 1994, creek flow was lower and more clear, and trout more abundant, but the number of forages (n=39) was still quite low. We believe that even though enough large trout were present to provide a potential prey base, eagles did not forage extensively in the creek (and an eagle concentration did not develop) because the trout that were present were not readily available.

There is no way to predict the timing or extent of future trout spawns in Nankoweap Creek, nor can we say how creek morphology and hydrology will interact to affect prey availability. Thus, despite increasing numbers of bald eagles nationwide (USFWS 1994), and growing winter populations in Arizona, there is no way to predict the future extent of eagle concentrations at Nankoweap.

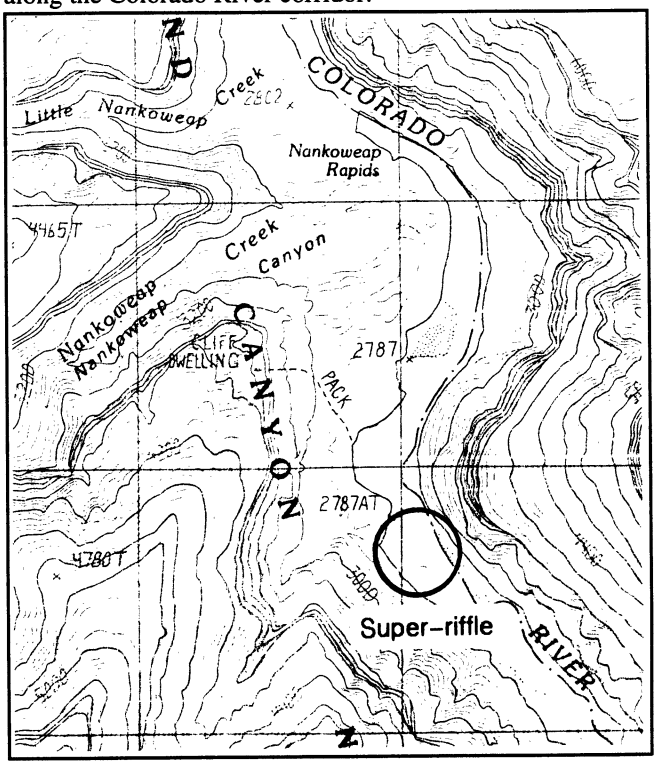
Are Bald Eagles Breeding at Nankoweap Creek?

In 1993 and 1994, a pair of bald eagles clearly established a feeding territory at Nankoweap Creek. We do not know if it was the same pair in both years, but behavioral cues suggest that this is the case. There was no evidence of such a phenomenon in 1990 or 1991. Given the large numbers of trout in the creek during 1990 and 1991, it is unlikely that a pair of eagles could have defended the area against the large number of "intruders" that concentrated there to take advantage of the abundant prey base. However, the low resource availability in 1993 and 1994 made it much easier to defend the area, and there was less incentive for intruding eagles to persist there. Although low trout availability was the primary factor, agressive behavior by the wintering pair may have contributed to the low number of eagles at Nankoweap in 1993 and 1994.

In Arizona, bald eagle courship and nest building peak in mid-November to mid-February (Hunt et al. 1992). Egg-laying typically occurs from January through mid-March, and hatching from February to April. Thus, the eagle pair resides at Nankoweap during at least the early part of the breeding season.

We do not have any evidence that breeding has taken place, but it is possibile that it has already occurred or may in the near future. As noted, possible bald eagle nests were seen on the cliffs of Little Nankoweap Canyon, and we observed adult eagles at or near these locations in 1993. Eagle nests in Arizona are almost always found within a short distance (mean = 200 m) of water, and often nest on canyon walls (Hunt et al. 1992). The canyon walls along Nankoweap Canyon and Little Nankoweap Canyon provide almost unlimited nest sites in close proximity to water. Breeding eagles in Arizona feed primarily on fish (Hunt et al. 1992), a prey that is always present in the river and often present in Nankoweap Creek (at least in sufficient numbers to support a pair of breeding eagles). Futher, there is a strong tendency for Arizona bald eagles to nest within 0.5 - 3 km of "super-riffles". The key feature of a super-riffle is that, as river flow level increases, water depth and velocity increase in only a small area of the riffle, while the total amount of shallow water increases as water spreads across the gravel bed (Hunt et al. 1992). The result is that there is some shallow water habitat (a preferred eagle foraging location) available over a wide range of river flow conditions. One such super-riffle is found a short distance downstream of Nankoweap Creek (Figure 25).

Figure 25. Locatation of Nankoweap Creek and Little Nankoweap Creek relative to the downstream "super-riffle" along the Colorado River corridor.



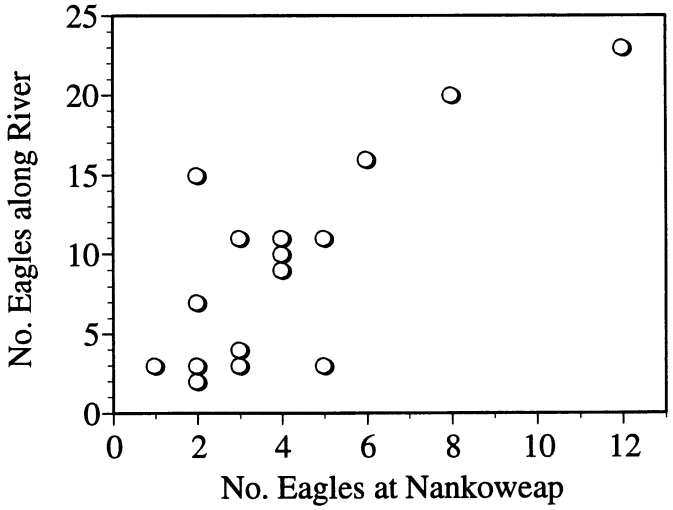
One might expect that any eagle nesting attempts would be readily discovered. There have been a few recent anectdotal accounts of adult or immature bald eagles at Nankoweap later in the spring (H. Solper [AGFD] and T. Yates, *pers. comm.*), butsuch sightings are rare. However, given the large scale of the canyon (particularly at the Nankoweap Delta) and the low visitation during the eagle breeding season, it is possible that nesting could be overlooked. We suggest that specific efforts be taken in 1995 to determine if eagles are nesting at Nankoweap.

Eagle Abundance Throughout the River Corridor

Year to year abundance of wintering eagles in the upper river corridor appears to be more consistant than is the case at Nankoweap. Helicopter-based monitoring began in 1991, with a high of 23 eagles on 25 February. Although no formal eagle monitoring occurred in 1992, anecdotal observations by river guides and biologists suggest that eagle numbers in the upper river corridor were similar to those in 1993 and 1994 (T. Yates, *pers. comm.*). Thus, since at least 1991, significant numbers of wintering bald eagles utilize the upper river corridor (Figure 24).

Large numbers of eagles use the river corridor even when the numbers at Nankoweap Creek are low. Indeed, although the number of eagles at Nankoweap generally increases with the number of eagles along the river corridor (Figure 26), the two are not closely related. Eagles continue to use the river corridor even at times when Nankoweap Creek offers little in terms of food resources.

Figure 26. The relationship between the number of eagles detected on the same day along the Colorado River corridor in the upper Grand Canyon and at Nankoweap Creek, 1991-1994.



It is important to recognize that the main river corridor, with its prey base of abundant trout and wintering waterfowl, is a valuable resource to bald eagles in the southwest. The number of eagles found along the river (during high counts) represents between five and 10 percent of the wintering eagles throughout the state. This is clearly a significant number of eagles, and management actions that could affect the eagles or their prey base should take this into account.

One such management action, selective withdrawl of warmer water from Lake Powell, has the potential of affecting eagles throughout the the river corridor (including Nankoweap Creek). Warming the waters of the Colorado River could alter foraging conditions for bald eagles. Numbers of carp, catfish, and suckers (common prey of bald eagles in Arizona; Hunt et al. 1992) could increase, providing more food. However, if decreasing trout numbers or increasing river turbidity reduce prey availability, bald eagles may have more difficulty foraging along the river corridor.

Evaulation of Monitoring Techniques

Establishing a base camp at Nankoweap Creek and counting eagles from the OP provides an accurate way to monitor the number of eagles concentrating at the site. However, this is very time- and cost-intensive, and provides no indication of eagle abundance outside the immediate Nankoweap area. Given that the number of eagles at Nankoweap usually represent only a fraction of those present along the corridor, and that it is not cost-effective to plan, organize, and conduct a large-scale effort at Nankoweap when it is quite possible that an eagle concentration may not develop, we do not recommend continued intensive annual monitoring at Nankoweap.

The idea of monitoring the eagles at Nankoweap Creek by counting them from the Nankoweap overlook has merit because it is relatively inexpensive in terms of logistics. Unfortunately, rim-based monitoring suffers from the same local focus as the river-based monitoring. More importantly, as discussed earlier, the unpredictability of access and the potential safety hazard to project personnel eliminate rim-based surveys from serious consideration as a long-term monitoring

technique. Thus, we do not recommend continued monitoring from the Nankoweap overlook.

We do suggest using helicopters to continue monitoring eagles along the upper river corridor. Although helicopter surveys detected on average only about half of the eagles at Nankoweap Creek, these surveys have several major advantages:

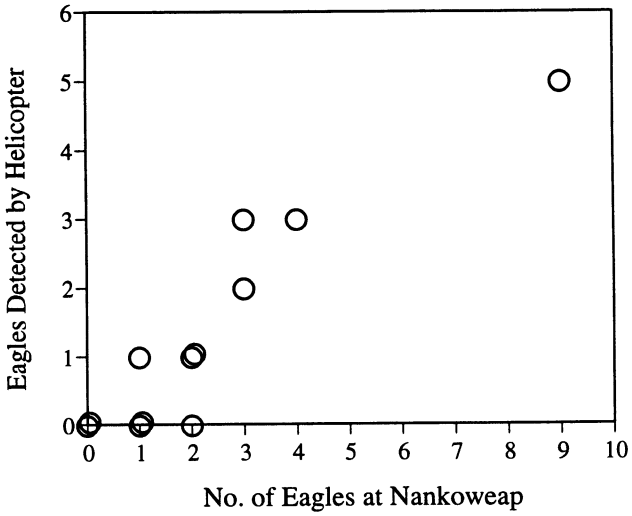
- Helicopter surveys take relatively little time (about 2 hrs of flight time per survey).
- Helicopters are a proven method of monitoring eagles (Hunt et al. 1992, National Park Service 1992, Arizona Game and Fish Department unpublished data).
- They allow monitoring of the eagles along the entire upper river corridor, which is an important migrating and wintering area for eagles.
- The number of eagles detected by helicopter at Nankoweap increased as eagle abundance increases at Nankoweap (Figure 27), and helicopter surveys would certainly detect a significant concentration of eagles at Nankoweap.
- The amount of data collected per unit of effort makes helicopter surveys very cost effective.
- Helicopter surveys along the river corridor can be easily modified to include nest searches along the cliffs in Nankoweap and Little Nankoweap canyons.

There are several drawbacks to helicopter surveys that need to be addressed. They are costly on a per hour basis (approximately $850 /hr for the Grand Canyon park helicopter), but this is offset by the reliability, flexibility and cost-effectiveness of the data collection. There is always an element of risk associated with low-level helicopter flights, but this can be minimized by utilizing the park helicopter (which has experienced OAS approved pilots and aircraft) and requiring survey participants to have OAS aircraft safety training.

Possibly the most serious drawback to using helicopters is the potential disturbance to park visitors. Low-level flight and associated noise is a sensitive issue in all parks, and the Grand Canyon in particular. We recognize the park's concern, and feel that several steps could be taken to minimize the disturbance to visitors:

- To the greatest extent possible, schedule helicopter flights on days when few or no visitors are rafting through the upper river corridor.
- Conduct the least number of surveys possible, consistant with the goals and objectives of monitoring.
- Schedule the surveys at least one week apart to minimize the chances that a group of visitors will be affected by more than one overflight.

Figure 27. The number of bald eagles detected by helicopter surveys at the Nankoweap Creek area versus the number of eagles actually present, 1991-1994



The park may be able to suggest additional steps to minimize the effects of helicopter overflights.

Human Disturbance

Research. Monitoring eagles from the OP had no effect on eagles in the Nankoweap area. We conducted almost all trout counts at night, which worked well for trout capture and avoided any disturbance to eagles. Helicopter-based surveys likewise had very little effect on eagles at Nankoweap, and more often than not did not flush any of the eagles present. During helicopter surveys along the river corridor, most eagles flushed from their perches as the helicopter approached but landed again as soon as it had passed. Thus, properly conducted research efforts have negligible negative effects.

Non-research. There were very few eagle disturbances by hikers and rafters in 1993, the year that a park closure was in effect. Disturbances increased in 1994, when no closure was in effect. Boats passing by (but not staying at) the delta created a low level of disturbance, but generally not enough to warrant steps to restrict them. Boat trips camping at the Nankoweap delta (including the upper Nankoweap Camp), as well as hikers and anglers near Nankoweap Canyon caused the greatest disturbance, and have the potential to seriously disrupt a wintering eagle concentration.

We recommend that Grand Canyon National Park continue to annually implement a closure of the Nankoweap delta from January through early March. All land-based activity in this area should be eliminated during this time. This may be particularly important if bald eagles are attempting to nest there. All research activities should also be regulated during this period, and conducted earlier or later if at all possible.

SUGGESTIONS FOR NEXT YEAR

Research and Monitoring.

1. Continue annual helicopter-based surveys to monitor the eagles throughout the upper Colorado River corridor in Grand Canyon National Park and Glen Canyon National Recreation Area.

2. During one or more of the helicopter surveys, visually search for eagle nests along the cliffs in Nankoweap Canyon and Little Nankoweap Canyon.

3. Integrate data from helicopter surveys (1991-1995) into a GIS database of sightings and locations. Analyse this information to determine if physical and hydrological features influence where eagles are found along the river corridor.

Human Use Closure at Nankoweap Creek

Institute a human use closure of the lower two miles of Nankoweap Creek. The Nankoweap delta area from 51.5 R to RM 53.0 R should also be closed to hiking, camping, and fishing. Both closures should be in effect from 1 January through 15 March, 1995. The Park may allow ccamping at the lower Nankoweap Camp, as well as normal trail access to the Anasazi graineries.

ACKNOWLEDGEMENTS

We thank Grand Canyon National Park and Glen Canyon National Recreation Area for their support of this project. We also thank the U.S. Bureau of Reclamation Glen Canyon Environmental Studies (GCES) program for funding and logistical support. This project would not have been possible without the skills and dedication of the many professional staff and volunteers that contributed to the project, including Sarah Allen, Greg Beatty, Dan Driscoll, Robert Dye, John Grahame, Terry Heimgartner, Chris Karas, Karen Kazan, Jill Kuenzi, Robert Mesta, Linda Sogge, Ruthie Stoner, and Paul Super. As always, Teresa Yates was instrumental to the success of the Nankoweap-based monitoring. Bill Vernieu and Jeanne Korn provided assistance with river and creek flow data. Paul Deshler was instrumental in GIS and data management efforts. Project coordination was made possible by the National Biological Survey and the U.S. Fish and Wildlife Service.

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United States Department of the Interior

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In Reply
Refer To:

December 28, 1994

Memorandum

To: Dave Wegner, Program Manager
Glen Canyon Environmental Studies

From: Mark Sogge, Ecologist
Colorado Plateau Research Station

Subject: Bald Eagle Monitoring Report

Enclosed are two copies of our report entitled *Wintering Bald Eagles in the Grand Canyon: 1993-1994*, one of the required deliverables for National Park Service (Western Region) Cooperative Agreement work order CA 8029-8-0002. The document outlines the results of the first two years of our three year Grand Canyon eagle monitoring project, funded by your Glen Canyon Environmental Studies program. Copies of the report have been distributed to Grand Canyon National Park, Glen Canyon National Recreation Area, adjacent Native American tribes, and other state and federal resource agencies.

I hope you find the information useful and of interest. Thanks for your continued support and assistance. Please feel free to call me (602/556-7468) if you have any questions or comments.

cc:
C. van Riper, CPRS/NAU