Enclosure 1

A DRAFT PROPOSAL TO ASSESS, MITIGATE AND MONITOR THE IMPACTS OF AN EXPERIMENTAL HIGH FLOW FROM GLEN CANYON DAM ON THE ENDANGERED KANAB AMBERSNAIL AT VASEYS PARADISE, GRAND CANYON, ARIZONA

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ABSTRACT

An experimental high flow has been proposed to determine the extent to which planned flooding can be used to maintain large, open sandbars in Glen and Grand canyons in Arizona. However, uncertainties exist regarding the ecological impacts of high releases on rare and endangered species, and other species of concern. The high flow experiment will result in take of the endangered Kanab ambersnail. We propose to conduct a cooperative, interagency analysis of the impacts of the high flow experiment on the Vaseys Paradise (VP) population of the Kanab ambersnail. Our study will allow us to assess sampling methodologies for determining population size; determine short- and long-term effects of the flood on Kanab ambersnail habitat; attempt to mitigate flood effects on the species; acquire short-term behavioral and demographic information required by the Biological Opinion relating to impact of the flood on Kanab ambersnail; and monitor post-flood behavioral and demographic processes to permit long-term assessment of mitigation activities and flood effects. The research we propose is designed to mitigate take of Kanab ambersnail by moving animals threatened by lethal immersion, and to improve our understanding of Kanab ambersnail behavior and demography to improve management efforts and better predict results of future high flow impacts to the Kanab ambersnail population at VP.

INTRODUCTION

Project Overview

We propose to conduct a cooperative, interagency analysis of the impacts of a high flow experiment from Glen Canyon Dam on the Vaseys Paradise (VP) population of the endangered Kanab ambersnail (KAS; SUCCINEIDAE: *Oxyloma haydeni kanabensis* Pilsbry). The proposed experimental high release (1,275 m^3/s = 45,000 cfs for 7 days in late March and early April, 1996) will inundate and potentially scour 11 to 16 percent of available KAS habitat, and may eliminate an equally high proportion of the KAS population (Stevens et al., 1995, Attachment A). Information on short- and long-term responses of KAS and its habitat to the proposed high flow event, as well as additional autecological and synecological KAS data, are needed to resolve KAS recovery and management issues related to dam operations. In addition, Arizona Game and Fish Department (AGF) studies (funded separately by FWS) will initiate identification of criteria for establishment of secondary populations. This study will provide the Bureau of Reclamation (BOR), the National Park Service (NPS), the Fish and Wildlife Service (FWS), AGF and other parties with ecologically appropriate, cost-efficient and expeditious management options and solutions.

The study of KAS is complicated by a number of physical and statistical constraints. The cryptic morphology of KAS, and factors related to topographic constraints at Vaseys Paradise (VP), host plant characteristics, and KAS ecology influence sampling design and associated precision and accuracy. Stems of the host plant species are fragile and break easily, making non-destructive sampling difficult. Many of the vegetation patches lie on steep, poison-ivy covered slopes where access is limited. Also, KAS avoid open areas, preferring decadent or dead cardinal monkeyflower (*Mimulus cardinalis*) stems and any portion of water-cress (*Nasturtium officinale*) canopies, which are difficult to sample non-destructively. These issues make the study of KAS difficult, and require considerable training of field staff. We enclose curriculum vitae of all primary researchers associated with this proposal (Attachment C).

Project Objectives

The following objectives are categorized in relation to the various risk and impact assessment, population management and recovery questions under consideration: (1) sampling protocol assessment and validation; (2) obligatory short-term studies that are based on Endangered Species Act (ESA) and the FWS Biological Opinion requirements; (3) studies to be used for long-term assessment of high flow effects, and KAS management and recovery (also required by the ESA); (4) ancillary studies that will

assist in (1) or (2); and (5) studies required by AGF for Section 6 consultation and that help resolve issues in (1) or (2).

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BACKGROUND

The KAS is a federally endangered succineid landsnail that occurs at two springs in the southwestern U.S. (Pilsbry and Ferriss 1911, Pilsbry 1948, Spamer and Bogan 1993): Three Lakes (near Kanab, UT) and Vaseys Paradise (Colorado River mile 31.5 in Grand Canyon, Arizona). KAS was proposed for emergency listing as an endangered species by the U.S. Fish and Wildlife Service in 1991 (England 1991a, 1991b), and was subsequently listed (Anonymous 1992, England 1992). Two KAS populations formerly occurred in the Kanab area, but one population was extirpated by desiccation of its habitat. The remaining Utah population at Three Lakes occurs at several, small spring-fed ponds on cattail (*Typha* spp.; Clarke 1991). The Three Lakes site is privately-owned and the land owner may commercially develop the property. KAS were first collected in 1991 at VP (Blinn et al., 1992, Spamer and Bogan 1993), and an interagency team lead by the Bureau of Reclamation examined KAS ecology there in 1994 and 1995 (Stevens et al., 1995, Attachment A). VP is a popular water source and attraction site for Colorado River runners; however access there is limited there by the dense cover of poison ivy (*Toxicodendron rydbergii*) and the nearly vertical terrain. Within Grand Canyon, KAS is apparently restricted to VP: no KAS were observed at 81 other Grand Canyon springs surveyed from 1991 to 1995. Rematched historic photographs of VP (e.g. Turner and Karpiscak 1980:58-59) reveal that cover of these two plant species has increased greatly at lower stage elevations since completion of Glen Canyon Dam.

Land surveys in 1995 revealed rapid changes in vegetation cover over the growing season, with 5.9% to 9.3% of the primary habitat occurring below the 940 m^3/s (33,000 cfs) stage, and 11.1% to 16.1% occurring below the 1,275 m^3/s (45,000 cfs) stage (Stevens et al., Attachment A). The total area of primary habitat was .09 ha, and the area of secondary habitat (patches of riparian vegetation that are not dominated by monkey-flower or water-cress, and not used by KAS) was also 0.09 ha, for a total vegetated area of the spring of 0.18 ha in June, 1995.

The total estimated VP KAS population rose from 18,476 snails in March up to as many as 104,000 snails in September, 1995 as reproduction took place in mid-summer (Stevens et al., 1995, Attachment A). The estimated proportion of the KAS population occurring below the 940 m^3/s stage rose from 1.0% in March to 7.3% in September, and that occurring below the 1,275 m^3/s stage was 3.3% in March, 11.4% in June and 16.4% in September, 1995.

Introduction of non-native water-cress and construction of Glen Canyon Dam increased the primary KAS habitat area by more than 40%, and resulted in an increase in the snail population (Stevens et al., Attachment A). The KAS population at VP apparently survived and recovered from innumerable similar and higher flows during the pre-dam era, and has survived six flows in excess of 1,275 m^3/s during the post-dam era (i.e., 1965, 1980, and 1983-1986). Short-term reduction in primary habitat area by scouring flows does not appear to hvae affected the integrity of the KAS population; however, the ESA requires analysis of flood impacts on this isolated population. Particular care is in order because this is the only protected population known for the species.

METHODS

Study Area

Vaseys Paradise is a cool-water, dilute dolomitic spring that issues from the Mooney Falls member of the Mississippian Redwall Limestone near the mouth of South Canyon in Grand Canyon National Park, Arizona, 51.2 km downstream from Lees Ferry, Arizona (Fig. 1; Huntoon 1974). The spring issues at 925 m elevation from three primary mouths, and divides into several large, and numerous small, rivulets as it flows ca. 100 m to the Colorado River. The climate is arid and continental, with a mean annual precipitation of 140 mm at Lees Ferry, the nearest weather station (Sellers and Hill 1974). Precipitation is bimodally distributed between summer and winter. Temperatures at Lees Ferry range

from < -10°C in winter to > 45°C in summer. Although the east-facing aspect of VP allows the spring to thaw relatively quickly after freezing winter nights, Stevens (personal observation) observed that the spring was nearly completely frozen and covered in ice in early January, 1975 and in December, 1990. Aspect also protects the spring area from hot, direct mid-afternoon sunlight during summer. VP lies in the U.S. Bureau of Reclamation's Glen Canyon Environmental Studies Program's (GCES) Geographic Information System (GIS) Reach 3 for long-term monitoring.

OBJECTIVE 1: High Flow Impacts on KAS Habitat.

1a. Determine potential primary habitat loss due to the high flow experiment.

In early March, 1996, assessment of potential primary KAS habitat loss will be accomplished using the methods of Stevens et al. (1995, Attachment A). The perimeters of all primary habitat patches lying below the 1275 m^3/s stage (the "low zone") will be surveyed during site visits in March (pre-flood), April (post-flood), late May/early June, July, August, September and October. Land surveys will be conducted with a total station/prism combination, and mapping accuracy will be ± 0.1 m. The Glen Canyon Environmental Studies (GCES) Geographical Information System (GIS) control network points (Arizona State Plane, Central Zone) will be used for the instrument and backsight stations. This reference datum allows accurate spatial referencing of map data, and provides suitable georeferencing for GIS analysis and future monitoring. Surveyed elevation data will be related to the stage-to-discharge model developed for the mainstream at VP, which was based on the Bureau of Reclamation STARS hydraulic model (Randle and Pemberton 1988). This stage-to-discharge relationship will be validated in 3a (below). We will identify the area of potentially inundated primary habitat and an additional 2.5% for mitigation purposes discussed in Objective 5 (below).

A triangulated irregular network (TIN) topographic model of the upper zone (> 1275 m^3/s) of VP will be produced using close-range oblique stereo-pair photographs collected in November 1995, before and after the high flow in spring, 1996, and in November, 1996. Polygons will drawn in the laboratory, ground-truthed in the field, and processed by the Bureau of Reclamation Remote Sensing Laboratory in Denver, Colorado against eight surveyed ground control points. The estimated error associated with the high zone map will be ± 0.5 m, corresponding to GCES-GIS mapping accuracy standards. The STARS-generated stage-to-discharge model will then be applied to these TIN models, allowing us to conduct an hypsometric analysis of the rectified area of primary KAS habitat in the "high zone" (> 1275 m^3/s stage).

A series of biomass measurements will be made on 20-cm plots in conjunction with preflood population surveys and destructive habitat sampling (2a and 3b below). These data will be used to estimate biomass of known quantities of primary habitat.

1b. Determine actual primary KAS habitat loss due to the high flow experiment.

Comparison of surveyed primary KAS habitat in the < 1,275 m^3/s stage before and after the high flow event will be used to quantify habitat loss. Additionally, photogrammetric and close-up site photographs will be used to document these changes.

1c. Determine the mechanism(s) of habitat loss during the high flow experiment.

Direct observation and measurement of scour (vegetation loss) will be made during the day of the rising hydrograph. Velocity measurements will be made at pre-designated stations through as much of the inundated habitat as is feasible to reach during this period.

1d. Determine the mechanisms and recovery rate of primary KAS habitat following the high flow experiment.

We will resurvey the site periodically during the summer months and document the rate of recovery of inundated vegetation patches that remain in the < 1,275 m^3/s zone. We will compare stem length, leaf size and phenology with plants growing in the non-inundated zone. We will document seedling establishment as it occurs, and we will compare seedling abundance of primary host plants in the < 1,275 and in comparable areas of the > 1,275 zones by direct counts/unit area.

1e. Determine historic development of KAS habitat, particularly colonization by water-cress.

Dr. Robert Webb (U.S. Geological Survey, Tucson, Arizona) has rematched a series of 12 pairs of pre-dam photographs of VP taken since 1890. Several sets of these photographs reveal the extent and composition of vegetation development at VP over time. He has offered to share these photographs with us. We propose to survey vegetation scour lines and relate those elevations to our stage discharge model for VP. By knowing the photo date and by cross-checking with the Lees Ferry gauging record, we will be able to determine whether the VP stage-to-discharge relationship has changed over time. With these data and the photogrammetric TIN model created by Stevens et al. (1995, Attachment A) we will: 1) determine the extent of low (and possibly high) zone pre-dam primary habitat over time; 2) determine approximately when *Nasturtium* colonized the site; and 3) assess other vegetation changes at VP over time. This information will provide insight into interactions between non-native host plant introductions and dam operations.

OBJECTIVE 2: High Flow Impacts on the VP KAS Population:

2a. Determine the proportion of the KAS population at risk to loss during the high flow experiment.

Measurement of KAS density will be performed using the techniques of Stevens et al. (1995, Attachment A). KAS population size will be measured using a replicated, small-plot method of sampling discrete vegetation patches (Brower et al., 1990). Habitat patches will be delineated on the basis of dominant vegetation cover (i.e., *Mimulus cardinalis, Nasturtium officinale, Adiantum capillus-veneris, Equisetum* spp., mixed wetland and grass species, and *Toxicodendron rydbergii*). Because KAS distribution is strongly seasonally correlated with the presence of *Mimulus, Nasturtium* and occasionally *Carex* and *Polygonum*, patches dominated by those species will be designated as primary habitat. Patches dominated by other riparian plant species contained few, if any, KAS in 1995, but we will continue to survey a sufficient number of secondary habitat patches to identify the extent of KAS presence there. Within-patch sampling replication will depend on patch size, with complete census of patches < 1.0 m^2, and up to 25 20-cm diameter (0.031 m^2) circular plots in larger patches, depending on sample variance and patch complexity. Particular sampling emphasis will be focused on patches lying below the 1,275 m^3/s stage (identified in 1a, above), which will be inundated during the high flow event. We will estimate how many KAS comprise an additional 2.5% of the population for mitigation purposes discussed in Objective 5 (below).

The number of KAS and other Mollusca in each plot will be recorded. In addition, plot substratum composition (bedrock, soil type), soil moisture, litter depth and relative moisture, vegetation species composition, vegetation density, stem and leaf characteristics, and estimated percent cover will be recorded. Shell lengths of each living KAS encountered will be measured, and microhabitat associations (e.g., substratum, litter, living water-cress leaf, dead monkeyflower stem, etc.) will be determined. During each visit to VP, streamflow will be estimated by timing the filling rate of 20 L buckets and by estimating additional rivulet flow. We will also measure VP water temperature.

Using the information in 1a (above), photogrammetry and the bootstrapping methods of Efron and Tibshirani (1993) and Stevens et al. (1995, Attachment A), we will estimate KAS density in vegetation patches in the low ($< 1{,}275$ m^3/s stage) and throughout VP in mid-March, 1996. We will estimate percent patch area change in the upper zone ($> 1{,}275$ m^3/s stage) by comparing November 1994 and November 1995 close-level photogrammetric images of the site, and adjust upper zone habitat patch area accordingly. We will use bootstrapped mean KAS densities to estimate snail abundance in high-zone patches. Because several high zone vegetation patches are not accessible, we will estimate KAS density in those patches by multiplying photogrammetric patch area measurements with the grand mean high zone KAS density measured from accessible high zone patches.

The FWS may continue to permit limited collection of KAS as voucher specimens and for future anatomical and genetics studies. For morphological and anatomical studies, specimens will be fixed in boiling water for one second and preserved in 70% EtOH for taxonomic verification and reference. We will request permission from the NPS to continue collections of associated invertebrate species and vegetation at VP and at other Grand Canyon springs. Specimens will be housed in the National Park Service Collections Repository at Northern Arizona University's Laboratory of Quaternary Paleontology, Flagstaff, AZ, Dr. James I. Mead, curator. Some specimens may also be housed at the Grand Canyon National Park Museum, pending approval of the U.S. Fish and Wildlife Service.

2b. Determine the proportion of the KAS population lost during the high flow experiment.

We will repeat the process described in 2a (above) promptly after the high flow event, and determine the extent of KAS population lost during the high flow event.

2c. Determine the mechanisms of KAS loss due to high flow experiment.

We will observe as many KAS as possible which are being inundated by the rising hydrograph and document whether KAS are lost to simple immersion or to a combination of inundation and increasing velocity (see also 4c below). In addition, we will conduct an experiment to determine at what point immersion results in snail death; all snails used for this experiment will be part of the collection already request by AGF for future genetic/morphologic research. This experiment will begin with a pilot analysis during which we will immerse snails in the river in enclosures that permits water exchange and observe snail deaths over time to develop a preliminary estimate of lethal immersion time. We anticipate lethal immersion will occur within 48 hours, based on observations made during collections in 1995. Depending on the time to death, we will then immerse an additional number of snails and remove individuals at intervals around the estimated lethal immersion time. We will observe the snails and develop an estimate of the proportion of the sample killed by immersion over a period extending several hours (as appropriate given the estimated lethal immersion time) before and after the estimated killing time. Using the results of these experiments, we hope to be able to predict impacts of future floods on snail populations and determine if there are flood configurations which might not impose losses due to immersion.

We will also use the immersion experiments to help us determine whether snails will behaviorally avoid immersion. Initially, some immersion chambers will have stalks of vegetation rising above the water surface. This facet of the experiment will allow us to predict whether snails at the edge of the inundation zone are likely to escape death by drowning if vegetation persists nearby.

2d. Determine KAS population recolonization for six months post-flood.

We will resurvey population density on KAS prior to and after the high flow experiment, and on a monthly basis through the 1996 growing season (through October 1996). Monthly surveys will allow us to quantify the rate of recolonization of inundated areas, as well as the rate of population growth and timing of reproduction after the flood. Land surveys will be performed at least seasonally on the vegetation patches, and related to the KAS patch-based population density data.

OBJECTIVE 3: KAS Sampling and Protocol Assessment

3a. Refine stage-discharge relationship at VP.

The stage-to-discharge relationship at VP will be refined by surveying to within 10 cm accuracy, and photodocumenting, the stage elevation during the 226 m^3/s and 1.275 m^3/s constant flow as well as during the up-ramp flows.

3b. Determine the accuracy of KAS density measurements made using the plot sampling method of Stevens et al. (1995, Attachment A).

Sampling strategies in 1995 employed haphazardly-distributed 20-25 cm diameter plots in vegetation patches and patch-based bootstrapping estimation of KAS density. In 1995 KAS population size was estimated through the following methods: 1) total counts of KAS were made in vegetation patches < $1.0m^2$; 2) KAS abundance in larger, accessible patches was generated by multiplying patch area by the bootstrapped mean density, and within-patch error estimates were generated from the bootstrapping process; 3) for patches that were not physically accessible, the grand mean KAS density in each primary patch type was multiplied by photogrammetrically determined patch size. We summed KAS abundance in all patches to derive a total population estimate at VP; however, overall error estimates were only available for individual patches, not for the total KAS population.

Issues of sampling thoroughness, variance testing with different levels of replication, and definition of plot boundaries can be explored using 1995 data and the KAS habitat that will be destroyed by the high flow event. As many arrays as possible of replicated 10-, 20- and 30-cm plots will be surveyed using our previous methodology and then destructively sampled in low-zone primary habitat in mid-March, 1996. We will attempt to place six replicates within each primary habitat vegetation stratum (pure *Mimulus*, pure *Nasturtium*, and mixes of the two species). During destructive sampling, we will remove all vegetation and count all snails. Vegetation from each plot will be dried, and stem length and biomass will be determined. Sampling will proceed from the perimeter of patches inward, until the whole patch has been covered. This method will provide data to be used to evaluate accuracy and precision of previous methodology and to test the effect of patch size on survey accuracy. Analyses will compare differences between methodologies, as well as differences in snail numbers between vegetation types and differences in snail densities within patches (e.g., between perimeter and center). All snails collected from these plots will be marked and moved to non-inundated patches.

3c. Determine the effects of plot size on habitat impacts.

As part of 3b (above) we will measure the number and proportion of primary habitat stems that are broken during sampling to assess the effects of plot size on habitat damage caused during KAS surveys.

3d. Determine species-area effects of plot size on KAS population estimation.

Using the data collected in 3b (above) we will determine whether any species-area effect of sampling complicates density estimation of KAS at VP. We will analyze KAS density as a function of plot size, and determine whether this regression is significantly different than a 1:1 relationship. If a plot size effect exists, we will adjust our population estimates accordingly.

3e. Compare KAS distribution and population estimation analysis techniques.

We will compare KAS population estimates based on patch mean and variance under various distributional assumptions (i.e., Poisson, negative binomial, etc.) with the bootstrapping methods of Stevens et al. (1995, Attachment A). The most reliable population estimate will be recommended for management decision-making.

OBJECTIVE 4: Behavior and Movement Studies

4a. Determine the most appropriate marking technique for KAS survivorship and movement studies.

We will conduct a literature survey and contact members of the malacological community to determine what marking techniques are available for snails with similar shell morphology and life habits. We will choose a technique suited to the species and the research environment. The candidate technique will be reviewed by Fish and Wildlife Service Ecological Services biologists and tested on surrogate species (e.g., *Catinella vermeta*). Marking protocol will be established by late February 1996.

4b. Develop a KAS ethogram.

During the constant 226 m^3/s (8000 cfs) period, we will formulate an ethogram for behavioral observations, formalizing behavior states (e.g. completely withdrawn into shell, out of shell-stationary, moving locally), point behaviors (e.g., withdraw antennae). Habitat variables of interest for snails in vegetation include vegetation part (leaf, stem, petiole), elevation above ground in vegetation, upper vs lower leaf surfaces and distance from edge of patch. Other habitat variables to be recorded for snails in vegetation and snails in litter/duff include litter and duff thickness and moisture, and presence and disposition of water in or beneath the duff. We will prepare detailed maps of each patch in order to precisely record KAS position in the patch.

4c. Determine KAS movement behavior in relation to the high flow.

All KAS located during protocol refinement studies, and any additional KAS needed to make up 7.5% of the estimated total pre-flood population at VP, will be marked and moved to a stage zone lying above the 1,250 m^3/s stage. Some resident, unmoved KAS will be also be marked at that time using the techniques identified in 3f above, and additional KAS will be marked during subsequent site visits unless contraindicated by mark-recapture return data.

Two general types of observations (focal and scan observations, Altmann 1973) will be used to record behaviors and movements of individual snails and of the snail population within known areas. **Focal observations** will allow us to describe bouts of behavior (e.g., how many minutes does the average snail movement last?) and rates of point behavior (e.g., how often does a snail defecate?). At the beginning of each focal observation, observers will note the temperature, the substrate/species on which the snail rests, position in patch (mapped), elevation above ground, and presence of any nearby conspecifics or other invertebrates. During observations of individual snails, observers will continuously record behavioral state and point behaviors, changes in host plant, and encounters with other invertebrates. At set intervals (≤ 1 min, observers will note distance moved and change in elevation since the last interval. If many snails are available, researchers will assign (systematically or randomly) a vegetation strata in which to begin observations. In this way, we can avoid biasing observation towards snails in the more readily observable, upper portions of the vegetation. During the um-ramp flows, focal observations of snails near the water's edge will also be made (see also 2c above). Focal observations will emphasize KAS on primary habitat species (monkeyflower and water-cress). Observations on litter/duff and bare rock can be taken if the opportunity arises. Following observations, the snail's ID will be recorded, and microsite habitat data will be collected (information about the immediate vicinity of substrate - e.g., litter thickness, moisture content of duff, light level at the snail's position). Fecal pellets deposited during the observation and still *in situ* will be collected and preserved in 70% EtOH.

Scan observations will permit point-in-time snapshots of a group of snails and can be used to describe behavior at the population level (e.g., what proportion of snails are quiescent at a given time of day or a given temperature?). Before the scan, observers will describe the area to be checked, and record temperature, light level, type and height of vegetation. Snails will be tallied into behavioral

categories, with care taken to note snails in the lower vegetation and litter of the patch. Scans will be made four times in a 24-hour period.

One of these scans will also serve as an ID-scan. During a scanning observation, all marked individuals will be removed briefly to determine their snail ID, and then replaced on the vegetation. The ID scan will be conducted while snails are relatively active (as opposed to during cold periods when it may be more difficult for snails to reattach to the vegetation) so that they can resume their activities easily. KAS quickly recover from handling (Stevens et al., 1995, Attachment A). Patch ID, position in patch, and substrate/host species will also be recorded.

Raw data will be entered and checked in the field. Following the experiment, data will be analyzed to document short-term distance moved, tabulated by resident status of snail (moved or resident), initial substrate/species, time of day, time of year. Effects of temperature, light level, and local snail density will be evaluated as covariates. Long-term distance moved will also be analyzed through tabulation of resident status and time of year. Long-term movement will be assessed by analyzing data on marked individuals, and possibly shells, relocated during monthly revisits to the site, during ID-scans taken during the experiment, and during possible repeat focal observations of given individuals. Covariate analyses will also be conducted.

The appropriate uses of scan and focal sampling for testing hypotheses of behavior are given in Altmann 1974. Parametric techniques will be used whenever continuous data meet the necessary assumptions. Metric data (distances moved, effects of temperature on distance moved) will be analyzed using t-tests, ANOVA, ANCOVA or the appropriate nonparametric counterparts. Composition data (activity budget, habitat use) will be analyzed using parametric or nonparametric chi-square and compositional analyses (Aitchison 1986, Aebischer et al. 1993).

4d. Determine survivorship of marked and moved versus resident KAS.

Using the same data used to analyze long-distance or long-term movement (see 4b below), we will attempt preliminary survival analyses for KAS as a function of resident status. Simple descriptive statistics (proportions of marked and unmarked snails, number of originally marked snails relocated) will be calculated. In addition, we will compare patch-based density estimates before and after the high flow event in all primary habitat patches. More advanced analyses may be possible that will detail changing survivorship over time, differential survivorship, etc. The exact type of these analyses cannot be selected until we have a better understanding of the amount and limitations of the data. However, as it seems likely that data will be strongly right-censored (some animals will not be relocated; these may have died or may simply be unobservable), log-rank and Wilcoxon tests may be used (Lee 1992, Fox 1993). The difficulties inherent in all phases of KAS research may preclude extremely precise survivorship estimates; however, we will make every effort to ascertain survivorship through the high flow event.

4e. Determine activity budgets and habitat use of marked resident and immigrant KAS in the growing season.

Activity budget will be tabulated by resident status and substrate/host plant species. The budget will be calculated for the population using scan observations. We will also summarize short-term information and compare short-term behavior to the population summary developed from scan observations. Habitat use will be tabulated by resident status. These data will be available from population sampling, scan, and ID-scan observations. ID-scan and possible repeat focal observations will also permit analysis of habitat use by individuals, giving us information on host plant fidelity. Covariate analyses will be conducted, but possibly at a coarser level than for continuous variables.

4f. Determine KAS diet through the 1996 growing season.

Analysis of fecal pellets collected after focal observations will be used to analyze KAS diet. Fifteen replicated paired fecal pellet and adjacent surface scraped samples will be collected from each host

plant species on a seasonal basis, and preserved in 70% EtOH. Samples will be analyzed under appropriate magnification for dietary composition. Diet will also be tabulated by resident status and substrate. Habitat use data (4b, above) will also be used to infer diet information. Defecation rates on different host plants may also allow us to infer differential ingestion rates and detect differences between resident and moved snail feeding rates.

4g. Observe interactions between KAS, parasites, potential competitors and potential predators.

This component is strictly observational, and only if data indicate probable significant interactions will further studies be proposed. Interactions between KAS, parasites, potential competitors (e.g., *Deroceras levae* and *Catinella* spp.) and potential predators (e.g., Carabid beetles and *Catherpes mexicanus*) will be made during focal observations (4b, above). Data can be analyzed to determine whether behavioral responses and distribution patterns differ in relation to species encountered. If necessary (if too few observations include encounters with other species), some focal observations can made of individuals that are initially in close proximity to other species.

OBJECTIVE 5: Mitigation and Longterm Studies

5a. Determine potential for growing KAS primary host plant species in controlled environments.

A prerequisite for establishing captive breeding KAS populations is understanding propagation potential of the primary host plants. Although water-cress is grown commercially, the VP stock may have specific microhabitat requirements that are not matched in commercial production. We will remove six batches each of water-cress and monkey-flower, and attempt to propagate these two species in a controlled environment at Northern Arizona University. Propagation of these species will also be attempted using seed from the VP stock in mid-summer. If successful, optimal growth experiments may be conducted. Growth rates and phenology will be compared with that occurring in the field.

5b. Determine palatability and use of alternate host plant food sources.

Water-cress is commercially available, but the utility of other strains of water-cress as a food source for KAS is unknown. Using several of the live KAS collected by AGF for future genetics studies, we will conduct field experiments to determine whether KAS can persist on commercially-available, as well as resident, water-cress. In addition, we will collect monkeyflower at several other spring sites and conduct a similar experiment with other KAS from the AGF collection batch. We will attempt to quantify use by observing fecal output from snails offered plants of different types. We will also offer different types simultaneously and quantify time spent on each by snails.

5c. Move low-zone KAS to non-inundated habitat at VP.

KAS that occur below the $< 1{,}275$ m^3/s stage will be marked and moved to a higher stage elevation at VP in sufficient numbers to ensure that no more than 7.5% of the population is lost. Currently, we anticipate moving $\leq 8.5\%$ of the population. This measure is designed to limit undue losses of KAS at VP during the high flow experiment, and will provide a suitable means of measuring high flow impacts on KAS, in addition to providing much-needed insight into snail dispersal, survivorship and essential like history characteristics. While mark-recapture techniques are traditionally used for population estimation, we will be using them primarily to determine behavioral parameters and to estimate survival of moved snails. KAS will be moved immediately before the high flow event, and will be monitored through the mark-recapture study. KAS will be moved to similar and different host-plant patches, where subpopulation densities are being monitored. Marking these snails will allow us to determine their fate after movement, in relation to controls of resident (unmoved) KAS in similar and the other host plant hatches.

An additional 100 snails will be collected for AGF to permit future genetic/morphological research. Specimens collected for future genetic research will be flash frozen in liquid nitrogen in the field and transported frozen to holding facilities.

5d. Determine fate of moved KAS.

The studies outlined in 4d (above) will allow us to determine the fate of moving KAS to higher stage elevations during this controlled high release. These data will be compared with mortality data on KAS inundated by the high flow and against survivorship and behavior of resident KAS (4c and d, above). These data will indicate whether this option can be used in future planned floods, how much expenditure of person-hours are required, and the long-term fate of moved KAS.

5e. Investigate comparable habitats in Grand Canyon for possible introduction sites.

In compliance with the Endangered Species Act, Arizona Game and Fish Department is in its third (final) year of Section 6 studies of KAS. This final year of funding is scheduled to focus on habitat a variety of KAS habitat-related issues, particularly the suitability of secondary population introduction sites. Criteria for secondary population establishment have yet to be defined, but AGF studies are designed to address issues of recognized. The AGF studies are currently funded and are described in Attachment B (below). Those studies will complement our research described above, which is entirely restricted to VP.

TASKS AND TIMETABLE

Prior to 22 March:

Complete literature review.
Identify and test marking protocol.
Logistic preparations (personnel, equipment, etc.).
Acquire additional plant specimens for palatability studies.
Set up camp and prepare site for research activities.

22-26 March:

Sample snail populations and survey habitat.
Estimate total population and proportion below the inundation line.
Conduct sampling/methodology experiments in low-zone patches.
Mark and move snails as necessary.
Set aside snails for immersion and palatability experiments.

27 March:

Begin immersion experiments.
Study behavior of snails at the water line during up-ramp flows.

28 March-5 April:

Continue immersion experiments.
Focal and scan sample snails in high-zone patches.
Conduct palatability studies.

early April:

Resurvey and rephotograph habitat patches.

Post-flood:

Resample snails and resurvey habitat monthly through October 1996.

DELIVERABLES

Results will be presented in a May 1996 report, quarterly and final FY96 reports, and prepared for peer-reviewed publication. Data will be provided to GCES and cooperating agencies in electronic form in Lotus or ASCII format, depending on agency needs.

BUDGET

P.I. salaries	Covered through interagency agreements with BOR
Technician salaries and FICA (NAU)	$6,000
Travel (NPS, AGF, USFWS)	$3,500
Equipment (laboratory and field)	$500
Diet analyses (180 samples over three seasons)	$3,000
Second population habitat and genetic studies (Attachment C)	Funded under Section 6 funds for FY96
Low level oblique photogrammetry (BOR, 4 images)	$6,500
Reporting and publication costs	$500
Overhead (20%)	$1,000
TOTAL PROJECT COSTS	$20,000

This budget does not include cooperating agency/entity salary costs, nor does it reflect logistics costs, including logistical support for 10 land-based or partial river trips.

STAFF

Sampling, analytical and legal issues associated with KAS research are complex and will benefit from a cooperative, interagency approach to resolution of high flow impacts and snail recovery. The field aspects of the research requires great care and considerable training of field staff. The team we have assembled for this project include thoroughly trained field scientists who participated in the 1995 studies of this species (Stevens et al., 1995, Attachment A). We enclose curriculum vitae of all primary researchers associated with this proposal (Attachment C).

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Enclosure 2

GLEN CANYON ENVIRONMENTAL STUDIES PROGRAM

WORK PLAN FOR MONITORING RESPONSES OF THE SOUTHWESTERN WILLOW FLYCATCHER TO A HIGH RELEASE FROM GLEN CANYON DAM

Bureau of Reclamation
Glen Canyon Environmental Studies Program
P.O. Box 22459
Flagstaff, AZ 86002-2459

23 February 1996

PRELIMINARY SUBJECT TO REVIEW

GLEN CANYON ENVIRONMENTAL STUDIES
WORK PLAN FOR MONITORING RESPONSES OF THE SOUTHWESTERN WILLOW FLYCATCHER TO A HIGH RELEASE FROM GLEN CANYON DAM

INTRODUCTION

To meet the reasonable and prudent measures and the terms and conditions of the U.S. Fish and Wildlife Service Biological Opinion on the Planned Flood from Glen Canyon Dam (1996), the Bureau of Reclamation will undertake a series of activities to ensure that take of this species and its proposed critical habitat in Grand Canyon is limited.

We propose administrative and monitoring activities related to the following objectives. These activities will be undertaken by qualified biologists from the Bureau of Reclamation, Applied Technology Associates and the National Park Service (Grand Canyon). Curriculum vitae of researchers is included with this work plan.

Reasonable and Prudent Measures

1. Complete the flow no later than 15 April, and preferably before 1 April, 1996.

2a. Verify stage-to-discharge relationships and flow models used to predict elevation and flow at nest sites.

2b. Monitor the level of incidental take by quantifying flow depth and velocity at each of the four historic territories.

3. Conduct on-site visits of the four historic nesting territories during the post-breeding season (late summer, 1996) to measure vertical structure, foliage height diversity, distribution of flood deposited debris, and habitat patch size and configuration. Habitat characteristics will be evaluated in relation to flood stage and Objective 2a and 2b (above).

4. Coordinate/assist with planned National Park Service summer SWWF population surveys, distribution and nesting success.

5. Initiate formal consultation for the SWWF on the preferred alternative to the Glen Canyon Dam Environmental Impact Statement (GCD-EIS) Preferred Alternative before 31 January, 1997, including results of the planned high flow, the final report for which is due 31 December 1996.

Terms and Conditions

1. Monitoring the project area and other areas that could be affected by the proposed action.

2. Draft report on flood impacts due by 30 September 1996, and final report due by 31 December 1996.

3. If nest trees are inundated by >1.5 m of water, the Bureau of Reclamation must immediately provide an explanation of the causes and review with the Fish and Wildlife Service the need for possible modification of the reasonable and prudent measures.

METHODS

Objective 1: Complete the high flow no later than 15 April, and preferably before 1 April, 1996.

Planned high flows are scheduled to return to interim flows levels on 3 April 1996. We will verify this by monitoring dam releases and USGS gauging station records.

Objective 2a: Verify stage-to-discharge relationships and flow models used to predict elevation and flow at nest sites.

We will visit each of the four historic nesting sites and establish one or more topographic transects from upslope of the nest trees to below the 566 m^3/s stage. During the high flow event we will visit these same sites and mark the high water stage and measure velocity (see 2b, below). We will return to the nest tree stands soon after high flows recede and survey in the high water stage elevation. These results will be compared with those of the nearest STARS model cross-section (Randle and Pemberton 1987).

Objective 2b. Monitor the level of incidental (habitat) take by quantifying flow depth and velocity at each of the four historic territories.

In the course of our during-flood visit we will quantify the depth to which the root crowns of nest trees are inundated by direct measurement, and we will measure flow velocity in the mainstream, in the various cells of the eddy, along the vegetated shoreline, and at the nest trees themselves using Marsh-McBirney velocity meter. We will compare pre-flood, during-flood and post-flood oblique photographs from fixed points in each nest tree stand and associated marsh.

Objective 3: Conduct on-site visits of the four historic nesting territories during the post-breeding season (late summer, 1996) to measure vertical structure, foliage height diversity, distribution of flood deposited debris, and habitat patch size and configuration. Habitat characteristics will be evaluated in relation to flood stage and Objective 2a and 2b (above).

We will return to the four historic nest sites, and to any other sites used by SWWF for nesting in 1996, in late summer 1996, and evaluate long-term impacts of flood flows on nest tree stands and associated marshes. Foliage height diversity has been demonstrated to be strongly correlated with avian species diversity (MacArthur and MacArthur 1961). We will measure foliage height diversity using a modified woody foliage profile density technique modified from Dueser and Shugart (1978). We will measure vertical structure and foliage profile density using a survey rod and counting the number of contacts with branches at 0.5 m intervals over the lowermost m, and at 1.0 m intervals from 1.0 m to the top of the canopy. Profile measurements will be made along 10 georeferenced transects oriented perpendicular to the river, running from upslope of the $1275 m_3/s$ stage to below the 566 m^3/s stage. On each transect, at least six measurements will be taken, $\geq$ 3 above the 1275 m^3/s stage and $\geq$ 3 between the 1275 m^3/s stage and the 566 m^3/s stage. We will also quantify litter and duff thickness, as well as living ground-covering vegetation, at each point and examine the site for driftwood scour or accumulation. Measurements will be made prior to the flood, immediately after the flood and in late summer 1996.

We will analyze the foliage height diversity and ground cover data by comparing the shift in mean values from before and after the flood in the >1275 m^3/s stage with the before-to-after shift in mean values in the <1275 m^3/s stage at each site.

We will map vegetation using pre-flood and post-flood 1:4800 Bureau of Reclamation black and white aerial photographs, using the mapping techniques of Stevens and Ayers (1995). Areal change in nest site stands and in associated marsh habitats will be quantified from these two sets of photographs, and marsh area will be remeasured in late summer 1996 to evaluate site changes through the growing season.

Objective 4: Coordinate/assist with planned National Park Service summer SWWF population surveys, distribution and nesting success.

The Bureau of Reclamation will coordinate and assist the National Park Service accomplish its planned monitoring of summer SWWF population size, distribution and nesting success in 1996 by providing funding and logistical support, and by assisting as needed in data management and report preparation. The NPS will conduct monthly trips from March through June, and will be requested to conduct a fledging success analysis in July 1996 as part of other, on-going GCES monitoring and research trips.

Objective 5: Initiate formal consultation for the SWWF on the Glen Canyon Dam Environmental Impact Statement (GCD-EIS) Preferred Alternative to the before 31 January 1997, including results of the planned high flow, the final report for which is due 31 December 1996.

The Bureau of Reclamation will initiate formal consultation for the SWWF on the GCD-EIS Preferred Alternative after the above information is compiled, and prior to 31 January 1997. The above information will be compiled into a draft report and submitted to the U.S. Fish and Wildlife Service by 30 September 1996, and a final report will be submitted by 31 December 1996.

SCHEDULE

The above monitoring and analyses will take place on the following schedule.

Pre-flood vegetation mapping, topographic profiling, foliage height diversity measurement, litter/ground cover measurement and site photography . . . . . 28 February-3 March 1996

During-flood peak stage marking, flow velocity measurement, and site photography . . . . . 29 March-1 April 1996

First NPS Avifauna Monitoring Trip . . . . . 30 March-12 April 1996

Post-flood vegetation mapping, topographic profiling, foliage height diversity measurement, litter/ground cover measurement and site photography . . . . . 16 April-21 April 1996

Second NPS Avifauna Monitoring Trip . . . . . 6 May-20 May 1996

First NPS SWWF Monitoring Trip . . . . . 28 May-9 June 1996

Third NPS Avifauna Monitoring Trip . . . . . 10 June-24 June 1996

Second NPS SWWF Monitoring Trip . . . . . 17-28 June 1996

Third NPS SWWF Monitoring Trip . . . . . 1-8 July 1996

Optional fledging success monitoring trip (coupled with Stevens July backwater trip) . . . . . 20 July - 2 August 1996

Late summer monitoring trip . . . . . 10-16 September 1996

Draft final report . . . . . 30 September 1996

Final report . . . . . 31 December 1996

DELIVERABLES

Three copies of the draft final report will be delivered to the USFWS Phoenix Field Office on 30 September 1996. The final report will be delivered to the USFWS on 31 December 1996, with a letter requesting formal consultation on the GCD-EIS Preferred Alternative.

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Enclosure 3

CURRICULUM VITAE OF SWWF RESEARCHERS

CURRICULUM VITAE: LAWRENCE EDWARD STEVENS

DATE OF BIRTH: 17 November, 1951, Cleveland, Ohio.

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EDUCATION:

Graduated with honors, Rocky River High School, Rocky River, Ohio, 1970.
BA Biology and fine arts, with honors, Prescott College, Prescott, Arizona,1974
Selected coursework in biology and fine arts, University of Arizona, 1977-1978.
MS Biology, Northern Arizona University, Flagstaff, Arizona, 1984.
PhD Biology, Northern Arizona University, Flagstaff, Arizona, 1989.

MARITAL STATUS: Married, Gwendolyn L. Waring, PhD, 29 June, 1989. No children.

PERTINENT EXPERIENCE, EMPLOYMENT:

1971-1974. Field research assistant for the Prescott College Ecological Survey, performing environmental impact surveys funded by the Arizona State Game and Fish Department, Arizona Department of Transportation, Salt River Project, National Forest Service, and Arizona Public Service Corporation.

1973. Consultant for NUS Corporation, Arizona Nuclear Power Project.

1974. Park Technician, Grand Canyon National Park, Grand Canyon, Arizona.

1975. Park Technician, Lake Mead National Recreation Area, Las Vegas, Nevada.

1975-1979. Research consultant in entomology and ornithology, Museum of Northern Arizona, Flagstaff, Arizona.

1976-1982. Whitewater guide in Grand Canyon for Wilderness World, Inc. Flagstaff, Arizona.

1979-1981. Graduate Research Assistant, Northern Arizona University, Flagstaff, Arizona.

1983-1989. Whitewater guide in Grand Canyon for Arizona Raft Adventures, Flagstaff, Arizona.

1984-1988. Research consultant, National Park Service and Bureau of Reclamation.

1985-1987. Graduate Research Assistant, Northern Arizona University, Flagstaff, Arizona.

1986-1989. Doctoral research, Northern Arizona University. PhD completed in May, 1989.

1989-1991. Summer faculty member, Northern Arizona University Department of Biological Sciences.

1986-present. Research Associate, Museum of Northern Arizona, Flagstaff, Arizona.

1988-1994. Ecologist, Grand Canyon National Park Resource Management and Planning Division, Grand Canyon, Arizona.

1990-present. Adjunct Faculty Member, Department of Biological Sciences, Northern Arizona University.

1993-present. Adjunct Faculty, Prescott College, Prescott, AZ.

1995-present. Ecological data analyst, Applied Technology Associates, Inc., contractor to the Bureau of Reclamation.

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1992. Blinn, D.W., L.E. Stevens and J.P. Shannon. The effects of Glen Canyon Dam on the aquatic food base in the Colorado River corridor in Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit 1992 Final Report, Flagstaff.

1992. Beus, S.S., C.C. Avery, L. Stevens, B.C. Cluer, M. Carpenter, R. Carruth, J. Schmidt, and W. Jackson. The influence of variable discharge regimes on Colorado River sand bars below Glen Canyon Dam. NPSCPSU Final Report, Flagstaff.

1993. Blinn, D.W., L.E. Stevens and J.P. Shannon. The impacts of interim flows from Glen Canyon Dam on the aquatic food base in the Colorado River in Grand Canyon National Park, Arizona. National Park Service Cooperative Parks Study Unit 1993 Annual Report, Flagstaff.

1993. Stevens, L.E. and T.J. Ayers. The impacts of Glen Canyon Dam on riparian vegetation and soil stability in the Colorado River corridor, Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit 1992 Final Report, Flagstaff.

1993. Stevens, L.E. and T.J. Ayers. The impacts of interim flows from Glen Canyon Dam on riparian vegetation in the Colorado River corridor, Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit 1993 Annual Report, Flagstaff.

1994. Blinn, D.W., L.E. Stevens and J.P. Shannon. The effects of interim flows from Glen Canyon Dam on the aquatic food base in the Colorado River corridor in Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit, Final Report, Flagstaff.

1994. Stevens, L.E. and T.J. Ayers. The impacts of interim flows from Glen Canyon Dam on riparian vegetation in the Colorado River corridor, Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit 1994 Annual Report, Flagstaff.

1995. Blinn, D.W., L.E. Stevens and J.P. Shannon. The effects of interim flows from Glen Canyon Dam on the aquatic food base in the Colorado River corridor in Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit, 1995 Final Report, Flagstaff.

1995. Stevens, L.E. and T.J. Ayers. The impacts of interim flows from Glen Canyon Dam on riparian vegetation in the Colorado River corridor, Grand Canyon, Arizona. National Park Service Cooperative Parks Study Unit 1994 Final Report, Flagstaff.

1995. Stevens, L.E., F. Protiva, D.M. Kubly, V.J. Meretsky and J. Petterson. The ecology of the endangered Kanab ambersnail (Oxyloma kanabensis Pilsbry) in Grand Canyon, Arizona. Bureau of Reclamation Glen Canyon Environmental Studies Report, Flagstaff.

GRANTS FOR RESEARCH IN RIVER AND WATERSHED ECOLOGY:

1980. Challenge grant from Wilson Foundation and the Grand Canyon Natural History Association. $2000.00.

1980. Grant from the Driscoll Foundation. $750.00.

1981. Grant from Sigma Xi. $250.00.

1981. Grant from the Driscoll Foundation. $500.00.

1982. Challenge grant from the Wilson Foundation and the Grand Canyon Natural History Association. $5000.00.

1984-85. Research funding from the Bureau of Reclamation and the National Park Service, with G.L. Waring. $16,0000.00.

1984-86.Research funding from the Bureau of Reclamation and the National Park Service, with G.L. Waring. $31,000.00.

1985-87. Organized Research Grants from Northern Arizona University. $6,500.00 each year.

1987-88. Riparian vegetation and soil conditions along the Colorado River in the Grand Canyon following post-dam flooding: a monitoring study. $29,950.00.

1989-1994. During these five years I coordinated proposal development on more than 15 large federal projects related to fluvial ecosystem studies associated with the Bureau of Reclamation Glen Canyon Environmental Studies Program, totaling more than $3.5 million. In addition to proposal development, and contract and project coordination, I am presently serving as an advisor on a large-scale planned flooding experiment to restore natural geomorphic features of the Colorado River in the Grand Canyon.

LECTURES AND UNIVERSITY COURSES

1987. The Natural History of Northern Arizona -- an undergraduate level course taught in the Northern Arizona University Department of Biological Sciences

1989, 1990 and 1991. Biological Techniques. A graduate level course for secondary science education teachers. Taught in the Northern Arizona University Biology and Geology Depts.

1989. The role of disturbance and moisture gradients as determinants of plant diversity in riparian ecosystems. Invited lecture presented to the Oklahoma State University Department of Biology, Norman, OK.

1989. The consequences of human impacts on disturbance regimes. Invited lecture presented to the Harvard School of Architecture, Cambridge, MA.

1991. River regulation and geomorphic control of fluvial marsh development in Grand Canyon, Arizona. Presented to the American Geophysicists Union, San Francisco, CA.

1992. Stevens, L.E. Improving natural resources management through research and monitoring in the Colorado River corridor, Arizona. Invited lecture presented to the SWARM/Arizona-Nevada Academy of Sciences, Tucson, AZ.

1992. Stevens, L.E. Dam-related changes in the Colorado River in Grand Canyon. Invited lecture presented to the New Mexico State Museum of Natural History, Albuquerque, NM.

1992. Jackson, W.L., S. L. Ponce, and L.E. Stevens. Issues surrounding the coexistence of National Parks and regulated rivers. Presented to the George Wright Society, 17 November, 1992, Jacksonville, FL.

1993. Stevens, L.E., S.S. Beus and M. Kaplinski. Interim flow effects on Grand Canyon sandbars. Lecture presented to the Colorado River Constituents Group, 12 March, 1993, Grand Canyon, AZ.

1993. M.J.Kearsley, L.E. Stevens, D.A. Bechtel, and T.J. Ayers. Geomorphic and hydrologic controls on riparian vegetation in the Grand Canyon, Arizona. Lecture presented to the 1993 Arizona Riparian Council, 20 March, 1993, Tucson, AZ.

1993. Stevens, L.E. Synopsis and recent developments in the Glen Canyon Environmental Studies Program. Lecture presented to Colorado River Guides Training Workshop, 2 April, 1993, Marble Canyon, AZ

1993. Stevens, L.E. Common plants and birds of the Grand Canyon. Lecture presented to Colorado River Guides Training Workshop, 3 April, 1993, Marble Canyon, AZ

1993. Stevens, L.E. Dam discharge impacts and management in the Grand Canyon, Arizona. Lecture presented to Grand Canyon National Park Interpretation Division, 7 July, 1993, Grand Canyon.

1993. Stevens, L.E. Natural resource tradeoffs in the Colorado River system. Lecture presented to NPS Water Resources Management Training Workshop, Ft. Collins, CO, 11 May, 1993.

1993. Stevens, L.E. and P. Hester. Ecology of the Colorado River in the Grand Canyon. Prescott College (Prescott AZ) course taught 3-27 May, 1993, Grand Canyon, AZ.

1993. Bechtel, D.A., L.E. Stevens, M.J. Kearsley, T.J. Ayers. Geomorphic and hydrologic controls on riparian vegetation in the Grand Canyon, Arizona. Lecture presented to the 1993 Ecological Society of America at the University of Wisconsin, Madison, WI, 3 August, 1993.

1993. Riparian plant succession in the dam-regulated Colorado River: why is saltcedar losing? Lecture presented to the 1993 Ecological Society of America at the University of Wisconsin, Madison, WI, 3 August, 1993.

1993. Kimberling, D.N., L.E. Stevens and A.C. Holm. Slope aspect effects on Colorado River corridor vegetation assemblages, Grand Canyon National Park, Arizona. Lecture presented to the 1993 Ecological Society of America at the University of Wisconsin, Madison, WI, 3 August, 1993.

1993. Mehlhop, P. and L.E. Stevens. Ant distribution across a flood disturbance gradient in the Grand Canyon, Arizona. Lecture presented to the 1993 Ecological Society of America at the University of Wisconsin, Madison, WI, 3 August, 1993.

1993. Stevens, L.E. Ecosystems of the Grand Canyon. Nine 1-hour lectures presented for the Grand Canyon Field Institute, Grand Canyon National Park, 14-16 September, 1993.

1993. Stevens, L.E. Ecosystems of the Grand Canyon. Four 1-hour lectures presented for the Grand Canyon Field Institute, Grand Canyon National Park, 2-3 October, 1993.

1993. Stevens, L.E. Ecosystems of the Grand Canyon. Nine 1-hour lectures presented for the Grand Canyon Field Institute, Grand Canyon National Park, 16-18 October, 1993.

1994. Buck, K.A. and L.E. Stevens. Temporal, geomorphic and flow regulation effects on Colorado River waterbird distribution in the Grand Canyon. Bulletin of the Ecological Society of America 75(2): 27.

1994. Kearsley, L.E., L.E. Stevens, and J.C. Schmidt. Riparian plant diversity in the Grand Canyon: disturbance, productivity, and geomorphic influences. Bulletin of the Ecological Society of America 75(2): 107.

1994. Kearsley, M.J.C., L.E. Stevens and T.J. Ayers. Interim flow effects on fluvial marsh plant communities in Grand Canyon. Bulletin of the Ecological Society of America 75(2): 107.

1994. Stevens, L.E., D.L. Wegner, R. Valdez, D.W. Blinn and D.T. Patten. Colorado River regulation effects on downstream fluvial ecosystem structure in the Grand Canyon. Bulletin of the Ecological Society of America 75(2): 219-220.

1994. M.D. Yard, L.E. Stevens, A. G. Haden, D.W. Blinn and W. Vernieu. Light attenuation, sediment concentration and fluvial ecosystem responses in the regulated Colorado River, Grand Canyon, Arizona. Bulletin of the Ecological Society of America 75(2): 219-254-255.

1995. Brod, C.R., L.E. Stevens and F.R. Protiva. Zonation nd water relations of riparian vegetation along the dam-regulated Colorado River, Grand Canyon, Arizona. Bulletin of the Ecological Society of America 76(3): 306-307.

1995. Hazel, J.E., Jr., M.A. Kaplinski and L.E. Stevens. Cyclic regeneration of fluvial habitats in the dam-regulated Colorado River, Grand Canyon, Arizona. Bulletin of the Ecological Society of America 76(3): 340.

1995. Kearsley, M.J.C., T.J. Ayers and L.E. Stevens. Continuing effects of a new flow regime on fluvial marshes along the dam-regulated Colorado River in Grand Canyon National Park, AZ. Bulletin of the Ecological Society of America 76(2): 130.

1995. Stanitski-Martin, D. and L.E. Stevens. River influences on riparian climate: Colorado River, Glen Canyon. Bulletin of the Ecological Society of America 76(3): 390.

1995. Stevens, L.E. and T.J. Ayers. Flooding and wetland development along a dam-regulated river. Bulletin of the Ecological Society of America 76(2): 254.

1995. Yard, M.D., G.E. Bennett and L.E. Stevens. A mechanistic model to predict PAR in the Colorado River, Grand Canyon, AZ. Bulletin of the Ecological Society of America 76(3): 406.

RECENT REVIEWS

1993. Review of FWS Draft Biological Opinion for Grand Canyon National Park. Submitted to Chief of Resources Management, Grand Canyon National Park.

1994. Review of Glen Canyon Dam Draft Environmental Statement for Grand Canyon National Park. Submitted to Chief of Resources Management, Grand Canyon National Park.

1994. Review of the U.S. Fish and Wildlife Service Draft Recovery Plan for the Kanab Ambersnail (Oxyloma haydeni kanabensis). Submitted to the Program Manager, Bureau of Reclamation Glen Canyon Environmental Studies, Flagstaff, AZ.

PROFESSIONAL AFFILIATIONS:

American Association for the Advancement of Science

Arizona Nevada Academy of Sciences

Arizona Riparian Council

Ecological Society of America

Grand Canyon River Guides Association

Grand Canyon Trust

Southwestern Association of Naturalists

The Nature Conservancy

The Sierra Club

CURRICULUM VITAE

***** VICKY J. MERETSKY *****

I. PERSONAL

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Flagstaff, Arizona 86002-3622

(520) 556-7456 (work) (520) 556-7368 (FAX)
(520) 525-3438 (home) meretsky@ccit.arizona.edu

II. EDUCATION

Institutions Attended:

Cornell University, Ithaca, NY — B.Sc. Biological Sciences, Jan. 1980
September 1976-January 1980

Humboldt State University, Arcata, CA — M.Sc. Wildlife, Aug. 1988
September 1980-March 1983
September 1987-June 1988

University of Arizona, Tucson, AZ — M.Sc. Statistics, May 1993
August 1988-April 1995 — Ph.D. Wildlife Ecology, Apr. 1995

III. POSITIONS HELD

Biometrician/Fisheries Biologist: U.S. Fish and Wildlife Service; Nov 94 - current. Duties include developing statistical tools; analyzing 5+ years of fisheries habitat data (primarily endangered for humpback chub) from the Grand Canyon and Colorado River tributaries; collecting fish census, fish habitat and water quality data in the Grand Canyon and related tributaries; working with cooperating agencies, tribes and private groups; writing, reviewing and editing peer-reviewed papers and reports; training and supervising technicians. Member of team of scientists from state and Federal agencies, academia and private firms working to integrate existing physical and biological data on the Grand Canyon ecosystem. Member of interagency team studying ecology of endangered Kanab ambersnail. Taught principal components analysis lectures in graduate biometrics course at Northern Arizona University.

Research Assistant: University of Arizona; Sep - Oct 94. Responsible for analysis of GIS database to determine the effects of scale on measures of landscape diversity and interspersion in desert ecosystems. Results to be published in coauthored, peer-reviewed paper.

Senior Research Specialist: University of Arizona, University of Idaho; Half-time: Jan 93 - Mar 94; full-time: Mar - Sep 94. Responsible for vegetation and GIS portions of multidisciplinary project to describe and map vegetation distribution, geomorphology, hydrology and water quality in Cienega de Santa Clara wetlands in Sonora, Mexico. Duties included field work to identify major wetland plant species, airborne videography to record vegetation in the cienega, interpretation of videography and production of a spatially explicit ARC/View GIS database incorporating data from all project elements. Responsible for avian, mammalian and

III. POSITIONS HELD (continued)

herpetological portions of Arizona GAP project including interpretation of current knowledge concerning species distributions and habitat relationships, work in GRASS and ARC/INFO with habitat maps, species occurrence maps, political, hydrological and topological overlays, consultation with researchers to revise and update final species maps, direction of two other researchers. One of two aerial videographers flying statewide riparian habitat survey for Arizona Game and Fish. Other duties: fly airborne videography as needed, train others in videography. Prepare GIS data using airborne video, image processing software and GIS computer packages. Identify plant communities from airborne video footage. Use global positioning systems (GPS) for terrestrial and airborne data collection.

Research Assistant: University of Arizona; Jan 91 - Dec 92 with continued occasional consultation. Team member in radiotelemetry study of Harris hawks to study habitat use, behavior, causes of mortality. Field duties included trapping, banding, drawing blood, tree climbing, radiotracking, behavioral observation. Trained 3 assistants in radio-tracking and observation skills (Jan 91 - Dec 92). Headed team in vegetation study of areas used by Harris hawks. Assisted with study design; field duties included vegetation mensuration, identification, mapping. Trained and supervised 2 assistants, maintained reference collection of plants and database of species and characteristics of plants encountered (Mar - Dec 1992). Designed database structure for radiotelemetry and vegetation databases, developed field data forms and training information for telemetry/behavior and vegetation studies, developed programs to error-check and support data bases. Trained and supervised 5 assistants in data entry and use of data-checking programs. Performed statistical analyses of habitat use and movement data.

Tutor: University of Arizona; informally: Aug 88 - Nov 94; formally: Sept 1992 - May 1993. Tutor students in undergraduate business statistics and graduate biostatistics classes. Explanation, drill, problem-solving techniques, organization of material for single students and groups.

Research design and analysis consultant: University of Arizona; Jan - June 1993. Team member of Wildlife Habitat Inventory Pilot program for Pima County to map urban wildlife habitat using air photos to delineate landuse types. Advised on research design for vegetation sampling, field techniques, data management; performed data analysis and documentation, graphics preparation, part of presentation to county planners.

Database consultant: U.S. Fish and Wildlife Service; Feb 1993. Developed contract for 3-day effort to bring older California Condor tracking data, stored on mainframes, into FileMaker Pro spreadsheet system. Wrote full documentation for use of FileMaker Pro and Word Perfect to permit use of previous data, translated previous location to UTM, produced data base with all available data in current spreadsheet, and trained staff biologist in its use.

Computer lab monitor: University of Arizona; Sep - Dec 1992. Monitored open personal computer lab. Assisted students with work in Word Perfect (word processing), Quattro Pro (spreadsheet), SAS (statistical), SPSS (statistical), IDRISI (geographical information system) and DOS (operating system) programs. Assistance included teaching, trouble-shooting, translation of manual gibberish and commiserating.

Teaching assistant: University of Arizona; fall semesters 1989 - 1992. Solely responsible for designing and teaching a nonmajors laboratory course in wildlife conservation. Developed lesson plans, arranged and conducted field trips, wrote all exams, assignments and much support

III. POSITIONS HELD (continued)

material, graded exams and papers, trained and supervised three other teaching assistants, handled all administrative work. Topics included life history of representative Arizona birds, mammals and herps, animal behavior, techniques to study feeding, trapping and marking, population processes, vegetation survey techniques, animal census techniques and writing scientific reports.

Wildlife biologist: U.S. Fish and Wildlife Service; Aug 1990 - Apr 1991. Contracted to write peer-reviewed paper on long-range movements and range use of California condors.

Wildlife biologist: Israel Nature Reserves Authority; Apr 1990 - Jan 1991. Contracted to prepare conservation and management plan for endangered Negev subspecies of lappet-faced vulture. Plan covers all aspects of captive breeding and releases to the wild.

Wildlife biologist: Univ. of Arizona; Feb - August, 1989 and 1990. Dissertation data collection on foraging behavior of Egyptian vultures in the Negev desert, Israel.

Wildlife biologist: U.S. Fish and Wildlife Service; Sep 1988 - Feb 1989. Contracted for final analysis of condor location data from remote tower installations. Involved extensive computer programming.

Wildlife biologist: U.S. Forest Service, McCloud Ranger District, Shasta-Trinity National Forest; Apr - August 1988. Responsible for all spotted owl monitoring for 1988 season. Supervised crew of 2-4 biologists, monitoring habitat areas and areas of special interest for spotted owls. Located and observed spotted owls in remote areas. Participated in region-wide study of spotted owl habitat use involving rigid, complex sampling protocol.

Accountant: Sea Shells and Sea Life, Arcata, CA; Aug 1987 - Feb 1988. Full-charge bookkeeper.

Production assistant: The Union, Arcata, CA; Aug 1987 - Apr 1988. Production assistant for local newspaper: typesetting, computer-graphics.

Wildlife biologist; Feb - Aug 1987: Pilot research for dissertation: foraging behavior of Egyptian vultures in the Negev desert.

Research associate: National Audubon Society/Condor Research Center; Sep 1984 - Feb 1987. Joint field biologist/data analyst position. Responsible for observing and tracking California condors using radio telemetry. Participated in trapping efforts, emergency searches, removal of eggs from nests, pit trapping and cannon-netting of golden eagles and all other aspects of field work. Responsible for daily running of remote tracking operation with a unique automated radio-tower system, responsible for development and implementation of all software used with tower data. Responsible for managing all coded field data (18,000+records), answering queries regarding data, writing and documenting all programs for use, support, organization and analysis of data. Worked with major statistical programs and programming languages. Responsible for purchasing all computers and associated hardware and software. 70% field, 30% office.

Research assistant: Humboldt Foundation; Apr 1983 - Sep 1984. Team member on telemetry study of dispersal of juvenile spotted owls. Nest site surveys, location and capture of juvenile owls, ground and air telemetry, budgeting and accounting, most statistical analyses, implementation of home-range programs and development of new programs.

III. POSITIONS HELD (continued)

Lecturer: Department of Wildlife, Humboldt State University; Spring 1982. Solely responsible for senior seminar dealing with public input in wildlife management.

Field assistant: Dr. B. Marcot, Oregon State University; Summers 1981, 1982. Supervisor and team member of habitat inventory team. Responsible for coordination of and participation in mensuration of young-growth Douglas fir forests, field notes, and specimen identification. Assisted with development of survey methodology and preliminary analyses.

Teaching assistant: Drs. B. Marcot, J. Koplin, D. Kitchen, R. Golightly, Humboldt State University; 1981 - 1983. Assisted with Wildlife Ecology: discussion sections, tutoring, writing and grading exams, preparation of support materials (3 quarters). Assisted with Wildlife Ethology: grading essay exams and term papers, teaching nonparametric statistics, methods of field research and scientific writing, developing exams (2 quarters). Assisted with nonmajors Introductory Wildlife Management: grading exams tutoring, preparation of support materials, some lectures (1 quarter).

Personal secretary and accountant: G. Weiss, Arcata, CA; Fall 1980 - Spring 1983. Kept records and accounts, prepared dictation in French and English.

Field research assistant: Dr. P.F. Brussard, Cornell University; Spring - Summer 1980. Maintained electrophoretic laboratory, trained two researchers in electrophoretic techniques. Responsible for all aspects of collections of sea lampreys for research: licensing for collections in eastern U.S. and Canada, location of collecting sites, collection, preparation, ordering supplies and budgeting, coordination of research personnel and correspondence. Occasionally assisted with collection of pine voles.

Research assistant: Dr. P.F. Brussard, Cornell University; Winter 1980 - Spring 1980. Maintained electrophoretic laboratory, prepared techniques manual, made computer literature searches, assisted with electrophoretic research.

Riding instructor: D. Scheraga, Cornell University Stables; Fall 1977 - Spring 1980. Taught beginning to advanced equitation, trained horses for sale, polo and school use. Responsible for some wound and illness care.

Curatorial assistant: Mammalogy collection, Cornell University; Winter 1979 - 1980. Reorganized osteology collection, identified uncatalogued specimens.

Lab technician: Dr. P.F. Brussard, Cornell University; Nov 1978 - Dec 1979 . Assisted in electrophoretic research: specimen prep, chemical prep, ordering supplies, filing, general duties.

Curatorial assistant: Ichthyology and Herpetology collections, Cornell University; Summer 1978. Preservation and identification of specimens.

Documentation center aide: Labor Management and Documentation Center, Cornell University; Fall 1977 - Spring 1978. Writing file summaries, ordering new files.

Acquisitions clerk: Industrial and Labor Relations Library, Cornell University; Summer 1977.

Library aide: Mann Library, Cornell University; Fall 1976 - Spring 1977.

IVa. HONORS AND SCHOLARSHIPS

Cornell University:
- Alpha Lambda Delta Honor Society
- Cornell Undergraduate Scholarship
- Cornell Agriculture Scholarship
- Carl Ladd Scholarships
- Women's Federation of Cornell Scholarships

Humboldt State University:
- Elvada Trautmann Scholarship
- Humboldt State University Scholarship

University of Arizona:
- International Wildlife Foundation Scholarship (2)
- Gamma Sigma Delta Honor Society
- University of Arizona Excellence in Teaching Award
- Richard A. Seegmiller Award for Outstanding Graduate Student
- Wildlife and Fisheries Outstanding Graduate Student Award

IVb. GRANTS AND CONTRACTS

Stephen R. Tully Memorial Grant	$ 500
Leslie Brown Memorial Grant	$ 500
Sigma Xi Grant-In-Aid	$ 300
Chapman Foundation Grant	$ 400
Blaustein Fellowship	$2000
U.S. Fish and Wildlife (remote telemetry)	$7920
U.S. Fish and Wildlife (condor publication)	$5200
Israel Nature Reserves Authority	$2000

V. PROFESSIONAL SOCIETIES

American Ornithologists' Union
Cooper Ornithological Society
Ecological Society of America
International Biometric Society
Raptor Research Foundation
Society for Conservation Biology
The Wildlife Society
Vulture Study Group

VI. UNIVERSITY COMMITTEES AND ASSOCIATIONS

Member, Natural Resources Student Association: 1988-1992.
Vice-President, Natural Resources Student Association: 1991-1992.
Graduate student representative - School of Renewable Natural Resources Curriculum Committee: 1992.
Graduate student representative - College of Agriculture Search Committee for Associate Dean, Instruction: 1992.

VII. SHORT COURSES

Radio Telemetry Methods and Equipment: Telonics. Arcata, CA. March 12-13, 1982.
Application of Remote Sensing to Wildlife Habitat Inventory, Humboldt State University. March 16-20, 1981.
Environmental Impact Statement Workshop, Cornell University. Jan. 25-27, 1980.

VIII. PEER-REVIEWED PUBLICATIONS

Zengel, S.A., V.J. Meretsky, E.P. Glenn, R.S. Felger and D. Ortiz. 1995. Cienega de Santa Clara, a remnant wetland in the Rio Colorado delta (Mexico): vegetation distribution and the effects of water flow reduction. Ecological Engineering 4:19-36.

Meretsky, V.J. and N.F.R. Snyder. 1992. Range use and movements of California condors. Condor 94:313-335.

Meretsky, V.J. 1987. Basic techniques for analyzing movement and home-range data. Pp. 135-137 in: Meretsky, V.J., tech. ed. Experimental design and data analysis for telemetry projects: summary of a workshop. Raptor Research 21:125-146.

Meretsky, V.J., tech. ed. 1987. Experimental design and data analysis for telemetry projects: summary of a workshop. Raptor Research 21:125-146.

Marcot, B.G. and V.J. Meretsky. 1983. Shaping stands to enhance habitat diversity. J. Forestry 81: 526-528.

IX. UNREVIEWED PAPERS AND PRESENTATIONS

Gorman, O.T., J.M. Seals, D.M. Stone, Z.M. Zdinak, and V.J. Meretsky. 1995. Studies of habitat use by the endangered humpback chub, Gila cypha, in the Little Colorado River in the vicinity of the Grand Canyon. 3rd Biennial Conference on Research in the Colorado Plateau National Parks, 17-20 September 1995, Flagstaff, AZ.

Gorman, O.T., D.M. Stone, Z.M. Zdinak, and V.J. Meretsky. 1995. Habitat use by spawning humpback chub Gila cypha in the Little Colorado River, Arizona near Grand Canyon. 27th Annual Symposium, Desert Fishes Council, 16-19 November 1995, Reno, NV.

IX. UNREVIEWED PAPERS AND PRESENTATIONS (continued)

Meretsky, V.J. 1995. Foraging ecology of Egyptian vultures in the Negev desert, Israel. Unpub. Ph.D. Diss. University of Arizona, Tucson, AZ.

Meretsky, V.J., O.T. Gorman, D.M. Stone and Z.M. Zdinak. 1995. Relative condition of humpback chub in the Little Colorado River. 27th Annual Symposium, Desert Fishes Council, 16-19 November 1995, Reno, NV.

Meretsky, V.J. and R.W. Mannan. 1995. Effects of food source reliability on foraging behaviors of a social scavenger. 80th Annual Ecological Society of America Meeting, 30 July-3 August, Snowbird, UT.

Meretsky, V.J. and R.W. Mannan. 1995. Supplemental feeding for vultures: effects of amount and timing of food deliveries. The Wildlife Society 2nd Annual Conference, 12-17 September 1995, Portland, OR.

Meretsky, V.J. and T.S. Melis. 1995. Integration of Grand Canyon physical and biological information. 3rd Biennial Conference on Research in the Colorado Plateau National Parks, 17-20 September 1995, Flagstaff, AZ.

F.R. Protiva, L.E. Stevens, D.M. Kubly, J. Petterson, and V.J. Meretsky. Desperate species, disparate times: observations on the life history of the endangered Kanab Ambersnail (Succineidae: Oxyloma kanabensis Pilsbry). 3rd Biennial Conference on Research in the Colorado Plateau National Parks, 17-20 September 1995, Flagstaff, AZ.

Stevens, L.E., F.R. Protiva, D.M. Kubly, V.J. Meretsky, and J. Petterson. 1995. The ecology of Kanab ambersnail (Succineidae: Oxyloma haydeni kanabensis) Pilsbry, 1948) at Vasey's Paradise, Grand Canyon, Arizona: 1995 Draft Final Report. Cooperative interagency report prepared for U.S. Bureau of Reclamation.

Webb, R.H., T.S. Melis, and V.J. Meretsky. 1995. Relating hydroclimatic effects to physical and biological resources of the Colorado River below Glen Canyon Dam. Hydroclimatology section: Draft prospectus on integration of biological and physical data below Glen Canyon Dam, Arizona: suggested approaches for assessing Biological Opinion issues. Prepared by an ad-hoc interdisciplinary work group for U.S. Bureau of Reclamation.

Santana-Bendix, M., O.E. Maughan, V.J. Meretsky, and C.R. Schwalbe. 1994. Movement and activity patterns of Boiga irregularis (COLUBRIDAE), introduced predator on the island of Guam. Final report to the National Ecology Research Center, National Biological Survey, Fort Collins, CO.

Zengel, S.A, V.J. Meretsky, E.P. Glenn, R.S. Felger and D. Ortiz. 1994. Vegetation analysis of Cienega de Santa Clara, a remnant wetland in the Rio Colorado Delta, Sonora, Mexico. Report to the U.S. Fish and Wildlife Service.

Shaw, W.W., L.K. Harris, M. Livingston, L. Propst, S. Ritter, and V.J. Meretsky. 1993. Wildlife habitat inventory pilot study. Final report to the Arizona Game and Fish Department Heritage Program, G20031-A.

IX. UNREVIEWED PAPERS AND PRESENTATIONS (continued)

Meretsky, V.J. and D. Lavee. 1991. Conservation and management of the Negev lappet- faced vulture in Israel. Plan prepared for Israel Nature Reserves Authority. 108 pp.

Meretsky, V.J. 1989. Final report: translation of tower radio telemetry data sets. Report to U.S. Fish and Wildlife Service.

Meretsky, V.J. 1988. Feeding ecology of marbled godwits on North Humboldt Bay. Unpub. M.Sc. thesis. Humboldt State University, Arcata, CA.

Cochran, W.W. and V.J. Meretsky. 1985. Preliminary report on development use of an automated tracking system. International Vulture Symposium, 1985 Raptor Research Foundation Symposium on the Management of Birds of Prey, International Meeting. November 2-3, 1985. Sacramento, CA.

Gutierrez, R.J., A.B. Franklin, W. LaHaye, V.J. Meretsky, and J.P. Ward. 1985. Juvenile spotted owl dispersal in northwestern California: preliminary results. Pp. 60-65 in Gutierrez, R.J. and A.B. Carey, tech. eds. Ecology and management of the spotted owl in the Pacific Northwest. Gen. Tech. Rept. PNW-185. U.S. Forest Service Pacific Northwest Forest and Range Experiment Station.

Meretsky, V.J. 1983. The effects of raptor presence on marbled godwit feeding behavior. Cooper Ornithological Society 54th Annual Meeting, June 20-23, Arcata, CA.

X. PAPERS IN PROGRESS

Meretsky, V.J. and R.W. Mannan. Foraging behavior of Egyptian vultures at simulated natural carcasses in the Negev desert. In review, Condor.

Snyder, N.F.R., H.A. Snyder and V.J. Meretsky. Further comments on the function of eye color in accipiter hawks. In review, Raptor Research.

Meretsky, V.J. and R.W. Mannan. Supplemental feeding for vultures: effects of amount and timing of food deliveries. In friendly review, for submission to Jl of Wildlife Management in 12/95.

Meretsky, V.J. and T.S. Melis. Integration of Grand Canyon physical and biological information. To be submitted to the Proceedings of the 3rd Biennial Conference on Research in the Colorado Plateau National Parks by end 12/95.

Meretsky, V.J. and G.P. Guertin. Effect of scale on landscape diversity analyses in desert ecosystems. To be submitted to Landscape Ecology in early 1996.

Meretsky, V.J. Use of chi-square analysis for habitat use/availability analyses under two-stage sampling. To be submitted to the Journal of Wildlife Management in early 1996.

Meretsky, V.J., other authors not definite. Temporal and spatial patterns in condition of humpback chub. To be submitted in 1996.

Meretsky, V.J., other authors not definite. Temporal and spatial variability in aquatic habitats. To be submitted in 1996.

CURRICULUM VITAE

BIOGRAPHICAL

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(520)638-2147 Home

EDUCATION

M.S. Wildlife Ecology, University of California - Davis, 1988. GPA: 3.9
Emphases on Vertebrate Ecology & Physiological Ecology

Community College Teaching Credential, University of California - Davis, 1989.
Zoology, Ecology, & General Biology.

B.S. Electronics Engineering, North Dakota State University, 1981. GPA: 3.3

RESEARCH AND WORK EXPERIENCE

Wildlife Biologist (GS-11), Grand Canyon National Park, AZ. (January 1995 - Present). Lead wildlife specialist responsible for developing and implementing comprehensive wildlife management and monitoring program for the park.

Wildlife Resource Specialist (GS-09), Virgin Islands National Park, St. John, VI. (May 1992 - January 1995). Responsible for implementing wildlife management projects relating to: monitoring shorebirds, waterfowl, seabirds, warblers, sea turtles, and bats; mongoose control; donkey immunocontraception, and wild pig reduction.

Chief Biologist (GS-11), Division of Science and Resource Management, Northwest Alaska Areas, Kotzebue, AK. (August 1990 - May 1992). Responsible for implementing a varied wildlife management program involving studies of shorebirds, waterfowl, passerines, raptors, grizzly bears, wolves, caribou, moose, musk oxen, Dall sheep, waterfowl, and salmon. Participated in the design, planning, and conducting field work of projects in either a co-investigator or primary investigator role. Served as the P.I. on a shorebird nesting study that involved color-banding shorebirds and locating nests. Instituted a FWS Breeding Bird Survey, set up 2 MAPS stations, and monitored nesting raptors. Gained proficiency in chemically immobilizing and aerial radiotracking large mammals, and using a variety of population estimation techniques.

Wildlife Biologist (GS-09), U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, (May 1990 - August 1990). Served as project leader for a migratory bird project conducted on northern Alaskan coast that compared bird habitat use and prey selection at two study sites. Planned and organized study design and field logistics, supervised two crews of four biologists, and analyzed data.

Wildlife Ecologist, QUAD Consultants, Sacramento, CA (October 1989 - March 1990). Designed and executed environmental impact studies to determine the potential effects of development projects on critical habitats and sensitive populations of Federally and State listed animal species. Authored biological assessments and environmental impact reports.

Biological Technician (GS-05), King's Canyon/Sequoia National Park (May - September 1988; June - August 1989). Conducted field inventories for terrestrial vertebrates. Responsible for sampling design, field collection and identification of animals, and preparation of museum specimens. Involved identifying birds by sight and vocalizations, mist netting for bats and birds, setting numerous different traps for small and medium sized mammals, and using scent stations for carnivores.

Research Assistant, Yosemite National Park, (June - August 1987). Conducted independent project that investigated relative abundances of mammalian prey used by great grey owls. Assisted in trapping, radiotracking, and making behavioral observations of great grey owls.

Electronics Engineer, IBM Corporation and National Semiconductor Corporation, Santa Clara, CA. (July 1981- August 1986). Designed electronic integrated circuits and telecommunications computers, wrote software for controlling circuitry, and gave technical presentations.

TEACHING EXPERIENCE

Graduate Research Assistant, University of California - Davis. (September 1989 - March 1990). Developed a new teaching curriculum for the mammalogy laboratory I had taught twice previously. Wrote a new 130 page manual that stressed the relationships between habitat parameters and wildlife use and developed a 250 slide audio-visual presentation with accompanying script.

Lecturer, American River Community College - Sacramento (September 1989 - January 1990). Instructed a 4 unit upper division course in general biology. Responsible for independent preparation of all materials for lectures, handouts, laboratories, and tests.

Lecturer, University of California - Davis. (January 1989 - April 1989). Instructed a 4 unit upper division course in vertebrate physiological ecology within the Dept. of Wildlife & Fishery Biology. Responsible for independent preparation of all materials for lectures, handouts, and tests.

Teaching Assistant, University of California - Davis. (September 1988 - March 1990). Taught laboratory sections for mammalogy, botany, and general biology

NPS Training Courses

Wildlife Capture and Immobilization Techniques (1992)	40 hours
Wildlife Management Techniques (1992)	120 hours

NPS Training Courses - (cont.)

Wildlife Law (1992)	16 hours
Vegetation Measurement and Management (1992)	120 hours
Geographic Information Systems (1993)	40 hours
Statistical Techniques and Computer Analysis (1992)	80 hours
Water Resources Monitoring (1993)	40 hours
Fire Ecology and Management (1993)	40 hours
Ecological Restoration (1993)	40 hours
Fisheries Management (1993)	80 hours
Air Quality Management (1993)	40 hours
Integrated Pest Management (1993)	40 hours
Natural Resources Law (1992)	40 hours
Cultural Resources (1993)	40 hours
Conflict Resolution Techniques (1993)	16 hours
Negotiating Skills (1993)	16 hours
Communications Skills (1991)	16 hours
Orientation to the National Park Service (1990)	24 hours
Monitoring of Non-game Landbirds (1995) (Point Reyes Bird Observatory Course)	60 hours

PUBLICATIONS

Petterson, J. R. 1995. Nest-site characteristics and habitat selection of shorebirds breeding in northwest Alaska. 15 pp. (in prep)

Petterson, J.R. 1992. Shorebird nesting ecology and monitoring in northwest Alaska. NRPP Project Report. National Park Service Technical Report, Kotzebue, Alaska, 35 pp.

Petterson, J.R. 1992. Yellow-bellied marmot predation on pikas. Canadian-Field Naturalist 106(1): 130-132.

Petterson, J.R. 1990. Influence of vegetation type and habitat structure on the distribution and ecology of North American mammals. Univ. Calif. Press Laboratory Manual. 130 pp.

Petterson, J.R. 1983. An auto-error correcting, auto-ranging analog data acquisition system. Data Communications 12: 84-94.

Petterson, J.R. 1983. Use of fiberoptic transmitters and receivers in high speed data applications. Photonics Spectra 16: 45-51.

Petterson, J.R. 1982. Design of an audio reverberation amplifier. IEEE Proceedings (77):102-110.

PRESENTATIONS

Petterson, J. R. 1994. Nest-site characteristics and habitat selection of shorebirds breeding in northwest Alaska. Paper given at A.O.U. Ornithological Meeting in Missoula, MT.

Petterson, J.R. 1992. Monitoring of shorebirds in National Park Service units in northwestern Alaska. Paper given at 4th Annual Alaska Bird Conference, Anchorage, AK.

FUNDED PROPOSALS AND PROJECTS

Integrated Program for Monitoring Southwestern Willow Flycatchers and Other Riparian Birds along the Colorado River in Grand Canyon NP. ($68,000) 1995. Co-authored with Mark Sogge, NBS.

Design and Establishment of a Long-term Natural Resource Monitoring Program for Virgin Islands National Park. ($2.0 million) 1995-2000; 5 years. Co-authored with Caroline Rogers, NBS, Virgin Islands.

Monitoring of Shorebirds and Waterfowl at Cape Krusenstern National Monument, AK. ($106,000) 1991-92. National Park Service Funding.

PROFESSIONAL AFFILIATIONS

American Society of Mammalogists
American Ornithological Society
The Wildlife Society
Cooper Ornithological Society

REFERENCES

Dr. Caroline Rogers
Research Scientist, National Biological Service
Virgin Islands National Park
Box 710
Cruz Bay, VI 00831
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Dr. David Graber
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Box 5614
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Lake Clark National Preserve
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******* FRANK R. PROTIVA*******

I. PERSONAL

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II. EDUCATION

Institutions Attended:

Northern Arizona University B.Sc. C. E. T. May 1987
September 1981 - May 1987

III. POSITIONS HELD

Survey Coordinator: Applied Technology Associates for Glen Canyon Environmental Studies; June 94 - current. Duties include coordinating 3 person survey staff to perform high-accuracy surveys of research sites along the Colorado River in Grand Canyon National Park. Methods used include survey-grade GPS, digital bathymetric data collection, close-range photogrammetry, and digital topographic mapping with total stations. Member of interagency team studying ecology of endangered Kanab ambersnail. Performed analysis of tributary thermal impact limits to determine the optimum available confluence habitat for the endangered *Gila cypha*. Review contracts with outside service suppliers to ensure timely delivery of useable products. Evaluate methods for integrating individual research projects into the Glen Canyon Environmental Studies' GIS for use in multi-disciplinary analyses.

Surveyor: Applied Technology Associates for Glen Canyon Environmental Studies; June 92 - June 94. Planned and executed geodetic, topographic, and bathymetric surveys. Reduced and performed least-squares adjustments on collected data. Generated hard-copy and digital map products for use by cooperating agency scientists. Reviewed draft manuscripts of photogrammetric topo maps and survey control to ensure compliance with National Map Accuracy Standards. Recommended quality control sampling plans for ground-truthing crews. Performed accuracy-check surveys on existing map control points. Provided review and comment on existing Grand Canyon survey control network, which is the base of spatial control for the GCES GIS.

Research Specialist: Northern Arizona University Geology Department; Jan 91 - May 92. Supervised survey crews of 3-6 individuals in the collection of detailed topo data to support EIS-mandated sediment studies of the Colorado River in Grand Canyon. Edited topo survey data and generated DTM's of sediment deposits. Used the DTM's to generate statistical summaries and presentation graphics illustrating trends in sediment aggradation/degradation. Participated in interdisciplinary team review of draft reports.

Development Review Engineer: City of Sedona, Arizona; Nov 89 - Jan 91. Responsible for the review of engineering plans for subdivisions and commercial development, including technical review of grading & drainage plans, hydrologic & hydraulic analyses (including floodplain encroachment studies), and traffic impact studies. Represented the City Engineer and presented recommendations at public hearings. Designed municipal drainage improvement projects, including hydraulic analysis using U.S. Army Corps of Engineers hydraulic modeling software. Supervised the acquisition and set-up of an ARC/Info GIS for the City, using photogrammetry to separate key features into over 100 different coverages.

Hydrologist: Yavapai County Flood Control District; Jul 87 - Nov 89. Reviewed grading & drainage plans for subdivisions, commercial development, and watercourse alterations. Represented the District at public hearings. Evaluated technical criteria for publication as acceptable minimums for submittals to District. Designed municipal infrastructure improvements to alleviate flooding problems. Designed database structure for use in floodplain management tasks.

Assistant Engineer (Co-op Student): Peabody Coal Company; three alternating semesters in 84 and 85. Designed sedimentation basins; performed hydrologic modeling, database management, and computer programming. Assisted in the compilation of OSM permit applications. Performed file management and record maintenance on surface impoundment data files. Performed construction and monitoring surveys on sedimentation basins and surface water impoundments.

Owner of commercial fixture shop: five semesters from 83 - 87, alternating with the Peabody Coal Co-op assignments. Opened this business to support myself through college when I wasn't on assignment at Peabody Coal. Designed and constructed clean-room fixtures for local medical products manufacturing company. Designed and manufactured office cabinetry for dental and optical labs. Average project size: $10K.

IV. PROFESSIONAL SOCIETIES AND LICENSES

American Society of Civil Engineers
Licensed Professional Engineer (Civil) - Arizona
Licensed Professional Engineer (Civil) - California
Licensed Professional Engineer (Civil) - Utah

V. SHORT COURSES

University of California - Davis : "Water Surface Profile Computation Using HEC-2" Aug 89.

VI. UNREVIEWED PAPERS AND PRESENTATIONS

Stevens, L.E., D. Kubly, J. Petterson, V. Meretsky, and F. Protiva. 1995. Desperate species, disparate times: observations on the life history of the endangered Kanab Ambersnail (succineidae: Oxyloma kanabensis Pilsbry). 3rd Biennial Conference on Research in the Colorado Plateau National Parks, 17-20 September 1995, Flagstaff, AZ.

Protiva, F.R., and M.D. Yard. An integrated approach to modeling thermal and topographic features at tributary confluences. Ecological Society of America Annual Conference 30 July-3 August, Snowbird, UT. 1995, Snowbird, UT.

Protiva, F.R. and R. Valdez. Regulated river influences on the thermal boundary at tributary confluences: Gila cypha reproduction in the Little Colorado River. North American Benthological Society Annual Meeting, May 24-27, 1994, Orlando, FL.

Enclosure 4

NATIONAL PARK SERVICE/NATIONAL BIOLOGICAL SURVEY

1996 SWWF MONITORING PROPOSAL

FISCAL YEAR 1996-7 TRANSITION MONITORING PROPOSAL:
SECTION IV: WETLAND AND RIPARIAN AVIFAUNA:

Integrated program for monitoring Southwestern willow flycatchers and other riparian birds along the Colorado River from Glen Canyon Dam to Lake Mead - 1996

Principle Investigators:

Dr. John R. Spence, Botanist
Clive Pinnock, Wildlife Biologist
Glen Canyon National Recreation Area
Resource Management Division
P.O. Box 1507
Page, AZ 86040

Jim Petterson, Wildlife Biologist
Grand Canyon National Park
Science Center
P.O. Box 129
Grand Canyon, AZ 86023

Dr. Kerry Christensen, Senior Scientist
Hualapai Department of Natural Resources
P.O. Box 300
Peach Springs, AZ 86434

Mark Sogge, Ecologist
National Biological Service
P.O. Box 5614
Northern Arizona University
Flagstaff, AZ 86011

October 30, 1995

Abstract

This program will institute an integrated avian monitoring project combining the efforts and resources of the Hualapai Tribe, Grand Canyon National Park, and Glen Canyon National Recreation Area - the three land management agencies that have been conducting regular avian monitoring along the Colorado River between Glen Canyon Dam and Lake Mead. By pooling resources and expertise, we will be able to conduct avian monitoring more effectively, and at a fraction of the cost, than would be possible by undertaking three separate monitoring programs. Integrating the avian monitoring efforts in this way also shifts the responsibility for avian monitoring to the entities that are responsible for managing these resources. The avian monitoring program consists of two major components. The first is continued monitoring of breeding Southwestern willow flycatchers, a federal and state designated endangered species. We will monitor breeding flycatchers using previously established protocols developed during past work along the river corridor and throughout the Southwest U.S. Emphasis will be placed on determining breeding status and success of willow flycatchers at historic and recent breeding sites, primarily between River Mile (RM) 46 and RM 71. The second program component focuses on developing and executing a standardized monitoring protocol to track abundance and composition of the general riparian breeding bird community along the Colorado River corridor. Data obtained from recent Colorado River avifauna monitoring projects in the Hualapai Reservation, Glen Canyon National Recreation Area, and Grand Canyon National Park will be analyzed and evaluated to determine the best combination of bird monitoring methods to be used in the long-term monitoring program. In order to monitor avian population trends during the 1996 breeding season, a team of experienced researchers from each of the cooperating entities will conduct bird surveys at a series of habitat patches between Glen Canyon Dam and Lake Mead. Surveys will be conducted three times between April and July, and will utilize both point-counts and total count surveys, in order to further standardize monitoring techniques while still allowing comparisons with past research and inventory data.

Principal Investigators

Dr. John R. Spence (email: John_Spence@nps.gov; phone: 520-608-6267) and **Clive Pinnock** (email: Clive_Pinnock@nps.gov; phone: 520-608-6274), National Park Service, Resource Management Division, Glen Canyon National Recreation Area, P.O. Box 1507, Page, AZ, 86040; **Jim Petterson**, National Park Service, Grand Canyon Science Center, Grand Canyon National Park, P.O. Box 129, Grand Canyon, AZ, 86023 (email: Jim_Petterson@nps.gov; phone: 520-638-7756); **Dr. Kerry Christensen**, Senior Scientist, Hualapai Department of Natural Resources, P.O. Box 300, Peach Springs, AZ 86434. (email: 74672.3047@compuserve.com; phone: 520-769-2255); and **Mark K. Sogge**, National Biological Service, Colorado Plateau Research Station, Northern Arizona University, P.O. Box 5614, Flagstaff, AZ 86011-5614 (email: msogge@nbs.nau.edu; phone: 520-556-7311).

COMPONENT 1: MONITORING OF SOUTHWESTERN WILLOW FLYCATCHERS

Introduction

The Grand Canyon Protection Act of 1992 mandated monitoring of significant natural and cultural resources of the Grand Canyon corridor. The Southwestern willow flycatcher (*Empidonax traillii extimus*) is a federal and state designated endangered species that breeds in riparian habitat along this river corridor. The flycatcher is a riparian obligate species, nesting only in dense willow, tamarisk, or similar riparian communities. Regionally, the Southwestern willow flycatcher has declined in recent decades due to loss, fragmentation, and changes in riparian habitat, invasion of riparian habitat by the exotic tamarisk (below 3,500 ft elevation), brood parasitism by brown-headed cowbirds (*Molothrus ater*), and predation (Sogge and Tibbitts 1994, Sogge et al. 1993, Hunter *et al.* 1987, Unitt 1987, Hunter *et al.* 1988, Whitfield 1990, Harris 1991, Rosenberg *et al.* 1991). The states of Arizona, New Mexico, and California comprise most of the Southwestern willow flycatcher's historic and current range.

The Southwestern willow flycatcher was once distributed along most major river systems in Arizona (Phillips 1948, Unitt 1987). Recent surveys conducted in association with the Arizona *Partners in Flight* program (Muiznieks et al. 1994, Sferra et al. 1994) have documented breeding flycatchers at 13 sites throughout the state, with an estimated breeding population of about 75-100 pairs. These surveys also showed that the flycatcher was absent from many historic breeding sites.

Justification/significance of the research

Willow flycatchers have been found in riparian habitat along the Colorado River corridor in Grand Canyon National Park for at least the last 50 years (Woodbury and Russell 1945). In fact, the Grand Canyon population was one of the largest known populations in the Southwest, prior to the recent intensive regional surveys. Bryan Brown conducted flycatcher surveys in the Grand Canyon regularly between 1982 and 1991, and found flycatchers primarily between Saddle Canyon and Cardenas Marsh (Brown 1988, 1991). Since 1992, the National Biological Service Colorado Plateau Research Station (CPRS) at Northern Arizona University has conducted annual flycatcher inventories and monitoring (Sogge and Tibbitts 1992, Sogge et al. 1993, Sogge and Tibbitts 1994, Sogge 1995, Sogge et al. 1995). Taken together, these surveys demonstrate that the willow flycatcher breeding population within Grand Canyon National Park is very low (four or fewer breeding pair per year). In addition, the number of breeding pairs and their breeding productivity varies significantly each year. Of particular concern is the fact that since 1993, only one known young willow flycatcher has been successfully raised and fledged within the canyon.

Due to the small size and highly variable breeding success of this willow flycatcher population, Grand Canyon National Park recognizes the need for continued population monitoring of this endangered species along the Colorado River corridor. Considerable

amounts of riparian vegetation were destroyed during the high flows of 1983 (L. Stevens, pers. comm.), which if repeated, could negatively impact the flycatchers. This monitoring effort will be conducted to provide valuable information to managers within the Bureau of Reclamation and Grand Canyon National Park for consideration in the Glen Canyon Adaptive Management Program.

Research objectives and hypotheses to be tested

1. Continue to monitor willow flycatcher population trends along the Colorado River corridor in Grand Canyon National Park.

2. Assess potential impacts to the flycatcher population from loss or modification of habitat due to fluctuating flows and due to other known threats such as cowbird parasitism.

3. Continue data collection on aspects of flycatcher biology related to potential impacts from Glen Canyon dam, particularly:
    a. breeding habitat characteristics
    b. nest placement characteristics
    c. habitat use
    d. territory/home range size

Study design and methodology

Surveys will be conducted during the willow flycatcher breeding season (roughly mid-May through mid-July) of each year. Surveys will follow the USFWS-adopted protocol presented in Tibbitts et al. 1994 (summarized below).

Willow flycatcher presence will be determined by sightings and song detections made from approximately 0530 to 1100 daily, when male song rates are the greatest (Unitt 1987, Sogge and Tibbitts 1992). When observers are camped in or near appropriate habitat, surveys will also be conducted in the afternoon and/or at dusk, when willow flycatchers: (a) respond to tape-playback calls (Sogge and Tibbitts 1992); and (b) typically display a secondary peak of singing (Weydemeyer 1973, Unitt 1987). Most observations will likely involve vocal detections of singing males. However, because territorial males do not sing every moment of the day, and because singing rate varies daily and throughout the breeding season (King 1955, Unitt 1987), it is important to maximize the likelihood of detecting male willow flycatcher song. To accomplish this, surveyors will use tape-broadcast songs of willow flycatchers, a proven method for eliciting a vocal response from nearby resident flycatchers (Seutin 1987, England et. al. 1988, Tibbitts et al. 1994). This also allows positive identification of the responding bird's song by comparison to the "known" tape.

Surveyors will walk through, or adjacent to, surveyed habitats whenever possible. Where terrain or dense vegetation prohibits walking surveys, observations will be made from boats

drifting slowly past the habitat patch. Willow flycatcher songs will be broadcast for 15-30 seconds (from a hand-held cassette player), after which the surveyor will listen approximately 1-3 minutes for a response. This procedure will be repeated every 30-50 meters throughout each survey site.

Surveys will be conducted in all riparian habitat patches that are deemed to be potential willow flycatcher habitat. Emphasis will be given to areas identified in earlier surveys as occupied by territorial or breeding willow flycatchers: Saddle Canyon to Kwagunt Creek (particularly the RM 50 - 52 L reach), Lava Chuar (RM 65.3 L) and Cardenas Marsh (RM 71.0 L).

All locations of singing/territorial willow flycatchers will be considered as potential territories, and will be mapped for follow-up evaluation. All willow flycatchers which are detected will be intensively observed to detect nesting activity. Flycatcher movements and use of habitat will be noted on aerial photographs or diagrams of the site. Nesting status will be verified by nest inspection when the nest is found, and on subsequent survey trips. Clutch size, number and age of young, and presence of cowbird eggs or young will be noted. Although there is some potential for increased predation and parasitism due to observer disturbance at the nest, most studies have shown that careful observation of nests does not increase the incidence of nest predation (Stoddard 1931, Roseberry and Klimstra 1970, Willis 1973, Klimstra and Roseberry 1975, DeSante 1982, Blancher and Robertson 1985). In addition, limited and careful nest site visits by observers do not cause nest abandonment in most birds, although excessive visits may cause disturbance (Blancher and Robertson 1985, Sogge unpublished data). Therefore, nests that are located will be monitored only once each survey trip, using a micro-video camera (or telescoping mirror) to eliminate a human scent trail directly to the nest.

To assess the threat of cowbird parasitism, observers will monitor flycatcher nest areas for the presence of cowbirds. The number and behavior of cowbirds will be noted, as will any flycatcher response. Nests will also be examined for presence of cowbird eggs and young.

Analysis

For each site where Southwestern willow flycatchers are detected during the breeding season, we will tabulate data collected regarding numbers of breeding pairs and floater (unpaired) males, number of young fledged, parasitism rates, and number of nest attempts. Comparisons will be made to previous years, but since sample sizes are expected to be small, rigorous statistical comparisons among sites or years will likely not be possible.

Documentation

We will map all willow flycatcher survey sites and territory locations on aerial photos; GPS coordinates will also be taken. Data will be compatible for Arc-Info GIS export files and follow metadata standards previously established by the GCES program. General nest sites

and nest microhabitat will also be photographed.

Collections

No collections are expected to be made during this study.

Deliverables

1. A written annual summary report will describe how the survey was conducted, the survey results, and recommendations for future surveys. This report will include photos and maps showing the locations of all willow flycatcher sightings. Potential resource management actions that could protect or enhance the willow flycatcher population will be discussed.

2. Locations of all willow flycatcher sightings will be placed on U.S.G.S. topographic maps and GPS readings taken. Sections of these maps will be provided in the annual report.

3. A National Park Service Investigator's Annual Report will be prepared and submitted to Grand Canyon National Park.

4. Data files, in dBase III+ format, of the measured variables on willow flycatcher locations (including UTMs), habitat parameters, and breeding phenology.

DELIVERABLES SCHEDULE

Annual Summary Report	December, 1996
Investigator's Annual Report	December, 1996
Data Files	December, 1996

DELIVERABLES QUANTITIES

Annual Summary Reports:

One copy of the reports will be sent to each of the following: Grand Canyon National Park, Glen Canyon NRA, Glen Canyon Environmental Studies office, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, the Hualapai Tribe Wildlife Management Division, and the National Park Service Intermountain West System Support Office Division of Resources Management and Research.

Investigator's Annual Report:

One copy will be presented to Grand Canyon National Park.

Data Files:

One copy of electronic data files, in dBase format, will be presented to Grand Canyon National Park and to the Glen Canyon Environmental Studies office following the previously established metadata standards .

Project Schedule

To accomplish the stated objectives, each site will be surveyed three to four times during each breeding season. Grand Canyon N.P. will provide the boats and logistics support for the surveys and will hire two temporary boatmen with the personnel funding requested in the budget.

Trip #1 (mid- or late May): This trip will be timed to detect willow flycatchers and locate potential nesting sites near the onset of egg laying. Cowbird presence will be determined.

Trip #2 (early June): This trip will be timed to re-survey and confirm potential nesting sites, and assess nesting success, at all locations identified on the first trip. This trip will also assess cowbird presence, and examine and describe willow flycatcher nesting habitat.

Trip #3 (mid- or late June): This trip will only visit sites at which breeding willow flycatchers had been detected on previous trips. Timing is designed to check status of any nesting attempts.

Trip #4 (early July): This trip will check on status of previously located nests, and to look for any late nesting attempts (such as renests after failed attempts).

Permits

A USFWS endangered species permit will be obtained prior to the beginning of any field work. All surveyors will have attended the mandatory southwest willow flycatcher survey workshop.

Literature Cited

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Blancher, P.J. and R.J. Robertson. 1985. Predation in relation to spacing of Kingbird nests. Auk 102:654-658.

Brown, B.T. 1988. Monitoring bird population densities along the Colorado River in Grand Canyon: 1987 breeding season. U.S. Dept. Commerce Nat. Tech. Infor. Ser. Rep PB89-103311. 26 pp.

Brown, B.T. 1988. Breeding Ecology of a Willow Flycatcher Population in Grand Canyon, AZ. Western Birds 19 (1):25-33.

Brown, B.T. 1989. Breeding ecology of riparian birds along the Colorado River in Grand Canyon, Arizona. U. of Arizona Cooperative Nat. Park Resources Studies Unit Tech. Rep., No. 25. 42 pp.

Brown, B.T. 1991. Status of Nesting Willow Flycatchers along the Colorado River from Glen Canyon Dam to Cardenas Creek, Arizona. Endangered Species Report No. 20 to the U.S. Fish and Wildlife Service, Phoenix, Arizona. 34 pp.

Brown, B.T. and R. Johnson. 1988. The effects of fluctuating flows on breeding birds. Pp. 287-295 in Glen Canyon Environmental Studies - Executive Summaries of Technical Reports. U.S. Bureau of Reclamation.

Brown, B.T., S.W. Carothers, and R.R. Johnson. 1987. Grand Canyon Birds. University of Arizona Press, Tucson. 302 pp.

Carothers, S.W. and B.T. Brown. 1991. The Colorado River through Grand Canyon. University of Arizona Press, Tucson. 235 pp.

Carothers, S.W. and N.J. Sharber. 1976. Birds of the Colorado River. Pp. 109-122 in Carothers, S.W. and S.W. Aitchison (eds). An ecological survey of the riparian zone of the Colorado River between Lees Ferry and the Grand Wash Cliffs, AZ. Colorado River Research Tech. Report No. 10. Grand Canyon National Park.

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England, A.S., M.K. Sogge, and C. van Riper III. 1988. Avian species of management

concern: Mill and Deer Creek drainages, Tehama County, California. National Park Service, CPSU/UC Technical Report 33.

Finch, D.M. 1991. Population ecology, habitat requirements, and conservation of neotropical migratory birds. U.S. For. Ser. Gen. Tech. Rep. Rm-205. 26 pp.

Grahame, J.D. and C.A. Pinnock. 1994. 1994 breeding bird survey along the Colorado River from Glen Canyon Dam to Lee's Ferry, Glen Canyon National Recreation Area. Final report to Glen Canyon Environmental Studies, Bureau of Reclamation. Resource Management Division, Glen Canyon National Recreation Area. 38 pp.

Grahame, J.D. and C.A. Pinnock 1995. Breeding birds along the Colorado River through Glen Canyon--past and present. Final report to Glen Canyon Environmental Studies, Bureau of Reclamation. Resource Management Division, Glen Canyon National Recreation Area. 43 pp.

Harris, J.H. 1991. Effects of Brood Parasitism by Brown-headed Cowbirds on Willow Flycatcher nesting success along the Kern River, California. Western Birds 22 (1):13-26.

Hilden, O. 1965. Habitat selection in birds: A review. Ann. Zool. Fenn. 2, 53-75.

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Hunter, R.D. Ohmart, and B.W. Anderson. 1988. Use of exotic saltcedar (*Tamarix chinensis*) by birds in arid riparian systems. Condor 90:113-123.

King, J.R. 1955. Notes on the life history of Traill's Flycatcher (*Empidonax traillii*) in southeastern Washington. Auk 72:148-173.

Klimstra, W.D. and J.L. Roseberry. 1975. Nesting ecology of the Bobwhite in southern Illinois. Wildl. Monogr. 41.

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submit any additional comments you may have on the proposed methodology to our Flagstaff, Arizona, office as soon as possible. Field work will be coordinated through our Upper Colorado Region, Salt Lake City, Utah, and Glen Canyon Environmental Studies Office, Flagstaff, Arizona. Curriculum vitae (Enclosure 3) for the researchers associated with the planned monitoring is enclosed. This work will also be coordinated with proposed National Park Service/National Biological Service monitoring of SWWF population size, distribution and nesting success in 1996 (Enclosure 4).

Please let us know if you have questions, comments or data requests associated with these proposals.

Enclosures 4

cc: Manager, Glen Canyon Environmental Studies Office, Flagstaff AZ
Attention: Dave Wegner (w/o encls)
Bob Winfree, Bilby Research Center, Suite 131, Campus Box 6013, Northern Arizona University, Flagstaff AZ 86011 (w/encls)