State of California
Department of Fish and Game

RECOVERY PLAN:
BANK SWALLOW
(Riparia riparia)

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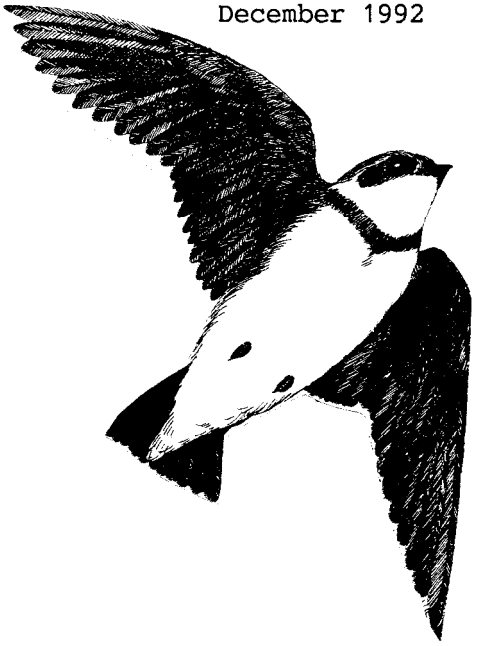
December 1992



NONGAME BIRD AND MAMMAL SECTION REPORT 93.02

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SUMMARY

On March 3, 1989, the California Fish and Game Commission listed the Bank Swallow *(Riparia riparia)* as a Threatened Species pursuant to Section 2070 of the Fish and Game Code and Section 670.1, Title 14, California Code of Regulations.

The population of Bank Swallows in California currently occurs over a small portion of its historic range. The center of the current range is along the remaining natural river banks of the Sacramento and Feather rivers in the Sacramento Valley. This region supports an estimated 70 percent of the statewide population. One of the primary reasons for decline of this species is loss of habitat. State and federal sponsored and funded bank protection projects have resulted in the rip-rapping of several miles of naturally eroding riverbank that the Bank Swallows depend on for nesting.

The goal of the Bank Swallow Recovery Plan is the maintenance of a self-sustaining wild population. The primary objectives necessary to achieve this goal include:

1) Ensure that the remaining population does not suffer further declines in either range or abundance.

2) Provide for the preservation of sufficient natural habitat to maintain a viable wild population in perpetuity.

Specific management strategies are presented in this Recovery Plan including an evaluation of artificial habitat and the primary management strategy consisting of protection, enhancement, and maintenance of natural habitats. Management alternatives discussed include the avoidance of impacts to natural bank habitats, a set-back levee/meander belt system, and consideration of the habitat needs of the Bank Swallow in existing habitat preserve plans currently proposed for portions of the Sacramento River. This latter strategy may necessitate modification of current preserve plans to include the specific habitat requirements of the Bank Swallow.

Finally, this Recovery Plan summarizes recent recovery accomplishments and also identifies several specific actions that must be implemented in order to achieve the goal of species recovery.

INTRODUCTION

Overview

The Bank Swallow *(Riparia riparia)* has been recorded in the lowlands of California since ornithologists began to explore these areas in the mid-nineteenth century (Grinnell and Miller 1944). Newberry (1857) considered the species to be common throughout California during his era. Today, Bank Swallows are locally common only in certain restricted portions of their historic range where sandy, vertical bluffs or riverbanks are available for these colonial birds to construct their nest burrows. The Bank Swallow nests in earthen banks and bluffs, as well as sand and gravel pits. It is primarily a riparian species throughout its North American and Eurasian breeding range. Once locally abundant in suitable habitats, numbers have declined statewide in recent years. It is now absent as a breeding bird in southern California.

A Department of Fish and Game study of the statewide population of Bank Swallows in 1987 found that the current population center for the species is along the Sacramento and Feather Rivers in the Sacramento Valley. Other concentration areas include the Klamath Basin and Modoc County areas in northeastern California. Most historical records of Bank Swallow nesting colonies were from central and southern California, where populations no longer exist. During 1987, only four colonies were found south of San Francisco Bay. The Sacramento River and Feather River populations comprise about 64 percent of the colonies and 70 percent of the California population.

Taxonomy

The Bank Swallow is a North American member of the swallow family Hirundinidae. There are six other swallow species common to this continent. The swallow family has a world-wide distribution with most members breeding in the Northern Hemisphere and wintering in the Southern Hemisphere.

Description and Life History

The Bank Swallow is the smallest of the North American swallows (about five and one-fourth inches long) and is a colonial nester in lowland river bank habitats and coastal bluffs (Bent 1939). It is distinguished from other swallows by its distinctive brown breast band contrasting against clean white ventral surfaces. The upper parts are dark brown. Sexes are similarly marked and cannot be distinguished based solely on plumage characteristics. The Bank Swallow is a migratory species spending the winter months in Central and South America (Rappole et al. 1983).

Hickling (1959) described three main types of Bank Swallow nesting habitat: seacliffs or hard consolidated sand, river banks of sand and sandy earth, and actively worked sand and gravel pits. In their present range in California, Bank Swallows primarily nest in steep earthen river banks that are subject to frequent water erosion, primarily during winter months.

Nest sites consist of burrows dug into a vertical earthen bank to a depth of 18-36 inches. The burrow entrance is a two inch high by three inch wide oval, and the several that make up a colony most often are found in soils that are fine silt and sandy loam in texture. After a short courtship, both sexes actively dig the nest burrow into the side of banks that generally deviate

less than seven degrees from vertical (90"). Burrows are dug into selected soil strata of a bank face. Generally, the more easily dug sandy strata become sites of burrows. Important habitat characteristics include soil moisture, texture, orientation of the bank face, verticality of the face, and proximity of the colony to foraging areas. Unique combinations of optimal habitat characteristics may dictate the size and success of individual Bank Swallow colonies. Burrows that remain available from a previous season may be used by a pair or after some renovation. Burrows are established within colonies that range from relatively small (IO burrows) to very large (3000 burrows).

In central California, Bank Swallows arrive in late March to mid-April and begin courtship and pairing. When the nest burrow is completed a clutch of three to six pure white eggs is laid. On the Sacramento River, egg laying occurs as early as April 10, with hatching occurring 21 days later. Nestlings are fed insects by adults until the young birds emerge from the burrow after a period of about 21 days. The young then are able to fledge and feed themselves. By mid-July most nesting activities are completed and colony sites are abandoned. Birds disperse in the general area of their colonies prior to migration in late August.

Bank Swallows spend the winter in Central and South America (as far south as Argentina) in riparian and grassland habitats. They remain on the wintering ground from September until March with a three-week travel time between their winter and summer ranges.

Bank Swallows are a relatively short-lived species with an average life span of two to three years with five years being exceptional. Mortality results from a number of causes including disease, parasites, and predation. Gopher snakes *(Pituophis melanolencus)* constitute an important predator of eggs and nestlings, and raptors such as Peregrine Falcons *(Falco peregrinus)* and American Kestrels *(F. sparverius)* may take recently fledged young and perhaps some adults. Destruction of nest sites including collapsed burrows due to natural or man-caused sloughing of banks, appears to be the most significant direct cause of mortality. Young and eggs are the primary victims of this type of mortality.

The food of Bank Swallows consists of several species of flying terrestrial and aquatic insects. Because they forage a few inches over water the swallows can catch mayflies and other aquatic insects just as they emerge from the nymph stage. Grasslands and certain croplands immediately adjacent to colonies also provide foraging habitat for Bank Swallows. The birds fly low over grasslands and agricultural fields catching insects in the air.

The colony is the focus of all social and breeding activities. The birds' interactions with the physical features of the colony bank are such that the colony functions as a living entity composed of several individual contributing units. The colony is an information center and facilitates such activities as food gathering. This pattern is not uncommon to many colonial species of birds, insects or mammals.

Historic Population Distribution

The Bank Swallow historically bred locally throughout lowland California (Grinnell and Miller 1944), (Appendix 1). The species once bred at coastal

sites from Santa Barbara County south to San Diego County. It has now disappeared as a breeding bird from southern California. The historical population along the Sacramento River was undoubtedly larger than it is today, but no population data exists from that era. We do, however, know the significance of the cumulative habitat loss within the floodplain due to state and federal bank protection projects and agricultural activities. For example, the Sacramento River Bank Protection Project, which was authorized by the U.S. Congress in 1960, has resulted in over 130 miles of rip-rap to date on the Sacramento River alone.

Current Population Distribution

During 1986, the most comprehensive population survey to date located 60 active Bank Swallow colonies on the Sacramento River between river mile (RM) 81.81 and RM 291.8. This serves as the baseline study against which all future population research shall be measured (Appendix 2) (Humphrey and Garrison 1987). During 1987 a repeat survey of the Sacramento River located 53 colonies in the same area. The 1987 survey located additional active colonies in other areas of the State (Appendix 3). A total of 107 colonies (41,880 burrows), including the 53 Sacramento River colonies were found north of San Francisco Bay. Only four colonies (1,960 burrows) were found south of San Francisco Bay (Laymon et al. 1988), with the southernmost located on the Salinas River near King City, Monterey County.

In the intervening years between 1987 and the present (1992) population surveys of varying intensity have been conducted (Appendix 4). During this time not all reaches of the Sacramento River were surveyed during a given year. Nor was there a consistent effort to resurvey the remainder of the range in northern California and elsewhere in the State. However, information gathered from various sources indicates that the majority of colonies located in 1987 are still active each year. The primary focus of survey effort has been the Sacramento River population inasmuch as it is the largest in the State and will become the center-piece of recovery actions for the Bank Swallow in California.

In those years when a combination of total number of burrows counted at the several Sacramento River colonies, and an estimate of the number of burrows occupied by nesting pairs of Bank Swallows allowed for estimation of the number of pairs of birds in the population, that number has ranged from a high of 12,348 pairs in 1986 to a low of 7,525 pairs in 1991, a 39 percent loss in five years. In 1992 the number of pairs increased slightly to about 8,550 pairs. Reason for this decline is not clearly understood but such factors as the continuing effects of the drought, and natural population fluctuation coupled with the loss of several important large colonies since 1986 may all contribute to the observed shrinking population numbers.

Historic and Current Population Abundance

Historically, the Bank Swallow was described as common throughout lowland California (Grinnell and Miller 1944). There is relatively little published research on the species in California, and few details on its historic abundance in the State exist. However, there are records of egg collections which can be used to determine former breeding range. More recent reports and sightings document some of the current reductions in the range of Bank Swallows and also instances of habitat loss. For example, habitat at three

Sacramento River colonies consisting of 1300 burrows or nests (representing an estimated minimum of about 727 breeding pairs) was destroyed by a state and federal bank protection project constructed during the height of the 1985 breeding season. In 1986 and 1987, at least six additional sites were eliminated. It is estimated that over 2000 pair were impacted at these sites. Jones and Stokes Associates, Inc. (1987) indicated that based on 1986 Bank Swallow population survey information, about 35 different colony locations occur within the Sacramento River Bank Protection Project study reach where approximately 25 miles of bank protection remains to be constructed.

Determining the causes of the observed population reduction is difficult given the limited nature of the data. Bank protection projects certainly are responsible for some declines. For example, the colony at RM 190.5 L was one of the largest natural colonies on the Sacramento River. In 1988, the colony had a maximum of 2730 burrows and accounted for 31 percent of the burrows in the reach from Butte City to Chico Landing. The site was riprapped in September, 1988, and an artificial site was built in 1988 and 1989. In 1989, swallows nested in the artificial site, and the colony had a maximum of 1740 burrows which accounted for 25 percent of total burrows in the reach. However, in 1990, the colony declined to 470 burrows which was 11 percent of the reach population. Therefore, the colony size at RM 190.5 L declined 83 percent from 1988 to 1990. In 1991 the colony size was 230, and there was an increase to 820 burrows in 1992. This is still only about 35 percent of the number recorded at the colony the last time natural habitat existed at this site (2330 burrows).

Population Viability Analysis (PVA)

Using data collected during surveys of Sacramento River Bank Swallow colonies, and data from the Swallow literature an attempt to model the population viability was completed (Buechner 1992).

Central to PVA is a technique known as risk assessment, the estimation of the likelihood that a wildlife population will decline severely or become extinct. In order to estimate the risk of population decline or extinction for the Bank Swallow along the Sacramento River in California, a simulation of the dynamics of age-structured populations was used. A program (RAMAS/age) runs models which track the course of the simulated population over a 50-year period. It utilizes mean age-specific survival, fecundity, and migration rates and the year-to-year variance in those rates to estimate the probability that the population will fall below specified threshold levels within the next 50 years.

While some parameters can reliably be estimated from available swallow literature, more information is needed on juvenile survival rates, the net loss or gain to the population as a result of migration in given years, and the variation in fecundity, survival, and migration parameters in the Sacramento River population over time.

The PVA employed population simulation models utilizing the best available information and a population base of 10,000 pairs (a slight over-estimate based on recent data) indicated that:

1. The risk of low numbers in some years was substantial for the Sacramento River Bank Swallow population and, under most modeled conditions, was considerably higher than the risk of near extinction.

2. Under all but the most optimistic conditions, a single isolated colony had a substantial (37 percent or greater) chance of falling to less than 50 breeding pairs and a somewhat smaller (9 percent or greater) chance of disappearing entirely. Under the "most likely" conditions, a single colony had a very large (62 percent) chance of falling to less than 50 breeding pairs and a substantial chance (30 percent) of disappearing entirely.

3. Under most conditions modeled, an isolated group of colonies had a substantial chance (15 percent or greater) of falling to less than 100 breeding pairs and a somewhat smaller chance (7 percent) of becoming extinct. Under the "most likely" conditions, an isolated group of colonies faced substantial chances of dropping to 100 breeding pairs (probability = 47 percent) or disappearing entirely (probability = 33 percent).

4. For most conditions modeled, a population of Bank Swallows about the size of the current population occurring along the Sacramento River (10,000 breeding pairs) had a substantial (20 percent or greater) probability of falling to low numbers (1000 breeding pairs). Under the conditions of the "most likely" model, the risk of the population disappearing entirely was also substantial (33 percent).

5. Even under very optimistic conditions, the number of breeding pairs required to ensure a large continuing population of Bank Swallows is much larger than the current population size. Utilizing the "most likely" model, it appears that a population of Bank Swallows of 100,000 breeding pairs (more than 10 times larger than the current population) would be necessary to ensure a less than 50 percent chance of falling below 5,000 breeding pairs within 50 years.

These PVA results suggest that the current Bank Swallow population faces a risky future. It may be necessary to protect very large numbers of Bank Swallows and very large areas of natural river bank habitat in order to ensure that the population does not fall to very low numbers in the near future. While the current PVA is only preliminary in nature, and any conclusions in the absence of more complete information must remain tentative, this model represents our best estimates of existing conditions and probable future scenarios for the Sacramento River population of Bank Swallows. Until additional data are available, this information represents the best estimate of risk for this population of Bank Swallows and will be used to establish target populations for the recovery of the species in California. As more information becomes available, refinement of the PVA and risk estimates will be possible.

Increased data from the field will help to reduce the problems resulting from a lack of information about the Bank Swallow. However, even if enormous amounts of data became available, we could still not predict exactly how many swallows would be lost following a given level of habitat disturbance. This is because it is impossible to predict the future of the individual birds in the communities of concern. Unpredictable environmental events, such as storms, droughts, changes in temperature, etc. can dramatically impact the species we are interested in. Even if the environment is relatively stable, the extinction of a given animal species is not completely predictable. The demography and genetics of a population, and hence its likelihood of extinction, are influenced by various natural and unnatural events.

A large number of factors can affect the ability of a given population to persist in the face of habitat loss or disturbance. These factors can be divided into two general types of effects: deterministic and stochastic. Deterministic effects are those which operate in a systematic way, whose occurrence is predictable, and which produce foreseeable outcomes. For example, the replacement of a large segment of Bank Swallow habitat by bank protection projects fairly straightforwardly reduces the number of birds which can be supported in an area.

Stochastic factors are those which come about as a result of chance events and whose outputs can only be predicted as probabilities, not as certainties. The stochastic factors affecting population persistence are generally divided into four categories:

1. **genetic stochasticity,** fluctuations in the genetic structure of a population, including such factors as inbreeding depression or the loss of heterozygosity in small populations.

2. **demographic stochasticity,** fluctuations in such factors as the number of offspring produced by individual organisms, the age at which individuals first breed, the sex ratio produced in a group of offspring, etc.

3. **environmental stochasticity,** fluctuations in climate and resources (food, den or nest sites, water, etc.), and the associated changes in the growth rate of the population.

4. **catastrophes,** such as fire, flood, drought, epidemics, etc. which dramatically reduce population size or growth rate.

Demographic and environmental stochasticity are often combined in analyses because in the field it is very difficult to separate the effects of the two. The impact of these, and similar, factors on population viability depends on the effective size of the population. Habitat fragmentation exacerbates the effects of these factors because it reduces population size, increases the impact of surrounding areas, and increases isolation between subpopulations.

PVA's are not purely biological exercises. They are based, in part, on knowledge of local and regional planning and policy. They make assumptions about the likelihood of future actions on the part of interested parties (resource agencies, developers, planners, conservation groups, etc.). Moreover, the definition of "acceptable risk" is not a biological decision. Biological models may produce estimates of the form "there is a 50 percent probability that the population will drop to less than 100 individuals within the next 50 years". Whether the biologically defined risk is acceptable is a policy question.

By conducting a PVA on this species, the fluctuating nature of Bank Swallow populations was revealed. A colony or group of colonies of average size has a substantial chance of dropping to very low numbers within any 50-year period. Thus, care should be taken in the recovery process to ensure that single colonies or small groups of colonies do not become isolated from the rest of the population. The risk of extinction for such isolated groups is very high.

The PVA also indicated that too complete a focus on the risk of extinction or near extinction may result in a false assessment of population "safety". Even

when the risk of extinction is very low, the chance that the population will drop to significantly low numbers may be substantial.

It is vital that critical threshold population sizes be specified and acceptable levels of risk defined. This decision should include a consideration of factors such as the likelihood that if a colony or group of colonies fall to very low numbers in a given year the stretch of river they inhabit may come under increasing pressure for new bank protection projects.

Even a moderate population of **10,000** breeding pairs (which is an over-estimate of the most recent **1992** count) has a substantial chance of falling to relatively low numbers within a 50-year period. The current population is not large enough to ensure persistence of a large ongoing population. It will be necessary to protect habitat which can accommodate much larger numbers of Bank Swallows than currently exist along the Sacramento River. In order to ensure that the population does not fall below specified thresholds it will be necessary to provide room for population expansion. This means that it will be necessary to protect or enhance habitat potentially utilized by the Bank Swallow which is currently not occupied by this species.

More field data are required before the results of the Bank Swallow PVA can be considered highly reliable. Variance in fecundity and juvenile survival rates, and data on return rates following migration, appear to be critical factors determining the likelihood of population declines. This emphasizes the need to:

1. Measure survival and fecundity rates in the California population over long enough periods of time so that accurate estimates of the year-to-year variance in those rates can be obtained. More complete life table data, based on several years of research, from several locations must be developed if more reliable PVA's are to be conducted. Mean age-specific fecundities and survival rates of Bank Swallows are needed for a ten year period from at least three locations in the State.

2. Obtain data on the average gain or loss to the population from migration. The current assumption that migration results in small gains or losses to the population in any given year needs to be validated. These data can dramatically influence the results of the computer simulations. Data are also needed on the spatial distribution of returning migrants.

3. Obtain reliable population counts over large areas of the Bank Swallows' current range for ten or more consecutive years. These data are vital to (a) establish the current population size, and (b) watch for evidence of population declines or cycles in population numbers.

It would also be useful to obtain data on any density dependence of population growth and any correlations between survival and fecundity rates. The current PVA model being used assumes no density dependence and no correlations between survival and fecundity. These assumptions are conservative and may result in underestimates of the risk of population decline. In addition, the present PVA does not model the impact of habitat loss due to bank protection projects or other human activities. Such assessments may be incorporated into the analyses proposed below.

Complete PVA's encompass several levels of analysis. In the case of the Bank Swallow at least three levels need to eventually be examined:

1. **Single population analyses.** The current PVA preliminarily addresses this level. As noted above, more data are necessary to move beyond the current preliminary stage of the PVA.

2. **Metapopulation analyses incorporating habitat measurements.** At this level we would analyze the spatial and temporal pattern of appearance and disappearance of whole colonies or interacting groups of colonies. This could include analyses of the temporal and spatial patterns of habitat availability, the capacity of habitat areas to support populations of the species, and the movement of birds between habitat areas. Currently more field data are needed before this kind of information can be used to determine the optimal number and arrangement of protected areas.

3. **Full population analyses incorporating migratory patterns.** This level includes large-scale analyses of the migratory patterns of the birds and the threats to habitat in both wintering and breeding habitats.

The current population analysis is preliminary in nature, and any conclusions must remain tentative. At present, data are not available from enough years or enough areas to perform a more complete and reliable PVA. The data suggested above must be gathered as part of the population monitoring program in this recovery plan. These data could then be used to conduct a more detailed PVA that would aid in predicting long-term Bank Swallow population prospects and determining recovery goals and criteria. More detailed data would allow analyses which focus on threats to habitat and management strategies for specific single colonies or interacting groups of colonies as well as the entire California Bank Swallow population.

Such analyses may not be available for some time due to the amount of field data that first must be acquired. In the meantime, the best available data indicate a need to protect all current Bank Swallow habitat and to encourage the future expansion of the present Bank Swallow population along the Sacramento River which remains the focus of research, management, and recovery of this Threatened species in the State.

RECOVERY PLAN NARRATIVE

Bank protection projects are currently the single greatest threat to Bank Swallow populations along the Sacramento River, which is the major riparian system within the bird's range in California. While there is some speculation that wintering habitat has deteriorated in South America there are no data to substantiate this notion. However, the immediate threats to the breeding population due to loss of nesting habitats because of bank protection projects are well documented. Without preserving the breeding population in California, the condition of wintering habitat becomes moot. To date, no long-term mitigation or habitat compensation commitment has been made for colonies lost to any bank protection project. These commitments are necessary for the continued viability of Bank Swallow populations.

Artificial River Banks

Bank Swallows have successfully bred at two artificial banks created to provide nesting substrate as an experimental mitigation study. The birds have dug burrows, nested, and successfully fledged young from these structures. They have also utilized "enhanced" natural banks (banks cleared of vegetation

and excavated with hand tools to provide a vertical bank surface suitable for Bank Swallow nesting) in a similar way. The long-term utility of these artificial techniques, however, is questionable because they will be costly to maintain and monitor over time. Currently, the Department and the U.S. Fish and Wildlife Service (FWS) consider these artificial techniques as experimental, and an evaluation study has deemed them inappropriate for long-term maintenance of Bank Swallows (Garrison 1991). Bank protection agencies have been anxious to institute widespread use of artificial nesting habitats to replace natural habitats lost to bank protection. However, the Department and the FWS now recognize that the primary value of artificial habitats was in the research information they provided on the biology and ecology of the Bank Swallow while we evaluated their feasibility as mitigation. While artificial nest sites may have some limited application in future recovery actions, they will not be considered as the primary method to compensate for lost habitat due to bank protection or similar incompatible projects or activities.

Protection, Enhancement, and Maintenance of Natural Habitat

Long-term strategies to preserve Bank Swallow habitat in the face of ongoing bank protection projects must include: 1**)** developing set-back levees and a riverine meander-belt; **2)** preserving major portions of the remaining habitat; and 3) developing a reach by reach habitat maintenance strategy based on PVA criteria outlined earlier. These strategies and others will be necessary in order to effectively reduce conflicts between bank protection projects and Bank Swallow habitat requirements and ensure that sufficient suitable habitat will be preserved in perpetuity.

The core of the State's Bank Swallow population, and therefore the most important habitat for long-term maintenance and recovery of the species, is found along the Sacramento River and its major tributaries. The focus of any long-term strategy for the recovery of the Bank Swallow must be the maintenance of a viable population within this portion of their range.

Strategies required to return the Bank Swallow to non-threatened status will undoubtedly be complex, costly, and difficult to implement. In order for this to occur, a change in current management practices on the part of bank protection agencies (the U.S. Army Corps of Engineers (Corps) and the State Reclamation Board) will be required. The only practical way to prevent further loss of Bank Swallow habitat is to first eliminate or greatly modify those practices responsible for the losses (i.e., bank protection projects).

In order to accomplish the goals of Bank Swallow habitat protection and species recovery, the Department recommends that a critical review and analysis of existing and proposed bank stabilization projects be initiated. The heart of a Bank Swallow conservation and recovery strategy must include the option to avoid impacts to habitat. An important step in this process will be the critical evaluation of all proposed projects that will impact known Bank Swallow colonies and potential habitat. The task would be to examine all proposed bank work and recommend alternatives that would avoid or reduce conflicts with the swallows. This strategy will require that the Corps and the State Reclamation Board participate at a very early stage in the review process. Field inspections of the levee system to identify future project sites should include input from Department and other concerned agency biologists to determine if Bank Swallow habitat will be affected and seek alternatives to reduce or eliminate impacts. Problem areas can be identified

early, and an interagency review and evaluation of the engineering and mitigation alternatives for the proposed project can be initiated. Such a review may recommend independent engineering expertise as part of its evaluation. The results of this process would include the integration of engineering and biological considerations to ensure the preservation of suitable Bank Swallow habitat for certain critical projects.

A habitat preserve strategy is the most likely alternative to ensure long-term viability of Bank Swallows. The habitat preserve concept can be applied both as a mitigation solution and as a means to ensure against future habitat losses. Certain reaches of the Sacramento River are known to support large Bank Swallow colonies in optimum habitat. These and other important areas should be identified and acquired or otherwise protected in perpetuity to provide for the long-term maintenance of Bank Swallow populations. These acquisitions can be part of mitigation required for bank protection project induced losses of Bank Swallow habitat.

Various habitat protection scenarios have been proposed to set aside the remnants of riparian vegetation on portions of the upper Sacramento River. The area identified as the Chico Landing to Red Bluff reach of the Sacramento River has been targeted for habitat acquisition in the proposed Sacramento River National Wildlife Refuge and some of the preserve proposals contained in the Upper Sacramento River Fisheries and Riparian Habitat Management Plan (SB **1086).** This reach of the Sacramento River also coincides with significant numbers of Bank Swallow colonies and some suitable potential habitats. However, additional areas on remaining reaches of the Sacramento, Feather, and other river systems must also be included in a habitat preserve strategy. Within these other areas exist some of the largest and most important colonies in the State.

Any habitat preserve strategy should incorporate specific management actions aimed at protecting the Bank Swallow in order to become an effective part of the recovery strategy for this species. Only a preserve system that eliminates the primary threats to Bank Swallow habitat will ensure long-term population viability. Portions of existing preserve designs may be reasonable to incorporate into a system for Bank Swallows but the species' unique habitat requirements necessitate avoiding any activities or projects that would interfere with erosion of river banks by any means.

Many of the Bank Swallow colonies on the Sacramento River are associated with open grasslands and agricultural lands rather than riparian forests. Thus the goal of riparian habitat acquisition programs which focus only on these forests, may not provide adequate safeguards or benefits for the Bank Swallow. It will be necessary to protect a broad diversity of riparian lands with a variety of habitat values as part of an overall riparian conservation strategy.

Bank Swallows have evolved in a dynamic ecosystem like the Sacramento River and other riverine systems in the Northern Hemisphere. These systems are constantly changing, and any plant or animal species associated with them must be able to exploit changing environmental conditions in order to survive. The Bank Swallow is truly one of those species. Bank Swallows quickly respond to changes in their environment that are favorable. Requirements for nesting habitat may appear to be simple but are probably far more complex than our research has discovered thus far. However, certain research information on

Bank Swallows has been applied in the relatively short time since **1986** and has led to the creation of artificial habitat that the birds have used. Thus, the artificial bank, while failing to provide a suitable means of mitigation for bank protection projects, has provided an opportunity to learn more about the species' biology and ecology.

The most practical, and probably also the most cost-effective, system to maintain suitable habitat in perpetuity is through conservation of a natural riverine system such as that which has historically supported Bank Swallow populations. The replication of such a system on any significant scale is not feasible at this time. The ecology of the Bank Swallow is inextricably bound to the natural functioning riparian habitats. Major modifications to riverine systems in the State will make it difficult to save species like the Bank Swallow from eventual extirpation. In addition, other Threatened species such as the Western Yellow-billed Cuckoo (Coccyzus *americanus occidentalis)* and the Swainson's Hawk *(Buteo swainsoni)* depend on riparian woodlands for at least a part of their habitat requirements. Their requirements and life histories are significantly different from those of the Bank Swallow. However, an ecosystem approach to the conservation and maintenance of large segments of riverine habitat including open areas, riparian forests, active channels, and eroding river banks will provide the greatest opportunity for addressing all the diverse requirements of these species and many others.

ALTERNATIVE RECOVERY ACTIONS

Set-back levees - Meander Belt Concept

Recovery of Bank Swallow populations in California will not be possible without the protection of nesting habitat along the Sacramento River and its major tributaries where active colonies and potential habitats are most abundant. Most of the habitat losses documented to date are the result of state and federal bank protection projects.

In an earlier era, it was desirable to confine the river within a system of levees. This allowed farmers to grow crops in the rich alluvial soils near the river's edge. If these levees had been set far enough back from the river's edge so that the river was allowed to meander naturally, the need for extensive bank protection would have been minimized. In the absence of bank protection projects, species such as the Bank Swallow would have optimum habitat conditions in the naturally functioning riverine ecosystem.

A system of set back levees, although difficult and expensive to develop, initially would have the advantage of low maintenance and relatively few environmental concerns. Landowners immediately adjacent to the current system of levees probably would lose some of their existing lands. Compensation may be required to offset these losses and those of cropland that may be subject to periodic flooding. However, certain seasonal crops could be grown within the meander belt area. Orchard crops, such as fruit and nut trees however, would not survive within a zone subject to flooding. Under this system certain lands will need to be acquired in public ownership. The meander belt concept has been discussed and evaluated as part of several riparian habitat preservation plans and has many long-term advantages. A significant concern is the private property losses resulting from set-back levees. Once an equitable system is developed to compensate for losses, the set-back levee appears to have the best chance for long-term maintenance of Bank Swallow populations and a host of other riparian habitat-dependent wildlife species.

Impact Avoidance

Bank protection projects that reduce or curtail erosion, and Bank Swallow habitat requirements, are for the most part contradictory in nature. The two cannot coexist on the same segment of riverbank. Artificial nesting habitats do not appear feasible over the long-term because of the need for constant and costly maintenance and the risk to the species if they are too dependent on intensively human-managed habitats. The artificial structure concept is considered a potential short-term management option that may be part of a larger and more extensive conservation strategy. At the forefront of this overall strategy, is impact avoidance. If impacts to Bank Swallow habitat are avoided, there is no need to compensate for loss. Avoidance can take several forms including: **1)** canceling construction activities at bank protection project sites; 2) delaying bank protection work because there is no immediate need for the project; and 3) relocating or reducing the size of the project to lessen negative impacts to Bank Swallow nesting habitat. There are undoubtedly instances where all of these measures can be applied to avoid impacts to Bank Swallows and their habitats.

Timing of work at bank protection sites has proven to be critical to Bank Swallow survival. Several instances of direct mortality caused by work at an active colony during the height of the nesting season have been documented. This has resulted in loss of nesting adults, nestlings, and eggs.

Bank protection agencies such as the Corps and the State Reclamation Board are now aware of the legal protection afforded nesting colonies, and they have delayed work at project sites and eliminated direct construction-related mortality to eggs, young birds, and adults since 1986. Coordination between the resource conservation agencies and bank protection agencies must continue in order to ensure that work is not carried out during the nesting season. A no-construction period developed in consultation with the FWS and the Corps, extending from April 1 to August 1 each year, has protected, and will continue to protect, nesting Bank Swallows from mortality due to bank protection construction and related activities. Some relaxation of this time frame can be made on a case by case basis through careful monitoring of Bank Swallow nesting activities and close coordination between the bank protection agencies and resource conservation agencies.

The concept of avoidance, then, has a number of applications. First, it may be possible to avoid impacts to Bank Swallows at particular sites by eliminating certain bank protection projects. It is also possible to delay projects or reduce their magnitude in certain instances in order to avoid impacts to Bank Swallow habitat and/or allow a few more successful nesting attempts at a colony site prior to its eventual loss. Finally, for each active Bank Swallow colony that is located at a proposed work site there is an established time period during which no construction should occur in order to protect nesting Bank Swallows from mortality.

Because it is difficult to make long-term predictions of the locations of Bank Swallow colonies in relation to proposed bank protection work sites, plans for impact avoidance will be developed as information becomes available. Annual monitoring of Bank Swallow colonies within the Sacramento River system will be an important part of this effort. Current site-specific information on Bank Swallow nesting colonies and potential habitat is vital to the recovery effort.

Close coordination between the bank protection and resource protection agencies is essential for successful resolution of conflicts between Bank Swallows and bank protection work. Critically important to this process is the review of proposed bank protection projects and the resulting recommendations aimed at eliminating or reducing impacts. The cooperating agencies must communicate at early stages of project planning while project design is still preliminary and may be flexible. Alternatives to bank protection as it has been traditionally practiced must be given serious consideration. Lack of cooperation in project planning will likely result in failure of this aspect of the recovery strategy.

Habitat Preserve Concept

The habitat preserve concept has several features that make it appealing as the major recovery strategy for Bank Swallows. It should be stressed that many of the attractive features inherent in the meander-belt concept would be effective in accomplishing the goals of a habitat preserve system. In threatened ecosystems such as the Sacramento River riparian system, it is vital to develop a means to preserve a sufficient portion of remaining suitable habitat to ensure the long-term viability of Bank Swallow populations. The most effective means to accomplish this objective is through protection of lands on the Sacramento River and elsewhere known to support active colonies or with suitable habitat features for future colony establishment. Protected lands could be placed in a preserve system that offers long-term protection from habitat losses. There may be certain types of land uses compatible with the preserve goal of providing a secure habitat base for Bank Swallow populations. Both the Sacramento River National Wildlife Refuge and the SB 1086 Riparian Lands Protection Program do not presently contain sufficient safeguards against incompatible land uses to effectively preserve Bank Swallow nesting habitats. These two conservation efforts should be modified to incorporate the requirements of this species.

RECOVERY PLAN GOALS AND OBJECTIVES

The primary recovery goal for the Bank Swallow is the maintenance of a self-sustaining wild population. Objectives are to ensure that: 1) the remaining population of this species does not suffer further declines in either range or abundance, and 2) sufficient habitat be available to ensure that the species will be able to survive as a member of California's native avifauna. Enhancing existing populations and reestablishing populations in target areas are additional objectives. While it is not expected that the Bank Swallow population can be fully restored to its former abundance and distribution, stabilizing the population at a level that ensures long-term viability is a reasonable and achievable goal. However, even achievement of this goal will not occur without the successful application of all recovery strategies identified in this document. The critical challenge of this planning effort is to devise ways to achieve population stability for Bank Swallows in the face of ongoing bank protection projects.

An estimate of population abundance and distribution needed to ensure viability, and therefore to effect recovery of Bank Swallows, will require information in addition to that currently available. Also, the feasibility of certain management actions needed to recover the species must be evaluated. The following research, monitoring, and management actions are intended to provide some of the needed information, and additional objectives and actions will undoubtedly be generated as these initial ones are pursued.

Research and Monitoring Actions

1) Continue to refine PVA to achieve better estimates of population size and distribution necessary to maintain a viable population of Bank Swallows over time.

   Schedule: ongoing Responsibility: DFG

2) Survey the Sacramento River and Feather River annually to determine Bank Swallow population abundance and distribution.

   Schedule: Annually Responsibility: DFG/Corps/DWR

3) Assess statewide population and distribution periodically.

   Schedule: 3-5 yrs Responsibility: DFG

4) Validate the Habitat Suitability Index model developed by the FWS to determine the abundance and quality of Bank Swallow nesting habitat.

   Schedule: annually Responsibility: DFG/DWR/FWS

5) Continue habitat studies to assess impacts of proposed bank protection projects.

   Schedule: ongoing Responsibility: DFG/DWR/Corps

6) Examine the relationship between Bank Swallow population dynamics and prey populations as well as other facets of Bank Swallow ecology.

   Schedule: 1995 Responsibility: DFG/DWR

7) Continue banding research to determine population movements, population dynamics, and colony site fidelity.

   Schedule: Annually Responsibility: DFG/DWR

8) Study conditions on the migration route and wintering ground and the relationship to Bank Swallow nesting populations in California.

   Schedule: 1992-93 Responsibility: DFG

9) Work with the public to keep them informed of status of the Bank Swallow research activities.

   Schedule: ongoing Responsibility: DFG/DWR

Manasement and Acquisition Actions

1) Continue coordination with bank protection project proponents to avoid, minimize, reduce or compensate for impacts to Bank Swallow nesting habitat at proposed work sites.

   Schedule: ongoing Responsibility: DFG/DWR/Corps

2) Work closely with project planners to avoid impacts early through the establishment of a review committee to evaluate proposed bank protection activities.

   Schedule: ongoing Responsibility: DFG/DWR/Corps

3) Inventory suitable nesting habitat to determine the most suitable locations for development of a preserve system. Design and initiate a suitable habitat preserve system that will ensure viable populations in perpetuity.

   Schedule: 1995-1998 Responsibility: DFG/FWS/DWR/Corps

4) Develop a habitat preserve system through protection of public and private properties on the Sacramento River, Feather River, and other significant habitat within the range of the Bank Swallow.

   Schedule: 1994 Responsibility: DFG/DWR/FWS/Corps/State Lands

5) Acquire needed suitable habitat as necessary to develop a habitat preserve system.

   Schedule: 1994 Responsibility: DFG/DWR/FWS/Corps/State Lands

6) Coordinate acquisition and protection efforts with other riparian habitat values important to other wildlife species.

   Schedule: 1994 Responsibility: DFG/DWR/FWS/Corps/State Lands

7) Coordinate Bank Swallow habitat preserve system establishment with other similar efforts on the Sacramento River and elsewhere (e.g., Sacramento River National wildlife Refuge).

   Schedule: 1994 Responsibility: DFG/DWR/FWS/Corps/State Lands

8) Work with the public to develop management actions necessary for the stabilization and eventual recovery of Bank Swallow populations.

   Schedule: ongoing Responsibility: DFG/DWR/Corps

9) Evaluate the feasibility of Bank Swallow reestablishment in southern California and central coastal California.

   Schedule: 1994 Responsibility: DFG/DWR

Continued development and implementation of strategies for the conservation of the Bank Swallow will be carried out as a cooperative and coordinated effort. These strategies will be evaluated on a regular basis and revised as appropriate. The direction set forth in this document is intended to set the stage for recovery of this species.

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APPENDICES

APPENDIX 1

Breeding records of the Bank Swallow in California, 1864-1985

Locality	Date	Source 1/
NORTH COAST REGION		
Del Norte County		
Smith River estuary	1983-1985	ABF
Humboldt County		
Eureka	16 June 1904	egg set WFVZ
Orick Lookout	20 June 1946	Talmadge 1947
Luffenholtz Ck near Trinidad	14 June 1946	Talmadge 1947
Mad River, Essex Rock	20 June 1946	Talmadge 1947
Table Bluff	20 June 1946	Talmadge 1947
Van Duzen River	21 June 1946	Talmadge 1947
Prairie Ck	1956	AFN 11:408 1956
Mendocino County		
Gualala area	1969	BBS
Sonoma County		
Sebastopol	pre-1890	Belding 1890
Sonoma River, Sonoma	23 May 1893	egg set SBCM
Ocean bluff near Jenner	23 July 1960	AFN 15:475 1960
Marin County		
Nicasio	19 March 1876	Belding 1890
KIAMATH-MODOC REGION		
Siskiyou County		
5 mi S. of Tule Lake	26 May 1940	egg sets(l5) WFVZ
Sheepylake, E of Dorris	5 July 1963	specimen MVZ
Lower Klamath NWR to Tule Lake	1972-1985	BBS & ABF (14 reds)
Klamath River	1985	ABF
Modoc County		
Likely	1972-73, 1976, 1978, 1984	BBS
Ingalls	1973, 1978	BBS
5 mi N of Alturas	12 May 1981	ABF
Cedarville	1977	BBS
Dorris Reservoir	23 June 1973	AB 27:916 1973
Clear Lake	1985	BBS
Newell	31 July 1986	Airola (pers. comm.)

APPENDIX 1-contd.

Locality	Date	Source 1/
Lassen County		
Nubieber	1971, 1977, 1980	BBS
Honey Lake	1972-1985	ABF, BBS, (Laymon (pers. obs.)
S. of Susanville	3 June 1973	AFN 27:916 1973
N. side Eagle Lake	July 1974	AB 28:946 1974
Pine Ck Estuary, Eagle Lk area	1977	NRP
Cold Run Creek	15 June 1983	Laymon (pers. ohs.)
Levitt Lake	15 June 1983	Laymon (pers. obs.)
Madeline Plains, near Termo	1984	ABF
Shasta County		
Fall River Mills	1978-1985	ABF
Baum Lake	1981, 1982	ABF
Hat Ck Park	1982, 1985	ABF
Fall River Reservoir	1986	Brown (pers. comm.)
SACRAMENTO VALLEY REGION		
Tehama County		
Deer Ck, near Vina	1956	AFN 10:408 1956
Sacramento River, Red Bluff to Tehama	1976	5 colonies ABF
Thomes Ck, near Henleyville	1982	ABF
Glenn/Butte County		
Sacramento River, Chico to Colusa	1972-1985	BBS (8 records) ABF (13 records)
Sutter County		
Feather River, 15 mi S. of Yuba City	1985	ABF
Sacramento County		
Sacramento area	pre-1870	Grinnell & Miller 1944
Sacramento "common"	pre-1890	Belding 1890
American River, near Sacramento	pre-1972, 1973-74	ABF
American River, San Juan Rapids	1985	ABF
SIERRAN REGION		
Placer County		
Auburn area	1974	BBS

APPENDIX 1 -contd.

Locality	Date	Source l/
El Dorado County		
Placerville area	pre-1888	Dawson 1923
Amador County		
Mokelumne River Area	1979	BBS
CENTRAL COAST REGION		
Contra Costa County		
Locations imprecise "rare"	pre-1890	Belding 1890
Alameda County		
Locations imprecise "rare"	pre-1890	Belding 1890
Hayward	pre-1927	Grinnell & Wythe 1927
San Francisco County		
Lake Merced	1908-1938	egg sets(l8) WFVZ fide H. Cogswell
Ocean Beach	pre-1927	Grinnell & Wythe 1927
Ocean Beach, Fort Funston	1956-1985	ABF, AFN 10:361 1956 AFN 14:475 1960
San Mateo County		
Near Pescadero	31 May 1896	egg sets (2) WFVZ
Ano Nuevo Point	1904-1907, 1971-1985	Grinnell & Miller 1944, NRP, ABF
Santa Cruz County		
Capitola	1889	specimen MVZ
Santa Cruz area	1889	Grinnell & Miller 1944
Westcliff Dr., Santa Cruz	1950	AFN 4:259 1950
Eastcliff Dr, Santa Cruz	1950	AFN 4:259 1950
San Andreas Road, 15 mi. E of Santa Cruz	1954	AFN 8:360 1954
Soquel	pre-1962	AFN 16:505 1962
Santa Clara County		
Betebel	28 May 1931, 6 June 1931	egg sets WFVZ

APPENDIX l -contd.

Locality	Date	Source l/
Monterey County		
2 mi N of Seaside	5 June 1897	egg sets(l) MVZ
5 mi N of Monterey	8 June 1898	egg set MVZ
2 mi N of Seaside	28 May 1898	egg sets(4) MVZ
2 mi N of Seaside	8 June 1898	egg sets(4) MVZ
San Ardo	pre-1923	Dawson 1923
E of Elkhorn Slough	3 July 1949	H. Cogswell (pers. comm.)
Trafton Rd., N of Moss Landing	1950-1952, 1974	AFN 4:259 1950
Moss Landing	9 May 1951	AFN 5:309
Old Toll Road	1952	AFN 6:298 1952
Watsonville	1954-1962	AFN 8:360 1954 AFN 16:505 1962
Greenfield	1972	ABF
Bluffs Rd, mouth of Pajaro River	1972-74, 1977-79, 1981-1983	AFN 26:805 1972 ABF
Salinas River-King City area	1973-1985	BBS, ABF
San Benito County		
Paicines	12 June 1898	n. specimen CAS
San Benito River, Hollister	3-20 June 1922	egg Sets(10) CAS
N San Benito County	21 May 1932	egg Sets(2) WFVZ
San Luis Obispo County		
near Shandon	13 May 1933	egg set MVZ
Cholame area	1970's	D. Roberson (pers. comm.)
W of Shandon	1971-73, 1977	BBS
near Paso Robles	1973	BBS
SAN JOAQUIN VALLEY REGION		
Stanislaus County		
Waterford, Tuolumne River	1984	BBS
Merced County		
10 mi E of Los Banos	21 May 1925	juv. specimen MVZ
Gustine	10 July 1940	juv. specimen MVZ
Kern County		
Buena Vista Lake	26 June 1921	juv. specimen UCLA

APPENDIX l- contd.

Locality	Date	Source 1/
MONO-INYO REGION		
Inyo County		
Owens River, Alvord near Big Pine	1891	Fisher 1893
Crowley Lake	pre-1950-present	D. Gaines (pers. comm.)
SOUTH COAST REGION		
Santa Barbara County		
Hope Ranch Beach, Santa Barbara	18 June 1913	egg set SBMNH
near Santa Barbara	28 June 1913	egg sets(2) SBMNH
Hendries Beach, Santa Barbara	4 June 1927	egg set WFVZ
Santa Barbara County	May 1933	egg sets(3) WFVZ
Goleta	9 May 1943	H. Cogswell (pers. comm.)
Ventura County		
Lake Sherwood	2 June 1864	egg set WFVZ
Santa Clara River, E of Santa Paula	5 May 1904	egg set WFVZ
Santa Clara River, Sespe Station	8 May 1910	egg set WFVZ
Santa Clara River, E of Santa Paula	13 May 1926	egg sets(2) WFVZ
Santa Clara River Estuary	1976	Garrett & Dunn 1983
Los Angeles County		
Los Angeles River, Los Angeles	19 May 1893	egg sets(2) WFVZ
Los Angeles	1907	Shepardson 1909
San Gabriel River, near Whittier	4 July 1894	egg set WFVZ
Alhambra	21 May 1902	egg set WFVZ
Long Beach, Bixby	21 May 1904	specimens MVZ
San Pedro	1904, 1908, 1909 1921,	Shepardson 1909 egg sets WFVZ BL 23:256 1921
Port Los Angeles	1907	Shepardson 1909
Long Beach	23 April 1913	specimens UCLA
San Pedro over harbor	2 May 1915	egg sets (2) WFVZ
Long Beach, Bixby	29 June 1919	egg set SBCM
Long Beach	16 April 1925	BL 27:271 1925
Soledad Cyn, 15 mi E of Newhall	26 April 1928	BL 30:282 1928
Orange County		
Huntington Beach	1906-09, 1918, 1927, 1937	egg Sets(l4) WFVZ SBMNH, Shepardson 1909
Newport Beach	pre-1917	Grinnell & Miller 1944

APPENDIX 1- contd.

Locality	Date	Source 1/
San Diego County		
Oceanside	1912-1925	egg set SBMNH Grinnell & Miller 1944 Willett 1933
Los Flores (ocean bluff, Camp Pendleton)	13 May 1917, 2 May 1919	egg sets WFVZ

1/ Source

AB	American Birds
ABF	American Birds Editors Files
AFN	Audubon Field Notes
WFVZ	Western Foundation of Vertebrate Zoology
CAS	California Academy of Sciences
SBCM	San Bernadino County Museum
SBMNH	Santa Barbara Museum of Natural History
MVZ	Museum of Vertebrate Zoology
BBS	Breeding Bird Survey, U.S. Fish and Wildlife Service
NRP	Nest Record Program, Cornell
UCLA	University of California, Los Angeles
BL	Bird Lore

APPENDIX 2

Bank Swallow colony location, size and number of breeding pairs of birds located on the Sacramento River, 1986

	Colony Size		Colony Location	
Colony Number	Burrows [1/]	Breeding Pair	River Mile	County
86-1	37	20	81.8R [3/]	Yolo
86-2	122	68	87.5L [4/]	Sutter
86-3 [5/]	127	71	97.1L	Sutter
86-4	271	151	100.4L	Sutter
86-5 [5/]	155	87	111.3L	Sutter
86-6 [5/]	26	15	119.4R	Colusa
86-7	106	59	121.7L	Sutter
86-8	213	119	126.1R	Colusa
86-9 [5/]	342	193	127.9RL	Colusa/Sutter
86-10	1,159	648	130.5RL	Colusa/Sutter
86-11	532	297	144.3L	Colusa
86-12 [5/]	261	146	147.5R	Colusa
86-13 [5/]	351	196	150.5RL	Colusa
86-14	75	42	155.1L	Colusa
86-15	1,553	868	156.2RL	Colusa
86-16 [5/]	106	59	158.7R	Colusa
86-17	362	202	159.3L	Colusa
86-18 [5/]	686	383	161.7L	Colusa
86-19 [5/]	346	193	162.1R	Glenn
86-20	957	535	165.4L	Glenn
86-21 [5/]	1,149	642	166.5R	Glenn
86-22 [5/]	69	39	168.7R	Glenn
86-23 [5/]	127	71	171.6R	Glenn
86-24	1,117	624	173.4R	Glenn
86-25	1,064	595	173.9R	Glenn
86-26 [5/]	458	256	178.1L	Butte
86-27 [5/]	21	12	179.4R	Glenn
86-28 [5/]	170	95	181.4R	Glenn
86-29 [5/]	1,617	904	182.8L	Butte
86-30 [5/]	372	208	184.L	Butte
86-31 [5/]	404	226	185.5R	Glenn
86-32 [5/]	54	30	187.9R	Glenn
86-33 [5/]	64	36	188.9L	Butte
86-34 [5/]	1,490	833	190.5L	Butte
86-35 [5/]	155	87	192.6L	Butte
86-36 [5/]	458	256	195.1RL	Glenn/Butte
86-37	37	21	201.4R	Glenn
86-38 [5/]	3,192	1,784	202.4R	Glenn
86-39	138	77	206.6L	Butte
86-40 [5/]	85	48	209.8R	Tehama
86-41	181	101	211.3R	Tehama
86-42	86	45	213.5L	Tehama
86-43 [5/]	3,192	1,784	218.6L	Tehama
86-44	176	98	221.1RL	Tehama

APPENDIX 2- contd.

Colony Number	Colony Size: Burrows[1/]	Colony Size: Breeding Pairs[2/]	Colony Location: River Mile	Colony Location: County
86-45[5/]	96	54	221.9L	Tehama
86-46	1,063	594	222.5L	Tehama
86-41[s/]	64	36	224.1R	Tehama
86-48	64	36	226.1L	Tehama
86-49[5/]	1,383	773	231.7RL	Tehama
86-50	106	59	232.5R	Tehama
86-51[5/]	138	77	234.3RL	Tehama
86-52[5/]	218	122	237.0R	Tehama
86-53[5/]	186	104	239.8L	Tehama
86-54	160	89	241.8L	Tehama
86-55	117	65	263.8R	Tehama
86-56	553	309	271.6L	Tehama
86-57	226	149	273.4R	Tehama
86-58	250	140	275.7L	Shasta
86-59	468	262	279.9L	Shasta
86-60	101	56	291.8L	Shasta
	28,894	16,149		

1/ Based on 0.94% accuracy
2/ Based at 55.9% occupancy
3/ Colonies located on the right side of river facing downstream (normally west)
4/ Colonies located on the left side of river facing downstream (normally east)
5/ Colonies randomly selected for intensive study

APPENDIX 3

Bank Swallow population distribution by geographic regions in California, 1987

Geographic Region	Number of Colonies	Percent of Total	Number of Burrows	Percent of Total
NORTHERN COAST	1	0.9	702	1.6
GREAT BASIN	27	24.3	7,395	16.4
SACRAMENTO VALLEY	79	71.2	33,696	74.8
SIERRAN	0	0	0	0
CENTRAL COAST	3	2.7	942	2.1
SAN JOAQUIN VALLEY	0	0	0	0
MONO - INYO	1	0.9	2,310	5.1
SOUTH COAST	0	0	0	0
MOJAVE - COLORADO DESERT	0	0	0	0
Total	111	100.0	45,045	100.0

APPENDIX 4

Bank Swallow population information by river reach on the Sacramento River, California 1986 to 1992.

River Reach	Year						
	1986	1987	1988	1989	1990	1991	1992
RM 81-RM 143							
No. colonies	13	12		6	6	6	9
Total burrows	2480	3720		750	980	1873	1646
Ave. burrows/colony	190	310		130	200	312	183
RM 144-RM 168							
No. colonies	14	13	18		16	10	14
Total burrows	6170	6980	7790		7450	5795	6827
Ave. burrows/colony	440	540	430		470	580	488
RM 169-RM 199							
No. colonies	17	17	25	22	14	13	13
Total burrows	7610	5110	8920	7090	4490	2866	4241
Ave. burrows/colony	450	300	360	320	320	220	326
RM 200-RM 243							
No. colonies	20	19			15	14	13
Total burrows	9520	8540			6880	5368	4053
Ave. burrows/colony	480	450			460	383	312
RM 243-RM 292							
No. colonies	6	5			3	3 [1/]	3 [1/]
Total burrows	1660	1400			820	820 [1/]	820 [1/]
Ave. burrows/colony	280	280			270	270 [1/]	270 [1/]
Total RM 81-RM 292							
No. colonies	70	66			53	46	52
Total burrows	27440	25750			20620	16722	17587
Ave. burrows/colony	390	390			390	364	338

1/ Estimate based on 1990 results.