ENHANCEMENT OF HABITATS FOR THE YUMA CLAPPER RAIL AND DESERT PUPFISH, IN THE VICINITY OF THE SALTON SEA, CALIFORNIA

FEBRUARY 1983

ENVIRONMENTAL SCIENCE AND ENGINEERING

UNIVERSITY OF CALIFORNIA, LOS ANGELES
REPORT NO. 83-52

ENHANCEMENT OF HABITATS FOR THE YUMA CLAPPER RAIL AND DESERT PUPFISH, IN THE VICINITY OF THE SALTON SEA, CALIFORNIA

February 1983

D.A. Bailey
K.H. Rodenbaugh

V.M.J. Ryden
P.B. Schumann

P.M. Merifield
W.D. Dritschilo

ESE Report No. 83-52

Prepared for
Southern California Edison Company
Contract No. C0991901

Environmental Science and Engineering
University of California
Los Angeles, CA 90024

ACKNOWLEDGEMENTS

This study was supported in part by a contract from the Southern California Edison Company for a study entitled "Land Use Issues in Development of Wind, Solar and Geothermal Energy Facilities in Southern California." The research was performed as part of a graduate professional research course in the Environmental Science and Engineering Program at UCLA. We wish to thank Terry Sciarrotta of the Southern California Edison Company for his patient assistance. In addition, we wish to thank the individuals cited in the text who communicated information not otherwise avail-ble. Any opinions are, however, strictly our own, or at least represent a consensus of opinion. We also wish to acknowledge the word processing services provided by Evalon Hall and Mariko Kitamura.

ABSTRACT

The feasibility of habitat enhancement at the Salton Sea was analyzed for two endangered species, the desert pupfish and the Yuma Clapper Rail. A number of management options have been considered, and costs for the preferred options are estimated. The two resources most crucial for both the pupfish and the rail habitats, land and water, are treated in detail. Management efforts are in progress in the Salton Sea area for both species. Efforts for the Yuma Clapper Rail have shown positive results; those for the desert pupfish have only recently been initiated. Enhancement options discussed in this report for the Yuma Clapper Rail focus on techniques similar to those used at the refuges at the Salton Sea, which involve holding pond construction for water level control. Options considered for the pupfish are more experimental and include tamarisk removal, exotic fish eradication, fish barriers, and backwater dredging.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ACEC	Area of Critical Environmental Concern (BLM)
AGF	Arizona Game and Fish
BLM	Bureau of Land Management
CDCA	California Desert Conservation Area (BLM)
CDFG	California Department of Fish and Game
CDWR	California Department of Water Resources
CEQA	California Environmental Quality Act
CVCWD	Coachella Valley County Water District
EPA	Environmental Protection Agency
FLPMA	Federal Land Policy and Management Act
FWCA	Fish and Wildlife Coordination Act
IID	Imperial Irrigation District
IWA	Imperial Wildlife Area
MSL	Mean Sea Level
MWD	Metropolitan Water District
SCE	Southern California Edison
SSNWR	Salton Sea National Wildlife Refuge
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

UNITS

AF	acre feet
cfs	cubic feet per second
ha	hectare
MAF	million acre feet
mg/l	milligrams per liter
ppm	parts per million
TDS	total dissolved solids

1.0 INTRODUCTION

1.1 Scope of Report

For the past several years, Southern California Edison (SCE) has pursued the development of alternative and renewable energy technologies to promote national energy independence and conserve fossil fuels. Commercial-scale renewable energy systems currently under consideration will be sited to best take advantage of the particular resource required, e.g., sunlight, wind, geothermal. The Salton Sea Basin in southern California is an attractive area for renewable energy development due to its high annual insolation, potential geothermal resources, available water, and relatively sparse population. Unfortunately, it is also a region of fragile desert and marsh ecosystems that, once damaged, are difficult to regenerate. It is important that energy development projects in the area be carefully planned to prevent unacceptable environmental degradation.

The Salton Sea is home for a variety of fish and wildlife, including endangered species such as the desert pupfish and Yuma Clapper Rail. Any activity that may alter or damage endangered species habitat must conform to strict federal and state laws and regulations designed to protect critical habitats. Power plant development and operations will undoubtedly have various long- and short-term environmental effects on the surrounding areas; consequently, mitigation options need to be explored to protect resident fish and wildlife populations. This paper identifies and evaluates potential mitigation measures, both direct and indirect, for the protection of the desert pupfish and the Yuma Clapper Rail.

Section 1 presents background information on the Salton Sea and discusses the use of mitigation choices as a planning tool. Section 2 evaluates land, water resource, and regulatory issues that play an integral role in the design and implementation of any species protection plan. Important first-step activities include procurement of land rights, water resources, and regulatory approval. After describing the habitat requirements of the pupfish and rail, Sections 3 and 4 explore alternative protection options for these species, which SCE can use to mitigate, or compensate for, the unavoidable environmental impacts of energy development. Cost data for the various options provided in these sections will facilitate the selection of a cost effective mitigation plan and provide guidelines for future contractor selection. Section 5 summarizes desirable mitigation alternatives based upon their expected cost, effectiveness, and acceptability. From the mitigation options recommended, it should be possible to construct a development plan that will satisfy the needs of SCE, responsible regulatory agencies, and other interested parties.

1.2 Mitigation and Project Planning

The Fish and Wildlife Coordination Act (FWCA) is the single most important federal legislation dealing with mitigation of the detrimental effects of human activity on fish and wildlife. First passed in 1934, this act was amended and strengthened in 1946 and most recently in 1958. It was originally intended to give consideration to fish and wildlife resources in the planning and construction of federal water development projects for irrigation, flood control, or hydroelectric power. Through subsequent congressional legislation, administrative regulations, executive orders, and court interpretations, the concept of mitigation has matured into a vital element of current environmental protection goals.

The term "mitigation" was first used in connection with wildlife in the FWCA. However, mitigation and the philosophy behind it has never been consistently or clearly defined by all agencies connected with its use. Regulations implementing the National Environmental Policy Act of 1969 define mitigation as avoiding, minimizing, rectifying, reducing, or compensating for project impacts on natural resources during project planning (40 CFR 1508.20). Mitigation differs from prevention (the 100 percent reduction of potential losses) in that it is acknowledged that some loss will occur; the goal of management is to make that loss less severe. The concepts of enhancement and compensation further expand the concept of mitigation.

Simply stated, enhancement is the development and improvement of wildlife resources. Under the FWCA, it is to be done in conjunction with mitigation. Land acquisition, along with the development, operation, and maintenance of appropriate habitat enhancement measures, has traditionally been the focus of most wildlife management, and the techniques for enhancement are well developed.

Compensation involves enhancement to produce benefits in one area to make up for impact-related losses in another area. Thus, unmitigated losses are accepted, and an attempt is made to recoup these losses through intensive enhancement elsewhere (1.1). Compensation can be a potentially powerful mitigation tool and is of particular interest for land-intensive projects proposed for desert areas. It may be in-kind (e.g., lost elk habitat is compensated by increased elk management) or out-of-kind (e.g., lost pheasant habitat is compensated by increased elk management). The advantages of out-of-kind mitigation include management efforts directed to higher priority resources and development of a broader range of mitigation alternatives. This increases the probability of selecting a mitigation plan readily acceptable to the public and to project decision makers.

Off-site compensation may be a viable means of mitigation when an endangered species is threatened by on-site development. The Endangered Species Act of 1973 (Section 7) requires that any federal action must show that it does not adversely affect the habitat of an endangered species. If an irresolvable conflict exists, the U.S. Fish and Wildlife Service (USFWS) may issue a "jeopardy" opinion with a list of "reasonable and prudent alternatives to the agency action," including off-site compensation strategies. The direct purchase and rehabilitation (enhancement) of private lands is the course of action normally followed by impacting agencies or organizations, although these groups may be allowed to compensate by purchasing lands already set aside by the federal government for mitigation purposes.

Obvious problems arise when attempting to mold compensation strategies. The "mitigation" habitat must be ecologically equivalent to that which is destroyed. Even if it is similar, it is usually occupied by an existing natural system of plants and animals. It should not be assumed that wildlife communities, any more than human communities, can be displaced by development and survive intact elsewhere (1.2). If the compensation strategy is an out-of-kind approach, it may be necessary to compare and qualitatively evaluate different wildlife values. The difficulty of comparing dissimilar habitats has been addressed by the U.S. Fish and Wildlife Service with the drafting and publishing of the Habitat Evaluation Procedure. This procedure is a means of quantifying non-economic values of wildlife resources by measuring project impacts and justifying mitigation requests on a biological basis of "habitat units." It focuses on resource quality, not only its use.

A variation on the theme of compensation is that unmitigated losses in one area may be partly compensated by prevention of losses in another area. For example, loss of riparian habitat by impoundment of a river can be partly compensated if means are provided to prevent imminent impoundment of remaining stretches of the river. This type of management differs from full compensation in that a net loss results, although the loss is not as severe as it would otherwise have been. This approach is often applied as trade-off analysis in siting studies, where damage to one resource may have to be accepted in order to prevent impacts to another resource.

No uniform system for arriving at mitigation recommendations has been agreed to by both construction and wildlife agencies. Nor is there agreement over criteria by which construction agencies accept, reject, or modify those recommendations. Early planning is viewed by many as the key to minimizing or avoiding conflicts over development. This concept involves the earliest possible notification of federal and state wildlife agencies, as well as the public, whenever a development is contemplated. To meet a legitimate need for power, a utility should approach the environmental licensing bar with a demonstration that, within the range of siting options and system configurations available, it has the best plan for mitigation and, if possible, for providing enhancement of fish, wildlife, and other environmental values.

Operation and maintenance of mitigative projects is as crucial to minimizing wildlife losses as initial implementation. Habitat manipulations must be repeated every 5 or 10 years if desired species populations are to be sustained (1.3). Results of mitigative measures may be negated when development sponsors and state or federal wildlife agencies refuse, or are unable, to fund operation and maintenance of those measures.

1.3 The Salton Sea

The Salton Sea is an inland saltwater lake, 58 km long and 14.5 to 24 km wide, in southeastern California. It is the state's largest lake, with 932 km^2 of water surface and 160 km of shoreline (1.4). At its lowest point, the sea is 84.7 m below mean sea level (msl), and its fluctuating surface level has currently stabilized at about 69 m below msl.

The Salton Sea originated through a series of unique and accidental occurrences (1.5, 1.6). The 21,644 km^2 Salton Sea Basin was cut off from the Gulf of California in ancient times as the Colorado River extended its delta into the gulf. The Salton Sea was formed in the lowest part of that basin in 1905-1907. Since then it has been maintained by the flows of natural and man-made channels that drain to the lowest part of the closed basin. By far the greatest inflow results from agricultural drainage, which is an essential function of irrigation in this desert area.

1.3.1 Problems Affecting the Salton Sea

The following three water resource problems are of overriding concern for the continued maintenance of the Salton Sea as a recreational area and wildlife habitat.

Salinity

An estimated 4 billion kilograms of salts per year enter the sea with drainage waters (1.7). As fresh water evaporates, these salts are left behind and, if a sufficient amount of fresh water is not replaced, the salinity of the water increases. Since 1974, the salinity has increased from 38,000 ppm to 40,600 ppm today (1.8), an average annual increase of 325 ppm. The recommended salinity level for perpetuating the sea's fishery and recreational resources is approximately 35,000 ppm, the salinity of ocean water.

Based on a number of scenarios for future water use in the area, a computer program has been developed to project Salton Sea salinity levels to the year 2000 (1.9). The projections reflect several potential land use activities, including agricultural conservation efforts, the construction of a solar pond, and geothermal energy production. Assuming that current water inflow to the sea remains unchanged, the salinity is expected to rise to 44,000 ppm by the year 2000. If plans for water conservation measures in the Imperial and Coachella Valleys are implemented, resulting in less inflow, salinity would reach 89,000 ppm by the year 2000. A less ambitious and more realistic estimate of agricultural water conservation measures would result in a salinity of 53,000 ppm by the year 2000.

The Salton Sea Project was proposed in 1974 to halt and reverse the increasing salinity levels of the sea. The plans of this project call for the construction of a 100 km^2 impoundment in the southeastern end of the sea in an area that overlaps much of the submerged National Wildlife Refuge (see Figure 1-1). The impoundment would act as an evaporation pond to trap and hold salt from the sea while the surrounding waters are replenished by relatively freshwater inflow. At its closest points to shore, the dike would be about 0.4 km from the mouths of the New and Alamo Rivers, and 1.6 to 3.2 km from the mouth of San Felipe Creek, allowing these tributaries to flow around the impoundment into the sea.

Water level

A second physical problem is water-level fluctuation. Changes in inflow to, and evaporation from, the sea have caused continually changing water levels during much of the sea's existence. The water level is now relatively stable at -69 m, a level that has come to be regarded as normal. However, water-level fluctuations could again become a serious problem if conditions of inflow and evaporation change.

Water-level fluctuations are disruptive to use of the sea-adjoining land. The gentle slopes of the land under and around the sea cause a large change in the shoreline with a relatively small change in water level. Shoreline developments are in danger of being flooded if the water level rises, or of being left at a considerable distance from the receding shoreline if the level falls. Drainage of agricultural lands would be adversely affected by

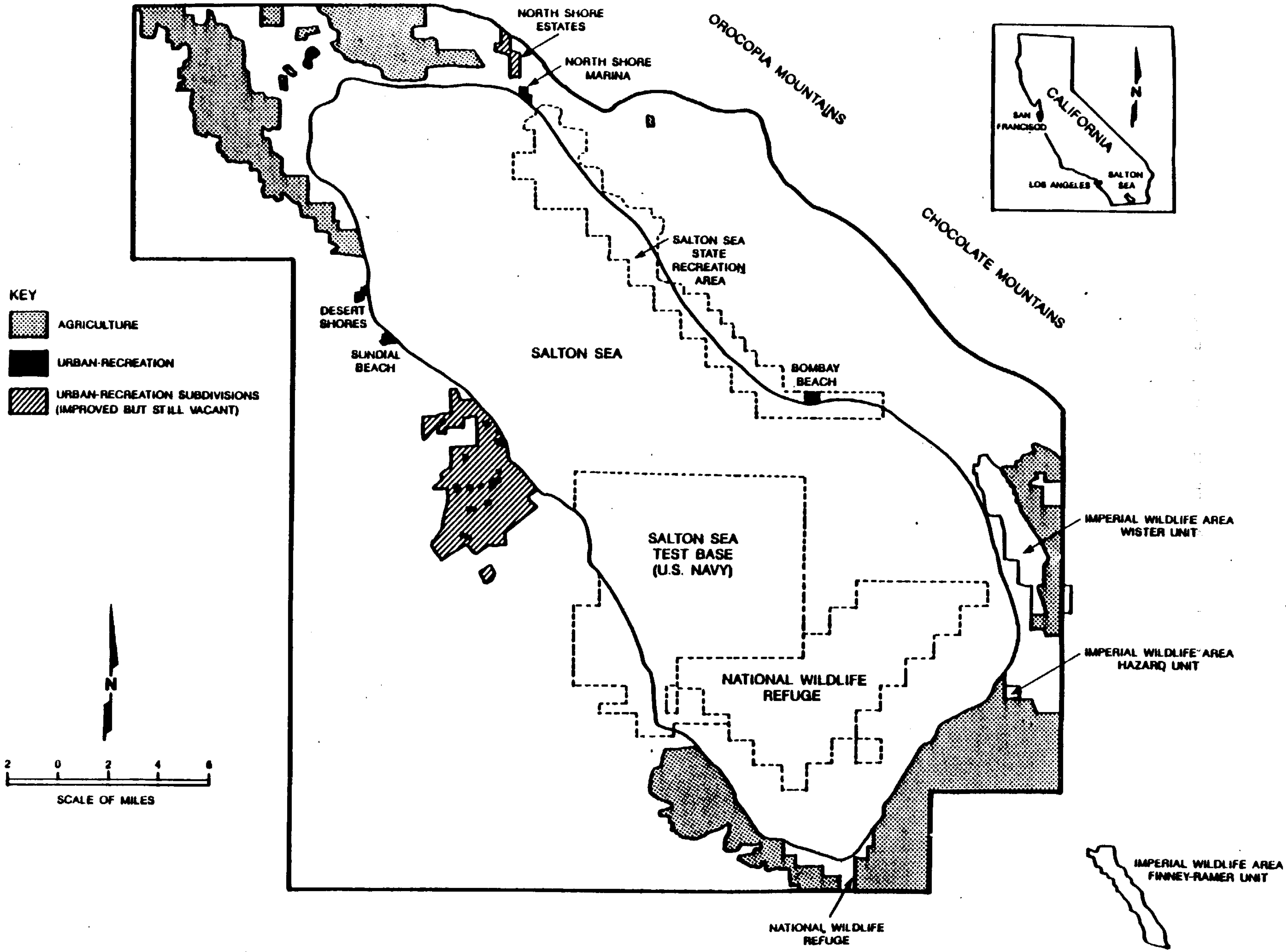

Figure 1-1. Land Use Around the Salton Sea (Ref. 1.4)

water levels higher than those presently prevailing. The Salton Sea itself has no priority to receive water from any source. Drainage and seepage waters that perennially sustain the sea are the incidental result of beneficial uses of water, governed by existing laws, agreements, and court decrees. The primary use of the sea to store these drainage and seepage waters is ensured by a Federal Public Water Reserve, and other public and private lands, set aside to provide a drainage repository (1.10).

Nutrients

The third major physical problem is eutrophication. The Alamo, New, and Whitewater Rivers and other drains discharge varying amounts of nutrients from agricultural, municipal, and industrial sources. The Salton Sea is thus abundantly supplied with mineral nutrients, mainly compounds of nitrogen and phosphorus, which encourage excessive growth of algae. Although algae are essential to the sea's ecology, algal blooms discolor the water and, upon death and decomposition, often deplete the water's oxygen content locally and produce obnoxious odors. Fish or other intermediate food chain organisms are occasionally killed by the temporary lack of oxygen. The Salton Sea has been highly eutrophic for some time and this condition is not expected to change significantly in the foreseeable future.

No agency or level of government has unilateral responsibility to stabilize the water level, limit the salinity, or control the nutrient-related problems of the Salton Sea. Many agencies - federal, state, and local - have legislative or administrative responsibilities, or own or administer lands, that would be affected by such programs. A recent court decree directed the Imperial Irrigation District to restrict water use to lower the Salton Sea level by 4 feet in order to protect farmland threatened with inundation.

1.3.2 Biological Characteristics of Interest

The identification and analysis of potential mitigation measures for the protection of the desert pupfish and Yuma Clapper Rail requires a basic understanding of the Salton Sea's biological resources, particularly its vegetation, fish, and waterfowl populations. The following information for these three areas of interest has been extracted from the Salton Sea Project Environmental Statement.

Vegetation contiguous to the sea is characteristic of environs associated with low humidity, low rainfall, high summer temperatures, and drying winds. With the exception of salt bush and salt grass, vegetation is sparse along the sea's shores. Rooted aquatic plants such as cattail, nutgrass, and other associated sedges are common at the confluence of freshwater drainages. Dense stands of salt cedar and cane occur along Salton Creek and other freshwater drainages. Bulrush grows in marsh areas and is found at the mouth of the Whitewater River. Salt grass is widely distributed wherever fresh water enters and grows partially submerged in the water. On the levees of the Alamo and New Rivers, above the influence of sea water, two species are found in abundance: arrow weed, which forms dense thickets, and heliotrope, a small herb.

The Salton Sea's aquatic environment is limited to specialized organisms because of high summer water temperatures (up to 36°C), low dissolved oxygen tension during the summer, a shifting sand shoreline bottom, and a salt composition similar in concentration to, but different in ionic composition from, ocean water (1.11). Populations of several freshwater fishes initially inhabited the sea, but, as the salinity levels increased, only the striped mullet survived. Meanwhile the desert pupfish, a native to the area, became firmly established.

From 1929-1950 numerous species were transplanted to the sea in order to establish a sport fishery; only three have survived to form the present fishery: orangemouth corvina, sargo, and bairdiella (gulf croaker). Additional species, which inadvertently became established in the sea and its various inflow channels, include the threadfin shad, molly, and mosquito fish. These species have hastened the decline of the pupfish population in common territories.

The Salton Sea is vital to waterfowl and other water-associated birds. The most attractive areas for waterfowl are at the northwest and southeast ends of the sea where marshy areas provide needed cover. Units of the Imperial Wildlife Area (IWA) and the areas around the mouths of the three main rivers (Whitewater, New, and Alamo) are by far the most productive for all water birds (1.12). On the east and west shores, sea and desert meet and water-associated birds are found where suitable habitat is present. Agricultural developments at the south end attract large numbers of birds. At least 20 species of shore birds use the sea for a place to feed and rest.

1.3.3 Land Use

The California Protected Waterways Plan, published by the State of California Resources Agency, designates the Salton Sea as a Priority A, Priority Action Waterway (1.13). Waterways with this designation have the highest protection priority, and detailed waterway management plans for them are to be undertaken immediately.

The map in Figure 1-1 shows the land use pattern for the area surrounding the Salton Sea that was evaluated by the Salton Sea Project study team in 1974 (1.4). The study area boundaries roughly parallel the shoreline, enclosing an area of approximately 2,356 km^2 in Riverside and Imperial Counties.

At present, Imperial and Coachella Valley lands bordering the Salton Sea are being intensively farmed. Small portions of the east and west banks have been developed (during a boom in the 1950's and 60's) into recreational areas, state parks, and wildlife refuges (1.4). Nevertheless, most of the land surrounding the sea remains in its natural state.

In 1972 there was about 4 km^2 of land that could be considered urban. Most of these areas contain single residential homes, with mixed full-time and part-time occupancy. Commercial development covers only a small area in each of the larger urban communities. However, there has been extensive agricultural development at both the north (Coachella Valley) and south (Imperial Valley) ends of the sea. In both areas, irrigated agricultural lands comprise a little over 194 km^2 within the study area.

Clear-cut county development plans for the area have not been formulated because of the uncertain future of the sea's salinity. Nevertheless, there is general agreement that, under uncontrolled conditions, land-use development would remain relatively unchanged and, as the salinity of the sea increases, there could be a decline in population and use.

1.3.4 Land Ownership

Land ownership for the area evaluated by the Salton Sea Project study team (see Figure 1-1) is described below. Land ownership falls into three basic categories: federal, patented (state and private), and Indian lands. Ownership is extremely complicated with administrative responsibilities and land-use priorities often overlapping.

Federal Land

Federal lands comprise 876 km^2 or 37 percent of the study area (1.14). Most of them are reserved for a specific use or combination of uses.

1. Reclamation withdrawal land - public domain land withdrawn by the U.S. Bureau of Reclamation (USBR) for its agricultural potential or for reclamation project rights-of-way such as the Coachella Canal.

2. Military withdrawals - lands attributed to the termination of AEC withdrawals and the transfer of lands to a military category (Navy). The Salton Sea Navy Base includes areas leased by other agencies.

3. Public water reserve lands - lands lying below -67 m elevation that are recognized as important for the storage of drainage water. Only 48 km^2 acres are singly labeled as such; the remaining acreage is in combination with other reservations.

4. Public domain lands - includes 74 km^2 of land classified for multiple use management and 37 km^2 for possible transfer.

5. Wildlife refuge lands - includes the Salton Sea National Wildlife Refuge (SSNWR) at the southern end of the sea. The refuge is primarily a wintering area for an important segment of the population of migratory waterfowl which travel the Pacific Flyway. Established in 1930, the refuge originally consisted of 131 km^2 bordering the sea. Inflow of agricultural runoff since that time has raised the water level, gradually inundating all of the original refuge.

Presently, the only shoreline being managed in the federal water flow program includes about 10 km^2 of land leased from the Imperial Irrigation District (IID) and 0.5 km^2 leased from a private owner. An additional 4 km^2 was added by the Migratory Bird Conservation Commission for the primary purpose of providing for the needs of wildlife and for growing crops to prevent degradation on adjacent farms.

Patented Lands

Well over half of the total study area is under patent. Incuded are the following:

1. Imperial Irrigation District - a major landowner which leases land to state and federal agencies. The state leases over 27 km^2 from IID for the Salton Sea Recreation Area.

2. State of California - maintains title to 13 km^2 in the 73 km^2 Salton Sea Recreation Area and leases 23 km^2 from federal agencies and 37 km^2 acres of patented land, partly for the Imperial Wildlife Area. The wildlife area, consisting of 32 km^2, is "farmed" for wildlife food production. Two of its three units (Wister and Hazard) are adjacent to the sea. The third (Finney-Ramer) is 13 km south.

3. Imperial County - does not have title to lands, but leases recreational sites from other agencies.

4. Riverside County - ownership is negligible.

5. Individuals - own the remainder of the patented land.

Indian Lands

All Indian land holdings are in the Torres-Martinez Indian Reservation (approximately 91 km^2). Of this amount, 40 km^2 are submerged in the northwest corner of the sea in checkerboard parcels.

1.4 References

1.1 Thompson, L.S. Mitigation as Management: Strategy and Some Alternatives, G.A. Swanson (Tech. Coord.). The Mitigation Symposium: A National Workshop on Mitigating Losses of Fish and Wildlife Habitats. Rocky Mountain Forestland Range Experimental Station. General Technical Report RM-65.

1.2 Yarn, Jane H. Refitting Noah's Ark: Adapting An Ancient Technique to New Problems, G.A. Swanson (Tech. Coord.). The Mitigation Symposium: A National Workshop on Mitigating Losses of Fish and Wildlife Habitats. Rocky Mountain Forestland Range Experimental Station. General Technical Report RM-65.

1.3 Rappoport, A. The Mitigation Problem: A Background Review for the Mitigation Symposium, G.A. Swanson (Tech. Coord.). The Mitigation Symposium: A National Workshop on Mitigating Losses of Fish and Wildlife Habitats. Rocky Mountain Forestland Range Experimental Station. General Technical Report RM-65.

1.4 U.S. Department of the Interior and the Resources Agency of California. Draft Environmental Statement - Salton Sea Project California, May (1974).

1.5 Hosmer, H. "Triumph and Failure in the Colorado Desert," American West, Vol. 3, No. 1, pp. 34-49 (1966).

1.6 Lawrence, M. "The Paradoxical Sea," Western Tanager, Vol. 46, No. 7, April (1980).

1.7 U.S. Department of the Interior and the Resources Agency of California. Salton Sea Project, California, Federal-State Feasibility Report, (1974).

1.8 Saluja, J. Colorado River Basin Regional Water Quality Control Board, Palm Desert, California. Personal communication (1982).

1.9 Environmental Science and Engineering, University of California, Los Angeles. Resource Use and Wildlife Issues in Development of Alternative Energy Technology in Southern California Deserts, Vol II (Energy Technology and the Salton Sea Ecosystem), Report No. 82-45, December (1982).

1.10 Goldsmith, M. Salinity Control Study Salton Sea Project, The Aerospace Corporation, El Segundo, California, Report No. ATR-71(59990)-5, Feb 9, (1971).

1.11 U.S. Department of the Interior and Federal Water Quality Administration, Pacific Southwest Region, Salton Sea, California Water Quality and Ecological Management Considerations, July (1970).

1.12 McCaskie, G. "Shorebird and Waterbird Use of the Salton Sea," California Department of Fish and Game, Vol. 56, No. 2, pp. 87-95 (1970).

1.13 California Resources Agency. California Protected Waterways Plan (Initial Elements), February (1971).

1.14 Holmes, W. (Bureau of Land Management), Frederic Varnum (Bureau of Indian Affairs), and S. Gershon (State Department of Water Resources). Salton Sea Project - Summary Report Work Area II. Land Ownership and Use, June (1969).

2.0 RESOURCE AND REGULATORY ISSUES

2.1 Land Acquisition

2.1.1 Introduction

There are few native habitats remaining for species in the Salton Sea area. Two of these, Salt Creek and San Felipe Creek/San Sebastian Marsh, are still fairly wild and pristine when compared to many other areas of the California desert. The relative lack of human disturbance is undoubtedly the chief reason for the continued viability of these habitats. However, the tremendous growth of off-road vehicle use, hunting, agriculture, and development in the Imperial Valley in recent years is beginning to impact even these areas. Their eventual degradation seems inevitable without careful protection, but patterns of intermingled land ownership constitute a major stumbling block to effective habitat management by industry or by state and federal agencies. Exchanges or acquisitions of land parcels, and agreements or easements obtained from landowners, are essential to minimize problems of access and lack of clearly identified boundaries, to optimize recovery efforts for the two species, and to ensure the effectiveness of these efforts by protecting the habitats from further human disturbances (2.1).

Land Use

General patterns of land ownership and use in the Salton Sea region have been described previously (Section 1.3.4), and will not be discussed further. This section outlines principal land uses in the habitat areas specifically considered in this report: the Whitewater River, the wildlife refuge areas, the Salt Creek area, and the San Felipe Creek-San Sebastian Marsh area.

Whitewater River

The marsh at the mouth of the Whitewater River in Riverside County is artificially maintained by runoff from irrigation water. Surrounding lands support irrigated agriculture, including producing dates, cotton, sugar beets and alfalfa. Most of the marsh property is owned by the Coachella Irrigation District, who operate their land and the adjacent Bureau of Land Management (BLM) land, under a USBR water resources withdrawal (2.2). The surrounding lands are mostly either patented or comprise a portion of the Torres-Martinez Indian Reservation (2.3). Use is principally recreational (fishing and hunting) and educational (birdwatching and scientific study), although privately operated duck ponds and a Riverside County sanitary landfill are located close to the marsh (2.3).

Wildlife Refuge Areas

The Imperial Wildlife Area, composed of the Wister, Hazard and Finney-Ramer Units, and the Salton Sea National Wildlife Refuge are located in Imperial County on the southern and eastern shores of the Salton Sea. They are managed as waterfowl reserves (for both game and nongame species) by the California Department of Fish and Game (CDFG) and USFWS, respectively, to maintain cropland, marsh and open water habitat. Hunting (in season), fishing, and nonconsumptive recreation occur in these areas. Surrounding lands are primarily privately owned and used for irrigated agriculture (2.4, 2.5).

Future use may include more intensive development of oil, gas, and geothermal resources (2.6, 2.7).

Salt Creek

This pupfish and rail habitat, located northeast of the Salton Sea in Riverside County, was one of 75 areas designated by BLM as an Area of Critical Environmental Concern (ACEC) in the California Desert Plan (2.1). The site was formerly used by the Cahuilla Indians, and Rancho dos Palmos, a spring in the northeastern part of the area, was a stage line stop before the turn of the century (2.8). This area is bordered by the Coachella Canal on the north and east and by Highway 111 and Salton Sea State Park on the west. It is bisected by a jeep trail, canal and power line maintenance roads (unpaved), and the railroad track for the Eagle Mountain mine (2.9). Public lands are designated Class L (see Section 2.1.3.1), and one bears USBR Public Water Reserve withdrawals, WDL PWR 90 (E03/10/24) and WDL PWR 114 (E02.23.28), as well as a withdrawal for the Yuma Reclamation Project (WDL YUMA PEC PWR S010/19/20). One section is state-owned. Private sections are undeveloped except for those near Rancho dos Palmos, which apparently include limited agriculture, as well as fish ponds and a commercial freshwater shrimp rearing facility, and several hot mineral spas a few miles southward (2.8, 2.10, 2.11). Possible future uses include water diversion for agriculture (2.8), exploration and development of the oil, gas and geothermal leases now on most parcels (2.9), and the proposed establishment of a new power line corridor (or expansion of the existing one) by Pacific Gas and Electric Company (2.12).

San Felipe Creek-San Sebastian Marsh

This represents one of the best remaining examples of natural desert wetland in the Colorado Desert (2.2, 2.8). It has been visited or occupied by man since at least 1500 AD, first by the Kamia Indians and later by migrants using the Anza Trail. The Harpers Well area was an important water source and rest stop for travelers, and a small settlement, San Sebastian, was briefly established west of the marsh (2.2).

Land ownership in this area is characterized by a checkerboard pattern of public and private lands resulting from federal land grants to the Southern Pacific Railroad in the 1850's (2.2). Many of these have subsequently changed hands several times, through a series of private owners planning to develop agriculture, though the marsh and its immediate environs remain undeveloped at present. There are agricultural lands both upstream and downstream of the marsh: Elmore Ranch, 8 km to the southeast, is irrigated with Colorado River water, and Ranch Oasis, 10 km west, uses groundwater to irrigate alfalfa (2.2). Other uses are mainly scientific and recreational; though the marsh is closed to off-road vehicle use, vehicular trespassing and vandalism are evidently frequent (2.11).

In 1971, the National Park Service designated the marsh a National Natural Landmark, and in 1974 the Heritage Conservation and Recreation Service identified it as one of the last natural streams in the Colorado Desert. BLM designated the marsh as an Outstanding Natural Area in 1975, and proposed it as an ACEC in the California Desert Plan (2.1). Its management plan has not yet been completed. Five of the public sections are under water resources withdrawal by the Bureau of Reclamation (2.13).

Future land uses threatening this habitat include agricultural development and its attendant problems of groundwater depletion, pesticide contamination and soil erosion (2.2). Such development could involve use of surface waters on the West Mesa made available by Imperial Irrigation District's conservation program (2.11). Development would mainly involve areas on the south banks of the creek. Nearly all public lands on the north banks have been leased by the BLM for oil, gas, and geothermal development via a noncompetitive bid program (2.11). These leases prohibit surface occupancy, but still threaten this habitat, depending on the degree and type of development that occurs.

2.1.2 Mechanisms of Land Acquisition

Fee Simple Acquisition

The direct purchase of land parcels, or conveyance of title for fee equaling fair market value, offers the simplest and most direct means of acquiring properties for the preservation of wildlife habitat. This has been the preferred method of acquisition of critical habitats and of cultural or historic sites by the U.S. Fish and Wildlife Service and by various other federal agencies. The California Department of Fish and Game has also acquired wetland, waterfowl reserves, and ecological study areas by purchase.

In Imperial County, lands are assessed on the basis of their likely use. Distance from roads, utilities, and potable water supplies are considered in the appraisal, as are geologic features, such as soils and nearness of active faults, and zoning regulations pertaining to the particular parcel. Tax assessments on many parcels have not been updated since 1975. Implementation of Proposition 13 regulations and manpower deficits have led to a policy where parcels are now reappraised only when title is transferred. Other properties are recalculated by adding 2 percent of the assessed value yearly. Land and mineral speculation in some areas, e.g., the West Mesa/San Felipe area, has contributed to suspicion and an unwillingness to cooperate on the part of the Imperial County Assessor's Office, when approached for appraisal information on specific parcels (2.14).

Some USFWS officials are now viewing fee acquisition as an "imperfect tool" in critical habitat preservation because of several common problems. First, high inflation rates dictate constant, expensive updating of land appraisals just to keep them current during acquisition negotiations on a given parcel. Second, landowners are often unwilling to sell desired parcels, or a willing seller's actions may be blocked by local or state governments responding to public antagonism towards increased federal land ownership in the West. Third, funds available for this purpose have dwindled in recent years, and manpower cutbacks have greatly increased the time required to complete a transaction (2.15). There have, however, been several successful fee acquisitions in our study area, including the 1982 purchase of additional lands for the Salton Sea National Wildlife Refuge, providing rail habitat (2.16), and the recent purchase of Oasis Ranch by the CDFG for pupfish habitat (2.11).

Land Exchange

Exchange of equal-valued land parcels to facilitate disposal, or enhance fish and wildlife values, was authorized by Section 206(a) of the Federal Land Policy and Management Act (FLPMA) of 1976 (see Section 2.3). This legislation requires the managing agency (usually BLM) to consider the value of lands on retention and the economic interests of local and state agencies and individuals, along with their land needs for production or development. Organic Act Directive 78-14 gave a step-by-step process for exchange actions and recommended that the feasibility report for a proposed exchange should include (1) a preliminary appraisal, including a review of the standards used and the credentials of the appraiser; (2) a preliminary indication of the public parcels desired by the private landowners and their values; (3) a preliminary opinion as to the acceptability of the private title and of the proponent's ability to convey unencumbered title to the U.S.; and (4) a written land exchange agreement including all lands, interests, terms, and conditions to be conveyed (2.17). A land exchange proposed by the BLM, and involving wetlands, may trigger actions related to one or more of the following laws and regulations: the National Environmental Policy Act, the FLPMA (Sections 201, 210 and 603), the Antiquities Act, Executive Order 11988 (flood-plan management), the Mining and Minerals Policy Act, the Historic Sites Act, the National Historic Preservation Act, the Endangered Species Act, the Sikes Act, Executive Order 11990 (wetland protection), and the Reservoir Salvage Act. Descriptions of these laws, and their relationships to management activities for the pupfish and the Clapper Rail, will be discussed in detail in Section 2.3.

Conservation Easements

Management of endangered and threatened species through obtaining or easements on private lands is a relatively recent concept developed by the resource agencies. Such easements may presumably be either negative (development rights to landowners on public lands) or positive (agency use rights on private lands), and might be secured by fee payment or granting of tax incentives (2.8). Advantages to the agency include securing rights of access and management activities, and prohibition of negative landowner effects, at a lower capital expenditure than that needed for outright purchases. Advantages to the landowner lie in the retention of title, at the cost of (a) land use restrictions and (b) continued property tax payments, and the compensation provided by the easement fee.

Ideally, an easement agreement might include, but not be limited to, the following stipulations: (1) rights of access for inspection and study of the habitat; (2) installation and maintenance of prescribed equipment (e.g., fish barriers, monitoring devices) by the managing agency; (3) prohibition of any modification of existing habitat without prior agency notification and approval (e.g., flow diversion, erosion by anthropogenic causes, vegetation removal, or drilling and pumping of wells within some specified proximity of the habitat which is detrimental to established water levels or flows); (4) the right to install fencing, signs, etc., and patrol the habitat; (5) prohibition of surface occupancy for purposes of mineral exploration or development; (6) regulation of activities that might be detrimental to the species, as determined by the managing agency (2.18).

Easements may have several disadvantages, including the following: (1) easement stipulations by landowners may not consider the best interests of management of the species; (2) certain USFWS needs and rights might be unacceptable to the landowner, which could lead to loss of trust and cooperation over time; (3) the easement fee negotiated might almost equal fair market value for outright purchase, depending on specific conditions; (4) future changes in management needs for the species, which were not originally provided for, might prove unacceptable to the landowner. Provisions for changing needs must somehow be included in either the initial agreement or its renewal clauses (2.18).

2.1.3 Acquisition and Management by Agencies

Federal Agencies

U.S. Fish and Wildlife Service

Acquisition and protection of habitats occurs through three programs: (1) the Endangered Species Program, which lists endangered and threatened species, and identifies and mandates the protection of critical habitats by acquisition and other methods; (2) the Ecological Services Division, which identifies negative impacts of proposed development projects and recommends enhancement and conservation programs, such as acquisition of lands for the National Wildlife Refuge System; (3) the Migratory Bird Program, which identifies waterfowl habitats and ranks them for priority of acquisition via fee title or easements. Funds are provided by the sale of Federal Migratory Bird Hunting and Conservation Stamps, which are required of every hunter. The National Wildlife Refuge System provides, manages, and protects a national network of more than 380 refuges and 100 waterfowl production areas and is the most visible activity of the USFWS (2.19). The 1969 Advisory Committee on Wildlife Management added the goals of maintaining natural ecosystems and identifying and acquiring acreage of threatened and endangered species habitats. Loss of private property is compensated according to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (84 Stat. 1894), which provides for reimbursement of moving expenses and relocation assistance. Compensation to local governments for the loss of property tax revenues is provided for by the Refuge Revenue Sharing Act (49 Stat. 383 as amended; 16 U.S.C. 715s).

Bureau of Land Management

The FLPMA gave BLM its first unified, comprehensive mandate for the retention (and acquisition) of public lands for multiple-use and sustained yield management (including the nondegradation of wildlife values), replacing older policies of development or disposal of "unwanted" public lands (2.20). There are several potential stumbling blocks to this, however: (1) Interior Secretary Watt's Asset Management Program, which proposes to dispose of 35 million acres of "surplus" western public lands to help offset the federal budget deficit. At present, details of which properties are involved are uncertain even among agency personnel (2.21). (2) FLPMA does authorize land purchases using Land and Water Conservation Fund Act monies (16 U.S.C. 4601-4 to 4601-11), but only for lands "primarily of value for outdoor recreational purposes" (2.8). Proposals for areas larger than 640 acres must also be accompanied by appropriate, comprehensive land use plans consistent with state and local plans and zoning regulations [Recreation and Public Purposes Act of 1926, U.S. Statute at Large, Volume 44, p. 741 (44 Stat. 741)], as amended by FLPMA, Section 212). Funding for such acquisitions is extremely limited. (3) Purchases of private lands for their biological values are provided for under FLPMA, but only BLM appropriations can be used for this purpose, and this source is even more limited than the Land and Water Conservation Fund (2.8). (4) Acquisition by eminent domain is avoided by BLM unless it is clearly the only alternative. For these reasons, current bureau policy is that land acquisitions in the near term will occur mainly through tax delinquencies or exchanges (2.20).

Currently, legal and regulatory restrictions make land exchanges time-consuming and expensive, and the BLM does not entertain proposals unless a compelling argument can be made that (1) acquiring the particular non-federal tracts will augment a long-range federal resource management program, and (2) the resource values of the lands to be lost, and the ability of BLM to effect the proposed exchange, have been fully considered (2.22).

Bureau of Reclamation

Under the Reclamation Act of 1902 (32 Stat. 388), many federal lands in the study area were withdrawn by USBR in 1920 under a "first form withdrawal order," which was originally intended to reserve public lands for the construction and operation of irrigation works. In the present case, this was part of federal involvement in the development of irrigated agriculture in the Imperial Valley (2.23). Currently, these lands are managed jointly by BLM and USBR under the Supplemental Land and Resource Management Agreement Act of 1978 (see Section 2.1.4). There are no known USBR programs for further acquisitions in this region; however, the presence of these withdrawals severely restricts acquisition of habitats by other agencies, as at San Felipe Creek (Section 2.1.4). The act provides for periodic withdrawal reviews, one of which is in progress for San Felipe Creek lands (2.2).

Heritage Conservation and Recreation Service

This is the principal federal agency for planning, evaluating and coordinating programs which preserve American cultural and natural heritage values, primarily through the National Natural Landmark Program (2.24). "Significant" natural areas are identified and managed through this program. National Natural Landmarks can also be designated by the National Park Service, as San Sebastian Marsh was in 1974 (2.2)

State Agencies

California Department of Fish and Game

CDFG acquires wildlife habitats primarily by fee purchase, in one of two ways: (1) Ecological Reserves, authorized by Article 4, Chapter 5, Sections 1580-1584 of the California Fish and Game Code (Stat. 1968, Chapter 1257). They are protected exclusively for their wildlife values. Funds come from the Park Bond Fund Acts of 1974 and 1976 (not renewed since 1980); the Environmental Protection Program Act (1970), supported by sales of personalized license plates; legislative allocations from the state General Fund (yearl since 1974); and other sources such as the settlement from an oil spill whic funded the Newport Bay Ecological Reserve (2.8). (2) Wildlife (or waterfowl) areas, authorized by Title 14, Section 550 of the CDFG Code and established by the Wildlife Conservation Board. Land acquisition funds come from several sources: The Imperial Wildlife Area, for example, was originally obtained through the Pitman-Robertson Fund, which provides acquisition monies from state tax revenues from pari-mutuel racing. Additional lands were recently purchased for the area using USBR wildlife mitigation funds given to CDFG for lining sections of the Coachella Canal (2.25). Operation and maintenance is funded by state excise taxes on sporting arms and ammunition and by the sale of hunting licenses and game tags (2.26). Acquisitions are generally limited by the unavailability of these funds due to budget cutbacks.

California Department of Parks and Recreation

This agency actively pursues acquisition of lands for the State Park System. However, their priorities are directed to lands having high cultural or visual values or recreational uses, rather than species preservation (2.8).

University of California Natural Land and Water Reserves System

The Land and Water Reserves System was established in 1965 to protect native habitats for university studies. It now has 26 such sites statewide, including the Fish Slough Ecological Reserve in Mono County, acquired specifically to protect the endangered Owens pupfish (see Sections 2.1.4, and 4.2.2). Limited funding precludes extensive land purchase by this system (2.8).

<u>Private Agencies</u>

Several private organizations acquire lands to preserve endangered species and habitats. The Nature Conservancy, established in 1951, is a national, nonprofit group dedicated to protecting native ecosystems. They have acquired one million acres of habitats at 30 sites in California alone (2.27). They also collect information on established scientific reserves for a proposed national data bank on natural ecological areas (2.28) and acquire threatened species' habitats to hold until the managing agency is able to purchase and manage the area as in the case of the San Bernardino Ranch National Fish Refuge in Arizona (2.29).

Other organizations include the Audubon Society, which acquires threatened habitats such as the Little Butte Falcon Eyrie and the Trust for Public Lands, a nonprofit charitable conservation group specializing in pre-acquisition of lands for future purchase by the lead agency for recovery of the threatened species. All of these groups can provide experience and expertise in real estate assessment and negotiation which can be invaluable in the acquisition of habitat to recover endangered species (2.30).

2.1.4 Cooperative Agreements

There are numerous legislative provisions for establishing cooperative agreements among agencies for purposes of protecting and managing endangered and threatened wildlife species and habitats (see Section 2.3). However, mandates providing strictly for cooperative multiagency land acquisition are rather limited. Section 1601.4 of the Federal Land Policy and Management Act does so indirectly, by requiring cooperation between federal and local agencies, organizations, and developers in implementing the regulations of the act generally. Other sections of the act specifically provide for the acquisition and retention of lands to protect their fish and wildlife values. Section 103(a), which defines and regulates ACEC's, includes provisions for cooperative agreements for the exchange and acquisition of private lands, and requires BLM consultation with the landowners when preparing or implementing ACEC management plans (2.31, 2.32).

The Supplemented Land and Resource Management Agreement Act of 1978 provides for joint administration by BLM and USBR of those public lands bearing a water resources withdrawal. It requires USBR approval of any BLM management decisions, and makes withdrawn lands unavailable for exchange without prior revocation of the withdrawal (2.2). The Secretary of the Interior is prohibited from revoking congressional withdrawals.

The Fish Slough Native Fish Sanctuary near Bishop, California, provides an example of a major recovery effort (for the endangered Owens pupfish) which involved cooperative action between the California Department of Fish and Game, the Los Angeles Department of Water and Power, and the University of California Natural Land and Water Reserves System. They cooperated in effecting a land exchange with reluctant landowners, in drafting and influencing passage of the congressional bill needed to modify a USBR water resources withdrawal on the parcels, and in obtaining other permits necessary for establishment of the refuge (2.33, 2.34).

Such cooperative agreements, between private parties or utilities and the federal and state agencies responsible for managing the desert pupfish and the Yuma Clapper Rail, might add significantly to the speed and effectiveness of the recovery efforts. Cooperation and assistance in habitat acquisition wi depend upon the particular areas chosen for acquisition and the acquisition method. Funds for land purchase could be provided to the managing agency. Alternatively, parcels could be purchased directly and donated (or leased at little or no charge) to the managing agency. This might conceivably create tax incentives and other related benefits for the donor.

Where a land exchange may be involved, as at San Felipe Creek, assistance could take the form of providing appraisal services or negotiators to the agency in the initial stages, by subsidizing other transaction costs, and by providing funds for transfer payments to landowners or to the agency itself. Most such exchanges are intended to involve equal-value parcels, as explained previously; however, a situation might arise where the only exchange acceptable to both parties is one in which the desired parcels have unequal fair market values. In this instance, a transfer payment to the party providing the lesser valued parcel could equalize these difference and allow an otherwise unacceptable exchange to take place.

Where a conservation easement is to be negotiated, appraisal and negotiation services could be donated as above, and funds could be provided in the amount of the easement fee or a portion thereof. A long-term agreement might involve donation of the annual fees, or assistance in any future renegotiations of the easement contract, which might be required by changing conditions.

In cases where the direct involvement of the donor or cooperating party might be controversial or otherwise unacceptable, or where direct land purchases by the party might cause inappropriate speculation and artificial inflation of local real estate values, these operations could be conducted through a neutral third party, such as the Nature Conservancy or other conservation organizations experienced in acquisition of wildlife habitats. Any of these strategies would be of invaluable assistance to the agencies responsible for recovering the pupfish and the rail, and an aggressive, cooperative role assisting agency acquisition of critical habitats is strongly recommended.

2.2 Water Resource Issues

Water, a precious commodity in the region around the Salton Sea, is an essential requirement for both rail and pupfish habitat. The availability of the water resources for habitat enhancement must be determined for all four regions considered in this report: Imperial Valley, Coachella Valley, Salt Creek, and San Felipe Creek. Currently three water sources exist: surface water imported from the Colorado River (taken directly from the distribution canals or indirectly from irrigation runoff), surface water from local precipitation and runoff, and groundwater. Potential sources include desalination of Salton Sea water or brackish groundwater and State Water Project (SWP) water.

2.2.1 Colorado River Surface Water

Colorado River water enters the Imperial and Coachella Valleys by way of the All American Canal and the Colorado River Aqueduct. The Imperial Irrigation District, the entity that manages water distribution in Imperial Valley, owns a network of canals linked to the Colorado River by the All American Canal. The entire system operates by gravity flow. The Coachella Valley County Water District (CVCWD) distributes Colorado River water by means of the Coachella Canal and the Colorado River Aqueduct. Water delivery from the Colorado River Aqueduct is made possible by an exchange agreement between CVCWD and the Metropolitan Water District (MWD) involving Colorado River water and State Water Project water (2.35).

Currently, lower Colorado River water is controlled for use in southern California through several contracts and court cases, including the Colorado River Compact (42 Stat. 171, 1922), the Boulder Canyon Project Act (45 Stat. 1057, 1928), a series of Arizona v. California Supreme Court decisions, and the 1931 Seven Party Water Agreement. The Colorado River Compact allocated 7.5 million acre-feet/year (MAF/yr) to the lower Colorado basin states (California, Arizona, and Nevada) for consumptive use. The Boulder Canyon Act restricted California's allocation to 4.4 MAF/yr. Arizona v. California (376 U.S. 340) upheld this decision and granted California entitlement to 50 percent of any surplus water over 7.5 MAF/yr. The Supreme Court decrees of 1964 and 1979 (Arizona v. California) guaranteed rights to five lower Colorado Indian reservations in California, Arizona, and Nevada. See Colorado River Board (2.36) for more information on these legal documents.

The Seven Party agreement was entered into by California entities using Colorado River water in response to a request by the Secretary of the Interior for a priority agreement in California (2.37). Table 2-1 lists the priorities

Table 2-1

Distribution of Water by Seven Party Water Agreement

Priority Number	Agency and Description of Service Area	Consumption AF/yr
1	Palo Verde Irrigation District - 104,500 acres*	
2	Yuma Project, California Portion - 25,000 acres*	
3(a)	Imperial Irrigation District and adjacent areas serviced by All-American Canal in Imperial and Coachella Valleys	
3(b)	Palo Verde Irrigation District - 16,000 acres*	
	Total for categories 1,2, and 3	3,850,000
4	Metropolitan Water District, City of Los Angeles and others on the coastal plain	550,000
	Total for categories 1, 2, 3 and 4	4,400,000
5(a)	Metropolitan Water District, City of Los Angeles and others on the coastal plain	550,000
5(b)	City and County of San Diego	112,000
6(a)	Imperial Irrigation District and adjacent areas serviced by All-American Canal in Imperial and Coachella Valleys	300,000
6(b)	Palo Verde Irrigation District - 16,000 acres*	
	Total Water Distributed	5,362,000

*Palo Verde and Yuma Project were guaranteed water for an amount of acreage to be irrigated rather than a quantity of water.

(Ref. 2.36)

established in the agreement. As is obvious from the total volume of water distributed, 0.962 MAF more than the 4.4 MAF/yr guaranteed to California was allocated. The assumption of surplus water availability has been possible because Arizona has not, thus far, requested its full entitlement of 2.8 MAF/yr, a situation that will change after completion of the Central Arizona Project. The limitation to 4.4 MAF/yr will have an effect on some of the parties of the Seven Party Agreement. Palo Verde is essentially fully developed at 91,000 acres adjoining the district and 5,000 acres on the mesa; this land is irrigated with 0.4 to 0.45 MAF/yr. The Yuma Project irrigates 14,000 acres with 0.095 MAF and about 5,000 more can be irrigated (2.38). IID, the third priority, has a present perfected right of 2.6 MAF/yr, 0.15 less than the 2.75 MAF/yr currently diverted into its canal system (2.37, 2.39). IID could expand the acreage irrigated from the current 490,000 acres to 590,000 acres if water was available (2.39). CVCWD is currently using about 0.55 MAF/yr to irrigate about 60,000 acres (2.40). The amount of irrigated acreage could be doubled to 120,000 acres if water was available. Table 2-2 lists current consumptive use of the members of the Seven Party Agreement. The first three priorities are currently consuming their allocation of 3.85 MAF/yr and, as long as the current level of consumption is maintained or reduced, little change is foreseen for these priorities.

The major reduction will occur with the MWD share. MWD's consumption was 0.838 MAF in the 1980-1981 fiscal year (2.35). To meet the 4.4 MAF/yr requirement MWD will have to reduce its withdrawal to 0.55 MAF/yr. If the case representing Indian rights to be presented before the Supreme Court in December 1982 is determined in the Indians' favor, another 0.087 MAF/yr will be removed from MWD's share (2.38).

The effect of the Central Arizona Project on water availability in the Imperial and Coachella Valleys appears to be minimal, since the loss will fall mostly on MWD. It can therefore be assumed that surface water availability for habitat enhancement can be determined from current availability through IID and CVCWD.

IID covers an area of 1,062,900 acres, of which 460,000 acres are devoted to irrigated agriculture (2.37). About 100,000 acres, mostly in the West Mesa region, could be farmed, if water was available and the distribution system extended (2.39). The IID distribution system includes both canals for water distribution and drainage ditches for collection of irrigation return flows (tailwater and tile drain flows). Three main canals (East Highline, West Main, and Central Main) transport the water from the All American canal, and many lateral canals emerge from the main canals. Ninety percent of the irrigated acreage is drained by the New and Alamo Rivers, while ten percent drains directly into the Salton Sea (2.41). The water entering the Salton Sea from the New and Alamo Rivers has a TDS concentration of between 3,200 and 3,600 mg/l (2.37). Such concentrations do not appear to inhibit marshland formation since marshland occurs naturally along the New and Alamo Rivers and at the terminus of drainage ditches.

Drainwater diversion for marshland habitat enhancement is currently occurring in Imperial Valley. IID permits both the Imperial Wildlife Area and the Salton Sea National Wildlife Area to divert drainage water into holding ponds and will even construct a diversion channel for that purpose (2.25).

Table 2-2

Current Water Use by Members of Seven Party Water Agreement

Agency	Consumptive Use AF/yr
Palo Verde	450,000
Yuma Project	95,000
Imperial County Water District	2,750,000
Coachella County Water District	550,000
Subtotal	3,845,000
Metropolitan Water District	838,000
Total	4,683,000

(Ref. 2.35, 2.38, 2.39)

The availability of drainage water may change in the future as the conservation practices of IID are implemented. These include lining of the canals, construction of reservoirs, and financial penalties for excess tailwater (2.37). IID is lining its system continuously at a rate of about 30 miles/year with an expectation of completion within 15 to 20 years (2.39). Three reservoirs have been constructed at the midpoint of each of the main canals. A fourth reservoir is currently under construction and two more are planned (2.37). These conservation practices should decrease drainage water. With less drainage water available for habitat, fresh water from canals might become necessary. It remains to be seen how receptive IID will be to providing significant quantities of fresh water for use in habitat enhancement. One incentive to protect marshland is that waterfowl are attracted away from the crops to the marshland. The IWA is already purchasing water from IID, since the volume of drainage water is inadequate for current operations; the cost projection for next year is $100,000 (2.25). Therefore, a precedent exists for purchase of water. Members of the irrigation district pay two fees: $1.90/acre/year and $7.50/AF ordered. Negotiations are in progress to raise the charge per acre-foot to $8.50 (2.39).

The Coachella Valley County Water District manages the Coachella Canal and a distribution network in order to serve the lower Coachella Valley, where 80 percent of the agriculture in the valley occurs. Groundwater represents 90-95 percent of the water source in the upper Coachella Valley; runoff or stream-flow diversion and treated waste water provide the remainder (2.42). In order to maintain an adequate water table, local water and water from the Colorado River Aqueduct are applied to spreading fields to recharge the basin. Colorado River Aqueduct water is made available to Coachella Valley through an exchange agreement with MWD (2.35). CVCWD has an entitlement to State Water Project water but distribution facilities have not been constructed for the Coachella Valley. In order to receive some state water, CVCWD exchanges with MWD an equivalent amount of State Water Project water for Colorado River Aqueduct water.

The lower Coachella Valley water supply is the most crucial for habitat enhancement around the Salton Sea. Currently, drainage water provides several locations for habitat. The Whitewater River (known as the Coachella Valley Stormwater Channel) is the principal surface water channel in the Coachella Valley. About 60 percent of the drainage water from the valley is discharged by the Whitewater River (2.41). Near the Salton Sea the river is perennial because of irrigation return flows which ensure the existence of Whitewater Marsh (2.43). The remaining drainage water from Coachella enters the sea by way of irrigation ditches. Habitat for both the rail and pupfish is present at the ends of the ditches. No agreements exist with CVCWD for use of excess drain water or fresh canal water for habitat enhancement.

The CVCWD water distribution system, having been constructed later than that of IID, is more modern. A significant portion of the system is already enclosed and lined. Lining of a 50-mile stretch from the All American Canal to Niland was completed in 1980, decreasing seepage from the canal by 132,000 AF/yr (2.40). If the entire canal is lined, perennial streams such as Salt Creek, where suitable habitat exists, will probably disappear, since seepage from the canal is the most likely reason for the existence of the perennial creek. Lining of the remainder of the canal will probably occur because only about half of the arable acreage in the lower Coachella Valley is irrigated, and conservation practices could make extension of the system possible (2.40). Under these circumstances, excess canal water will be difficult to obtain leaving irrigation return flows as the only likely source of surface water in the Coachella Valley. Fresh water, if available, would have to be purchased.

Surface water in the San Sebastian Marsh region of San Felipe Creek flows both from groundwater and from precipitation and runoff. Imported water from the Colorado River is not available. Imported water does contribute to flow in the lower stretches of the creek, where irrigated agricultural land is present. IID's distribution system extends to lower San Felipe Creek through the Trifolium Extension (2.37).

As was mentioned above, at its lower stretches Salt Creek is a perennial, effluent stream because of seepage from the Coachella Canal. If the canal is completely lined, the surface flow will decrease and the creek will become ephemeral again. In order to maintain habitat for the pupfish and/or rail, water will have to be intentionally diverted from the Coachella Canal, either directly through diversion canals or indirectly by spreading over fields for groundwater recharge.

Surface water imported from the Colorado River is physically available for habitat along Salt Creek and in the Imperial and Coachella Valleys, but not along San Felipe Creek at San Sebastion Marsh. If the IID distribution system is extended, San Sebastian could be served, though this is unlikely since pumping would be required. Other than in the San Sebastian Marsh region, restrictions on surface water availability will therefore be institutional rather than physical, and institutional constraints are potentially very significant. The irrigation districts import Colorado River water through the distribution systems and are required to provide water to member landowners if the water is to be used for agricultural purposes. For any other use the board votes on whether or not to sell the water (2.39). A precedent exists in Imperial Valley, but not Coachella Valley, for sale of canal water for the purpose of habitat enhancement. If excess drainage water is unavailable, sufficient surface water may be difficult to obtain.

2.2.2 Precipitation and Runoff

Direct precipitation and runoff from local rainfall are not major sources of water for habitat use around the Salton Sea because most of the streams are ephemeral. Naturally derived surface water cannot, therefore, be depended upon to provide water for year-round habitat management (2.44, 2.45). The average rainfall in Imperial Valley (El Centro) and Coachella Valley (Indio) is 3.2 inches (81 mm) and 3.6 inches (91 mm), respectively (2.45). At Harpers Well near San Felipe Creek the average annual rainfall is 2.5 inches (64 mm) (2.2). Average, maximum and minimum flow values of the major streams in the region are listed in Table 2-3.

Local and regional precipitation patterns do have an effect on habitat management and must be considered, especially when calculating operation and maintenance costs. Occasional extreme flooding, and the associated erosion and redeposition, can have a significant effect on habitat management by causing destruction of man-made structures such as dikes or stream barriers.

Table 2-3

Water Discharge Records

River	Gauge Location	Years of Record	Minimum (cfs)	Average (cfs) AF/yr	Maximum (cfs)
Alamo[a]	near Niland	38	288	ng 635,000 AF/yr[b]	4,500
New[a]	near Westmorland	38	293	ng 458,000 AF/yr[b]	3,000
Whitewater[a]	near Mecca	31	37	ng 95,000 AF/yr[b]	2,500
Salt Creek	near Mecca	19	.06	6.87 4,980 AF/yr[c]	9,900
San Felipe	near Westmorland	19	0	7.57 5,480 AF/yr[c]	100,000

ng: not given
a: Discharge is mainly from seepage and return flow from irrigated areas
b: Discharge in acre feet per year for 1979
c: Average discharge in acre feet over the period of record

(Ref. 2.43)

95,000 AF/yr ≃ 260 af/day ~ 130 cfs

San Felipe Creek and Salt Creek are particularly affected by flooding, as evidenced by the maximum flow values in Table 2-3 compared to the average value. In the 19-year record at the gauge on San Felipe Creek near Westmorland, the maximum flow was 100,000 cfs (2.43), and in general the flow exceeded 1,000 cfs more than 17 times. At that gauge, flow is usually between 0.0 to 0.3 cfs (2.2). In Salt Creek the maximum flow in the 19-year period was 9,900 cfs, with an average of 6.87 cfs. Whitewater, New, and Alamo Rivers also have flooding problems occasionally, but due to the large flood plains, energy is dissipated more rapidly; therefore, less destruction will occur in the areas considered for habitat.

2.2.3 Groundwater

Groundwater basins underlie the areas surrounding the Salton Sea being considered for habitat enhancement. Table 2-4 lists the name, size, capacity and stream that drains the largest and most important basins (2.46).

Imperial Valley Basin contains a significant quantity of groundwater (2.44). Three groundwater regions exist at three depths in the basin: (1) a shallow unconfined perched aquifer 6 to 40 feet below ground surface, (2) an intermediate depth aquifer, and (3) geothermal waters which vary in depth from 3,500 to 5,000 feet (2.37). Salinity levels range from 2,500 to 4,500 mg/l in the shallow aquifer. Extraction of groundwater from shallow wells is difficult because the aquifer consists of lake deposits of relatively low permeabillity. The intermediate aquifer, with TDS values of 700-5,700 mg/l, has low vertical permeability. Artesian wells occur east of the Alamo River and may contain high concentrations of boron, fluoride and chloride. The salinity levels of the geothermal waters vary from 2,500 near Heber to 250,000 mg/l near the Salton Sea (2.37). Wells adjacent to the main canals are more likel to contain water with low TDS, but that will probably change as the canals are lined. Because of the poor quality groundwater and the soils of low permeability in the valley, particularly in the central and eastern regions, overdrafting has not occurred. This is fortunate since the subsidence that can result from overdrafting would adversely affect the gravity flow distribution system of IID. Local subsidence areas would produce local sinks. This has been documented as a concern with geothermal energy activity in the area (2.7) and would most likely also be of concern with groundwater withdrawal for habitat enhancement.

The Ocotillo Valley basin is located southwest of the Salton Sea. Since groundwater is the only continuous water source in the region, an understanding of the basin characteristics becomes essential. San Felipe Creek and its tributaries, Fish Creek Wash and Carrizo Wash, drain the basin. San Sebastian Marsh, at the confluence of these streams, contains the only section of San Felipe Creek, above the irrigated land near the Salton Sea, that is perennial. Precipitation, which increases surface flow and infiltration to groundwater storage, is the major source of inflow; most of the outflow is due to evapotranspiration. Information about this basin is limited. Little well information exists, groundwater movement is not well understood, and the depth base and number of aquifers under the marsh are not known at this time (2.47). It is believed that the aquifers under San Sebastian Marsh are recharged in Lower Borrego Valley, west of the marsh, where coarser material is present. All well data in the region show that a surface layer (an unconfin aquifer) of about 180 feet in depth overlies a clay layer of 200-300 feet tha

Table 2-4

Groundwater Basins

Name	Size (sq mile)	Storage Capacity MAF	Usable Capacity	Drained by
Coachella Valley	690	39	3.6	Whitewater River
Ocotillo Valley	410	5.8	1.9	San Felipe Creek
Imperial Valley	1,870	14	unknown	New and Alamo Rivers
Chocolate Valley	120	1	unknown	Salt Creek
East Salton Sea	150	.36	unknown	Salt Creek

(Ref. 2.46)

acts as a confining layer. Several additional layers of sand and clay occur at lower depths, which suggests that several aquifers may be present (2.47). The reason for perennial flow through San Sebastian Marsh is as yet unexplained. Distinct surface springs, which should occur if the water originates from the semi-perched aquifer, are not apparent, so it has been hypothesized that the perennial water could be due to faulting through the top clay layer. Water from the lower confined aquifer moves upwards and mixes with the upper aquifer, leading to a gradual, diffuse appearance of water, rather than a distinct spring (2.47).

San Sebastian Marsh is dependent on groundwater for its existence. Currently enough water is available to provide habitat for the desert pupfish. Pumping of groundwater that exceeds the natural recharge of about 20,000 AF/yr could jeopardize that supply (2.47). The water table has apparently dropped 2 to 12 feet in the past few years. Two possible explanations for the drop are groundwater pumping and increased phreatophyte growth in the region (2.2).

The Coachella Valley basin is divided by faulting into four subbasins: Desert Hot Springs, Mission Creek, Garnet Hill, and Indio (2.48). Indio, the largest subbasin, is adjacent to the Salton Sea. In the upper Coachella Valley, groundwater is the major water source and water levels are declining (2.37). In the lower valley, where the groundwater system is characteristically confined or partly confined with numerous zones of perched groundwater, the Colorado River water used for irrigation provides the major source of water; water levels have been rising since 1949, when the Coachella Canal was completed (2.37). The semi-perched groundwater body (recharged by Colorado River water) under the lower valley is of relatively poor quality (2.37, 2.48). Recharge of the deeper aquifers is mostly from stream flow, and takes place largely in the upper valley. Except for the semi-perched aquifer, water quality is generally good. The semi-perched aquifer has a high fluoride content (2.48).

The subsurface flow of groundwater through Coachella Valley results from natural and artificial recharge in the upper valley and from irrigation recharge. Irrigation return must recharge the lower aquifer to a certain extent because mineralization is higher near the Salton Sea (2.48). The outflow into the Salton Sea of approximately 30,000 AF/yr from Indio subbasin prevents spreading of irrigation return water through the main groundwater zones (2.41, 2.3). Continued overdraft in the upper valley will cause water levels to drop, which may result in a decrease or cessation of subsurface flow into the Salton Sea and an increase of poor quality irrigation water into the main aquifers.

Little information is published about the Chocolate Valley groundwater basin, which is drained by Salt Creek. Well yields are unknown, the depth zone is 20-220 feet, and the storage capacity is 1 million acre-feet. Natural recharge is estimated at about 200 AF/yr, and the water quality is poor for domestic and irrigation use (2.46). Groundwater pumping is not recommended because of the low natural recharge.

In summary, physical constraints to withdrawal of groundwater for habitat enhancement exist in Salt Creek and San Felipe Creek. Pumping is not recommended in either area, although limited withdrawal could occur in San Felipe

Creek with enforcement of withdrawal restrictions upstream and control of phreatophyte growth. Both Imperial and Coachella Valleys represent regions of significant quantities of groundwater and substantial recharge from percolation of irrigation water. No legal restrictions prohibit extraction of the groundwater, but three potential problems could impede the use of groundwater in these areas: (1) poor water quality, (2) difficulty in extraction of water because of soils of low permeability, and (3) subsidence potential. The groundwater is generally very brackish. Marshland can tolerate fairly high salinity levels, so this may not be a serious problem. For high concentrations, treatment is recommended. The soils around the Salton Sea are of low permeability, particularly close to the sea and south of the Alamo River. North of the Alamo River artesian wells are present. Thus groundwater withdrawal is possible near IWA-Wister but is probably not an alternative near SSNWR. The problem of subsidence relates to impacts on the gravity flow distribution system of the irrigation districts when withdrawal exceeds recharge. If subsidence is not likely to occur, groundwater withdrawal is acceptable.

2.2.4 Other Potential Sources

In 1960, Coachella Valley contracted for a total State Water Project entitlement of 23,100 AF/yr, the total sum to be received by 1990. Extension of the California Aqueduct, which would make it possible for Coachella to receive the entitlement, has been considered for several years (2.49). Two routes have been proposed, but the contracting agencies involved have not made a choice. The construction of the extension would be very expensive and would probably not be undertaken by agencies such as CVCWD or the Desert Water Agency (which serves Palm Springs). If the extension is constructed, more recharge to the groundwater basin will occur, which should provide for continued flow into the Salton Sea and should guarantee some water for marshland habitat.

2.2.5 Conclusions

Currently water is available from some source in most regions around the Salton Sea. Which source should be tapped for habitat enhancement depends on the specific area of interest. In the regions near the Whitewater, New and Alamo Rivers and at the mouth of San Felipe Creek, the recommended sources, in order of priority, are drainage water, fresh water from distribution canals, and groundwater. Drainage water ranks first because it is the easiest to obtain and is already being used at the southern end of the sea for habitat enhancement. Drainage water will be available as long as water is available for irrigation; however, the quantity may decrease as more conservation practices are implemented. Fresh water from the canals, provided by the irrigation districts, will be more difficult to obtain. In-stream uses of water, of which this is an example, have a lower priority than agricultural use. Obtaining significant quantities of canal water may, therefore, involve a certain amount of negotiation for water purchase. As previously explained, groundwater can be both difficult to extract and of poor quality around the Salton Sea, making it less desirable than surface water. The expense of digging a well and the need to pump water in areas where artesian flow is not available also cause groundwater to be designated as the third priority.

In the Salt Creek region, if the available water for habitat is to be augmented, the only feasible water source is surface water purchased from the CVCWD. The low rate of groundwater recharge prohibits groundwater extraction and irrigation drainage ditches are not present. Providing significant quantities of water from the canal to Salt Creek would require construction of a diversion canal, an expensive venture.

The only continuous water source in San Felipe Creek near San Sebastian Marsh is groundwater. Since groundwater sustains the flow through San Sebastian Marsh, withdrawal must be controlled to prohibit overdraft. Protection of the current water supply to San Sebastian Marsh should take priority over any activity that may be water consumptive.

2.3 Regulatory Framework for Species Management

2.3.1 Introduction

Any actions taken to recover an endangered or threatened wildlife species will automatically trigger a host of federal, state, and local regulations and laws. Anticipating which legislation will be involved with a particular management action and complying with its mandates are essential for the proposed actions to be effective. Thus the effectiveness of the actions will depend on which actions are chosen, where they are taken (whether on public lands, private lands, ACEC's, critical habitat areas, wildlife refuges, etc.), which agency or agencies have primary responsibility for species recovery, and the status of the species (endangered, threatened, rare, sensitive or proposed for listing). The following section describes the federal, state and local mandates most likely to be involved with the mitigation and recovery efforts for the desert pupfish and Yuma Clapper Rail suggested in this study. Perspectives of the managing agencies regarding management of these two species will then be outlined, followed by a legal and workable framework for cooperative recovery planning.

2.3.2 Pertinent Legislation

Federal Legislation

The Endangered Species Act of 1973, PL93-205, 87 Stat. 884; Title 16, U.S. Code, Section 1531 (16 U.S.C. 1531) made the preservation of endangered species and their habitats an official policy of all federal agencies. It prohibits anyone from taking, importing or exporting, shipping, or selling such species, Title 50, Code of Federal Regulations, Part 17.21 (50 CFR 17.21), except as allowed by permit for scientific purposes or "to enhance propagation or survival of the species" (50 CFR 17.22). USFWS proposes species for endangered listing for the following reasons (50 CFR 424.11):

1. Present or threatened destruction, modification, or curtailment of its habitat or range

2. Overutilization for commercial, sporting, scientific, or educational purposes

3. Disease or predation

4. The inadequacy of existing regulatory mechanisms

5. Other natural or man-made factors affecting its continued survival

There are provisions for identifying the critical habitats of species, defined as those areas having physical or biotic features (1) essential to species conservation and (2) requiring particular protection or management efforts (50 CFR 424.12; 45 Federal Register 13010-13026). Certain areas may be excluded from this designation by the Secretaries of Interior or Commerce, however, if they decide the economic costs of such a designation are too high (2.50). The act mandates the prompt development and implementation of a recovery plan for each species designated as endangered. Only federal activities and programs are affected by the act under Section 7, which requires USFWS consultation for all proposed federal actions affecting listed species. Private actions on non-federal lands are not specifically restricted by the act unless direct harm to the listed wildlife would result. Also, designation of private or state lands as "critical habitat" does not close them to human activity or make the area a "wilderness sanctuary" (2.50). USFWS is required to consider economic and other impacts of each critical habitat proposal as well (50 CFR 424.17(b)(5).

The National Environmental Policy Act (NEPA) of 1969 (PL91-190, 83 Stat. 852, 42 U.S.C. 4321) requires that the possible environmental impacts of any federal action be evaluated, with consideration given to alternative actions and mitigating measures. The implementing regulations (Section 1501) prescribe procedures for public hearings and for preparation of a full Environmental Impact Statement (EIS) if one is found necessary.

The Federal Land Policy and Management Act of 1976 (PL 94-579, 90 Stat. 2743,43 U.S.C. 1701) legislates the broadest authority regarding federal land uses. FLPMA policies relative to the acquisition or disposal of habitat lands have been mentioned previously (Section 2.1). Section 302(b) of the act allows the Secretary of the Interior to regulate all private use and development on public tracts (presumably including wildlife enhancement measures, although there are no precedents testing this use) through permits, leases, easements, etc. Uses in certain areas, such as ACEC's, are strictly regulated by BLM (Section 2.3.3). Management of multiple-use Class "C" areas is consistent with their "preliminary wilderness" designation (2.1), which by definition includes "roadless islands of public lands identified to have wilderness characteristics" (2.51). Some of the restrictions pertinent to our study areas are as follows: (1) FLPMA recognizes certain existing uses and rights - FLPMA, Sec. 701(h), including non-impairment of leases for oil, gas, geothermal and minerals, provided they meet the "grandfather clause" criteria of active use on the date of FLPMA's enactment - FLPMA Sec. 603(c). (2) Vegetation manipulation is prohibited. (3) Watershed manipulations must not impair an area's wilderness suitability. (4) Vehicle use, road establishment and other surface-disturbing activites are prohibited or severely restricted in such areas - FLPMA, Sec. 603(a). (5) Utility corridor rights-of-way must be routed for minimal environmental damage (FLPMA, Secs. 501-505). Other restrictions are included in various sections of the act.

The Geothermal Steam Act of 1920 (30 U.S.C. 1001-1025) requires that USFWS recommend lands to be excluded from geothermal leasing due to the presence of hatcheries, wildlife refuges or management areas, or lands acquired specifically for endangered species protection.

Several sites considered in this report, Salt Creek, San Felipe Creek, and the Whitewater River, contain significant cultural and Native American resources. These are protected by several federal mandates: (1) the Antiquities Act of 1906 (PL 59-209, 34 Stat. 225, 16 U.S.C. 432-433), which prohibits "appropriating, excavating, improving or destroying any historic or prehistoric ruin or monument or object of antiquity" without permission of the Secretary of the Interior, and requires a thorough site survey of these resources prior to any planned public land transfer action; (2) the Historic Sites Act of 1935 (PL 74-292, 49 Stat. 666, 16 U.S.C. 461 et seq.), which denies transfer and mandates preservation of any sites, buildings, structures, or objects of significance to American history (which might presumably include, for example, Harpers Well, the Anza trail, or the San Sebastian townsite near San Felipe Creek); (3) the National Historic Preservation Act of 1966 (PL 89-665, 80 Stat. 915, 14 U.S.C. 470), the Archaeological Resources Protection Act of 1979 (PL 96-95), and Executive Order 11593 (Archaeologic, Historic, and Scientific Resources), all of which empower federal agencies to preserve archaeological, historic, and scientific resources by methods including land acquisition, matching grants, and penalties for violators.

In California, virtually no desert wetlands are legally protected outside of the Salton Sea National Wildlife Refuge (2.8). Management activities in aquatic habitats, required for both the pupfish and the Clapper Rail, will require compliance with other legislation specific to wetland areas. The Federal Water Pollution Control Act (FWPCA) of 1972 (PL92-500, 33 U.S.C. 1251 et seq.), as amended, mandates the protection and nondegradation of natural waters via federal agency involvement in the development and implementation of water quality plans (FWPCA Sec 208). The Environmental Protection Agency (EPA) is responsible for administering the discharge permit program, including all discharges within wetlands (40 CFR 122, FWPCA Secs. 402, 404). USFWS is responsible for preparing a National Wetlands Inventory, and for commenting on any proposed state permits and programs for control of discharges in wetlands, including dredged and fill materials (2.52).

The Watershed Protection and Flood Prevention Act (16 U.S.C. 1001-1009) allows, but does not require, the Secretary of the Interior to make recommendations on conservation of wildlife resources in small watershed projects. Executive Order 11988 (Floodplain Management) of 1977 requires federal agencies to minimize flood hazards, and to restore and preserve floodplains involved in land transfer actions. These actions must have prior public participation and strict limitations on the proposed uses of wetlands to be transferred. Executive Order 11990 requires the consideration of fish and wildlife habitats and the water quality values of a wetland for which any development action is being proposed. Further guidelines are provided by the BLM (2.51).

Any dam construction must comply with features of the Reservoir Salvage Act of 1960 (PL 86-523, 74 Stat. 220-221, 16 U.S.C. 469), which protects any historical or archaeological data that would be lost because of the project. It is unclear whether small features, such as spillway-type fish barriers or dike structures for waterfowl impoundments, would meet the "dam" designation that would trigger this legislative action.

The U.S. Army Corps of Engineers (USCE) is given primary responsibility for construction activites in "navigable waters". In 1975, this agency was given guidelines (40 CFR 230) for issuance of permits for dredge discharges into all natural waters and their adjacent wetlands, which require them to consider the cumulative environmental impacts of granting the permit on the wetland involved and to solicit public comment and review of all such proposals.

State Legislation

The California Environmental Quality Act of 1969 (CEQA) establishes a state policy to preserve environmental quality and provides guidelines for involvement of state and local agencies and the public in the planning of every public or private project deemed likely to have environmental impacts, especially those involving endangered species or unique habitats. It requires preparation of an Environmental Impact Report (EIR) as the vehicle through which this involvement is achieved and as the means by which these impacts are analyzed and mitigating measures and alternative actions are considered (2.2).

The California Endangered Species Act of 1970 (CFG Code 2050-2055) was the first state legislation defining rare and endangered wildlife and prohibiting import, taking, possession, and sale of any species so listed by the state.

The California Species Preservation Act of 1970 (CFG Code 900-903) authorized the CDFG to identify and inventory endangered and threatened wildlife and to report on their status to the legislature bianually. The California Native Plant Protection Act of 1977 (Chapter 11 CFG Code; Div. 23, Calif. Food and Agricultural Code) protects rare and endangered plants by restricting the numbers and types of plants, both living and dead, that may be collected. It establishes a permit system for this, administered by the counties.

Chapter 11, Title 14, Section 630 of the CFG Code provides regulations for managing state ecological reserves for the protection and enhancement of their wildlife resources. These include prohibitions or restrictions on fishing, swimming, boating, specimen collections, trail use, firearms, pets, littering, grazing, and aircraft and motor vehicle use within the reserves. Strict penalties are also provided for introduction of pesticides or exotic species.

The State Water Code (SWC) mandates the protection of water resources including "the preservation and enhancement of fish, wildlife, and other aquatic resources" in the Porter-Cologne Act (SWC Secs. 13050(f), 13243). This authorizes the regional water quality control boards to adopt discharge prohibitions and regulates their issuance of National Pollutant Discharge Elimination System (NPDES) permits based on the retention of good water quality for wildlife as a beneficial use of natural waters (2.53). State Water Resources Control Board (SWRCB) Resolution 68-16 further delineates the nondegradation policy for state waters, as provided by federal regulation (40 CFR 130.17(e)). SWRCB laws also allow for designation of "areas of special biological significance", but these are appropriate to coastal, not inland, waters (2.53).

Nondegradation of wetland habitats is further provided for by Section 1600 of the CFG Code, which requires that anyone planning to divert or obstruct flows, or change beds or banks of wetland areas, must first notify

CDFG, who are required to comment on the plans and suggest mitigative measures. The project can proceed only after the CDFG certifies that the habitat will not be adversely affected. This law provides for mediation by a panel of arbitrators in cases where CDFG and the developer cannot reach agreement on the proposal.

Local Agencies

The Imperial County General Plan considers ecological and aesthetic criteria as well as economic interests in its development guidelines (2.4) and provides specifically for the protection of threatened wildlife and plants as well as important cultural and archaeological sites in its "preservation" category. The need for desert open space, and its fragility when subjected to incompatible or conflicting uses, is also recognized (2.2), and only "compatible" uses are allowed near such areas.

Open space zoning in Imperial County allows agriculture, recreational use, and preservation, and is designed to discourage intensive urban use. Most lands near San Felipe Creek, for example, are zoned as open space by the county. This zoning threatens the marsh, and its rail and pupfish populations, for three reasons: (1) Agricultural use is considered compatible with desert open space by the county, thereby allowing the possibility of future agricultural development on private parcels in the marsh, as long as they remain in their present ownership; (2) Agriculture has priority over desert open space (including wildlife and watershed management) in the general plan, encouraging this potential development; (3) CEQA guidelines are established by each county. In Imperial County, a private landowner need not obtain a county permit before beginning agricultural development on his parcels, by virtue of the zoning philosophies expressed in (1) and (2) above (2.2). Therefore, agricultural development could begin near San Felipe Creek without benefit of any review process, which would otherwise occur under stricter CEQA implementation standards (via the need for permit application, or an EIR, on the proposed development). Thus, state mandates protecting the state-listed pupfish and federally listed Clapper Rail could be compromised by county regulations to a dangerous degree.

2.3.3 Cooperative Agreements

Interagency cooperation in efforts for preserving endangered species, habitats, unique lands, and cultural resources is provided for throughout the legislative framework described above. The Endangered Species Act requires interagency consultations (Section 7 of the act), and allows cooperative programs between USFWS and state agencies for development and implementation of recovery plans, including fund matching (Section 6 of the act, 50 CFR 402). FLPMA's implementing regulations prescribe cooperation between local agencies, private developers, and BLM in developing land use plans (Sections 1601.4 and 202(c)(9), FLPMA) and provide for periodic interagency reviews of withdrawn lands (2.2). Regulations for management of ACEC's in FLPMA, Sec. 103(a), provide for cooperative agreements between agencies, private landowners, and BLM in obtaining or exchanging lands for ACEC protection (2.31). Such an agreement for equal management of the San Felipe Creek/San Sebastian Marsh ACEC exists now between CDFG and BLM (2.11).

The Sikes Act of 1960, amended in 1974, gave a congressional mandate for cooperation between state and federal resource agencies for planning and implementing wildlife management and habitat development, especially for land purchases using wildlife stamp funds.

Cooperation among various federal agencies is provided for by (1) the Fish and Wildlife Coordination Act of 1958, 16 U.S.C. 661-667(e), which requires USFWS review of all proposed federal actions affecting a stream or water body with regard to impacts on fish, wildlife, and water quality; (2) parts of the Federal Water Pollution Control Act requiring cooperation between USFWS and EPA in water quality planning and conservation; and (3) portions of the National Historic Preservation Act and the Archaeological Resources Protection Act, which provide for interagency agreements and planning for cultural resource preservation.

Cooperation between agencies and private parties is basic to the execution and continued management of both land exchanges and conservation easements. The potential role and effectiveness of the private sector in cooperative efforts to secure habitat acquisitions by these methods was discussed in Section 2.1.4 of this report. Private sector involvement in species recovery could be extended well beyond assistance in habitat acquisition to include (1) direct subsidy of the recovery or management activities of the lead agency; (2) direct assumption of management responsibilities on the acquired lands, subject to approval, guidance, and supervision by the lead agency; (3) donation of manpower or equipment to the managing agency. This would require, at a minimum, drafting of a Memorandum of Understanding (MOU) or a Memorandum of Agreement (MOA) between the lead agency (probably USFWS, BLM or CDFG), the private entity desiring to participate in species management, and other agencies and parties (e.g., landowners) involved. This was done for the recent interagency effort to reintroduce the desert pupfish on national forest lands in Arizona (2.54).

Preferably, a cooperative management agreement can be drafted similar to the 4-party agreement for managing the Owens pupfish at the Fish Slough Ecological Study Area in Mono County, California (2.55). It might include, but not be limited to, the following elements:

1. Parties involved

2. Purpose of the agreement

3. Site description, land ownership, and natural values

4. Education values

5. Management details

    a. membership and responsibilities of the joint committee (management plans, liaisons, annual reports, permit policies, recommendations to each agency on management of their holdings)
    b. meetings
    c. chairmanship

6. Objectives (e.g., maintenance of pristine habitat; variable management/zoning of different areas; encouragement of scientific and educational uses and discouragement of others, except nondestructive recreation; prohibition against taking plants and animals without permits; limits on hunting, fishing, grazing, and off-road vehicle use)

7. Responsibilities of each party and agency

8. Expenses - who bears what costs

9. Terms of agreement (e.g., 10-year agreement with yearly renewals afterward, periodic reviews, rollover clauses)

Such an agreement may provide a viable mechanism for allowing the private sector an aggressive role in endangered species management. It may significantly expedite recovery of a species by effectively overcoming the problems of lengthy review processes, long lead times for action, and funding limitations, which have severely limited the effectiveness of governmental agency recovery efforts in the past.

2.4 References

2.1 Bureau of Land Management. California Desert Conservation Area Plan. U.S. Dept. of the Interior, Desert District, Riverside, CA (1980a).

2.2 Lebo, A., L. Nitikman, and C. Salmen (eds). San Sebastian Marsh: A Resource Survey and Management Plan. Imperial County, California, Environmental Field Program, Univ. of California, Santa Cruz, Publication No. 9 (1982).

2.3 Maynard, J., J. Riley, G. Taoka, and L. West. Blowsand and Marsh Studies: Whitewater River Project. Dept. of Landscape Architecture, Calif. State Polytechnic University, Pomona (1981).

2.4 Imperial County Board of Supervisors. Imperial County Ultimate Land Use Plan. El Centro, CA (1973).

2.5 Salton Sea Project. Land Ownership and Use, Summary Report, Work Area II. California Department of Water Resources, Los Angeles (1969).

2.6 Bureau of Land Management. Final Environmental Assessment. Potential Impacts Resulting from Leasing of the Hydrocarbon Resources at the Salton Sea. U.S. Dept. of the Interior, Desert District, Indio Resource Area, Indio, CA (1982).

2.7 Westec Services, Inc. Final Salton Sea Anomaly Master Environmental Impact Report and Magma Power Plant 3 (49 MW) Environmental Report. Vol. I. San Diego, CA (1981).

2.8 U.S. Fish and Wildlife Service. Important Fish and Wildlife Habitats of California. U.S. Dept. of the Interior, Washington, D.C. (1980).

2.9 Davis, F. Salt Creek Desert Pupfish/Rail Habitat Area of Critical Environmental Concern Management Plan. U.S. Bureau of Land Management No. CA-06ACEC-60, Riverside, CA (1982).

2.10 Black, G. Fishery Biologist. California Dept. of Fish and Game, Chino, CA. Personal Communication (1982).

2.11 Moore, K. Fisheries Biologist. Calif. Dept. of Fish and Game, Imperial County, CA. Personal Communication (1982).

2.12 Sciarrotta, T. Southern California Edison Co. Personal Communication (1982).

2.13 Black, G. Status of the Desert Pupfish, Cyprinodon macularius (Baird and Girard) in California. Inland Fisheries Endangered Species Program Special Publication 80-1 (1980).

2.14 Avitia, T. Administrative Analyst, Imperial County Assessor's Office, El Centro, CA. Personal Communication (1982).

2.15 Kennedy, J. Memorandum to the file. University of California Natural Land and Water Reserves System, Nov. 20 (1979).

2.16 Pisapia, R. Field Office Supervisor, Division of Ecological Services, U.S. Fish and Wildlife Service, Laguna Niguel, CA. Personal Communication (1982).

2.17 Ruch, J. B. California State Director, Bureau of Land Management. Letter to J. Roger Samuelson, Director, U.C. Natural Land and Water Reserves System, Dec. 12 (1979).

2.18 Mozejko, A. Environmental Assessment, Proposed Land Acquisition for Moapa Dace (Moapa Coriacea), an Endangered Species, Clark County, Nevada. (Revision of original E.A., Jan. 1979). U.S. Fish and Wildlife Service, Portland, Ore. (1981).

2.19 National Wildlife Refuge Study Task Force. Recommendations on the Management of the National Wildlife Refuge System. U.S. Fish and Wildlife Service, Washington, D.C. (1978).

2.20 Lyle, J.T., A. Jokela, and D.E. Bess. Land Tenure Adjustment Strategy for BLM. Laboratory for Experimental Design, California Polytechnic and State University, Pomona (1979).

2.21 Armantrout, N. "BLM Agency Report," Proc. Desert Fish Council. Vol. 14. In press (1982).

2.22 Ruch, J.B. California State Director, Bureau of Land Management. "Instruction Memorandum on Land Exchange Policy." Memorandum No. CA-79-161, March 14 (1979).

2.23 U.S. Bureau of Reclamation. Letter to R.M. Thatcher, on file at BLM, El Centro, CA, U.S. Dept. of Interior, August 29 (1979).

2.24 Cherm, J.D. Pacific Southwest Region Director, Heritage Conservation and Recreation Service. Letter to Robert Sandy, Director, Mono County Planning Dept, Bridgeport, CA, August 22 (1979).

2.25 Gonzales, C. Manager, Imperial Wildlife Area, California, Dept. of Fish and Game, Niland, CA. Personal communication (1982).

2.26 Gelfand, P., and T.E. Blankenship. Effects of the Five-Year Management Plan for the Wister Unit of the Imperial Wildlife Area on the Yuma Clapper Rail. California Dept. of Fish and Game, Niland, CA (1977).

2.27 Ellis, S., C. Fallat, N. Reece, and C. Riordan. Guide to Land Cover and Use Classification Systems Employed by Western Government Agencies. Western Energy and Land Use Team, U.S. Fish and Wildlife Service, Fort Collins, CO. No. FWS/OBS-77/05 (1977).

2.28 Livermore, D. The Nature Conservancy. Agency Report. Proc. Desert Fishes Council 12:161 (1980).

2.29 Burton, G. "The First U.S. Fish and Wildlife Service National Fish Refuge: The San Bernardino Ranch." Proc. Desert Fishes Council Vol. 14. In press (1982).

2.30 Johnson, T. "The Nature Conservancy." Proc. Desert Fishes Council. Vol 14. In press (1982).

2.31 Bureau of Land Management, Final Guidelines for Areas of Critical Environmental Concern. U.S. Dept. of the Interior, Riverside, CA (1980).

2.32 Bureau of Land Management. Policy and Guidelines for Identifying and Protecting Areas of Critical Environmental Concern. U.S. Dept. of the Interior, Riverside, CA (1980).

2.33 Miller, R.R., and E.P. Pister. "Management of the Owens Pupfish, Cyprinodon radiosus, in Mono County, California." Trans. Amer. Fish. Soc. 100(3):502-509 (1971).

2.34 Pister, E.P. Fishery Biologist. Calif. Dept. of Fish and Game, Bishop, Ca. Personal Communication. (1982).

2.35 Metropolitan Water District of Southern California. Annual Report, edited by S.H. Landsman, Los Angeles, CA (1981).

2.36 California Department of Water Resources. Investigation Under California Water Code Section 275 of Use of Water by Imperial Irrigation District. Southern District Report, Dec. (1981).

2.37 Colorado River Board. Appendix to California's Stake in the Colorado, Colorado River Association, Los Angeles, CA (1979).

2.38 Valentine, V. Colorado River Board, Assistant Chief Engineer, Los Angeles, CA. Personal communication (1982).

2.39 Wilson, R. Imperial Irrigation District, Manager of Water Department. Personal communication (1982).

2.40 Ainsworth, K. Assistant General Manager, Coachella Valley County Water District, Coachella, CA. Personal communication (1982).

2.41 Littlefield, W.M. Hydrology and Physiography of the Salton Sea, California. Hydrologic Investigations Atlas HA-222, US Geological Survey. Prepared in cooperation with California Department of Water Resources (1966).

2.42 Sullivan, R.R. and S.C. Anderson. Preliminary Evaluation of State Water Project Ground Water Storage Program: Upper Coachella Valley, DWR Technical Information Record Study Code No. 1610-14-J-1 (1980).

2.43 United States Geological Survey. Water Resources Data for California, Vol. I. Colorado Basin, Southern Great Basin from Mexican Border to Mono Lake Basin and Pacific Slope Basins from Tijuana River to Santa Maria River, USGS Water Data Report, CA-80-1, Water Year 1980 (1981).

2.44 Loeltz, O.J., B. Irelan, J.H. Robison and F.H. Olmsted. Geohydrologic Reconnaissance of the Imperial Valley, California. Water Resources of Lower Colorado River-Salton Sea Area, Geological Survey Professional Paper 486-K, U.S. Government Printing Office, Washington, D.C. (1975).

2.45 California Department of Water Resources. Coachella and Imperial Valleys Agricultural Land Use Study, 1978. District Report, July (1980).

2.46 California Department of Water Resources. California's Ground Water. DWR Bulletin No. 118, Sept. (1975).

2.47 Geothermal Surveys, Inc. Geohydrologic Reconnaissance and Ground Water Model Evaluation of the San Sebastian Marsh Area, Imperial County, California. Prepared for Bureau of Land Management, Denver Service Center, YA-553-RFPO-29, Dec. (1980).

2.48 California Department of Water Resources. Coachella Valley Investigation. Bulletin No. 108, July (1964).

2.49 California Department of Water Resources. Report on the Feasibility of Extending the California Aqueduct into Upper Coachella Valley. District Report, Feb. (1979).

2.50 U.S. Fish and Wildlife Service. Placing Animals and Plants on the List of Endangered and Threatened Species. U.S. Department of the Interior, Washington, D.C. (1981).

2.51 Bureau of Land Management. Interim Management Policy and Guidelines for Lands Under Wilderness Review. U.S. Dept. of the Interior, Washington, D.C. (1979).

2.52 Horwitz, E.L. Our Nation's Wetlands. Interagency Task Force Report. Council on Environmental Quality, Washington, D.C. (1978).

2.53 Attwater, W.R. Chief Counsel, State Water Resources Control Board. Memorandum to R. Hampson, Executive Officer, Lahontan Regional Water Quality Control Board, Victorville, CA, Aug. 21 (1979).

2.54 Arizona State Director, Bureau of Land Management. "Memorandum of Understanding Between the United States Department of the Interior, Bureau of Land Management, Arizona, and the State of Arizona Game and Fish Department." U.S. Dept. of the Interior, Phoenix, Arizona, April 9, (1982).

2.55 Anonymous. Fish Slough Ecological Study Area Cooperative Management Agreement. Draft outline, June 22 (1982).

3.0 THE DESERT PUPFISH

3.1 Species Description

The desert pupfish, Cyprinodon macularius, is one of a number of pupfish species that have evolved in the streams, springs, and lakes of southwestern United States and northern Mexico. Pupfish are members of the Cyprinodontidae or "killifish" family, which can be found throughout most of the world. Killifish tend to be successful in extreme habitats that exclude other fish species. Desert pupfish are small (less than 75 mm in length), chunky, and olive brown (except for breeding males which are an iridescent blue) with black vertical bars on their sides. Some of the isolated populations of C. macularius are considered to be separate subspecies. However, subspecies are not universally accepted and may be somewhat arbitrarily designated (3.1).

3.1.1 Distribution

C. macularius is endemic to the Gila River drainage in Arizona; the Sonoyta River drainage in northern Sonora, Mexico; and the lower Colorado River drainage (including the Salton Sea and some of its tributaries) of California and Baja California (3.2). Desert pupfish were once considered the "most abundant" species of the fishes of the western desert area and "exceedingly common" in the Salton Sea (3.3). As late as 1961, 10,000 individuals were estimated to be in a single shoreline pool of the Salton Sea (3.4).

Existing populations in "native" habitat are limited to the tributaries of the Salton Sea, principally San Felipe Creek, and the Sonoyta River drainage (3.5). However, the distinction between native and modified pupfish habitat is problematic: The Salton Sea is man-made and thus a modified habitat. The pupfish in Quitobaquito Springs in Arizona (Gila River drainage) occupy a modified habitat because of construction and dredging to enhance the habitat (3.6), whereas San Felipe Creek is spring-fed and unmodified. Salt Creek, a tributary on the north end of the Sea, has recently been found to support a relatively large population of desert pupfish, but its flow is probably due in large part to leakage from the Coachella Canal (3.1), and thus might be considered non-native habitat. The desert pupfish currently accounts for about 2% of the total fish sampled from the Salton Sea, tributaries, shoreline pools, and irrigation drains (3.5). The decline of the pupfish from these habitats is generally due to the introduction of competing and predatory species, shoreline development (including agriculture), and competing uses for the water supply (3.7, p. 251).

Distribution in and Around the Salton Sea

Various habitats were surveyed by the California Department of Fish and Game (CDFG) from March 1978 to March 1979, including the following: (1) Irrigation drains and channels on the northern and southern ends of the Salton Sea, ranging in length from 55 to 4000 m and in width from 1 to 5 m. (2) Shoreline pools on the southern and eastern portions of the sea. See Figure 3-1 for habitats surveyed. These standing pools, partially separated from the sea proper by sand bars or barnacles, ranged in size from 25 to 1000 m in length, 5 to 50 m in width, and 5 to 61 cm in depth. The salinity of shoreline pools has been reported to be two to three times that of the sea itself (3.8). (3) Natural tributaries (Whitewater River, Salt Creek, and Whitefield

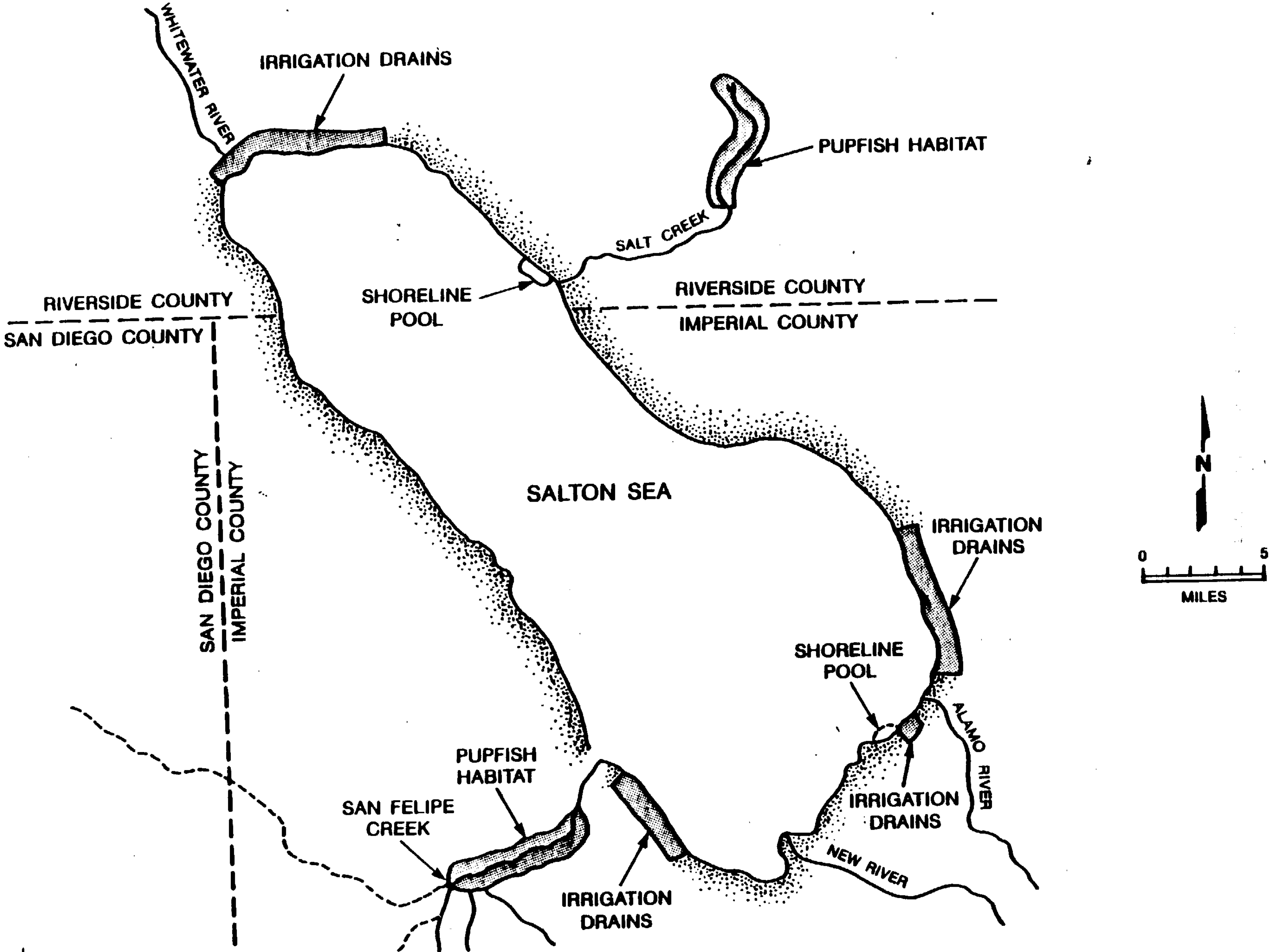

Figure 3-1. Distribution of Desert Pupfish Around the Salton Sea, California (Adapted from Ref. 3.5)

Creek). (4) The Salton Sea proper. San Felipe Creek urveyed separately. CDFG is currently in the process of surveying e and other areas around the sea to determine more precisely the status of the pupfish. Preliminary findings from this latest survey indicate the existence of a relatively large population of pupfish in Salton Creek and a few individuals in Whitewater River (3.1).

The results of the 1978-1979 survey indicated that in all areas the sailfin molly was the most abundant species, except during winter surveys of shoreline pools and the Salton Sea, when the long jaw mudsucker was most abundant. Desert pupfish accounted for 2% of the total catch, on the average, from all of the habitat areas (for a total of 324 pupfish). In general, irrigation drains and shoreline pools had seasonal populations but the sea and natural tributaries (other than San Felipe) did not. Recent findings and conversations with CDFG personnel indicate that the above surveys do not represent the existing relative abundance of pupfish and other fish species accurately. For example, the sailfin molly is no longer a predominant species in the sea or surrounding habitat, perhaps due to massive die-off from cold temperatures (3.9, 3.1). There is evidence that much of the pupfish population in the irrigation drains has been eliminated. This is due to intermittent flow, irrigation channel dredging, and invasion by tilapia. (3.6). The status of the shoreline pools and pupfish populations within the pools is now considered marginal. The 1978-1979 survey indicated that pupfish were the predominant species in San Felipe Creek. This still appears to be the case based on our observations and conversations with CDFG personnel.

Refugia Populations

The first refugium for desert pupfish was established in 1970 at Palm Canyon in Anza-Borrego Desert State Park. This is the largest refugium, with about 1,000 individuals in a 60 ft x 15 ft x 3 ft concrete pond. Two other refugia were subsequently established in Anza-Borrego State Park: a 20 ft x 8 ft natural spring fed pond, with depth ranging from 8 in to 24 in at Palm Spring (May 1978), and a 20 ft x 8 ft pond ranging in depth from 4 in to 8 in at the Visitor Center (1979). Another refugium was established in a 10 ft x 2 ft concrete pond at the Living Desert Reserve, Riverside County, in 1972, with an estimated 100 individuals. In 1975, a refugium containing an estimated 30 individuals was established in Arroweed Spring, Imperial County, in a 10 ft x 10 ft x 3 ft concrete wildlife watering pond (3.5). Most recently, a sixth refugium was established in the Salton Sea State Park on the northern end of the sea (3.1).

3.1.2 Life History

Desert pupfish in general live one to two years. They mature rapidly and may produce more than one generation per year. Thus, segregated populations can and do become distinct fairly rapidly. Growth is rapid and depends somewhat on temperature and salinity. The following sections discuss selected life history characteristics of the desert pupfish.

Foods

Desert pupfish are somewhat unselective, omnivorous feeders showing spatial and temperal changes in the relative percentages of food categories eaten (3.10). Detritus at the bottom of ponds is apparently preferred over the fresh green algae (3.11). In a preliminary examination of the stomach contents of pupfish from the Salton Sea (3.10), it was observed that animals comprised from 30 to 56% of gut volume, detritus from 0 to 43% and algae from 0 to 56% of gut volume. A large portion of the animal diet was chironomid larvae, dipteran pupae, and lepidopteran larvae. In controlled experiments, mosquito larvae were significantly reduced by C. macularius to the point that all mosquito breeding in the test pond ceased, while in the control pond mosquito breeding continued (3.12). Adult pupfish will eat their eggs. Loiselle (3.13) found evidence that adult males recognize and avoid their own spawn, but will eat eggs spawned by other males within their territories. Predation by adults upon young pupfish occurs only rarely.

Daily Movements

Desert pupfish are somewhat predictable in their daily movements into and out of shallow areas in their pond habitats. This movement is in response to temperature changes and seems to be completely independent of salinity and oxygen tension (3.14). Pupfish tend to spend nights in the shallowest, coolest areas of the pools and at dawn move to deeper, warmer areas (though most territorial males will sleep in their territories and not retreat to the shallowest water at night (3.4). Later they work their way back to the shallows but leave again if the temperature exceeds 36°C to 37°C (3.4).

Territoriality

The aggressive defense of territories by male cyprinodonts is well established. The territories characteristically are in shallower parts of pools (less than 1 m) and are centered around food sources or irregularities in the bottom topography (rocks, debris, etc.) (3.4). In optimal habitat (great topographic and substrate heterogeneity), males defend boundaries efficiently by threat displays and consequently spend most of their time in the center of their territories. In marginal habitat (silty substrate and few rocks and irregularities), males engage more frequently in overt aggression and spend less time near the center of their territories (3.15). Non-territorial males flee to plants or to the surface when chased from another individual's territory.

Reproductive Behavior

Spawning takes place from April to October whenever the temperature exceeds 20°C (3.7, p. 254). Brightly colored males patrolling their territories vigorously is the first sign of breeding activity. Typical breeding behavior in the native environment consists of the female and male approaching each other in the male's territory. Following a spawning ritual, the female lays an egg, which the male fertilizes. Several eggs may be deposited and fertilized in quick succession. The females may swim up to males in groups or alone, and a single female will lay from 50 to 800 eggs a season (3.7, p. 254). Eggs hatch after 10 days at 20°C and the larvae start feeding on small invertebrates within a day after hatching (3.16). Desert pupfish are 4 to 5 mm at hatching and double their size in about eight weeks. Since they may become sexually mature at 15 mm, their life cycle can be completed in the first summer. However, most pupfish do not breed until their second summer (3.7, p. 254).

3.1.3 Habitat Characteristics

Sloughs, marshes and backwaters along the Gila, Sonoyta, and Colorado River drainages comprised the original habitat of the desert pupfish (3.17, 3.18). The most similar areas in the Salton Sink have shallow (5 to 50 cm) warm water, with algal mats or emergent vegetation, sandy-silty substrates, and little or no current. Salton Sea habitats undergo huge seasonal and diurnal variations in their physical and chemical regimes. The physical tolerances and preferences of the desert pupfish are fortunately fairly well known, or can be readily inferred, because of the preponderance of research on this and other cyprinodont species (3.19).

Temperature

Salton Sea habitats vary between 8°C (winter) and 44°C (summer), and by as much as 26°C diurnally (3.5, 3.14, 3.20). Lowe and Heath (3.21) determined the critical thermal maximum of desert pupfish from Quitobaquito Springs, Arizona, to be 44.6°C in the laboratory, and found them active in the spring at 40-41°C. Barlow (3.14) found Salton Sea pupfish in shore pools at 39-40°C, and Schoenherr (3.18) collected them at 39°C in an irrigation drain. As discussed earlier, diurnal movement in shore pools is strongly correlated with temperature. Temperatures above 36-37°C are avoided during most of the day when cooler water is available (3.14). However, both Schoenherr (3.18) and Lowe and Heath (3.21) observed voluntary selection of warmer water when cooler water was available. Schoenherr ascribed this to competitive displacement of pupfish by exotic fishes in the irrigation canals. In the latter case, though, this behavior might allow optimal rates of food intake (greater at the higher temperatures), while assimilation could occur more efficiently in the cooler periods later in the day (3.20). Such behavior may thus favor optimal growth rates in young pupfish, which commonly prefer slightly higher temperatures than adults, often within 1-2°C of their incipient lethal temperature (3.4, 3.14, 3.20 - 3.24). Desert pupfish in the Salton Sea do not undergo stress at 38-40°C, but they are compelled to forage continuously at these temperatures (3.14, 3.21).

Temperature sensitivity varies with life stage. Schrode and Gerking (3.25) found that oogenesis was the most temperature-sensitive stage in the Saratoga Springs pupfish, C. n. nevadensis, with limits equal to those for successful hatching (24-30°C). This is about one-fifth of the normal activity range and one-seventh the thermal tolerance range. Kinne and Kinne (3.22) and Crear and Haydock (3.16) found three periods of low thermal stability of desert pupfish embryos: (1) just before fertilization, (2) between fertilization and gastrulation, and (3) just before hatching. Red River pupfish (C. rubrofluviatilis) hatched and developed normally between 14.0° and 36.4°C, and bred between 12.8 and 33.9°C (3.26). Smith and Chernoff (3.27) found developing ova in a Cyprinodon chronically exposed to 39.2-43.8°C in a thermal stream. In Saratoga Springs pupfish, tolerance to maximum temperatures is lowest during the egg stage, intermediate in adults and highest in young (3.25).

Salinity

Pupfish habitats in the Salton Sea range from fresh water (in pools and channels, especially following heavy rains) to more than 90 parts per thousand (ppt) in isolated shoreline pools (3.5, 3.8, 3.18). Barlow (3.14) observed healthy desert pupfish in shoreline pools at 52-68 ppt, and found some juveniles that survived acute exposure to 90 ppt (3.8). Live (but dying) pupfish were reported in salinities exceeding 200 ppt in the evaporation ponds of a now-defunct salt works (3.28). They readily tolerate sudden transfers of up to 15 ppt as well (3.20, 3.21).

Cowles (3.3) reported that the desert pupfish prefers to breed in fresh water, but Kinne and Kinne (3.22) and Gerking and Lee (3.29) found that moderate salinities stimulated embryo viability. Reproductive performance of Saratoga Springs pupfish, as measured by embryo viability, number of eggs per spawn, and eggs/g body weight/day, occurred mainly between 0.2 and 20 ppt, peaking at 10 ppt (3.29). Between 20 and 43 ppt, the female may lay a few eggs, but they will not hatch. Kinne and Kinne (3.22) reported that pupfish eggs were still viable at 70 ppt salinity.

pH

Barlow (3.14) considered local pH differences in the Salton Sea too minor to elicit a response from desert pupfish. This may not be true, however, in irrigation drains receiving water of highly variable quality (3.5), or in shoreline pools, marshes, and newly inundated areas with highly reduced, organic substrates (3.18). Egg production ceases at pH levels below 5.0, and both production and viability were reduced by 50% below pH 6.5 in *C. n. nevadensis* (3.29). Their larvae were less tolerant of acid waters than were the adults, which had a 96-hr LC_{50} at pH 4.6. They did not acclimate to acid conditions, nor were its effects on reproductive performance fully reversible.

Dissolved Oxygen

Levels in Salton Sea shore pools vary between approximately 1.7 and 4.8 mg/l (3.14). Desert pupfish readily tolerate dissolved oxygen levels from saturation (often found in irrigation drains) to 0.1 ppm (3.18, 3.30). Hypoxic tolerance is required by adults remaining in their territories at night (3.2, 3.4, 3.14) and for burrowing behavior, which is commonly observed in cyprinodonts escaping predators (3.18, 3.24) or avoiding cold winter temperatures (3.23, 3.31). Development of embryos is progressively retarded at oxygen concentrations below 70% air saturation as temperatures increase above 18°C (3.22).

Depth

Salton Sea pupfish prefer relatively shallow areas (5-50 cm) of runs and pools in undisturbed habitats. Breeding territories are generally located between 10 and 100 cm (3.3, 3.4, 3.14). Young pupfish commonly school in the shallowest areas, seeking optimal temperatures for feeding and growth, and to avoid predators (3.4, 3.14, 3.18, 3.21, 3.32). In most areas, pupfish of all sizes have been displaced to the shallowest, most extreme habitats by exotic fishes (3.18).

Habitat heterogeneity

As previously described, pupfish clearly prefer bottom diversity for breeding territories. The distribution of pupfish in stream and irrigation return channels and pools is often associated strongly with rooted aquatic vegetation (3.18, 3.32). Diverse substrates, flows and depths in irrigation canals provided shelter for desert pupfish and segregated both native and exotic fishes in nearly pure species populations, while no such sorting occurred in the same channels when habitat diversity was lacking. This coincided with a decline in both relative and absolute abundance of desert pupfish (3.18, 3.32).

3.1.4 Current Status and Threats

Desert pupfish were abundant in Salton Sea shoreline pools and tributaries until the 1950's-1960's, and were, in fact, the only native fish species present (3.3, 3.14, 3.33, 3.34). However, both absolute and relative abundance have declined dramatically since then, coincident with the appearance of exotic fishes, especially sailfin mollies and cichlids. Pupfish habitat continues to be severely reduced by human development around the Sea (3.5, 3.34).

The precarious status of the desert pupfish is directly related to anthropogenic interferences including (1) introduction of exotic fishes; (2) destruction of habitat by urban and agricultural development, uncontrolled water level fluctuations, irrigation drain maintenance, and surface and ground water use for agriculture; and (3) improper use of pesticides (3.5, 3.18, 3.32, 3.34, 3.35, 3.36, 3.37). These are discussed in detail below.

Exotic Species

At least 22 exotic fish species are now present in pupfish habitats in the Salton Sink (3.18). California Department of Fish and Game quarterly surveys in 1978 and 1979 showed that desert pupfish comprised only 3% of the catch in irrigation drains, 5% from shoreline pools, and less than 1% from tributaties and the sea itself (3.5), clearly demonstrating the rapid displacement of pupfish by the exotics in these habitats. This may involve several mechanisms: predation, competition, aggressive bahavior, and reproductive interference.

The sailfin molly, Poecilia latipinna, was the most abundant species in all habitats. It's physiological tolerances and habitat preferences are fairly similar to those of the pupfish (3.18, 3.38). Male mollies court male and female pupfish, interfering with their reproduction (3.32). Some die-offs of mollies have occurred since 1980, apparently due to cooler temperatures, and their relative abundance has declined in all areas (3.1, 3.39, 3.40).

Zill's cichlid (Tilapia zilli) was introduced to the Salton Sea area for aquatic weed control in 1971, and it has successfully spread into all areas inhabited by pupfish, displacing them to the most marginal habitats (3.5, 3.34). The food resources of juvenile Zill's cichlids overlap highly with those of pupfish, and they occur together in the shallow areas (3.34). While chasing cichlids off their nests, territorial male pupfish waste courtship opportunities and leave their eggs exposed to predation by other pupfish (3.32). Adult cichlids of all species probably prey on juvenile pupfish. Cichlids are introduced both inadvertently and purposely by anglers; they may also escape from flooded channels and private ponds following heavy rains or releases of excess water from irrigation canals (3.5, 3.37).

Predation by exotic species has caused extirpations of other cyprinodonts (3.31, 3.36, 3.41, 3.42), but in the Salton Sea this is largely incidental and probably does not significantly affect pupfish populations (3.1). Introduction of exotics has also affected many endemic southwestern fish by introducing diseases and parasites (3.42, 3.43). The pupfish may be susceptible to such infestations (3.3, 3.16).

Habitat Destruction and Water Resource Depletion

Pupfish habitat is destroyed by the clearing and leveling of land around springs; capping of springs for resort or agricultural development; the filling, lining, and maintenance of irrigation canals; sea level fluctuations; the displacement of rushes and cattails by phreatophytes (*Tamarix* spp.), which choke channels and consume their flows; and diversion of surface waters and pumping of groundwater for development and agriculture (3.5, 3.34, 3.36, 3.37, 3.42). BLM, CDFG and the U.S. Bureau of Reclamation (USBR) are currently cooperating to arrange the exchange of 12 sections of land to preserve the riparian habitats along San Felipe Creek that comprise the San Sebastian Marsh Outstanding Natural Area (3.5, 3.44). The Salt Creek Desert Pupfish-Rail Habitat ACEC Management Plan has just been completed (3.37). However, agency priorities may not provide for sufficiently rapid implementation of either plan to avoid the extirpation of both populations.

The areas containing the best native populations, San Felipe Creek and Salt Creek, may be in the greatest jeopardy. In San Felipe Creek, the pupfish comprised 70-90% of the catch in the 1980 surveys; in Salt Creek they comprised 50% of the January catch and 72.7% of the May catch in 1980 (3.5, 3.39). This population is threatened by planned agricultural and housing developments whose use of groundwater may severely impair the surface flow of the creek, with grave consequences for the pupfish (3.5).

Pesticides

Fish kills due to exposure to agricultural pesticides have frequently been observed in Imperial Valley channels (3.5). Following most such events, the cichlids reestablish themselves in the drains more quickly than any other species (3.1). While some cyprinodonts seem capable of recognizing and avoiding certain pesticides (3.45), it is not known whether the desert pupfish has this ability.

Future Development

Any of the factors just described, if left unchecked, will likely cause eventual extirpation of the desert pupfish from the Salton Sea. The proposed development of oil, gas, geothermal, and alternative energy sources in the Imperial Valley could accelerate the pupfish's decline, depending upon the particular combination of development plans that is finally implemented (3.46).

3.1.5 Current Protection Efforts

The desert pupfish was listed as endangered by the California Fish and Game Commission in June, 1980 (3.1, 3.47), and is currently proposed for full federal listing, including critical habitat recommendation (3.37, 3.44).

3.2 Mitigation Alternatives

Figure 3-2 is a flow sheet indicating habitat areas, substantial issues (land acquisition, management responsibilities), and specific mitigation alternatives to be considered for enhancing pupfish habitat. A first step in outlining mitigation alternatives involves ensuring some form of natural or artificial habitat for the pupfish. The basic options include protecting and enhancing existing habitat, captive rearing, establishing refugia, or some combination of the above. These options are analyzed to determine the most preferred habitats. Proposed actions within the preferred habitats are discussed and rough cost estimates provided in Section 3.3.8. Land acquisition will be a critical and integral component of any mitigation alternative proposed. However, the issue of land acquisition has been treated somewhat generically (in Section 2.1) because the proposed land acquisition alternatives are essentially unexplored in the region, and even land ownership is uncertain in many cases. Implementation of any proposed mitigation measures is contingent upon resolution of the land acquisition issue and determination of the respective management roles among SCE, agencies, and landowners.

3.2.1 Protecting Existing Habitat

Black (3.5) delineated four categories of pupfish habitat in the Salton Sea region. These were described in Section 3.1.1 on pupfish distribution in and around the Salton Sea. The four habitat categories, and the rationale for designation as preferred or not preferred, are as follows:

Salton Sea. In the 1978-1979 CDFG fish surveys, in which 13 areas of the Salton Sea were sampled, only one desert pupfish was trapped (3.5). Empirical observation seems to be enough to indicate that the sea is not a viable habitat. Evidence for this includes massive die-off of tilapia, probably due to eutrophication; unstable fish population in general, e.g., sailfin molly has decreased sharply in relative abundance since the 1978-1979 survey (3.9); and simply that the sea is too large to manage for protection of the desert pupfish.

Shoreline Pools. The 1978-1979 CDFG surveys indicated that pupfish were relatively abundant in pools (3.5). Historically, as noted in previous sections, the shoreline pools provided habitat for tens of thousands of desert pupfish. However, it is uncertain whether the shoreline pools continue to exist or are destroyed and then reformed as the sea level fluctuates. Schoenherr reported that the rise in relative and absolute abundance of Zill's cichlid has replaced the pupfish in most habitats of the Salton Sea region except shallow areas of tributaries and irrigation drains (3.7). Although it is believed that shoreline pools are probably not optimal habitat (3.6, 3.9), the pools should not be ruled out entirely. A need exists for comprehensive mapping and surveying of the shoreline of the Salton Sea to identify existing pools and fish populations within them (3.1, 3.37).

Irrigation Drains. Desert pupfish were widely distributed in the irrigation drains surveyed in 1978-1979 by CDFG, though their relative abundance was low (3.5). Since the above survey, tilapia have become the most abundant species in the drains, having replaced sailfin mollies in this regard, and have apparently replaced the pupfish in the process (3.6). Irrigation drains are subject to variable conditions (dredging, flooding, etc.) and thus do not

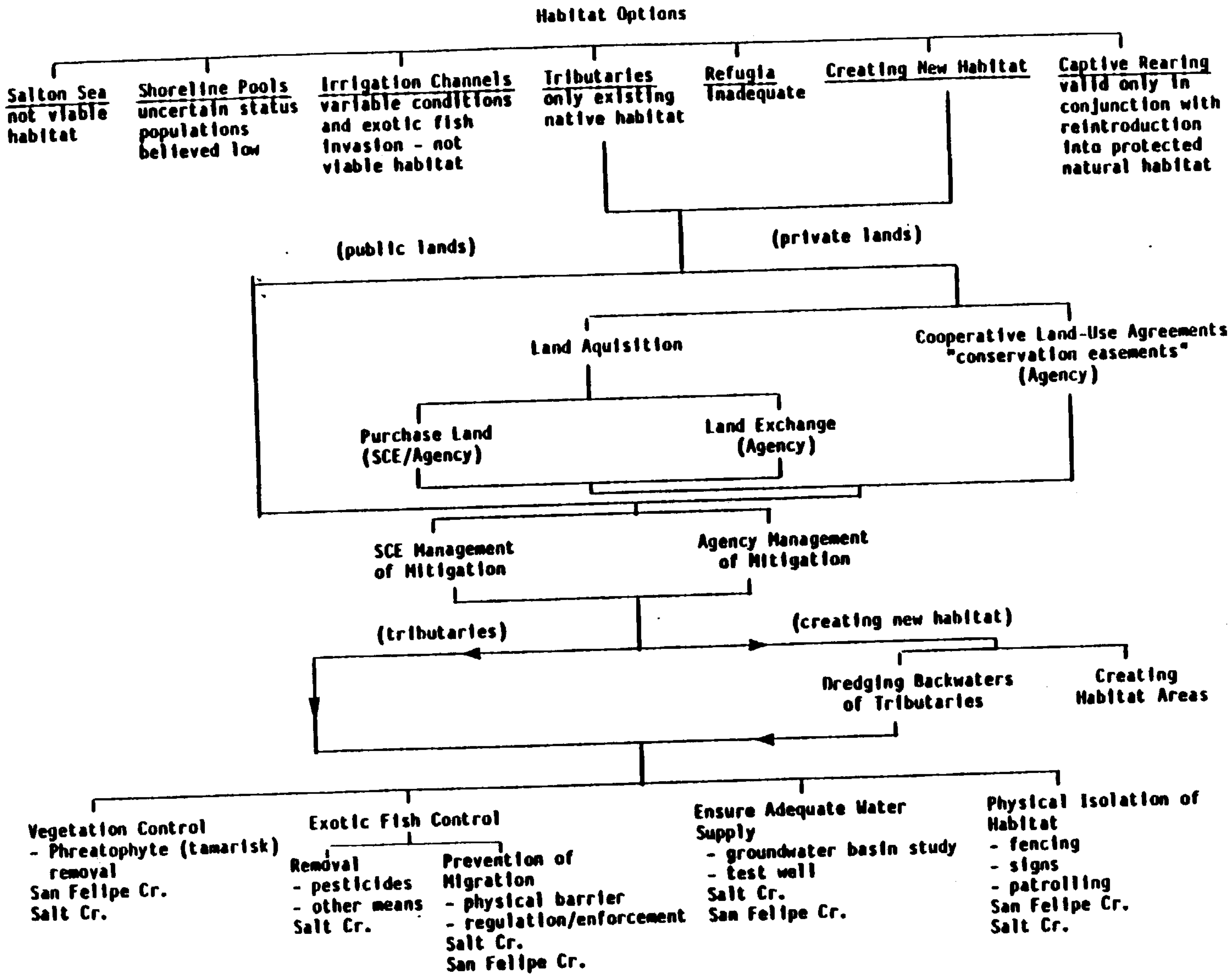

Figure 3-2. Mitigation Alternatives for the Desert Pupfish

provide a stable habitat. For example, the King Street Canal at the north end of the sea was used by Schoenherr to study niche separation of five species including the desert pupfish. A thermal gradient and good habitat diversity provided for a nearly complete population separation of the five species. Flooding and subsequent reconstruction of the canal in 1977 resulted in loss of habitat diversity, reduced populations of the five species, and introduction of tilapia (3.18). Recent observation of the canal revealed almost complete loss of flow due to diversion of the main source of runoff and dramatic changes in what was once good pupfish habitat (3.6). Thus, irrigation drains in general are not considered preferred habitat for pupfish.

Tributaries. Tributaries are the only remaining viable habitat for pupfish in the Salton Sea area. CDFG survey results and conversations with agency personnel (3.1, 3.9) indicate that the best known populations of pupfish occur in San Felipe Creek and Salt Creek. These two areas represent the only existing native habitat of significance for the pupfish in the Salton Sea region. The desert pupfish in San Felipe Creek is the most abundant species and appears to be doing well (3.9). Significantly, there have been no reports of invasion by tilapia in the good pupfish habitat in San Felipe Creek. Salt Creek pupfish are somewhat less secure in that tilapia have invaded the better pupfish habitat (3.9). These two creeks represent preferred habitat in which to carry out specific mitigation measures. Recommended measures will thus relate mainly to activities at San Felipe Creek or Salt Creek; however, other protection options, will also be analyzed.

3.2.2 Refugia

Creating artificial refugia for pupfish is considered an inadequate protective measure for a variety of reasons. Six refugia already exist in or near the Salton Sea region and one more would not make a significant impact. Agency personnel see refugia as a stop-gap measure to ensure preservation of the gene pool. However, genetic divergence may occur rapidly in pupfish so that a refugium population may become genetically distinct from the natural population it was meant to preserve. Creating refugia does not address the real need of the pupfish - that of ensuring adequate natural habitat. Refugia are also inferior, aesthetically and otherwise, to natural habitats. The preferred measure is to ensure natural habitat for the pupfish. A refugium may be a valid element in a habitat enhancement plan if it is designed to address and minimize the problems with refugia noted above (see Section 3.3.6).

3.2.3 Captive Rearing

Pupfish are easy to rear. However, only if subsequent reintroduction into protected native habitat is planned can this be a feasible protective measure. A "Johnny Appleseed" approach of planting pupfish in every water body in the area and hoping for the best has an uncertain probability of success and faces some clear opposition from agency personnel. However, similar approaches are not altogether unprecedented. Arizona Game and Fish (AGF) and BLM have a Memorandum of Understanding for stocking desert pupfish in natural habitats. Two sites have been stocked and about a dozen more are planned. However, crayfish predation has so far negated just about all efforts (3.48). If suitable natural springs and water bodies are identified, captive rearing might become a viable option.

3.2.4 Creating New Habitat

One option that deserves some favorable consideration is selective modification or expansion of existing natural habitat for pupfish. This can be done in a variety of ways. Dredging the backwaters of Salt Creek to expand habitat selectively for pupfish has been proposed by BLM (3.37). The USFWS recovery plan for the Moapa Dace relies heavily on modification and expansion of existing habitat as well as creation of new habitat designed to simulate natural habitat (3.49). Creating habitat through engineering is an established procedure. It would most likely apply to low flow areas of Salt Creek and San Felipe Creek. The extent to which this option would apply in other areas depends on the existence and discovery of appropriate natural water sources in the form of springs, seeps and ponds.

3.3 Description and Economic Analysis of Specific Measures

The mitigation actions recommended in this section do not represent a site-specific package. For example, two recommended actions may be incompatible or the feasibility of some recommended measures at specific sites may be highly uncertain. Additionally, there may be various methods of achieving a given recommendation. Given the above qualifications, an effort is made to present a compatible package of measures, noting the various methods of achieving them and the extent to which such measures have been successful in similar situations elsewhere.

As noted previously, the most viable pupfish population exists in the upper reaches of San Felipe Creek (See Figure 3-3). This specific site should be the focus of mitigation efforts with respect to protecting the desert pupfish.

San Felipe Creek is an ephemeral stream with some permanent pools and surface flow. Water flows along the entire length of the creek, all the way to the Salton Sea, after heavy precipitation. In the winter of 1980, water flowed continuously along a five kilometer stretch of the creek from the Fish Creek and San Felipe Creek confluence down to one kilometer past the San Felipe-Harpers Well confluence (3.50). This stretch of the creek is roughly equivalent to the area known as San Sebastian Marsh. The stream dimensions vary from widths of 0.5 m to 1.0 m, with a depth of 0.25 m, to pools up to 10 m wide with depths from 1.0 m to 1.5 m. San Felipe Creek is characterized by periods of extreme flooding, which can result in a change in width of the stream from 1 m to 12 m in one day. Groundwater contributions to San Felipe Creek surface flow are fairly constant and amount to approximately 0.3 cfs (3.50). At the USGS gauging station at Highway 86, 5 miles downstream from San Sebastian Marsh, the average flow over a 12-year period was 7.49 cfs (3.50), although the measured flow usually ranges from 0.0 to 0.3 cfs. Periodic flooding resulted in the high average flow. During a 17-year period (1961 to 1978) flows of 1,000 cfs or more were recorded 17 times at the USGS gauging station. A flow of 100,000 cfs is the estimated extreme maximum over the 20-year period of record from 1960 to 1980 (3.51).

The other site recommended for habitat enhancement measures is Salt Creek (see Figure 3-4). The area surrounding Salt Creek has been designated as an Area of Critical Environmental Concern by the BLM. The flow in Salt Creek is perennial and less extreme than that in San Felipe Creek. The minimum daily

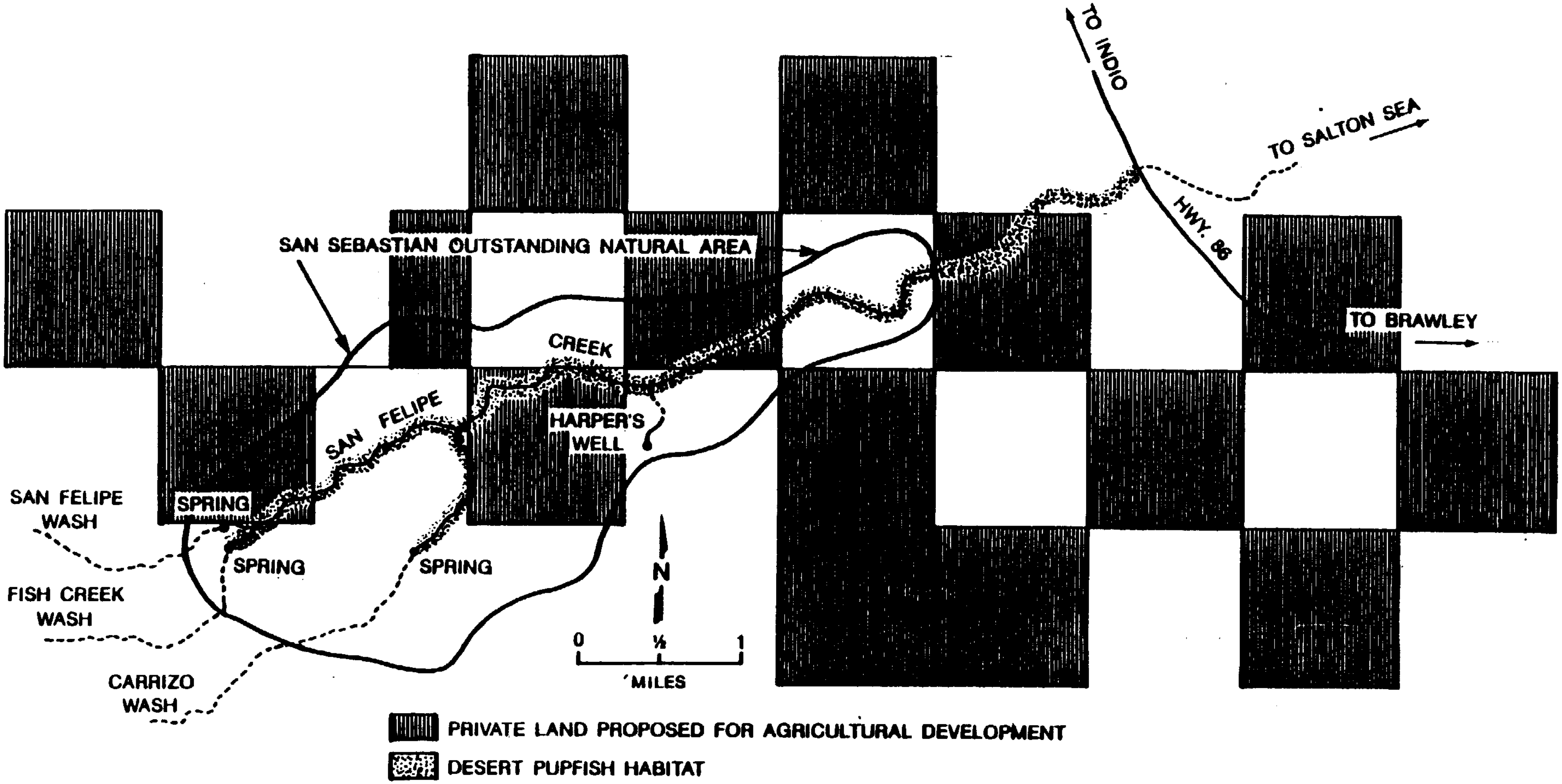

Figure 3-3. Land Status of Pupfish Habitat at San Felipe Creek and San Sebastian Marsh Outstanding Natural Area, Imperial County, California (Adapted from Ref. 3.5)

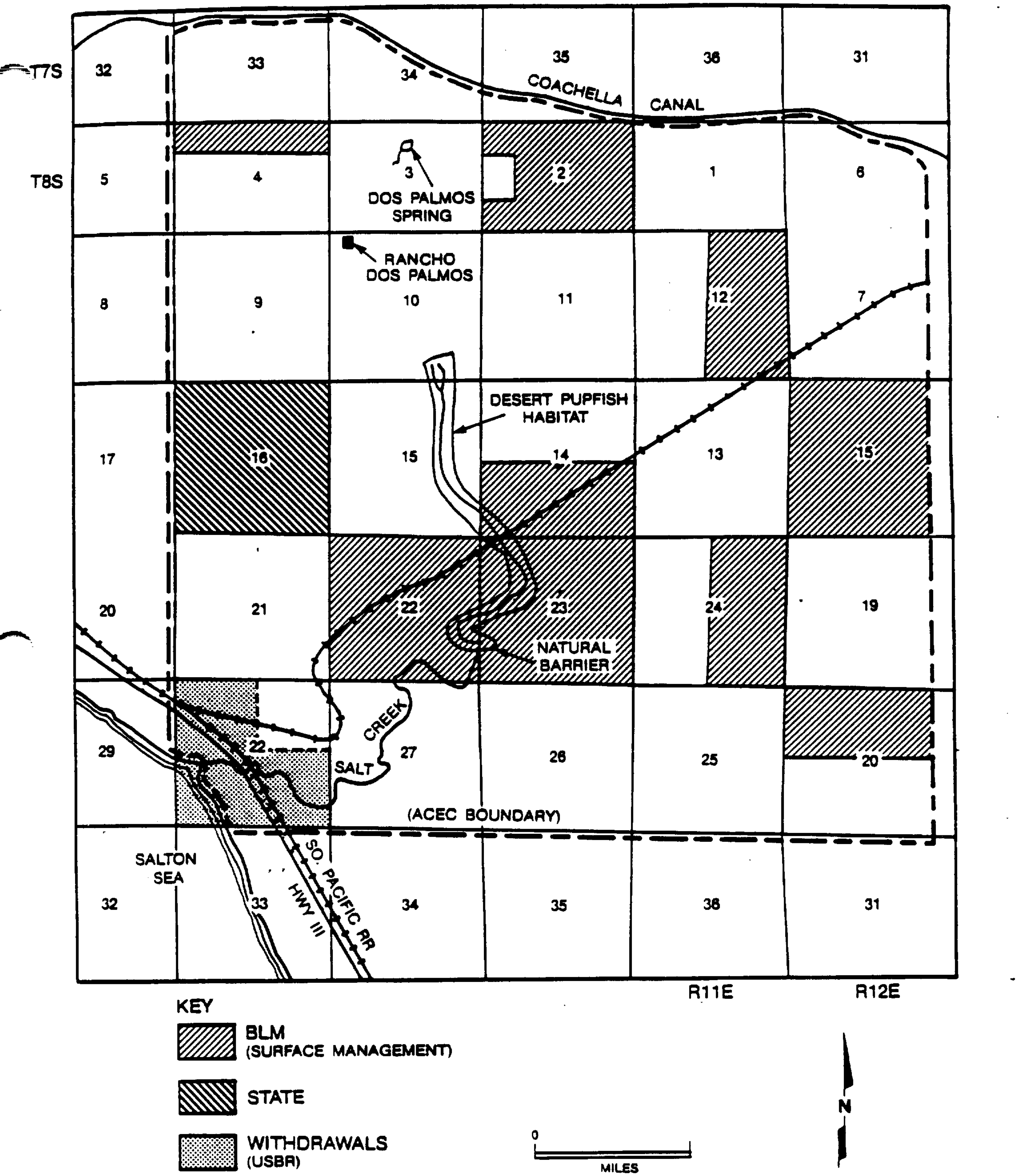

Figure 3-4. Land Status of Pupfish Habitat in the Salt Creek Desert Pupfish/Rail ACEC, Riverside County, California (Adapted from Ref. 3.37)

flow, recorded from 1961-1980 at the USGS gauge located on the pier of the Southern Pacific Railroad bridge is 0.6 cfs. The maximum flow is 9,900 cfs and the average flow is 6.87 cfs (3.51). Flow is sustained by irrigation water seepage from the Coachella Canal.

Salt Creek and San Felipe Creek differ in a number of respects (e.g., fish populations, other wildlife, hydrology, etc.). The two areas are, however, similar enough with respect to pupfish habitat that specific recommendations for enhancing habitat will be presented generically, noting site-specific differences in applicability, feasibility and method of implementation.

3.3.1 Tamarisk Removal

Tamarisk is the dominant vegetation in the larger washes, along the banks of San Felipe Creek, and in San Sebastian Marsh. This vigorous exotic has replaced coldenia, a native plant (3.50). The significance of tamarisk is its ability to transpire vast quantities of groundwater, due in part to a deep root system which may reach 30 feet or more. Estimates of evapotranspiration rates vary but it has been reported that large trees can evapotranspire as much as 200 gallons of water per day (3.52, 3.53). Given the fact that tamarisk often completely covers areas of San Sebastian Marsh, and in fact defines by its presence the bounds of permanent water along San Felipe Creek, the potential for surface water depletion due to this phreatophyte may be great. There are conflicting accounts of how much, if any, water is saved from tamarisk removal (3.54). Thus, the assumed benefits of tamarisk removal are somewhat speculative and may depend on site specific conditions.

Tamarisk has spread rapidly throughout the United States over the past 100-years, and millions of dollars have been spent on its control and removal, especially in the western river basins. Control methods vary depending on the size, location, and age of the particular stand to be controlled and the reason for wanting to control. The most efficient and least expensive method consists of bulldozing the tamarisk and then "root-ripping" over the area again. Other methods include spraying (aerial and ground), burning, and hand cutting. Bulldozing would have little or no usefulness as a method of tamarisk removal in either Salt Creek or San Felipe Creek for two reasons. Common sense dictates that bulldozing in or near a pupfish habitat area will create severe soil disturbance, erosion, and turbidity problems. Secondly, bulldozing for vegetation control is specifically prohibited in the BLM's California Desert Conservation Area (CDCA) plan for Class "C" (closed) areas (3.55). Both habitat sites are predominately in Class "C" designated areas. Thus, more labor intensive and expensive hand removal methods would certainly be required in most, if not all, of the areas in which tamarisk removal would be implemented.

Hand-cutting with chain saws (for large stems up to 20 in diameter), brush cutters (0.5 in diameter), or pruning shears, followed by application of a registered herbicide to the stumps has proved an effective (but time-consuming and expensive) method of removal (3.53). Hand-cutting and direct application of the herbicide Tordon® (a 2,4-D complex of Dow Chemical

Company)* to the cut stumps has been used successfully to eradicate tamarisk at Eagle Borax in Death Valley. Tordon® is a standard brush killer registered with the EPA for tamarisk removal. 2,4-D is nontoxic to mammals and has a TL_m (LD_{50}) in bluegill of 350 ppm (3.56). Use of Tordon® in San Sebastian Marsh should be considered only under an extremely controlled situation, and only after an empirical and theoretical demonstration that its use would not adversely affect the desert pupfish. The California Desert Plan requires removal or control of exotic vegetation (tamarisk), but eradication should only be undertaken if it is found that San Sebastian Marsh is lacking in water flows, and if efficient methods of eradication can be found that do not adversely affect the marsh (3.50). Spot application of herbicide is not allowed in Class "C" areas under the CDCA plan (3.55). Thus, effective tamarisk removal utilizing herbicide application may not be possible without a special variance.

The upper reaches of San Felipe Creek, which have permanent water, and thus tamarisk, cover approximately 5 km in length. It is assumed, based on observation of the creek, that tamarisk growth covers about 20 meters in width, on average, for those 5 kilometers. There are thus an estimated 100,000 m^2 of tamarisk growth (or about 25 acres) in San Sebastian Marsh. Salt Creek, upstream of the proposed fish barrier, likewise has an estimated 25 acres of tamarisk growth (assuming growth is 20 m wide and 5 km in length above the barrier).

Mechanical removal of tamarisk by bulldozing is relatively easy, efficient and economical. Cost estimates for this method are easy to obtain and don't vary greatly with variable density and size of the tamarisk stands. Bulldozing, root-ripping and re-leveling the land is estimated to cost $520/acre (3.57). However, hand removal (chain saws, shears, etc.), which will be required for most, if not all, of the tamarisk around pupfish habitat, is much more expensive and varies more with different densities, making it difficult to estimate costs. Hand-cutting with chain saws and cutters, then raking, piling, burning, and applying herbicide to the cut stumps has an estimated cost for each of the two habitat areas of $1800/acre ($45,000 for the 25 acres to be controlled). Tamarisk removal will be required on at least an annual basis. The cost of the second year of control is $270/acre or $6,750 for each site (see Section 3.3.8.). Cost estimates for tamarisk removal are outlined in Table 3-1.

3.3.2 Exotic Fish Species Eradication

Recent CDFG surveys indicate that the Salt Creek pupfish habitat has been invaded by tilapia (3.9). Therefore, attempts to protect and enhance the pupfish habitat at Salt Creek will require measures to eradicate this threat to the pupfish. San Felipe Creek currently has no tilapia, and eradication of other exotics found there, including gambusia (mosquito fish) and sailfin mollies, is not recommended. If these other exotics are found to pose a significant threat to the desert pupfish or if tilapia invade San Felipe, then exotic fish removal might be considered for this population as well.

---

* Use of trade names is not an endorsement by the University of California

Table 3-1

Cost Estimate - Tamarisk Removal - Hand Methods

Tamarisk Removal - Hand Methods	
Cutting, Mowing 25 acres x $400/acre	$10,000
Raking, Piling, Burning 25 acres x $400/acre	$10,000
Herbicide Application 25 acres x $100/acre	$2,500
Total x 2 (reasonable scale up factor)*	$45,000

*See Section 3.3.8, number 1.

There are two methods of eradicating exotics. One method applies to lakes and ponds (preferably artificial ponds with drain outlets) and simply involves draining the water, trapping the favorable species in a wire screen, and discarding the exotics. The other method involves chemical treatment to kill exotics. In the easier of the two situations, the water body to be treated has only exotic species. In the other situation, favorable and exotic species exist together, and the favorable species must be removed from the water and held in temporary storage while exotics are eradicated. There is some evidence that selective chemical killing of exotics in the presence of the favorable species can be successful, but this usually requires that the two groups exhibit some clear niche separation (e.g., warm top water versus cold deep water). The Salt Creek situation requires that pupfish be trapped or seined out and held in temporary structures (preferably in a few different locations and types of storage in the event of some unforeseen catastrophe) while the creek is treated with a fish toxicant.

Rotenone, the first widely use fish toxicant, was first used in the United States in 1934 to eradicate goldfish from two small ponds in Michigan (3.58). Fish are generally more sensitive to rotenone than are other aquatic organisms, and the chemical may remain toxic for up to 30 days in cold water. Antimycin A, an antibiotic, is the other most widely used fish toxicant. Antimycin is believed to work by blocking oxygen uptake.

Chemical eradication for situations in which there are not favorable fish species in the waters to be treated is the easier and the more common method for removal of exotics. An example is the use of rotenone and antimycin at Scotty's Castle in Death Valley to eradicate mosquito fish (3.53). Gail Kibetich of the USFWS (3.59) has eradicated gambusia from the Corn Creek ponds in the Desert National Wildlife Refuge. In this example, killifish were present in the ponds and had to be seined out and stored for one week while the antimycin was dissipating. The three ponds were first drained to reduce to a minimum the water to be treated. The antimycin was then "time released" by containing it in a tightly woven cloth bag placed at the headwaters to the series of ponds. The entire process of treating one quarter mile of a 2-3 cfs stream, including draining, seining, and reintroduction, took two weeks. Approximately 200 killifish were seined out and 127 survived to be reintroduced after the chemical treatment.

The BLM proposes to control and eradicate exotics from Salt Creek in cooperation with CDFG (3.37). Proposed methods include chemical controls and electroshock treatment. A particularly insidious aspect of the exotics problem at Salt Creek is that invasion may be occurring from upstream (Dos Palmas area) as well as downstream. Thus, to prevent further invasion from upstream a regulation and enforcement program must be implemented. In addition, a downstream barrier to control invasion from the Salton Sea is proposed. Fish barriers to control exotic fish migration are discussed in the next section.

Any program of exotic fish removal from existing pupfish habitat must be researched thoroughly before implementation to ensure no adverse impacts to the pupfish. It is recommended, given the uncertainty of success and the high cost of failure, that any proposed method be tested first on a small scale. The BLM proposes completion of an environmental assessment prior to implementation of any exotic fish eradication program (3.37).

Salt Creek meanders for approximately 6 miles and the stream bed varies in width from a few to over 50 feet. Since construction of an exotic fish barrier is proposed at about the middle of the creek, only the upper 3 miles must be treated for removal of exotics. Other than the costs of researching the feasibility of alternative methods, the estimated cost of eradication at Salt Creek is $57,000 to $76,000 (see Section 3.3.8). Cost estimates for exotic fish removal are outlined in Table 3-2.

3.3.3 Fish Barriers

As indicated, exotic fish, notably tilapia, pose a significant threat to the viability of pupfish populations. San Sebastian Marsh in San Felipe Creek is presumably free of tilapia at this time. A primary objective of any habitat enhancement program at San Felipe is protection of the pupfish habitat from exotic fish invasion. Construction of a fish barrier in the lower reaches of San Felipe Creek has been recommended as a favorable measure by a number of sources (3.5, 3.9, 3.50). A fish barrier has also been recommended to replace the natural drop barrier that has been washed away at Salt Creek (3.37).

The exact nature and design of an appropriate fish barrier has not been proposed for either site. The most difficult problem to overcome in designing an appropriate fish barrer is the flow regime at the creeks (San Felipe especially). The maximum flow at San Felipe, since 1960 when records were first recorded, is estimated to be 100,000 cfs. Designing a typical drop structure, with a rectangular weir discharge and a 6 - 10 foot drop to prevent fish migration for this maximum flow would result in an unreasonably large and expensive structure. Even designing for a 10,000 cfs flow, which is the maximum estimated flow at Salt Creek since 1961, would result in a large, expensive structure. Also, assuming a typical flood-control-type drop structure was built, the stream course might meander around the structure during a period of extreme flooding.

Other kinds of fish barriers include: rotating screens, electric fences, and chemical barriers. Most efforts in the design and implementation of fish screens have been employed to keep "game" fish in a confined area rather than keep exotic fish out. The specific environmental conditions at San Felipe and Salt Creeks, and the specific goals to be achieved, imply a need for custom designed barriers for each habitat site.

3.3.4 Habitat Isolation

Fencing off the immediate habitat area is recommended to prevent inadvertent or intentional damage to pupfish habitat at Salt Creek and San Felipe Creek. Fencing will pose a deterrent to off-road vehicle use in the area and should also serve to protect against exotic fish invasion, via human vectors, and other human disturbances of the habitat. The estimated length of fence required to contain San Sebastian Marsh and the area of Salt Creek to be protected is approximately 12 kilometers in each case. A 5- to 6-foot barbed wire fence for this length would cost an estimated $59,000 to $69,000. A 5-foot chain-link fence over the same length would cost approximately $138,000 installed. Chain link with barbed wire on the top would cost approximately $157,000 installed over the same length (see Section 3.3.8).

Table 3-2

Cost Estimate - Exotic Fish Removal

Seining, Storage and Reintroduction	$53,600-72,000
(Salaries and equipment)	
($1,500-$2,000) x 36 (scale up factor)*	
Antimycin	$3,600
$100 x 36 (scale up factor)*	
Total (range)	$57,200-75,600

*See Section 3.3.8, number 3

Another recommendation is that the pupfish habitat enclosures be patrolled periodically to further protect against human damage to the habitat. Other measures to consider include restricting access to habitat areas by installing locked gates on appropriate roads and constructing interpretive signs with pupfish information and details of management efforts at offsite locations (near highway-creek intersections). Cost estimates for gates are $1,000 each, and it is assumed that two are required for each site (San Felipe and Salt Creek). Cost estimates for the interpretive signs are $4,000 each.

3.3.5 Water Supply

Providing sufficient water for the pupfish is clearly one of the most important steps to be taken in habitat management. As noted previously, San Sebastian Marsh is fed predominantly by a series of underground springs. Salt Creek surface flow is mainly the result of seepage from the Coachella Canal. Periodic flooding at San Felipe and Salt Creeks is due to heavy precipitation and, perhaps at Salt Creek, to large, periodic discharges from the Coachella Canal into washes draining into the creek.

Efforts to ensure surface flow at San Felipe Creek should focus on protecting the groundwater supply. This would require control of groundwater pumping in the area. Although there is no extensive pumping of groundwater, future development in the area could lead to pumping that would exceed the rate of recharge. Ranch Oasis, an alfalfa farming operation 6 miles northwest of the marsh, is the only significant source of groundwater pumping. The water level in 4 wells at Ranch Oasis declined, on average, about 45 feet during the period from 1954 to 1971. There is some evidence, based on changes in topographic map locations of springs in San Sebastian Marsh, that the water table around the marsh has fallen between 2 and 12 feet since 1956 (3.50). It is recommended that a test well be drilled somewhere between the marsh and Ranch Oasis to determine whether they are supplied by a common aquifer. A 900-foot test well is estimated to cost $3,600. The underground aquifer system in the area is not completely understood. Water quality characteristics from two USGS wells (958 feet and 55 feet) near Highway 86, Harpers Well in the marsh (320 feet), and at a nearby spring, indicate that there may be two separate aquifers, with the deeper one exhibiting some artesian flow and slightly better quality. Acquiring land surrounding San Sebastian Marsh by purchase, exchange, or execution of conservation easements restricting groundwater pumping is an alternative strategy to protect the water source that ensures the continued existence of pupfish habitat.

If the Coachella Canal is lined in the region above Salt Creek, seepage into the creek could be significantly reduced. One possible measure to mitigate this loss of seepage would be to purchase water from the water district and have it fed directly into Salt Creek on a controlled basis. The technical, administrative, and political feasibility of such a measure has not been explored.

3.3.6 Dredging Backwaters and Creating Habitats

Dredging backwaters of tributaries may encourage increased numbers of pupfish, based on the principle of a population increasing in proportion to available habitat. Also, modified or newly created habitat may be designed, in theory, with selective advantages for the pupfish with respect to competing or predatory species (for example, habitat that is very shallow and warm to exclude larger competing fish). The Salt Creek ACEC Management Plan (3.37) proposes dredging backwater areas of the creek by hand or with a small front-end loader and only in the dry wash areas to prevent impacts to adjacent pupfish habitat. Some hand dredging will be required immediately adjacent to existing pupfish habitat. The areas to be modified and the extent of the work will be determined in conjunction with CDFG, USFWS and BLM. The areas will have to be monitored during dry periods and further modified, if necessary, to prevent the formation of isolated pools. The BLM estimates the initial dredging will cost one worker-month and $400 for rental of a front-end loader (3.37). This estimate assumes volunteer assistance in implementation of the plan. A similar plan may be appropriate at San Felipe Creek. However, the extreme flooding, erosion, and sedimentation in these areas (especially San Felipe Creek) may render this alternative impractical. If such an alternative is implemented, it should be carried out on a small scale and evaluated after one season of precipitation, flooding, erosion, and sedimentation.

A more elaborate, engineered measure for creating new habitat would be to construct large fish ponds in areas adjacent to the existing pupfish habitats at San Felipe and Salt Creek. Although an artificial habitat may be aesthetically unappealing in comparison with the natural habitat, and is likely to meet with agency skepticism and opposition, some beneficial aspects of such an approach are as follows. An isolated fish pond would be easier to safeguard from exotics and would provide some form of insurance against a catastrophic loss of pupfish from the natural habitats. The rationale for such an approach is, as for any of the existing refugia, to preserve the gene pool of the species. The proposal for constructing ponds near the natural habitats would differ from the refugium concept by allowing mixing of the different populations and minimizing the problem of genetic divergence. Also, the ponds could be designed to simulate natural habitat, yet be located to avoid the hazards of flooding and erosion and be non-contiguous with the natural waters to reduce the threat from exotic fish.

A nominal design for a fish pond, with cost estimates, is as follows. Assuming an arbitrary size of 1/2 acre, the (USFWS) cost estimate for a lined fish pond, 1/2 acre in size, is $96,000. This is based on the assumption that water would be supplied by pumping groundwater. (This may not be feasible at Salt Creek, where it might be more realistic to divert surface water.) Cost estimates assume that a 300-foot well can be drilled at a total cost of $12,000 and a pump purchased for $13,000, along with 200 feet of piping installed at a total cost of $4,400 (see Section 3.3.8 for all estimates). Although creation of a fish pond may prove infeasible for one reason or another, it is an alternative that should be explored. The cost estimates, outlined in Table 3-3, do not include indirect costs for engineering studies, permits, or contingencies.

3.3.7 Monitoring Requirements

Monitoring requirements for some of the alternative measures have already been discussed. Also required is monitoring of (1) the backwater areas dredged for continuity of flow, (2) the regrowth of tamarisk, (3) groundwater at San Felipe Creek and surface flow at San Felipe and Salt Creek, (4) the presence and abundance of exotic fish in relation to pupfish, (5) the condition of fences and gates, (6) the effectiveness of fish barriers in preventing

Table 3-3

Cost Estimate - Constructing New (Artificial) Habitat - Fish Pond

1/2 Acre, Lined Fish Pond	$92,000
Water Well - 8" diameter 300 ft x $40/ft	$12,000
Pump - 50 gpm diesel	$13,000
Piping - installed 200 ft x $22/ft	$ 4,400
Total	$121,400

upstream migration and the extent of downstream exotic invasion from the Dos Palmos area into Salt Creek, and (7) the populations in artificial ponds as well as the general condition of the ponds and associated equipment.

Monitoring should include biannual fish surveys at Salt Creek and San Felipe Creek. Photographs should be taken twice a year at three or four sites within the creek areas to monitor changes in stream course, surface water, and vegetation. Funding could be provided to the USGS for continuous monitoring of their gauging stations at the mouth of Salt Creek and at the intersection of San Felipe Creek and Highway 86. In addition, flow in permanent water sections of San Felipe Creek and the upper reaches of Salt Creek should be monitored with a simple weir-type gauge. Periodic observations of the fish barriers, fences, and ponds would satisfy the monitoring requirements for those structures. The estimated cost of monitoring the USGS gauging stations for surface flows would be $1,500 for salaries and $3,000 in materials annually. The estimated costs for all other periodic monitoring requirements would be approximately $3,000 in salaries and $12,000 in materials annually (see Section 3.3.8).

3.3.8 Cost Estimates

Cost estimates provided for the pupfish habitat enhancement alternatives are not based on rigorous analyses of well-defined tasks because (1) the feasibility of certain alternatives has not been demonstrated at the habitat sites, and (2) cost estimates are generally based on similar measures implemented under different conditions and at differing scales elsewhere. Individual cost estimates are explained below.

1. <u>Tamarisk Removal</u>

   a) Removal options:

      i) Mechanical removal (bulldozing, root-ripping, and leveling). Bertin Anderson, an Arizona State University researcher in Blythe, California, estimates that this method of removal costs $520/acre. $520/acre x 25 acres = $13,000 for removal at either site. This method of removal is probably unsuited for most, if not all, of the 25 acres.

      ii) Hand methods (chain saws, weed cutters, etc., followed by application of herbicide to the cut stumps). Will Graff (3.54), a professor at ASU at the Center for Southwest Studies, derives the following estimates based on work done by the Arizona Flood Control District for removal of tamarisk.

      $400/acre - cutting with chain saws, large mowing equipment, etc.
      $400/acre - raking, piling, and burning
      $100/acre - herbicide application by hand tools

      $900/acre - total

      It seems reasonable to double this cost for application of this method to sensitive pupfish habitat, which requires less mechanical means and careful implementation. Also, the above do not include rental costs for machines, but do include fuel costs, spare parts, salaries, etc. Thus, \$1,800/acre x 25 acres = \$45,000.

b) Second year maintenance. Will Graff estimates that it would cost \$135/acre to go back the next year and remove the second year growth. Doubling this gives \$270/acre x 25 acres = \$6,750.

2. Fish Barrier

As noted in Section 3.3.3, designing an appropriate barrier will require further site-specific research. Thus, no realistic cost estimate for this alternative can be provided. However, it might be noted that typical drop structures cost approximately \$400 per running foot (3.60) in place (or about \$350/cubic yard). Assuming an arbitrary 100-ft running length yields \$400/ft x 100 ft = \$40,000.

3. Exotic Fish Removal - Salt Creek

The USFWS carried out an exotics eradication project at Corn Creek, as described in Section 3.3.2. The dimensions of Corn Creek are: length - 1/4 mile; width - 1 foot; depth - a few inches to 1 1/2 ft; and flow - 2 to 3 cfs. There were ponds in the stream course 10-ft wide. The whole project, as described in the text, was estimated to cost \$1,500 - \$2,000 in salaries and about \$100 for the antimycin (3.61). The dimensions of the stream area in Salt Creek to be treated are estimated to be as follows: length - 3 miles; width - 3 ft; depth - same as above; flow - same as above. Thus, the treated area at Salt Creek is roughly 36 times that at Corn Creek. Assuming all else to be equal, the scaled up cost for Salt Creek is \$1,600-\$2,100 x 36 = \$57,600-\$75,600. This clearly ignores any economies of scale, but it is assumed that the inherent difficulties in treating a large natural creek, such as Salt Creek, will offset any unit treatment cost savings.

4. Habitat Isolation

a) Fencing options:

i) A 5-foot barbed wire fence (dry post) is estimated to cost \$1.50/linear foot (3.62). It was estimated that about 12 kilometers would be required to fence either of the two creek habitat areas (\$1.50 x 12 km x 3281 ft/km = \$59,058).

ii) A 6-foot chain-link fence (dry post) is estimated to cost \$3.50/linear foot, installed (3.62) (\$3.50 x 12 km x 3281 ft/km = \$137,802).

iii) A 6-foot chain link fence with 3 strands of barbed wire on top is estimated to cost \$4.00/linear foot, installed (3.61) (\$4.00 x 12 km x 3281 ft/km = \$157,488).

b) Roadway gates:
Sixteen-foot wide gates are estimated to cost \$1000 each (3.59).
Note: The referenced USFWS cost estimating guide "(3.59)" contains

generic costs for construction and rehabilitation based on labor, materials, equipment, and services as of July 1982. Indirect costs for engineering, contingencies, assessment, clearances, studies, permits, etc., are not included.

c) Interpretive signs.
The estimated cost is $4,000 each and is based on a "small entrance sign" (3.59).

5. Water Supply

a) Land aquisition/conservation easement:
The cost of acquiring land or easements could be substantial, and the range of estimated costs for the various acquisition options is wide. The exact figure will depend on which option (purchase, exchange, easement, etc.) is implemented to secure an adequate water supply. No estimates are available at this time.

b) Test well:
The estimated cost for drilling, casing and testing an 8-inch diameter well is $40/ft (3.59). Nine hundred feet is the assumed depth to the deeper aquifer located midway between Ranch Oasis and San Sebastian Marsh (900 ft x $40/ft = $36,000).

6. Dredging Backwater Areas of Tributaries

This estimate comes almost directly out of the BLM's ACEC Management Plan for Salt Creek. It was estimated that a dredging program would require 1 worker month and $400 for rental of a front-end loader (3.37). Assuming that one month's salary, benefits, etc., is $3,000, the estimated cost of the program is $3,400. The BLM estimate assumed "volunteer groups would be contacted for assistance." The extent of the area to be dredged was not specified in the plan, but is to be determined in cooperation with CDFG and USFWS. Thus, $3,400 represents a low estimate of what it might cost to perform dredging on even a limited basis.

7. Creating New (Artificial) Habitat

The estimates given below are not for a pond designed specifically for either of the two habitat sites under consideration for enhancement. Rather, the estimates are for a generic design, which may or may not be applicable to the specific sites, in order to give a rough idea of the cost of creating artificial habitat.

a) A 1/2 acre, lined fish pond.
The estimated cost for such a pond is $92,000 (3.59).

b) Water well.
It is assumed that groundwater from the deep aquifer, needed to supply the pond, will be found at 300 ft. The estimated cost of an 8-inch diameter well is $40/ft (300 ft x $40/ft = $12,000).

c) Pump.
Since the characteristics of the groundwater basin are unknown, the pump capacity must be arbitrarily chosen. Assuming a 50-gpm diesel powered pump can be used, its estimated cost is from $8,500 - $14,000 (3.63) for a vertical turbine with an 8-inch casing and a 300-foot setting; We have assumed a cost of $13,000.

d) Piping.
Assuming 200 feet are needed at an installed cost of $22/ft (3.58), the total cost would be 200 ft x $22/ft = $4,400.

8. Monitoring Requirements

a) Water gauging stations.
BLM's ACEC Management Plan assumes that funding could be provided to USGS for continuous monitoring of the gauging station at Salt Creek at an annual cost of ½ worker month (assume $1,500) and $3,000 in other costs (3.37) ($1,500 + $3,000 = $4,500).

b) Fish surveys, photo plots, patrols, etc.
The ACEC plan estimated that annual fish surveys and biannual photo surveys at 3 locations on Salt Creek would cost ½ worker month ($1,500) and $6,000 in other costs. The additional monitoring we have recommended (including upstream flow measurements; observations of fish barriers, fences, and ponds; additional photo and fish surveys; and periodic patrols of the sites) provided the rationale for doubling the BLM cost estimates [($1,500 + $6,000) x 2 = $15,000].

3.3.9 Summary of Mitigation Alternatives and Research Needs

Tamarisk Removal. Given the potential negative impacts (mostly increased erosion and herbicide use) associated with a large-scale tamarisk removal program and the uncertain nature of the benefits (reduced water loss), it is recommended that tamarisk removal be implemented on an experimental plot, on a small scale. A plot along the lower reaches of Salt Creek could be used to evaluate the feasibility of hand removal methods and the potential environmental impacts. The potential benefits of tamarisk removal, with respect to amounts of water saved, should be quantified. This could involve compiling the best estimates from the literature for transpiration rates of tamarisk and the vegetation that would be expected to replace it, and comparing them to get expected savings in water. Alternatively, lysimetry experiments could measure evapotranspiration rates of the various vegetation types directly. A full-scale tamarisk removal program would depend on an analysis of the environmental costs versus the expected benefits and acceptance by, and cooperation with, BLM, CDFG, and USFWS.

Exotic Fish Species Eradication. The high risk and relative importance of this measure require that it be implemented on an experimental basis initially. A logical choice again would be the lower reaches of Salt Creek as this would allow for evaluation of a particular method of eradication under conditions essentially the same as those in the better pupfish habitat areas in the higher reaches of Salt Creek. The exact nature of the method of eradication would be determined in cooperation with the BLM, CDFG, and USFWS. Prior to implementation of any eradication alternative, an environmental assessment is to be prepared by BLM. Consideration of financial support for such an assessment is recommended.

Fish Barriers. The difficulties and uncertainties in designing an appropriate fish barrier at San Felipe Creek or Salt Creek were noted in Section 3.3.3. An engineering analysis of the environmental conditions and design of the barrier is necessary. Construction of a fish barrier may be a particularly important measure for the following reasons. The need for an exotic fish barrier has been pointed out by Black (3.5) and has been affirmed by others (3.37, 3.50). The construction of a fish barrier downstream from Highway 86, on San Felipe Creek, may represent a unique opportunity to directly implement a habitat enhancement measure. This measure may be relatively free of regulatory and agency restrictions because the location is outside of proposed critical habitat designations by BLM and USFWS.

Habitat Isolation. Fencing, patrolling, restricting road access, and interpretive signs are measures which have been proposed by others (3.37, 3.50) for the two habitat sites. These measures require appropriate agency involvement and cooperation.

Water Supply. A need exists for a comprehensive understanding of the groundwater basin feeding San Sebastian Marsh. A test well between the marsh and areas of groundwater withdrawal for agriculture would be helpful in this regard. Another possible option to ensure a more secure water source would be acquisition (purchase or exchange) of private lands surrounding the marsh. This may prove prohibitively expensive and the usefulness of it will depend on results from a comprehensive groundwater basin study.

Dredging Backwaters of Tributaries and Creating Habitat Areas. Dredging should be tested on a small scale to determine its effectiveness in expanding pupfish habitat. This could be done at a test plot along the lower reaches of Salt Creek. Evaluating the engineering feasibility of creating a secure pond near the natural habitat is also necessary. The practical feasibility, in terms of CDFG, BLM and USFWS acceptance of this concept, should be determined, as these agencies will have an integral role in this or any other measure adopted in either of the two critical habitat areas.

Monitoring Requirements. It is recommended that consideration be given for financial support of the monitoring requirements discussed in Section 3.3.7.

3.3.10 Summary

Desert pupfish no longer occur within their known historic range along the Colorado River and within numerous springs in the Salton Sink area. Pupfish do occur in three basic habitats around the Salton Sink area: (1) artificial refugia, (2) marginal habitats in and around the Sea (irrigation drains, shoreline pools, etc.), and (3) tributaries to the sea, principally the natural desert spring habitat of San Felipe Creek and Salt Creek, which is fed predominately by irrigation water leakage. Desert pupfish also occur outside of the Salton Sink area in Quitobaquito springs, Arizona, and in the Sonoyta River drainage in northern Mexico.

The physical habitat requirements for the pupfish are well known. Pupfish can withstand fairly extreme levels of salinity, temperature, and dissolved oxygen. They tend to prefer shallow, warm, slow moving water and rooted aquatic plants and filamentous algae. Pupfish favor heterogeneous substrate for breeding territories.

The major threats to the pupfish are (1) exotic fishes, notably Zill's cichlid (Tilapia zillii), which interfere with reproductive behavior or pose a threat through competition and predation, and (2) habitat loss due to agricultural and urban development, water level fluctuations, irrigation drain maintenance and dredging, and groundwater pumping.

Basic mitigation alternatives considered for the pupfish are as follows:

1. Protecting existing habitat. The only areas of natural habitat with viable populations to be protected are San Felipe and Salt Creeks.

2. Refugia. Artificial habitat construction is an inferior approach to protecting the pupfish.

3. Captive Rearing. This option is considered only in conjunction with reintroduction of pupfish into natural habitat, which has been done in Arizona, but doesn't appear feasible in the Salton Sink area.

4. Creating New Habitat. Consideration was given to dredging and expanding the backwater areas of San Felipe and Salt Creeks. Also discussed was construction of refugium ponds, discontinuous but adjacent to the natural creeks, as insurance against catastrophic loss of the creek populations.

Specific measures proposed for habitat enhancement include the following.

1. Tamarisk Removal. Research is required to develop efficient hand removal methods with minimal impacts to critical habitat areas, an expensive measure with uncertain benefits.

2. Exotic Fish Eradication. Research is required to determine feasibility. Exotic fish eradication is potentially very beneficial to Salt Creek populations especially.

3. Fish barrier. Research is required to determine feasibility. The most pressing need is for a barrier to protect the upper reaches of San Felipe Creek. If feasibility is proven, a fish barrier may provide the best single measure to be undertaken in terms of (1) benefits to the pupfish, (2) lack of land acquisition issues, (3) lack of negative impacts to habitat, and (4) "visibility". This conclusion rests on locating the barrier on San Felipe creek, just east of highway 86 away from the habitat area.

4. Habitat Isolation. This includes fencing and patrolling the habitat areas at Salt and San Felipe Creeks.

5. Water Supply. Test wells for a comprehensive groundwater study are required to determine the effect of future pumping on spring flow at San Felipe Creek.

6. Dredging Backwaters and Creating Habitats. This option requires determining the feasibility of dredging or creating a refugium-type fish pond in or around desert pupfish habitat. This measure is a good idea in theory, but the feasibility and impacts of such a project are uncertain.
7. Monitoring. Monitoring is required to test the effectiveness of any mitigation measures in preventing tamarisk regrowth and exotic fish abundance, for example, and also to measure the abundance of pupfish.

The issue of land acquisition is vitally important in habitat enhancement. This was not treated specifically in Section 3 due to the complex ownership patterns and ongoing acquisition efforts by government agencies that are described in detail in Section 2.1. Other important issues such as regulatory restrictions, management responsibilities, and the permits required for specific mitigation measures under consideration were similarly not addressed in Section 3. A more generic description of these issues is found in Section 2.2. The cost estimates provided for specific measures are intended to give a rough idea of their costs, ignoring the costs of land acquisition, regulatory compliance, and permits.

3.4 References

3.1 Black, G.F. Fisheries Biologist. California Department of Fish and Game, Chino, California. Personal communication (1982).

3.2 Miller, R.R. "The Status of Cyprinodon macularius and Cyprinodon nevadensis, Two Desert Fishes of Western North America." Univ. Mich. Mus. Zool. Occ. Papers (1943).

3.3 Cowles, R.B. "Notes on the Ecology and Breeding Habitats of the Desert Minnow Cyprinodon macularius, Baird and Girard." Copeia 1:40-42 (1934).

3.4 Barlow, G.W. "Social Behavior of the Desert Pupfish Cyprinodon macularius, in the Field and in the Aquarium." Am. Midl. Nat. 65(2):330-359 (1961).

3.5 Black, G.F. "The Status of the Desert Pupfish Cyprinodon macularius (Baird and Girard) in California." Inland Fisheries Endangered Species Program - Special Publication 80-1. March (1980a).

3.6 Schoenherr, A. Professor of Biology, Fullerton College. Personal Communication (1982).

3.7 Moyle, P.B. Inland Fishes of California. University of California Press, Berkeley, California (1976).

3.8 Barlow, G.W. "High Salinity Mortality of Desert Pupfish, Cyprinodon macularius." Copeia 1958(2):231-232 (1958b).

3.9 Moore, K. Fisheries Biologist. California Department of Fish and Game. Personal communication (1982).

3.10 Naiman, R.J. "Preliminary Food Studies of Cyprinodon macularius and Cyprinolan nevadensis (Cyprinodontidae)." Southwestern Naturalist 24(3):527-556 (1979).

3.11 Cox, T.J. "The Food Habitats of the Desert Pupfish (Cyprinodon macularius) in the Quitobaquito Springs, Organ Pipe National Monument, Arizona." J. Ariz. Acad. Sci. (1):151-156 (1972).

3.12 Legner, E.F., R.A. Medved, and W.J. Hauser. "Predation by the Desert Pupfish, Cyprinodon macularius on Culex Mosquitoes and Benthic Chironomid Midges". Entomophaga 20(1): 23-30 (1975).

3.13 Loiselle, P. Personal communication, as cited in Schoenherr, Reference 3.32.

3.14 Barlow, G.W. "Daily Movements of Desert Pupfish, Cyprinodon macularius, in Shore Pools of the Salton Sea, California". Ecology, 39(3): 580-87 (1958a).

3.15 Kodric-Brown, A. "Establishment and Defense of Breeding Territories in a Pupfish (Cyprinodontidae: Cyprinodon)". Anim. Behav. 26(3):818-834 (1978).

3.16 Crear, D., and J. Haydock. "Laboratory Rearing of the Desert Pupfish, Cyprinodon macularius". Fishery Bull. 69(1):151-156 (1971).

3.17 Hubbs, C.L., and R.R. Miller. "Studies of the Fishes of the Order Cyprinodontes XVII. Genera and Species of the Colorado River System." Univ. Mich. Mus. Zool. Occ. Papers, 433:1-9 (1941).

3.18 Schoenherr, A.A. "Niche Separation Within a Population of Freshwater Fishes in an Irrigation Drain Near the Salton Sea, California." Bull. So. Cal. Academy Sci. 78(1):46-55 (1979).

3.19 Naiman, R.J., and D.J. Soltz (Eds.). Fishes in North American Deserts. Wiley - Interscience, New York (1981).

3.20 Kinne, O. "Growth, Intake and Food Conversion in a Euryplastic Fish Exposed to Different Temperatures and Salinities." Physiol. Zool. 33:288-317 (1960).

3.21 Lowe, C.H., and W.G. Heath. "Behavioral and Physiological Responses to Temperature in the Desert Pupfish, Cyprinodon macularius." Physio. Zool. 42(1):53-59 (1969).

3.22 Kinne, O., and E.M. Kinne. "Rates of Development in Embryos of a Cyprinodont Fish to Different Temperature-Salinity-Oxygen Combinations." Can. J. Zool. 40:231-253 (1962).

3.23 Brown, J.H. "The Desert Pupfish." Sci. Amer. 225:104-110 (1971).

3.24 Soltz, D.L., and R.J. Naiman. The Natural History of Native Fishes in the Death Valley System. Los Angeles Co. Nat. Hist. Mus. Sci. Ser. 30 (1979).

3.25 Schrode, J.B. and S.D. Gerking. "Effects of Constant and Fluctuating Temperatures on Reproductive Performance of a Desert Pupfish, Cyprinodon n. nevadensis." Physiol. Zool. 50(1):1-10. (1977).

3.26 Echelle, A.A., C. Hubbs, and A.F. Echelle. "Developmental Rates and Tolerances of the Red River Pupfish, Cyprinodon rubrofluviatilis." Southwest Nat. 17(1):55-60 (1972).

3.27 Smith, M.L., and B. Chernoff. "Breeding Populations of Cyprinodontoid Fishes in a Thermal Stream." Copeia 1981(3):701-702 (1981).

3.28 Coleman, G.A. "A Biological Survey of Salton Sea". California Fish and Game, 15(3): 218-27 (1929).

3.29 Gerking, S.D., and R.M. Lee. "Reproductive Performance of the Desert Pupfish (Cyprinodon n. nevadensis) in Relation to Salinity". Env. Biol. Fish. 5(4):375-378 (1980).

3.30 Lowe, C.H., D.S. Hinds and E.A. Halpern. "Experimental Catastrophic Selection and Tolerance to Low Oxygen Concentrations in Native Arizona Freshwater Fishes." Ecology 48(4):1013 (1969).

3.31 Norris, L.L. "Fish of the Desert." Western Tanager 47(5):1-3 (1981).

3.32 Schoenherr, A.A. "The Role of Competition in the Replacement of Native Fishes by Introduced Species." In Naiman, R.J., and D.L. Soltz, Eds. Fishes in North American Deserts. Wiley-Interscience, New York (1981).

3.33 Walker, B.W. (ed.) The Ecology of the Salton Sea, California, in Relation to the Sportfishery. Calif. Dept. of Fish and Game, Fish Bull. No. 113 (1961).

3.34 Soltz, D.L. "Fishes in the California Desert." In Southern Calif. Audubon Chapters, "Wildlife in the California Desert: Is There a Future? Nat. Audubon Society (1979).

3.35 Deacon, J.E., and S. Bunnell. "Man and Pupfish". Cry Calif. 5(2):14-21 (1970).

3.36 Pister, E.P. "Desert Fishes and Their Habitats." Trans. Amer. Fish. Soc., 103(3):531-40 (1974).

3.37 Davis, F. Salt Creek Desert Pupfish/Rail Habitat Area of Critical Environmental Concern Management Plan. U.S. Bureau of Land Management, Riverside, California (1982).

3.38 Herre, A.W. "American Cyprinodont in Phillipine Salt Ponds". Phillipine Jour. Sci. 38-121-126 (1929).

3.39 Black, G.F. "Fisheries Survey of Salt Creek and the Springs and Seeps in the Dos Palmos Area". California Department of Fish and Game, Fisheries Report (1980b).

3.40. Black, G.F. "Fisheries Survey of Salt Creek Drainage." California Department of Fish and Game, Fisheries Report (1980c).

3.41 Minckley, W.L. Fishes of Arizona. Arizona Game and Fish Dept. (1973), pp. 186-194.

3.42 Deacon, J.E., and W.L. Minckley. "Desert Fishes". In G.W. Brown, Jr., ed., Desert Biology, Vol. II. Academic, New York (1974), pp. 385-488.

3.43 Deacon, J.E., C. Hubbs, and B.J. Zahuranek. "Some Effects of Introduced Fishes on the Native Fish Fauna of Southern Nevada." Copeia 2:384-388 (1964).

3.44 Williams, J.E. Endangered Species Biologist. U.S. Fish and Wildlife Service, Sacramento, Calif. Personal communication (1982).

3.45 Hanson, D.J. "Avoidance of Pesticides by Untrained Sheepshead Minnows." Trans. Amer. Fish Soc. 98(3):426-429 (1969).

3.46 Bureau of Land Management. Final Environmental Assessment #CA 066-2-4. Potential Impacts Resulting from Leasing of the Hydrocarbon Resources at the Salton Sea, Riverside and Imperial Counties, California. California Desert District Indio Resource Area Office, Indio, CA. March (1982).

3.47 California Department of Fish and Game. At the Crossroads 1980: A Report of California's Endangered and Rare Fish and Wildlife. California Department of Fish and Game, Sacramento, California (1980).

3.48 Kepner, W.G. Aquatic Ecologist, U.S. Bureau of Land Management Phoenix District Office, Phoenix, Ariz. Personal Communication (1982).

3.49 U.S. Fish and Wildlife Service, Moapa Dace Recovery Plan. Portland Oregon. Sept. (1982a).

3.50 Lebo, A., L. Nitikman and C. Salmen (Eds.). San Sebastian Marsh. Publication No. 9. Environmental Field Program, University of California, Santa Cruz (1982).

3.51 U.S. Geological Survey. Water Resources Data for California: Water Data Report CA-80-1. USGS Water Resources Division, August (1981).

3.52 Sanchez, P.G. "Tamarisk Fact Sheet". Desert Bighorn Council Transactions (1975).

3.53 Sanchez, P.G. Resources Management Specialist, Death Valley National Monument, Death Valley, CA. Personal Communication (1982).

3.54 Graff, W. Professor, Center for Southwest Studies, Arizona State University, Tempe, Arizona. Personal Communication (1982).

3.55 Bureau of Land Management. California Desert Conservation Area Plan, U.S. Dept. of the Interior, Desert District, Riverside, CA (1980).

3.56 Meyer, F.A., "Aquatic Plant Control". In A. Calhoun, ed., Inland Fisheries Management, California Resources Agency, Department of Fish and Game (1966), pp. 70-95.

3.57 Anderson, B. Research Scientist. Arizona State University, Center for South West Studies, Blythe, CA. Personal communication (1982).

3.58 Bennett, G.W. Management of Lakes and Ponds. Van Nostrand Reinhold Company, New York, N.Y. (1970).

3.59 U.S. Fish and Wildlife Service. Office of Engineering. Rehabilitation and Cost Estimating Guide. July (1982b).

3.60 Carlassare, M. Chief, Design Section, U.S. Army Corps of Engineers, Los Angeles, CA. Personal Communication (1982).

3.61 Kobetich, G. Field Supervisor, Endangered Species Program, U.S. Fish and Wildlife Service, Sacramento, California. Personal Communication (1982).

3.62 Allen Fence Company, Desert Hot Springs, California, Cost Estimation (1982).

3.63 Harmon Pump Co. Cost Estimation. 1110 East 14th St., Los Angeles, CA 90021 (1982).

4.0 THE YUMA CLAPPER RAIL

4.1 Species Description

4.1.1 Life History

The Clapper Rail, or "marsh hen," is a large, 14-16 1/2 in. (36-42 cm) gray-brown, tawny breasted bird. It has a henlike appearance with strong legs, a long, slightly decurved bill, heavily barred flanks, and a white patch under a short tail (4.1). The Yuma Clapper Rail (Rallus longirostris yumanensis Dickey) is the smallest and palest of the three subspecies in California, described as relatively pale brown with pointed wings (4.2). Additional background on the taxonomy can be found in Banks and Tomlinson (4.3; 4.4).

Unlike most Clapper Rails, the Yuma subspecies can be found during the breeding season in freshwater habitat inland from coastal areas (4.5). It is a resident of fresh or brackish marshes along the Colorado River from Needles in San Bernardino County south to the delta area in Mexico. In addition, the bird is found in marsh surrounding the Salton Sea (see Figure 4-1 and Table 4-1). It is believed that there has been a relatively stable population of about 700 breeding birds in the United States each year since 1973 (4.6). There is, however, strong disagreement with this statement among the recovery team (4.7). As shown in Table 4-1, the Salton Sea has only been infrequently censused, so population size estimates are extremely variable.

The breeding season at the Salton Sea runs from the end of March to early October. There are two styles of nest construction. When built over the water, the nests are tied into cattail stems and located 13 3/4 - 21 1/4 in (35-54 cm) above the water surface. These nests all have a "ramp" of fallen cattail leading up from the water surface. When the ground under the nests is reasonably dry, the nests are located on fallen cattail 2 - 6 1/4 in (5-16 cm) above the surface; these nests have no ramp. The average egg count prior to hatching is 7.8 eggs per nest; hatching dates range from 19 May to 14 June with most eggs hatching during the first week in June. Hatching success is 90%, and immature mortality about 80%. Constant water level is extremely important as the downy chicks cannot swim. Most nests are located over water from 1/2 - 6" (1-15 cm) in depth. In all nests that are over water deeper than 2 3/4" (7 cm), there is a ramp of fallen cattail tied into the nest and leading to a mud flat or to high ground. It should be noted that the highest numbers of crayfish, a major food item, are found in water partly covered with floating vegetation, 2 1/4 - 4" (6-10 cm) deep, and near flowing fresh water (4.9).

Bennett and Ohmart (4.9) observed only a small overwintering population of 9 rails in January at the Salton Sea. The migration characteristics of the rail are controversial. McKaskee (4.12), an ornithologist who visits the Salton Sea frequently, questions whether migration occurs at all. Ohmart (4.13) believes that migration occurs but that the number of individuals migrating has decreased as more marsh habitat has become available, particularly along the Colorado River. The controversy surrounding migration will not be resolved until telemetry studies are performed on at least 10-15 rails. The exact winter habitat is therefore not known (4.5). Other information that should be obtained concerns the necessity for continuity of marsh

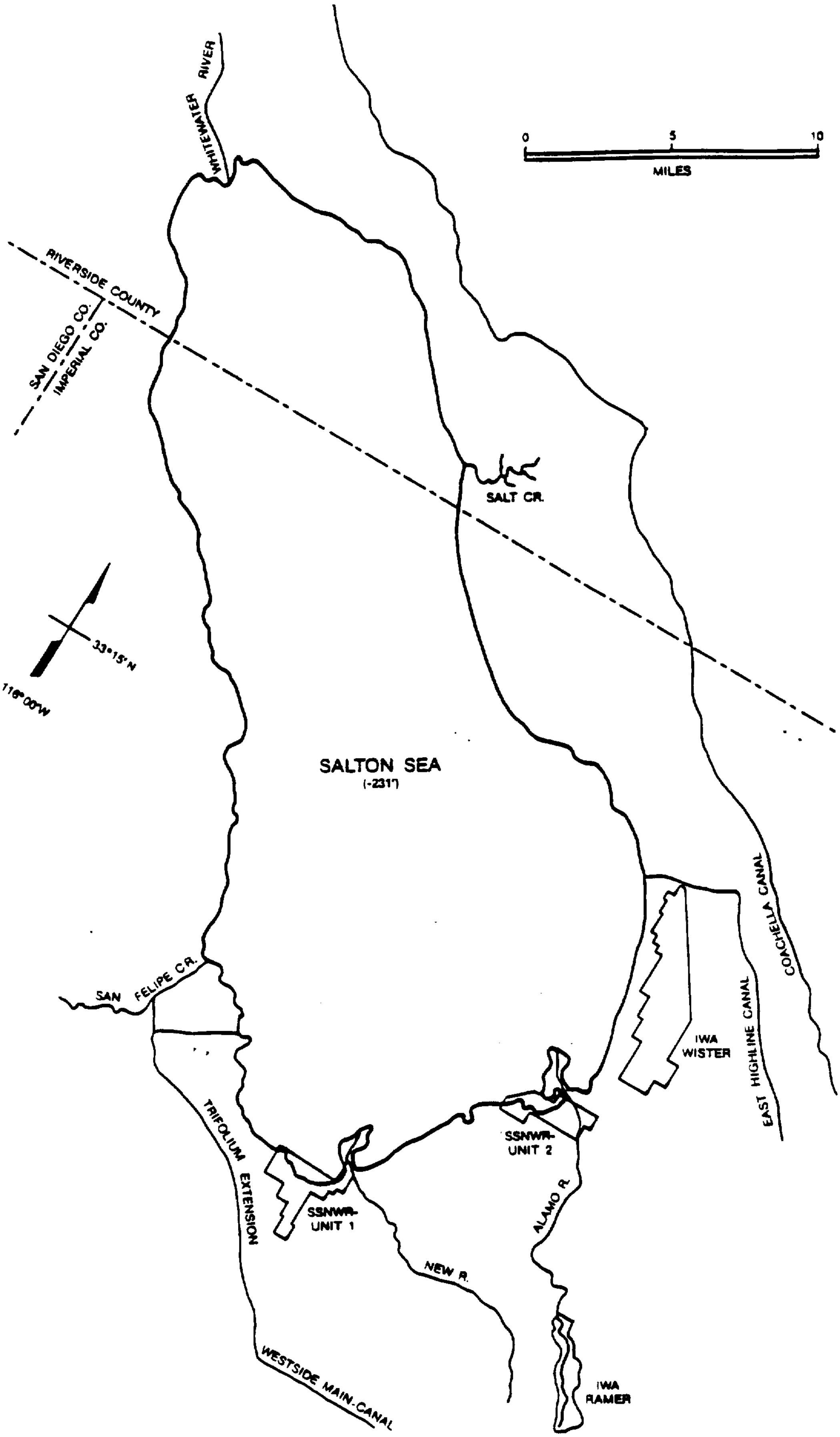

Figure 4-1. Yuma Clapper Rail Habitats, Salton Sea Area

Table 4-1

Survey Results - Yuma Clapper Rail

	1973[1]	1974[1]	1978[2]	1981[3]	1982[4]
Colorado River	668	681	n.s.[5]	592	421
Salton Sea	n.s.	134	182	55	n.s.
U.S. Sub-Total	668	815	182	647	421
Colorado River Delta, Mex.	145	104	n.s.	41	n.s.
Total	813	919	182	688	421
Salton Sea					
IWA[6] - Wister		86	94	19	
- Finney - Ramer		5	6	7	
SSNWR[7]		15	33	29	
Alamo R. Delta		12	9	n.s.	
New R. Delta		16	18	n.s.	
Whitewater R. (BLM)		0	2	n.s.	
Salt Cr. (BLM)		0	14	n.s.	
Coachella Canal Seeps[8]		n.s.	6	n.s.	

Notes

[1]Ref. 4.8

[2]Ref. 4.9

[3]Ref. 4.10

[4]Ref. 4.11

[5]not surveyed

[6]Imperial Wildlife Area (State)

[7]Salton Sea National Wildlife Refuge (Federal)

[8]No longer exists due to canal lining

habitats and the impact of power transmission lines across migration lines, because the rail flies very low (4.7).

4.1.2 Habitat Requirements

The habitat requirements of the Yuma Clapper Rail are described in several reports (4.9, 4.12, 4.15, 4.16, 4.17). The preferred breeding habitat consists of freshwater marshes with (1) mature cattail (*Typha* spp.), bulrush (*Scirpus* spp.) or carrizo (*Phragmites* spp.) as the dominant emergent vegetation, (2) constant, shallow water levels, (3) abundant crayfish, and (4) high ground proximally located with a gentle slope between the shoreline and high ground.

Available literature on vegetation preference does not indicate an absolute preference for cattail, bulrush, or carrizo. Bennett and Ohmart (4.9) found that territorial selection was related to vegetation. Dense cattail was used more than expected, while carrizo was significantly underutilized, based on the proportion of each habitat available. All paired rails were located in cattail, or bulrush associated with cattail, and although foraging occurred in various types of vegetation, the rails returned to the cattail at night. Anderson *et al*. (4.18) observed that rails used a variety of habitats, including cattail, bulrush, and carrizo. A recent analysis (4.17) found that Yuma Clapper Rails were located about equally in carrizo and in bulrush or cattail dominated areas, while both Smith (4.17) and Gould (4.8) found little or no preference for carrizo over cattail and bulrush. This variation in choice of vegetation could be related to the locations studied. Since Bennett and Ohmart (4.9) surveyed the Salton Sea region, the results of their study are used to determine habitat requirements around the Salton Sea.

Besides the actual type of vegetation present, vegetation density, percentage of surface area covered by fallen vegetation and open water availability are important habitat characteristics to be considered. Smith (4.19) found that sparse cattail regions (<75 stems/m^2) had a higher rail population with a lower percentage of habitat available, while Bennett and Ohmart (4.9) found the highest rail population where the mean stem density was 79.6 stems/m^2. Smith (4.19) observed that regions with a greater than 5% surface coverage by floating vegetation maintained the highest rail density. Presumably the floating or fallen vegetation provides surface area on which the rails walk while feeding. Open water is usually present in rail habitat (4.17).

A constant, shallow water level constitutes a critical habitat requirement because it affects vegetation growth, crayfish abundance, and chick mortality. Cattail will grow in water depths from as great as 3 1/2 feet (1 m) to as little as damp mud (4.20), and the highest crayfish density is found in depths of 6 to 10 cm. Fluctuating water levels may lead to increased chick mortality. An increase in water level would result in an increase in depth beneath the nest, an increase in distance to shore, and early abandonment of the nest. Rail chicks are not proficient swimmers as the down tends to mat rapidly (4.21). Bennett and Ohmart (4.9) hypothesized that the high chick mortality observed was due to drowning. Predation, another possible cause of mortality, was not observed to be a problem.

Crayfish (Procambarus sp. and Orcopectes sp.) are the principal food supply for the rail (4.22). The seasonal presence of the rail in the region of the Salton Sea is very closely correlated with the appearance of crayfish. Crayfish density is dependent on water depth, floating vegetation and flowing water. The greatest number of crayfish are found near slowly flowing fresh water (either a pond inlet or along a stream bank) that is 6 to 10 cm deep and partly covered with vegetation (4.9). Smith (4.23) found that crayfish were never located in open water more than 0.7 meters deep. The previously mentioned requirement that greater than 5% of the habitat surface be covered by floating vegetation relates to crayfish as well as the rail. Additional food sources for the rail include small fish, isopods, water beetles, snout beetles and other insects, and small seeds (4.22).

Topographic features important for rail habitat include a minimum required area and a gently sloping region between the nesting location and some high ground. Gould (4.8) found that in all the habitats surveyed, 68% of the rails located were in areas greater than 8 hectares (20 acres). Bennett and Ohmart (4.9) found that the territory for unpaired birds ranged from 0.32 to 0.70 ha with a mean of 0.48 ha; for paired birds it ranged from 0.27 to 0.71 ha with a mean of 0.47 ha. Territories of rails with neighbors were smaller than those without adjacent rails, and territory size in dense cattail was significantly smaller than in sparse cattail.

Rails use the high ground mainly for "loafing" and for rearing of their young. Dikes and levees usually provide the necessary high ground in the Imperial Valley, although rails do not appear to use dikes over 40 cm high. Steep banks are also avoided. Bennett and Ohmart (4.9) hypothesized that the reason so few rails were located near Finney Lake in the Imperial Wildlife Area was its steep banks.

In summary, the following should be considered as requirements for a successful Yuma Clapper Rail habitat:

1. A freshwater marsh with a minimum of 8 hectares
2. Cattail (ca. 75 stems/m^2) or bulrush, with >5% surface area covered by fallen vegetation
3. Abundant crayfish
4. A constant water level with a depth less than 1 foot
5. Flowing water
6. Proximal high ground, with gentle slope from shoreline
7. Open water

The suggestion by Ohmart (4.13) concerning the possibility of a decrease in the number of rails migrating to Mexico justifies providing marsh land with the above requirements throughout the year.

4.1.3 Environmental Pressures

Destruction of freshwater marsh habitat due to the development of marshlands, water development projects, and fluctuating water levels constitutes the most significant environmental pressure affecting the Yuma Clapper Rail. Accidental death or injury due to hunting or migration currently appears to present a less important danger. Some potential future problems include a loss of food supply resulting from water quality problems, i.e., increased salinity levels or pesticide concentrations, and a loss of the minimum habitat necessary for the continuity of migration from Mexico to Needles, the present northern limit in the United States, and to the Salton Sea.

Water development projects requiring dam construction, channelization, and dredging have both created and destroyed rail habitat, particularly along the Colorado River. Both the formation of impoundments and regulated water releases decrease the river flow rate, permitting increased sedimentation and initiation of marsh development. Unfortunately, frequent dredging and channel manipulation interrupt this process. Overall, the creation of new marsh habitat resulting from dam construction, in conjunction with formation of the Lower Colorado River Management Program Coordinating Committee and Work Group to coordinate development with minimal habitat destruction, has led to an increase in habitat along the Colorado River as compared to 50 years ago (4.6, 4.13).

The dependence on a constant, shallow water level is the most serious problem for the rail. This requirement is important to ensure both the food supply and the preferred vegetation and perhaps to minimize chick mortality. Around the Salton Sea two phenomena, the rising sea level and uncontrolled irrigation runoff, have resulted in habitat loss. Until 1981, the rising sea level resulted in the inundation of freshwater habitat (4.24). In the past year the level has decreased, a situation that can be attributed to several factors, including the current conservation practices of the Imperial Irrigation District, a decrease of acreage planted in highly water consumptive crops such as cotton and sugar beets, and local weather patterns (4.25). If this trend continues, more habitat should become available.

Irrigation runoff and water releases by the water districts explain the continued existence of the Salton Sea and the surrounding freshwater marsh. When uncontrolled, the runoff and releases can cause water fluctuations that are unacceptable to proper rail habitat development. Regulation of water flow through management practices at the IWA-Wister Unit and the Salton Sea National Wildlife Refuge (SSNWR) has increased rail habitat in those regions (4.26, 4.27). Uncontrolled water flow is currently a serious problem at Salt Creek, Whitewater Marsh, and San Felipe Creek. These areas all have suitable rail habitat, but the water flow must be controlled for successful management.

Loss of food supply does not currently represent a threat. Crayfish are available where the appropriate rail habitat exists. The possibility of crayfish kills due to high pesticide concentrations or increased salinity should be studied. The New and Alamo Rivers currently have a salinity level of 3,200 to 3,600 mg/l (4.24). At this level there are no apparent adverse effects on crayfish populations; however, periodic water quality and biological monitoring of the crayfish population is recommended.

The threat to the rail population from both hunting and migration hazards appears minimal. A majority of the rails migrate south before the hunting season, and the secretive nature of the rail provides the remaining population with some protection (4.17).

The minimum aggregate habitat area in Mexico and the United States required for rail survival must be determined. Since the rail is not a strong flyer, short hops seem to be the most probable migration mechanism (4.7). If this is the case, suitable habitat must be available along the migration corridor in order for the species to survive.

4.1.4 Current Protection Efforts

The Yuma Clapper Rail is listed as rare on the California Endangered Species list and endangered on the federal list (4.2). Regulations relating to the protection of endangered species can be found in the California Administrative Code, Title 14, Section 670.5, and the Code of Federal Regulation, Title 50, Part 17. A recovery team has been formed and a draft recovery plan circulated (4.6). Once the plan is accepted, critical habitat will be designated.

Current efforts to manage the rail include several activities. The goal of most long-term projects is usually extensive management, involving construction of dikes and levees for water-level control combined with habitat construction or enhancement. Excellent examples of such management practices are the Topock Marsh project on the Colorado River and the IWA-Wister Unit management program.

South of Needles, along the Colorado River, the Bureau of Reclamation, upon request by the USFWS, enhanced Topock Marsh for rail habitat in 1973. The north and south extremities of the marsh were diked for water-level control. Dredging spoils, deposited in various locations in the marsh, provided the shallow water necessary for cattail and bulrush growth. Islands, formed in such a fashion, were indistinguishable from other islands in the marsh within four years (4.28). The islands have not proven to be very attractive to rails, while the population around the dikes has increased significantly (4.29). This could be due to the limited size of the islands and demonstrates the need for a minimum required habitat area. Nonetheless, this project does demonstrate the feasibility of creating a successful habitat.

At the Salton Sea, a much more artificial rail habitat has been created (4.26, 4.27, 4.30). Water, diverted throughout the year into rectangular holding ponds formed by the construction of levees, allows for growth of cattail and bulrush and for the presence of crayfish. Water level in the ponds is controlled by regulation of input and by drop buckets that direct overflow by gravity into a lower holding pond. In the center of several holding ponds, islands are formed by deposition of dredging spoils. Management activity on these islands is minimal, since the more acceptable habitat containing dense cattail and sufficient fallen vegetation develops with little or no intervention and maintenance. At the IWA-Wister Unit, the preferred vegetation for rails grows beside the levees along the drainage ditches and is not removed. The rails have been observed using this vegetation for nesting and the adjacent levees for loafing (4.27). The operation and maintenance costs for both IWA and the Salton Sea National Wildlife Refuge are low. Major reconstruction is usually needed only every 5-10 years. At IWA-Wister, no management has been necessary on the islands for the past 3 years.

As a consequence of the lining of the Coachella Canal, from the All American Canal to Niland, both the CDFG and the USFWS will increase management for all waterfowl, including the Yuma Clapper Rail. The Bureau of Reclamation and the Coachella and Imperial Irrigation Districts, as well as USFWS and CDFG, took part in the negotiations. This mitigation effort is believed to be necessary because the lining decreases available waterfowl habitat. Financial compensation includes $1.2 million and $1 million for management at IWA and the SSNWR, respectively (4.31). CDFG will enhance the habitat around the IWA-Finney-Ramer Unit by extending Hunter's Pond northwest of Ramer Lake and by managing more extensively the current habitat around both lakes (4.27). USFWS planned to buy two quarter sections adjacent to the national refuge and possibly develop the land into appropriate habitat with any remaining funds. Recent developments indicate that $1 million probably will not provide enough funding for purchase of surface rights and mineral rights for two quarter sections (4.31). The Bureau of Reclamation is negotiating this land acquisition.

Unlike extensive management, which requires major construction such as dikes and levees, selective management is limited to vegetation control, which will also enhance habitat, but will not be as effective. Presumably, more operation and maintenance expenditures will be required as the floodwater levels destroy acceptable habitat; reconstruction will often be necessary. BLM is currently recommending minimal management through vegetation control in the Salt Creek ACEC (4.32). Removal of tamarisk and carrizo will allow for growth of cattail and bulrush.

4.2 Mitigation Alternatives

Figure 4-2 is a flowsheet showing the approach used to explore management options for the rail. The major categories are captive breeding, research, acquisition of private lands, and the enhancement of public lands. With the exception of captive breeding, all of these are viable options. It should be noted that, for any of these alternatives, consultation, coordination, and approval from the appropriate agencies will be needed (see Section 2.3.3).

4.2.1 Captive Breeding

Captive breeding is considered by many to be a last-ditch effort, used only in order to save a species from certain extinction. There are many problems associated with this approach, including inbreeding, inadvertent selection, and reduced genetic variability (4.33). The rail population is currently thought to be in the range of 700-1,000 breeding birds (4.6). While not high enough to warrant relaxed vigilance, the number is too high to justify a breeding program. This alternative will not, therefore, be proposed.

4.2.2 Research Needs

There are still many questions about the rail to be investigated. Some of the most pressing needs are the following:

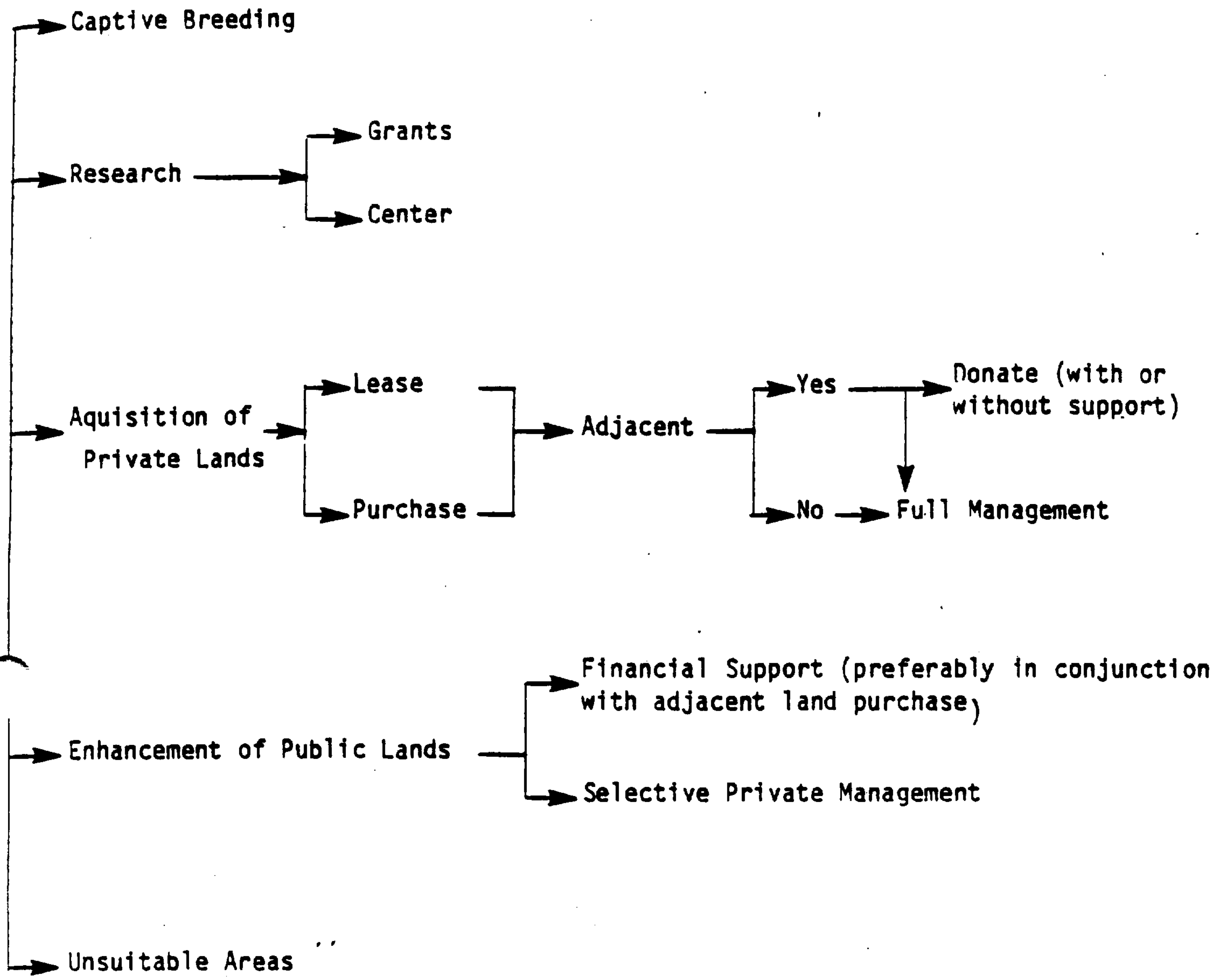

Figure 4-2. Mitigation Options - Yuma Clapper Rail

1. Comprehensive surveys of the entire Salton Sea region

2. A study of migratory behavior, including the wintering location, the existence of any overwintering population, the need for continuity of marsh along routes, and the rails' flying height vis-a-vis transmission lines and other structures

3. Studies of preferred habitat

4. Studies of the effects of increasing salinity and pesticide releases on the rail, on their preferred vegetation, and on their prey

5. The efficiency of various management strategies

These needs could be met in two ways. The first would be to set up an ongoing system for administering research grants, targeted to specific problems. The second method would be the establishment of a research center in the Salton Sea area, patterned perhaps on the University of California Natural Land and Water Reserves System (NLWRS). This group of 26 natural reserves, created in 1965 to serve as "living laboratories" for field teaching and research, has resulted in both enhanced learning and increased research productivity. Local examples are the James San Jacinto Mountains Reserve near Idyllwild and the Phillip L. Boyd Deep Canyon Research Center south of Palm Desert (4.34). Such a center could be set up for both terrestrial and aquatic research on all aspects of the sea. Because of the paucity of information on the rail and on other listed species, this is an attractive option. Since the amount of support could vary so much, specific costs cannot be estimated.

4.2.3 Acquisition of Private Lands

The two basic options for acquiring land are leasing and purchase. Many stretches along the shoreline are owned by duck clubs, which create ponds during the winter in order to attract migrating waterfowl to their hunters' blinds. During the off-season, which coincides with the rails' breeding season, the clubs drain the areas and either leave them fallow or use them for agriculture. One possibility, then, would be to timeshare with the clubs, leasing their land only during the spring, in order to provide additional rail habitat. With the ongoing uncertainties regarding future agricultural, geothermal, oil and gas development in the region, leases would probably only be a short-term solution. There is also growing evidence for an overwintering population of rails; for both of these reasons, leasing will not be proposed.

Land acquisition, discussed in Section 2.1, is strongly recommended as an option for rail habitat creation and protection. The purchased land may, or may not, be adjacent to an existing refuge (IWA or SSNWR). If it is adjacent, a determination must be made as to whether to manage the land or to donate it and whether to provide further financial support. If the land is some distance from the refuge, it will probably have to be completely managed. Both of the current refuges are comprised of two widely spaced segments: IWA at Wister and Finney-Ramer, and SSNWR at Unit's One and Two (see Figure 4-1). This separation, requiring shuttling back and forth or duplication of equipment and personnel, has increased both capital and operation and maintenance (O & M) costs. In light of this, it is doubtful that either refuge would be willing to take on an extension.

4.2.4 Enhancement of Public Lands

There are two main choices concerning public lands, the first involving financial support for current management efforts. This could consist of helping to meet their O & M costs or purchasing the necessary allotments of water. Only a small percentage of these expenses is currently being used for rail related projects at IWA and SSNWR. However, neither IWA or SSNWR can expand its rail project significantly without conflicting with its mandate. The stated objectives, by priority, are to provide habitat for the protection of waterfowl of the Pacific Flyway, to protect surrounding agricultural lands from depredatory waterfowl by providing feeding and resting areas, to provide public hunting opportunities, and lastly to provide for multiple recreational use, when such use does not interfere with the primary objectives. The IWA-Wister Unit has just recently begun to plan habitats for rails and other wading birds (4.30). This option, then, is recommended, especially in conjunction with purchase of land adjacent to the refuge and financial support specifically for creation of rail habitat.

The other option relates to the two BLM ACEC's, Salt Creek and San Felipe Creek. Both areas are in need of selective management that will help insure the protection of their unique natural resources. Both areas have desert pupfish in their upper reaches, and their proposed status as critical habitat for pupfish would preclude rail habitat management there. However, the areas closer to the mouth, which are not suitable pupfish habitat, could be operated for the rail. Involvement would primarily consist of vegetation control (i.e., removal of tamarisk and its replacement with cattail and bulrush), insuring an adequate supply of water, and seasonal work after infrequent winter flooding. A management plan for Salt Creek has already been prepared (4.32), and one is in preparation for San Felipe Creek. The plans could serve as guides for more efficient private management of these public lands, in the absence of a significant BLM presence due to budgetary constraints. The costs for this alternative cannot be quantified as the present management plan does not focus enough on the rail to define all the work needed. In addition to the need for management in these areas, land ownership is very checkered, so land acquisition and donation to BLM within the ACEC boundaries is also a recommendation.

4.2.5 Unsuitable Areas

Many areas along the shore of the sea, especially along the west side, do not currently support rail habitat, primarily due to the scarcity of surface water. Attempts to work in these areas would involve expensive water diversion construction, as well as habitat creation. The Whitewater River Marsh is ruled out as a habitat mainly on jurisdictional grounds. It is presently under a U.S. Water and Power withdrawal from BLM control, and is being managed by the Coachella Valley County Water District. In addition, the marsh abuts the Torres-Martinez Indian Reservation and a sanitary landfill operated by the County of Riverside (4.35). See Section 2.1.3 for a further discussion of land withdrawals.

4.2.6 Synopsis

Table 4-2 shows management recommendations for each site. Full management, our prime recommendation, would involve the creation of ponds like those

Table 4-2

Management Recommendations

Geographic Areas	Land Acquisition	Land Acquisition Adjacent	O&M Support	Water Allotment	Selective Mgt.	Full Mgt.	Unsuitable
	Recommendations						
Shore Area - N and W							X
- E, S, and SW	X					X	
Refuge - IWA		X[1]	X	X			
- SSNWR		X[1]	X	X			
BLM - ACEC - Salt Creek		X			X		
- San Felipe Creek		X			X		
- Whitewater River							X

[1] With financial support for initial construction

of Wister, where the highest rail densities have been found. The ponds would need water flowing at a constant level, cattail and bulrush planting, and the necessary O & M. Whether management is carried out privately or by agencies, the costs will be similar.

4.3 Economic Analysis of Full Management

This analysis makes the assumption that the habitat project is located some distance from a refuge; thus all constructional and O & M expenses are incurred. If land adjacent to an existing refuge is purchased and donated, this analysis will give a rough approximation of the funding required to extend the refuge. The analysis does not take into consideration the economies of scale, which would lower, somewhat, the project's expenses.

4.3.1 Pond Habitat

IWA-Wister, which has been chosen as a model of the best rail management effort in the Salton Sea area, is set up as a series of 1/4 section (160-acre) fields. Each field is then subdivided into a number of ponds. The actual number of ponds in a given field depends on the fall across the field, i.e., the difference between the elevation at the upslope side of the field and the elevation at the downslope side. The fields are set up so that there is a dike for every one foot of drop (4.27). For our generic design we have assumed a 1/4 section, with a fall of ten feet across the field and, therefore, the need for eleven dikes, resulting in ten ponds. This factor, fall or slope, will have a strong effect on the earth moving component of construction and will depend on the site. The assumption is probably reasonable for areas near the sea, but will be less so as distances increase, especially on the southwestern and eastern sides.

Another aspect of the project's design that will be site specific is wind effects. The prevailing winds in the area are westerly, and as they blow across the open water ponds they create waves and subsequent erosion of the dikes. This would not be too much of a problem on the eastern shore, where the upslope dike is affected, or along the south shore, where the larger boundary dike is compacted. But on the western shore, it would be the downslope dike that was being eroded. The possibililty of several dikes failing in a domino fashion could increase maintenance costs. Our design incorporates extensive plantings of cattail and bulrush, which would reduce the wind's effects and reduce water movement (4.36).

The principal cost component of this design is, of course, land; however, land costs in this area are hard to obtain. Due to Proposition 13 cutbacks, the Imperial County Assessor's Office was unable to supply us with prices in this area without a long delay (4.37). As mentioned in Section 4.1.4, SSNWR was given approximately one million dollars to buy two quarter sections adjacent to the refuge. However, this amount would not be enough to enable them to purchase the land free and clear, but only enough for the surface rights (4.31). Based on these sketchy figures, we have assumed a price of one million dollars for a quarter section with all rights.

Figure 4-3a illustrates the overall project design for the ¼ section. The main boundary dikes are set back 75 ft due to an IID regulation that prohibits standing water within this distance of a canal or road (4.27). These

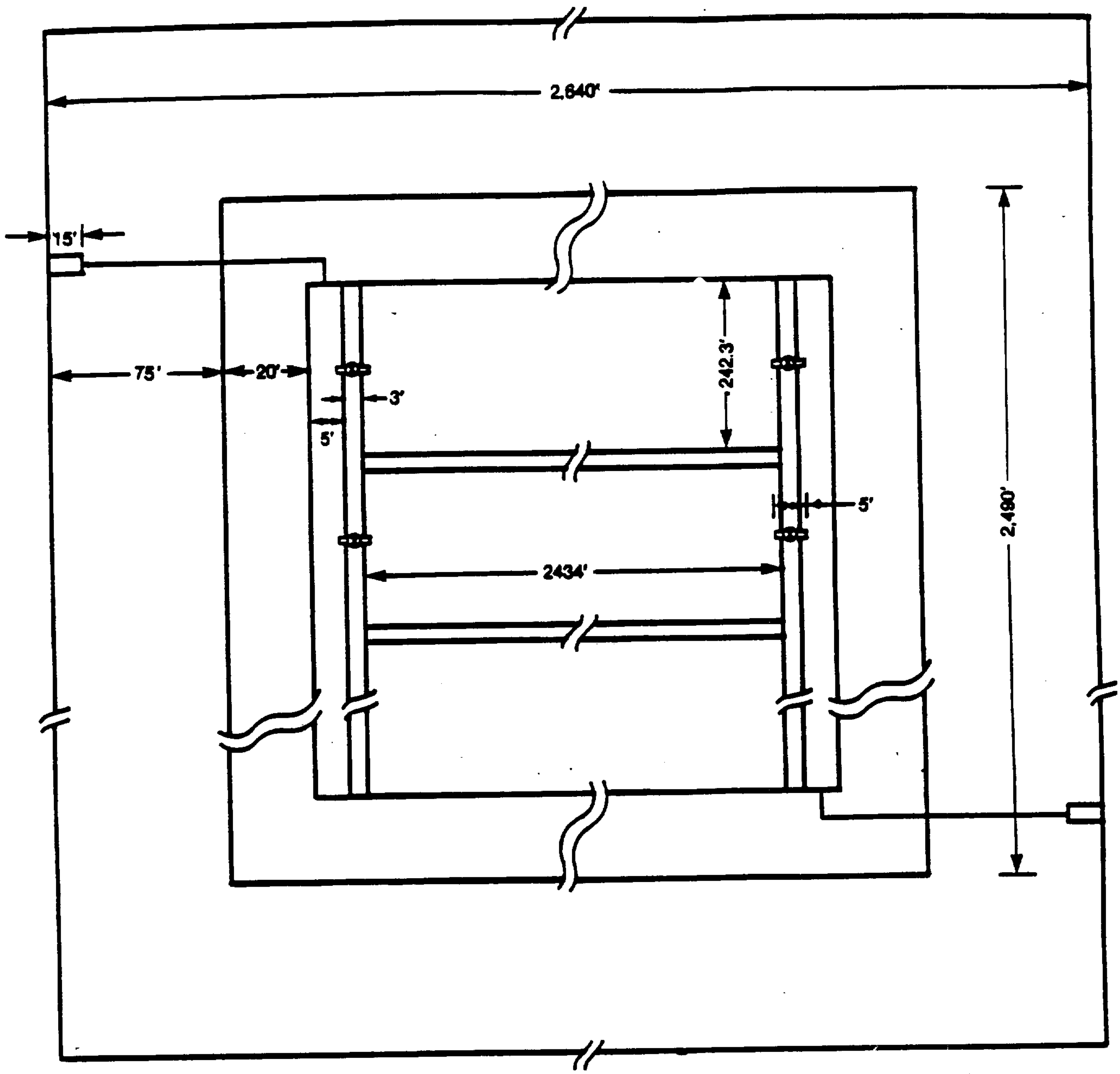

Figure 4-3a. Plan of Recommended Option, Yuma Clapper Rail Habitat

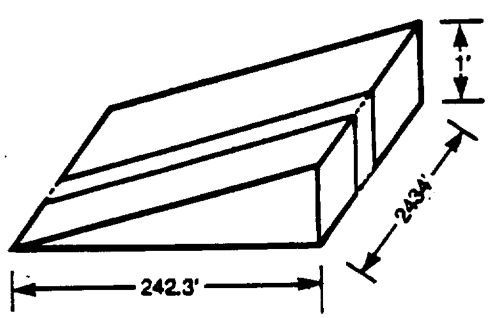

Figure 4-3b. Wedge of Earth to be Removed from Each Pond

main dikes are 20 ft wide by 5 ft high, and will be compacted for durability. Inside of them are two 5 ft wide drainage ditches, created by an additional 3 ft wide dike on two interior sides. The addition of 5 ft cross-piping with gates allows the water to flow from pond to pond and to bypass individual ponds during maintenance. These ditches will provide additional habitat as vegetation invades them. Figure 4-3b illustrates the amount of dirt that will need to be removed for a given pond, while Table 4-3 shows the calculations for normal and compacted earth.

As discussed under each category, these prices are very much site specific. For instance, if the land purchased is currently in agriculture, it may be possible to skip the first two steps as they were probably already done. On the other hand, steeper areas such as Salt Creek would involve extensive levelling and result in an unrealistically high number of ponds.

4.3.2 Construction of Ponds

Table 4-4 shows the costs involved for this design. The individual components are:

Preliminary Land Survey

This survey is needed to establish the four corner boundaries of the plot. The cost is in the $700-800 range if work has already been done in the area and a reference point exists. Otherwise, the cost may be in the $1,000 range (4.38).

Land Clearing

The land must be cleared of any vegetation cover so that the levelling survey can set out a pattern of stakes and also to facilitate construction of the ponds. The cost per acre is a function of the condition of the land. Flat desert can run $5-10, a normal range is $10-20, and land with deep ravines or heavily wooded could go as high as $50 (4.39).

Levelling Survey

The land is then surveyed to set out pond boundaries, and the position of each of the dikes. Stakes are placed so that actual construction work can be done quickly, with a minimum of supervision. The surface does not have to be as exact as in laser levelling for farming, since some variation in depth is desired within the ponds. Prices per acre range from $8.75 (4.39) to $15 (4.38).

Earth Moving

The actual pond construction is the most expensive item. A bulldozer is used to move earth by the cut-to-fill method. In addition the main boundary dikes are compacted. Normal earth moving costs, for distances less than 300 yards from cut to fill, are $\$0.52/yd^3$. Compaction requires mixing the dirt with water as it is laid, results in a 20% shrinkage factor, and is twice as expensive (4.36).

Table 4-3

Total Amounts of Earth to be Moved

1) Per Pond (see Figure 4-3b)

   $= 5' * 242.3' * 2434' * yd^3/27\ ft^3 = 10,921.5\ yd^3$

2) Total Moved

   $= 10\ ponds * 10,921.5\ yd^3/pond = 109,214.5\ yd^3$

3) Dike Compaction

   $= [2 * (5' * 20' * 2490')/N\text{-}S\ Dike + 2 * (5' * 20' * 2450')/E\text{-}W\ Dike]$

   $= [988,000\ ft^3] * yd^3/27\ ft^3 + 20\%$

   $= 43.911.1\ yd^3$

4) Cost

   $= [(109,214.5 - 43,911.1) * \$0.52/yd^3] + [43911.1\ yd^3 * \$1.04/yd^3]$

   $= \$79,626$

Table 4-4

Full Management Expenses

LAND	$1,000,000
CONSTRUCTION OF PONDS	
Preliminary Land Survey	$1,000
Land Clearing	2,400
160 acres * $15/acre	
Levelling Survey	1,600
160 acres *$10/acre	
Earth Moving	80,000
[see Table 4-3]	
Water Diversion and Piping	6,600
2 * $2,000 + [2 * 80' + 10 * (5'+5')]	
Vegetation	800
2 days * 8 hr/day * $50/hr	
Water Fill	4,000
10 ponds * (242.3' * 2434') * 2.2957E-5 acres/ft^2	
135.4 acres * 0.75' * $8.50/acre-ft	
Interpretive Sign	4,000
SUB-TOTAL	$100,400
TOTAL	$1,100,400

OPERATION AND MAINTENANCE	
Water	$9,600
182 days * 4 acre-ft/day * $8.50/acre-ft	
183 days * 2 acre-ft/day * $8.50/acre-ft	
160 acres * $1.90/acre	
Worker	30,000
Maintenance and Rebuilding (10% of construction costs)	10,000
	$49,600
TOTAL	$50,000/year

Water Diversion and Piping

Water must be moved from irrigation canals into a drainage ditch along one side, into and through the ponds, into a drainage ditch on the other side, and then into an irrigation drain. The Imperial Irrigation District will build a structure with a gate and 15 ft of ditching from its canal for $2,000 (4.27). The cost for piping and hand operated gates from there into and around the ponds is approximately $10/foot (4.36). Each pond needs its own gates so it can be drained for maintenance without disturbing the other ponds.

Vegetation

After the ponds have been roughed out, they must be seeded for cattail and bulrush. This should take about 2 days for one worker (4.27). We estimate that an average cost for worker and rented equipment would be $50/hour.

Water Fill

After seeding, the pond is flooded to an average depth of 8 in, with deeper areas for open water and shallow areas for nesting. Water prices are approximately $8.50/acre-foot (4.27).

Interpretive Sign

A sign should be placed near the area describing the project and its purpose, the rail and its status, and the corporate responsibility for the project. A rough estimate of $4,000 was taken from a USFWS guidebook (4.40).

4.3.3 Operation and Maintenance Expenses

Flowing Water

Flowing water is crucial for rail habitat. At IWA-Wister (4.27), they use 4 acre-ft/day during the summer and fall and 2 acre-ft/day during the winter and spring. There is a yearly fee of $1.90/acre. See Section 2.2.1 for a discussion of rates.

Personnel

At least one worker will be required for water supply monitoring and general maintenance. An estimate of direct and indirect costs of $30,000 was used.

Normal Maintenance and Rebuilding

Due to flooding in the area, the whole project may need a major overhaul every ten years or so (4.26). A yearly expense of 10% of the total construction costs was used to account for maintenance and to depreciate re-building expenses.

4.4 Summary

The Yuma Clapper Rail, the only Clapper Rail that inhabits freshwater habitat inland from coastal areas, is found in the United States along the

Colorado River and at the Salton Sea. Most of the population is believed to migrate to an as yet undetermined location in Mexico. A small overwintering population has been observed at the Salton Sea and along the Colorado River.

The habitat requirements of the rail are as follows:

1. A freshwater marsh with a minimum of 8 hectares

2. Cattail (ca. 75 stems/m^2) or bulrush, with 5% surface covered by fallen vegetation

3. Abundant crayfish

4. A constant water level with a depth less than 1 foot

5. Flowing water

6. Proximal high ground, with gentle slope from shoreline

7. Open water

Current management practices at the Salton Sea, which involve construction of holding ponds to control water level and vegetation growth, appear to be successful since the rail population has increased in the area.

The following mitigation alternatives for rail habitat enhancement at the Salton Sea were analyzed and discussed in this report:

1. Captive breeding. This is not recommended.

2. Research. More research is needed. This should be funded either individually or through the creation of a research center.

3. Acquisition of private lands. Two options, purchase or leasing, are possible. Purchase potentially provides a more long-term solution, since the land cannot be transferred to other uses. Preferably the land should be adjacent to current habitat in a refuge. This provides the potential for donation of the land to an agency, which will then perform the management. If the land is donated, continuous financial support for full management should be supplied. If not, full private management is necessary.

4. Enhancement of public lands. A program of enhancement of public lands would include (a) financial support for current and future agency activities related to rail management, (b) selective private management (e.g., vegetation control) in conjunction with, or separate from, public management, or (c) private management of public lands.

Two areas around the Salton Sea were determined to be unsuitable for consideration of alternatives: the west shore and the Whitewater River region. The most suitable areas for mitigation would be the regions along the southern shore of the Salton Sea (southeast to southwest).

An economic analysis of construction and management of the type of holding ponds found in current rail management programs at the Salton Sea was presented. The overall cost of management on the southern shore of the sea where the land is relatively flat includes three cost estimates: $1 million for land acquisition, $100,400 for initial construction and $50,000 for annual operation and maintenance. Costs will increase if the location chosen requires significant levelling.

4.5 References

4.1 Peterson, R.T. A Field Guide to Western Birds. Second Edition. Houghton Mifflin Co., Boston, MA (1961), p. 72.

4.2 California Department of Fish and Game. At the Crossroads: A Report on the Status of California's Endangered and Rare Fish and Wildlife. Sacramento, CA (1980).

4.3 Banks, R.C., and R.E. Tomlinson. "Taxonomic Status of Certain Clapper Rails of Southwestern United States and Northwestern Mexico." Wilson Bull. 86(4):325-335 (1974).

4.4 American Ornithologists' Union. Check-list of North American Birds. Fifth Edition. Port City Press, Inc., Baltimore, MD. (1957), p. 154.

4.5 Tomlinson, R.E., and R.L. Todd. "Distribution of Two Western Clapper Rail Races as Determined by Responses to Taped Calls." Condor 75(2):177-183 (1973).

4.6 U.S. Fish and Wildlife Service. Yuma Clapper Rail Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM, Draft, (1982b).

4.7 Powell, R. Memorandum to the Region 5 Manager, California Dept. of Fish and Game, dated 17 August (1982a).

4.8 Gould, G.I., Jr. Yuma Clapper Rail Study - Census and Habitat Distribution 1973-74. California Dept. of Fish and Game, Wildlife Management Branch Admin. Rep. 75-2 (1975).

4.9 Bennett, W.W., and R.D. Ohmart. Habitat Requirements and Population Characteristics of the Clapper Rail (Rallus longirostris yumanensis) in the Imperial Valley of California. Unpub. ms., University of California, Lawrence Livermore Laboratory (1978).

4.10 U.S. Fish and Wildlife Service. 1981 Yuma Clapper Rail Survey Results. Unpub., Yuma Clapper Rail Recovery Team (1981).

4.11 Busch, D., and J. Forman. Colorado River Yuma Clapper Rail Survey - 1982. Unpub., Yuma Clapper Rail Recovery Team (1982).

4.12 McKaskee, G. Ornithologist, San Diego, CA. Personal communication (1982).

4.13 Ohmart, R.D. Professor of Biology, Arizona State University, Tempe, AZ. Personal communication (1982).

4.14 Ohmart, R.D. and R. Smith. North American Clapper Rail (Rallus longirostris) Literature Survey with Special Consideration Being Given to the Past and Current Status of Yumanensis. Bureau of Reclamation Report, Boulder City, NV (1973).

4.15 Wilbur, S.R., and R.E. Tomlinson. The Literature of the Western Clapper Rails. U.S. Fish and Wildlife Survey Spec. Sci. Report Wild. No. 194 (1976).

4.16 Wilbur, S.R. Additions to the Literature of the Clapper Rail and Black Rail. Unpub., U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD (1979).

4.17 U.S. Fish and Wildlife Service. Yuma Clapper Rail Habitat Analysis - Colorado River. Yuma Division, Unpub., Yuma Clapper Rail Recovery Team (1982a).

4.18 Anderson, B.W., R.D. Ohmart, J.K. Meents and W.C. Hunter. "Avian Use of Marshes on the Lower Colorado River." Paper presented at the Conference on California Riparian Systems: Their Ecology, Conservation and Productive Management. University of California, Davis, September 17-19 (1981), cited in Reference 4.17.

4.19 Smith, P.M. Yuma Clapper Rail Study, Mohave County, AZ. California Department of Fish and Game, Federal Aid Project W-54-R, "Nongame Wildlife Investigations," Job II-5.9 (1974).

4.20 Powell, R. Associate Wildlife Manager Biologist, Colorado River Coordinator, Environmental Services, Department of Fish and Game, Blythe, CA. Personal communication (1982b).

4.21 Pettingill, O.S. Jr. "Intelligent Behavior in the Clapper Rail." Auk 55(3):411-415 (1938).

4.22 Ohmart, R.D. and R.E. Tomlinson. "Foods of Western Clapper Rails." The Wilson Bulletin 89(2):332-336 (1977).

4.23 Smith, P.M. Habitat Requirements and Notes on the Clapper Rail, R.l. yumanensis. Master of Science degree, Arizona State Univ. (1975).

4.24 California Department of Water Resources. Investigation under California Water Code Section 275 of Water by Imperial Irrigation District. Southern Division District Report (1981).

4.25 Wilson, R. Manager of Water District, Imperial Irrigation District. Personal communication (1982).

4.26 Dean, L. Manager, Salton Sea National Wildlife Refuge, Calipatria, CA. Personal communication (1982).

4.27 Gonzales, C. Manager, Imperial Wildlife Area, California Dept. of Fish and Game, Niland, CA. Personal communication (1982).

4.28 Deason, W.O., and F. Sharpe. "Development of Hydraulic Structures for Improvement in Habitat of the Endangered Yuma Clapper Rail." In Driver and Wunderlich, eds., Environmental Effects of Hydraulic Engineering Works, Proc. of an international symposium held at Knoxville, Tennessee, Sept. 1978 (1979), pp. 285-294.

4.29 Berry, T. 1982. Havasu Refuge Manager, Havasu National Wildlife Refuge, Mohave County, Arizona. Personal communication, November 22, 1983.

4.30 Gelfand, P., and T.E. Blankenship. Effects of the Five Year Management Plan for the Wister Unit of the Imperial Wildlife Area on the Yuma Clapper Rail. California Dept. of Fish and Game (1977).

4.31 Pisapia, R. Field Office Supervisor, Division of Ecological Services, USFWS, Laguna Niguel, CA. Personal communication (1982).

4.32 Davis, F. Salt Creek Desert Pupfish/Rail Habitat Area of Critical Environmental Concern Management Plan (CA-06ACEC-60). Prepared by the U.S. Dept. of Interior, BLM, California Desert District, Indio Resource Area (1982).

4.33 Conway, W.G. "Breeding Endangered Birds in Captivity: The Last Resort." S.A. Temple, ed., Endangered Birds: Management Techniques for Preserving Threatened Species. University of Wisconsin Press, Madison, Wisconsin (1978) pp. 225-230.

4.34 Kendrick, J.B., Jr. "The NLWRS - A Valuable Resource for Field Science." Transect 1(1):8 (1982).

4.35 Maynard, J., J. Riley, G. Taoka, and L. West. Blowsand and Marsh Studies: Whitewater River Project. Dept. of Landscape Architecture, Calif. State Poly. Univ., Pomona, CA (1981).

4.36 Huber, G. Estimator, Elm's Equipment Rental, Brawley, CA. Personal communication (1982).

4.37 Avitia, T. Desert Land Appraiser, Imperial County Assessor's Office, El Centro, CA. Personal communication (1982).

4.38 Eldred, B. Surveyor, Eldred and Johnson Surveying, El Centro, CA. Personal communication (1982).

4.39 Barrett, T. Estimator, Tesco Engineering, El Centro, CA. Personal communication (1982).

4.40 U.S. Fish and Wildlife Service. Rehabilitation and Construction Budget Cost Estimating Guide. Office of Engineering, Appendix 7 (1982c).

5.0 CONCLUSIONS AND RECOMMENDATIONS

Habitat enhancement for both the desert pupfish and the Yuma Clapper Rail is feasible around the Salton Sea. Successful management practices for the rail currently can be observed on Topock Marsh in Havasu Wildlife Refuge on the Colorado River and at IWA and SSNWR on the Salton Sea. The desert pupfish is in a more precarious position than the rail, and management options are still relatively experimental. Conclusions and recommendations for managing species individually or separately will be presented in Sections 5.1 and 5.2 for the pupfish and rail, respectively. The only remaining management option that deserves some attention, joint management of the rail and pupfish in the same region, will be discussed in Section 5.3.

5.1 Desert Pupfish

Implementation of specific measures at San Felipe Creek or Salt Creek clearly requires first addressing the issue of land acquisition. Federal and state resource agencies are legally directed to protect endangered and threatened species through habitat acquisition. Such efforts are currently underway for both species, as discussed in Section 2.1.

We recommend that these efforts be assisted in one or more of the following ways: (1) by providing funds for fee acquisitions to the designated lead agency, or by purchasing the desired parcels and donating or leasing them to the lead agency; (2) by providing appraisal or negotiating services for land exchanges and acquisition of conservation easements and funds for transfer payments, in cases where exchanges of unequal value represent the only feasible option; (3) by entering into long-term cooperative agreements with managing agencies for conservation easements, to assist in annual fee payments or in future renegotiations, when needed. Fee purchases and donation of parcels might conceivably be arranged through a third agency, such as the Nature Conservancy, in cases where direct involvement might be unwarranted or trigger inflation of land prices through inappropriate speculation.

Specific management recommendations will depend on resolution of the land acquisition issue. Responsibility for management will likewise depend on land ownership, agency responsibilities, and regulatory constraints. Furthermore, the proposed measures are largely untested, and require both basic research and site-specific analysis of their feasibility prior to unqualified recommendation. Specific management recommendations are the following:

1. Implement program of tamarisk removal on an experimental basis to determine feasibility.

2. Research the relative costs and benefits of a large-scale tamarisk removal program.

3. Implement an exotic fish eradication program on an experimental scale.

4. Perform engineering feasibility analysis of constructing fish barriers at Salt and San Felipe Creeks.

5. Construct fish barriers if feasible and practical.

6. Provide for fencing and patrolling, and constructing interpretive signs near, the critical habitat areas.

7. Perform a comprehensive groundwater basin study for San Felipe Creek area.

8. Drill a test well near San Sebastian Marsh.

9. Monitor Salt and San Felipe Creeks, including fish surveys, surface flows, and photo plots.

10. Conduct an extensive aerial and ground survey of the shoreline pools around the Salton Sea.

11. Conduct an intensive search for additional pupfish populations in the springs and seeps on the margins of the Salton Basin. This will also identify potential sites for future reintroduction.

5.2 The Yuma Clapper Rail

Rail habitat requirements are listed in Section 4.1.2. Augmentation and enhancement of available habitat to meet those requirements can be effected in several ways. The strategy chosen depends on both the goals of the project, such as maximum increase in rail population and desirability of cooperation with public agencies, and the availability of funds. The following options are listed in descending order of cost:

1. Purchase land not adjacent to public land and perform full management. (See Section 4.3 for costs.)

2. Purchase land adjacent to public land and perform, or fund, full management. (Costs decrease because of the opportunity to collaborate with a public agency.)

3. Provide financial support for full management of a specific region of public land. (Cost of land is eliminated.)

4. Perform selective management (e.g. vegetation control) on public lands. (Construction cost of ponds is eliminated, and operation and maintenance will involve only manual removal of vegetation.)

For a goal of maximum increase in the rail population, categories 1 and 2 are recommended, since land designated for marshland habitat will increase. The prime area in which to implement these options is the southern shore of the Salton Sea, where public land exists and is relatively flat. If interaction with public agencies is preferred, categories 3 and 4 are recommended. Category 3 should be considered for an interaction with USFWS at SSNWR or CDFG at IWA. Category 4 should be considered for the Salt Creek ACEC (BLM).

One last recommendation that must not be ignored is the need for research. Many questions about the Yuma Clapper Rail, including acceptability and success of management options, remain unanswered. The results of any research should be applied to proposed enhancement projects. See Section 4.2.2 for additional research recommendations.

5.3 Joint Management

Joint management is defined in this report as management of both species in the same location, an option that would be less expensive than separate management. The areas around the Salton Sea analyzed in this report are Imperial Valley, Coachella Valley, and the regions drained principally by Salt Creek and San Felipe Creek. Since locations considered for pupfish habitat have been restricted in this report to Salt Creek and San Felipe Creek, joint management will be discussed for those two regions.

San Felipe Creek remains the best location for pupfish habitat. In addition, certain areas within the marsh contain the preferred vegetation for the rail. Therefore, the area could be enhanced for both species. However, the water in San Sebastian Marsh flows from a groundwater source that should be protected to insure preservation of the perennial stream. Withdrawal of water for use in rail management, a water consumptive practice, could jeopardize that source. No justification exists for extensive rail management requiring construction of ponds in San Sebastian Marsh. Furthermore, annual maintenance of the ponds could be quite expensive because of the frequent flooding that occurs. The only location along San Felipe Creek acceptable for full rail management lies at the mouth of the creek, an area which is almost exclusively agricultural land. The water source in that region could be surface water from IID, eliminating the need for groundwater. Management for the rail at the mouth of San Felipe Creek and for the pupfish at San Sebastian Marsh would be separate, not joint, management because the enhancement efforts would have to be in different locations.

Salt Creek also provides habitat for both the pupfish and the rail. Currently the pupfish reside upstream while the rail is observed at the mouth. This area has problems similar to those at San Felipe Creek. Flooding increases the projected maintenance costs for both species. Groundwater can not be pumped to augment supplies because the natural recharge is very low. To perform full rail management, water would have to be diverted from the Coachella Canal to ensure sufficient water supplies. Pond construction for the rail along the creek would be a major project because Salt Creek has cut a relatively deep bed. Even construction at the mouth of Salt Creek would be extensive due to the large drop (over 30 feet) within a quarter section, requiring many holding ponds. With these difficulties in mind, joint management in Salt Creek should only include minimal rail management such as vegetation control. Of course, this will not provide the maximum increase in rail population.

Besides the physical constraints that have been mentioned concerning joint management, the compatibility of the species is questionable. Research would need to be done to determine whether some characteristics of the rail habitat, such as the requirement for crayfish, may imperil the pupfish population. It is believed that crayfish consume pupfish eggs when the eggs are found in the same locale. Since joint management could be detrimental, it has not been recommended in this report. Management of one species, or separate management of each one, in the recommended locations would be more effective.