CHAPTER II

Problem Definition

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PROBLEM DEFINITION

Described in this chapter are the problems toward which alternative plans are directed as solutions. The problems include those which are physical, economic, environmental, social, and cultural in nature.

2.0 INTRODUCTION

The causes and effects of the Salton Sea's problems are many and complex because the Sea is an integral part of a dynamic hydrologic system. The physical problems of the Sea are directly related to the characteristics of inflow, to hydrologic factors in the Basin, and to the geometry of the Basin and the Sea. Due to its present physical, chemical, and biological characteristics, the Sea falls short of its potential contribution toward National, regional, and local needs for recreation opportunity, wildlife conservation, and local needs for community enhancement.

2.1 WATER QUALITY PROBLEMS

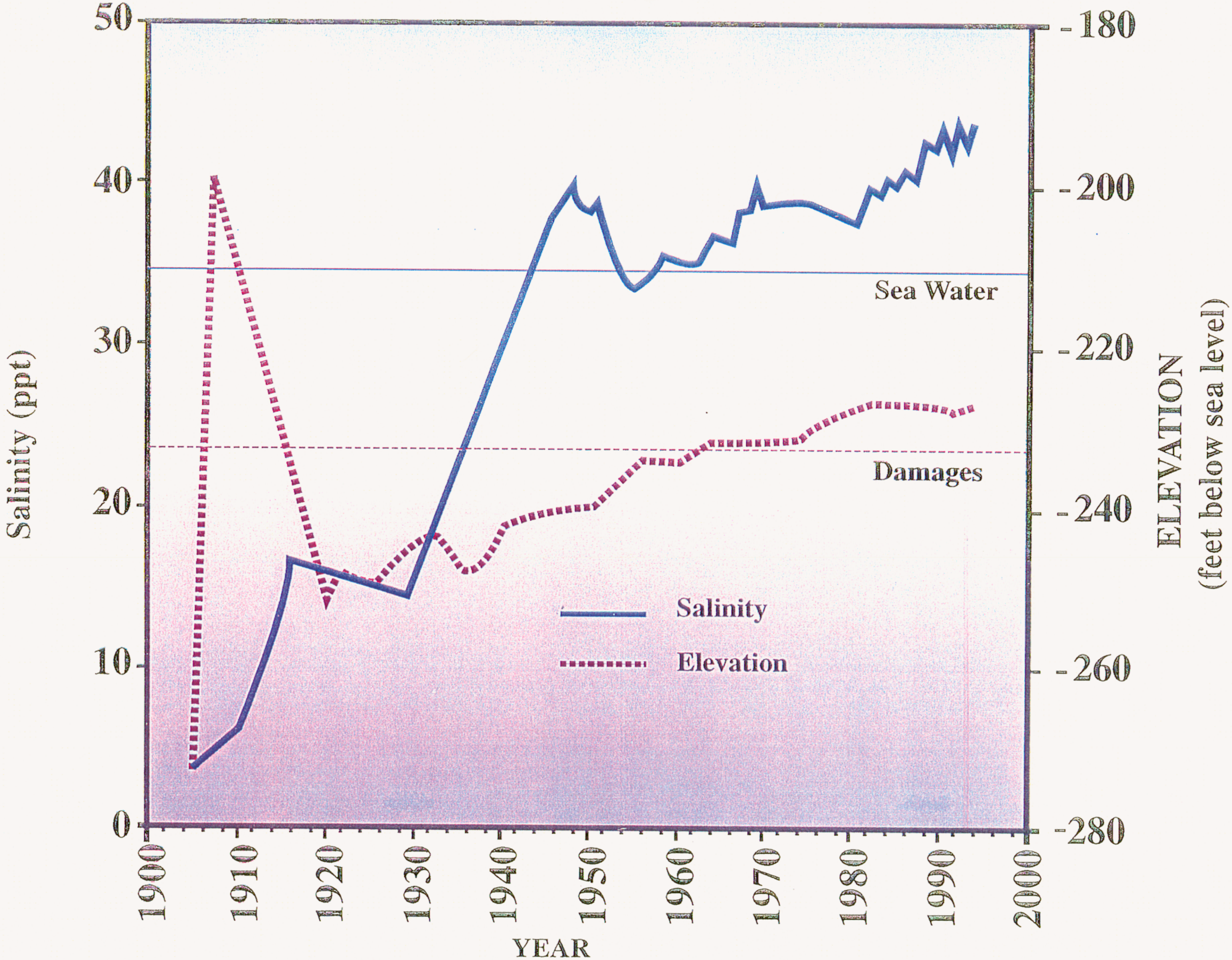
Salinity

For the last 25 years, the problem that has had the most attention has been salinity. That problem has become more pressing over the past 10 years as salinity concentrations have surpassed that of ocean water salinity. Measurements indicated that the salt concentration at the end of 1995 was about 44 ppt, which is 9 ppt higher than average ocean salinities. An estimated 4 million tons of salt are added to the Sea each year with inflows and left behind as the water evaporates. This rate of salt inflow causes an increase in salinity of about 0.39 ppt each year, provided the volume of water in the Sea remains unchanged.

Ideally, for the saltwater species of fish and other aquatic life in the Sea, a salinity level equivalent to ocean water should prevail at around 35 ppt. However, biologists regard a salinity level of between 33 ppt and 37 ppt as adequate. With increasing salinity, however, survival of the fish in the Sea is in jeopardy. The limited reproductive success of some species have placed physiological stresses on the organisms providing the fishery food chain, as well as fish eggs, larvae, and adult fish. At some level, one or more of the links will finally break down. At this point, the fishery will gradually or suddenly be lost, depending on the link that is broken first. It is not known at what salinity level the chain may break, but aquatic biologists believe that reproduction of corvina may be unsuccessful when the salinity permanently exceeds 40 ppt (Lasker et al., 1972, May 1975, May 1976).

High salinity also tends to discourage recreational use of the Sea for body contact sports, such as swimming and water skiing. In general, highly saline water can be irritating to the eyes and skin.

Higher salinity also causes increased corrosion of boats and other recreational equipment. With increasing salinity, there has been a gradual decline in water-related recreational use of the Sea. Figure 3 presents historical changes in the Sea's salinity and elevation.



Historical Salinity and Elevation Through Time

FIGURE 3.

Organochlorine Pesticides

Organochlorine residues have been reported for fish and birds in the Salton Basin (Linn 1987; Mora 1984), and dichlorodiphenyl trichloroethane (DDT) metabolites may be bioaccumulating in certain water fowl tissues (Setmire et al., 1990). Pesticides have been traced to agriculture in the Imperial, Coachella, and Mexicali valleys entering the Sea's tributaries.

Selenium

Selenium is a naturally occurring element normally found in the Colorado River, the source water for much of the inflow to the Sea. In order to protect wildlife, the Federal criterion for selenium is set at 5 micrograms per liter (µg/L) in water. Although samples of various source waters to the Sea show elevated concentrations—one as high as 300 µg/L—a composite collection in the Sea showed 1 µg/L. Selenium concentrations in sediment ran as high as 3.3 milligrams per kilogram (mg/kg), although there was variation in this concentration that correlated with the amount of water in the sample. This led Setmire et al. (1990) to conclude that selenium is being removed from the water and concentrated in the sediment, creating a greater opportunity for selenium to be taken up into the food chain, with possible bioaccumulation. Selenium tissue samples containing concentrations of 27 and 42 micrograms per gram (µg/g) have been observed in black-necked stilts and cormorants. These concentrations have not resulted in documented adverse effects at the Salton Sea, but at other locations, similar concentrations have been shown to cause reproductive problems (Setmire et al., 1990).

Current theory suggests that much of the uptake of selenium starts with bacterial action. Purple and green sulphur bacteria have been identified as present in the water and sediment of the Sea, but there have been no significant investigations into what role, if any, they play in the selenium transport out of the area or its uptake into the food chain. Selenium has similar chemical properties to sulphur, and it is conceivable that bacteria could use it as an alternate energy source. If this is the case, then selenium could be processed by bacteria as hydrogen selenide, a gas similar to hydrogen sulfide, or incorporated into the food chain through ingestion of bacteria by invertebrates, mainly *Brachionus plicatilis*, or pileworms. This could make selenium available to various aquatic birds and their predators that come to the area and either feed directly on pileworms or feed on the fish that feed on pileworms.

Eutrophication

The Salton Sea is a highly productive body of water. The Alamo, New, and Whitewater Rivers and other drains discharge varying amounts of nutrients from agricultural, municipal, and industrial sources. The Sea is abundantly supplied with mineral nutrients, mainly compounds of nitrogen and phosphorus, which encourage excessive growth of phytoplankton. Although phytoplankton are essential to the Sea's ecology, phytoplankton blooms discolor the water and, upon death and decomposition, often deplete the water's oxygen content locally and produce unpleasant odors. The additional loss of oxygen in areas with already low oxygen has

been cited as a contributing factor in fish kills in the Sea (California Regional Water Quality Control Board, 1990). In addition, these conditions reduce the Sea's aesthetic appeal and may contribute to the reduction of water contact recreation.

Photo 3. Environmental factors contribute to high fish mortality events.

2.2 WATER LEVEL PROBLEMS

In addition to salinity, a second major problem is water level fluctuation. The Sea's elevation is a balance between inflow and evaporation, and it normally fluctuates within 1 foot during a given year. In the history of the Sea, the elevation rose quickly to its highest point of close to -200 feet msl during its formation and then fell to around -250 feet msl until the introduction of agriculture to the area in the early 1920's. Since that time, it has steadily increased to its present height of approximately -227 feet msl. Changes in inflow to and evaporation from the Sea have caused continually changing water levels during much of the Sea's existence.

Water level fluctuations are a serious problem as conditions of inflow and evaporation change. Both Coachella Valley Water District and Imperial Irrigation District, the irrigation districts in the area, have had legal action brought against them for damages to shoreline property because of inundation. Water level fluctuations are disruptive to use of the Sea and adjoining land. The gentle slopes of the land under and around the Sea cause a significant change in the shoreline with a relatively insignificant change in water level. Shoreline developments are being flooded as the water level rises, and changes in water level affect both private and public facilities. As the water level increases, there are additional costs in levee construction and maintenance. Millions of dollars have been spent in dealing with these issues alone. In addition, agricultural drainage would be adversely affected by water levels higher than those presently prevailing.

One consideration in selecting a management alternative is that a drop in elevation could also cause developments to be left at a considerable distance from a receding shoreline. There is also a correlation between salinity and elevation such that any increase in the Sea's volume is accomplished by inflow from a less saline water source which dilutes the existing salt concentration. Also, any decrease in volume is by evaporation, which raises the salinity by concentrating the salt in the remaining water.

Rising water surface elevations also can disrupt historic flow patterns and contribute to access problems at marinas. Deposition of sediment and barnacles in channels that provide access to boat slips and docking facilities can require increased maintenance to keep those channels open. In some cases, these problems have denied access altogether.

2.3 ECONOMIC DEVELOPMENT NEEDS

Remedial action at the Sea will exert influence on three major geographic areas: the immediate vicinity of the Sea, the southern California region, and the rest of the nation. The first contains the area that would be most directly affected by the Project, while the last two are the origin of recreational needs beyond the local area. The region under consideration is the immediate area that is primarily served by the Salton Sea. It consists of the complete areas of Imperial, Riverside, San Diego, and Orange Counties and most of San Bernardino and Los Angeles Counties. This region is also considered as the primary recreation market area. Ninety-seven percent of the anglers who visited the Sea during the period from 1965 through 1967 originated in that source area. In the future, 87 percent of the anglers are expected to originate in this region (Reclamation and DWR, 1974).

The rest of the nation is important because the Sea is used by visitors and recreationists originating throughout the United States, particularly winter visitors from the northern states. Thirteen percent of the future anglers are expected to come from the rest of the nation. The rest of the nation also has a strong interest in the environmental aspects of the Sea and the surrounding area, particularly in the preservation and enhancement of wildlife habitat used by threatened species of birds and by birds migrating in international flyways.

Population Trends/Salinity

Population projections for the region to year 2020 are shown in Table 2, "The Salton Sea Recreation Market". The projections were developed by the California Department of Finance, Series D Projections. Under this set of projections, the annual rate of population increase was 1.813 percent between 1965 and 1980, 1.667 percent between 1989 and 2000, and 1.312 percent between 2000 and 2020. Beyond 2020, a rate of increase of 1.000 percent per year was projected for this investigation (Reclamation and DWR, 1974).

The population in the immediate vicinity of the Sea will be significantly affected by the Sea's fate. From a population of about 3,200 in 1970, the population by year 2020 is conservatively expected to increase to 45,000, if the Sea is preserved at a salinity close to that of ocean water. However, if the Sea were to deteriorate through increased salinity, permanent population could decline from its current level (Reclamation and DWR, 1974).

Salton Sea Recreation Market

Visitor surveys have been made at the Sea for a number of years by the California Department of Fish and Game and the California Department of Parks and Recreation. Information from these surveys was examined to estimate recent recreational use of the Sea and to determine trends in use. Recreational use was at its greatest during the years 1961 through 1968 and, during that period, the salinity of the Sea was less than 37 ppt. Since 1969, recreation and angler success rates at the Sea have declined (Reclamation and DWR, 1974). The rising salinity of the Sea is regarded as the major contributor to this decline, although several other factors (such as competing recreational opportunities, changing recreational desires, and publicity of the pollution levels of the New River) probably account for part of the decline.

TABLE 6
THE SALTON SEA RECREATION MARKET

Year	Regional Population[4]	Unsatisfied Recreation Demand Days in Region[5]	Recreation Use of the Salton Sea Historic and Potential[3]	
			All Categories of Visitor Days	Angling Visitor Days
1965	10,360,000	251,000,000	705,000[6]	377,000[7]
1980	13,560,000	409,000,000	224,000	100,000
2000	18,875,000	644,000,000	1,497,000	718,000
2020	24,500,000	900,000,000	1,940,000	943,000

[3] Potential recreation visitor days with a project.

[4] California Department of Finance Series "D" projections for South Coastal and Colorado Desert Subregions.

[5] Types of recreation supplied by the Salton Sea (Sources: Comprehensive Framework Study: California Region, Appendix XII; Recreation: Pacific Southwest Inter-Agency Committee, Water Resources Council, June 1971).

[6] Average for 1965-1967 Base Period: 735,000.

[7] Average for 1965-1967 Base Period: 357,000.

The period from 1965 through 1967 was selected for analysis as a base period of recent recreational use while the salinity of the Salton Sea was close to that of ocean water. During that period, visitation at the Sea for all categories of recreation was a relatively consistent 3.3 percent of the population of the region. It was also found that water-oriented general recreational use of the Sea was approximately 106 percent of the amount of angler use of the Sea, measured in visitor days (Reclamation and DWR, 1974).

The decline in visits to the Sea, however, particularly for angling, is projected to continue as the salinity continues to rise. By the time salinity has been above 40 ppt for several years, the angling use is expected to be approximately 100,000 angler days per year, provided there are no unexpected adverse effects to the mature fish living in the Sea. After that, fishing rates would either decline rapidly to zero without salinity control, or would improve in several more years if salinity control was initiated.

Recreational demand in the southern California region is substantial and will increase as the population increases and as a higher standard of living provides more personal leisure time. An estimate of *unsatisfied* recreational demand was made in 1971 as part of the Comprehensive Framework Study for the California Region. (Unsatisfied recreational demand is the portion of recreational demand that is not expected to be satisfied by existing or planned recreation development by certain future years.) Unmet recreational needs occur typically because, compared to population growth, land and water resources that offered outdoor recreation opportunities remained relatively constant. The unsatisfied recreational demand for recreation of the type that could be provided by the Salton Sea was projected in 1974 to rise from about 251 million visitor days annually in 1965 to about 900 million visitor days in 2020 (Reclamation and DWR, 1974).

The role that the Sea could play in satisfying demand for outdoor recreation is shown on Table 6, depicting the potential recreational use of the Salton Sea if the salinity were controlled at a concentration close to that of ocean water. These projections are based on the relationship between regional population and visitation during the base period, modified slightly to account for the fact that fishing license sales are increasing at a faster rate than population. The projections also assumed eutrophic conditions would not worsen. As shown in Table 6, the projected unsatisfied recreational demand greatly exceeds the recreation opportunity that the Sea could provide, indicating that recreational opportunity provided by the Sea would not compete with recreation opportunities provided in other areas (Reclamation and DWR, 1974).

Related Economic Activities

Residential, recreational, and commercial development at the Sea increased at a rapid rate from 1960 to the base period of 1965 to 1967 and, since that time, has fallen off. During the best years, many facilities were built that are now underutilized. Some facilities around the shore of the Sea have been abandoned. A valuation appraisal in 1972 indicated that the value of private development at the Sea, including improvements, was $380 million, including $302 million in land values and $78 million in improvements (Reclamation and DWR, 1974).

Business activity levels are far below baseline figures on the east shore of the Sea but have been rising slowly on the west shore as the number of resident retirees and winter visitors at Salton City have increased. Employment in the area is very low and is primarily service-oriented with some State and County employment at recreational facilities. Employment has fallen with the decline in visits and business activity since the base period.

No change in recreation and commercial development is expected unless angler visitation increases after salinity control begins since the area is presently overbuilt in relation to demand and ample facilities exist for the present level of recreation visitors. With salinity control, angler visitation would increase, employment would rise at the business and recreational service facilities, and new employment opportunities would be created in public and private construction and operation and maintenance (O&M) of a salinity control project.

Without action to manage salinity, all values are expected to remain low or even fall. Property values would remain depressed or fall. Diminishing property values would reduce the local tax base, causing a loss of revenues to the counties and local districts. Employment rates could decline if places of business closed.

Agriculture

Irrigated agriculture, the primary economic enterprise north and south of the Salton Sea, is the result of large investments in land and water distribution facilities, estimated in 1969 to be approximately $750 million. This entire enterprise is dependent upon the Salton Sea for disposal of drainage waters. Imperial Irrigation District operates and maintains approximately 1,400 miles of deep and surface drains, which convey drainage and seepage waters away from the farmlands to the Sea. The Coachella Valley Water District operates an almost entirely underground drainage system that will ultimately total 250 miles (Reclamation and DWR, 1974).

The salinity of the Sea has little effect upon its use for agricultural drainage. However, its water level may affect the hydraulics of discharges from drains and river channels, particularly the drains in lower-lying areas. A rise of several feet from the present elevation could cause serious problems. For the most effective drainage, a lower elevation than at present would be desirable.

Because of the impact of rising water surface elevations on shoreline improvements, some property owners filed suit against the irrigation districts, seeking compensation for damages incurred from the rising water levels. The case went to trial, and the judge's ruling was favorable to the plaintiffs. Consequently, the plaintiffs were awarded monetary compensation by the irrigation districts, and the districts continue to pay damages as long as the water surface elevation is at a level that causes negative impacts.

2.4 ENVIRONMENTAL QUALITY NEEDS

Environmental quality needs involve management, conservation, preservation, creation, restoration, or improvement of natural and cultural resources and ecological systems. Emphasis is placed on enhancement and protection of the environment as a source of present enjoyment and a heritage for future generations.

The Sea has many such needs. There are, in fact, compelling reasons to believe that a decision to preserve the Sea should be based substantially on environmental considerations. By virtue of its size, scenic setting, climatic location, and existing and potential uses, the Sea appears to have environmental values at least equal in importance to its economic values. The need for preservation stems from the basic belief that scenic or recreational resources should not be despoiled; rather, these resources should be maintained to ensure an adequate physical and recreational environment for the future.

Conservation of the physical resource base includes the preservation of flora and fauna. Without corrective measures, the Sea's fishery is in danger of being destroyed and its value as a recreational resource lost. In addition, there would be losses of the unique and valued ecological system that exists in the Sea and valued wildlife habitat surrounding the Sea.

There is a need to preserve and to increase wildlife habitat at the Sea for wildlife maintenance and public enjoyment. In particular, an increase in the habitat of threatened species is desirable. In addition, estuaries that have been established at the mouths of the rivers which flow to the Sea provide habitat that are declining in other areas of the United States.

The Sea is a saltwater biological system based on its own unique food chain that has evolved through gradually changing conditions of salinity and water level. The extinction of this system would mean the loss of these unique biological phenomena of scientific interest. Without corrective measures, valuable wildlife habitat that exist around the perimeter of the Sea will be degraded, some of it occurring naturally at the fringes of irrigated areas and at the deltas deposited by the Alamo and New Rivers. Other valuable habitat has been improved by the Salton Sea National Wildlife Refuge and the State's Imperial Wildlife Area at the southern end of the Sea. Several species in the area are viewed as being in need of special protection either by the State or Federal Governments, including desert pupfish, American peregrine falcon, Yuma clapper rail, and California brown pelican.

Since its formation, the Sea's biotic community has undergone major changes because of the significant increase in salinity from its source water in the Colorado River. The aquatic community consists of bacteria, phytoplankton, phytobenthos, invertebrates, fish, and aquatic birds. The terrestrial habitat of the area varies across the Basin and includes Sonoran creosote bush scrub, desert saltbush scrub, desert sink scrub, stabilized and partially stabilized desert dunes, tamarisk scrub, freshwater marsh, cisontane alkali marsh, Sonoran cottonwood-willow riparian/tamarisk scrub intermediate, open water, mud flats, ruderal, and agricultural lands.

In some environmental categories, there is a close relationship between environmental quality considerations and economic development considerations. The preservation of the fishery and other marine life in the Sea is, for example, both an important environmental objective and a source of economic benefits.

Fluctuations

The wildlife habitat is affected by the Sea in several ways. Fluctuating water levels have an adverse effect through periodic inundation by rising water. In addition, prevailing winds from the northwest sometimes raise the Sea's elevation 1 foot or more at the Wildlife Refuge on the southern end and cause temporary inundation of some marginal lands.

2.5 SOCIAL AND CULTURAL NEEDS

Social and cultural needs include physiological needs, economic sufficiency and security, social acceptance, and related elements. In physical terms, these needs are met by adequate economic and social opportunity, adequate health and safety provisions, and, on a broader scale, National security and economic considerations. Several such needs exist in connection with the Sea.

Economic Opportunity

A number of economically disadvantaged members of minority groups live in the populous areas north and south of the immediate Project area. Many minority group members are agricultural workers, whose occupation tends to be seasonal with summer peak periods. Workers in agricultural-related businesses face similar work fluctuation.

The general employment situation of some of these workers could be improved by a broadening of the economic base of the Sea's area. Increased recreational-based development at the Sea would help meet this need. Much of the new work would be in service jobs in the peak recreation season from September through mid-June and would dovetail well with the seasonal pattern of agricultural employment.

Data from the Salton Sea State Recreation Area point to a drastic decline in visitation to the area after a period of slow decline starting in the late 1960's and early 1970's. Several reasons for the declining visitation have been offered. Selenium, source water quality from the New River, high salinity, odor, fish kills, diminishing bird populations, lack of infrastructure to support tourism, and poor publicity have, at one time or another, been presented as reasons for the lack of tourism in the area. The ultimate solution to the Sea's problems will at least have to address these issues. Although the return of tourism is not one of the top reasons for constructing a solution to the Sea's problems, it is a central issue to some—notably the local business community. Given that the operation, maintenance, and construction costs of the preferred alternative will most likely be paid, at least in part, by the local economy, it becomes necessary to address the decline in tourism and determine what effect the alternative will have future tourism rates.

Community Enhancement

The communities that have developed around the Sea have been arrested in their growth by the impending high salinity of the Sea. Initial development was stimulated by the recreational potential of the Sea. At present, most of these communities are unbalanced in that development is sparse and scattered, and permanent residents are predominantly retired persons. The provision of utilities, public services, and schools is costly and inefficient (Reclamation and DWR, 1974).

Any additional decline in the attractiveness of the Sea's area will proportionally affect community well-being. Not only could economic loss to private investors be substantial, but community amenities and cohesiveness could be jeopardized. Any reduction in tax base could lead to reductions in public services.

A stimulus is needed that will encourage and support additional growth to expand existing communities, to provide a better tax base, and to support adequate public facilities. Because of the area's orientation toward the Sea, the most valuable stimulus is the enhancement of the Sea's potential.