OUTDOOR RECREATIONAL USE OF THE SALTON SEA WITH REFERENCE
TO POTENTIAL IMPACTS OF GEOTHERMAL DEVELOPMENT*

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INTRODUCTION

The Salton Sea, the second lowest place in the United States (after Death Valley), is a unique physiographic feature, and a recreational and visual resource. Located two hours east of San Diego and on the major highway route between Los Angeles and Mexico, the Salton Sea area is a favorite stopover for recreational travelers, and the destination of about 500,000 hunters, fishermen, and others each year. In 1967, an estimated 1,000,000 people¹ visited the area; the decline is apparently due to the effects on fishing and boating of steadily rising water level and salinity over the last decade.

At the south end of the Sea is one of the most promising energy resources in the country, a geothermal field estimated as having a capacity to produce 3,300 MW, which could supply up to 8% of California's present needs.

Fresh water is critical to the use of both resources: The Salton Sea badly needs stabilization of surface level and reduction of salt content, and geothermal energy plants would also need large quantities of water for cooling purposes.

The objectives of this study were to describe the types, levels, and locations of outdoor recreation uses in the Salton Sea area, the number and principle activities of visitors, and to estimate the consequences upon outdoor recreation of geothermal development and other activities that might affect the Salton Sea.

THE SETTING

The Salton Sea is a large salt-laden lake that, together with the Coachella Valley to the northwest and the Imperial Valley to the southeast, makes up part of a long narrow alluvial valley known as the Salton Trough. It is a large lake (approximately 12 by 35 miles compared to Lake Tahoe's 11 by 22 miles), but quite shallow. At its deepest point, the lake bottom is approximately 186 feet below sea level and the surface is currently at approximately 228 feet below sea level with a maximum depth of 42 feet. At one time, in 1970 (see Figure 1), the surface was at approximately 183 feet below sea level, with a maximum depth of 88 feet.

During most of the 1960s, the lake level had reached a relative equilibrium; several recreational and residential facilities were constructed in anticipation of stable shoreline, and up to a million people visited the Sea. In the last years, increased irrigation has created an imbalance between the supply of water to the lake and evaporation, and combined with exceptional rains has nearly totally inundated several of these facilities. At the present time, all control of irrigation inflow, hence lake surface levels, rests with the Imperial Irrigation District which operates under a ruling of the State Water Resources Control Board that "the primary purpose of the Salton Sea is to receive natural and agricultural drainage and seepage waters."²

The Sea's long axis is paralleled by mountain ranges--on the west the Santa Rosa and Vallecito Mountains, on the east the Chocolate Mountains. Much of the beauty of the lake's setting is contributed

Fig. 1 Historic Shorelines, Salton Sea

by these mountains and the alluvial fan-slopes that connect them with the shoreline. While many of the recreational activities that take advantage of the lake's surface, its wildlife, or its shoreline do not depend on scenic surroundings, such experiences are improved by the beauty of the setting.

The Sea is part of the Colorado Delta region. The Delta--known to geologists as the Salton Trough Physiographic Province, to farmers as the Imperial, Mexicali, and part of the Coachella Valleys, and to transcontinental travelers as an ordeal--is a region with an interesting history and unusual features. It is a skewed delta with the old channel of its parent river--the Colorado--to one side (Figures 2 and 3).

The early Mexicans gave the region its most expressive name: *La Palma de la Mano de Dios*, the palm of the hand of god.³ The Salton sink is the palm, the thumb the mountains north of Yuma, the fingers separate the various channels through the Mexicali Valley.

Until the first part of this century, when California farmers first channeled water from the Colorado, the Valley was part of the Sonora Desert--dry (less than 4 cm. of rainfall per year) and hot (35 C. average May to September, with a world record of 60 C. recorded at Estacion Delta).⁴

Of approximately 700,000 hectares (2 million acres) in the Delta, some 350,000 hectares (1 million acres) are presently devoted to irrigated agriculture, evenly divided on either side of the border. The California lands are irrigated via the All American Canal carrying 2.8 million acre-feet/year from the Colorado near Yuma; the Mexicali Valley is irrigated by part of the approximately 1.5-2.0 maf, which is all that makes it past Yuma (a considerable amount is transported to Tijuana).

On each side of the border are salt lakes (Laguna Salada and Salton Sea). Each has historically existed naturally at times, but the lakes presently owe their existence to the activities of

Fig. 2 Southern California Region

Fig. 3 Ownership, Salton Sea Area

man: Weaknesses in irrigation gate structures allowed the Colorado to flow eastward into the two sinks- from 1905 to 1907, rather than southward to the gulf. Ninety percent of the inflow to the Salton Sea is from Imperial County; the Alamo River provides 619,000 af/year and the New River provides 445,000 af/year.

Underlying this large fertile cap of alluvial soil is what appears to be a great reservoir of water and stored energy, for the Salton Trough is a manifestation of a joint between two of the earth's major crustal plates. The joining zone is made up of jagged faults (the San Andreas, Imperial, and San Jacinto) that apparently allow the magma to rise near the surface to heat the intruding sea and river waters.

The Salton Sea, as the palm of the delta hand, has no outlet to the Gulf of California; its level is therefore dependent upon the relationship between incoming waters and evaporation. Intense sunshine in this extension of the Sonora Desert can cause enough evaporation to affect annual lake levels by as much as six feet, but rains together with irrigation have exceeded that amount in recent years, and the Sea continues to rise.

Salinity in 1907 was 3600 ppm; the six million af of water now test at 40,000 ppm, higher than ocean water, and source waters are becoming more saline as the Colorado River continues to decline in water quality. The long sides of the Sea are bordered by desert characterized by widely separated scrubby plants. On the west side, Salton City is the largest of several recreational communities.

With approximately 1700 permanent residents, Salton City is an unincorporated development. There are 20,000 individually owned lots in an area of 21 square miles that are served with water lines and partial sewers. There are a school, a golf course, and a few stores. The City fronts on the Salton Sea, and its residents are primarily retired couples (see Figure 4).

Fig. 4 Salton City

Fig. 5 Imperial Valley

Fig. 6 Westmorland

Fig. 7 Highway 86, Westmorland

Fig. 8 Recreation in the Colorado Delta Region

Retired couples also live on the upper desert terrace to the east, in mobile home communities clustered around hot mineral water spas.

At either end of the Sea there are flat agricultural areas with a characteristic NS-EW grid pattern. Most of the landowners live in valley towns or outside of the county. Tall processing or storage facilities, high-density cattle feedlots, and other constructions and engineering works punctuate the visual scene at irregular intervals (Figure 5). Typical of the towns scattered throughout the Valley is Westmorland, located near the southern end of the Sea.

A small service community for an agricultural region, Westmorland has a population of about 1400. There are an elementary school, a post office, gas stations, a city hall, two motels, two cafes, and several agricultural implement dealers. The residential areas are laid out in a grid pattern, the original town having nine square blocks in each quadrant of the main central intersection (Figures 6 and 7).

Recreation sites in the region are widely dispersed (Figure 8). The rather moderate slopes of the dunes areas on either side of the valleys, and the expanses of unfenced flat scrubby desert, are inviting to off-road vehicles of all sorts as well as to self-contained mobile residential units such as campers. According to the Imperial County Planning Department,⁵ hardly any part of the unirrigated land is without a weekend resident, and the thickest clusters tend to be near the Salton Sea and San Felipe. Laguna Salada is seen by Mexican officials as an area to be developed for camping in the near future and are directing waste water from the Cerro Prieto geothermal power plant to Laguna Salada in a new channel through the Sierra de los Cucapas.

San Felipe has a beautiful beach, and is a port for sport-fishing in the gulf as well as a point of debarkation for auto-

camper exploration of the Baja Peninsula. Weekend beach users regularly come from as far away as Phoenix, Arizona.

Another important recreational activity is rockhounding, with opportunities for finding petrified wood, quartz, fossils, and other collectors' items.

The largest concentration of activities, such as hunting, fishing, dune-buggy, and water skiing is at the Salton Sea.

USER GROUPS

Four major categories of outdoor recreational user groups can be identified in the Imperial Valley; hunters and fishermen, boaters and water skiers, off-road vehicle (RV) enthusiasts, and retired persons. These are general nonexclusive classes of people; a systematic survey would be needed to establish quantitative estimates for each user group.⁶ Nevertheless, these distinctions are useful to describe the participants in recreational activities in the Imperial Valley.

Hunters and Fishermen. Hunting and fishing are the most significant non-desert-oriented outdoor recreational activities in the Salton Sea Area. A conservative estimate of the annual number of hunters and fishermen enjoying the resources of the Imperial Valley can be made from records kept by the four major facilities (Table 1). Over 90 percent of the fishermen come from outside the County (Table 2).

Boaters and Water Skiers. Records of the Imperial County Parks Department show that in recent years boat launching for non-fishing purposes--that is, pleasure boating and water-skiing--has comprised about 9 percent of the total. Recent observations by members of this study group confirm this estimate.

Table 1

Visitor Days, Hunting and Fishing, Salton Sea Area

June 1975 - June 1976

	<u>Hunters</u>	<u>Fishermen</u>
National Wildlife Refuge	1,097	5,895
Imperial Wildlife Area	11,553	10,685
Imperial County Parks	2,400	22,400
Salton Sea Recreation Area ⁷	--	30,800
Private Marinas (estimate)	<u>--</u>	<u>5,000</u>
Totals	13,050	74,780

Table 2

Place of Origin of Fishermen

<u>County</u>	<u>Percent of Total Anglers</u>
Los Angeles	40%
San Diego	14
San Bernardino	15
Riverside	13
Orange	8
Imperial	8
Other	1
Out-of-State	<u>1</u>
	100%

Source: California Dept. of Fish and Game, 1967.

*Estimate based upon 220,000 visitors to the SSRA, of whom an assumed 14% (30,800) engaged in fishing. This assumption is based upon observations made by Development Research Associates, (1967).

Off-road Vehicle Owners. The expanses of open desert land to the east and west of Imperial Valley's irrigated agricultural area are used by large numbers of people who come in campers and trailers, bringing with them dirt bikes, dune buggies, and other off-road vehicles. To maintain this use, the Bureau of Land Management conducts an aerial census of vehicles on desert lands. Other than unofficial estimates, these are the only indicators of the magnitude of recreation use in the desert. Off-road vehicle activities, by both organized clubs and individuals, involve the majority of people visiting the desert. Table 3 summarizes the vehicle use of desert areas recorded by the Bureau of Land Management.

Using 1975 data as a base year because flights were most frequent during that year, a conservative estimate of the annual number of vehicles in the desert can be projected. Regular flights were scheduled for weekends only, so that the estimates reflect weekend use. However, this provides some indication of peak use and comparative concentrations of desert recreation. The estimates of vehicle days in Table 4 were obtained by assuming that the average number of vehicles counted in any single month can be extended to weekends in that month for which no census was taken. A further assumption was that people will stay an average of two days per weekend trip.

Retired Persons. The Imperial Valley, situated outside of the irrigated agricultural area, offers the open land and warm winter climate desired by retired people; the Salton Sea and nearby hot springs are additional attractions. Several recreational communities (Salton City, Desert Shores) are scattered along the western shoreline of the Salton Sea, but resident populations have remained low. Three campgrounds with hook-ups for over a thousand campers and trailers are located at the hot springs east of the Salton Sea.

TABLE 3: AERIAL SURVEY OF VEHICLE USE: SUMMARY

	1974			1975			1976		
	TOTAL VEHICLES COUNTED	NUMBER OF FLIGHTS	DAILY AVERAGE	T.V.C.	N.D.F.	D.A.	T.V.C.	N.D.F.	D.A.
Yuha Desert (South of I-8)	795	14	57	1204	21	57	820	17	48
Yuha Desert (Coyote Mtns., Painted Gorge, Ocotillo, Plaster City)	589	14	42	859	21	41	1476	17	87
Lower Borrego	4866	14	348	7506	21	357	5756	17	339
Mammoth Wash	574	14	41	915	21	44	522	17	31
Gecko Campground and Road	1572	14	112	2783	21	133	2455	17	144
S-78 from Canal to Glamis	3900	14	279	9400	21	448	5052	17	297
North Dunes (not including Mammoth Wash)	8394	14	600	14,095	21	671	11,787	17	693
Salton Sea	344	9	38	515	12	43	200	2	100

TABLE 4: "VEHICLE-DAYS" ESTIMATED FOR 1975

AREA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTALS
Yuha Desert (South of I-8)	168	1152	542	456	1350	18	24	10	16	104	868	72	4,780
Yuha Desert (Coyote Mtns., Painted Gorge, Ocotillo, Plaster City)	168	752	450	880	1252	36	16	0	24	216	580	40	4,414
Lower Borrego	872	3588	5850	3560	8424	54	0	380	168	1744	6160	432	31,232
Mammoth Wash	8	700	896	312	918	0	0	80	48	544	950	40	4,496
Gecko Campground and Road	352	1980	1866	1400	3556	28	8	870	240	728	2746	184	13,536
S-78 from Canal to Glamis	1096	5684	6930	2832	16,560	64	104	3,350	456	984	10,044	432	48,536
North Dunes (not including Mammoth Wash)	1544	8272	10,120	4272	21,474	90	128	4,570	696	3072	16,330	616	71,184
South Dunes	240	2364	3,110	1664	7434	64	112	890	88	832	4654	160	21,850
Salton Sea	800	900	750	0	0	0	0	0	0	0	400	0	2,850
TOTAL	5248	25,392	30,514	15,376	60,968	354	392	10,150	1736	8224	42,723	1,976	203,062

- Assumptions:
- (1) Weekend use represents primary use.
 - (2) Vehicles remain an average of two days per weekend.
 - (3) Average count per month can be extended for all weekends in that month.
 - (4) December 1976 data can substitute for Dec. 1975, for which no flights were flown.

Although these areas seem to be the principal facilities available to permanent retired residents and to winter visitors, the populations at these resort communities are not a good indication of the actual number of retired persons in the Valley. Not all of the residents are retired, and a large uncounted number of retired visitors camp in the desert and along the irrigation canals. An area known locally as Slab City, located east of Niland, is the largest concentration of these. Originally a military installation and later an internment camp, all that is left are the concrete foundations of barracks--the "slabs"--and remnants of roads. No census has been taken of people camped there; interviews with local recreation area managers indicated that at peak use in January, Slab City has a population of several thousand. Dances are organized, and a sign welcomes visitors to the area even in the off-season (Table 5).

RECREATION RESOURCES

The visitors we have described have at their disposal, as described by the Imperial County Recreation Element of the General Plan, an area with "hot mineral springs, an inland sea, a vast desert region of pure sand, a playground for thousands of dune buggies, abundant wildlife provide game for the hunter, fish for the angler, and beautiful plumed birds and fowl for the bird watcher."

The most important resource, both in the active sense of use and in the passive sense of scenery, is the water--the Sea itself. It is played in, skied on, boated on, fished in, hunted from, and also as landed upon by seaplanes. It is also regarded as something restful to the eyes, something that reflects the mountains, the sky, the moon, and visually defines the floor of an expansive space; and something that creates an edge between itself and the surrounding land.

TABLE 5

SUMMARY OF RECREATION DAYS, SALTON SEA AREA

July 1976 - June 1977

Fishing	74,000 angler days
Hunting	20,000
ORV's ⁸	102,300
Camping	124,600
Boating	19,000
Sight Seeing	75,000
Golf, Misc.	<u>25,000</u>
	439,900 recreation days

*Salton Sea and Lower Borrego areas, from Table 4, times
3 persons/ORV

The Sea can be circumnavigated by auto, an approximately 125 mile trip, and is the visual focus of a vast space (some 2,500 square miles). With the exception of the agricultural areas at either end, the Sea and surrounding mountains are almost constantly visible from the highway and the lands on either side (Figure 9).

While the Tahoe lover would find the Salton Sea unclear and its surroundings barren and unforested, several of its attributes attract a certain constituency, particularly those self-contained travelers (i.e., recreational vehicle owners) who bring their own shelter, food, power, and urban entertainment, seek expansiveness, elbow-room, an "undeveloped" but close-to-highway area on a shoreline, and the proximity of their like-equipped overnight neighbors.

With the exception of two developed boat club/motel areas, one at Salton City and the other at North Shore, most of the publicly accessible sites for experiencing the lake are simply gravel areas, leveled for parking and camping, with possibly some shade (ramadas), fresh water, perhaps a modest store, and a boat-launching ramp.

Perhaps, coincidentally, the most popular sites are not only level, with ample parking and lake access, they are also sited where the highway is closest to the sea, and, as will be seen below, the surrounding mountains and opposite shore are at their nearest.

ENVIRONMENTAL ZONES

This study has identified nine zones surrounding the sea (Figure 10), in each of which there is relative environmental homogeneity, but some degree of distinctness from neighboring zones. Zone boundaries are assumed as perpendicular to the lake shore, so each zone is roughly a wedge (Figure 11) with a

Fig. 9 Salton Sea physiography

Fig. 10 Environmental Zones, Salton Sea

Fig. 11a Transverse section

Fig. 11b Typical Environmental Zone

foreshore area, an alluvial terrace-slope, and bounded by surrounding mountains. Beginning with the southernmost zone, and moving clockwise around the sea, the following is a description of the physical environment, visual characteristics, and recreational resources of each zone:

Zone 1: This zone is bisected by the New River, the main source of irrigation drainage to the sea. Primarily an agricultural plain, the land slopes imperceptibly to the sea, the interface consisting primarily of dikes and some rushy marshland, although most of this is covered by rising water.

Benson's landing, the only public access to the sea in this zone, is basically a launching site for fishermen and hunters. Swimming and water skiing are prohibited. Views from this area (Figure 12) are of a placid lake with low mountains beyond.

Much of the shoreline in this zone is within the Salton Sea National Wildlife Refuge, comprising 35,484 acres, 33,000 acres of which are presently under water.

The Salton Sea National Wildlife Refuge was established in 1930 to protect wintering and year round waterfowl, and to prevent damage to Imperial Valley agricultural lands from waterfowl attracted to the area by the formation of the sea. Hundreds of thousands of waterfowl winter on the Salton Sea, including over 200,000 pintail ducks, American widgeon and green-winged teal, 20,000 snow geese, 8,000 Great Basin Canada geese, and numerous species of rare and endangered birds.

Food crops are grown on refuge lands, and grain is distributed to attract and hold bird populations at the refuge rather than on nearby farm lands.

Approximately 60,000 visitors came to the SSNWR from July 1975 to June 1976. Although hunting is permitted, this use remained a low 1,097 hunter days during the 1975-76 season.

Fig. 12a Zone 1: View from Wildlife Refuge

Fig. 12b Zone 1: View from Benson's Landing

Self-guided and conducted tours are available; a photography blind has been constructed in recent months, and fishing is popular. The "Public Use Report" for 1975-76 indicates that the winter months of October through March is the season of highest use. Peak visitor periods occur during the spring and fall bird migrations.

Zone 2: This zone is primarily an alluvial fan, with a broad, somewhat gentle slope up from the water's edge. The highway is elevated enough to provide panoramic views of the sea, and the not-too-distant Chocolate Mountains (Figure 13); these views are often screened by trees.

Access to the shoreline is prohibited because of the Navy base.

The southwestern portion of this zone, rising uphill from Highway 86 toward the Fish Creek Mountains, is an alluvial fan desert area principally under Bureau of Land Management control. BLM manages this land as part of the Cahuilla Area, under the Yuba Desert Management Plan, a unit of designated California Desert National Resource Lands.

BLM allows ORV use of their area only on designated roads and trails, with vehicles restricted from the Superstition Hills and San Sebastian Marsh. Competitive events are organized by the BLM between Superstition Hills and Westmorland.

In addition to ORV use, the area is a focus of fossil and rock hounding enthusiasts, campers, and dove hunters.

Zone 3: A contribution of the desert-dry alluvial fan to the south, this zone is one of the most pleasant, with the Santa Rosa Mountain close on the west, and the Chocolate Mountains and the eastern lakeshore at their closest point. (Fig. 14)

Fig. 13 Zone 2: View from Navy base

Fig. 14 Zone 3: View from Salton City

Commercial development is at its most intense here, with motels, trailer parks, campgrounds, and water access at Salton City, Salton Beach, Lido Palms, and Desert Shores. There is a permanent population of perhaps 3000 people in the zone, with the largest community being Salton City. Trailer parks, a golf course and landing strip are located nearby.

In March, 1977, the only marinas open for use on the western shore of the Sea were Salton City Yacht Club and Lido Palms. Lido Palms may close by summer 1978 due to rising sea levels.

Lido Palms and Vista del Mar estates are easily identified by an extensive planting of palm trees lining the empty streets of the subdivision. A campground and marina are open at Lido Palms. However, no residences have been constructed in the Vista del Mar estates.

Salton Sea Beach is smaller than, but similar to, Desert Shores. Marina facilities do not appear to be in use at this time, although camping and picnicking are open to visitors.

Desert Shores is a recreational subdivision. It is located at the northern boundary of Imperial County on the western shore of the Salton Sea. The community includes a marina, now flooded, gas stations, restaurants, motels and assorted commercial establishments serving visitors and residents. A few single family homes are scattered among the majority of trailers housing both permanent and seasonal residents.

Visitors have access to camping facilities and a trailer park.

Beyond Desert Shores is Travertine Rock, an interesting outcrop, which lends a sense of "gateway" at the northern end of the zone, at the Imperial/Riverside County line.

Zone 4: Immediately on entering Riverside county there is a drastic landscape change, as northern California (salt-free)

water and marketing tradition enable citrus, grapes, and date palm groves to dominate the use of land. As in Zone 1, this is the valley floor, the Sea an extension of the same plain, with mountains on the distant horizon in a view perpendicular to the shore (Figure 15).

There is no public access to the shoreline, and the highway is set far back.

Zone 5: From Mecca, the highway swings again toward the sea; while the land use is agricultural, it is mostly row crops, so the sea is again visible. In a perpendicular view, the western mountains now dominate, and the color of the sea changes as the afternoon sun is in front of the observer (Figure 16).

With the green fields in the foreground, and backlit jagged mountains beyond the lake, opening spatially toward the Imperial and Mexicali Valleys, the sense of color and expansiveness is quite striking. While the fields are not "natural," there are few hard or shiny man-made objects, so the scene is nature-dominated.

Zone 6: Zone 6 is the most heavily used, has the most developed (and most pleasantly landscaped) facilities for boat launching and camping, and the most traditionally scenic views (Figure 17). There are palm or other foreground trees, sailboats on the sea, and prominent and interesting mountains in the background, behind which the winter sun sets.

Commercial facilities include the North Shore Yacht Club and marina, large moorage with a breakwater for onshore winds, and a landing strip. The headquarters and the most improved campgrounds of the Salton Sea State Recreation Area are also in this zone.

The headquarters campground of the SSSRA has 50 developed

Fig. 15 Zone 4: View from Oasis

Fig. 16 Zone 5: View from Mecca

Fig. 17 Zone 6: View from North Shore

campsites, a boat ramp, visitors' center, and room for 120 persons in a group camp. Running water and toilets are available here and at nearby Mecca camp, which has 140 sites.

Zone 7: For the entire length of this zone, the highway is proximate to the shore, which, although arid and with few trees, attracts large numbers of self-contained campers due to the fact that it is all part of the State Recreation Area, and has access to some of the best fishing and water-skiing areas.

Corvina, Salt Creek, and Bombay Beach camps of the SSRA are all primitive campgrounds, with water, chemical toilets, and unmarked sites. On Memorial Day in 1977, there were 1277 sites occupied.

The view from most of the shore is rather plain (Figure 18), relieved only by the Superstition Hills in mid-background and whatever boats or seaplanes are active. From Bombay Beach, a commercial marina and camping site, the view is principally of water, with the mountains being further away than from any other shore site. There are no trees or shrubs, shade being provided only by RV's and tarps, hence the foreground is dominated by clustered vehicles.

The commercial area of Bombay Beach has the only boat launching facility remaining open north of Niland and south of North Shore. One marina with space for 100 boats in a protected harbor was reconstructed at a slightly higher level after the Fall 1976 storm. All other marinas on the east side of the Salton Sea are flooded.

The Bombay Beach resort community has a permanent population of approximately 275, and 800 property owners. A trailer park has hookups for 80 units.

At the foot of the Chocolate Mountains are two existing hot

Fig. 18a Zone 7: View from State Recreation Area

Fig. 18b Zone 7: View from Bombay Beach

mineral spa developments, and one under construction. These spas provide pools for soaking in the artesian mineral waters, and trailer parking for up to 3,500 vehicles. All sites are able to see the Salton Sea and the distant Santa Rosa Mountains.

Zone 8: This zone is probably visually the least interesting. The hills are far away, the highway again a mile and a half from the shore and paralleled by electric transmission lines and the SPRR. The land is arid, with little vegetation. Niland Marina, a county launching facility and boat basin, is popular principally because of proximity to the agricultural population of Imperial Valley.

Niland Marina has accommodations for 300 campers, and 60 hookups for trailers; sanitary facilities and water are provided. A small store and gas station are located on Highway 111 at the road to Niland Marina.

Niland Marina is flooded, the Sea nearly reaching the sewage oxidation ponds. In the event that happens, the Park may be closed.

In fiscal 1976, 6000 fishermen, 1000 campers, and 2500 ORV's were registered at Niland Marina.

Views from the Marina (Figure 19) are of barren shore, water to the south (hence glary), relieved only by mirages of Red Hill and Obsidian Butte in the mid-background, and on a clear day La Citadela in the far distance.

Zone 9: This zone is hardest hit by rising waters, with the access road to the Red Hill Marina presently a threatened causeway, and adjacent agricultural access roads innundated (Figure 20).

Fig. 19 Zone 8: View from Niland Marina

Fig. 20a Zone 9: View from Red Hill

Fig. 20b Zone 9: View from Obsidian Butte

Red Hill, a county park, has 300 campsites, 30 trailer hook-ups, showers, sanitary facilities, a snack bar and gasoline pump.

Obsidian Buttes to the south is one of the most visually interesting places around the Sea, the only place with relief from a flat and arid foreshore. The mountains are distant, but Mullet Island provides some midground interest.

The State of California manages an important wildlife refuge within this zone, the Wister units of the Imperial Wildlife area, for the following purposes:

- (1) to help preserve California's waterfowl resource and other wildlife;
- (2) to attract and hold the hordes of hungry, wintering waterfowl off of Imperial Valley's multi-million dollar agricultural crops; and
- (3) to provide public hunting, fishing, nature study and other recreation compatible with the two other objectives.

The Wister Unit of the Imperial Wildlife area is located along Highway 111 approximately 4 miles north of Niland along the east shore of the Salton Sea. It is managed primarily to provide habitat area for wintering waterfowl. Hunting is allowed three days a week during hunting season with a maximum of 200 hunters per day at the Wister Unit and the Salton Sea National Wildlife Refuge combined. In addition to public recreation opportunities, the Wister Unit provides land for the Imperial Valley State Warm Water Fish Hatchery.

A system of levees and canals throughout the Wister Unit creates impoundments maintained as fresh and brackish water marsh, and crop production is an important element in the waterfowl management practice. During 1975-76, 1520 acres were planted in rye grass, barley, watergrass, alkali bulrush and milo; and an additional 1200 acres of rye grass, alkali bulrush and watergrass were "volunteer" fields. Tule, sasbania and other marsh

vegetation are maintained, and 1400 acres of bulrush and millet were flooded prior to waterfowl season.

Public hunting is permitted in season for waterfowl, Wilson Snipe, cottontail and jackrabbits, Gambel's quail and dove. Upland game hunting is not permitted at the Wister Unit during waterfowl season, however. Permits for both the Wister Unit and the SSNWR are regulated from the Wister Unit check station. A total of 5,170 acres were open to public hunting at the combined Wister and Salton Sea National Wildlife Refuge areas. Of these, 850 acres were in green barley or annual rye grass for goose hunting.

Hunter use at the Wister Unit for the 1974-75 and 1975-76 seasons were as follows:

Table 6: Hunter Days, Wister Unit

	<u>1974-75</u>	<u>1975-76</u>
hunters	10,419	10,927
waterfowl bagged: ducks	17,655	19,125
geese	989	3,716
coots	<u>570</u>	<u>501</u>
Total waterfowl bagged	19,214	23,311

Fishing and non-consumptive recreation also occurs at the Wister Unit, as follows:

Table 7
Non-Hunting Activities, Wister Unit, 1975-76

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
fishing	154	87	55	113	108	118	153	175	210	184	264	36
nature study	6	4	4	21	5	8	26	82	31	15	13	11
camping	1	117	28	18	27	35	48	71	10	7	5	1
sightseeing	56	85	41	86	131	121	251	225	78	69	30	10
birding	7	21	38	16	17	29	116	136	42	30	22	15
fragging	18	4	--	--	--	--	--	--	--	--	--	--
Totals	242	318	116	254	288	311	594	689	371	305	334	173

Yearly total 4,045

fishing 1,757

Approximately 90% of public lands hunting in the county occurs in the Imperial Wildlife Area. However, hunting is a popular form of recreation throughout the Imperial Valley. The California Department of Fish and Game published a "Report on Hunter Use" for the Imperial Valley in 1972 and a special study was made of the area between the Coachella canal and Highline canal, from the All-American Canal to Wister. Data indicated that dove and quail hunting were the most popular hunting activities, and the best hunting for dove and quail was in agricultural land habitats. The following estimates of county-wide hunting use were published in the "Report on Hunter Use" for 1972.

Table 8
Hunting Activities, Imperial County, 1972

	<u># of May-days</u>	<u>Est. # of hunters</u>
deer	--	200
cotton tail rabbits	16,200	810
jack rabbits	15,400	770
quail	34,400	11,350
dove	109,600	36,170
waterfowl	--	250
coyote, bobcat, etc.	--	400
	175,600	49,950

It was noted by the manager of the Imperial Wildlife Area that the backwaters along the canals are a very important and somewhat ignored wildlife habitat in the Imperial Valley. Although there is a lower diversity of bird species than the Wister Unit, mammalian species are numerous.

SUMMARY OF RECREATIONAL RESOURCES

The majority of recreational activities at the Sea itself take place along the northern shore, primarily because of the 18 mile shoreline of the SSSRA.

The following map (Fig. 21), shows known public access points to the Sea, observed boat usage on a spring day, and an estimate, based upon observation, of mobile homes and campers parked at various sites.

Visual Resources. Travertine Rock, Obsidian Butte, Red Hill, and the trees planted at Lido Palm Oasis, and Northshore, are very important reference points and objects worthy of inspection

Fig. 21 Public Access to Salton Sea

by visitors. Transitory features (boats, skiers, seaplanes) are also important visual attributes of the Sea. These features are all near to hand; another important feature is the enclosing ring of mountains. One of the conclusions of this study is that there is a strong correlation between distance and likely preference, the shortest "viewsheds" being the most likely to be preferred. As found in other similar studies, most people prefer a legible landscape (simple and few elements), water as a focus, foreground interest, and a sense of enclosure.

The following map shows points from which the views in Section IV (Figure 22) were taken; the table (Table 9) indicates relative distance from highway viewing point to the foreshore, the opposite shore, and the background mountains.

CONSEQUENCES OF GEOTHERMAL DEVELOPMENT IN THE SALTON SEA AREA

The Nature of Proposed Development. The largest concentration of geothermal electric plants as postulated in a maximum scenario most recently by Ermak,⁷ would be directly east of Salton Sea. This scenario is based upon current estimates of site suitability and appropriate technology, and also upon a first-level screening-out of environmentally sensitive sites (defined as the Salton Sea itself, wildlife refuges, urban areas with a half-mile buffer zone, active faults). (See Fig. 23.) Some 40 plants could eventually be developed in the area.

Economically feasible plants are assumed to be 110 MWe (100 MW operating normally at 90 percent capacity), with a land requirement of 8 ha. and wells scattered on adjoining lands 2.5 ha. (1 sq. mi.) in area. The 75 MW Cerro Prieto plant, just south of the City of Mexicali, provides a good example of the manner in which underground water, heated by magma, is converted to electrical energy.

Figure Table 9 VIEWING DISTANCES

Fig. 22a Observer Stations and View Distances

Fig. 22b Points of Visual Interest, Salton Sea

Fig. 23 Possible Locations of 100 MWe Geothermal Plants

At Cerro Prieto 13 wells scattered across a 2.5 km^2 (1.5 sq. mi.) field extend to 1300 m. to reach water of 350 C. Hot water and steam are separated, the saline water disposed of in evaporation ponds, and the steam used to drive two 37,400 KW turbo alternators. Waste heat is disposed of in conventional cooling towers.

While resources on the American side are more saline and not as hot as those of Cerro Prieto, the physical configuration of the plant and ponds would be generally the same in appearance. (Fig. 24.) Sites would be of approximately 20 acres for each 100 MW power plant, with pipelines from wells following existing roads and irrigation ditches.

Estimates (Ermak) to date are that a 100 MW plant will produce 6240 af/year of water from steam condensate, which could be used to satisfy the 6000 af/yr. evaporative cooling requirement.

If the water is reinjected, then cooling water would have to be drawn from the Salton Sea, or from irrigation sources. This, for a development of 3000 MW, would be 240,000 af/yr.

Goldsmith estimates that for 240,000 af/yr., the Sea could potentially be lowered by nearly ten feet annually, and salinity would increase alarmingly.

Conversely, if reinjection of brine and cooling water proves infeasible, the Sea could rise an equal amount or more each year, even allowing for evaporation. In this case, some 40 million tons of salts per year could be added to the Sea, or 10 times the present annual input.

Consequences of Development. Published and available draft discussions of consequences⁸ tend to agree that the estimable direct environmental affects are generally negligible within the following substantive areas: land consumption, hydrogen sulphide dispersal, noise, subsidence, water pollution, and water consumption.

Fig. 24 Typical Geothermal Plant

These are summarized below:

1. Land Consumption - Ermak describes land needs for maximum power production, for the whole of Imperial County, as comprising only 3 percent of the agricultural land (500 ha. for a maximum of 80 plants) and concludes that this is not a significant problem.
2. Hydrogen Sulfide - Apparently scrubbing technologies are available and feasible to reduce the H₂S (rotten egg) smell to negligible levels, below present competitive odors of cattle feed lots.
3. Noise - With the exception of unlikely but possible well blowouts, noise will be kept within present argo/industrial standards. The Salton Sea field is water-dominated, hence far quieter than steam-dominated fields such as at Cerro Prieto.
4. Subsidence - Pasqualetti⁹ states the most widely held view thusly: "... all predictions (about subsidence) are conjectural," meanwhile assuming that reinjection of spent fluids will prevent any significant changes in valley grades. Tolerances are small in an area dependent upon irrigation and drainage systems, and therefore this is an extremely sensitive area, in which reasonably accurate predictions can be made only after direct on-site experience.
5. Water Pollution - If geothermal brine wastes, as noted above, are added to the flow of agricultural wastes to the Salton Sea, then the salinity levels would quickly rise beyond the point in which the present game fish could survive. Reinjection of fluids is again seen as the solution, and assumed to be feasible by most technologists to date.
6. Water Consumption and/or Production - If all brines drawn from the reservoirs must be reinjected, and cooling waters drawn from irrigation sources, the Salton Sea may be able to reach a balance approaching 1967 levels, as irrigation increases have already impacted shoreline recreation and wildlife areas significantly. If, on the other hadn, reinjection is infeasible, then Sea levels will continue to rise, eventually at an alarming rate.

7. Consequences for Outdoor Recreation - With a water level rise of another two feet, the remainder of the National Wildlife Refuge's dryland and marsh area will be inundated, and most private and public marinas will have to close or be rebuilt. Since recreation visits have already declined from an estimated 1,100,000 visitor days in 1967 (Development Research Associates) to half that amount in 1977, the developed resource recreation use will nearly disappear, at least along the shoreline.

Another aspect, and an important one, is visual quality. In order to make some judgement as to magnitude of visual impact, the following map (Figure 25) has been developed, showing comparative sensitivity to visual degradation, and also to change in water level, up or down. The most sensitive areas to both visual degradation, and also to change in water level, up or down. The most sensitive areas to both visual degradation and sea-level change are at the north end of the Sea, farthest from proposed power plants, with the exception of the wildlife refuges.

Visual Consequences. There are four basic situations in which an observer might find himself confronted with geothermal plants or the pipes and power lines which accompany it (Fig. 26). These are:

1. Seeing a plant in the agricultural area, from the agricultural or wildlife refuge areas.
2. Seeing a plant in the agricultural area from the surrounding desert.
3. Seeing a plant outside of the agricultural area, from within the agricultural area; and
4. Seeing a plant in the surrounding desert from the desert.

Fig. 25 Sensitivity to Visual Degradation and Change in Water Level

Fig. 26 Vantage Points

The agricultural areas near Salton Sea are part of what we might call the ubiquitous American landscape, little studied by visual theorists.

The defining and orienting features of this landscape are not meandering brooks and enclosing hills as we see in our mind's eye when we think of "farmscape". Instead, they are highways, power lines, irrigation ditches, and tall bulky processing plants, a landscape of hard straight lines, ". . . not a product of agrarians, but of engineers."¹⁰ The pattern is unrelievedly rectangular, the grid-form established by Jefferson, in what Kouwenhaven calls the simultaneous ". . . impact of democracy and technology." And one of its attributes is change itself, the processes of the use of land for productive purposes made visible.

One can argue that there is an aesthetics of resource extraction, that even visitors to a place like the Delta Region understand and appreciate it. A major increase in bulky structures, even those with steam plumes, will not be a major disruption, particularly structures which are not radically different from others in the Valley. As long as pipes are below grade and in the grid pattern, and the new power lines simply expand those presently visible, neither will they be a problem, at least for situation (1) (Fig. 27). The plants themselves may even seem a welcome change from the monotony elsewhere in the lower Delta (Fig. 27).

Situation (2) is a bit more difficult to describe and discuss. The most affected area would be that northwest of Niland, which the County designates as developable for residential communities (Fig. 28). From this gently rising land, the view of the Valley would be changed, with some forty bulky new plants in the middle-ground. Again, however, we would expect people to accept this as an extension of an existing situation with no major ill effects (except H_2S if that is not controlled at the source.)

Fig. 27 Situation 1: Geothermal Plants in the Agricultural Landscape

Fig. 28 Situation 2: Geothermal Plants from Mineral Spa area

The third situation (3) is, however, a marked change. The area north of Niland, and outside of the present agricultural perimeter, is likely to be developed; for the first time, major visible aspects of resource extraction would extend the agricultural/industrial environment beyond the delta flats into the lower alluvial fans of the surrounding mountains (Fig. 29).

Plants in this area would be highly visible: their white steam plumes would stand out against a dark backdrop, they are elevated and hence conspicuous, and as projected they would be scattered and could be visually disruptive to an extensive area.

A case should be made here for consolidation of plants into a few large units, siting to maximize concealing terrain features, and dark earth colors on all exposed elements (Fig. 30).

Situation (4) deserves the same comments as (3), but is probably less significant: The observer is himself in terrain which rolls, and is less likely to see distant plants than if he were on the Valley floor.

Guidelines for Siting and Design of Geothermal Plants. The following summarizes comments made above, and is the kind of list which might be adopted by local government agencies as a part of regulations to minimize adverse consequences of geothermal development:

1. Plants should be sited at least 1/8 km from major public roads;
2. Their long axis should be perpendicular to the major road.
3. Lines of fast-growing tall trees, such as eucalyptus or poplar, would be helpful parallel to plant structures.
4. Pipelines should be below grade or behind berms, and should follow the agricultural grid.

Fig. 29 Situation 3: Geothermal Plants on Desert Slopes

Fig. 30 Consolidated Plants

5. Cyclone fences, if necessary for security, should be set well back from roads, with oleander or other plantings in front, to minimize the unsightliness of blown trash.
6. On slopes above the Valley floor, plants should be consolidated into clusters wherever possible, and their structures, fences, pipes, and powerline structures painted in earthtones complementary with the landscape.

Powerlines. The same situations and their vulnerability, as discussed above for geothermal plants, apply to major powerlines. Assuming that these lines will be above ground for the near future, they will add significantly to the visual changes in the region.

Within the agricultural perimeter, they probably should be sited to follow existing grid lines, not so much for visual reasons as for legibility, hence safety to crop-dusting aircraft.

Outside the perimeter, their effect can be lessened by the following:

1. consolidation into a single route out of the region, if possible;
2. siting in valleys, not on ridges;
3. earth colors for towers, not raw galvanized steel or raw aluminum.

Secondary Consequences. Construction of 40 power plants in the Salton Sea area would potentially increase population by up to 7500 people, and an equal number of people related to plant construction further south might seek homes nearby.¹² 15,000 people might be accommodated in some version of the following three alternatives, as illustrated below, in

- (A) an extension to the town of Westmorland

Fig. 31 Approaching an Expanded Westmorland

Fig. 32 Approaching a New Compact Community

- (B) a high density compact community just west of Westmorland on the desert lands, or
- (C) a low-density community such as Salton City.

These three community types can be examined for visual consequences in the same way as the geothermal plants, i.e., are they extensions of an existing man-made environment, or intruders in the desert?

(A) Westmorland - Westmorland is "one of those towns you drive through." For the passerby, the impact of the extension would be positive, because new levels of investment and new consumers would be likely to induce a spruce-up of main street (Highway 86), after the first initial downward economic effects of new shops south of town.

For a few years, new subdivisions would be apparent as one approaches town from the south, but they would be low, on flat land, and therefore can be soon screened by trees (Fig. 31). Windrows of trees should be a requirement for subdivision approval in this alternate.

Community (B) - This community, on a gentle plain above the highway, would be highly visible: something to drive to. It could be an apparently appealing oasis, or a white and shiny distraction in an otherwise undisturbed expansive desert scene. The walled oasis town of the Middle East is probably the most compelling image: dust-colored walls, shady groves on the highway side thriving on waste water, low-scaled dwellings with a few higher apartments appearing to grow out of the mass as in a pueblo (Fig. 32).

One of the visual problems for designers here (and elsewhere in the Southwest) is the necessity for reflective exterior materials

for cooling and energy-saving purposes. Solar collectors angled to the southern sun and white gravel roofs can be extremely disturbing visually. In this case, the town would be sited above and to the south of the highway, ameliorating that problem somewhat. Again, windrows of tall trees, which would help to reduce ambient temperatures as well as soften visual impact, should be required by governing agencies.

Community (C) - This town would be below the road, with roofs highly visible, and homes scattered over vast acreages, so, although you drive on by it, you wouldn't miss the fact that the desert is being settled (Fig. 33), so screen planting would be a necessity.

CONCLUSIONS

Since the Salton Sea is considered legally to be a sump for agricultural, municipal, and presumably geothermal waste waters, recreational use of the Sea for fishing and boating (from present marinas) will undoubtedly continue to decline, unless there is a major policy change. Use of the shoreline for camping, the surrounding roads and lands for scenic viewing, ORV events, and retirement or recreation communities will not decline, and will probably increase, assuming control of Hydrogen Sulfide odors.

There would seem to be two primary ways in which the fishing and present boating facilities could be returned to a wholly usable steady state. One is by construction of the expensive diked evaporation pond system proposed by the Department of the Interior, at the south end of the Sea. This would allow a means of control over both water level and salinity.

Another means, less costly but more difficult to effectively control, would be to budget geothermal plant use of, and disposal of wastes in, Salton Sea water. Such budgeting would require a

Fig. 33 A New Low-Density Community

capability of geothermal plants to shift to reservoir withdrawal or reinjection as necessary to maintain a desired salinity and level of Sea waters.

Either alternative would affect the Sea only in the distant future, after 10 to 15 years. In the interim, there is little that can be done except for patch-up: raising the level of dikes which protect wildlife lands, raising roads, such as that to Red Hill Marina, rebuilding boat ramps at a higher elevation.

Would \$300 million for dikes and evaporation ponds, and some control over geothermal water use and wastes be worth it to "save" the Salton Sea fishing resource? Even if fishing use could increase to 300,000 person-days per year, that would still be \$100/person-day spread over 10 years, and hardly seems worth it.

Since all other uses can adjust to sea-level change, and are relatively independent of salinity, it would seem more reasonable to attempt to control levels with a system of smaller impoundments and a flexible water-use system toward which geothermal development might contribute.

Footnotes

¹Development Research Associates, 1969.

²Imperial County Planning Commission. Conservation element of the Imperial County General Plan, 18 December 1973.

³Frank Waters. The Colorado River. New York: Reinhard, 1946.

⁴John E. Chappell, Jr. Passing the Colorado Salt. The Geographical Magazine, July 1974, 569-574.

⁵Imperial County Planning Commission, Imperial County Ultimate Land Use Plan, 25 June 1973. "Recent aerial views indicate 10,000 to 50,000 persons . . . on a weekend (in the County)."

⁶This study initially assumed that a differentiation could be made between resident and nonresident participation in outdoor recreation. The consensus of officials interviewed, however, was that county residents tend to leave the immediate area for outdoor recreation, preferring the Gulf of California and the Colorado River. The exception to this observation may be hunting, but available hunter data do not deal with place of origin.

Another qualification must be made: The available data are for designated and managed areas, and a good deal of hunting and fishing takes place along the unsupervised miles of Sea shoreline, and irrigation canals, presumably by local residents.

⁷Donald L. Ermak. A scenario for geothermal electric power development in Imperial Valley. Environmental Sciences Division, Lawrence Livermore Laboratory, University of California, 1977. He emphasizes that these are "hypothetical locations chosen from the (apparently suitable) regions" for purposes of exploring effects on environment.

⁸Donald L. Ermak. Op. cit. Also M. J. Pasqualetti, Geographical and environmental analysis. Riverside: Department of Earth Sciences, University of California, January 1977.

⁹Pasqualetti, Op. cit.

¹⁰Jackson, J. B. "The historic American landscape." In E. Zube (Ed.), Landscape assessment. Stroudsburg, Penna.: Dowden, Hutchinson, & Ross, 1975.

¹¹Kouwenhoven, J. The beer can by the highway. New York: Doubleday, 1961.

¹²Sidener, J. Settlement patterns in the Colorado delta region, 1977.

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APPENDIX

OUTDOOR RECREATION PLANNING, AN ANNOTATED BIBLIOGRAPHY

This appendix is an annotated bibliography on outdoor recreation planning. It reviews the traditional concepts of recreation demand and supply and follows with a discussion of recreation travel, including the concepts of access and visual analysis. Its emphasis is on the conceptualization and resolution of the major issues in recreation planning.

Recreation is a good, often exhilarating, experience perceived by an individual when he engages in a particular activity. It is an

. . . activity (or planned activity) undertaken because one wants to do it. In a deeper sense, recreation refers to the human emotional and inspirational experience arising out of the recreation act. (Clawson and Knetsch, 1966, p. 5)

Current thinking stresses the importance of recreation as an experience rather than as an activity. For example, Driver and Brown (1975) define recreation

. . . not as activity but as a particular type of human experience that finds its source in intrinsically rewarding voluntary engagements (mental and physical) during nonobligated time. (p. 66)

This serves to warn the planner that when he limits recreation planning to planning for activities, as he often must, he serves in an indirect capacity in the fulfillment of recreation needs.

DEMAND

The demand for recreation refers to the propensity of the population to recreate. Historically, the recreating public has

been disaggregated by socio-economic factors because of the availability of secondary data sources such as the national census. But unlike economics, recreation demand schedules are not easily constructed due to difficulties in the evaluation of the recreation experience.

Socio-Economic Factors

Different levels of participation in recreation activities by socio-economic groups is the underlying assumption of the most widely used recreation forecasting method. The participation rates of socio-economic groups are used to weigh their population projections in order to obtain an estimate of total recreation participation. This method had its origin in the Outdoor Recreation Resources Review Commission studies of 1962. Cicchetti (1973) has emerged as its major proponent.

The factors considered in the ORRRC study were income, age of head of household, race, region, place of residence, education of household head, paid vacation, life-cycle stage, and occupation of household head (ORRRC, 1962, #20, p. 27.). These factors have been widely criticized. Cunningham (1970) saw no evidence linking occupation with type of recreation. Orthner (1976) found little similarity between the recreation pattern of husbands and wives. And Hendee (1969) questioned the significance of place of residence in recreation activity.

The most controversial factor is income. Although some investigators have found that poor people do not participate in costly activities (ORRRC, 1962, #19; Cicchetti, 1973; Rosma, 1973; Tatham and Dornoff, 1971), that they do so out of preference is not clear. Lindsay and Ogle (1972) found that when a recreation area is very close to an urban area, no difference between the income level of users exists when compared to that of non-users. Hecock states that "no relationship was found that would link past experiences, socio-economic status, or demographic group type to

any measure of accessibility on Cape Cod. Apparently beach visitors with small children or low incomes are as likely to travel long distances as any other group" (Hecock, 1970, p. 243). In contrast, Ellis (1967) found that high income groups had a higher tendency to perform more energetic activities, travel farther distances, haul trailers or boats, enter wilderness areas, and go sight-seeing. Vaux (1975) found that a disproportionately small group of low income people use wilderness areas. The National Recreation Access Study (VTN Midwest Research Institute, 1975) indicates a strong relationship between income and high cost recreational activities such as golf, snow skiing and deep-sea fishing, but shows an inverse correlation with fresh-water fishing and driving for pleasure.

Other factors, such as childhood experience (Christensen and Yoestring, 1973), taste, "the thing to do," and cultural background (Leonhardt, 1971), or recreation as a form of play action (Burch, 1965) and recreation versus work experience (Spaulding, 1976), distinguish recreationists. Kaplan (1975) has proposed relationships between time, selection, function, meaning, social group, values and leisure.

The activities of groups and group dynamics in recreation appear to be perspectives for future study (Field and O'Leary, 1973). Lee (1973) identifies local, non-local, and lifestyle recreation user groups, and further disaggregates these groups into single persons, friendship, and kinship groups. Brewer and Gillespie (1974) have pointed out that on the basis of an empirical index, group activities may not maximize total satisfaction because some members of the group are not fully satisfied.

Another aspect of socio-economic characteristics is their relationship to combinations of activities, or activity packages, which may be preferred over a random assortment of possible activities. Factor analysis and non-metric methodologies, such as cluster analysis and multi-dimensional scaling, have been used to

investigate the existence of activity packages (Bishop, 1970; Neulinger and Brent, 1969; Burton, 1971B; Ditton et al., 1975; Rosma, 1973; Romesburg, 1973; Becker, 1976). Generally, three to eight activity groupings are found, representing various degrees of active to passive recreation. However, the findings appear to be directly related to local cultural and natural features, making comparisons difficult.

Benefit Estimation

Recreation benefits have been associated with a marginal analysis of the recreationists' "willingness to pay." The methods used to measure willingness to pay are interview techniques and estimates of consumer surplus. Interviews conducted on the site, in the vicinity of the site, and at origins attempt to establish the value of the experience, how much more the recreationist would be willing to pay, or how "big a bribe" he would accept to stay away (Knetsch and Davis, 1966). In another approach, Crutchfield (1962) set the value of sport fishing at the market price of the fish caught. This method has been amplified by Stevens (1966, 1967) and Stoevener (1972) with the inclusion of the effect of water quality.

Consumer surplus, the additional price that recreationists would be willing to pay, is derived from participation data. The chief proponents of this techniques are Clawson and Knetsch (1966). They hypothesized that demand for a particular site can be measured through the frequency and travel costs of visits to the site. A demand schedule is constructed from the cost differentials per unit population from various zones and different demand curves are generated through the disaggregation of income, leisure time available, conditions of access roads, or management policies at the site. This approach has been investigated and extended to include the establishment of pricing policies based on benefit estimation (Becker, 1975; Binkely, 1977; Nautizal and Chowdhary, 1975;

Willis et al., 1975).

The major criticism of recreation benefit estimation is that willingness to pay should not be confused with ability to pay. Many low income groups may not be able to participate in costly activities whether or not they want to (lavery, 1975). In addition, the Clawson and Knetsch method lumps all types of activities together; in reality, some sites lend themselves to particular types of activities in either a physical or social sense. Finally, the approach does not address the complex question of intervening opportunities, and does not consider the effects on the primary site, of other sites, or the introduction of competition either in the form of new sites or improvement in old ones.

SUPPLY

Recreation supply is described through the use of standards, and through the concept of carrying capacity. Both of these approaches attempt to indicate the level and type of activity possible at a recreation facility. They complement the site suitability analysis whereby the compatibility of activities with the site, other activities and management policies lead to a site design.

Standards

Standards are used to estimate the sufficiency of recreation supply and as a guide in the design of new facilities. They are also used in recreation program development and management. Standards may be spatial, linear, based on a per capita measure of population or on a fraction of recreation area (Gold, 1976). Major sources of standards are the U. S. Bureau of Outdoor Recreation (1964, 1967), the National Park and Recreation Association (Buechner, 1971), and the American Society of Planning Officials (Moeller, 1965). A recent BOR publication (1977) stresses the

relationship between carrying capacity and standards.

Standards are never disaggregated by any socio-economic or other attribute, and they never address the possibility of simultaneous activities occurring in the same area (Twiss, 1970). Standards may also be used to overestimate recreation participation (see Ackerman et al., 1974, pp. 127-130).

At present, the consensus among recreation experts is to use standards as guidelines rather than absolutes (Gold, 1973, p. 154). However, when they are used as rules, it is because they are simple; they are set by an established national organization and can be defended on the principle of authority; they are a symbol of pride (they become ends rather than means); and finally, that they are useful as bargaining points in the allocation of financial resources (Gold, 1973, p. 149).

Carrying Capacity

The carrying capacity of recreational facilities was first popularized by Wagar (1964). Generally, it is defined as the number of recreationists that a facility can support within its design, its resource-bearing and its psychological-social constraints (Lime and Stanky, 1971, Alldredge, 1972). Recreation carrying capacity has also been defined as "the use at which total satisfaction or benefits, produced by a recreation area, are maximized" (Greist, 1976).

Recreation carrying capacity has three components, each of which can limit the capacity of a recreation facility. First, the design capacity is expressed in terms of installed visitor facilities such as the size of a parking lot, level of maintenance, and other similar considerations, and may be viewed as a reflection of management policies and budgetary constraints (see Fisher and Krutella, 1972). Second, the resource-bearing capacity is the maximum number of persons a facility can accommodate without

irreversible permanent degradation occurring in the natural environment (see Clark, 1977). Finally, the psychological-social capacity of an area consists of psychological and social barriers as distinguished by race, language, and other attributes (see Wager, 1974). This component of carrying capacity is often cited in relation to crowding and standard setting. However, crowding is a problem only when an individual or a group wants privacy. Hecock (1970) found evidence of a positive crowding effect whereby teenagers tended to congregate at beaches that had food facilities and other teenagers.

The concept of carrying capacity implies a limit that should not be exceeded. This level may be established by any of the components of carrying capacity that are limiting under the prevailing conditions. However, the limits may be removed. The carrying capacity of an area may be increased by a technological innovation or a change in management policy; it may also change over time as a function of societal needs (Caly, 1971).

PARTICIPATION, OR CONSUMPTION

Recreation participation is often confused with the concept of recreation demand by recreation planners. The ORRRC studies of 1965 introduced the recreation participation model which is used in most State Comprehensive Outdoor Recreation Plans (SCORP) today.

Demand Versus Participation

In the Analysis of the Outdoor Recreation Resources Review Commission (ORRRC) studies of 1962, the forecast of recreation participation was mistakenly called a recreation demand forecast. Lavery (1975) calls participation, effective demand; Mercer (1973) sees participation as an expressed need for recreation. Latent, or unexpressed, recreation demand is the difference between participation and total recreation demand and is one of the primary

concerns of recreation planners. Mercer separates latent demand into the deferred demand of those who could participate but do not, either through a lack of knowledge, or lack of facilities, or both; and the potential demand of those who cannot at present participate and require an improvement in their social and economic circumstances to do so.

Other authors have hypothesized that factors that inhibit participation and cause latent demand include entrance fees, inaccessibility, and the lack of knowledge and experience (McClelland and Mecrich, 1968), as well as satisfaction levels, life cycle stage (e.g., families with small children), time, money, proximity to resources, and perception of resource characteristics (Hecock and Rooney, 1975).

Intervening Opportunities

As discussed by Burke (1977) the intervening opportunities effect, or diverted consumption (Burton, 1971), occurs where the same or other activities are pursued elsewhere, perhaps due to an increase in supply at a new location. These shifts in consumption indicate a demand that is not fulfilled by the existing supply. However, demand is not readily identified under these circumstances for the following reason. Individuals seek out their preferred recreation activity, but they may also be attempting to minimize travel impedance, a complex trade-off between preference and impedance occurs. This results in a less preferred, but a more opportune, participation in recreation activities. Hendee and Burdge (1974) have referred to this phenomenon as substitutability--the interchangeability of recreation activities in satisfying participants' motives, needs, and preferences (p. 157). Becker (1976) stresses the role of an individual's perception of activity benefits in this trade-off.

This view explains the socioeconomic differences in participation as differences in opportunity rather than demand.

The Recreation Participation Model

The participation approach attempts to forecast recreation "consumption" based on socioeconomic characteristics and recreation site attributes which have been linked to recreation through the empirical analysis of data collected in the National Recreation Surveys (ORRRC, 1962; USBOR, 1965, 1967, 1971, 1972).

Recreation "demand" is assumed to vary with population size, real per capita income, education, leisure time, age, race, marital status, and other socioeconomic characteristics. Recreation "supply" is assumed to be a function of recreation land and water acreage, natural environment acreage, historical and cultural acreage, levels of environmental degradation, and other factors.

The calibration of the participation model through the use of regression techniques to estimate the participation co-efficients, or parameters, has been a major area of recreation research over the last decade. (Cicchetti, 1972a, 1972b, 1973a, 1973b; Cicchetti et al., 1972).

Once the model is calibrated, forecasts of participation may be obtained through projections of population disaggregated by socioeconomic characteristics and estimates of increases in recreation supply. Many of the State Comprehensive Outdoor Recreation Plans (SCORP) are based on such an approach (Brown and Wilson, 1975).

California has developed a Park and Recreation Information System (PARIS) which inputs the "recreation demand" from a participation model and compares it with the supply of private and public facilities. The comparison is disaggregated over intra-county areas called geopieces. The difference between demand and

supply in each area is expressed as a "need". Needs can be projected into the future based on population projections, and are meant to provide recreation planners with a basis for determining a priority for recreation development throughout the state.

In addition to projection use, PARIS also presents tabular and graphic summaries of visitor attendance for each of the state parks (California Department of Parks and Recreation, 1966; Yotter, 1975).

RECREATION TRAVEL

Recreation travel has two distinctive characteristics. First, it is done primarily by car. The recreation access study indicates that as much as 95% of all recreation person-trips are made by car or private recreation vehicle (VTN/Midwest Research Inst., 1975). Second, recreation travel is the most popular form of recreation. The Bureau of Outdoor Recreation reports that over 70% of the recreating public participates in sightseeing and driving for pleasure (BOR, 1972). These findings are collaborated throughout the recreation literature and in particular point to the importance of the visual experience in recreation.

Of interest to the recreation planner are the methods used to predict recreation travel volumes and analyze the visual experience on highways linking population origins and recreative facilities.

Recreation Travel Models

Reviews of recreation travel models have been undertaken by Burke (1977), Cesario (1969), Deacon et al. (1972), Lavery (1975), Moeller and Echelberger (1974), Thompson (1967), Wilkinson (1973) and Yotter (1974). The major types of models used to predict recreation travel volumes are gravity and attraction; probabilistic and the network or flow. As one might expect, these approaches are similar since they describe a single paradigm of recreation par-

ticipation.

The gravity and attraction models assume that the attraction of a recreation facility varies inversely as a function of its distance from a population center. Ellis and Van Doren (1966), Ullman and Volk (1962), Deacon et al. (1972), and McAllister and Kleth (1976) have used the gravity formulation in recreation studies. Wolfe (1972) and Beamon (1974, 1976) have discussed possible forms of the distance component of the model. The attraction model is essentially the same as the gravity model except that it uses regression techniques for the evaluation of its parameters (Cesario, 1969).

Probabilistic models are a variation of gravity and attraction models. They derive the probability that a trip from a particular origin will terminate at a particular destination. Ellis and Van Doren (1966) describe two forms of the mode. The intervening opportunity model is a probabilistic model which allows for the analysis of the effect of alternative sites on recreation travel.

The network or flow models, also called the systems theory model, was developed by Ellis and Van Doren (1966). It describes recreation travel with the theory of electrical networks.

Linear programming approaches to recreation travel analysis have been undertaken by Tadros and Kalter (1971) and Penz (1975). A simulation model has been contrived by Gaumnitz (1973). Finally, future recreation travel models will probably be derived from psychological models (Lambe, 1969) and entropy maximizing models (Cesario, 1975b).

Burke (1977) discusses the weaknesses of recreation travel models. They fail to disaggregate for user, trip, and site characteristics. They may forecast an "average" number of recreationists, regardless of activity preference, trip duration, or site attractiveness characteristics. The gravity model, in par-

ticular, does not consider the capacity of each site, the type of recreation trip (such as vacation, weekend trip, or daily trip), or the effect of intervening opportunities (Kalter, 1971). But the network model improves on the gravity model by considering the interaction between sites.

Visual Analysis

The popularity of sightseeing and driving for pleasure indicate the importance of visual quality in the recreation experience. The visual aspect of recreation is enhanced by picturesque settings in the mountains or along the coast which serve as destinations for the outdoor recreationist. But other landscapes such as the desert offer exciting visual experiences as well.

As described by Schauman (1974), visual resource technology can be disaggregated into

- (a) taxonomy or classification of the landscape,
- (b) viewer preference,
- (c) visual perception, and
- (d) landscape management.

However, these categories are not independent. The measurement, including classification, and assessment of the landscape depends, in part, on viewer preference which in turn is an integral part of the perception mechanism.

From a recreation planning standpoint, visual analysis includes the delineation of the viewshed; what one actually sees from the highway and from recreation areas. The United States Forest Service has used computers for viewshed identification for several years. VIEWIT (Travis *et al.*, 1975) and the Visual Management System (U.S. Forest Service, 1973) are used to assist in the assessment of visual impact of development and logging in potential recreation areas. These programs determine the line-of sight viewshed based on viewer and project altitudes and height.

While useful for project evaluation, they are not readily adapted to the visual experience of an observer in a moving vehicle with no fixed visual target.

Once the viewshed is identified, the next planning step distinguishes between different types of visual experiences, often based on landscape type (Hamill, 1971) followed by an evaluation of their relative worth (Peterson and Neuman, 1969; Zube et al., 1975). The final step is the establishment of area specific management guidelines or policies which preserve good views and improve or eliminate eyesores. Of course, such guidelines and policies require strong administrative or legal support in order to be effective.

Litton (1973) ties together landscape evaluation and the visual experience from the highway (Hornbeck, 1970) with the introduction of landscape control points. Control points are determined by their relationship to roads or trails, areas of concentrated use, views of landscapes of special value, best viewing opportunities and overlapping fields of view and different views of the same landscape segment.

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