# Drainage-Return, Surface-Water Withdrawal, and Land-Use Data for the Sacramento-San Joaquin Delta, with Emphasis on Twitchell Island, California

*By* William E. Templin *and* Daniel E. Cherry

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### Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| acre | 0.4047 | hectare |
| acre-foot (acre-ft) | 1,234 | cubic meter |
| acre-foot per year (acre-ft/yr) | 1,234 | cubic meter per year |
| mile (mi) | 1.609 | kilometer |
| square mile ($mi^2$) | 259.0 | hectare |
| | 2.590 | square kilometer |

## Vertical Datum

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

## Definition

An acre-foot is the quantity of water required to cover 1 acre to a depth of 1 foot.

## Selected Water-Unit Relations

1 gallon = 8.3453 pounds
1 million gallons = 3.07 acre-feet
1 thousand acre-feet per year = 1.121 million gallons per day
1 cubic foot = 62.4 pounds
1 cubic foot = 7.48 gallons
1 acre-foot = 325,851 gallons
1 acre-foot = 43,560 cubic feet
1 kilowatt = 0.7457 horsepower
1 kilowatt hour = 0.000293 British Thermal Units

# Drainage-Return, Surface-Water Withdrawal, and Land-Use Data for the Sacramento-San Joaquin Delta, with Emphasis on Twitchell Island, California

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## ABSTRACT

Partial data on drainage returns and surface-water withdrawals are presented for areas of the Sacramento-San Joaquin Delta, California, for March 1994 through February 1996. These areas cover most of the delta. Data are also presented for all drainage returns and some surface-water withdrawals for Twitchell Island, which is in the western part of the delta. Changes in land use between 1968 and 1991 are also presented for the delta.

Measurements of monthly drainage returns and surface-water withdrawals were made using flowmeters installed in siphons and drain pipes on Twitchell Island. Estimates of monthly returns throughout the delta were made using electric power-consumption data with pump-efficiency-test data. For Twitchell Island, monthly measured drainage returns for the 1995 calendar year totaled about 11,200 acre-feet, whereas drainage returns estimated from power-consumption data totaled 5 percent less at about 10,600 acre-feet. Monthly surface-water withdrawals onto Twitchell Island through 12 of the 21 siphons totaled about 2,400 acre-feet for 1995. For most of the delta, the monthly estimated drainage returns for 1995 totaled about 430,000 acre-feet. The area consisting of Bouldin, Brannan, Staten, Tyler, and Venice Islands had the largest estimated drainage returns for calendar year 1995.

Between 1968 and 1991, native vegetation in the delta decreased by 25 percent (about 40,000 acres), and grain and hay crops increased by 340 percent (about 71,000 acres). For Twitchell Island, native vegetation decreased about 77 percent (about 850 acres), while field crop acreage increased by about 44 percent (about 780 acres).

## INTRODUCTION

The Sacramento-San Joaquin Delta of California is an area consisting of about 738,000 acres of islands and channels (fig. 1) that receive runoff from about 40 percent of the State's land area (California Department of Water Resources, 1993). About 500,000 acres of the delta is agricultural land, much of which is below sea level and is dependent on levees for protection from flooding. The delta is part of California's water-delivery system, which stores water in reservoirs north and south of the delta and delivers irrigation water to millions of acres of farm land south of the delta and drinking water to two-thirds of the State's population. Many of California's water issues involve delta water use issues.

In 1993, a cooperative study of the Sacramento-San Joaquin River Delta was started by the U.S. Geological Survey (USGS) and the California Department of Water Resources (DWR), Division of Local Assistance, Municipal Water Quality Investigations Section, and Division of Planning, Delta Modeling Section. The purpose of the study was to update drainage-return data for delta islands, to quantify surface-water withdrawls, and to compile digitized land-use data needed to improve DWR's model of consumptive use on the delta islands.

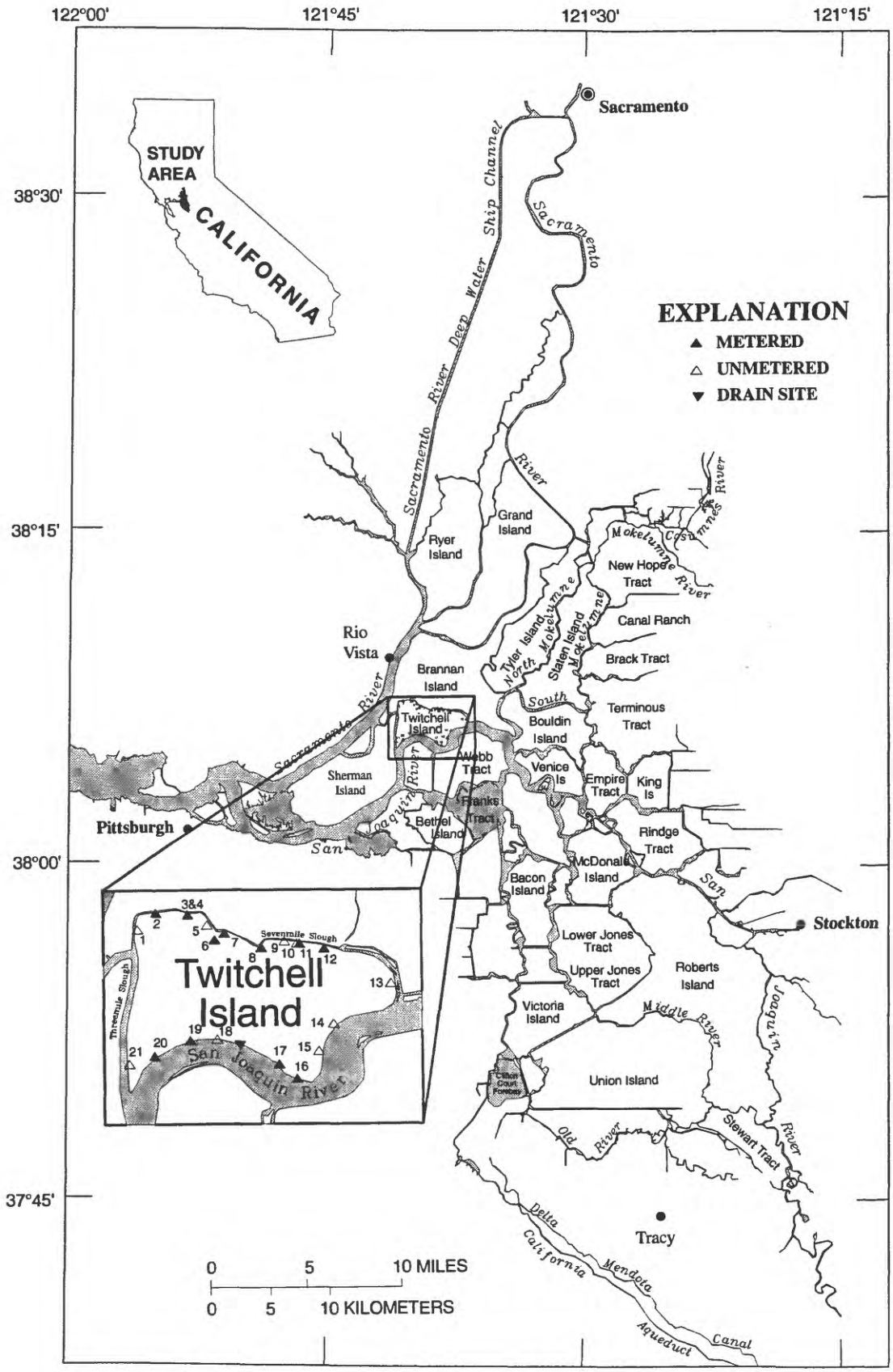


**Figure 1**. Locations of the Sacramento-San Joaquin Delta and of the withdrawal siphons and the drain site on Twitchell Island.

The methods used for the drainage study are similar to the methods used during a study by the California Department of Water Resources (1956). Since 1956, the need for more current water-use information has increased with increased concerns about water and land use in the delta and the effects of these uses on the quality and quantity of water available from the delta. Knowledge of water consumption in the delta is needed to estimate freshwater discharge to San Francisco Bay. Agricultural drainage pumped off the islands into delta channels contains natural organic chemicals that form carcinogens (such as trihalomethanes) when the water is chlorinated for municipal use. Island drainage also introduces pesticide residues into the habitat of threatened fish species.

The objectives of this study were to estimate drainage returns using electrical power-consumption data, to measure selected surface-water withdrawals, to digitize land-use maps for 1968, and to compare the 1968 maps with the digital land-use maps available for 1991. The study involved estimating drainage returns for 236 drains with electrically powered pumps, quantifying surface-water withdrawals at 12 of the 1,800 surface-water withdrawal sites, and digitizing the 1968 land-use maps. Twitchell Island was selected for intensive monitoring of drainage returns and surface-water withdrawals because it is owned by DWR and because one of the withdrawal siphons on the island was already being measured.

The purpose of this report is to present data on delta drainage returns and surface-water withdrawals collected between March 1994 and February 1996, a tabulation of changes in delta land use between 1968 and 1991 for the areas of DWR's consumptive-use model, and methods used to obtain these data.

The authors gratefully acknowledge the assistance of personnel from other agencies and companies who have contributed to this study. In particular, we would like to recognize Rick Carter, Linda Carter, and Joe DaCruz, Reclamation District 1601; Todd Bruce and Michael Menard, Pacific Gas and Electric Company; Kim Robinson, Electronic Engineering; Leonard Kirkpatrick, Kirkpatrick & Associates; and Ted Mayer, Sharman Incorporated.

## DRAINAGE RETURNS

To prevent flooding of the delta islands, drainage returns—which are a combination of precipitation, seepage, unconsumed irrigation water, and surface-water withdrawals for other uses—are pumped into adjacent channels (fig. 2). To obtain a record of Twitchell Island's drainage returns, DWR collected weekly drainage-return and electric power-consumption data at its one drain site (fig. 1). Independently, USGS collected monthly drainage-return and electric power-consumption data at the Twitchell Island drain site and obtained monthly power-consumption records from Pacific Gas and Electric Company (PG&E). USGS used this power-consumption data with pump-efficiency-test data provided by PG&E, Twitchell Island Reclamation District, and DWR to make additional drainage-return estimates.

### Measurement Using Flowmeters

The drain on Twitchell Island was equipped with a flowmeter during this study; it is the only drain site of the 236 drains (fig. 3) in the PG&E data base known to be equipped with a flowmeter. Thus, drainage returns were measured at this drain site. McCrometer invasive flowmeters with straightening vanes were used to measure flows discharged by the main pump and the auxiliary pump at the drain site. These flowmeters are reported to have an absolute relative error of less than 2 percent (Schwankl and Hanson, 1993, p. 6). The data were obtained by manually recording dial readings and calculating cumulative flows. Electric power-consumption readings were also manually recorded during each visit.

DWR recorded weekly drainage returns for Twitchell Island between August 1994 and January 1996 (table 1). USGS recorded monthly drainage returns within 1 day of the first day of each month (table 2). Drainage returns pumped from Twitchell Island during 1995 totaled 11,232 acre-ft (table 2). The largest monthly drainage returns during 1995 were pumped during January and March (2,499 and 1,926 acre-ft, respectively), and the smallest monthly total returns were pumped during September, October, and November (323, 298, and 340 acre-ft, respectively) (table 2).

### Estimates Using Electric Power-Consumption Data

Drainage returns can be estimated using electric power-consumption data with pump-efficiency-test data. PG&E maintains a pump-efficiency-test data base that includes 58 of 236 drains in the delta for which they have electric power-consumption records. Additional drains may operate in the delta, but a complete inventory of the drains in the delta was beyond the scope of this study. At the time of this study, the data

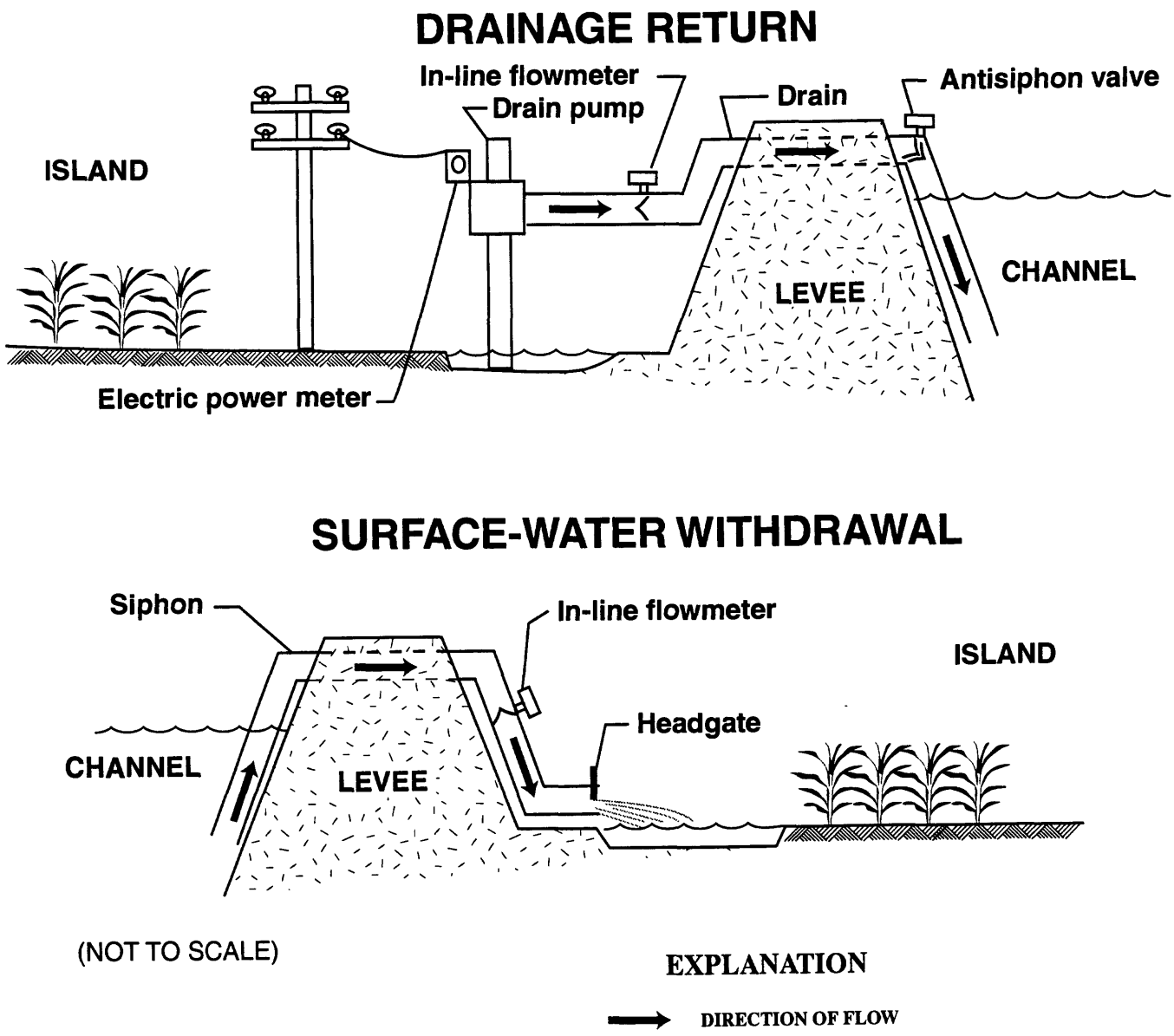


**Figure 2.** A schematic of a drainage-return site and a surface-water withdrawal siphon similar to those on Twitchell Island in the Sacramento-San Joaquin Delta, California.

base contained data on 220 pump-efficiency tests done at the 58 drains. USGS acquired the power records from PG&E with an agreement that the records would be released only after being aggregated into areas more than 36 $mi^2$. For Twitchell Island, USGS computed monthly drainage-return estimates using power-consumption data collected during site visits with PG&E pump-efficiency data.

### Methods

An empirical equation called the unit power-consumption method (Diamond and Williamson, 1983, p. 7) or the coefficient of power method (Ogilbee and Mitten, 1970, p. 7) was used to estimate drainage returns from the power-consumption data. The equation has the form

pumpage (acre-feet) = power (kilowatt hours)/unit-use coefficient (kilowatt hours per acre-foot).

The unit-use coefficient is determined by conducting pump-efficiency tests during which pumpage and power consumption are measured. The unit power-consumption method is the most convenient method of estimating pumpage because the needed data are

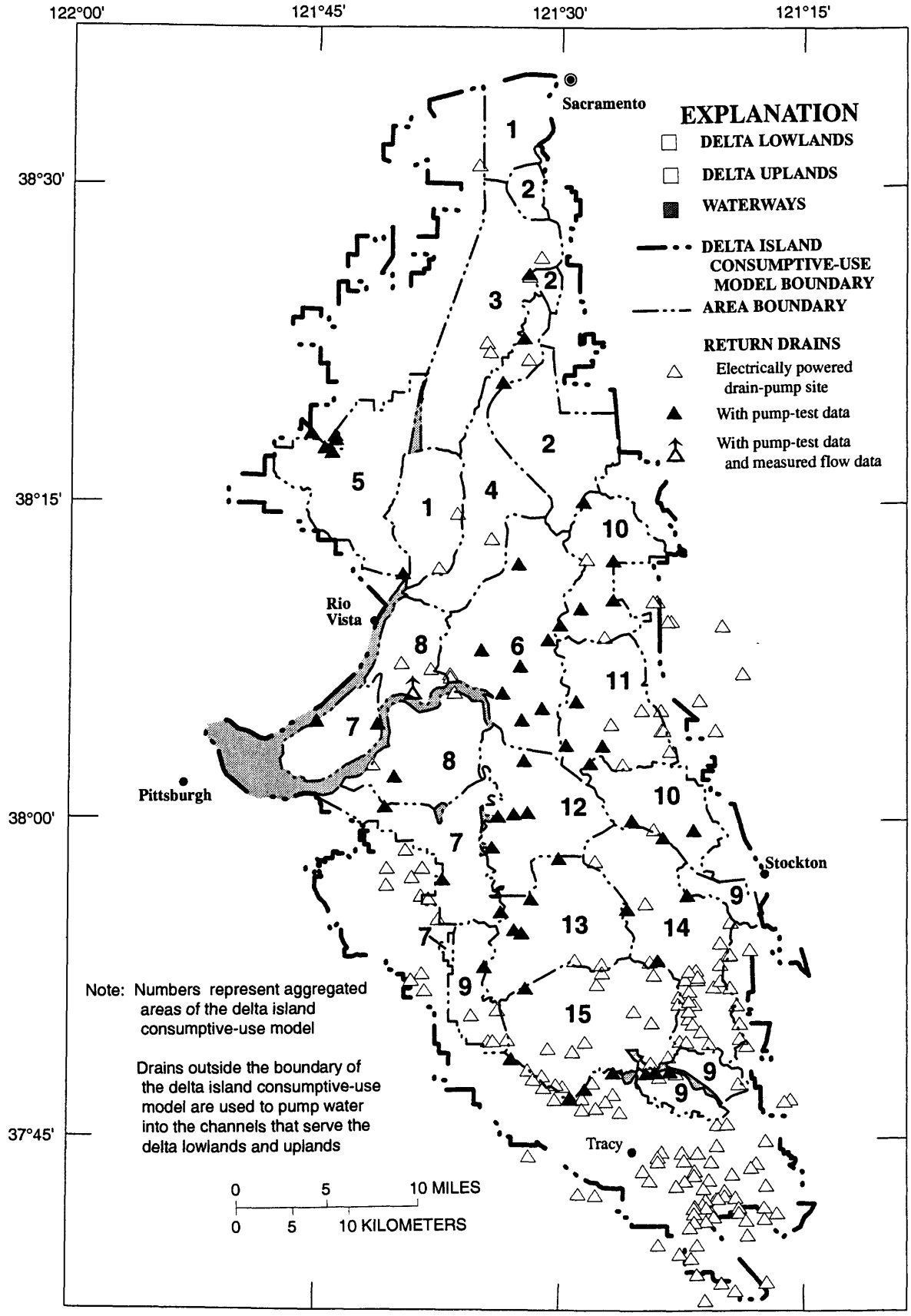


**Figure 3.** Locations of the return drains in the Sacramento-San Joaquin Delta, California, and of the aggregated areas of the California Department of Water Resources' delta island consumptive-use model. Boundaries of areas generally are the channels.

**Table 1.** Drainage returns from Twitchell Island in the Sacramento-San Joaquin Delta measured weekly by the California Department of Water Resources, August 9, 1994, to January 8, 1996[1]

[Values, in acre-feet, are the differences between successive readings of cumulative flows. NR, not read]

| Date meter was read | East pump | West pump | Total | Date meter was read | East pump | West pump | Total |
|---|---|---|---|---|---|---|---|
| 08/09/94 | 67.32 | 282.75 | 350.07 | 05/01/95 | 0 | 112.50 | 112.50 |
| 08/16/94 | NR | NR | NR | 05/08/95 | 67.48 | 96.55 | 164.03 |
| 08/23/94 | 65.95 | 329.59 | 395.54 | 05/15/95 | 50.14 | 104.18 | 154.32 |
| 08/30/94 | 19.04 | 117.75 | 136.79 | 05/22/95 | 2.67 | 143.28 | 145.95 |
| | | | | 05/29/95 | 0 | 157.26 | 157.26 |
| 09/06/94 | 17.37 | 95.59 | 112.96 | | | | |
| 09/13/94 | 15.98 | 128.59 | 144.57 | 06/05/95 | 3.46 | 115.04 | 118.50 |
| 09/20/94 | 20.80 | 156.33 | 177.13 | 06/12/95 | 10.80 | 110.59 | 121.39 |
| 09/27/94 | 20.24 | 153.54 | 173.78 | 06/19/95 | 16.92 | 110.55 | 127.47 |
| | | | | 06/26/95 | 4.67 | 134.16 | 138.83 |
| 10/05/94 | 28.34 | 182.99 | 211.33 | | | | |
| 10/11/94 | 20.11 | 127.87 | 147.98 | 07/03/95 | .27 | 143.92 | 144.19 |
| 10/17/94 | 14.06 | 103.58 | 117.64 | 07/10/95 | 0 | 114.22 | 114.22 |
| 10/26/94 | 33.51 | 69.50 | 103.01 | 07/17/95 | 0 | 145.04 | 145.04 |
| | | | | 07/24/95 | 0 | 157.27 | 157.27 |
| 11/02/94 | 3.80 | 73.66 | 77.46 | 07/31/95 | 0 | 225.91 | 225.91 |
| 11/09/94 | 0 | 101.64 | 101.64 | | | | |
| 11/16/94 | 0 | 111.43 | 111.43 | 08/07/95 | 0 | 206.58 | 206.58 |
| 11/23/94 | 0 | 106.94 | 106.94 | 08/14/95 | 0 | 210.03 | 210.03 |
| 11/30/94 | 0 | 122.12 | 122.12 | 08/21/95 | 0 | 205.90 | 205.90 |
| | | | | 08/28/95 | 0 | 173.57 | 173.57 |
| 12/07/94 | .10 | 141.97 | 142.07 | | | | |
| 12/14/94 | .00 | 156.98 | 156.98 | 09/05/95 | 0 | 135.69 | 135.69 |
| 12/21/94 | .13 | 199.69 | 199.82 | 09/11/95 | 0 | 69.04 | 69.04 |
| 12/28/94 | NR | NR | NR | 09/18/95 | 0 | 72.04 | 72.04 |
| | | | | 09/25/95 | 21.59 | 46.98 | 68.57 |
| 01/04/95 | 115.06 | 538.40 | 653.46 | | | | |
| 01/11/95 | 213.27 | 287.17 | 500.44 | 10/02/95 | 43.06 | 29.53 | 72.59 |
| 01/18/95 | 267.25 | 297.04 | 564.29 | 10/10/95 | 25.57 | 47.03 | 72.60 |
| 01/25/95 | 261.30 | 298.15 | 559.45 | 10/16/95 | 27.39 | 38.49 | 65.88 |
| | | | | 10/23/95 | 4.16 | 56.00 | 60.16 |
| 02/01/95 | 252.60 | 300.25 | 552.85 | 10/30/95 | NR | NR | NR |
| 02/08/95 | 68.74 | 303.86 | 372.60 | | | | |
| 02/15/95 | 12.71 | 282.78 | 295.49 | 11/06/95 | 32.36 | 116.49 | 148.85 |
| 02/22/95 | 14.07 | 274.10 | 288.17 | 11/14/95 | NR | NR | NR |
| | | | | 11/20/95 | 63.53 | 89.45 | 152.98 |
| 03/01/95 | .39 | 213.76 | 214.15 | 11/27/95 | 0 | 74.73 | 74.73 |
| 03/08/95 | 61.26 | 279.53 | 340.79 | | | | |
| 03/15/95 | 213.30 | 321.45 | 534.75 | 12/04/95 | 55.60 | 24.96 | 80.56 |
| 03/22/95 | 125.35 | 299.82 | 425.17 | 12/11/95 | NR | NR | NR |
| 03/29/95 | 226.37 | 330.73 | 557.10 | 12/18/95 | 119.65 | 191.67 | 311.32 |
| 04/05/95 | .11 | 207.22 | 207.33 | 01/08/95 | 66.57 | 711.60 | 778.17 |
| 04/12/95 | .25 | 177.72 | 177.97 | | | | |
| 04/19/95 | 6.91 | 161.85 | 168.76 | | | | |
| 04/26/95 | .20 | 163.79 | 163.99 | Total | 2,781.78 | 11,870.38 | 14,652.16 |

[1]Because of differences in periods of record, monthly totals for these meter readings may not agree with totals in table 2. However, the total for August 1994 through December 1995 agree (14,652 acre-feet).

usually available (Ogilbee and Mitten, 1970, p. 7; Diamond and Williamson, 1983, p. 7).

For Twitchell Island, the mean unit-use coefficient for all PG&E pump-efficiency tests provided by the Twitchell Island Reclamation District, 50 kilowatt hours per acre-ft, was used with USGS records of electrical power consumption for the Twitchell Island drain to calculate drainage returns. For the 58 drains in the

**Table 2.** Drainage returns from Twitchell Island in the Sacramento-San Joaquin Delta, California, measured monthly by the U.S. Geological Survey, August 1994 through January 1996

[Values are in acre-feet]

| Month | West pump | East pump | Total |
|---|---|---|---|
| 1994 | | | |
| August | 743 | 155 | 898 |
| September | 590 | 82 | 672 |
| October | 477 | 89 | 566 |
| November | 469 | 0 | 469 |
| December | 815 | 0 | 815 |
| Total | 3,094 | 326 | 3,420 |
| 1995 | | | |
| January | 1,390 | 1,109 | 2,499 |
| February | 1,074 | 96 | 1,170 |
| March | 1,300 | 626 | 1,926 |
| April | 756 | 7 | 763 |
| May | 535 | 121 | 656 |
| June | 521 | 36 | 557 |
| July | 736 | 0 | 736 |
| August | 846 | 0 | 846 |
| September | 265 | 58 | 323 |
| October | 227 | 71 | 298 |
| November | 224 | 116 | 340 |
| December | 903 | 214 | 1,118 |
| Total | 8,777 | 2,454 | 11,232 |
| Total for 1994-95 | 11,871 | 2,780 | 14,652 |
| 1996 | | | |
| January | 1,007 | 326 | 1,333 |
| Total for period of record | 12,878 | 3,106 | 15,985 |

delta with pump-efficiency-test data, the mean unit-use coefficient for each drain was used with PG&E power-consumption records to calculate drainage returns. These coefficients ranged from a high of 83 kilowatt hours per acre-ft to a low of 18 kilowatt hours per acre-ft. For the remaining 178 drains in the delta for which no pump-efficiency-test data were available, using pump horsepower to infer a unit-use coefficient was considered. However, coefficient-horsepower plots of the 220 pump-efficiency-test results indicated that the correlation of the data in the present pump-efficiency-test data base is poor (fig. 4). Therefore, the mean unit-use coefficient of all pump tests in the pump-efficiency-test data base, 40.6 kilowatt hours per acre-ft, was used with the power-consumption data to calculate drainage returns for the remaining 178 drains. Drainage-return estimates were aggregated into larger areas using the geographic information system, ARC/INFO.

## Results

Drainage returns from Twitchell Island were estimated using both USGS and PG&E power-consumption records for the drain (table 3, fig. 5). Both USGS and PG&E power-consumption records indicate that the total drainage-return estimates for 1995 was about 10,600 acre-ft. The total for estimated returns was about 5 percent less than the total for the measured returns (about 11,200 acre-ft). Monthly drainage returns for 1995, estimated from USGS power-consumption records, ranged from 14 percent less than the measured returns in April to almost 4 percent more than the measured returns in December (table 3). Differences between the estimated monthly drainage returns generated from USGS and DWR power-consumption records probably result primarily because of different intervals between the meter readings. The most notable difference was in March 1995 (fig. 5); this large difference occurred because the meter had not been read by PG&E since December 1994.

Monthly drainage returns were estimated for the 236 drains in the delta using PG&E power-consumption data for January 1995 through February 1996. The estimates for the 236 drains were aggregated into 62 of the 142 subareas in DWR's delta island consumptive-use model; these 62 subareas cover most of the delta (the shaded areas on fig. 6). To meet a confidentiality agreement with PG&E, which restricts the releasing of pumping data for individual accounts or for areas of less than 36 $mi^2$, the estimates for the drainage returns were then aggregated into 17 areas for reporting (table 4): the 15 areas within the delta island consumptive-use model area, which represent the delta lowlands; the delta upland area; and the area just outside the boundary of the delta island consumptive-use model (fig. 3). (The drains outside the delta island consumptive-use model boundary are used to pump water into the channels that serve the delta lowlands and uplands and thus were used for this study.) The data were aggregated using ARC/INFO (fig. 6). Of the 236 drains with power-consumption data, 215 of the drains are in the 62 subareas, with 91 of the drains in the delta uplands; the remaining 21 drains are outside the model boundary. Area 2 is the only aggregated area for which there were no power-consumption data available to make drainage estimates.

Area 6 (fig. 3), which consists of Bouldin, Brannan, Staten, Tyler, and Venice Islands, had the largest estimated drainage returns (about 73,000 and 96,400 acre-ft for calendar year 1995 and for the period

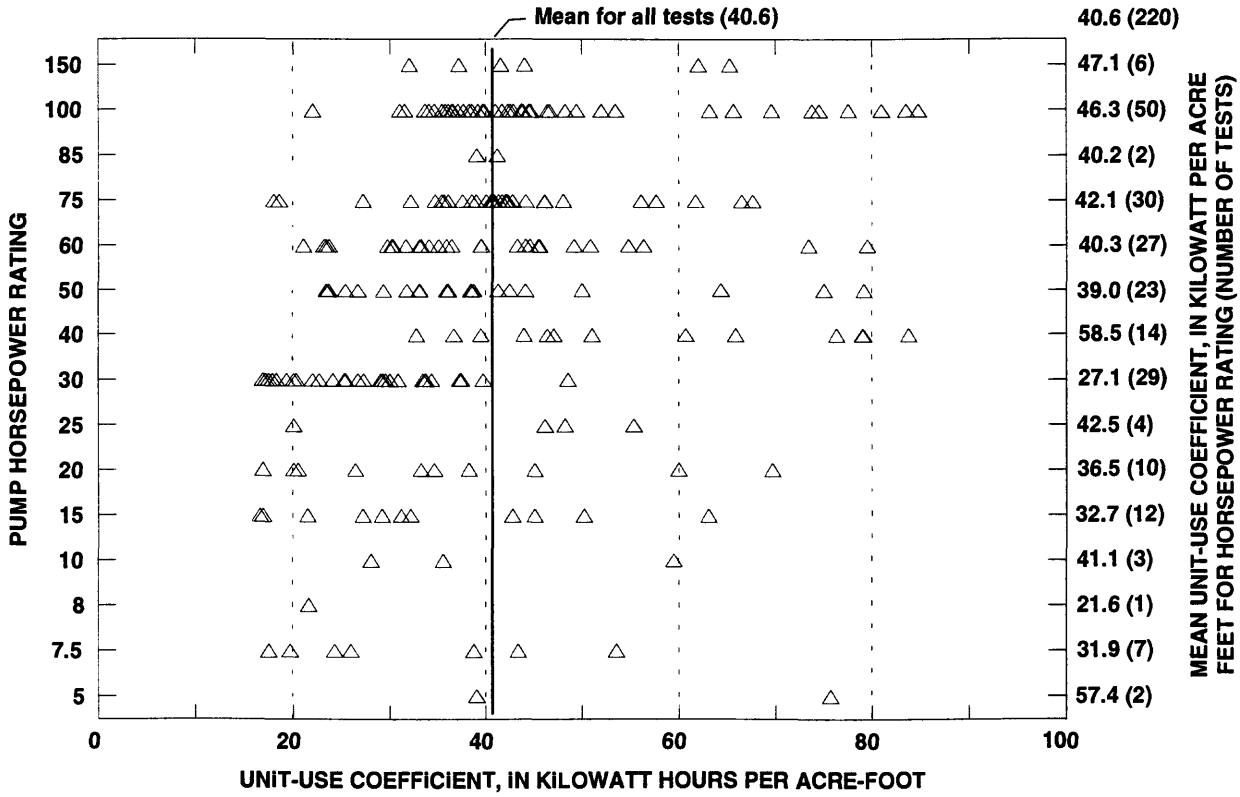


**Figure 4.** Horsepower ratings of pumps as related to unit-use coefficients derived from pump-efficiency tests for drains in the Sacramento-San Joaquin Delta, California.

January 1995 through February 1996, respectively, table 4). The 1995 estimate for area 6 was about 17 percent of the total estimated drainage returns (430,000 acre-ft) for the delta and about 18 percent of the total estimated drainage returns (about 537,000 acre-ft) for the period January 1995 through February 1996. Monthly drainage-return estimates were largest in March 1995 (about 61,900 acre-ft) and smallest in November 1995 (about 11,200 acre-ft). Drainage-return estimates were also large in August 1995 and January and February 1996 (about 53,100; 50,600; and 55,100 acre-ft, respectively) (table 4).

## SURFACE-WATER WITHDRAWALS ONTO TWITCHELL ISLAND

Water is siphoned from the channels of the delta over the levees onto the islands (fig. 2). The hydraulic properties of each siphon and the opening of the delivery end of the pipe control the flow rate through each siphon. Although the hydraulic properties of a siphon can be readily estimated, doing so for a large number of siphons is a laborious task that had not been done at the time of this study. Even if hydraulic information were available, data on the time histories of pipe openings and tides would also be needed to estimate the quantities of water withdrawn by a siphon. Instead of recording pipe openings and tides, USGS and DWR used flowmeters to measure withdrawals onto Twitchell Island for 12 of the 21 siphons.

### Methods

At the time of this study, DWR (Environmental Services Office) and the California Department of Fish and Game were using McCrometer flowmeters in a study of the effectiveness of fish screens on siphons in the delta, including siphon 16 on Twitchell Island (fig. 1). Eleven additional McCrometer flowmeters were installed on the siphons on Twitchell Island for this study. The flowmeters were operated by DWR and USGS. The data were obtained by manually recording dial readings and calculating cumulative flows.

### Results

DWR recorded flowmeter readings weekly between August 9, 1994, and January 8, 1996 (table 5)

**Table 3.** Drainage returns from Twitchell Island in the Sacramento-San Joaquin Delta, California, estimated and measured monthly by the U.S. Geological Survey, August 1994 through January 1996

[Values are in acre-feet. USGS, U.S. Geological Survey; PG&E, Pacific Gas and Electric Company]

| Month | Estimated drainage returns using data collected by USGS (A) | Estimated drainage returns using data from PG&E (B) | Metered drainage returns (C) | Difference between estimated returns (USGS data) and metered returns (A - C) | Percent difference $\frac{A-C}{C}x100$ | Difference between estimated returns (PG&E data) and metered returns (B - C) | Percent difference $\frac{B-C}{C}x100$ |
|---|---|---|---|---|---|---|---|
| 1994 | | | | | | | |
| August | 743 | 0 | 898 | -155 | -17.3 | -898 | -100.0 |
| September | 599 | 855 | 672 | -73 | -10.9 | 183 | 27.2 |
| October | 512 | 1,289 | 566 | -54 | -9.5 | 723 | 127.7 |
| November | 391 | 1,319 | 469 | -78 | -16.6 | 850 | 181.2 |
| December | 698 | 741 | 815 | -117 | -14.4 | -74 | -9.1 |
| Total (excludes percentages) | 2,943 | 4,204 | 3,420 | -477 | -13.9 | 784 | 22.9 |
| 1995 | | | | | | | |
| January | 2,489 | 0 | 2,499 | -10 | -0.4 | -2,499 | -100.0 |
| February | 1,077 | 0 | 1,170 | -93 | -7.9 | -1,170 | -100.0 |
| March | 1,809 | 6,239 | 1,926 | -117 | -6.1 | 4,313 | 223.9 |
| April | 653 | 0 | 763 | -110 | -14.4 | -763 | -100.0 |
| May | 586 | 1,205 | 656 | -70 | -10.7 | 549 | 83.7 |
| June | 483 | 0 | 557 | -74 | -13.3 | -557 | -100.0 |
| July | 647 | 1,039 | 736 | -89 | -12.1 | 303 | 41.2 |
| August | 751 | 796 | 846 | -95 | -11.2 | -50 | -5.9 |
| September | 317 | 0 | 323 | -6 | -1.9 | -323 | -100.0 |
| October | 296 | 288 | 298 | -2 | -0.7 | -10 | -3.4 |
| November | 349 | 354 | 340 | 9 | 2.6 | 14 | 4.1 |
| December | 1,160 | 663 | 1,118 | 42 | 3.8 | -455 | -40.7 |
| Total (excludes percentages) | 10,617 | 10,584 | 11,232 | -615 | -5.5 | -648 | -5.8 |
| 1996 | | | | | | | |
| January | 1,457 | 1,812 | 1,333 | 124 | 9.2 | 479 | 35.9 |
| TOTAL (excludes percentages) | 15,017 | 16,600 | 15,985 | -968 | -6.1 | 615 | 3.8 |

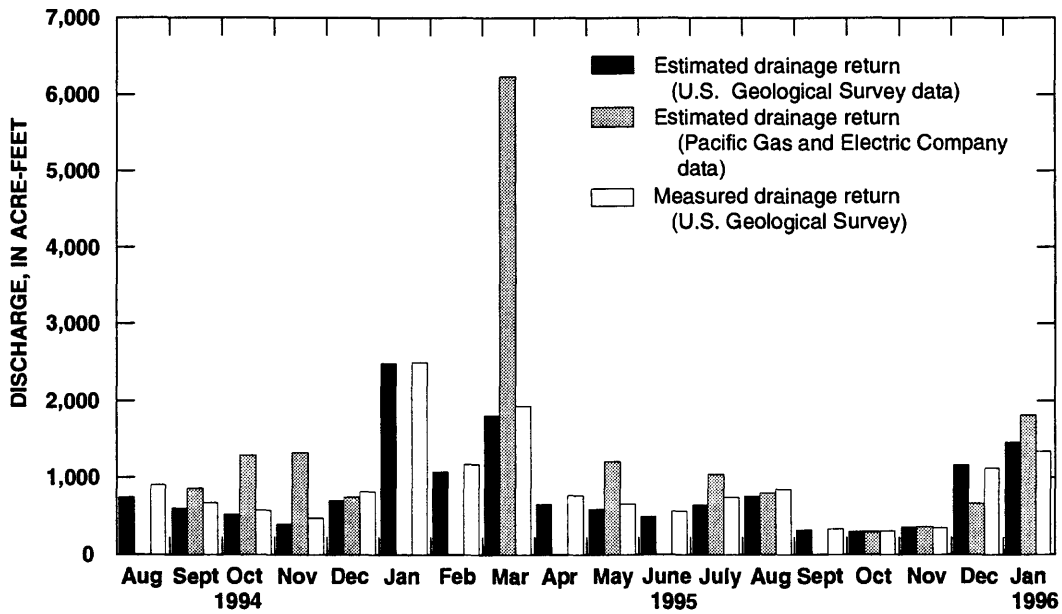


**Figure 5.** Estimated and measured monthly totals for drainage returns from Twitchell Island in the Sacramento-San Joaquin Delta, California, August 1994 through January 1996. Estimates were made by the U.S. Geological Survey using U.S. Geological Survey and Pacific Gas and Electric Company data.

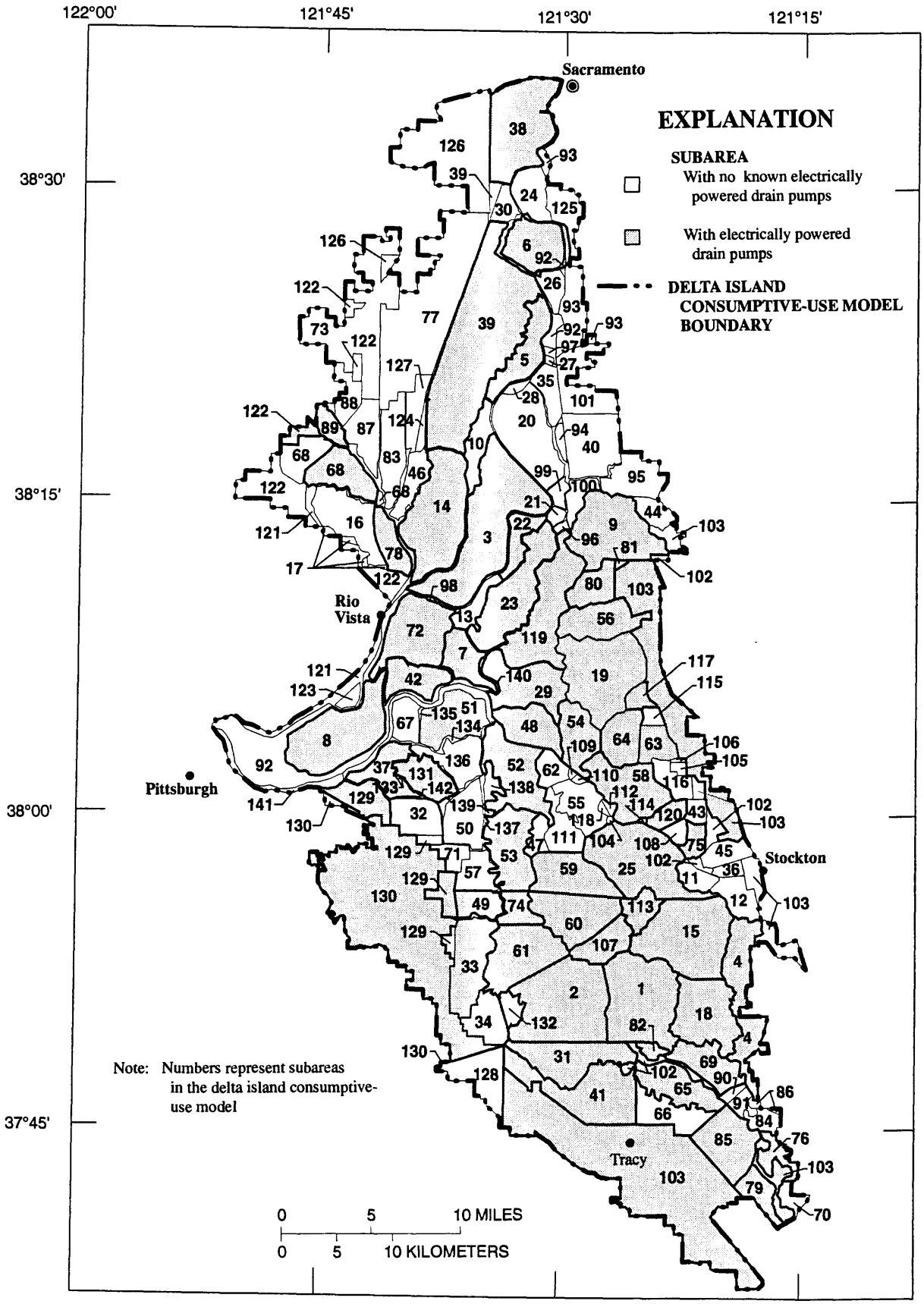


**Figure 6.** Subareas of the California Department of Water Resources' delta island consumptive-use model for the Sacramento-San Joaquin Delta, California.

**Table 4.** Drainage returns estimated monthly for aggregated areas of the California Department of Water Resources' delta island consumptive-use model for the Sacramento-San Joaquin Delta, California, January 1995 through February 1996

[Area 2 is omitted because no power-consumption data were available. Values are in acre-feet. Area boundaries are shown on figure 3]

| | Aggregated area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | 1 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Number of pumps** | **21** | **2** | **5** | **4** | **2** | **9** | **6** | **6** | **13** |
| 1995 | | | | | | | | | |
| January | 5 | 0 | 1,037 | 0 | 0 | 3,086 | 37 | 95 | 184 |
| February | 59 | 0 | 953 | 1,638 | 1,205 | 6,233 | 2,523 | 173 | 1,047 |
| March | 4 | 0 | 838 | 591 | 2,472 | 19,409 | 2,310 | 6,374 | 225 |
| April | 90 | 384 | 1,413 | 1,756 | 288 | 3,254 | 2,251 | 163 | 2,098 |
| May | 301 | 0 | 329 | 726 | 472 | 9,545 | 834 | 13,463 | 2,246 |
| June | 538 | 0 | 294 | 4,487 | 671 | 5,046 | 885 | 525 | 2,095 |
| July | 323 | 0 | 164 | 406 | 1,156 | 4,573 | 1,345 | 2,425 | 3,436 |
| August | 538 | 0 | 182 | 490 | 1,261 | 8,957 | 26 | 2,865 | 3,614 |
| September | 555 | 0 | 109 | 8 | 0 | 1,634 | 0 | 0 | 62 |
| October | 233 | 0 | 9 | 216 | 157 | 1,910 | 41 | 391 | 1,438 |
| November | 115 | 0 | 13 | 0 | 145 | 2,217 | 45 | 662 | 188 |
| December | 8 | 0 | 50 | 152 | 264 | 7,313 | 187 | 2,175 | 372 |
| Total | 2,769 | 384 | 5,391 | 10,470 | 8,091 | 73,177 | 10,484 | 29,311 | 17,005 |
| 1996 | | | | | | | | | |
| January | 25 | 0 | 276 | 404 | 437 | 13,432 | 208 | 3,451 | 210 |
| February | 41 | 0 | 688 | 1,146 | 1,295 | 9,838 | 538 | 3,828 | 487 |
| Total | 66 | 0 | 964 | 1,550 | 1,732 | 23,270 | 746 | 7,279 | 697 |
| TOTAL | 2,835 | 384 | 6,355 | 12,020 | 9,823 | 96,447 | 11,230 | 36,590 | 17,702 |

| | Aggregated area | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | 14 | 15 | (2) | Total |
| **Number of pumps** | **12** | **8** | **5** | **7** | **29** | **16** | **91** | **236** |
| 1995 | | | | | | | | |
| January | 8,383 | 4,907 | 7,115 | 7,832 | 3,627 | 611 | 744 | 37,663 |
| February | 6,941 | 2,681 | 5,262 | 11,689 | 3,626 | 116 | 1,385 | 45,531 |
| March | 10,683 | 6,227 | 4,865 | 3,851 | 1,297 | 1,429 | 1,280 | 61,855 |
| April | 5,367 | 2,441 | 5,620 | 10,253 | 3,586 | 316 | 2,859 | 42,139 |
| May | 3,953 | 1,010 | 1,409 | 2,998 | 3,277 | 1,433 | 3,198 | 45,194 |
| June | 3,542 | 2,196 | 2,063 | 2,570 | 2,596 | 729 | 5,066 | 33,303 |
| July | 7,133 | 4,278 | 2,082 | 1,754 | 4,015 | 1,123 | 4,781 | 38,994 |
| August | 7,529 | 3,844 | 6,062 | 6,612 | 4,368 | 922 | 5,816 | 53,086 |
| September | 5,197 | 1,784 | 2,809 | 2,882 | 3,879 | 446 | 4,595 | 23,960 |
| October | 2,594 | 582 | 1,623 | 1,905 | 1,875 | 402 | 2,824 | 16,200 |
| November | 1,971 | 592 | 1,896 | 1,927 | 705 | 114 | 614 | 11,204 |
| December | 4,286 | 3,000 | 1,547 | 1,788 | 303 | 287 | 318 | 22,050 |
| Total | 67,579 | 33,542 | 42,353 | 56,061 | 33,154 | 7,928 | 33,480 | 431,179 |
| 1996 | | | | | | | | |
| January | 4,361 | 4,635 | 8,024 | 10,876 | 3,266 | 473 | 486 | 50,564 |
| February | 12,391 | 6,252 | 4,963 | 7,701 | 3,841 | 865 | 1,199 | 55,073 |
| Total | 16,752 | 10,887 | 12,987 | 18,577 | 7,107 | 1,338 | 1,685 | 105,637 |
| TOTAL | 84,331 | 44,429 | 55,340 | 74,638 | 40,261 | 9,266 | 35,165 | 536,816 |

[1]Area outside the delta uplands and lowlands.

[2]Delta uplands.

**Table 5.** Surface-water withdrawals from the 12 metered siphons on Twitchell Island in the Sacramento-San Joaquin Delta, California, measured weekly by the California Department of Water Resources, August 9, 1994, through January 8, 1996

[Values are in acre-feet. NR, not read; --, no data. Because of different periods of record, these totals will not agree with totals for period in table 6]

| Date meter was read | Siphon number and flowmeter number | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, 95-981-12 | No. 3, 95-983-8 | No. 4, 94-4586-12 | No. 6, 94-5142-08 | No. 7, 95-985-16 | No. 8, 95-980-10 | No. 11, 95-987-18 | No. 12, 95-982-12 | No. 16, 92-1612-7 | No. 17, 94-4559-24 | No. 19, 95-986-16 | No. 20, 95-984-16 | |
| 08/09/94 | -- | -- | -- | NR | -- | -- | -- | -- | 25.06 | 26.71 | -- | -- | 51.77 |
| 08/16/94 | -- | -- | -- | NR | -- | -- | -- | -- | 11.23 | NR | -- | -- | 11.23 |
| 08/23/94 | -- | -- | -- | NR | -- | -- | -- | -- | 18.58 | 26.02 | -- | -- | 44.60 |
| 08/30/94 | -- | -- | -- | NR | -- | -- | -- | -- | 6.26 | 0 | -- | -- | 6.26 |
| 09/06/94 | -- | -- | -- | NR | -- | -- | -- | -- | NR | 0 | -- | -- | 0 |
| 09/13/94 | -- | -- | -- | NR | -- | -- | -- | -- | 6.34 | 0 | -- | -- | 6.34 |
| 09/20/94 | -- | -- | -- | NR | -- | -- | -- | -- | NR | 0 | -- | -- | 0 |
| 09/27/94 | -- | -- | -- | 0.02 | -- | -- | -- | -- | 0 | 0 | -- | -- | .02 |
| 10/11/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 14.25 | 0 | -- | -- | 14.25 |
| 10/19/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 6.77 | 0 | -- | -- | 6.77 |
| 10/26/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 11/02/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 11/09/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 11/16/94 | -- | -- | -- | 0 | -- | -- | -- | -- | .08 | 0 | -- | -- | .08 |
| 11/25/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 11/30/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 12/07/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 12/14/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 12/21/94 | -- | -- | -- | 0 | -- | -- | -- | -- | 1.64 | 0 | -- | -- | 1.64 |
| 01/04/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 01/11/95 | -- | -- | -- | NR | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 01/18/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 01/25/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 02/01/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 02/08/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 02/15/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 02/22/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |

**Table 5.** Surface-water withdrawals from the 12 metered siphons on Twitchell Island in the Sacramento-San Joaquin Delta, California, measured weekly by the California Department of Water Resources, August 9, 1994, through January 8, 1996—Continued

| Date meter was read | Siphon number and flowmeter number | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, 95-981-12 | No. 3, 95-983-8 | No. 4, 94-4586-12 | No. 6, 94-5142-08 | No. 7 95-985-16 | No. 8, 95-980-10 | No. 11, 95-987-18 | No. 12, 95-982-12 | No. 16, 92-1612-7 | No. 17, 94-4559-24 | No. 19, 95-986-16 | No. 20, 95-984-16 | |
| 03/01/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0.54 | 0 | -- | -- | 0.54 |
| 03/08/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 03/15/95 | -- | -- | -- | 0 | -- | -- | -- | -- | NR | 0 | -- | -- | 0 |
| 03/22/95 | -- | -- | -- | 0 | -- | -- | -- | -- | NR | 0 | -- | -- | 0 |
| 03/29/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 04/05/95 | -- | -- | -- | NR | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 04/12/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 04/19/95 | -- | -- | -- | NR | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 04/26/95 | -- | -- | -- | NR | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 05/01/95 | -- | -- | -- | NR | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 05/08/95 | -- | -- | -- | NR | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 05/15/95 | -- | -- | -- | NR | -- | -- | -- | -- | NR | NR | -- | -- | 0 |
| 05/22/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 05/30/95 | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| 06/05/95 | -- | -- | -- | NR | -- | -- | -- | -- | 5.96 | 0 | -- | -- | 5.96 |
| 06/12/95 | -- | -- | -- | NR | -- | -- | -- | -- | 4.99 | 0 | -- | -- | 4.99 |
| 06/19/95 | NR | 0 | 0 | 0 | 0 | 0 | 36.42 | 0 | 5.10 | 0 | 0 | 0 | 41.52 |
| 06/26/95 | 0 | NR | NR | 0 | NR | 0 | 77.49 | NR | 4.52 | 0 | 0 | NR | 82.01 |
| 07/03/95 | 0 | 0 | 0 | 0 | 0 | 0 | 74.57 | NR | 11.39 | 0 | 0 | .02 | 85.98 |
| 07/10/95 | 0 | 0 | 0 | 0 | 0 | 4.30 | 55.06 | NR | 0 | 0 | 0 | .01 | 59.37 |
| 07/17/95 | 0 | .40 | 0 | 0 | 0 | 18.67 | 77.85 | 0 | 12.16 | 0 | 0 | 0 | 109.08 |
| 07/24/95 | 0 | 0 | 0 | 0 | 0 | 22.84 | 122.07 | 0 | 11.49 | 0 | 46.05 | 0 | 202.45 |
| 07/31/95 | 0 | .07 | .01 | 0 | 0 | 30.41 | 145.29 | 0 | 34.07 | 0 | 36.76 | 0 | 246.61 |
| 08/07/95 | 0 | NR | NR | NR | NR | NR | NR | NR | .13 | 0 | 12.34 | 3.30 | 15.77 |
| 08/14/95 | 0 | 40.44 | 42.53 | 0 | 0 | 32.73 | 207.42 | .04 | 35.53 | 1.74 | 0 | 1.93 | 362.36 |
| 08/21/95 | 0 | 15.49 | 22.79 | 0 | 0 | 27.20 | 50.53 | 0 | 22.85 | 53.06 | 102.07 | .03 | 294.02 |
| 08/28/95 | 0 | 30.42 | 0 | 0 | NR | 22.99 | 96.03 | 0 | 27.02 | 50.46 | 24.70 | 3.27 | 254.89 |

**Table 5.** Surface-water withdrawals from the 12 metered siphons on Twitchell Island in the Sacramento-San Joaquin Delta, California, measured weekly by the California Department of Water Resources, August 9, 1994, through January 8, 1996—Continued

| Date meter was read | Siphon number and flowmeter number | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, 95-981-12 | No. 3, 95-983-8 | No. 4, 94-4586-12 | No. 6, 94-5142-08 | No. 7 95-985-16 | No. 8, 95-980-10 | No. 11, 95-987-18 | No. 12, 95-982-12 | No. 16, 92-1612-7 | No. 17, 94-4559-24 | No. 19, 95-986-16 | No. 20, 95-984-16 | |
| 09/05/95 | 0 | 16.45 | 0 | 0 | 0 | 16.73 | 58.25 | 0 | 25.38 | 0.99 | 0 | 0 | 117.80 |
| 09/11/95 | 0 | 0 | 0 | 0 | 0 | 0 | 22.61 | 0 | .11 | 0 | 0 | 0 | 22.72 |
| 09/18/95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 09/25/95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | NR | 0 |
| 10/02/95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .11 | .11 |
| 10/10/95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/16/95 | 0 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | 0 |
| 10/23/95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10/30/95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/06/95 | 0 | NR | NR | NR | NR | NR | NR | NR | 0 | 0 | 0 | NR | 0 |
| 11/14/95 | 0 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | 0 |
| 11/20/95 | 0 | NR | NR | NR | NR | NR | NR | NR | 0 | 0 | 0 | NR | 0 |
| 11/27/95 | 0 | 0 | 0 | NR | 0 | NR | 0 | NR | 0 | 0 | 0 | NR | 0 |
| 12/04/95 | 0 | 0 | 0 | NR | NR | 0 | 0 | 0 | 0 | 0 | 0 | NR | 0 |
| 12/11/95 | 0 | 0 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | 0 |
| 12/18/95 | 0 | 0 | 0 | 0 | 0 | NR | 0 | 0 | 0 | 0 | 0 | NR | 0 |
| 01/08/96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 399.45 | NR | 399.45 |
| Total | 0 | 103.27 | 65.33 | 0.02 | 0 | 175.87 | 1,023.59 | 0.04 | 291.45 | 158.98 | 621.37 | 8.67 | 2,448.59 |

for the 12 metered siphons on Twitchell Island, and USGS recorded readings monthly between March 1994 and January 1996 (table 6). Measured surface-water withdrawals were largest during July and August 1995. Because 9 of the 21 siphons on the island were not measured, it is not known if total monthly withdrawals for Twitchell Island were also largest during July and August.

Withdrawals at siphon 16 totaled more than 400 acre-ft during a 23-month period of record and more than 200 acre-ft for calendar year 1995 (table 6). At siphons 6 and 17, measured withdrawals were 0 and 170 acre-ft, respectively, for an 18-month period of record. At siphon 17, more than 100 acre-ft was siphoned during calendar year 1995; siphon 6 was not used during the 18-month period of record.

The remaining nine metered siphons had 8-month periods of record (table 6). Siphons 11 and 19 had the largest recorded withdrawals. Withdrawals at siphon 11 totaled more than 1,000 acre-ft between June and September 1995, with recorded monthly values of about 440 and 370 acre-ft for July and August 1995, respectively. Siphon 19 had the largest recorded monthly value, about 450 acre-ft, during December 1995; however, this monthly value includes the reading for the first 10 days of January 1996. The December reading was not made until January 9 or 10, 1996. Withdrawals at the nine remaining metered siphons ranged from 0 acre-ft at siphons 2 and 7 to about 180 acre-ft at siphon 8.

## LAND USE

Land-use maps for 1968 were digitized and compared with digital land-use maps available for 1991. Changes in crop acreages between 1968 and 1991 were identified, and the crop types were aggregated into the subareas of DWR's delta island consumptive-use model.

### Methods

DWR used USGS 7.5-minute topographic quadrangle maps to map land use in the delta in 1968 using their standard mapping methods (California Department of Water Resources, 1971). DWR provided USGS with full-size paper copies of these maps from which land-use coverages were created. USGS digitized the land-use maps, quality assured the data, and aggregated the data into subareas (fig. 6) of DWR's delta island consumptive-use model using ARC/INFO.

Land use during 1991 was mapped and digitized by DWR, and an ARC/INFO coverage was created by the California Department of Pesticide Regulation. These 1991 data were compared with the 1968 data. Delineations of subareas of DWR's delta island consumptive-use model (California Department of Water Resources, 1995) were used to create the coverage of the subareas (fig. 6) used in this study to aggregate land use and drainage returns.

Quality-assurance checks included automated analyses done within ARC/INFO at the time the maps were digitized and visual comparisons between the original copies and the digitized maps. In addition, differences were calculated between the digitized and the actual locations of the corners of the 7.5 minute topographic quadrangle maps to estimate the error introduced in digitizing the paper maps.

The 34 individual land-use coverages for 1968 were combined into a single coverage for the entire study area. The coverages for 1968 and 1991 were combined with the coverage of DWR's delta island consumptive-use model, and land-use acreages were then tabulated by subarea. The land-use attributes used for the 1991 coverage were also used with the 1968 data. The aggregated data are limited because the mapping of the 1968 data was less detailed and less complete than the 1991 data.

### Results

The differences among the 34 quadrangles digitized for 1968 land use were, for the most part, within the standard of 0.005, with differences ranging from 0.001 to 0.018. This variability is attributed primarily to the use of paper copies of the maps, which are not scale stable. This degree of variability, however, was acceptable for the purposes of this report

Annual land-use data for 1968 and 1991 were aggregated by subareas of DWR's delta island consumptive-use model for comparison (table 7). The changes in acreage totals for land uses throughout the delta between 1968 and 1991 indicate that native vegetation decreased by 25 percent (39,945 acres), from 159,259 acres to 119,314 acres, and grain and hay crops increased by 340 percent (71,452 acres), from 21,034 acres in 1968 to 92,486 acres in 1991 (table 7). Field-crop acreage on Twitchell Island (subarea 42, fig. 6) increased by 44 percent (782 acres), from 1,787 acres in 1968 to 2,569 acres in 1991, and native vegetation decreased 77 percent (855 acres), from 1,115 to 260 acres between 1968 and 1991 (table 7).

**Table 6.** Surface-water withdrawals from the 12 metered siphons on Twitchell Island in the Sacramento-San Joaquin Delta, California, measured monthly by the U.S. Geological Survey, March 1994 through January 1996

[Values are in acre-feet. NR, not read; --, no data]

| Month | Siphon number and flowmeter number | | | | | | | | | | | | Partial total for months and years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, 95-981-12 | No. 3, 95-983-8 | No. 4, 94-4586-12 | No. 6, 94-5142-08 | No. 7, 95-985-16 | No. 8 95-980-10 | No. 11, 95-987-18 | No. 12, 95-982-12 | No. 16, 92-1612-7 | No. 17, 94-4559-24 | No. 19 95-986-16 | No. 20, 95-984-16 | |
| 1994 | | | | | | | | | | | | | |
| March | -- | -- | -- | -- | -- | -- | -- | -- | 0.01 | -- | -- | -- | 0.01 |
| April | -- | -- | -- | -- | -- | -- | -- | -- | 3.95 | -- | -- | -- | 3.95 |
| May | -- | -- | -- | -- | -- | -- | -- | -- | 38.07 | -- | -- | -- | 38.07 |
| June | -- | -- | -- | -- | -- | -- | -- | -- | 21.82 | -- | -- | -- | 21.82 |
| July | -- | -- | -- | -- | -- | -- | -- | -- | 88.73 | -- | -- | -- | 88.73 |
| August | -- | -- | -- | 0 | -- | -- | -- | -- | 61.14 | 52.73 | -- | -- | 113.87 |
| September | -- | -- | -- | 0 | -- | -- | -- | -- | 14.17 | 0 | -- | -- | 14.17 |
| October | -- | -- | -- | 0 | -- | -- | -- | -- | 13.19 | 0 | -- | -- | 13.19 |
| November | -- | -- | -- | 0 | -- | -- | -- | -- | .08 | 0 | -- | -- | .08 |
| December | -- | -- | -- | 0 | -- | -- | -- | -- | 1.64 | 0 | -- | -- | 1.64 |
| Total | | | | 0 | | | | | 242.80 | 52.73 | | | 295.53 |
| 1995 | | | | | | | | | | | | | |
| January | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| February | -- | -- | -- | 0 | -- | -- | -- | -- | .54 | 0 | -- | -- | .54 |
| March | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| April | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| May | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | 0 | -- | -- | 0 |
| June | [1]0 | [1]0 | [1]0 | 0 | [1]0 | [1]0 | [1]163.86 | [1]0 | 31.96 | 0 | [1]0 | [1]0.02 | 195.84 |
| July | 0 | 1.11 | .04 | 0 | 0 | 80.77 | 440.87 | .04 | 57.83 | 0 | 95.15 | .01 | 675.82 |
| August | 0 | 102.17 | 65.29 | 0 | 0 | 79.00 | 370.81 | 0 | 110.80 | 106.25 | 126.77 | 8.53 | 969.62 |
| September | 0 | 0 | 0 | 0 | 0 | 16.10 | 48.05 | 0 | .11 | 0 | 0 | .11 | 64.37 |
| October | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| November | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [2]450.07 | 0 | 450.07 |
| Total | 0 | 103.28 | 65.33 | 0 | 0 | 175.87 | 1,023.59 | 0.04 | 201.24 | 106.25 | 671.99 | 8.67 | 2,356.26 |
| 1996 | | | | | | | | | | | | | |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11.89 | 0 | 0 | 11.89 |
| TOTAL | 0 | 103.28 | 65.33 | 0 | 0 | 175.87 | 1,023.59 | 0.04 | 444.04 | 170.87 | 671.99 | 8.67 | 2,663.68 |

[1]Indicates incomplete readings for month meter was installed.

[2]December reading includes the first 10 days of January 1996. The total for December 1996 is 50.62 acre-feet larger than total for January 8, 1996, in table 5 because of the 2 added days to the December reading (meter was read by the U.S. Geological Survey January 10, 1996)

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California

[Values are in acres. <, actual value is less than shown]

| Land use | Subarea 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 208 | 513 | 0 | 0 | 1,691 | 1,904 | 240 | 176 | 238 | 381 |
| Grain and hay crops | 980 | 675 | 918 | 425 | 0 | 4,579 | <1 | 546 | 0 | 890 |
| Field crops | 2,476 | 3,367 | 1,953 | 5,739 | 7,288 | 6,471 | 1,501 | 890 | 2,478 | 846 |
| Truck and berry crops | 5,125 | 2,740 | 7,353 | 2,291 | 2,969 | 1,849 | 774 | 1,716 | 1,075 | 777 |
| Pasture | 2,450 | 3,974 | 2,519 | 4,403 | 1,749 | 1,048 | 3,076 | 2,134 | 242 | 548 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 76 | 0 | 0 | 1,093 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 38 | 0 | 8 | 0 | 0 | 0 | 382 | 0 | 25 |
| Semiagricultural | 28 | 75 | 50 | 77 | 0 | 174 | <1 | 108 | 0 | 69 |
| Native | 502 | 390 | 960 | 809 | 3,146 | 778 | 1,766 | 819 | 879 | 308 |
| Urban | 0 | 10 | 0 | 0 | 85 | 153 | 86 | 1,053 | 0 | 23 |
| Undesignated | 13 | 1 | 2 | 0 | 0 | 0 | 145 | <1 | 0 | 3 |
| Total acres | 11,782 | 11,783 | 13,755 | 13,752 | 16,928 | 16,956 | 7,664 | 7,824 | 4,912 | 4,963 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 159 | 0 | 51 |

| Land use | Subarea 6 | | 7 | | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| Deciduous fruits and nuts | 46 | 21 | 2 | 0 | 56 | 0 | 153 | 281 | 1,055 | 1,080 |
| Grain and hay crops | 0 | 882 | 0 | 441 | 0 | 1,732 | 1,874 | 1,668 | 0 | 181 |
| Field crops | 2,665 | 2,316 | 2,092 | 2,605 | 3,172 | 6,589 | 2,116 | 3,336 | 892 | 454 |
| Truck and berry crops | 380 | 1,094 | 137 | 0 | 946 | 463 | 3,193 | 2,061 | 147 | 285 |
| Pasture | 1,195 | 1,045 | 62 | 0 | 521 | 380 | 1,851 | 556 | 270 | 167 |
| Vineyards | 0 | 202 | 0 | 0 | 0 | 0 | 23 | 1,174 | 0 | 153 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 0 |
| Idle | 0 | 23 | 0 | 38 | 0 | 646 | 34 | 1 | 0 | 1 |
| Semiagricultural | 0 | 34 | 0 | 2 | 0 | 47 | 40 | 128 | 0 | 32 |
| Native | 1,544 | 111 | 1,094 | 135 | 2,750 | 528 | 332 | 507 | 250 | 245 |
| Urban | 0 | 111 | 46 | 213 | 5 | 51 | 279 | 428 | 0 | 5 |
| Undesignated | 29 | 0 | 0 | 0 | 2,986 | 0 | 53 | 0 | 0 | 0 |
| Total acres | 5,859 | 5,858 | 3,433 | 3,434 | 10,436 | 10,436 | 9,974 | 10,140 | 2,614 | 2,616 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 165 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | | 12 | | 13 | | 14 | | 15 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 203 | 115 | 172 | 420 | 166 | 49 |
| Grain and hay crops | 0 | 358 | <1 | 0 | 0 | 357 | 0 | 3,263 | 1,381 | 1,306 |
| Field crops | 0 | 0 | 0 | 0 | 655 | 889 | 6,832 | 3,879 | 1,670 | 3,424 |
| Truck and berry crops | 0 | 0 | 84 | 0 | 53 | 0 | 2,173 | 2,126 | 2,499 | 3,049 |
| Pasture | 0 | 0 | 22 | 78 | 151 | 0 | 551 | 1,170 | 5,049 | 3,134 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 537 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 23 | 0 | 33 |
| Semiagricultural | 0 | 0 | 0 | 174 | 0 | 12 | 0 | 80 | 63 | 148 |
| Native | 31 | 444 | 650 | 350 | 492 | 165 | 2,250 | 440 | 293 | 251 |
| Urban | 1,529 | 836 | 1,925 | 2,079 | 174 | 188 | <1 | 9 | 381 | 585 |
| Undesignated | 78 | 0 | <1 | 0 | 0 | 0 | 0 | 13 | 477 | 0 |
| Total acres | 1,638 | 1,638 | 2,681 | 2,681 | 1,728 | 1,729 | 11,978 | 11,980 | 11,979 | 11,979 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 16 | | 17 | | 18 | | 19 | | 20 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 41 | 211 | 0 | 0 | 1,541 | 1,509 |
| Grain and hay crops | 0 | 347 | 0 | 127 | 12 | 1,473 | 1,573 | 3,299 | 424 | 871 |
| Field crops | 1,389 | 1,551 | 3 | 39 | 0 | 1,944 | 4,870 | 5,211 | 3,529 | 2,537 |
| Truck and berry crops | 647 | 0 | 0 | 0 | 143 | 1,054 | 3,574 | 357 | 1,270 | 1,952 |
| Pasture | 317 | 1,100 | <1 | 22 | 167 | 2,790 | <1 | 1,039 | 1,793 | 332 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 122 | 0 | 191 | 81 | 1,003 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 1,373 | 0 | 67 | 0 | 20 | 95 | 134 | 0 | 267 |
| Semiagricultural | 0 | 14 | 0 | 0 | <1 | 80 | 7 | 52 | 80 | 139 |
| Native | 3,198 | 1,149 | 569 | 243 | 128 | 266 | 779 | 954 | 103 | 126 |
| Urban | 0 | 16 | 0 | 72 | 0 | 0 | 68 | 39 | 0 | 84 |
| Undesignated | 0 | 0 | 0 | 0 | 7,224 | 0 | 75 | 0 | 0 | 0 |
| Total acres | 5,551 | 5,550 | 572 | 570 | 7,715 | 7,960 | 11,041 | 11,276 | 8,821 | 8,820 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 245 | 0 | 235 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | | 22 | | 23 | | 24 | | 25 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 28 | <1 | 423 | 435 | 250 | 275 | 8 | 0 | 28 | 14 |
| Grain and hay crops | 0 | 147 | 0 | 586 | 0 | 2,665 | 0 | 0 | 2,027 | 2,830 |
| Field crops | 166 | 0 | 988 | 705 | 5,422 | 4,922 | 625 | 0 | 3,939 | 2,688 |
| Truck and berry crops | 97 | 0 | 412 | 234 | 509 | 199 | 525 | 7 | 3,839 | 3,136 |
| Pasture | 0 | 179 | 143 | 218 | 91 | 351 | 470 | 0 | 508 | 1,534 |
| Vineyards | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 214 |
| Semiagricultural | 0 | 4 | 0 | 28 | 0 | 40 | 0 | 124 | 60 | 114 |
| Native | 123 | 42 | 445 | 190 | 2,642 | 446 | 293 | 366 | 859 | 779 |
| Urban | 88 | 122 | 21 | 17 | 23 | 39 | 37 | 2,759 | 219 | 272 |
| Undesignated | 0 | 0 | 0 | 0 | 0 | 0 | 1,299 | 0 | 101 | 0 |
| Total acres | 502 | 503 | 2,432 | 2,434 | 8,937 | 8,937 | 3,257 | 3,256 | 11,580 | 11,581 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | | 27 | | 28 | | 29 | | 30 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 106 | 118 | 118 | 0 | 357 | 338 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 290 | 0 | 0 | 0 | 0 | 0 | 1,993 | 0 | 228 |
| Field crops | 655 | 628 | <1 | 0 | 0 | 0 | 4,299 | 3,396 | 621 | 201 |
| Truck and berry crops | 412 | 233 | 4 | 0 | 49 | 0 | 856 | 0 | 0 | 366 |
| Pasture | 96 | 162 | 0 | 0 | <1 | 0 | 76 | 0 | 299 | 413 |
| Vineyards | 0 | 0 | 0 | 112 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 4 | 0 | 0 |
| Semiagricultural | 0 | 39 | 0 | 8 | 0 | 6 | 0 | 18 | 0 | 6 |
| Native | 322 | 122 | 8 | 10 | 16 | 36 | 1,673 | 1,340 | 386 | 130 |
| Urban | 0 | 0 | 0 | 0 | 3 | 0 | 11 | 165 | 0 | 29 |
| Undesignated | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 65 | 0 |
| Total acres | 1,591 | 1,592 | 130 | 130 | 425 | 425 | 6,915 | 6,916 | 1,371 | 1,373 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31 | | 32 | | 33 | | 34 | | 35 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 62 | 53 | 23 | 0 | 0 | 0 | 0 | 0 | 139 | 162 |
| Grain and hay crops | 0 | 261 | 0 | 157 | 513 | 804 | 0 | 0 | 147 | 115 |
| Field crops | 1,066 | 743 | 0 | 0 | 2,391 | 732 | 297 | 540 | 938 | 675 |
| Truck and berry crops | 2,400 | 2,976 | 0 | 0 | 1,710 | 1,205 | 195 | 0 | 239 | 240 |
| Pasture | 2,491 | 2,242 | 1,864 | 1,652 | 1,206 | 1,091 | 37 | 0 | 610 | 101 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 782 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 37 | 0 | 433 | 0 | 69 | 2,533 | 13 | 0 | 25 |
| Semiagricultural | 0 | 24 | 47 | 52 | 0 | 12 | 8 | 6 | 0 | 15 |
| Native | 838 | 475 | 1,206 | 769 | 344 | 1,231 | 322 | 2,869 | 88 | 49 |
| Urban | 0 | 25 | 256 | 332 | 192 | 1,227 | 0 | 0 | 0 | 0 |
| Undesignated | 0 | 22 | 0 | 0 | 15 | 0 | 35 | 0 | 0 | 0 |
| Total acres | 6,857 | 6,858 | 3,396 | 3,395 | 6,371 | 6,371 | 3,427 | 3,428 | 2,161 | 2,164 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 36 | | 37 | | 38 | | 39 | | 40 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 94 | 13 | 75 | 180 | 132 |
| Grain and hay crops | 0 | 0 | 0 | 0 | 0 | 1,190 | 0 | 6,089 | 686 | 932 |
| Field crops | 0 | 0 | 571 | 0 | 0 | 2,815 | 11,658 | 8,281 | 2,331 | 2,195 |
| Truck and berry crops | 0 | 0 | 0 | 0 | 0 | 249 | 4,771 | 4,217 | 250 | 475 |
| Pasture | 0 | 0 | 2,355 | 2,805 | 0 | 600 | 5,287 | 4,444 | 2,558 | 2,033 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 53 | 0 | 716 | 0 | 310 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 325 | 0 |
| Idle | 0 | 0 | 0 | 16 | 0 | 422 | 0 | 381 | 51 | 0 |
| Semiagricultural | 0 | 0 | 0 | 9 | 0 | 192 | 10 | 377 | 36 | 63 |
| Native | 0 | 87 | 626 | 729 | 0 | 1,002 | 3,780 | 1,319 | 141 | 348 |
| Urban | 772 | 685 | 8 | 0 | 0 | 4,360 | 153 | 245 | 0 | 71 |
| Undesignated | 0 | 0 | 0 | 0 | 10,976 | 1 | 159 | 3 | 0 | 0 |
| Total acres | 772 | 772 | 3,560 | 3,559 | 10,976 | 10,978 | 25,831 | 26,147 | 6,558 | 6,559 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 316 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 41 | | 42 | | 43 | | 44 | | 45 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 23 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 665 | 0 | 189 | 151 | 0 | 102 | 167 | 1 | 0 |
| Field crops | 1,495 | 1,511 | 1,787 | 2,569 | 105 | 0 | 201 | 768 | <1 | 0 |
| Truck and berry crops | 1,906 | 1,027 | 597 | 242 | 222 | 0 | 385 | 307 | 0 | 0 |
| Pasture | 3,538 | 3,911 | 133 | 320 | 0 | 0 | 259 | 185 | 0 | 0 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 213 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 600 | 0 | 0 | 0 |
| Idle | 0 | 235 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 |
| Semiagricultural | 0 | 272 | 0 | 15 | 0 | 14 | 10 | 9 | 0 | 0 |
| Native | 2,069 | 501 | 1,115 | 260 | 183 | 129 | 203 | 99 | 33 | 149 |
| Urban | 578 | 1,569 | 0 | 10 | 301 | 828 | 0 | 0 | 2,025 | 1,911 |
| Undesignated | 0 | 25 | 0 | 0 | 9 | <1 | 9 | 23 | 0 | 0 |
| Total acres | 9,609 | 9,744 | 3,632 | 3,630 | 971 | 971 | 1,769 | 1,771 | 2,059 | 2,060 |
| Double-crop acres | 0 | 134 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 46 | | 47 | | 48 | | 49 | | 50 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 390 | 0 | 0 | 0 | 1,146 | 0 | 172 | 0 | 2,926 |
| Field crops | 716 | 613 | 759 | 0 | 2,232 | 1,575 | 929 | 438 | 1,730 | 63 |
| Truck and berry crops | 471 | 254 | 0 | 0 | 306 | 0 | 837 | 1,147 | 434 | 0 |
| Pasture | 0 | 0 | 0 | 0 | 0 | 0 | 180 | 381 | 689 | 304 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 481 |
| Semiagricultural | 0 | <1 | 0 | 0 | 0 | 4 | 0 | 32 | 63 | 14 |
| Native | 1,165 | 1,089 | 545 | 1,304 | 2,039 | 1,851 | 479 | 214 | 1,315 | 442 |
| Urban | 0 | 0 | 0 | 0 | 0 | <1 | 0 | 9 | 0 | 0 |
| Undesignated | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total acres | 2,352 | 2,353 | 1,304 | 1,304 | 4,577 | 4,576 | 2,425 | 2,425 | 4,231 | 4,230 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea 51 | | 52 | | 53 | | 54 | | 55 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 1,334 | 0 | 401 | 0 | 0 | 0 | 1,344 | 0 | 643 |
| Field crops | 4,074 | 3,464 | 1,216 | 2,916 | 402 | 2,215 | 2,638 | 1,982 | 1,083 | 1,001 |
| Truck and berry crops | 26 | 0 | 2,932 | 1,017 | 4,422 | 2,908 | 605 | 123 | 1,896 | 863 |
| Pasture | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 389 |
| Vineyards | 0 | 0 | 238 | 475 | 0 | 57 | 0 | 0 | 12 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 46 | 0 | 50 | 0 | 29 | 0 | 0 | 0 | 139 |
| Semiagricultural | 0 | 25 | 0 | 32 | 0 | 36 | 0 | 11 | 0 | 17 |
| Native | 1,347 | 581 | 3,385 | 2,843 | 1,780 | 1,407 | 1,190 | 967 | 730 | 604 |
| Urban | 0 | 0 | 0 | 1 | 0 | 25 | 0 | 7 | 0 | 66 |
| Undesignated | 3 | 0 | 0 | 0 | 73 | 0 | 0 | 0 | 2 | 0 |
| Total acres | 5,450 | 5,450 | 7,774 | 7,774 | 6,677 | 6,677 | 4,433 | 4,434 | 3,723 | 3,722 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea 56 | | 57 | | 58 | | 59 | | 60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 767 | 596 | 0 | 1,309 | 71 | 712 | 922 | 1,756 | 765 | 1,073 |
| Field crops | 1,600 | 2,217 | 1,752 | 574 | 3,678 | 4,535 | 2,611 | 930 | 4,205 | 2,169 |
| Truck and berry crops | 623 | 405 | 0 | 15 | 2,549 | 1,025 | 798 | 2,582 | 1,068 | 1,952 |
| Pasture | 1,729 | 691 | 22 | 292 | 105 | 19 | 1,229 | 0 | 0 | 685 |
| Vineyards | 0 | 511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 146 | 0 | 81 | 0 | 133 | 0 | 267 | 0 | 0 |
| Semiagricultural | 0 | 25 | 0 | 3 | 0 | 32 | 0 | 32 | 0 | 13 |
| Native | 323 | 488 | 791 | 289 | 644 | 670 | 391 | 311 | 800 | 834 |
| Urban | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 82 | 0 | 112 |
| Undesignated | 37 | 0 | 0 | 0 | 80 | 0 | 0 | 0 | 0 | 0 |
| Total acres | 5,079 | 5,082 | 2,565 | 2,563 | 7,127 | 7,126 | 5,951 | 5,960 | 6,838 | 6,838 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 61 | | 62 | | 63 | | 64 | | 65 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 7 |
| Grain and hay crops | 0 | 1,318 | 0 | 134 | 755 | 446 | 0 | 1,890 | 0 | 85 |
| Field crops | 6,760 | 934 | 521 | 952 | 623 | 152 | 1,493 | 931 | 582 | 1,067 |
| Truck and berry crops | 118 | 3,238 | 0 | 0 | 591 | 192 | 1,245 | 512 | 1,636 | 1,346 |
| Pasture | 0 | 1,481 | 0 | 0 | 0 | 1,276 | 0 | 0 | 2,013 | 1,977 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 0 | 67 | 0 | 0 | 0 | 0 | 68 |
| Semiagricultural | 0 | 11 | 0 | 0 | 0 | 4 | 0 | 4 | 0 | 99 |
| Native | 901 | 798 | 1,280 | 702 | 236 | 184 | 1,111 | 735 | 607 | 191 |
| Urban | 0 | 79 | 0 | 22 | 0 | 18 | 11 | 29 | 0 | 78 |
| Undesignated | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 43 | 0 |
| Total acres | 7,779 | 7,859 | 1,810 | 1,810 | 2,272 | 2,272 | 3,860 | 4,101 | 4,917 | 4,918 |
| Double-crop acres | 0 | 79 | 0 | 0 | 0 | 0 | 0 | 241 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 66 | | 67 | | 68 | | 69 | | 70 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 7 | 0 | 0 | 0 | 0 | 0 | 170 | 123 | 0 | 0 |
| Grain and hay crops | 0 | 84 | 0 | 0 | 0 | 292 | 0 | 693 | 0 | 0 |
| Field crops | 622 | 809 | 1,097 | 0 | 2,431 | 1,586 | 1,234 | 356 | 110 | 242 |
| Truck and berry crops | 680 | 518 | 0 | 0 | 1,491 | 517 | 618 | 1,215 | 351 | 260 |
| Pasture | 2,004 | 1,576 | 99 | 637 | 2,317 | 2,257 | 1,450 | 1,454 | 304 | 328 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 32 | 0 | 1,287 | 0 | 1,664 | 0 | 0 | 0 | 50 |
| Semiagricultural | 19 | 116 | 0 | 9 | 0 | 37 | 0 | 7 | 13 | 24 |
| Native | 582 | 342 | 964 | 206 | 1,236 | 1,094 | 692 | 360 | 291 | 167 |
| Urban | 186 | 624 | 15 | 35 | 0 | 0 | 0 | 28 | 21 | 20 |
| Undesignated | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 0 | 0 | 0 |
| Total acres | 4,100 | 4,101 | 2,175 | 2,174 | 7,475 | 7,476 | 4,237 | 4,236 | 1,090 | 1,091 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 71 | | 72 | | 73 | | 74 | | 75 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 192 | 165 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 882 | 0 | 1,530 | 0 | 3,297 | 0 | 899 | 429 | 210 |
| Field crops | 752 | 0 | 3,393 | 5,084 | 1,438 | 2,672 | 429 | 0 | 356 | 30 |
| Truck and berry crops | 153 | 0 | 360 | 25 | 488 | 62 | 612 | 749 | 361 | 0 |
| Pasture | 169 | 74 | 573 | 63 | 8,493 | 3,910 | 0 | 0 | 0 | 188 |
| Vineyards | 0 | 0 | 0 | 103 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 257 | 0 | 45 | 0 | 2,255 | 0 | 40 | 0 | 80 |
| Semiagricultural | 0 | 0 | 0 | 33 | 0 | 56 | 0 | 5 | 0 | 6 |
| Native | 286 | 148 | 3,211 | 546 | 2,848 | 993 | 1,117 | 453 | 190 | 149 |
| Urban | 0 | 0 | 15 | 151 | 43 | 143 | 0 | 13 | <1 | 674 |
| Undesignated | 0 | 0 | 0 | 0 | 0 | <1 | 0 | 0 | 0 | 0 |
| Total acres | 1,360 | 1,361 | 7,744 | 7,745 | 13,310 | 13,388 | 2,158 | 2,159 | 1,336 | 1,337 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 79 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 76 | | 77 | | 78 | | 79 | | 80 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 120 | 0 | 1,548 | 0 | <1 | 0 | 79 | 1,374 | 456 |
| Field crops | 311 | 458 | 3,419 | 3,365 | 1,148 | 1,657 | 470 | 292 | 893 | 1,835 |
| Truck and berry crops | 399 | 321 | 470 | 192 | 455 | 283 | 540 | 203 | 181 | 412 |
| Pasture | 887 | 895 | 4,507 | 1,455 | 495 | 560 | 324 | 1,418 | 285 | 114 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 458 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 23 | 0 | 6,195 | 0 | 98 | 0 | 97 | 119 | 0 |
| Semiagricultural | 0 | 13 | 0 | 20 | 0 | 0 | 0 | 26 | 10 | 11 |
| Native | 263 | 47 | 10,998 | 7,058 | 710 | 208 | 887 | 103 | 252 | 300 |
| Urban | 0 | <1 | 0 | 0 | 0 | 0 | 249 | 252 | 0 | 0 |
| Undesignated | 17 | 0 | 0 | 1 | 0 | 0 | 0 | <1 | 15 | 0 |
| Total acres | 1,877 | 1,877 | 19,852 | 19,834 | 2,808 | 2,806 | 2,471 | 2,470 | 3,129 | 3,128 |
| Double-crop acres | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 81 | | 82 | | 83 | | 84 | | 85 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 31 | 40 |
| Grain and hay crops | 0 | 0 | 88 | 130 | 0 | 2,537 | 0 | 72 | 0 | 233 |
| Field crops | 0 | 56 | 139 | 212 | 2,357 | 1,231 | 432 | 438 | 703 | 1,604 |
| Truck and berry crops | 64 | 0 | 223 | 0 | 1,152 | 265 | 337 | 346 | 2,805 | 1,459 |
| Pasture | 95 | 61 | 236 | 308 | 0 | 0 | 15 | 192 | 1,049 | 1,943 |
| Vineyards | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 13 | 0 | 39 |
| Semiagricultural | 0 | 0 | 0 | 3 | 0 | 221 | 0 | 8 | 10 | 70 |
| Native | 0 | 0 | 58 | 90 | 1,089 | 319 | 533 | 247 | 1,394 | 360 |
| Urban | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 156 | 412 |
| Undesignated | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 |
| Total acres | 166 | 167 | 744 | 743 | 4,598 | 4,599 | 1,319 | 1,321 | 6,160 | 6,160 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 86 | | 87 | | 88 | | 89 | | 90 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 6 |
| Grain and hay crops | 0 | 0 | 0 | 0 | 0 | 795 | 0 | 0 | 0 | 68 |
| Field crops | 0 | 0 | 1,113 | 225 | 0 | 220 | 355 | 73 | 76 | 0 |
| Truck and berry crops | 47 | 51 | 112 | 582 | 0 | 0 | 0 | 0 | 5 | 98 |
| Pasture | 7 | 0 | 211 | 1,616 | 790 | 0 | 987 | 955 | 238 | 258 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 8 | 0 | 659 | 0 | 0 | 0 | 328 | 0 | 0 |
| Semiagricultural | 0 | 0 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 0 |
| Native | 107 | 87 | 2,039 | 350 | 1,320 | 1,096 | 173 | 159 | 127 | 14 |
| Urban | 54 | 69 | 11 | 0 | 0 | 0 | 0 | 0 | 5 | 92 |
| Undesignated | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total acres | 215 | 215 | 3,486 | 3,486 | 2,110 | 2,111 | 1,515 | 1,515 | 468 | 536 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea 91 | | 92 | | 93 | | 94 | | 95 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 273 | 222 | 0 | 0 | 0 | 0 | 0 | 79 |
| Grain and hay crops | 0 | 24 | 16 | 91 | 0 | 268 | 29 | 0 | 259 | 571 |
| Field crops | 176 | 0 | 349 | 192 | 561 | 784 | 250 | 168 | 545 | 1,193 |
| Truck and berry crops | 219 | 44 | 15 | 8 | 304 | 16 | 190 | 159 | 267 | 190 |
| Pasture | 132 | 514 | 151 | 59 | 601 | 217 | 0 | 171 | 2,264 | 685 |
| Vineyards | 0 | 0 | <1 | 64 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 0 |
| Idle | 0 | 0 | 0 | <1 | 0 | 107 | 0 | 0 | 18 | 71 |
| Semiagricultural | 0 | 16 | 2 | 13 | <1 | 75 | 0 | 1 | 0 | 22 |
| Native | 395 | 275 | 7,684 | 15,036 | 3,918 | 3,255 | 64 | 34 | 860 | 1,428 |
| Urban | 9 | 58 | 19 | 152 | 1,656 | 2,839 | 0 | 0 | 0 | 25 |
| Undesignated | 0 | 0 | 7,328 | 0 | 519 | <1 | 0 | 0 | 21 | <1 |
| Total acres | 931 | 931 | 15,837 | 15,837 | 7,559 | 7,561 | 533 | 533 | 4,265 | 4,264 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea 96 | | 97 | | 98 | | 99 | | 100 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 5 | 0 | 0 | 0 | 76 | 89 | 0 | 0 |
| Grain and hay crops | 0 | 0 | 73 | 0 | 0 | 0 | 0 | 0 | 383 | 181 |
| Field crops | 189 | 0 | 87 | 0 | 35 | 30 | 52 | 0 | 611 | 1,067 |
| Truck and berry crops | 0 | 190 | 1 | 0 | 0 | 0 | 0 | 0 | 369 | 276 |
| Pasture | 0 | 0 | 2 | 79 | 0 | 0 | 0 | 92 | 129 | 0 |
| Vineyards | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 54 | 0 | 0 |
| Semiagricultural | 0 | 0 | 9 | 2 | 0 | 0 | 0 | 3 | 0 | 3 |
| Native | 38 | 36 | 32 | 90 | 11 | 3 | 600 | 490 | 90 | 60 |
| Urban | 0 | 0 | 45 | 55 | 13 | 27 | 24 | 24 | 0 | 3 |
| Undesignated | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| Total acres | 227 | 226 | 254 | 250 | 59 | 60 | 752 | 752 | 1,589 | 1,590 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 101 | | 102 | | 103 | | 104 | | 105 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 187 | 269 | 5,309 | 5,505 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 452 | 269 | 352 | 20 | 645 | 2,429 | 0 | 0 | 224 | 0 |
| Field crops | 1,060 | 1,924 | 551 | 0 | 6,008 | 12,112 | 0 | 0 | 5 | 0 |
| Truck and berry crops | 22 | 130 | 479 | 251 | 14,308 | 4,654 | 0 | 0 | 90 | 0 |
| Pasture | 2,676 | 1,293 | 421 | 14 | 16,390 | 11,368 | 0 | 0 | <1 | 0 |
| Vineyards | 0 | 303 | 0 | 167 | 0 | 470 | 0 | 0 | 0 | 0 |
| Rice | 69 | 0 | 0 | 0 | 98 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 57 | 0 | 190 | 0 | 1,751 | 0 | 0 | 0 | 296 |
| Semiagricultural | 0 | 59 | 17 | 147 | 406 | 939 | 0 | 0 | 0 | 0 |
| Native | 747 | 938 | 781 | 847 | 5,326 | 2,802 | 89 | 89 | 59 | 82 |
| Urban | 1 | 96 | 452 | 1,340 | 6,154 | 13,078 | 0 | 0 | 0 | 0 |
| Undesignated | 42 | 0 | 3 | 0 | 184 | 69 | 0 | 0 | 0 | 0 |
| Total acres | 5,069 | 5,069 | 3,243 | 3,245 | 54,828 | 55,177 | 89 | 89 | 378 | 378 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 348 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 106 | | 107 | | 108 | | 109 | | 110 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 1 | 0 | 734 | 0 | 0 | 711 | 0 | 0 | 0 | 0 |
| Field crops | 15 | 0 | 813 | 739 | 402 | 0 | 0 | 0 | 0 | 0 |
| Truck and berry crops | <1 | 0 | 1,536 | 1,711 | 397 | 60 | 0 | 0 | 0 | 0 |
| Pasture | 0 | 0 | 2 | 563 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Semiagricultural | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 |
| Native | 90 | 84 | 153 | 267 | 85 | 112 | 130 | 130 | 195 | 195 |
| Urban | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Undesignated | 0 | 4 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total acres | 106 | 107 | 3,293 | 3,292 | 884 | 883 | 130 | 130 | 195 | 195 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea 111 | | 112 | | 113 | | 114 | | 115 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 273 | 0 | 0 | 69 | 126 | 0 | 0 | 254 | 351 |
| Field crops | 477 | 0 | 0 | 0 | 586 | 682 | 0 | 0 | 169 | 55 |
| Truck and berry crops | 1,329 | 1,533 | 0 | 0 | 926 | 85 | 0 | 0 | 214 | 0 |
| Pasture | 0 | 171 | 0 | 0 | 544 | 1,182 | 0 | 0 | 0 | 222 |
| Vineyards | 138 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 397 | 0 | 0 | 0 | 45 | 0 | 0 | 0 | 0 |
| Semiagricultural | 0 | 57 | 0 | 0 | 18 | 43 | 0 | 0 | 0 | 7 |
| Native | 926 | 436 | 248 | 250 | 111 | 58 | 87 | 87 | 92 | 93 |
| Urban | 19 | 22 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 0 |
| Undesignated | 0 | 0 | 2 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| Total acres | 2,889 | 2,889 | 250 | 250 | 2,260 | 2,260 | 87 | 87 | 729 | 728 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea 116 | | 117 | | 118 | | 119 | | 120 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 209 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 718 | 264 | 370 | 320 | 0 | 0 | 0 | 3,208 | 118 | 529 |
| Field crops | 366 | 178 | 118 | 342 | 0 | 0 | 6,407 | 5,204 | 249 | 731 |
| Truck and berry crops | 561 | 266 | 523 | 148 | 0 | 0 | 0 | 337 | 746 | 83 |
| Pasture | 65 | 785 | 0 | 194 | 0 | 0 | 165 | 0 | 0 | 0 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 |
| Idle | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Semiagricultural | 0 | 6 | 0 | <1 | 0 | 0 | 0 | 17 | 0 | 20 |
| Native | 230 | 209 | 85 | 92 | 182 | 182 | 3,276 | 1,055 | 260 | 254 |
| Urban | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 9 | 106 | 0 |
| Undesignated | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | <1 |
| Total acres | 1,940 | 1,942 | 1,096 | 1,096 | 182 | 182 | 9,848 | 9,848 | 1,485 | 1,617 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 133 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 121 | | 122 | | 123 | | 124 | | 125 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 0 |
| Grain and hay crops | 0 | 67 | 0 | 651 | 0 | 0 | 0 | 177 | 0 | 0 |
| Field crops | 29 | 59 | 613 | 323 | 0 | 0 | 244 | 108 | <1 | 0 |
| Truck and berry crops | 2 | <1 | 411 | 0 | 0 | 0 | 127 | 177 | 1 | 0 |
| Pasture | 256 | 252 | 1,139 | 952 | 0 | 0 | 0 | 0 | <1 | 0 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 7 | 0 | 893 | 0 | 0 | 0 | 0 | 0 | 0 |
| Semiagricultural | 0 | 11 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 |
| Native | 5,313 | 6,112 | 6,690 | 5,185 | 636 | 636 | 181 | 90 | 803 | 1,123 |
| Urban | 21 | 19 | 103 | 402 | 0 | 0 | 0 | 0 | <1 | 1 |
| Undesignated | 924 | 19 | 0 | 522 | 0 | 0 | 0 | 0 | 321 | <1 |
| Total acres | 6,545 | 6,546 | 8,956 | 8,956 | 636 | 636 | 552 | 552 | 1,125 | 1,124 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 126 | | 127 | | 128 | | 129 | | 130 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 7 | 0 | 0 | 0 | 0 | 68 | 23 | 13,611 | 6,045 |
| Grain and hay crops | 0 | 2,811 | 0 | 0 | 0 | 219 | 0 | 531 | 8 | 3,415 |
| Field crops | 581 | 6,597 | 1,357 | 0 | 787 | 0 | 549 | 552 | 1,681 | 2,244 |
| Truck and berry crops | 2,780 | 2,217 | 0 | 0 | 0 | 0 | 591 | 182 | 6,409 | 6,176 |
| Pasture | 1,215 | 1,039 | 0 | 0 | 1,450 | 2,330 | 1,157 | 924 | 3,176 | 3,018 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 46 | 145 | 255 |
| Rice | 696 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 387 | 0 | 0 | 0 | 558 | 0 | 438 | 208 | 3,338 |
| Semiagricultural | 0 | 32 | 0 | 0 | 0 | 26 | 83 | 64 | 6 | 571 |
| Native | 1,612 | 1,567 | 890 | 2,247 | 2,303 | 1,390 | 3,402 | 2,605 | 6,641 | 3,650 |
| Urban | 3 | 189 | 0 | 0 | 41 | 155 | 114 | 599 | 891 | 4,152 |
| Undesignated | 7,768 | 13 | 0 | 0 | 111 | 15 | 4 | 0 | 3 | 7 |
| Total acres | 14,655 | 14,859 | 2,247 | 2,247 | 4,692 | 4,693 | 6,027 | 5,964 | 32,779 | 32,871 |
| Double-crop acres | 0 | 204 | 0 | 0 | 0 | 0 | 64 | <1 | 8 | 99 |

**Table 7.** Land use in 1968 and 1991 for subareas of the California Department of Water Resources' delta island consumptive-use model of the Sacramento-San Joaquin Delta, California—Continued

| Land use | Subarea | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 131 | | 132 | | 133 | | 134 | | 135 | | 136 | | 137 | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Grain and hay crops | 0 | 0 | 369 | 348 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Field crops | 0 | 0 | 0 | 526 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 27 | 0 |
| Truck and berry crops | 0 | 0 | 545 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pasture | 1,066 | 8 | 0 | 0 | 1 | 0 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Idle | 0 | 2,488 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Semiagricultural | 70 | 137 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Native | 1,908 | 346 | 302 | 304 | 333 | 359 | 1,354 | 1,365 | 122 | 123 | 3,602 | 3,602 | 1,505 | 1,533 |
| Urban | 458 | 524 | 0 | 8 | 26 | <1 | 12 | <1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Undesignated | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total acres | 3,502 | 3,503 | 1,220 | 1,220 | 360 | 359 | 1,366 | 1,365 | 123 | 123 | 3,602 | 3,602 | 1,532 | 1,533 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Land use | Subarea | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 138 | | 139 | | 140 | | 141 | | 142 | | | |
| | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 | 1968 | 1991 |
| Subtropical fruits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 84 |
| Deciduous fruits and nuts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27,558 | 21,184 |
| Grain and hay crops | 0 | 304 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21,034 | 92,486 |
| Field crops | 632 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 174,621 | 172,439 |
| Truck and berry crops | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 117,743 | 80,988 |
| Pasture | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | 108,510 | 100,056 |
| Vineyards | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 772 | 9,222 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,303 | 18 |
| Idle | 0 | 298 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 3,125 | 31,094 |
| Semiagricultural | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,165 | 6,319 |
| Native | 174 | 204 | 86 | 86 | 2,124 | 2,145 | 403 | 1,604 | 174 | 174 | 159,259 | 119,314 |
| Urban | 0 | 0 | 0 | 0 | <1 | <1 | 0 | <1 | 0 | <1 | 20,198 | 47,495 |
| Undesignated | <1 | 0 | 0 | 0 | 0 | 0 | 1,201 | 0 | 0 | 0 | 42,630 | 748 |
| Total acres | 806 | 806 | 86 | 86 | 2,145 | 2,145 | 1,664 | 1,604 | 174 | 174 | 678,918 | 681,447 |
| Double-crop acres | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 2,591 |

## SUMMARY

Partial data on drainage returns and surface-water withdrawals from March 1994 through January 8, 1996, are presented for areas of the Sacramento-San Joaquin Delta.These areas cover most of the delta. Measurements were made using flowmeters installed in drain pipes and siphons, and estimates were made using electric power-consumption data with pump-efficiency-test data. In 1995, measured drainage returns for Twitchell Island totaled about 11,200 acre-feet, whereas estimated drainage returns calculated from power-consumption data totaled about 10,600 acre-feet. Drainage-return estimates for most of the delta totaled about 430,000 acre-feet for 1995. Surface-water withdrawals onto Twitchell Island measured for 12 of 21 siphons totaled about 2,400 acre-feet for 1995.

Data on changes in delta land use between 1968 and 1991 are also presented. Maps of land use in 1968 were digitized and stored in a geographic information system (ARC/INFO) and compared with digital land-use information for 1991. Between 1968 and 1991, native vegetation in the delta decreased by 25 percent (about 40,000 acres), and grain and hay crops increased by 340 percent (about 71,000 acres). For Twitchell Island, native vegetation decreased about 77 percent (about 850 acres), while field-crop acreage increased by about 44 percent (about 780 acres).

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