

**BIOLOGICAL, CHEMICAL AND PHYSICAL MONITORING OF LOS PENASQUITOS**

**LAGOON**

**Summary Report: 1987 – 2005**

prepared for

Los Peñasquitos Lagoon Foundation

c/o Mike Hastings

P.O. Box 940

Cardiff, CA 92007

by

Michelle Cordrey, Jeff Crooks, and Mike Hastings

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## Exhibit 2: Monitoring Program Summary 1987-2005

### Background

Biological and physical monitoring at the lagoon began in 1987 as part of the Los Peñasquitos Lagoon Enhancement Plan, which was developed by the California State Coastal Conservancy and the Los Peñasquitos Lagoon Foundation in 1985. A baseline study was made in 1986-87 sampling adult and juvenile fishes, benthic invertebrates, vegetation and physiochemical parameters within the lagoon (Nordby and Covin 1988). The monitoring sites and protocols used in the ongoing monitoring program were based on the initial study and recommendations. Subsequent changes have been made to the protocols and station locations based on an adaptive approach. This has allowed some level of consistency across time while also permitting better assessment of changing conditions, such as increases in freshwater inputs or shifting distributions of invasive species. Additionally the sampling methods have been developed to make results more comparable to ongoing monitoring at Tijuana National Estuarine Research Reserve (TRNERR), whose monitoring is part of a nationwide NOAA effort. The Tijuana Estuary makes an excellent reference location as the mouth of the reserve is rarely restricted as is Los Peñasquitos Lagoon (LPL), which allows for comparisons between tidally-restricted and unrestricted systems.

This report documents the monitoring program at the lagoon and highlights major changes in the monitoring locations, frequency of sampling and methodology over time. It also discusses possible future directions for the LPL monitoring program.

### Vegetation

#### *Sampling Locations*

Initially, eight sites were chosen for vegetation and soil salinity sampling. One to three transects were established at each site. Transect lengths varied from 50 to 80 meters. The sites were chosen based on earlier studies done in the area to allow for long-term comparisons, especially to monitor the effects of freshwater inputs and impoundments on saltmarsh vegetation communities located in native saltmarsh habitat. Five areas were chosen in the western portion of the lagoon and three in disturbed areas in the eastern portion (Fig. 1). The three eastern areas also serve to monitor: a) marsh to upland conversion (area 6), b) effects of freshwater inputs and impoundment on saltmarsh (area 7), and c) populations of the rare plant *Lasthenia glabrata*.

In 1988, two stations, 6 and 7, were discontinued because they could not be relocated (Nordby 1989). In 1990 four areas, 9 -12, were added to the eastern portion of the lagoon to better document freshwater invasive species encroaching into native saltmarsh habitat (Boland 1991). Another area was added in 2000 to enhance the ability to detect the expansion of exotic species near Carmel Valley (due to increased freshwater inflows) and to replace transect 10, which became impassable when *Typha* sp. expanded to the edge of the creek (Ward et al. 2001).

#### *Sampling Frequency*

The vegetation areas have generally been sampled once a year, usually in September, at the end of the growing season. An additional sampling of the vegetation transects was done in the spring of 1990 to assess invasive species that are annuals and

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have disappeared by the end of the growing season. Soil salinities are currently sampled concurrently with the vegetation, although initially they were sampled both at the end of and beginning of the growing season.

### *Methods*

At five meter intervals along each transect, percent cover, total cover and maximum height of each species were measured within a 0.25 m<sup>2</sup> quadrat using the following cover classes: 1 = < 1% cover; 2 = 1-5% cover; 3 = 6-25% cover; 4 = 26-50% cover; 5 = 51-75% cover; 6 = 76-100% cover. From 1993 onward an additional class was added to better represent the upper cover classes. Class 6 was modified to include 76 – 95% cover and class 7 included 96 – 100% cover. Soil salinities were measured at 10 meter intervals at one transect at each area using a refractometer. Prior to 1996, soil salinities were determined in the field using expressed interstitial water. In 1996 the methodology was changed to the sole use of soil pastes to better account for inconsistencies in measuring the salinity of dry and wet soils.

Initially the monitoring of the saltmarsh daisy (*Lasthenia*) was done using three standard methods: the nearest individual method, nearest neighbor method, and by direct counts of individuals within 0.10 m<sup>2</sup> quadrats along permanent transects. This methodology was abandoned in 1988 in favor of monitoring discrete patches (Nordby 1989). Until 1995 the method used was as follows: while walking the margin of each salt panne, a 1-m wide belt transect was run through the margin vegetation every 5 m, and *Lasthenia* presence or absence was noted. From this data, the percent of panne margin containing *Lasthenia* was calculated. Also, a portion of the panne margin where *Lasthenia* was most abundant was chosen and stem densities were estimated per 0.1 m<sup>2</sup>.

From 1995 until present GPS technology has been utilized to track changes in *Lasthenia* patch location and size. Plant locations and patch perimeters were delineated by pre-survey flagging (Fig. 3). Spatial groupings of plants were based on distances to their nearest neighbor, and could be placed into one of three classes:

- Point [P] = single plant or small group of plants in an area <1 m diameter. Any individual in the group is >5 m from any and all other plants of the same species outside the group. A Point is indicated by a single GPS point in middle of a group, coded by the letter [P].
- Superpoint [S] = group of plants in an area 1 - 5 m diameter. Any individual in the group is >5 m from any and all other plants of the same species outside the group. A Superpoint is indicated by a single GPS point in middle of a group, coded by the letter [S].
- Polygon [G] = contiguous group of plants (defined as all plants separated by less than 5 m) that cover an area >5 m diameter. A Polygon is indicated by points that trace the outer boundary of an area. Any individual in the group is >5 m from any and all other plants outside the group. Polygon points are coded by a letter [G] followed by an assigned number for that polygon (e.g., G1, G2, etc...).

Although this current methodology no longer addresses changes in population densities *per se*, it is a cost-effective conservation tool that increases our ability to provide accurate spatial representations of populations over time.

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### *Future Directions*

A goal of the LPL monitoring program should be to increase the use of remotely-sensed images and GIS for monitoring work. This will allow better broad-scale assessments of conditions in the estuary, and will facilitate communication with other interested parties. In general, this remote sensing / GIS work will be facilitated by utilizing the resources at the TRNERR.

In the immediate future, we plan on using remotely-sensed images to delineate the extent of the salt-panne habitat suitable for *Lasthenia*. We also will map the spatial locations and extent of other important species in the lagoon. Plants of special interest are cattails (*Typha* sp.), arundo (*Arundo donax*), and widgeon grass (*Ruppia maritima*). Preliminary work indicates that *Typha* and perhaps *Arundo* can be mapped from existing imagery. We also will determine the feasibility of monitoring *Ruppia* extents within the reserve using existing remote sensing products (i.e., without having to employ costly overflights dedicated to *Ruppia* monitoring). From this information, we will assess the overall feasibility of increased remote-sensing and GIS work and develop strategies for incorporation of this work into the standard monitoring plan.

### **Fishes**

#### *Sampling Locations*

In 1986 and 1987 an initial study was performed by Ecological Research Associates (ERA) establishing five fish and invertebrate monitoring sites in the lagoon (Greenwald and Britton 1987) (Fig. 2). Three of these sites were selected for continued monitoring efforts. These sites were chosen to provide a spatial gradient to reflect the “upper” and “lower” lagoon (Nordby and Covin 1988). Two of the station locations were changed in 1992 so that all three sites were located along a gradient in the north arm of the reserve with fish and invertebrate samples being taken at the same locations. From 1988 through 1991 separate sites were being used to monitor fishes and invertebrates. Two stations were added in 1996 to better monitor areas which are heavily influenced by freshwater inputs. Monitoring at these five sites has continued to the present with only small variations necessitated by changes in hydrology and geomorphology within the lagoon.

#### *Sampling Frequency*

Fishes were sampled seasonally in spring, summer, fall and winter from 1986 through 1989, and from 2002 through the present. Between 1990 and 2001 they were sampled semi-annually in the winter and summer only. Seasonal sampling was resumed to enable better emphasis of seasonal differences.

#### *Methods*

At each study site a linear distance of 5 -10 m (depending on the size of the channel) is measured parallel to the channel and blocking nets are deployed to confine all

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fishes within this area. A bag seine is then swept between the two blocking nets and across the channel to the opposite bank (defining 1 pass). Passes are repeated until the fishes effectively captured by seine approaches zero. The species composition and number of fishes collected are recorded separately for each pass. Sub-samples of at least 30 individuals per species are measured and then released outside the blocking nets. In 2004 the protocol was augmented to include the capture from each blocking net in addition to the seine passes.

### **Invertebrates**

#### *Sampling Locations*

As with the fishes, five stations were established to monitor invertebrates in the initial study (Greenwald and Britton 1987)(Fig. 2). In 1998 three stations were selected for ongoing sampling. These three stations were located along a gradient in the north arm of the reserve and have been monitored continuously to present.

#### *Sampling Frequency*

Prior to 1996 invertebrates were sampled seasonally in spring, summer, fall and winter. This was reduced to semi-annually, winter and summer only when densities have been shown to be at their highest. Beginning in 2001 and continuing to present, sampling was again reduced, and it is now annual sampling that occurs during the summer. This decision was based on a scientific assessment of the necessary periodicity of invertebrate sampling, given that processing of benthic samples is labor intensive and costly.

#### *Methods*

The baseline study in 1987 utilized Birge-Ekman grab samples with a 218.68 sq cm sample area. Three replicates were made and passed through a 1-mm mesh sieve. Subsequent sampling has utilized cylindrical “clam guns” with a 15-cm diameter (176 cm<sup>2</sup> area) pushed to a depth of 20cm. Between 1988 and 1990, small shallow dwelling organisms (mainly polychaetes and amphipods) and large deep dwelling organisms (mainly bivalves) were determined using the same samples passed through a 1-mm mesh sieve. Three samples of three cores each were taken at each station, for a total of nine cores per station. Easily identified animals were counted and released, while others were preserved and identified in the lab. Most animals were identified to the species level, although some species were pooled into more broad taxonomic categories.

It was determined that most small organisms could be found within the top 5cm of the surface, so beginning in 1990 shallow organisms were sampled at a depth of 5cm and deeper dwelling organisms at a depth of 20cm. Different mesh sizes were also used to process the samples: 1-mm mesh for shallow organisms and 3-mm mesh for deeper organisms. This resulted in much improved processing efficiency. Until 2004 the number of cores at each station was reduced by combining three cores into each sample at each station for a total of three samples per station. Starting in 2004, the sub-samples were no longer pooled, which allows calculation of sample variation and improves analytical power, while also allowing direct comparisons to earlier data.

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### **Water Quality**

The most important factor determining the "health" of the estuary is whether the mouth of the lagoon is open or closed. When the mouth is open, tidal flow is extensive and the channel water does not stagnate. When the mouth is closed, however, the channel water can stagnate, causing the oxygen levels drop to lethal levels and invertebrate and fish kills are possible (Boland 1993). The water quality program at the lagoon is designed to gather standard water parameters (i.e. temperature, salinity, and dissolved oxygen) for "normal" conditions within the lagoon, when the mouth is open and tidal exchange is unrestricted. This can serve as a guide for mechanical mouth openings to prevent water quality from becoming low enough to kill channel organisms. Sampling consists of periodic spatial sampling at three locations in the lagoon, and continuous measurement at one location.

### *Sampling Locations*

In 1987, the 3 spatial stations were established (Greenwald and Britton 1987), which represent the same general sites that are used currently (Fig. 2). The continuous sampling site, located at the railroad crossing, was established in 1997.

### *Sampling Frequency*

Since 1987, three stations have been sampled every two to four weeks, with increased frequency during mouth closure events. Water quality measurements are also made while performing fish and invertebrate sampling. In addition, intensive sampling has been conducted using datalogger deployed at one station from two weeks to 1 month for each sampling period.

### *Methods*

Spatial sampling at the three stations is done in the field using handheld instruments both at the surface and bottom of the channel. Parameters measured include water temperature, dissolved oxygen, salinity and water depth at the sample location. Measurements are made before 9am and on an outgoing tide (when possible) to limit diurnal and tidal variations between sampling stations and dates and to insure that dissolved oxygen values are sampled when they are relatively low.

Temporal measurements are made using a multiparameter water quality sonde which can be deployed unattended at the station. Parameters measured are identical to the spatial sampling, with the addition of pH. The sonde is deployed at a consistent depth approximately 0.3 meters from the bottom of the channel. The depth was chosen to monitor conditions which most affect benthic organisms. A sampling interval of 30 minutes is used to maximize deployment time and to be easily comparable to monitoring being done at the TR NERR.

Freshwater flow into the lagoon was monitored in the past using the floating object method: a piece of floating material was placed into the stream the time taken for it to float a known distance was measured. The discharge of freshwater could be calculated using the equation:  $D = 0.9wdl / t$ , where  $D$  is discharge in  $m^3$ ,  $w$  = mean width of the channel in meters,  $d$  = mean depth of the channel in meters, and  $l$  = distance in meters over which the float travels

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in time  $t$  which is measured in minutes (Hynes 1970). Currently, a handheld flow meter is used and measurements are taken at predetermined intervals and depths along a cross section of the stream. This method is more accurate than the previous method in that it takes into account variations in flow across a stream.

### *Future Directions*

Although the water quality parameters now measured allow assessment of estuarine conditions and provide empirical support for management decisions, a variety of other possible measurements will serve to provide a more in depth picture of the health of LPL. In general, water quality properties such as nutrients, coliforms, and toxics could be measured. In addition, temporal changes in the estuary could be better characterized by increased deployment of continuous data recorders. In all such effortd, it will be especially important to strive for real-time delivery of information. This will readily make information available to managers, and will allow the incorporation of LPL monitoring into larger ocean observing system networks (such as the Southern California Coastal Ocean Observing System).

In the short term, we will assess the feasibility of collecting nutrient and coliform data and develop appropriate sampling methodologies. This will be accomplished by collecting and analyzing water samples for total and fecal coliform bacteria at a minimum of 4 locations. Sampling will occur at least twice, trying to capture different ambient conditions in the lagoon (e.g. rainy vs. dry season). In addition, we will measure freshwater flow at the three tributaries into the lagoon, as this is a key factor influencing water quality parameters.

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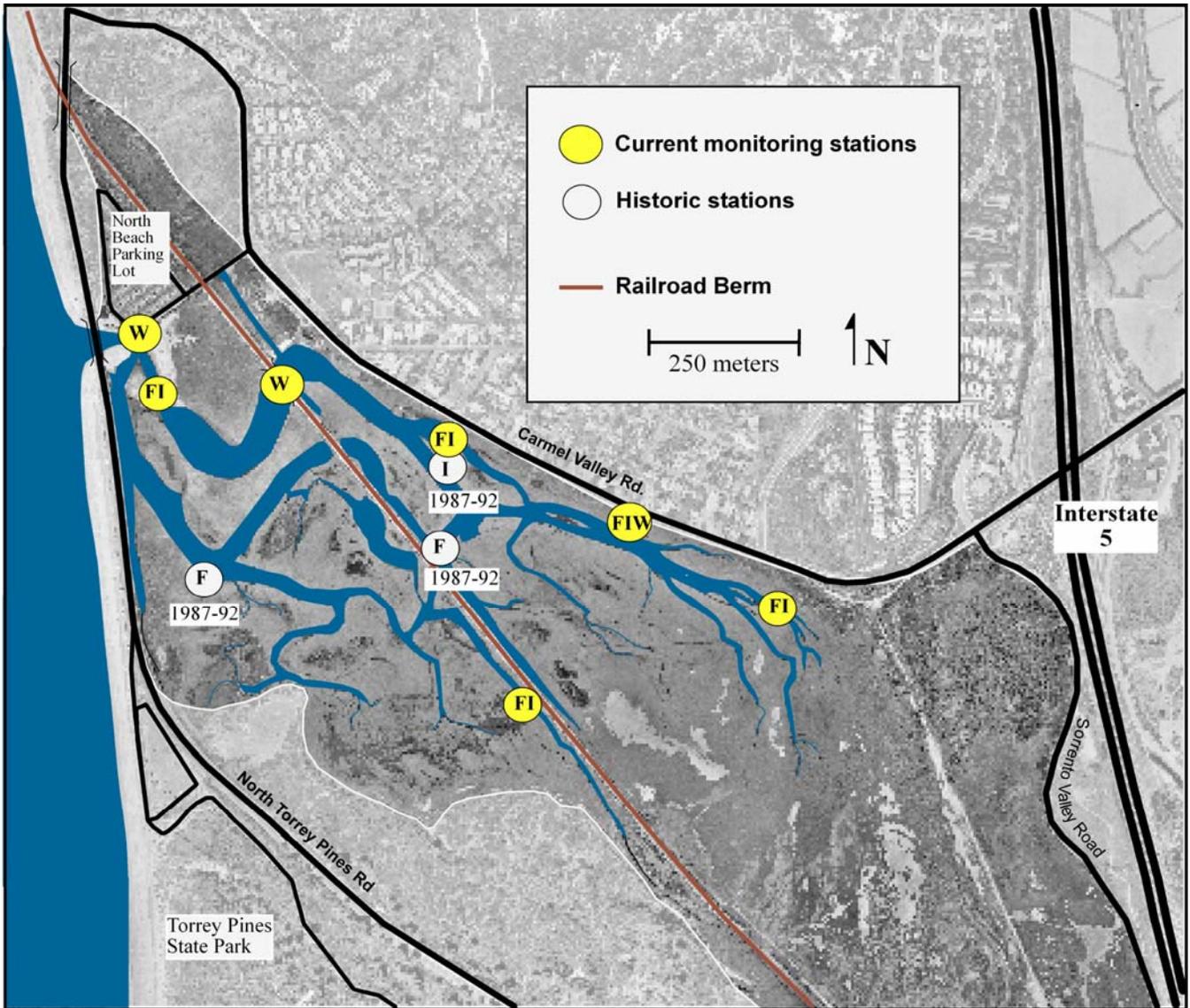


Figure 1. Location of current and historic water quality, fish and invertebrate monitoring stations at the Los Peñasquitos Lagoon. F = Fish stations I = Invertebrate stations W = Water quality stations

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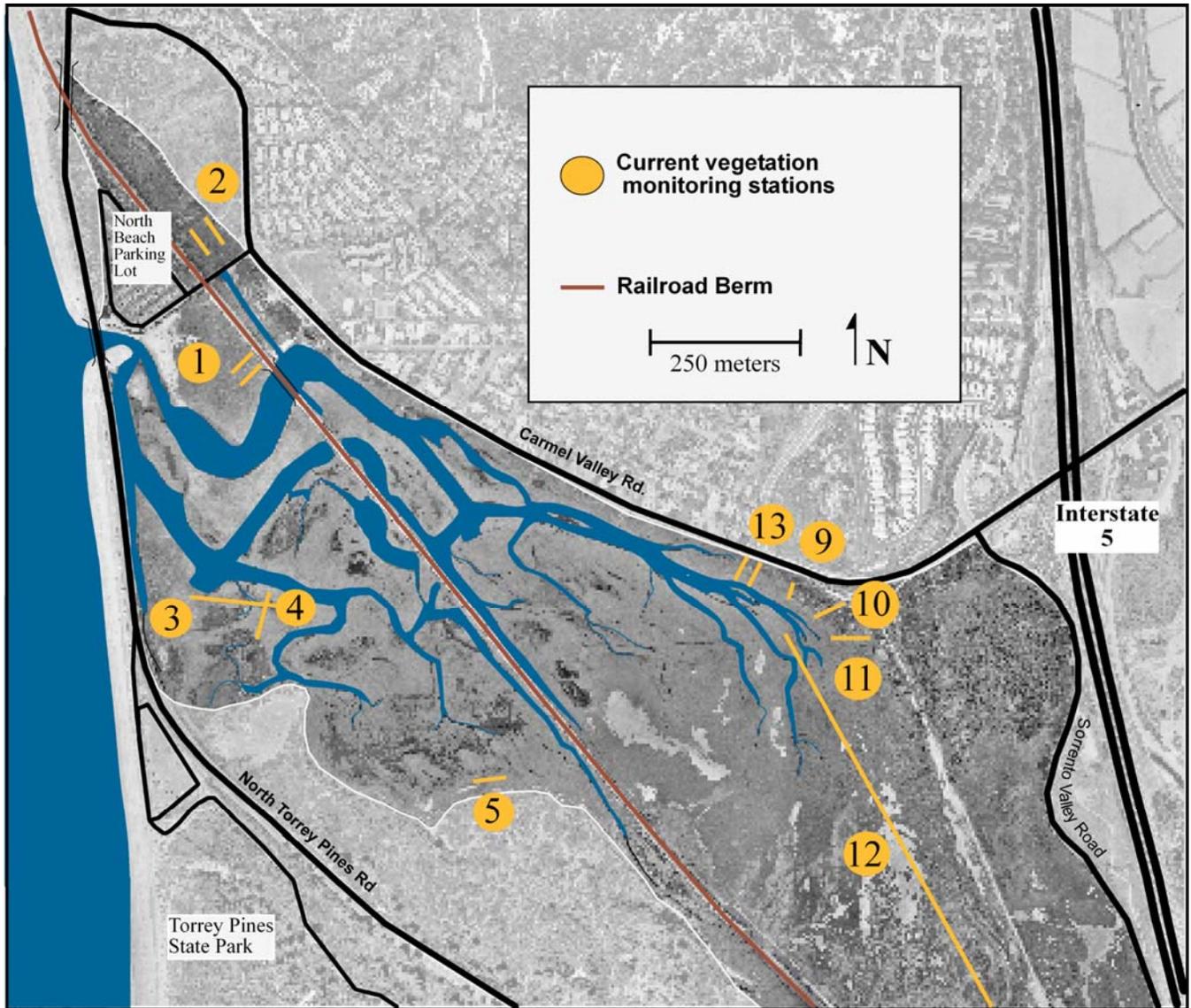


Figure 2. Los Peñasquitos Lagoon current vegetation monitoring stations.

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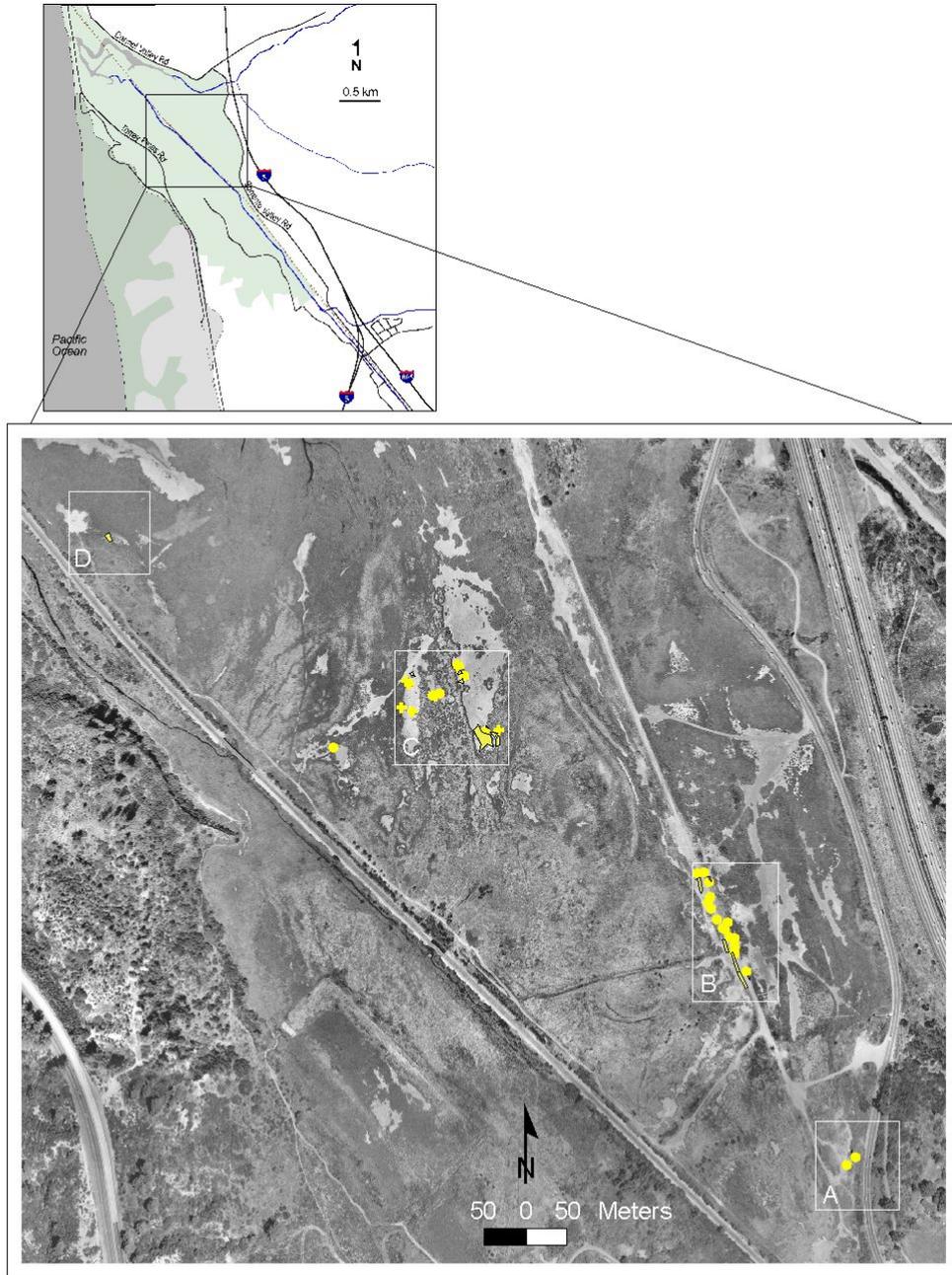


Figure 3. Location of current *Lasthenia glabrata* monitoring areas in the Los Peñasquitos Lagoon.