San Diego Coastal Ocean Observing System

California Clean Beaches Initiative

Final Report
January 2005

to
City of Imperial Beach
Contract # 401-663-605-000

"Funding for this project has been provided in full or in part through a contract with the State Water Resources Control Board (SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendations for use."

SDCOOS contributors: Eric Terrill, Ph.D., Lisa Hazard, Axel Pierson, Joel Hazard, Mark Otero, Paul Reuter, Timothy Harris, Todd Hansen, Billy Middleton, Jared Dimock, Tony de Paolo

Coastal Observing Research and Development Center
Marine Physical Laboratory
Scripps Institution of Oceanography, University of California, San Diego

Table of Contents

I. Introduction

A. Problem Statement

The city of Imperial Beach experiences a significant number of beach closures as a result of high concentrations of indicator bacteria. For example, the beach was closed 39 times in the year 2000, with over half of the closures occurring in dry summer months when beach attendance is at a peak. Not only is the incidence of bacterial contamination and associated beach closures and postings a problem, but time lags between sampling of the coastal water and completion of the analysis likely result in situations when beach waters may be clean when posted, and not clean when not posted.

Possible sources of bacterial contamination responsible for bacterial exceedances include discharge from the South Bay International Water Treatment Plant (SBIWTP) outfall, the Tijuana River outflow, northward flow of contaminated waters from Mexico, local runoff from Imperial Beach, and sewage spills. Implications involving the status of beaches have been differentiated into two classifications: beach closures and beach advisory/posting. The County of San Diego Department of Environmental Health (DEH) will issue an advisory or beach posting if urban runoff or any nonpoint source causes bacterial exceedances. If, however, bacterial exceedances are caused by a reported sewage spill, DEH will post a beach closure. While the source of a beach closure is well known, beach postings can occur throughout the year in both wet and dry weather. A general advisory/posting is issued by the DEH following .2" or more of rainfall as sampling has shown increased bacterial levels due to urban runoff. The DEH will issue dry weather advisory/postings following bacterial level exceedances during routine monitoring. Throughout this report, we examine bacterial levels exceeding current standards and do not differentiate between postings and closures. The focus of this report remains on transport mechanisms from potential source locations and preliminary ocean observing results. The multiplicity of possible sources within close proximity of a few miles radius to the beaches of Imperial Beach has made source identification difficult and has resulted in stalled mitigation and abatement efforts. Under the present level of understanding, it is difficult to assess how these sources contribute to the city's beach contamination problems. While source identification is the first step in any mitigation or abatement program, the statistics of beach warnings suggest that the sources and physical transport processes in this region are complex. Physical properties of the area need to be examined and continuously monitored with sufficient detail within time and space if solutions to beach advisories resulting from non-local pollution are to be developed.

B. Description of the Coastal Monitoring System

Scripps Institution of Oceanography has established the San Diego Coastal Ocean Observing System (SDCOOS) (www.sdcoos.ucsd.edu) under contract to the City of Imperial Beach through funding provided by the California Clean Beach Initiative. The area monitored encompasses a region spanning from Point Loma to the U.S. - Mexico Border and waters offshore to distances of approximately 16nm (30 km). The backbone of the coastal monitoring system is an array of high-resolution radars designed to provide a spatial map of the local ocean surface currents on a real-time basis. The basis for the system is the scattering of radio waves from ocean surface waves over known regions of the ocean. Through appropriate signal processing of the radio waves scattered back to the radar, currents can be determined at a large number of discrete locations, referred to as range cells, at locations spaced as closely as .16nm (300m) apart. Refer to appendix 2 for technical details covering HF radar operation. The Coastal Ocean Dynamics Radar (CODAR) sites are in operation by a large number of research institutions at sites on both the east and west coasts of the United States. The regional coverage provided by the current array and the direct measurement of the ocean's surface currents allows the tracking of transport routes from various potential pollution sites and will identify which regions of the coastline may be impacted by surface flow from offshore or non-local sites. The immediate application of the current maps has been to provide a framework for interpreting results from water quality testing programs. Much has been learned from investigating time histories of the surface current fields in regions of contamination as time histories allow transport routes to be tracked backwards in time to determine the source origins.

The radar array is composed of three installations located at the following sites: Border Field State Park, Point Loma, and a third site located on the Coronado Islands. The installation on the Coronado Islands was made possible through a collaborative arrangement with Mexican research scientists at Universidad Autonoma de Baja California (UABC) The Center for Scientific Investigation and Higher Education of Ensenada (CICESE), who operate a similar current mapping radar unit south of the border. The placement of the radar at an offshore site is highly favorable since it provides current mapping coverage very close to the shore. The HF radar signal is lost once it propagates over land making near shore measurements difficult. An offshore site is not shadowed by land allowing for improved coverage. An offshore site also improves the geometry for total vector calculation. In more technical terms, a single 25MHz HF radar site measures radial velocity over 19nm (35 km) centered at the antenna (see figure 7). Combined radial data from two systems will produce a surface current direction and magnitude (see figures 8-12). Surface currents cannot be resolved on the direct line (known as the baseline) between radar systems, because equal but opposite radial vectors cancel one another. For this reason a third system offshore whose radial vectors combine along the baseline aids in overall coverage. Further details regarding HF radar principles for measuring surface currents can be found in appendix 2. The real-time surface current maps generated by the radar array are complemented by satellite remote sensing and a number of in-water monitoring systems deployed locally offshore of Imperial Beach. Vertical profiles of currents including those associated with ocean surface waves were continuously measured closely offshore of the City's beaches using an Acoustic Doppler Current Profiler (ADCP) and the density stratification of the water column was continuously measured with a vertical temperature sensor array. The vertical structure of the currents and the density stratification are important parameters to measure since they indicate the potential for sub-surface waters to either penetrate to the surface or be transported cross-shore into the surf zone. In addition, a water quality monitoring system is mounted on the Imperial Beach pier near the center of human contact activities. This system includes the measurement of salinity, temperature, turbidity, and chlorophyll, as well as a current meter to measure the long-shore transport in the surf-zone which is closely tied to the direction of the swell breaking on the beach. The current profile and wave heights and direction are also measured off the end of the pier. The real-time water quality parameters measured at the pier site are used to investigate whether measurable parameters exist which allow the real-time determination of water origin or provide indication of contamination events. Basic meteorological variables are also measured at the end of the pier and tied into a central data logging and distribution system.

The long-term benefits of the monitoring system result from two modes of use. In the first mode, direct operation of the system provides real-time information regarding the environment, providing an early warning of potential contamination due to onshore flow. First responders for water quality (Department of Environmental Health, Marine Safety Officers, City officials) are the primary users of this information. The second mode of using the information is to generate a large data base describing how this coastal region responds to different environmental forcing such as tides, wind, different swell conditions, and heavy precipitation, and how these forcing events and the different flow configurations associated with them coincide with the occurrence of fecal contamination at the beaches. Through an understanding of the coastal response to these various forcing events, statistical predictors of beach closures can be developed. Local and regional managers can use the information to guide the development of future water quality clean up projects.

II. Work Completed

A. Task Schedule

The City of Imperial Beach was responsible for completing three of the four project tasks, Task 1 – Project Management and Administration, Task 2 – Quality Assurance Project Plan, and Task 4 – Reporting. UCSD – SIO was responsible for the performance of work in Task 3 – Statement of Work that consists of four major tasks as outlined in State Water Resources Control Agreement Number 01-074-550-2 and shown below.

1.0 Project Management and Administration

1.1 Provide all technical an administrative services as needed for contract completion; monitor, supervise and review all work performed; and coordinate budgeting and scheduling to assure that the contract is completed within budget, on schedule, and in accordance with approved procedures, applicable laws, and regulations.

1.2 Ensure that the contract requirements are met through completion of quarterly progress reports and through regular communication with the SWRCB Project Representative. The progress reports shall describe activities undertaken and accomplishments of each task during the quarter, milestones achieved, and any problems encountered in the performance of the work under this contract. The description of activities and accomplishments of each task during the quarter shall be in sufficient detail to provide a basis for payment of invoices and shall be translated into percent of task work completed for the purpose of calculating invoice amounts.

1.3 State Disclosure Requirements – Include the following disclosure statement in any document, written report, or brochure prepared in whole or in part pursuant to this contract:

"Funding for this project has been provided in full or in part through a contract with the State Water Resources Control Board (SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do no necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitute endorsements or recommendation for use." (Gov. Code 7550, 40 CFR 31.20)

1.4 The Contractor and any of its contractors shall notify the SWRCB Project Representative at least ten working days prior to any public or media event purblicizing the accomplishments and/or results of this contract and provide the opportunity for attendance and participation by SWRCB representatives.

1.5 Complete a one-page contract summary form (form to be provided by the SWRCB within three months of the contract execution

1.6 Award contract(s) to appropriate organizations(s) to perform tasks as outlined in this agreement. Document steps taken in soliciting and awarding the contract and submit them to the SWRCB Project Representative for review. Document all contractor activities in quarterly reports.

1.7 At the completion of this project and prior to final payment, the Project Representative shall fill out and provide a project survey form to the SWRCB Project Representative.

Task Deliverables: 1.2 Quarterly Progress Reports, 1.5 Contract Summary Form, 1.6 Subcontractor Document, 1.7 Project Survey Form

2.0 Quality Assurance Project Plan

2.1 Prepare and maintain a Quality Assurance Project Plan (QAPP). The SWRCB Project Representative prior to the implementation of any sampling or monitoring activities shall approve the QAPP.

Task Deliverables: 2.1 QAPP

3.0 Statement of work

SDCOOS was responsible for the performance of the work as set forth herein below and for the preparation of products and reports as specified in this Exhibit. During the course of the project, SDCOOS staff promptly notified the Contract Manager of events or proposed changes that affected the scope, budget, or schedule of work performed under the agreement.

3.1. Coastal Ocean Dynamics Application Radar (CODAR)

3.1.1 Conduct site planning and assessments for three CODAR potential site locations. Site assessment matrix to include criterion based on geographic orientation and exposure to achieve maximum effectiveness of the instrumentation to achieve the goals laid out in this contract, availability of utilities for support of the remote site CODAR hardware, data telemetry options, and site security. Select appropriate operating RF frequency within operating band of CODAR system and existing band usage.

3.1.2 Obtain necessary permissions or collaborative agreements from the various land managers/owners for the three CODAR site locations.

3.1.3 Issue appropriate subcontracts with vendors for the fabrication of instrumentation.

3.1.4 Physical installation of CODAR instrumentation at three sites. Installation to include appropriate equipment enclosures to protect instrumentation from the environment, routing of appropriate utilities to the instrumentation, securing of CODAR antennas to appropriate existing structures, and routing of RF antenna cables to the instrumentation enclosure.

3.1.5 Install a Central Site Computer for the merger of CODAR data fields from the three respective remote sites into a map of ocean surface currents for the region.

3.1.6 Establish internet telemetry links between the Central Data Processing Center and the remote CODAR stations using telephone landlines, wireless technology, or other appropriate internet access technology.

3.1.7 Conduct radar antenna pattern measurements over the ocean using a small craft and a portable RF transponder unit. Integrate measured antenna patterns into radar signal processing algorithms. Repeat antenna measurement procedure if antennas are moved over the course of this project.

3.1.8 Optimize operation of CODAR array to provide real-time ocean surface current vector fields. Implement necessary procedures to have system operate on a continuous basis.

3.1.9 Integrate data with other Task efforts listed below.

3.2. Nearshore Currents and Water Type Sampling System

3.2.1 Fabricate a bottom-mounted current profiler system composed of a) an acoustic Doppler current profiler (RDI or similar) b) a conductivity and temperature sensor (Seabird or similar). Both sensors a) and b) of the system to be appropriately integrated to provide data output using a single power and communication cable over distances to at least 750m. System will be mounted to a bottom support and appropriately treated with anti-fouling paint and other protective measures to minimize sensor fouling from biological growth. Bottom support to be designed to minimize effects of scour.

3.2.2 Conduct a site assessment to choose an appropriate deployment site either north or south of the City of Imperial Beach Pier in water depths between 5m – 20m. Site to be selected on criterion for effectively monitoring water transport to beaches of heavy usage.

3.2.3 Deploy both systems at the chosen site using an appropriate work vessel. Install armored data and communication cable between the sampling system and an appropriate piling at the end of the IB Pier. Cable to be secured by piling clamps fabricated by contractor. Route cable on Pier to first floor of IB Pier Lifeguard Tower in consultation with City of IB personnel.

3.2.4 Install system operation and communication computers in the first floor of the IB Pier Lifeguard Tower. Computers to conduct continuous real-time acquisition of data streams from the in-water sensors.

3.2.5 Invert water velocity data from the system to extract surface wave properties (wave height, period, and direction). Data inversion to be conducted on a continuous real-time basis.

3.2.6 Integrate data with other Task efforts listed below.

3.3. Surf-zone Currents and Water Quality Sampling System

3.3.1 Fabricate an environmental sampling system for the measurement of the long-shore currents and water quality parameters. System to be composed of a current meter (Sontek or similar) and seawater sampling intake mounted on a piling on the south side of the IB pier in shore of the Lifeguard Tower. Piling location to be within the surf zone at region influenced by long-shore transport. The current meter and seawater sampling intake to be placed at an appropriate depth to ensure the system is operational over all water level fluctuations due to tides and waves.

3.3.2 Install pumped sampling system to bring water from the seawater intake to a water quality sensor suite (YSI or similar) located on the pier. Water quality parameters to be measured include conductivity, temperature, turbidity, and dissolved oxygen. A flow cell is to be integrated into the seawater sampling system to allow continuous measurement of these parameters and provide the capability for placement of additional sensors within the sampling system. A tap shall also be available to provide for obtaining discrete water samples for conducting culture analysis of bacteria. Pump and sensors to be mounted in an accessible location on the underside of the pier to minimize vandalism. Site placement of pump and sensors to be determined with cooperation of City of IB personnel.

3.3.3 Install data and power cable to operate sampling system from the first floor of the IB Pier Lifeguard tower.

3.3.4 Integrate data with other Task efforts listed below.

3.4. Water Column Stratification Measurement System

3.4.1 Fabricate a buoy and mooring system designed for the measurement of water column temperature structure. Temperature sensors to be spaced vertically at 10ft (3m) increments from the surface to the seafloor. Buoy is to be deployed at an appropriate site offshore Imperial Beach to measure water column stratification over a 99ft (30m) depth in a region near the South Bay Ocean Outfall. Deployment to be conducted with a suitable work vessel as determined by the contractor. Exact mooring location to be reviewed with U.S. Coast Guard.

3.4.2 Fabricate a vertical array of water temperature sensors spaced at 1m depth increments. Vertical array to be mounted to the outermost piling on the IB Pier. Route a power and communication cable to the first floor of the Imperial Beach Lifeguard Tower in consultation with City of Imperial Beach personnel. Data to be logged on real-time basis from a logging station.

3.4.3 Integrate real-time measurements of water column stratification with other Task efforts listed below.

3.5. Central Data Acquisition and Real-Time Data Distribution System

A central data acquisition and real-time data distribution system will be developed to merge measurements conducted under efforts 1.1- 1.4 above into a centralized database. Data will be accessible via an internet accessible, real-time data distribution system.

3.5.1. Merge various data streams from Tasks 1.1- 1.4 into a centralized database on a real-time basis.
3.5.2. Develop web access tools for interfacing data users to centralized database. Generate summaries of real-time data and provide real-time access to these summaries.
3.5.3. Provide maintenance of database and internet based distribution system as needed.

Task Deliverables: 3.1 Installation and operation of Coastal Dynamics Application Radar (CODAR) system, 3.2 Installation and operation of nearshore current profiler/directional wave gauge and salinity/temperature sensor, 3.3 Installation and operation of surf-zone current meter and water quality sensors, 3.4 Installation and operation of water column temperature sensors, 3.5 Development and implementation of a central data acquisition and real-time data distribution system

4. Project Implementation

Data obtained through the course of the two year effort will be interpreted with the joint goals of identifying the transport processes that are relevant to coastal water quality at Imperial Beach and the identification of remote pollution sources which impact Imperial Beach. Our approach to these goals will be a focused analysis effort using both statistical analysis techniques and a hypothesis-based physical transport approach. The two methods have distinction: while a statistical approach may provide a rigorous mathematical basis for the statistics related to beach closures, a parallel analysis of the data guided by the physics of transport mechanisms in the region provide an enhanced understanding of how pollution may be transported. These complementary analysis approaches will be applied to the data directly obtained and funded within this contract as well as the data from the enhanced bacteria monitoring efforts to be conducted by other groups who perform monitoring in this region.

4.1 Reports

Reports will be generated on a quarterly basis and submitted to the office of the Contract Manager. Reports shall include the following items:

4.1.1. Written progress of the project describing activities undertaken, milestones accomplished, problems encountered in the performance of the work under this agreement.
4.1.2. Data summaries of the data aquired under the monitoring efforts.
4.1.3. Summary of preliminary findings from data interpretation efforts.

The task schedule presented below was based upon a nominal start date of July 1st, 2002. Task durations are shown in brackets next to the scheduled completion date based on a July 1st, 2002 start. As a result of the monitoring and research goals of this project, tasks undertaken in the contract were parallel efforts that continued through the specified 2 year period of performance. Hence, tasks were not completed in sequential order through the period of performance.

TASK ITEM	**Schedule completion date based on a July 1, 2002 start**
1.0 Project Management and Administration	
1.1 – 1.2 Quarterly Progress Reports	continuous effort through June 30, 2004 (24 months)
1.3 – 1.4 state disclosure and notification requirements	continuous effort through June 30, 2004 (24 months)
1.5 Contract summary form	December 16, 2002 (6.5 months)
2.0. *Quality Assurance Project Plan*	
2.1 prepare and maintain QAPP	January 2004 (19 months)
3.1. *Coastal Ocean Dynamics Application Radar*	
3.1.1 – 3.1.3 site planning, array design, order system	September 15, 2002 (2.5 months)
3.1.4 – 3.1.6 system installation	January 31, 2003 (7 months)
3.1.5 – 3.1.8 system calibrations and optimization	September 15, 2003 (14.5 months)
3.1.9 data integration	continuous effort through June 30, 2004 (24 months)
3.2. *Nearshore Currents and Water Type Sampling*	
3.2.1 – 3.2.2 system fabrication, site planning	December 15, 2003 (5.5 months)
3.2.3 – 3.2.4 system installation	January 15, 2003 (6.5 months)
3.2.5 – 3.2.6 data integration	continuous effort through June 30, 2004 (24 months)
3.3. *Surf-zone Currents and Water Quality Sampling System*	
3.3.1 fabricate system	December 15, 2002 (5.5 months)
3.3.2 install system	January 15, 2003 (6.5 months)
3.3.3 install data cable / logging computers	January 15, 2003 (6.5 months)
3.3.4 data integration	continuous effort through June 30, 2004 (24 months)

3.4. *Water Column Stratification Measurement System*	
3.4.1 – 1.4.2 system fabrication and installation	January 1, 2003 (6 months)
3.4.3 data integration	continuous effort through June 30, 2004 (24 months)
3.5. *Central Data Acquisition and Real-Time Data Distribution System*	
3.5.1 – 3.5.3 database development, data merger, online access tool development	continuous effort through June 30, 2004 (24 months)
4.0. *Reporting*	
4.1.1-4.1.3 progress reports of activities, milestones, data summaries, and interpretation efforts	continuous effort through June 30, 2004 (24 months)

B. Project Management and Administration

The City of Imperial Beach conducted all technical and administrative oversight of the project to ensure that the described tasks were completed in accordance with the State's grant agreement and met the project's goals.

The City of Imperial Beach prepared and administered the subcontractor, the University of California, San Diego for the completion of Task 3 – Statement of Work through an agreement for professional services issued on July 1, 2002 with a termination date of June 30, 2004. On September 15, 2004 an amendment was issued to extend the contract rhrough November 30, 2004. The City also secured the collaboration of the County of San Diego Department of Environmental Health for support with beach water quality data sharing and other information related to routine coastal monitoring activities conducted as part of AB411.

As noted in the grant agreement, the City is required to include the State Disclosure Statement on all documents, reports or brochures associated with the project. The City took appropriate steps to include the statement. The disclosure is included on the cover of this report

Notification was issued to whe SWRCB Project Representative of any an all public media events publicizing the accomplishments and/or results of this project with at least ten (10) days notice.

The City completed the one-page contract summary form and provided it to the SWRCB on December 16th, 2002.

The City entered into contract with the Regents of the University of California to secure the technical expertise of the University of California, San Diego; Scripps Institution of Oceanography (SIO) in order to implement the technical components of the project described in Task 3. SIO was responsible for the Imperial Beach (IB) Pier design and installation of the Coastal Ocean Dynamics Application Radar (CODAR), the Nearshore Currents and Water Type Sampling System, the Surf-zone Currents and Water Sampling System, the Central Data Acquisition and Real-Time Data Distribution System, and corresponding Reporting. Details of the work performed in each of these tasks are found in Sections II.D – II.I

C. Quality Assurance Project Plan

The City coordinated and finalized the QAPP for the project with assistance from the County of San Diego's Department of Environmental Health and SIO. The QAPP was prepared in accordance with the SWRCB outline and requirements in place at the time and completed in January 2004.

D. Coastal Ocean Dynamics Application Radar (CODAR)

i. Site Installations & Networking

By October 2002, three months after the project start date, all three CODAR sites were identified and two systems were installed. The first system was installed at Point Loma (site name SDPL) on August 30th, 2002 and the second at Border Field State Park (site name SDBP) on September 7th, 2002. Permission for these installations was obtained from California State Parks, local and national Navy Public Works Offices, and Space and Naval Warefare Systems Center (SPAWAR) system center in Charleston, North Carolina. System optimization had also begun by making antenna pattern measurements (transponder runs) from a small vessel for both SDPL & SDBP.

Through the remainder of 2002, the focus of efforts with CODAR systems was on establishing reliable communication lines from Scripps to Border Field State Park and Point Loma for system maintenance and real-time data transfer. The networking infrastructure at the Border Field State Park site consists of a wireless link. An antenna is installed on a light post at the park that directs a signal to the Marine Safety Center located at the foot of the Imperial Beach Pier. Upon receiving the signal at the IB Pier, the network is connected to a high-speed cable modem installed by COX Cable Company.

Figure 1. CODAR antenna at Border Field State Park.

High-speed internet access to the Point Loma CODAR site was initially provided by SPAWAR Naval Systems Center. However, we experienced difficulties in maintaining stable communications to this site, possibly due to firewalls on SPAWAR's network. We researched an alternative networking topology based on an existing wireless backbone installed on Mount Woodson which provided access to the University of California, San Diego (UCSD) network. The Mount Woodson site was installed by a networking research consortium funded by the National Science Foundation (HPWREN & ROADNet). We were able to take advantage of the Mount Woodson local access point to continue a network connection out to Point Loma. The wireless system was operational by February 2003 and proved to be a stable communication link. Collaborative efforts with HPWREN and ROADNet continued for the development of telemetry links to the third site on South Coronado Island. Essentially, we were able to extend the wireless link from Mount Woodson to Point Loma, to South Coronado Island and finally extend further to Mexico on connectivity through the Mount Woodson link.

Figure 2. CODAR and wireless equipment at Point Loma installation. Directional antennas pointed toward Scripps and South Coronado Island are shown.

The third CODAR installation on South Coronado

Figure 3. Helicopter drop at South Coronado Island.

Island of the Mexican owned Coronado Islands began with paperwork that had been submitted by October 2002. Permission for the installation was granted from the Mexican Department of State by the end of the year and system design was underway. Due to the remote location of this site, a solar panel system needed to be designed and installed for power. Access to the island is also limited and system installation required helicopter transport of heavy equipment. Permits for the helicopter lift of equipment from Border Field State Park to South Coronado Island included (a) clearances from Tijuana air traffic control for a U.S. owned helicopter to enter Mexican airspace (b) permission from the Mexican Navy to land a helicopter on South Coronado Island (c) permission from the U.S. Border Patrol to stage a helicopter lift operation from Border Field State Park and (d) submittal of U.S. Customs paperwork for the transport of scientific instrumentation outside the U.S. By mid-February, 2003, the final CODAR installation on South Coronado Island and the associated support infrastructure including a solar power system, wind generator, and a wireless telemetry system was complete. Antenna pattern measurements were also made for this site's optimization.

Figure 4. Solar panel array at South Coronado Island.

Since February 2003, CODAR data from a system operated by colleagues at CICESE/UABC located near Rosarito Beach, MX has been integrated with data from sites at Border Field State Park, Point Loma and South Coronado Island. Costs for integrating the Rosarito Beach system and wireless data telemetry were provided by funds received from the National Science Foundation. The integration of this fourth site enables mapping of surface currents further south into Mexico. Wireless equipment at Rosarito beach and the previously mentioned existing backbone link to UCSD enabling access to Point Loma, Coronado Island, and Rosarito are efforts funded by another source.

Surface current maps produced from the CODAR systems have been processed and posted to the web in near real-time at http://www.sdcoos.ucsd.edu/ since the start of the program. Various products from the CODAR data have since been (and continue to be) developed, including a 24 hour average which indicated the long term circulation for the region and estimated alongshore flow off of the Tijuana River mouth for indicating where a potentially polluted river plume may advect.

Figure 5. Directional antennas for wireless communications at South Coronado Island.

Following the installation and networking of all CODAR sites, radar installations entered a maintenance and upgrade phase, which involved system software upgrades, data archiving, and daily upkeep of equipment and the network. Improvements on this system continue today. Recently, we have been focusing efforts on developing an improved data transfer and archiving method for coastal radar data. Data transfer involves an Object Ring Buffer which reliably transfers data from remote sites to a computer network at the San Diego Supercomputer Center. The computer network then hosts a central database and repository for coastal radar data that can be accessed via the internet.

ii. Surface Current Synopsis

The CODAR system has been running for over two years. A summary of the operational periods for each site is presented in Figure 6 below:

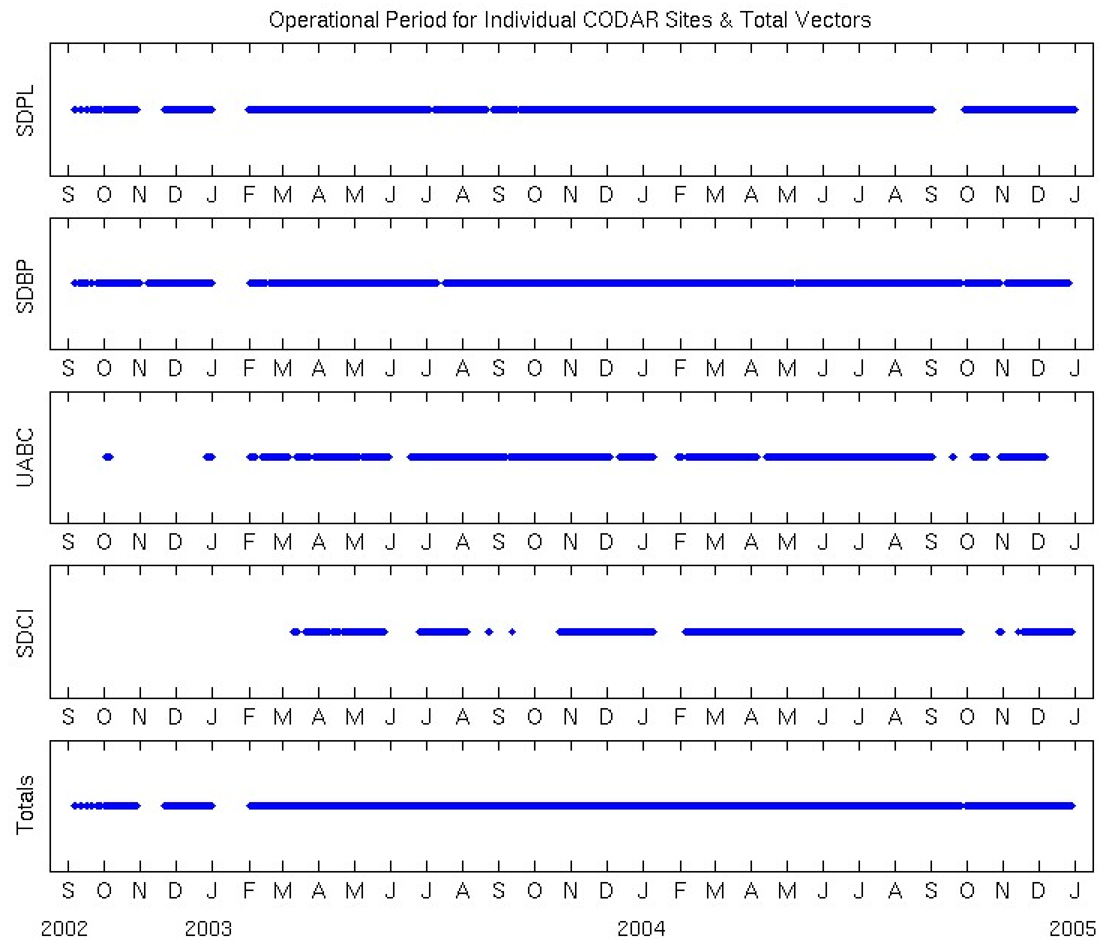


Figure 6. Operational periods for each CODAR site as well as total vectors resulting from the combination of data from two or more sites. The four-letter designation on the vertical axis of graph refers to short hand CODAR site names. SDPL: San Diego Point Loma; SDBP: San Diego Border Park, UABC: Universidad Autonoma de Baja California, SDCI: San Diego San Clemente Island

Gaps in the data are due to software bugs or hardware failures that required either additional development activities or the deployment of staff to the remote sites for hardware repair. Gaps tend to be larger for more remote sites where access is limited to favorable weather conditions. An example of data gathered by each site is shown in Figure 7 below:

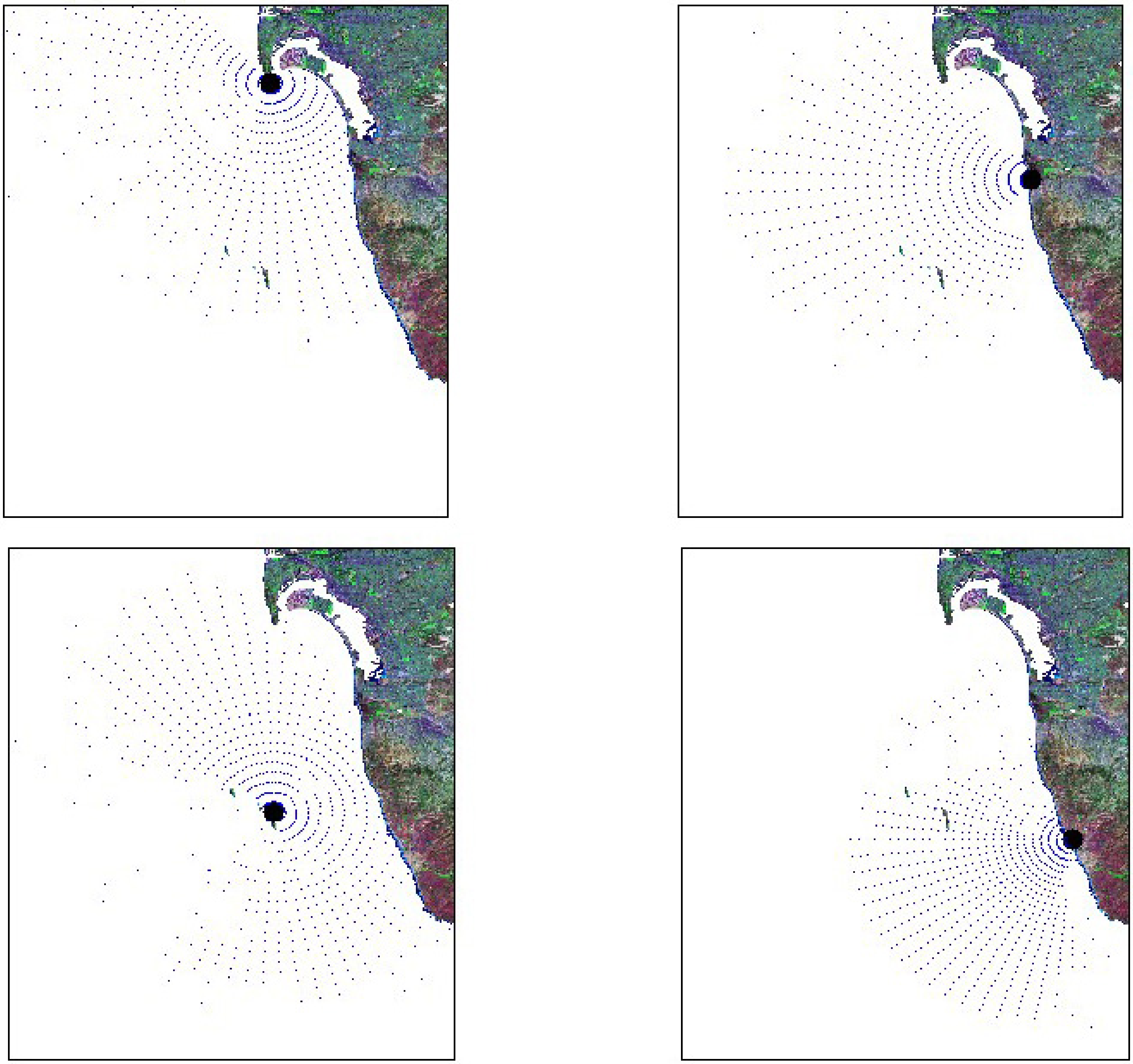


Figure 7. Example CODAR radial data from each site; Point Loma (upper left), Border Field State Park (upper right), South Coronado Island (lower left), and UABC (lower right).

Radial data from each site (shown above) is combined on an hourly basis to give a total surface current map each hour. The volume of data collected by the system is beginning to lend itself to a variety of statistical analyses. Some elementary analyses and observations are summarized next.

Statistical analyses often begin with determining the mean state of a dataset before delving into mechanisms that give rise to variability about the mean. The mean flow of surface currents off of the San Diego coastline is a predominant southward flow (Figure 8).

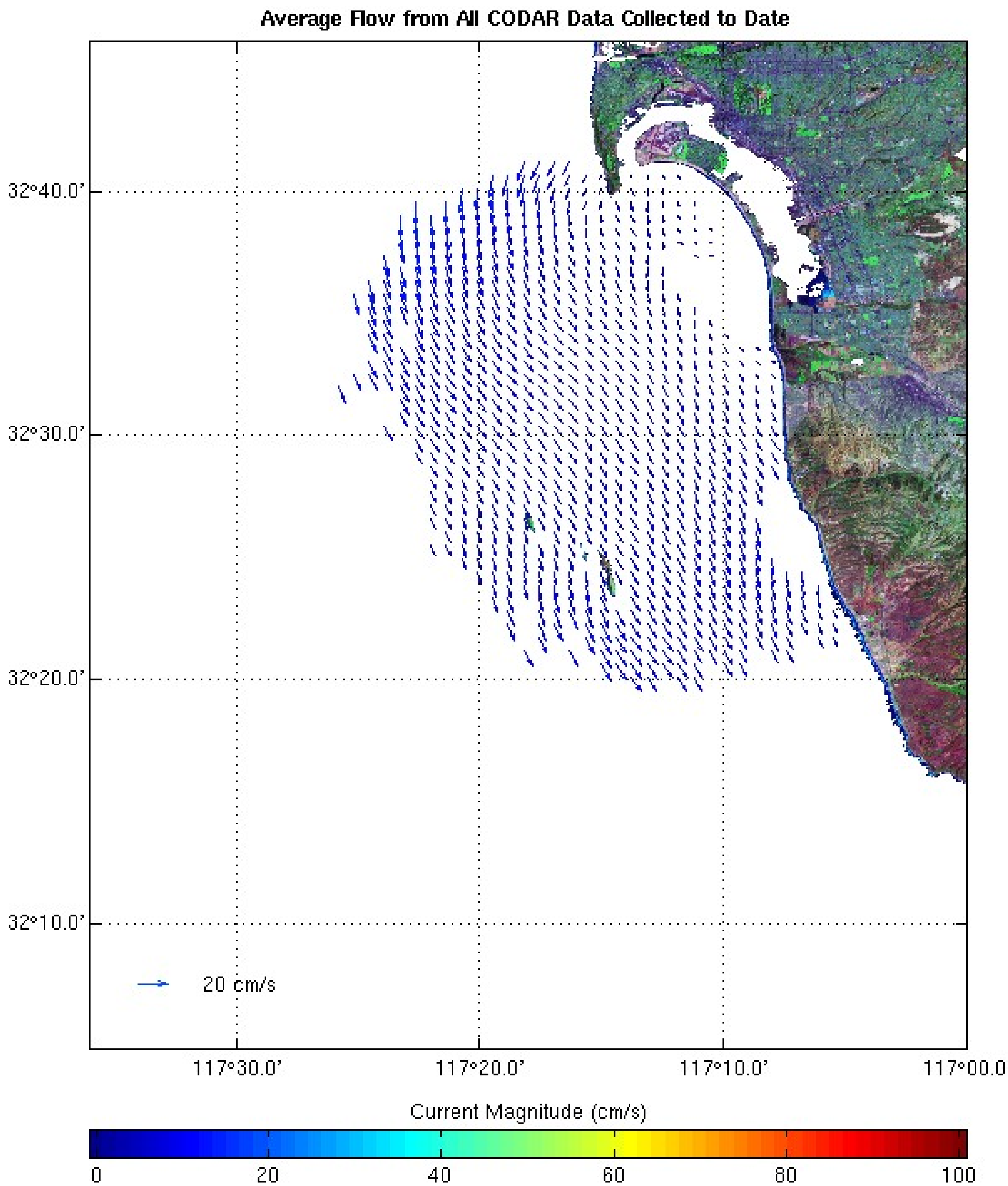


Figure 8. The mean surface current flow for all CODAR data collected to date (Sept 2002 through Dec 2004).

Although a simple uniform southward flow is observed in mean state of surface currents, there is large variation about this mean state in the form of flow reversals over the span of one day and eddies that last anywhere from hours to days. Examples of some variations about the mean state are shown in the following figures.

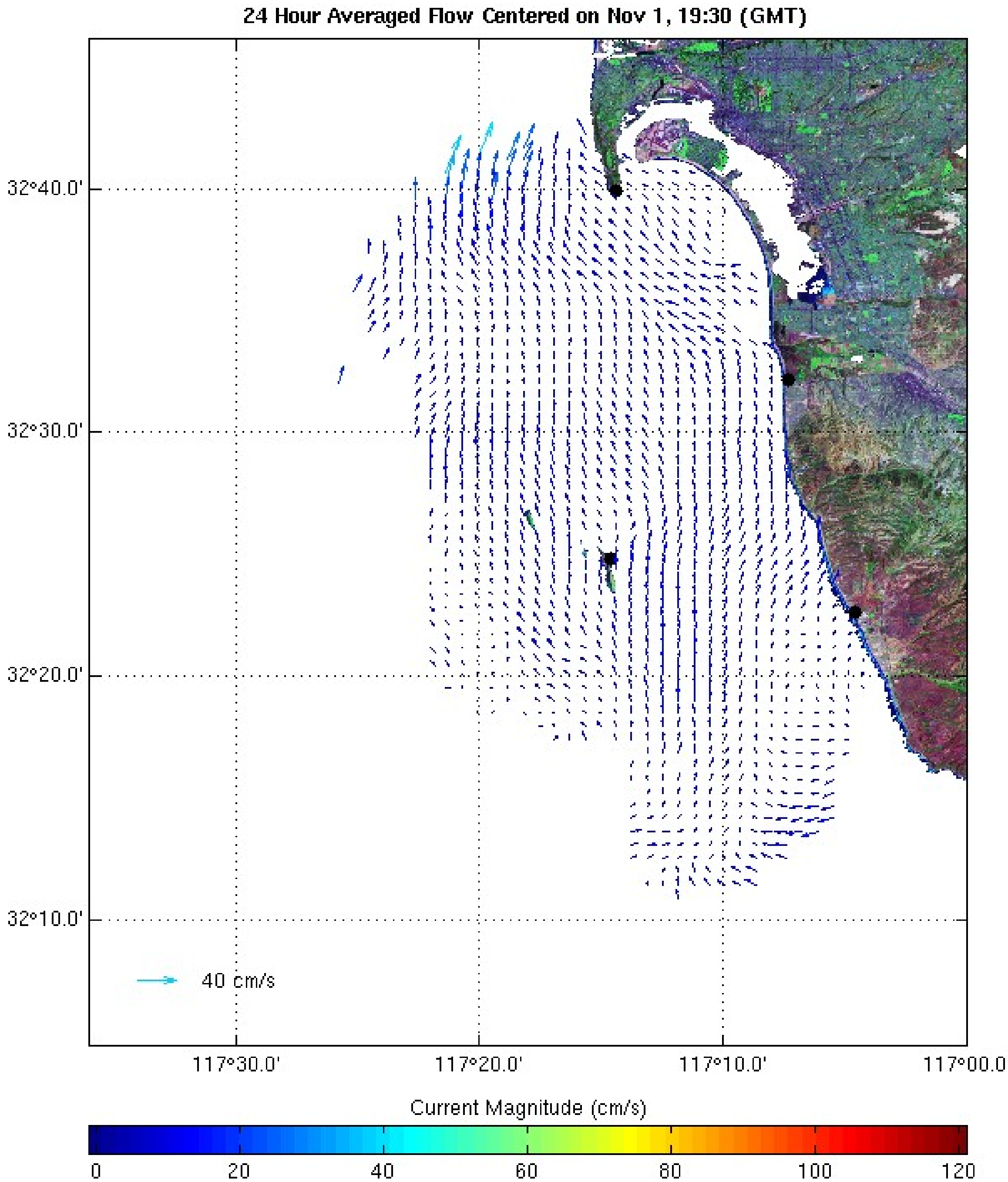


Figure 9. While the dominant flow is southward for the region, northward flow is commonly observed as shown here on November 1st, 2003. Initial observations suggest this occurs most often in winter with the arrival of storms. Northward flow has obvious consequences relating to the transport of potentially polluted waters from the Tijuana Estuary to South Bay beaches.

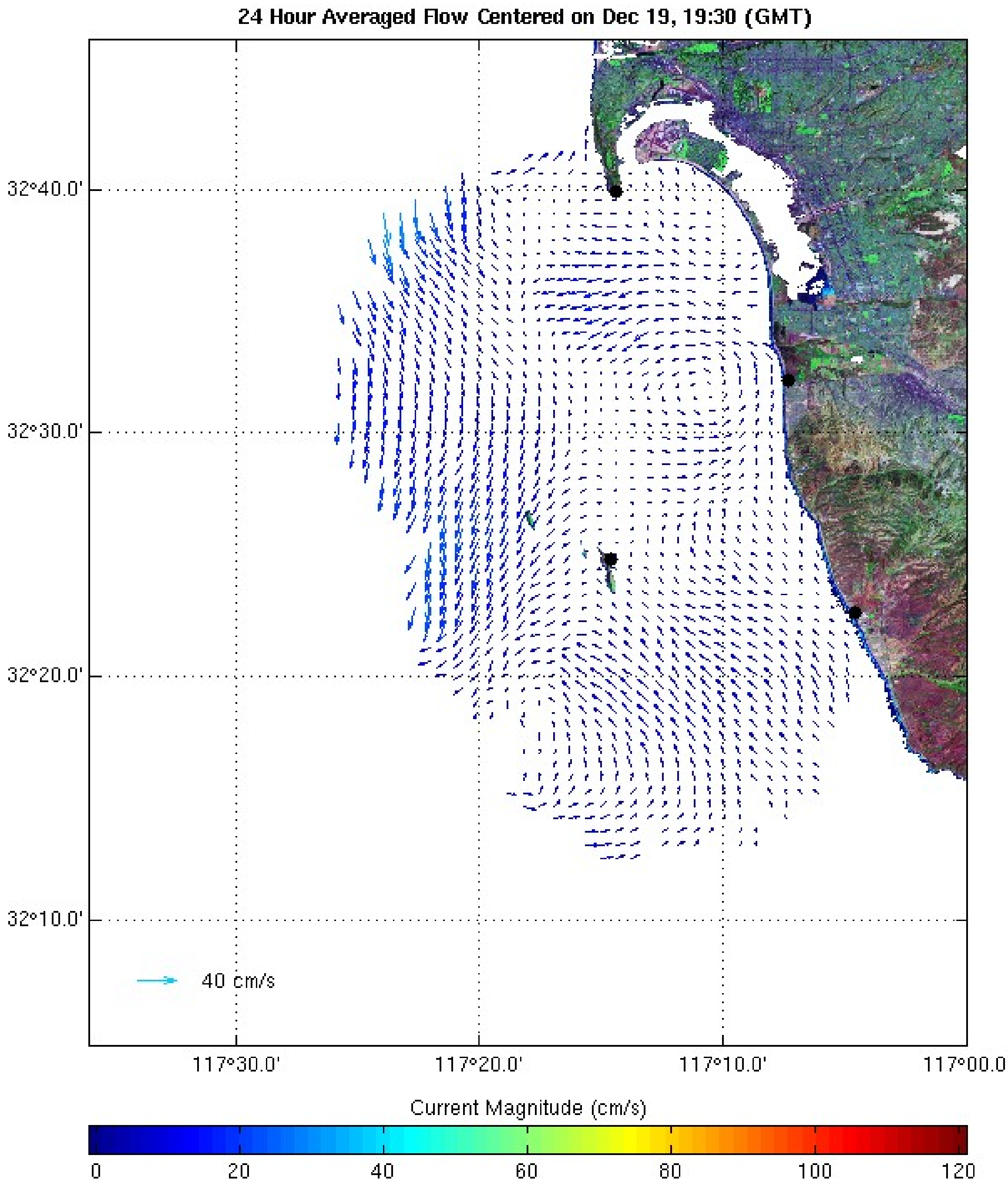


Figure 10. This counter-clockwise eddy was observed on several occasions and can persist for anywhere between one and five days. One important feature of this eddy is the localized northward flow that brings water from the Tijuana Estuary to South Bay beaches. Ongoing studies will help determine the mechanisms that give rise to this eddy formation and provide a predictive capability to the region.

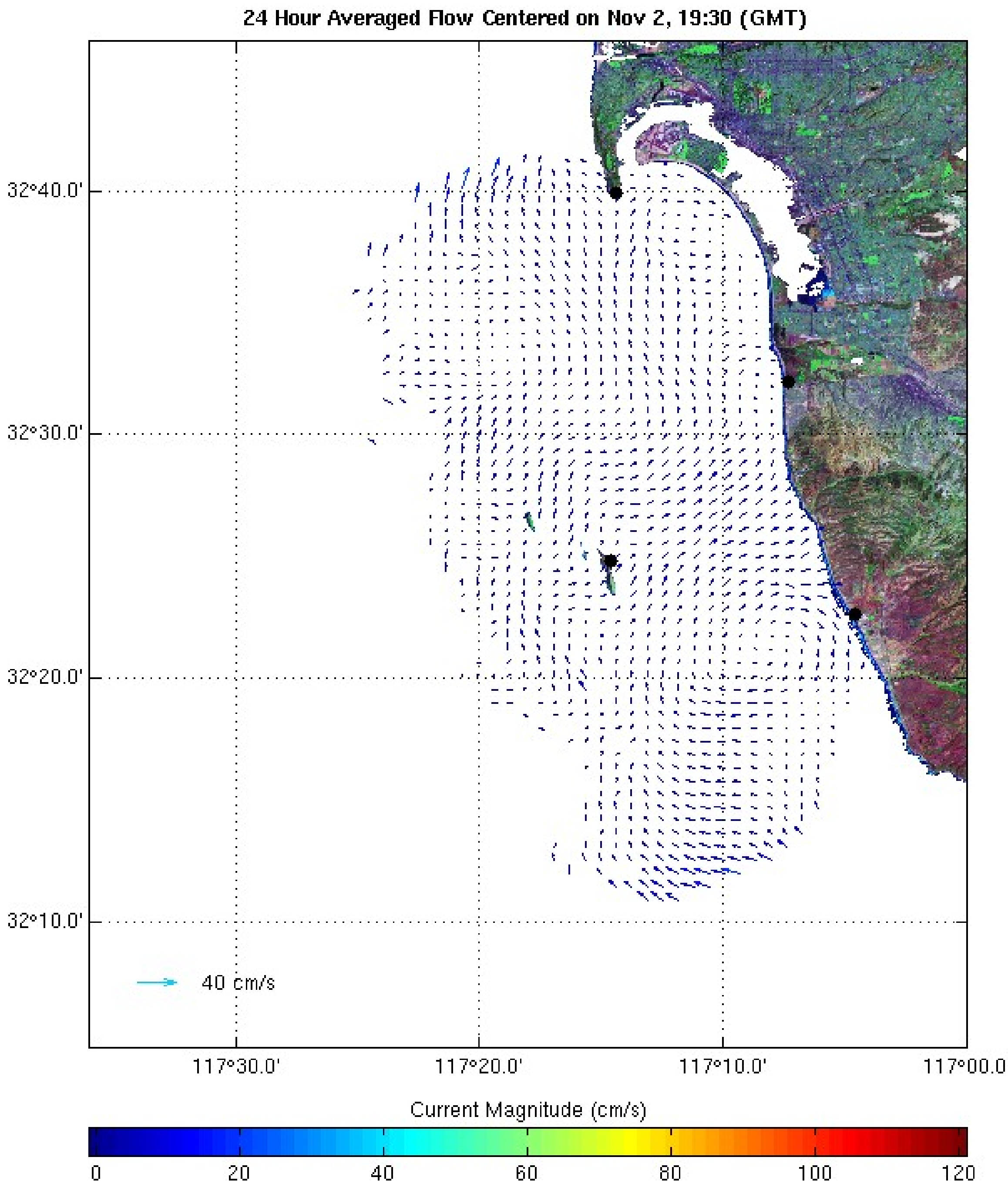


Figure 11. Clockwise eddies are also observed in the data as shown here on November 2nd, 2003. This eddy was observed offshore of the southernmost UABC site in a predominantly northward flow pattern.

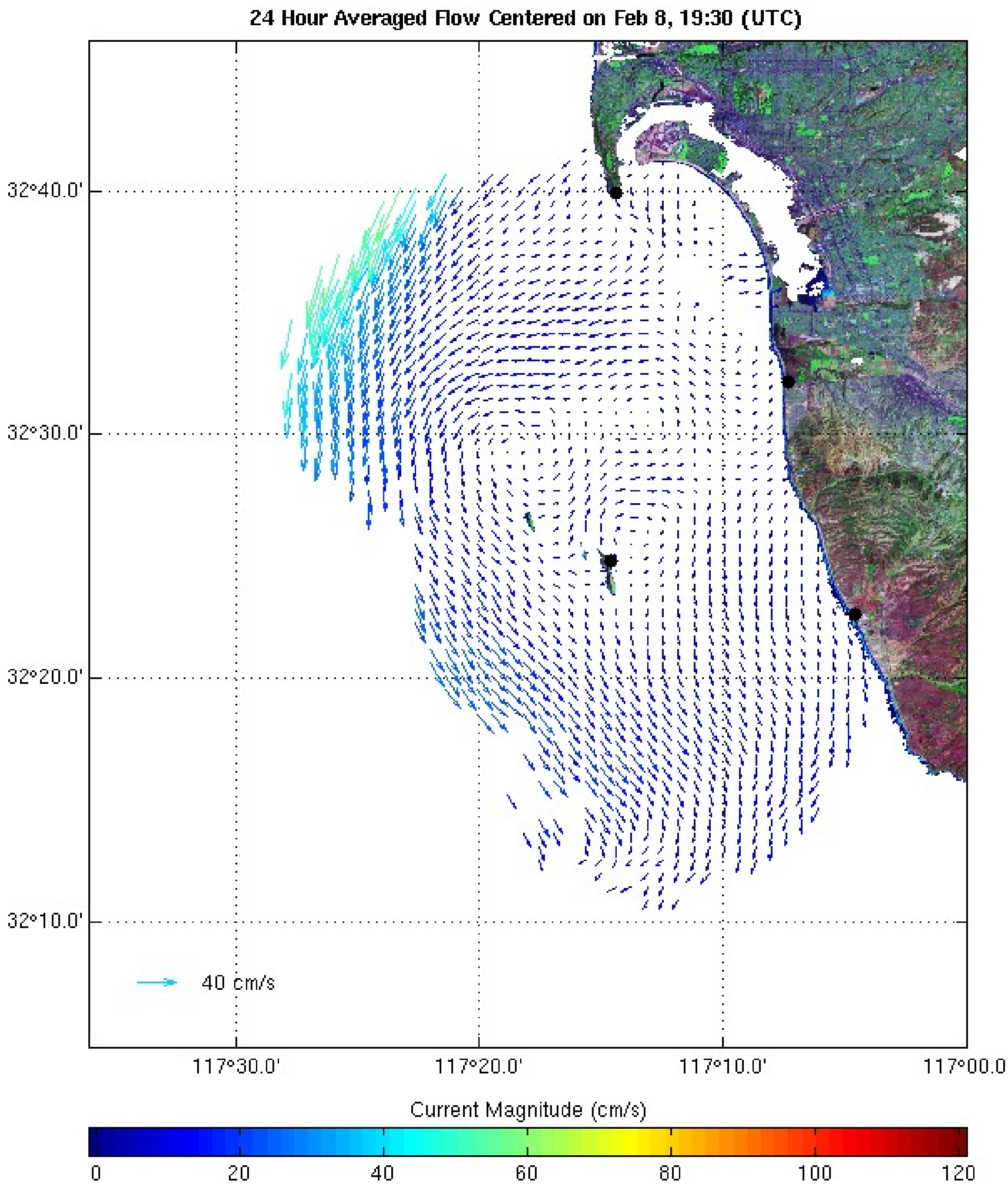


Figure 12. This flow pattern from February 8th, 2004 demonstrates the variation is space and orientation that eddies have in the region. Three eddies are observed in this region just north of the Coronado Islands. Two counter-clockwise eddies are situated to the north of a clockwise eddy and the three eddies seem to be interacting as flows converge in the center.

E. Nearshore Currents & Water Type Sampling

i. Site Preparation & Hardware Installation

By October 2002, the system design for a bottom-mounted Acoustic Doppler Current Profiler (ADCP) off of the end of the IB pier had been completed and fabrication was underway. An offshore piling required cleaning for installation of cable conduit from the pier to the instruments. Further development on the system was delayed until favorable conditions permitted the piling to be cleaned. In the meantime, the remaining supporting infrastructure on IB pier was developed along with tasks associated with the surf-zone current measurements (see section 2.4). By July 2003, the ADCP was deployed on a tripod (Figure 13) approximately 200 ft (61m) from the end of the IB pier. Data is then transmitted in real-time through cabling to the IB pier tower, wirelessly to the shore tower, then through a high speed cable modem back to Scripps. We began displaying real-time current profiles and wave data from the ADCP on the SDCOOS site on October 7th, 2003 following quality assurance.

Figure 13. Underwater tripod with an acoustic doppler current profiler (ADCP) mounted in the center. The white pressure case on the side of the tripod is for connecting the ADCP to an underwater cable.

The data inventory for the waves ADCP shows a few large gaps spanning several weeks after the initial deployment in July 2003 followed by a relatively stable period from mid-October 2003 through the end of February 2004 (Figure 15). These large initial data gaps resulted from a number of power outages on IB pier. Many of these outages were not reported to SDCOOS staff which delayed troubleshooting and restarting the system. Several steps were taken to make the system more stable including the deployment of an uninterruptible power supply (UPS) for computers and software improvements enabling recovery from unplanned shutdowns. In addition, staff from the Imperial Beach Safety Center were asked to communicate power outages to SDCOOS staff so that the system can be restarted.

Figure 14. A bosun's chair was used to lower personnel to the waterline at low tide to clean growth off an offshore piling. A conduit for the underwater cable was attached to the clean piling using stainless steel clamps.

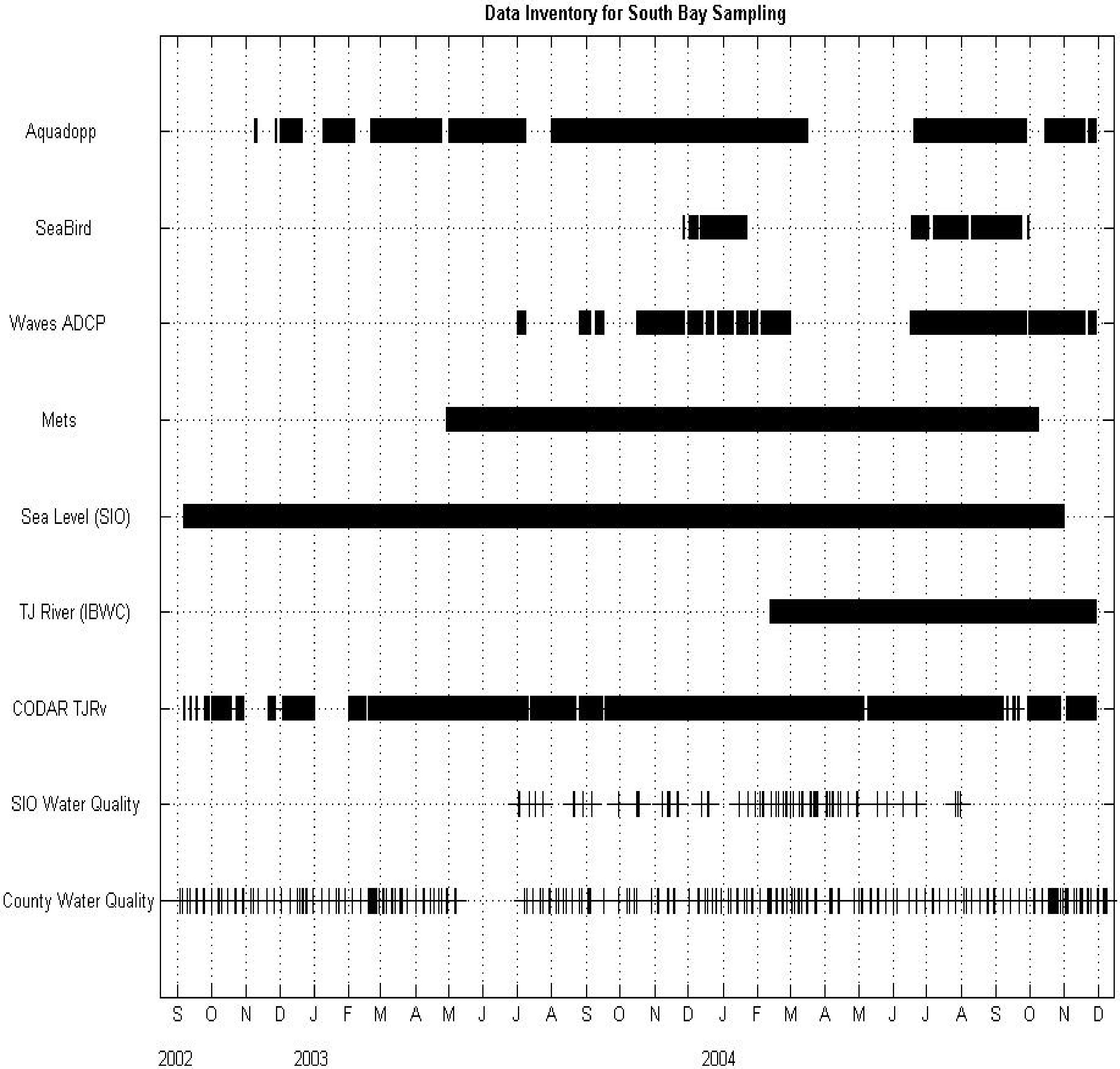


Figure 15. Data inventory for several SDCOOS instruments as of roughly October 2004. Deployment, recovery and gaps in the data record are discussed throughout the text for the SeaBird, waves ADCP and mets (meteorological instruments). CODAR TJ River is the alongshore water velocity extracted from CODAR data near the Tijuana River for determining where potentially polluted waters may advect. Sea Level data obtained from SIO and flow data for the Tijuana River collected by the IBWC have been added to data displayed on the SDCOOS web site to enable more comprehensive real-time analysis. Water quality samples collected by the county as well the enhanced bacterial monitoring program are shown to indicate where data overlap occurs.

The ADCP had to be recovered in early March 2004 when local teens caught their fishing lines on cables, tested their strength and ultimately caused irreparable damage to instrumentation. A major overhaul of the system was required due to this act of vandalism. The system was redeployed on June 16th, 2004 with the addition of a SeaBird instrument (see section 2.4 for its initial deployment) which measures temperature, conductivity (salinity) and density and a WetLabs FLNTUS optical sensor for measuring water turbidity and plant biomass (chlorophyll). The SeaBird began having communication problems in late September 2004 and was repaired. The ADCP continues in normal operation today.

ii. Examples of Data

The following plots are examples of data obtained from the ADCP, SeaBird & WebLabs optical instrument. Real-time versions of these plots are also available on the SDCOOS web site.

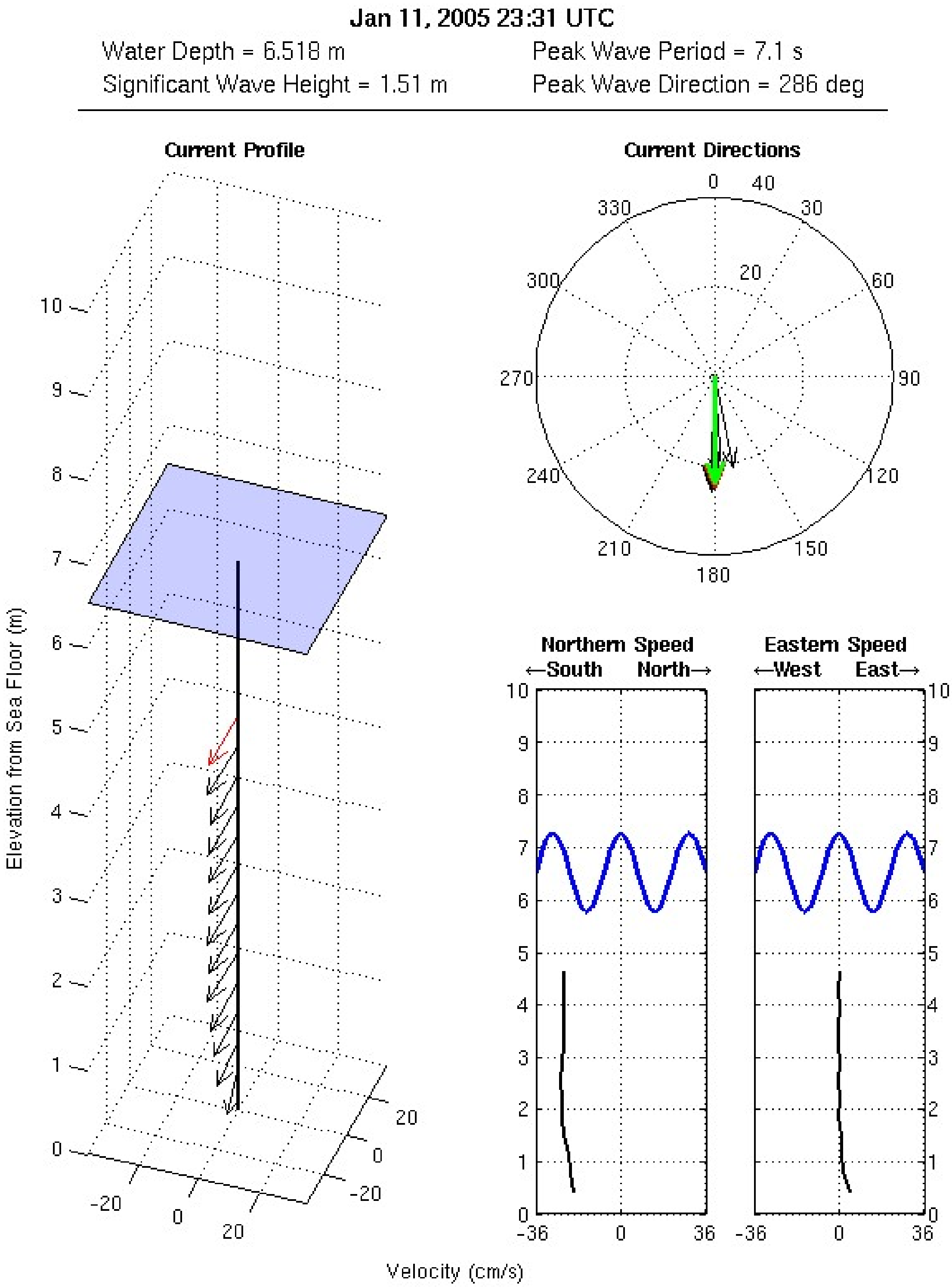


Figure 16. Current profile information obtained from the ADCP. The left panel shows a three-dimensional view of the water level and current direction and magnitude. The upper right panel shows the current direction and magnitude as viewed directly overhead while the lower right panel shows the water level, wave height and current magnitude in the cardinal directions.

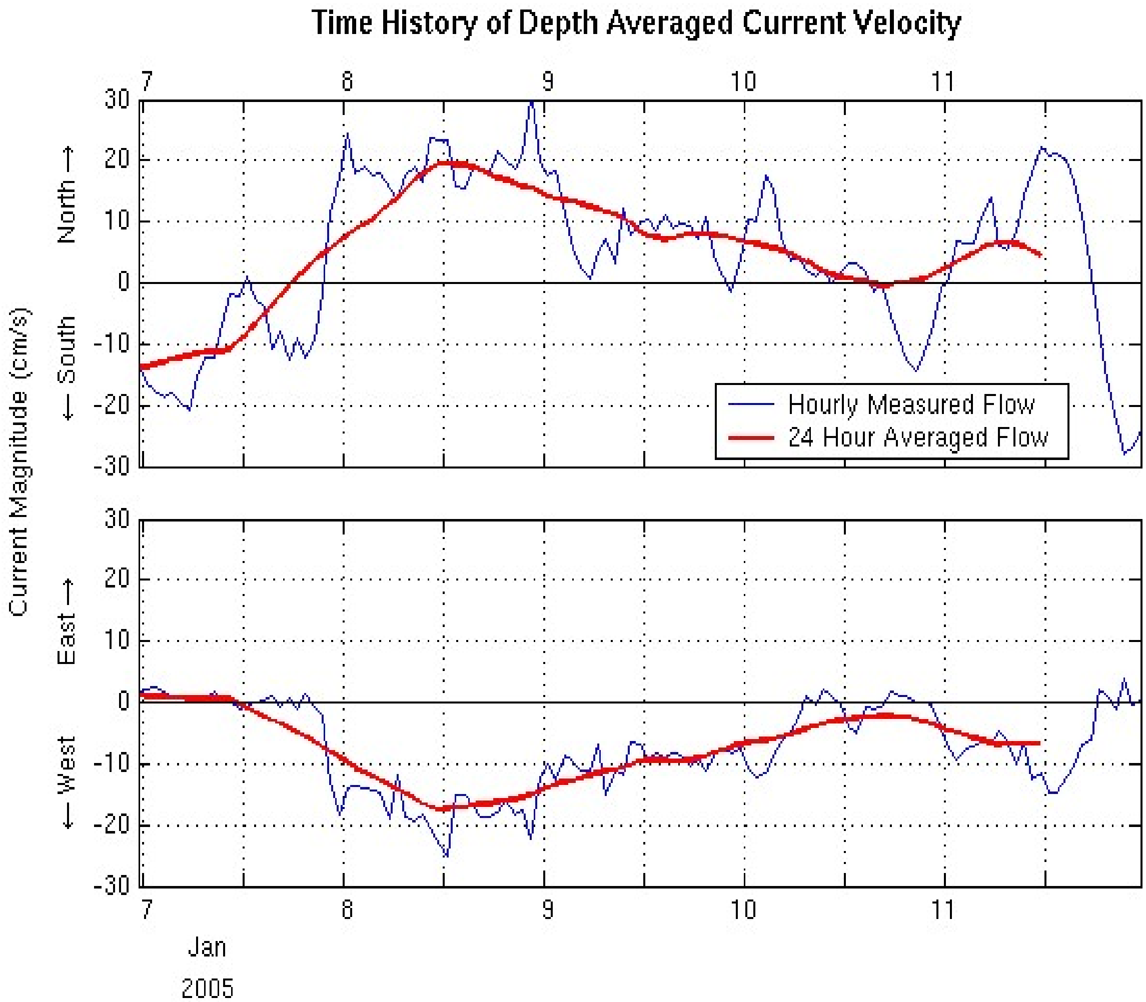


Figure 17. Time history of alongshore (north/south) and cross-shore (east/west) current magnitude as measured by the ADCP.

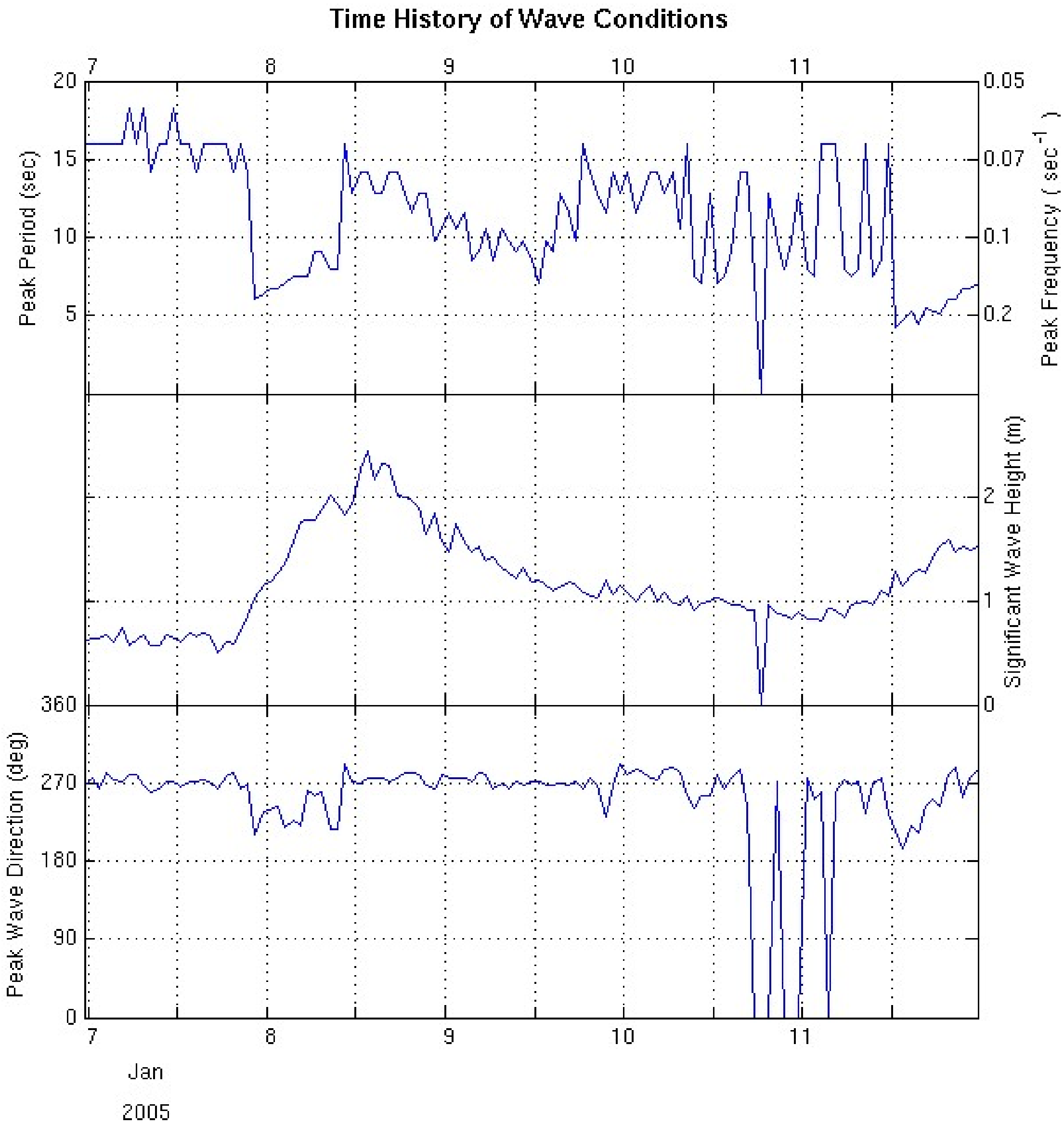


Figure 18. Time history of wave conditions at IB Pier as measured by the ADCP.

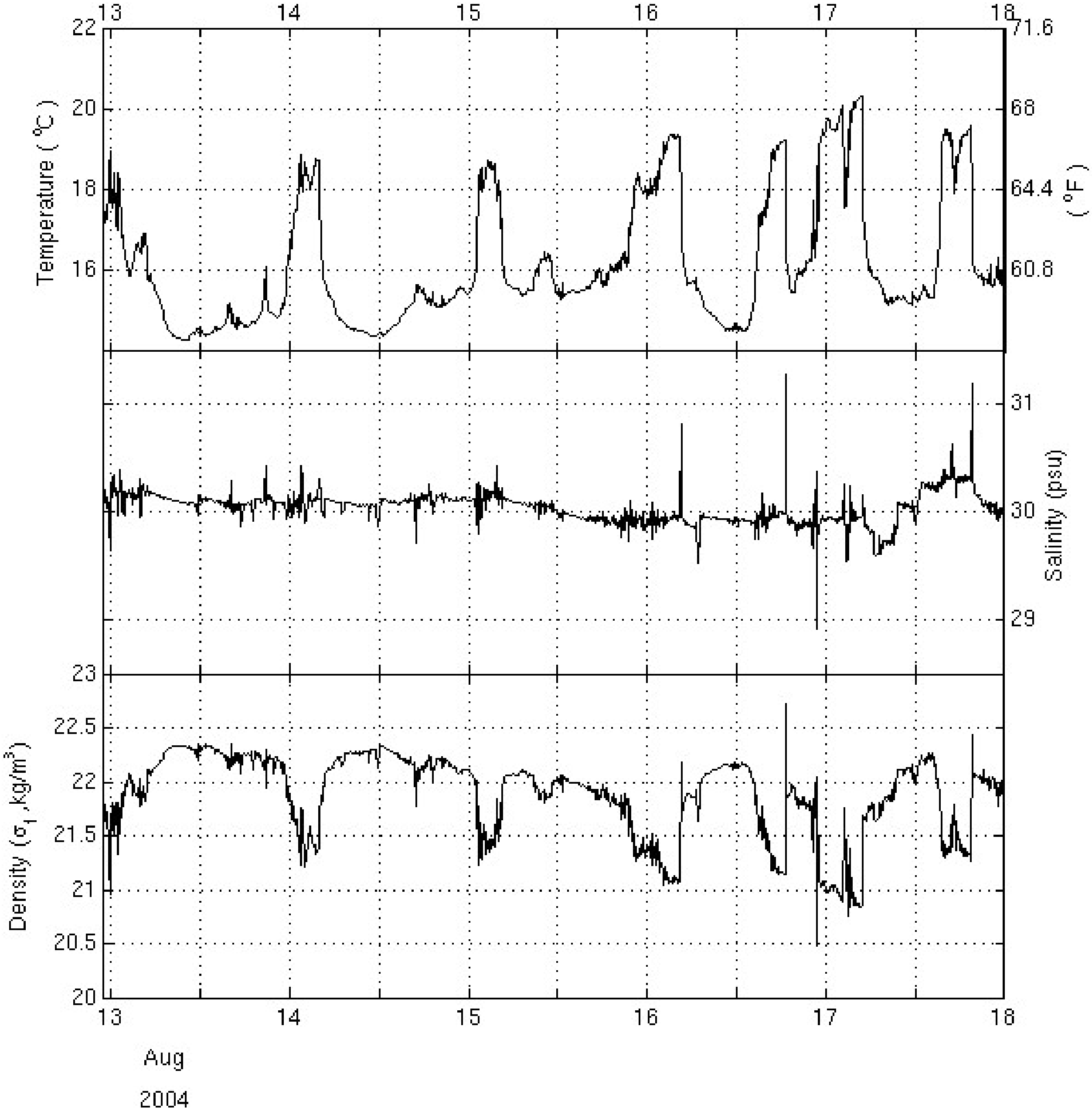
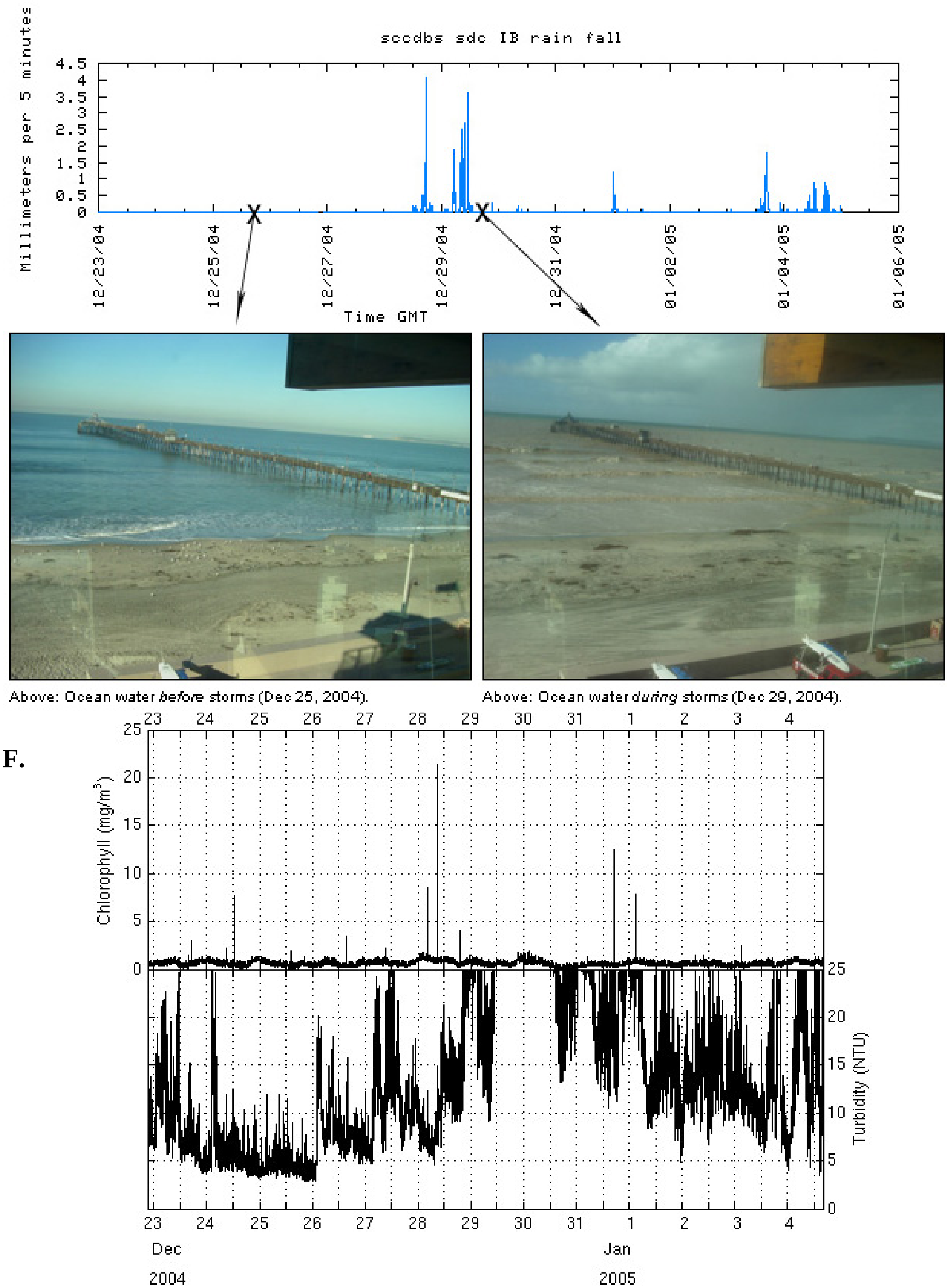


Figure 19. Time history of Temperature, salinity & density at the end of the IB pier as measured by the SeaBird.



F.

Figure 19. Chlorophyll (plant biomass indicator) and water turbidity measured by the WetLabs optical instrument off the end of IB pier (bottom panels) has shown good correspondence with rainfall measured at IB pier (top panel) and images obtained from the IB web-cam (center). The web-cam image acquired on December 25th, before the storm, shows clear blue water while turbidity measurements are low. Immediately following the storm, on December 29th, web-cam images show waters have changed from clear blue to murky brown, which is reflected in high turbidity measurements, as the Tijuana River plume was advected northward into Imperial Beach. This is one example of how turbidity measurements may be used by city staff to assess water visibility and the potential presence of Tijuana River plume water.

F. Surfzone Currents & Water Quality Sampling System

i. Site Preparation & Hardware Installation

Prior to installing instruments on the IB pier, computers and supporting infrastructure were installed on both the pier and shore lifeguard towers. A computer network was established on shore at the at the safety center with a 2-way directional wireless antenna to send and receive data from the pier tower. On the pier tower, cabling was routed down to instruments on the pier pilings from a computer cage inside the tower. Finally another 2-way directional antenna was mounted on the pier tower to enable data communication back to Scripps as well as remote management of the instruments on the pier.

The current meter portion of the surfzone system had been designed, purchased, and installed on the south side of IB pier's piling 28 by October 2002. The pier piling was cleaned by Scripps divers prior to installing the instrument (aquadopp) inside a copper nickel tube to protect it from the elements and biofouling. The mounting system had survived several storms. However, quality assurance on the data indicated that the current meter had been rotated by large waves during winter storms. Despite several attempts to rotate the instrument, the current meter was not rotated until August 3rd, 2004 when conditions were favorable and personnel were available. Ever since the instrument was rotated into its proper orientation, it has been producing reliable data that agrees with measurements from CODAR and ADCP data as well as qualitative observations made by IB lifeguards.

Figure 20. Scripps staff from the Marine Physical Laboratory installing a signal cable on the underside of the Imperial Beach Pier (top). This cable connects the current meter to the lifeguard tower allowing real-time access to the data. Also shown is the computer system that was installed in the lower floor of the lifeguard tower (bottom). This system forms the hub for the environmental sensors that are located on the pier.

The water quality system consists of a WebLabs FLNTUS optical instrument for measuring water turbidity and chlorophyll and a SeaBird for measuring ocean temperature and salinity. The system was deployed November 24th, 2003 on a pier piling directly beneath the lifeguard tower. Prior to deployment, the piling was cleaned of barnacles and the FLNTUS was deployed by a team of both divers and top side personnel. Cabling from the instrumentation to the logging

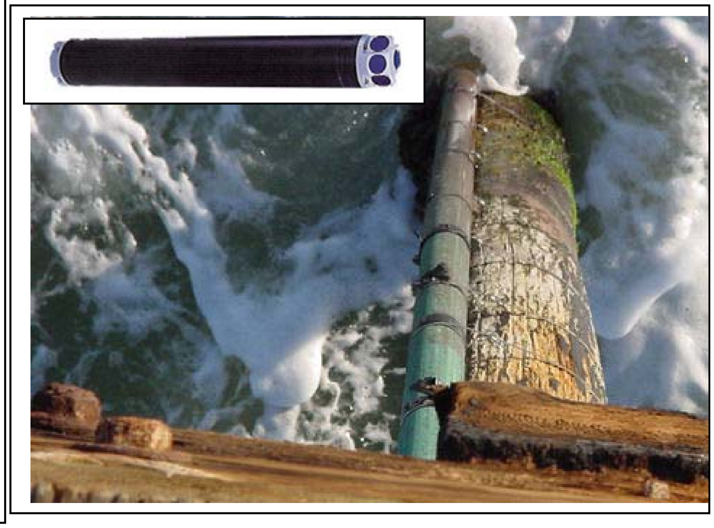


Figure 21. Photograph of divers installing the equipment onto a piling on the south side of the Imperial Beach Pier (left). Axel Pierson is suspended from a bosun's chair guiding the hardware into place. The current meter mounted to the pier piling (right). The current meter (see inset) fits into the end of a copper/nickel pipe with the sensing head sticking 2" out of the end. This pipe is banded to the wood piling by stainless steel bands. The instrument is protected from the elements and biofouling inside the pipe.

system inside the pier tower was completed on December 2nd, 2003 enabling real-time transmission back to Scripps. The surf zone proved to be too harsh of an environment for these relatively sensitive instruments. By late January 2004, we had to recover our water quality system due to storm damage. The instruments were securely mounted to the pier piling but the communications cables were damaged and began transmitting bad data. The instruments were sent back to the factory for repair and recalibration while a new deployment scheme was devised. With recovery of the bottom-mounted waves system in early March 2004, we decided to engineer an integrated system with both the water quality sensors and the waves ADCP mounted on the tripod (see section 2.3). This provided a much more stable environment for the water quality instruments although we encountered problems with fishing line getting wrapped around the optical instrument. After another recovery and redeployment in December 2004, the optical instruments are now working reliably and have shown responses in water turbidity following several large

Figure 22. The water quality system ready to be deployed. The system is coated with anti-fouling paint. The copper 'brillo' pads are fixed to either end of the conductivity and temperature probe to provide additional anti-fouling protection. The armored cable provides power and communication to the system.

storms.

ii. Examples of Data

Figure 23 is an example of data obtained from the aquadopp current meter in the surf zone. Similar example plots for the water quality sensors (SeaBird & WebLabs optical instrument) can be seen in section 2.3.2. Real-time versions of all plots are available on the SDCOOS web site.

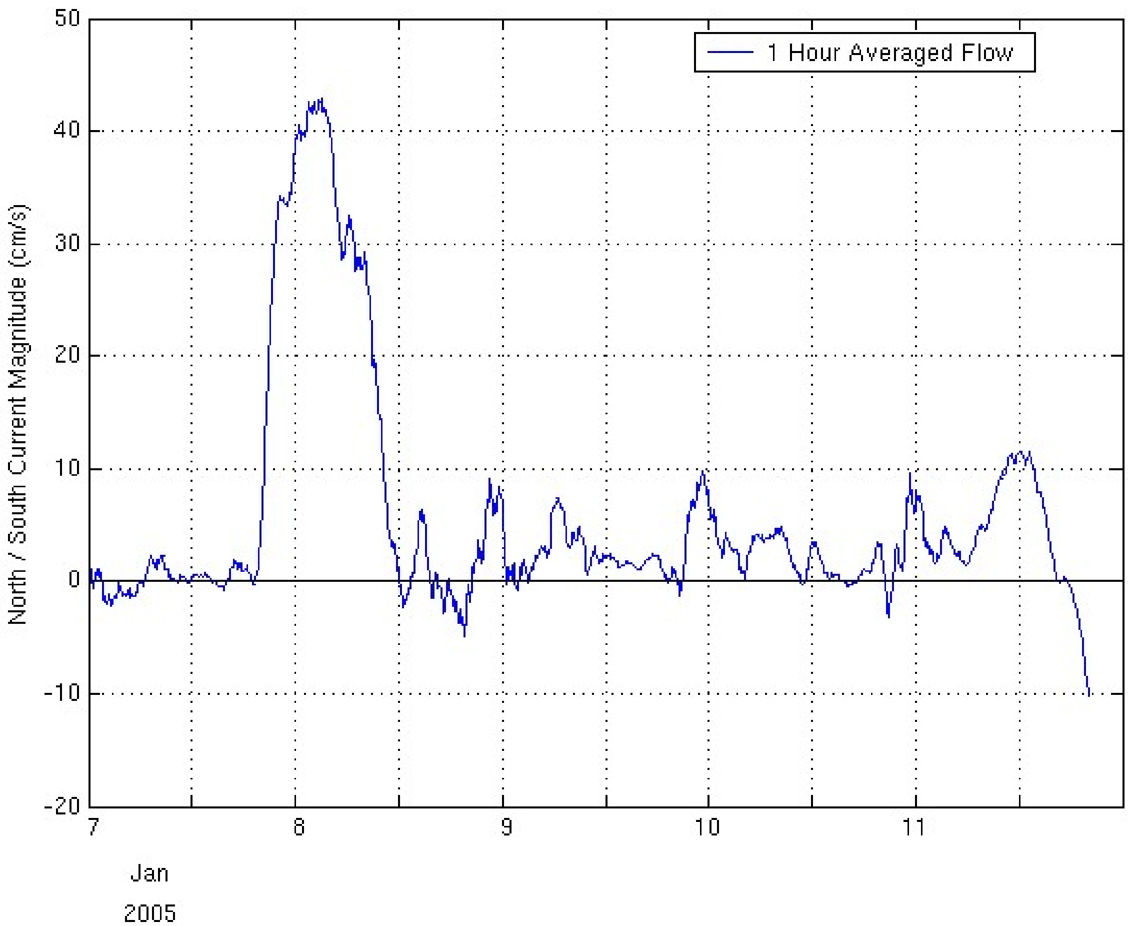


Figure 23. Hourly averaged alongshore flow in the surfzone at IB pier. Positive values are northward flow while negative values are southward flow. The large northward event on January 8th coincides with large amounts of rainfall resulting in high turbidity and continued beach closures.

G. Imperial Beach Pier Meteorological Station

By leveraging funds from other federal programs, we were able to install a meteorological station on the roof of the IB pier tower. The station provides atmospheric pressure, humidity, rainfall rate, air temperature, solar radiation wind speed and wind direction in real-time through existing infrastructure installed for other IB pier sensors. The station was installed in April 2003 and had has provided reliable data ever since. The wind and rain data are of

Figure 24. Meteorological station installed at IB pier.

particular interest since winds play an integral role in driving coastal flow and local rainfall data are critical to understanding the influence of local runoff on beach water quality. Plots of all data are available in real-time at the SDCOOS web site. An example of the rainfall rate plot is shown in Figure 24.

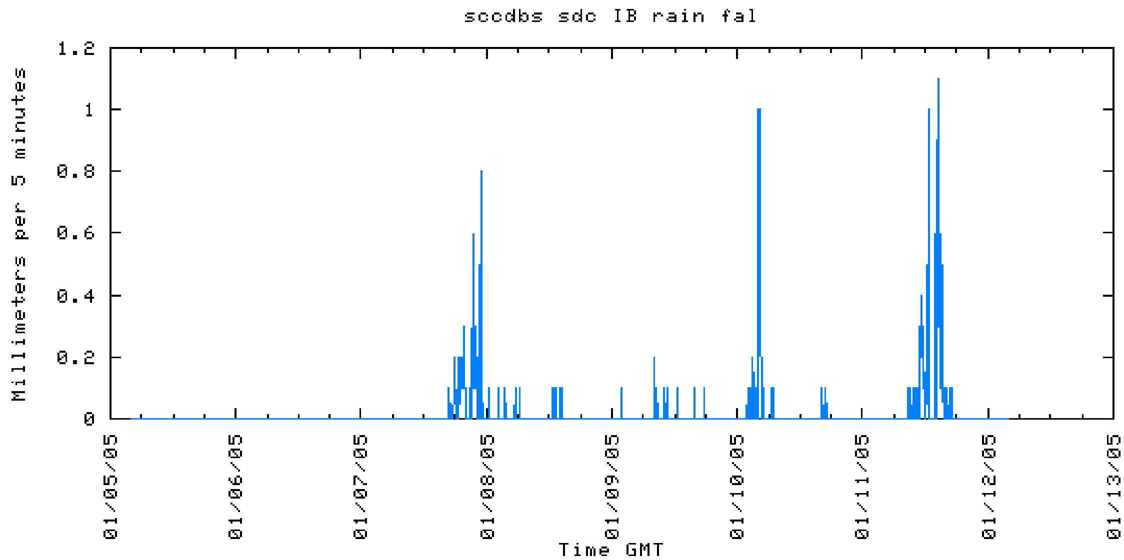


Figure 25. Rainfall rate data as presented on-line at the SDCOOS web site in real-time. Several rain events occurred during early January 2005. Note the rain event on the 8th and corresponding northward flow observed by both the aquadopp in the surf zone (Figure 23) and the ADCP further offshore (Figure 17).

H. Water Column Stratification Measurement System

i. Buoy Construction & Deployment

The water column stratification measurement system was designed and built by April 2003. The system consisted of a temperature string for measuring water temperature at 4m increments from the surface to the sea floor, an ADCP (provided through separate funds) for measuring currents through the water column and a GPS for tracking the buoy. An interim system consisting of another temperature string with 16.4ft (5m) resolution through the water column was deployed at the wye of the IBWC South Bay Ocean Outfall, near the planned deployment site for the buoy. Although this was intended as an interim system, it continues to be serviced today. The interim system is not real-time but, once data is recovered, it is processed and posted to the SDCOOS web site. The buoy system was deployed on September 5th, 2003 in 92ft (28m) water depth near the center of the wye diffuser of the South Bay Ocean Outfall.

Figure 26. The SDCOOS buoy and mooring prior to deployment near the South Bay outfall. The workboat Sammy G was used for deployment of the mooring and its 2000 pound anchor.

Real-time telemetry of data back to Scripps was established through a wireless link to the IB pier tower, allowing access to real-time water column stratification at the IBWC outfall location. ADCP data was also transferred, but not processed and posted in realtime. In February 2004 there was an apparent theft of the hardware and all data communication with the buoy was lost. Fortunately, IB lifeguards spotted the buoy on September 29th, 2004 close to Mexican waters and SDCOOS personnel were able to recover the hardware. An autonomously recording temperature string has also been in place and providing us continuous observations of stratification at the site. This back up measurement platform allowed us to continue the time series for the duration of the project. Support for additional moorings would be a logical expansion to SDCOOS.

Figure 27. The SDCOOS buoy deployed at its mooring location. The buoy was designed with minimal structural components to prevent vessels from tying off to the buoy and to protect instruments from vandalism. A radar reflector (the wide plastic object) and a solar powered flashing light notifies vessels of its presence in the water. In addition, a Notice to Mariners was filed with the U.S. Coast Guard to identify the SDCOOS buoy in nautical charts of the region. The black antenna at the top of the buoy allows data to be telemetered to shore.

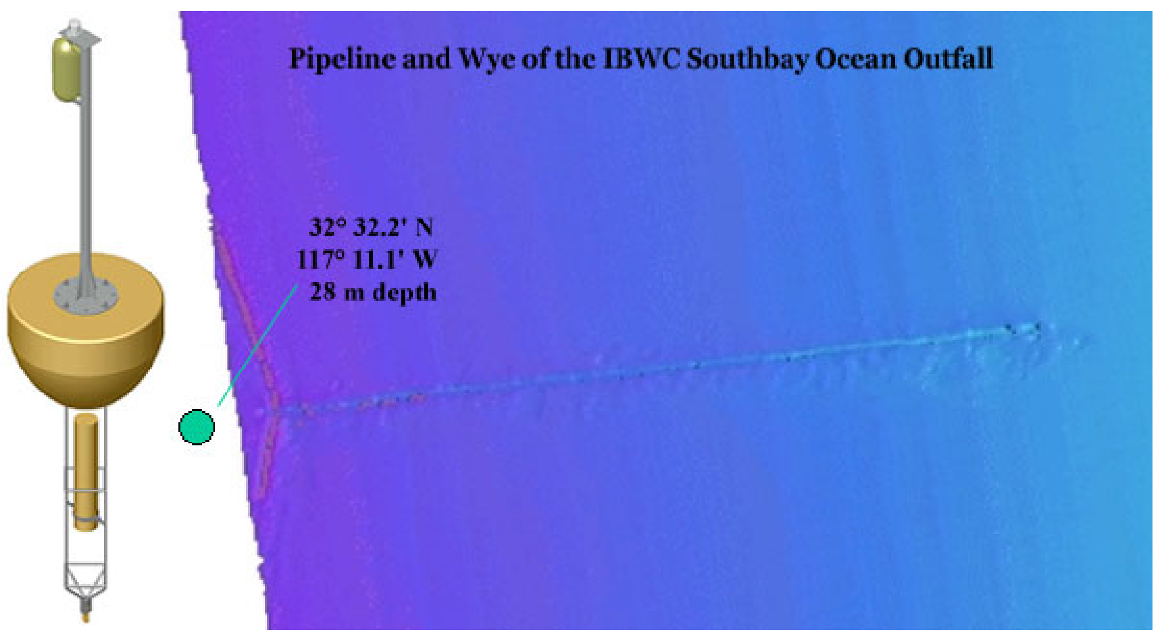


Figure 28. Multibeam bathymetry map showing the IBWC pipeline and diffuser wye and the relative buoy location.

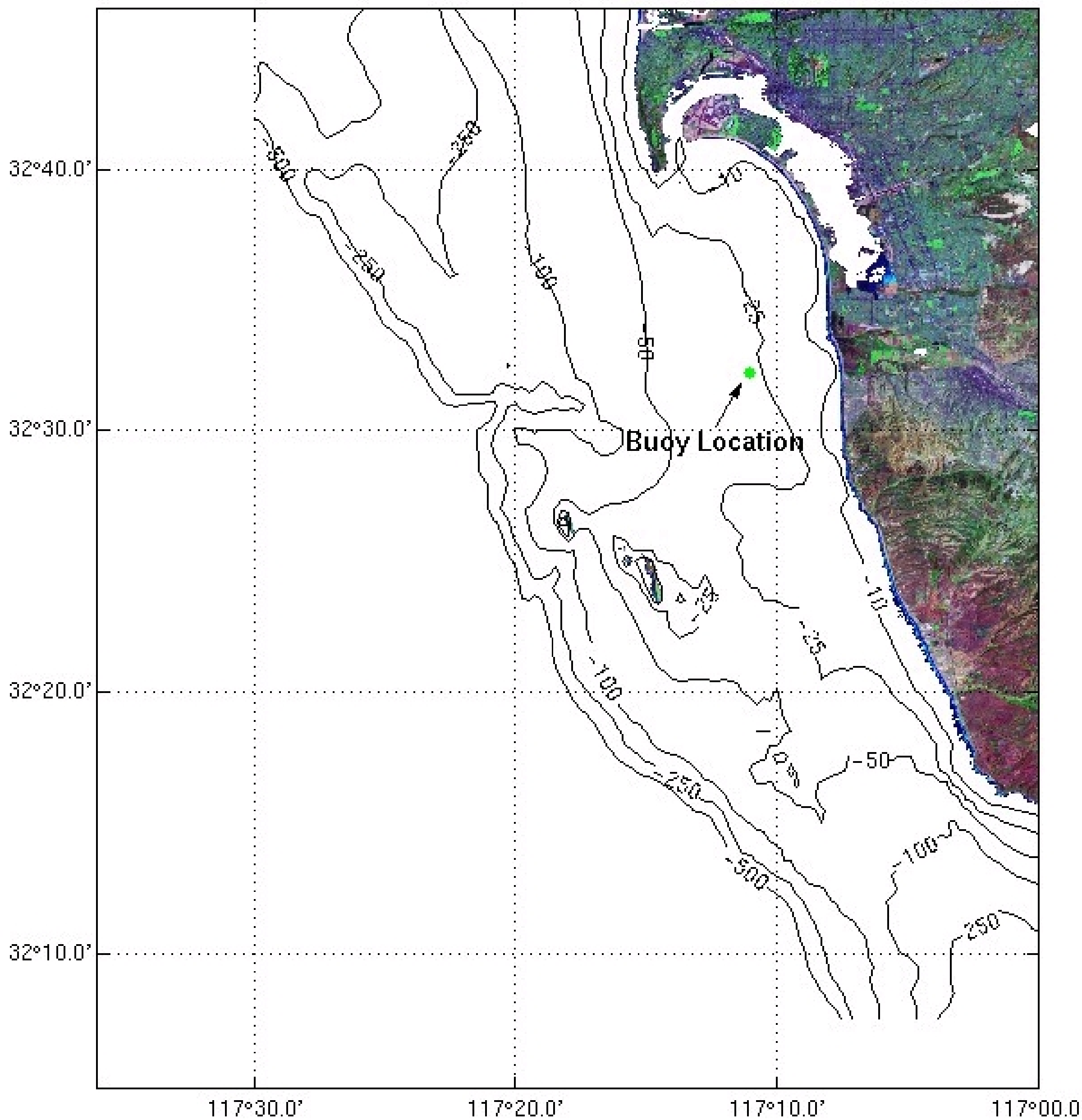


Figure 29. A map of the San Diego South Bay region showing bathymetry contours and the location of the SDCOOS buoy at the South Bay outfall.

ii. Examples of Data

The following figures provide data examples of the information provided by the ocean buoy via the SDCOOS web site.

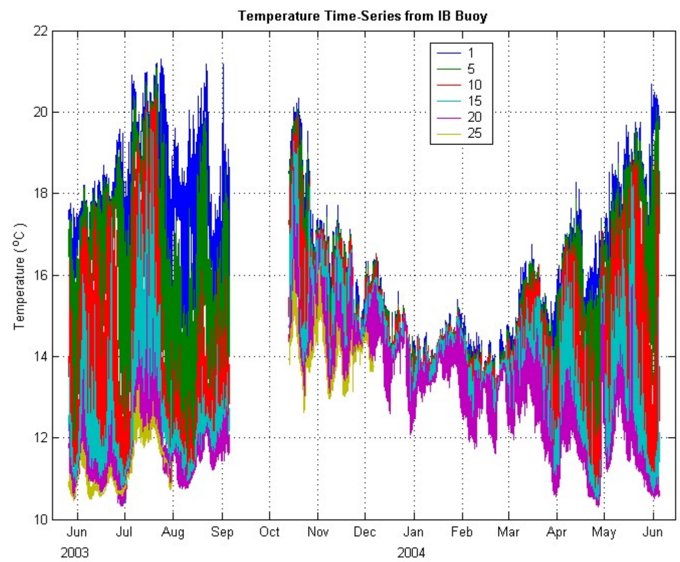


Figure 30. Temperature data collected over one year from the temperature string, which is maintained at the IBWC outfall location. Different colored lines indicate water temperature from different depths (in meters). Temperatures spread over a wide range related to with depth occur when the water column is stratified, reducing exchange of deep water with surface waters. When temperatures from several depths converge, as seen in winter months, then the water column is well mixed and deep water exchange with surface waters is facilitated. During times of weak stratification, outcropping of the outfall plume is possible.

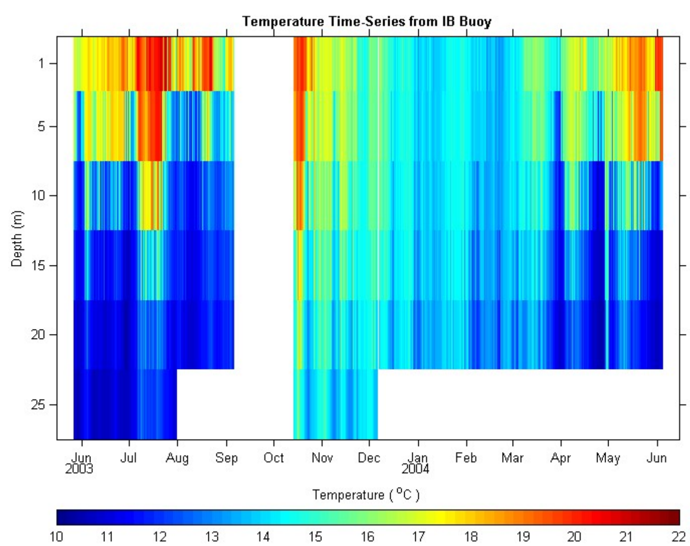


Figure 31. This time-series data is the same as that shown in Figure 29 except that ocean temperatures are mapped as colors here with the depth spread out in the y-axis. Weak stratification in winter months is also apparent in this plot as the entire water column cools to approximately 59^{o}F (15 ^{o}C). Note that periods of weak stratification also occur throughout the remainder of the year.

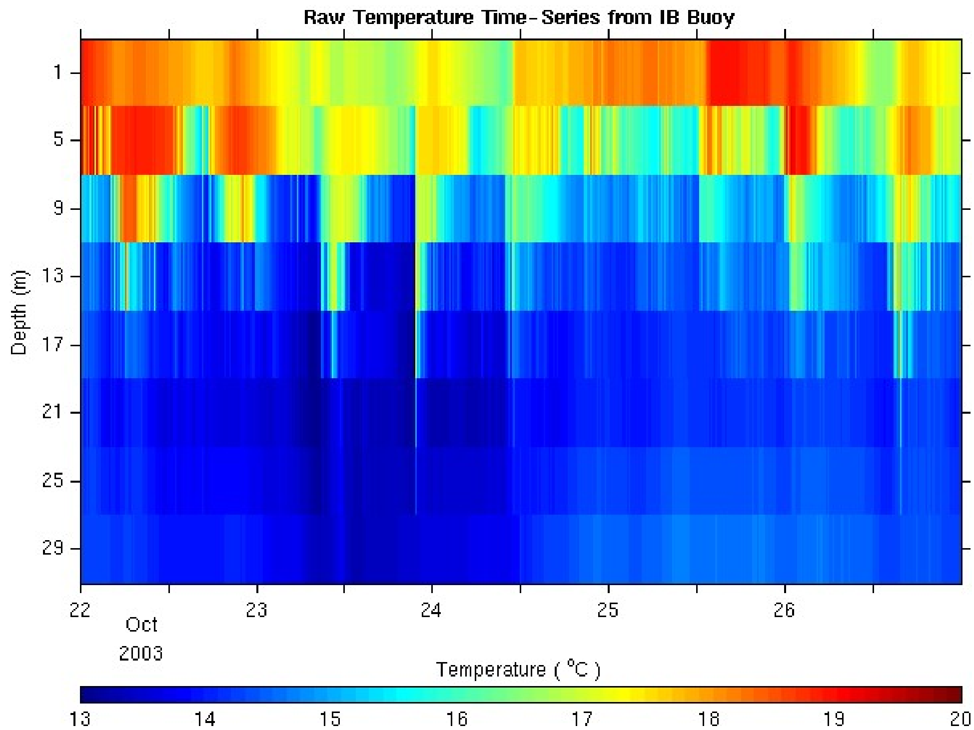


Figure 32. Ocean temperature data from the real-time buoy system is shown above. These same plots were posted to the SDCOOS web site in real-time when the buoy was active enabling periods of weak stratification to be detected and monitored.

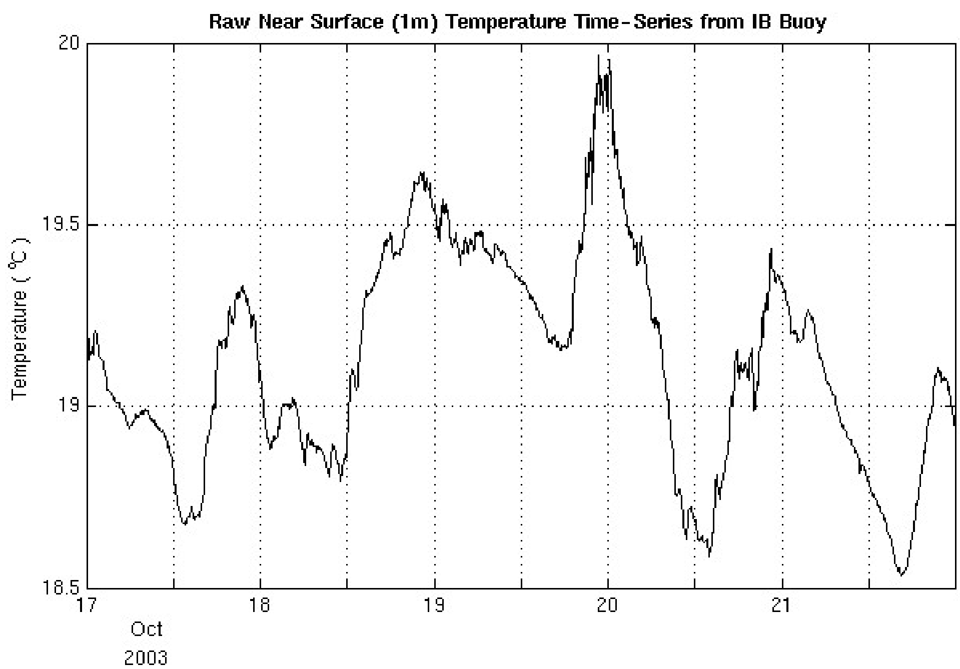


Figure 33. Surface temperature was extracted from the real-time buoy data and plotted as shown above on the SDCOOS web site.

I. Central Data Acquisition & Real-time Data Distribution System

The SDCOOS web page (http://www.sdcoos.ucsd.edu/) established at the beginning of the program has grown dramatically and continues at present. Instead of providing a detailed timeline of the additions and changes to the web site it will suffice to say that as instruments were deployed in the field there were parallel efforts at Scripps to bring the data on-line in real-time after initial quality assurance and control. The following is a summary of the various data products that are (or were at one time) available on the web site as well as some of its roles in facilitating data aggregation, distribution and interpretation.

Figure 34. SDCOOS home page, www.sdcoos.ucsd.edu.

The SDCOOS Home Page has quick links to IB weather information and ocean surface current maps. Links to pages highlighting environmental events are also placed here when they occur. For example, web pages were made during the November fires in 2003, the Bight 03 regional monitoring program, and the US Coast Guards Spill of

National Significance training exercise. A web page of data and imagery from recent storms is currently posted. The home page menu also provides links information about the program, background on the Clean Beaches Initiative Projects, partnership information, and related documents including the quarterly reports.

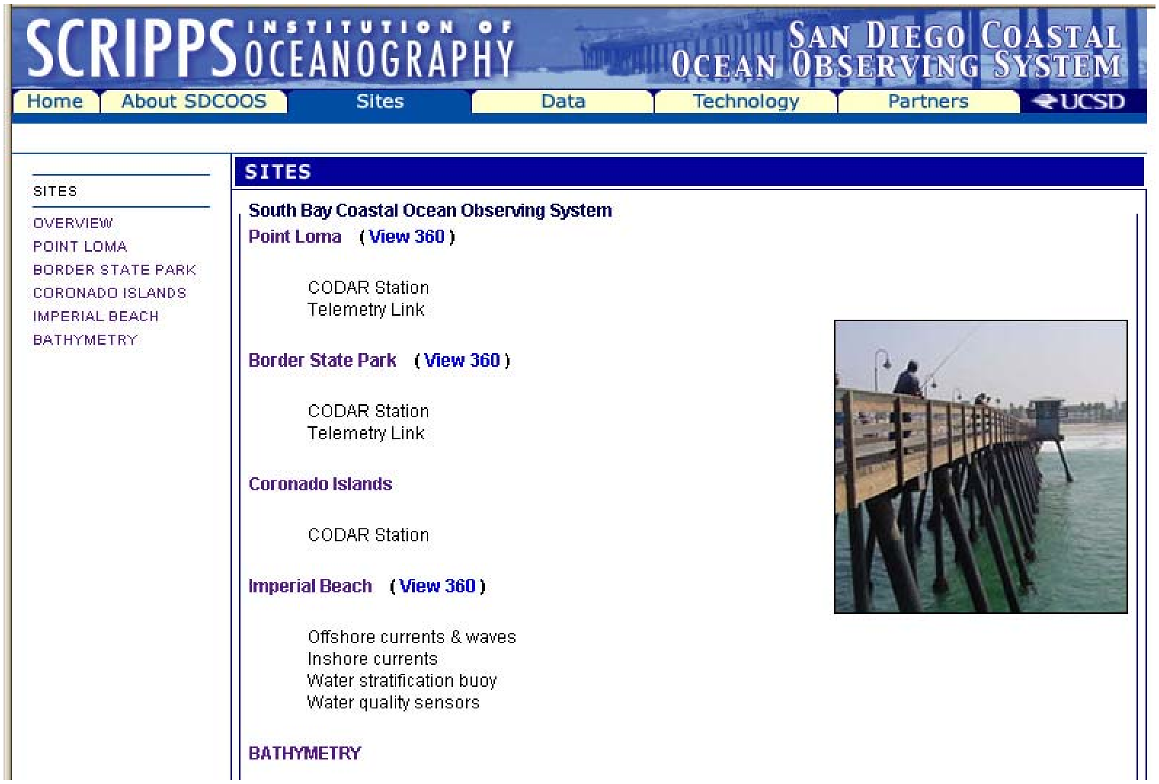


Figure 35. SDCOOS Sites page containing information about equipment deployed at each location.

The 'Sites' page outlines where equipment is deployed, some information about its configuration and pictures of the location. Interactive 360^o views are also available for each site.

Figure 36. SDCOOS technology overview of equipment and wireless communication at IB pier.

The ‘Technology’ page provides background of the principles behind CODAR operation and an overview of some instruments and wireless technology used at IB pier to gather and relay data (shown above). Two other diagnostic pages are currently available; (1) Radial Diagnostics and (2) SDCOOS Diagnostics. The Radial Diagnostics page is used by operators to monitor the health of CODAR instruments at each site by cross comparison. The SDCOOS Diagnostics page is used by SDCOOS staff to monitor data flow to the web.

Figure 37. SDCOOS data gateway.

The 'Data' page hosts the crux of the SDCOOS site. It is the most dynamic part of the site as data is continually updated. The Data page is broken into four sub-sections; (1) Ocean Data, (2) Weather, (3) Water Quality and (4) Satellite Data. The Ocean Data page hosts all data from instrumentation funded by this project as well as additional data obtained from other agencies or through other funding sources. The 'surface currents' section contains imagery for the last two days of hourly CODAR data. The most recent 24hr average is also shown because it indicates what the long term flow is without the reciprocative flow of the tides. A vorticity map of the 24hr average data indicates where the flow is turning and helps indicate where eddies may be present.

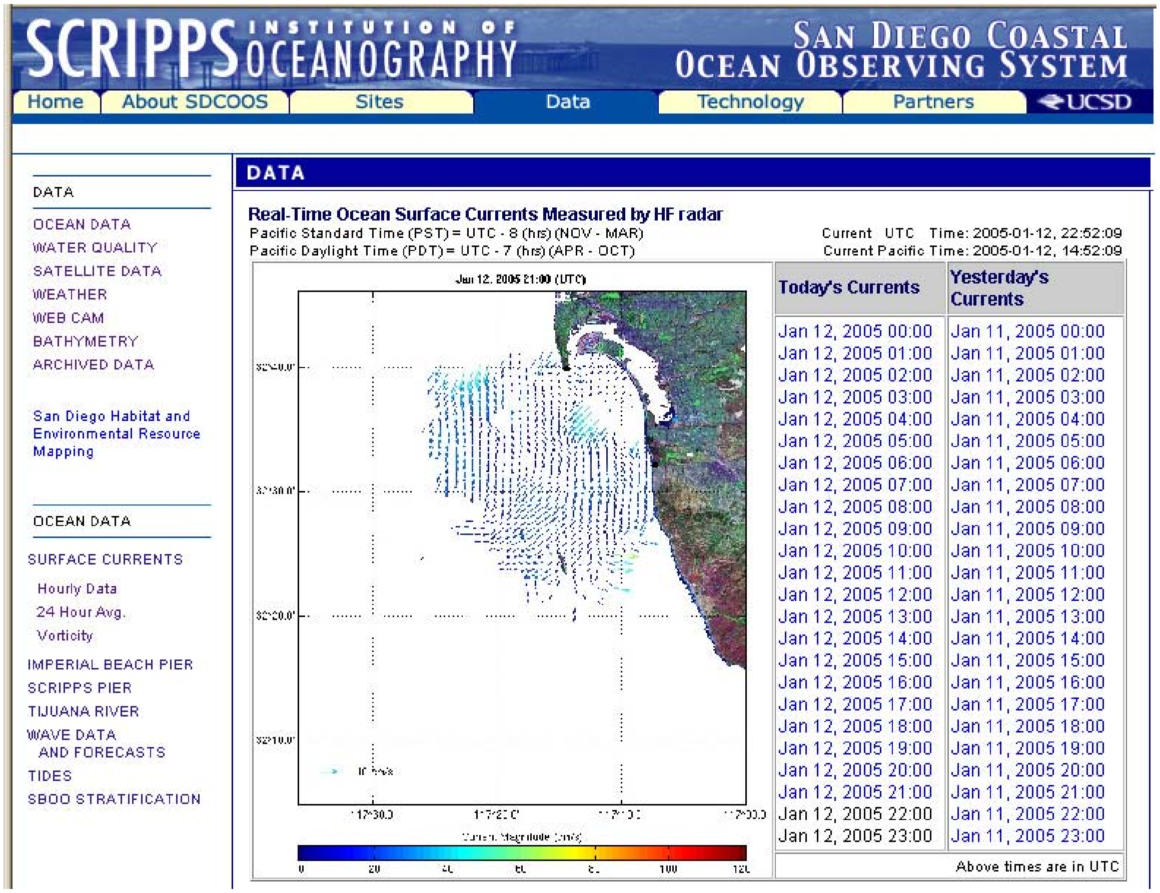


Figure 38. SDCOOS ocean data page. Hourly surface current maps for the past two days are shown.

All the ocean data from sensors mounted on the IB pier are presented on the 'Imperial Beach Pier' section of the Ocean Data page. These include the current meter in the surf zone, the current meter/wave sensor (ADCP), temperature, salinity sensor (SeaBird), and optical turbidity and chlorophyll (WetLabs) instruments off the end of the pier, the meteorological station on the pier tower and the web-cam mounted at the Safety Center. Data from the water column stratification measurement system is hosted under the 'SBOO Stratification' section. During the buoy's operation, several pages were active for displaying temperature data. Since the buoy's recovery, only the summary page is maintained which updates with data from the 'interim' buoy described in section 2.6 above.

Data collected by the International Boundary Water Commission (IBWC) on the stage and flow from the Tijuana River as well as rainfall are gathered from outside agencies and integrated into the 'Tijuana River' section of Ocean Data. Along-shore current velocity extracted from CODAR data is also plotted on this page. This provides a quick assessment of where potentially polluted waters may advect given the river's flow conditions. Managers from the Department of Environmental Health often use this page in conjunction with data from current meters deployed at the IB pier to help assess water quality conditions at South Bay beaches and guide sampling on days that were not scheduled.

The 'Wave Data and Forecasts' and 'Tides' sections under Ocean Data are made up of data obtained from other organizations including the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS) and the Coastal Data Information Program (CDIP). The 'Wave Data and Forecasts' section displays swell predictions at IB pier which are provided by CDIP. Swell maps for Southern California as well as marine forecasts are also displayed. Water level and tide predictions from NOAA/NOS/CO-OPS are displayed under the 'Tides' section.

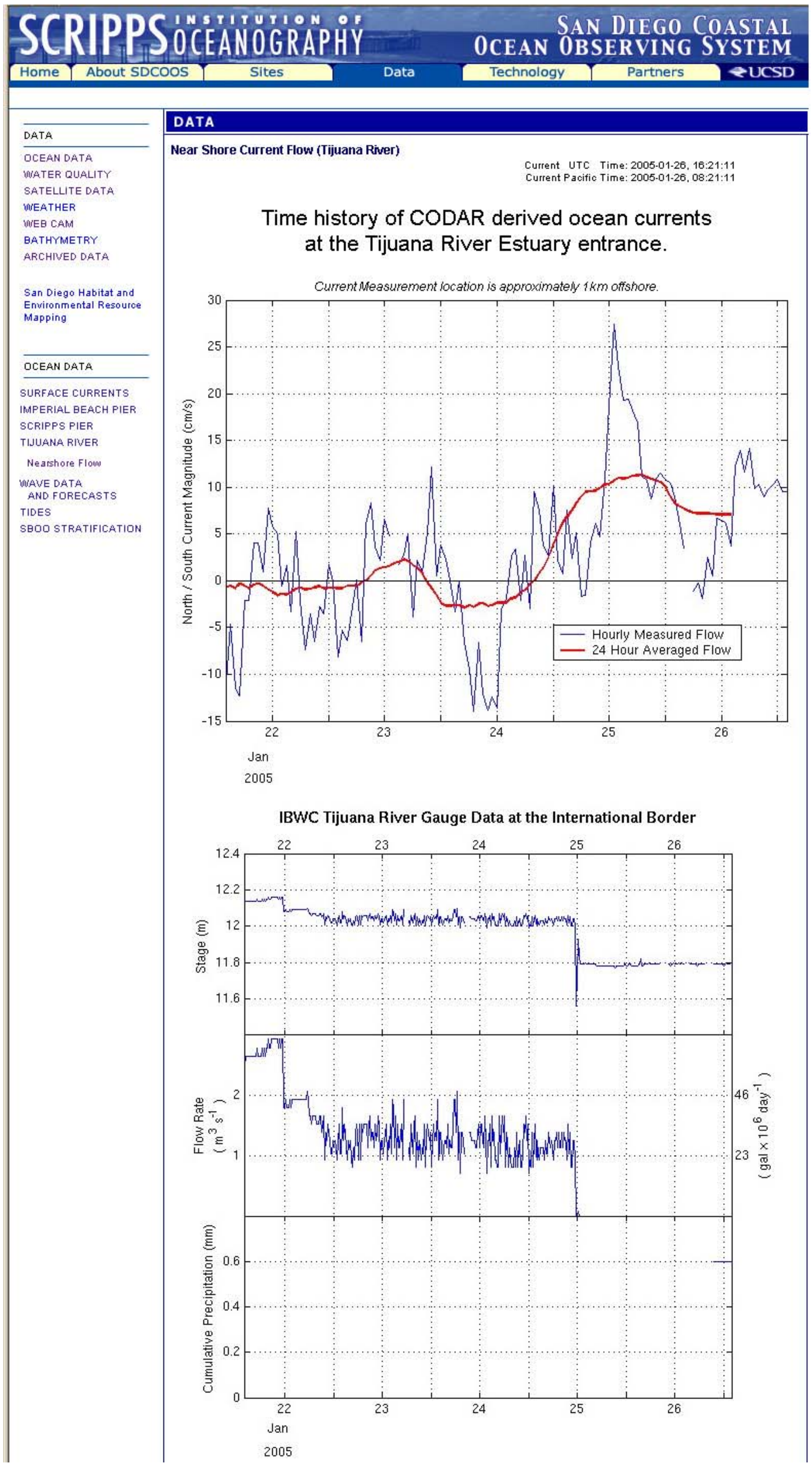


Figure 39. IB pier meteorological data page displays the most recent web-cam image and current atmospheric conditions.

Real-time meteorological data from both South Coronado Island and IB pier are hosted at the 'Weather' sub-section on the Data page. Surface wind data obtained from the Geophysics Branch at the Naval Air Warfare Center Weapons Division is displayed along with precipitation, radar reflectivity, and cloud cover obtained from the NWS.

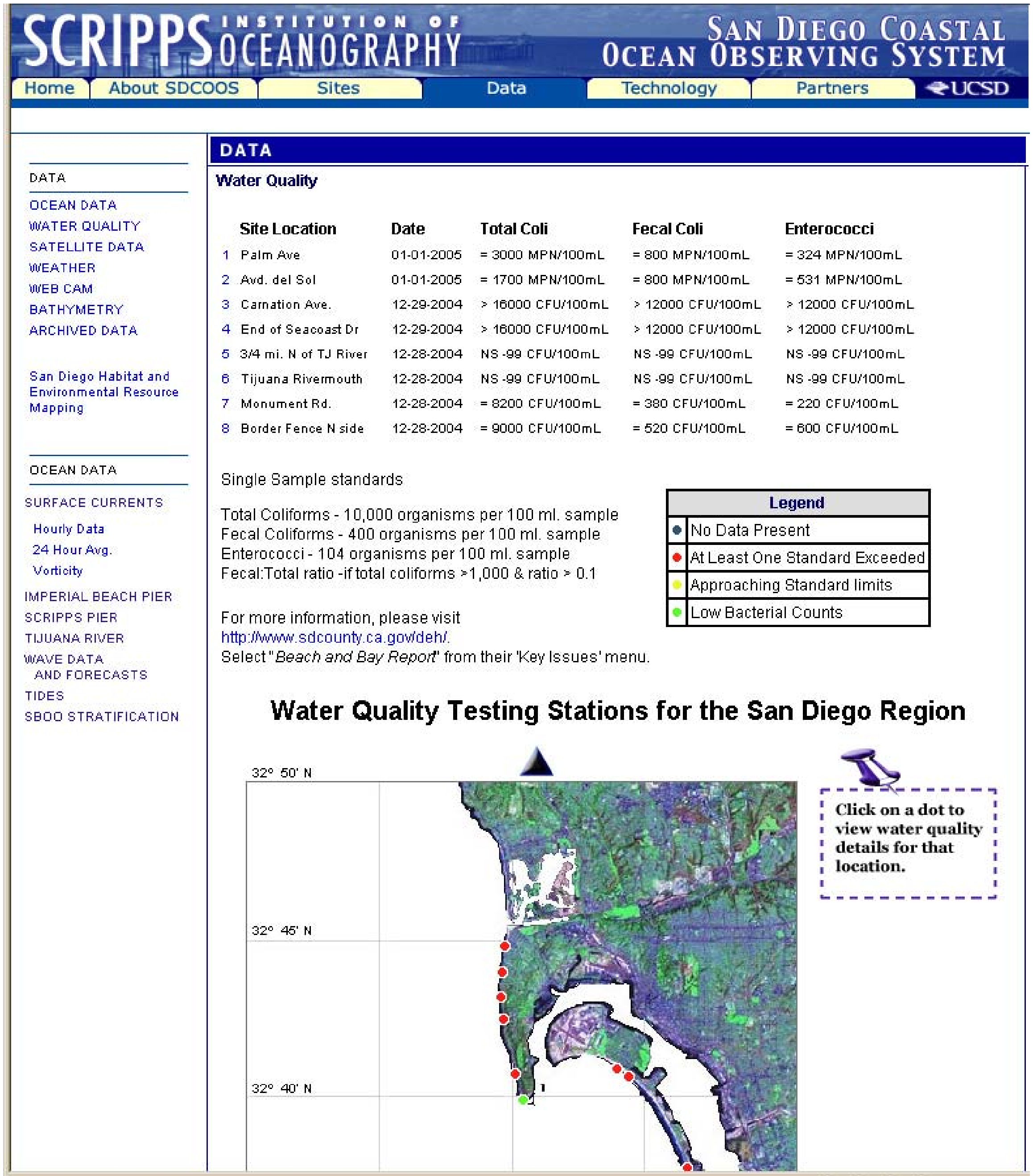


Figure 40. The water quality data is updated by the San Diego County Department of Environmental Health though web-based data entry. The most recent results are posted to this page, as shown above, in both tabular and graphical form. Historical data for all sites can be accessed interactively.

The most recent water quality measurements and AB411 exceedances are displayed in tabular and graphical form on the 'Water Quality' section of the Data page. In addition, historical data for any sampling location can be accessed interactively. Another page, used by County of San Diego Department of Environmental Health officials, allows web-based data entry for updating information on this page.

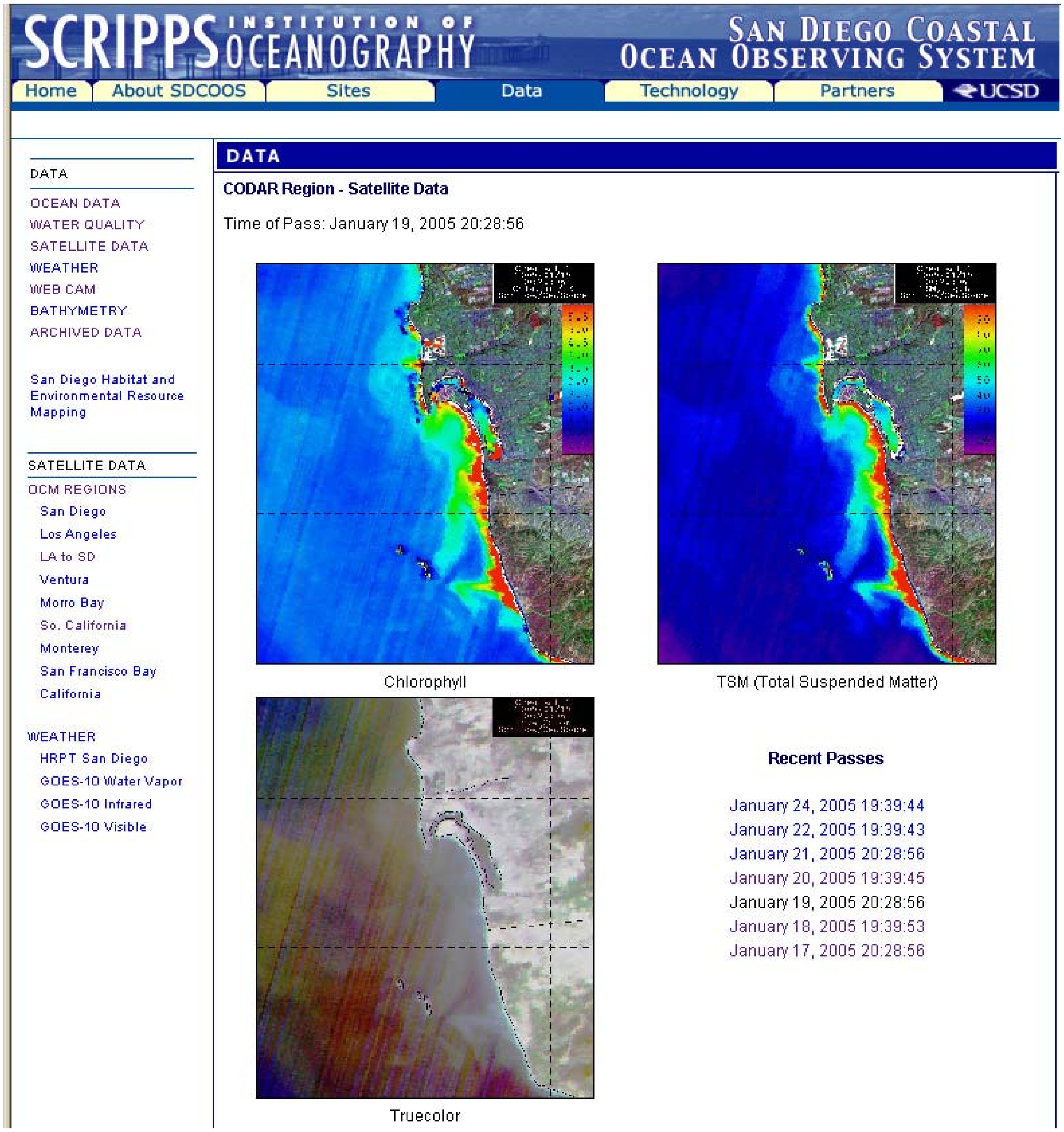


Figure 41. Oceansat-1 data for the San Diego region on January 11, 2005 showing high water turbidity following several storms. Imagery from previous days can also be viewed. Older imagery can be accessed through the archive page.

Through partnership with SeaSpace Corporation and outside sources of funding, we have been obtaining 984ft (300m) resolution ocean color data from Oceansat-1, an Indian satellite, for the state of California. This high-resolution ocean color data shows fine detail in nearshore features such as river plumes that provides accurate measurements of plume locations as well as the detail necessary to understand ocean dynamics driving the plumes. Daily ocean color images from Oceansat-1 are available at the 'Satellite' sub-section of the Data page for several sub-regions throughout the state. Recent weather satellite images obtained from SeaSpace and NWS are also available on this page.

Figure 42. Archived images for CODAR, OCM and water quality can be accessed by searching the archives.

In addition to the four sub-sections mentioned above, there are supplementary pages under the data page for a web-cam at Imperial Beach, an interactive bathymetry site, and an interactive image archive site. Images for hourly and 24hr averaged surface current maps, all OCM regional maps, and interactive water quality maps can all be obtained through a search tool. The archive capabilities were made possible through partnership with personnel at the San Diego Supercomputer Center.

Data support has been provided through the SDCOOS page to programs interested in sampling specific events or features in San Diego waters. A web page was made for the Bight ’03 Southern California Regional Marine Monitoring program. The page contained all the relevant plots updating in real-time on a single page for a quick reference to ocean conditions. Plots for specific events were also captured and saved for future reference. This sort of support was especially important to the Bight’03 program because of their interest in sampling specific features (i.e. river plumes). Satellite data from the SDCOOS page enabled ‘plume tracking’ so that the proper locations could be sampled. A similar page was made for the Coast Guard’s Spill of National Significance (SONS ’04) exercise program.

The SDCOOS site has been monitored since February 2003 so that web statistics could be compiled. There have been nearly 3,000,000 hits to date with an average of 55 visits per day. The site receives the most visits during weekdays and between 10:00 and 11:00am (Figure 43). Both new and repeat visitors have been growing steadily since the site was launched with an average of 19 new visitors per day. The increasing trend of repeat visitors implies a growing community of users accessing data presented on the SDCOOS site. While the majority of domains are unresolved (possibly consisting of a mixture from all groups), there is roughly equal distribution of use between educational and commercial domains (Figure 44). Military use is limited but expected to increase as products of interest to the U.S. Coast Guard and Navy are developed. Phone communication with Navy medical and dive officers indicate they do use the data to guide diving operations in the South Bay region.

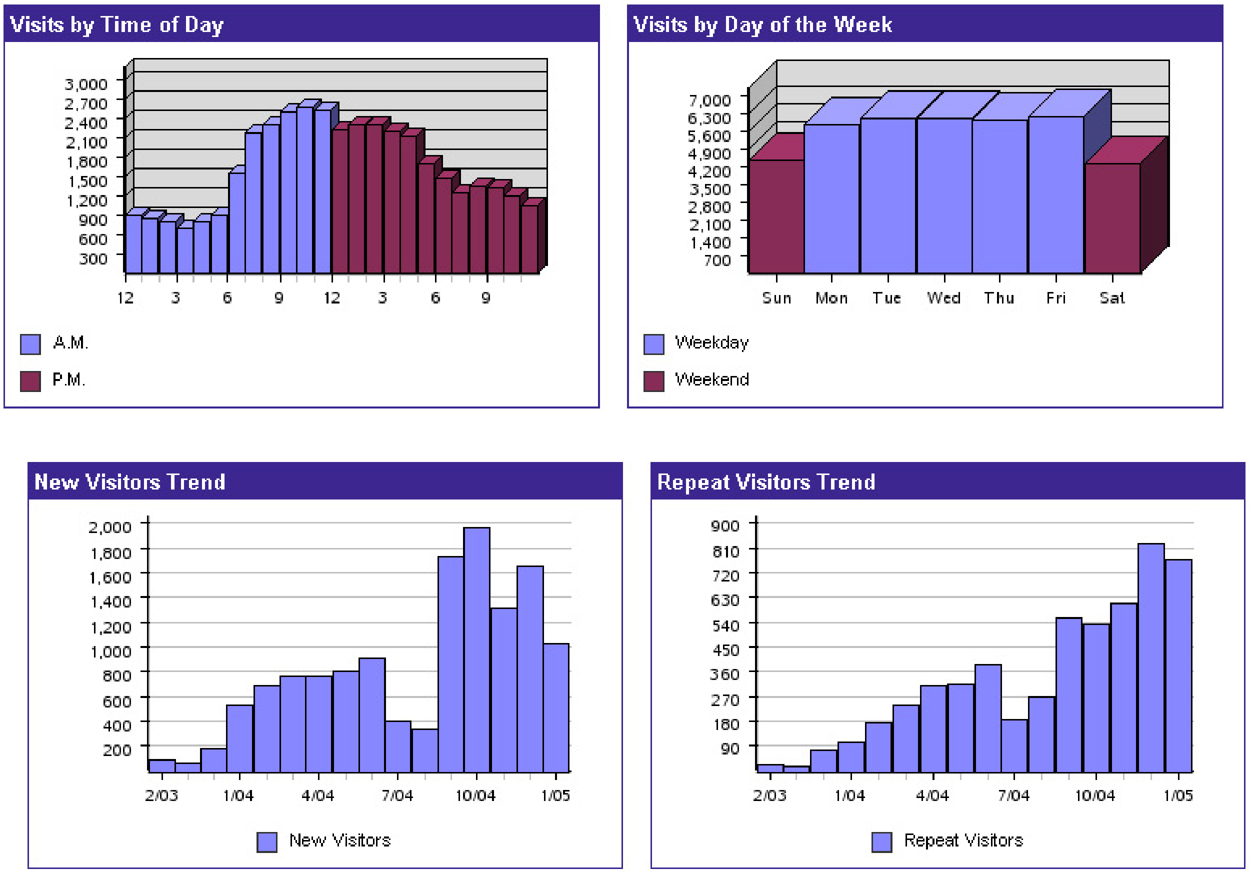


Figure 43. Web statistics for the SDCOOS site since February 2003. The site is most frequently visited on weekdays and between 10:00 and 11:00am. Both new and repeat visitor trends have been steadily increasing since the site was launched.

J. Data Interpretation

Interpretation of various data has been provided in quarterly reports (see appendix 5 quarterly reports 1-7). Further analysis is provided in section 3.0 of this report.

K. Reporting

Quarterly reports were prepared by the project team and submitted to the SWRCB as noted in the agreement. The quarterly reports consisted of project activity summary, milestones achieved, problems encountered, system performance, and data interpretation efforts. The final report was written primarily by SIO staff at UCSD with collaboration from City of Imperial Beach staff and contractors. This final report includes the project's data analysis summary and conclusion in Section III.

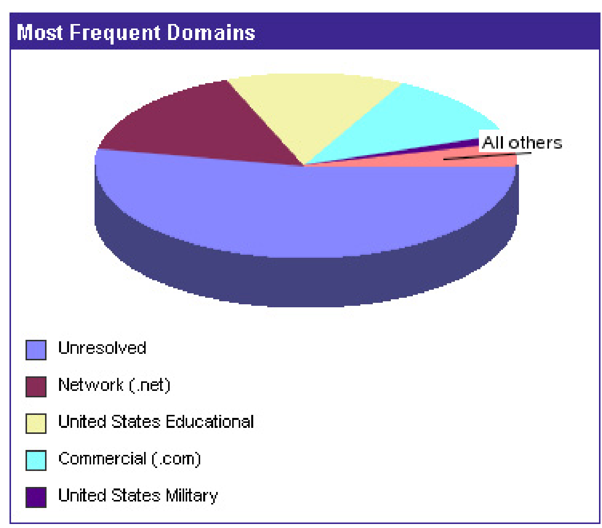


Figure 44. Distribution of domains visiting the SDCOOS site.

III. Data Synthesis & Interpretation

Terrestrial runoff from rain events has been a dominant factor contributing to poor water quality (as indicated by the exceedance of AB411 standards) in the South Bay during the time period of this project. Source contributors include local runoff and the Tijuana River, with common understanding that the river is the dominant non-local point source of contamination. A complementary report, prepared for the County of San Diego Department of Environmental Health (DEH) on the Imperial Beach Enhanced Bacteria Monitoring Program (IBEBMP, Appendix 4), presents some details of the bacteriological sampling that took place to examine the temporal and spatial variability of contamination from this source. Our analysis focuses strictly on the number of exceedances determined at DEH and IBEBMP sampling stations as opposed to DEH closures and postings. Below is a chart detailing exceedance numbers collected by DEH for the entire year of 2003 as compared to the AB411 sampling season of April 1st – Oct 31st.

	San Deigo Department of Environmental Health sampling					
	Year 2003			AB 411 (April 1 - October 31 2003)		
Station	number of exceedances	number of samples	% exceedances given sample number	number of exceedances	number of samples	% exceedances given sample number
Border Fence	8	39	21%	2	20	10%
Monument	10	39	26%	3	20	15%
Rivermouth	17	46	37%	4	21	19%
3/4 North	11	44	25%	1	20	5%
Seacoast	12	55	22%	1	21	5%
Cortez	9	33	27%	2	17	12%
IB Pier North	6	40	15%	1	18	6%
Carnation	12	58	21%	2	23	9%
TOTAL	85	354	24%	16	160	10%

Figure 45. Summary of DEH data in tabular format comparing year 2003 and AB411 sampling season. First column indicates the number of samples that exceeded AB411 standards; Second column shows the number of samples taken at each location; and the third column shows a percentage exceedance based on number of exceedances compared to number of samples for a given location.

The IBEBMP enhanced sampling of routinely monitored sites by the DEH by sampling additional locations and more frequently. The IBEBMP ran for one year from July 2003 through July 2004. Due to the time scale of the project, we are unable to detail the entire 2003 year nor 2004 year compared to AB411 sampling season.

Station	Imperial Beach Enhanced Bacteria Monitoring Program (IBEBMP)		
	July 2003 - July 2004		
	number of exceedances	number of samples	% exceedances given sample number
Border Fence	1	18	6%
Monument	2	18	11%
Rivermouth	16	52	31%
Rivermouth2	7	41	17%
3/4 North	8	48	17%
Seacoast	5	49	10%
Cortez	4	47	9%
IB Pier South	4	41	10%
IB Pier North	0	5	0%
IB Pier	4	34	12%
IB Pier End	4	39	10%
TOTAL	55	392	14%

Figure 46. Summary of IBEBMP data in tabular format over the duration of the experiment.

A summary of all fecal indicator bacteria (FIB) data collected shows that values were highest during winter and are associated with rain events which triggered terrestrial runoff. With the exception of one other event in July 2003, all exceedances of AB411 standards in FIB data collected by the IBEBMP occurred in association with terrestrial runoff from rain events (see appendix 4; page 25). Based on the observations summarized in the IBEBMP report, the transport mechanisms associated with tidal pulsing and longshore transport in the surfzone (surfzone currents), are minor when compared to the impacts of wet weather events. Consequently, analyses summarized in this report focus on observations surrounding rain events.

Water quality was poorest, as indicated by AB411 exceedances measured by the IBEBMP, from February through March in 2003 and from February through April in 2004. All exceedances during these time periods coincide with rainstorms and ensuing flow from the Tijuana River. The IBEBMP report and references therein show that the Tijuana River Estuary is the dominant non-local point source for elevated FIB levels affecting South Bay beaches. Following rain events, persistently elevated FIB levels are observed around the Tijuana River after region-wide contamination from local runoff has subsided. This implies that ocean currents play a crucial role in assessing, understanding and predicting water quality at South Bay beaches through the transport of contaminated runoff from the Tijuana River.

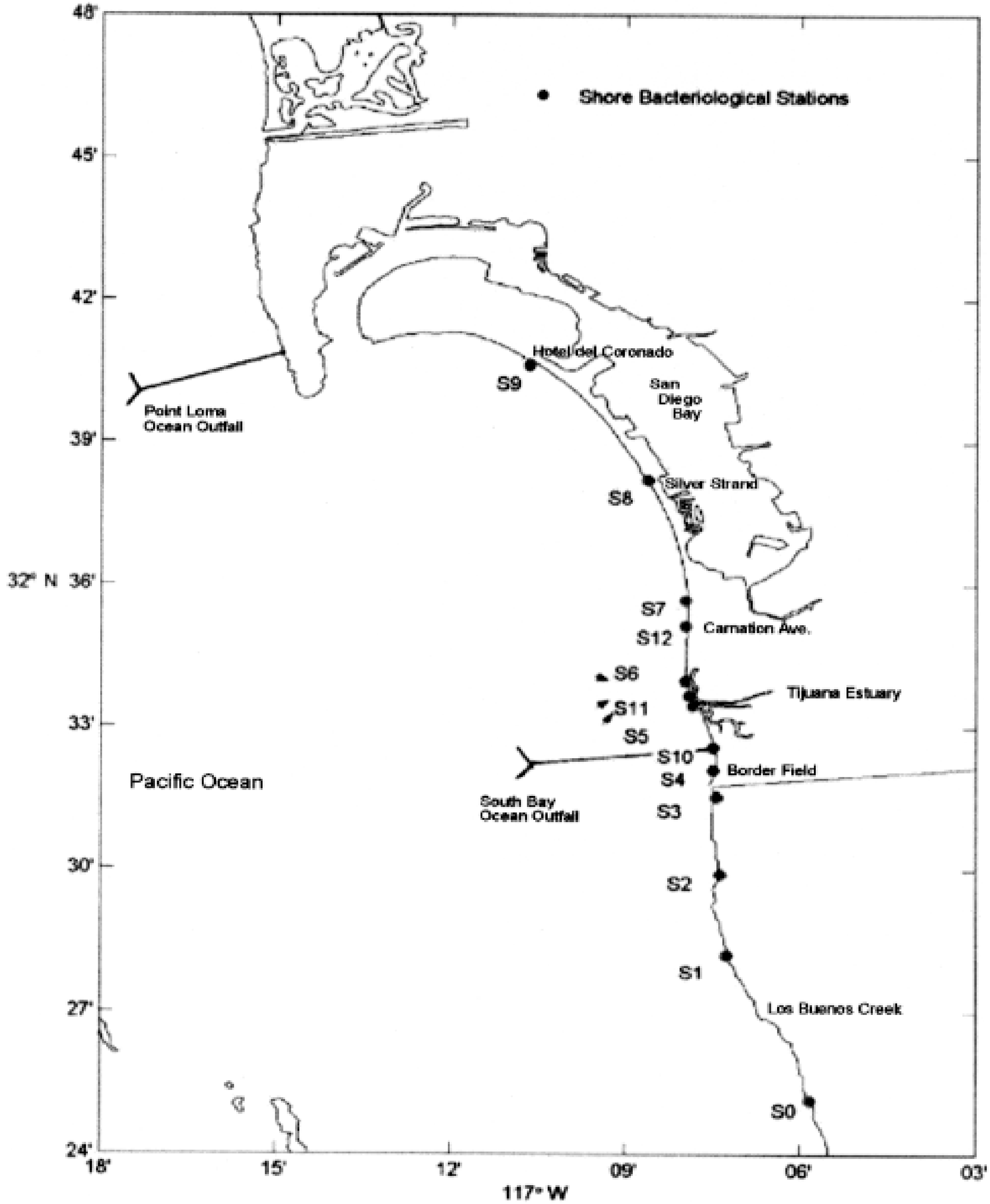


Figure 47. County of San Diego Department of Environmental Health shore bacteriological sampling stations.

Three major rain/runoff events which occurred between Febuary and March are examined for 2003. The first two rainstorms are shown in Figure 48 while subsequent discharge from the Tijuana River is shown in Figure 49 (middle panel). AB411 exceedences for South Bay stations corresponding to Figure 47 and alongshore flow measured by CODAR near the Tijauna River mouth are also plotted in Figure 49 to show the relationship between flow from the River, alongshore transport of the river plume and elevated levels of FIB.

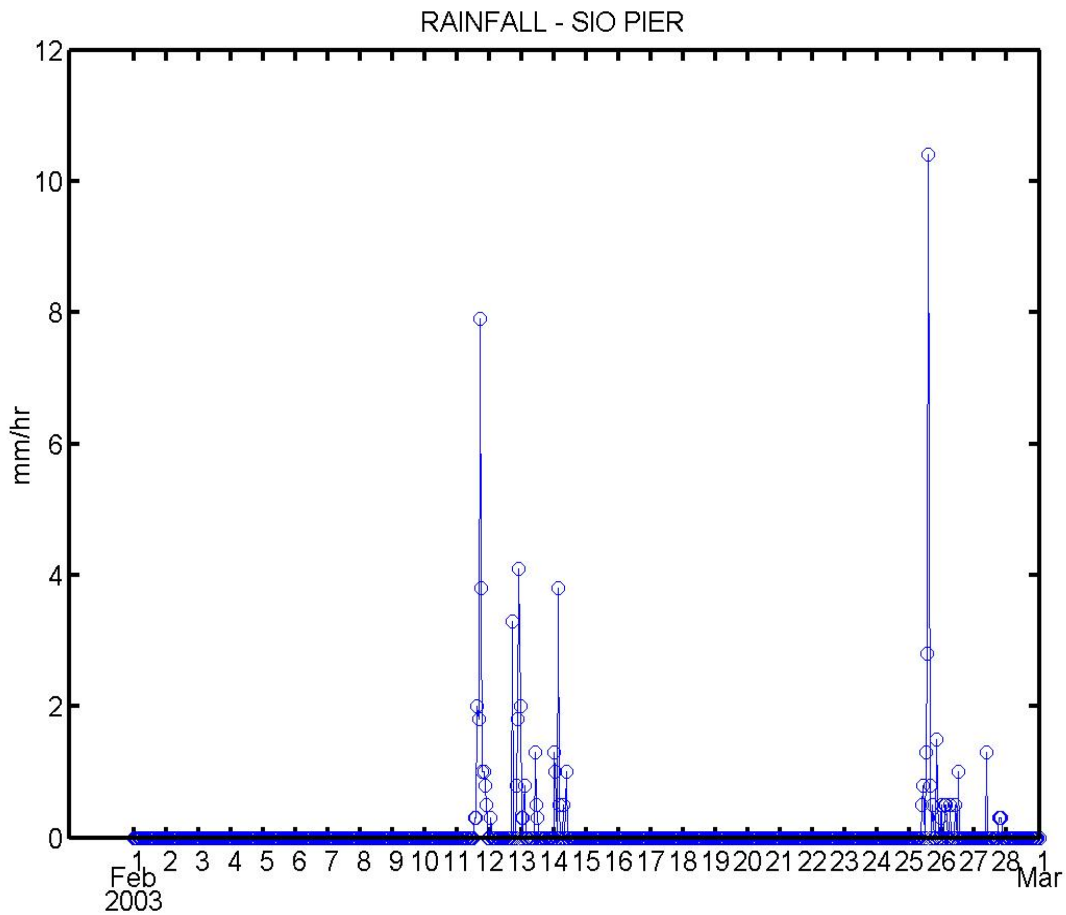


Figure 48. Rainfall measured at SIO pier for February 2003.

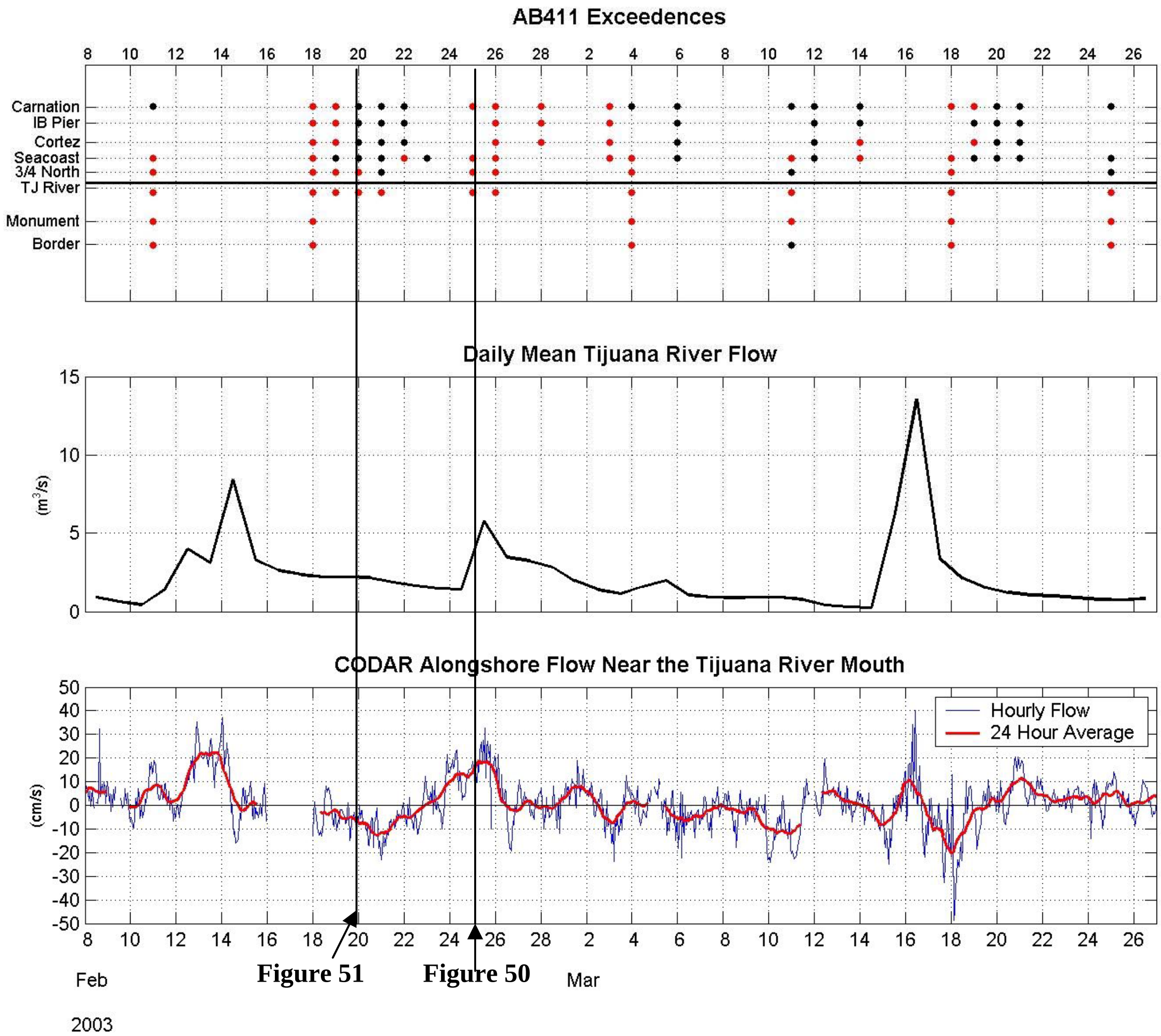


Figure 49. San Diego County Department of Environmental HealthAB411 exceedences at South Bay sampling locations (top). All samples taken during the time period are plotted. Black dots indicate FIB values are below AB411 standards while red dots are above standards. Daily mean flow from the Tijuana River as measured by the IBWC (middle). Alongshore flow measured by CODAR near the Tijuana River mouth (bottom). Positive values indicate Northward flow while negative values indicate Southward flow. The 24 hour average represents the mean sub-tidal flow.

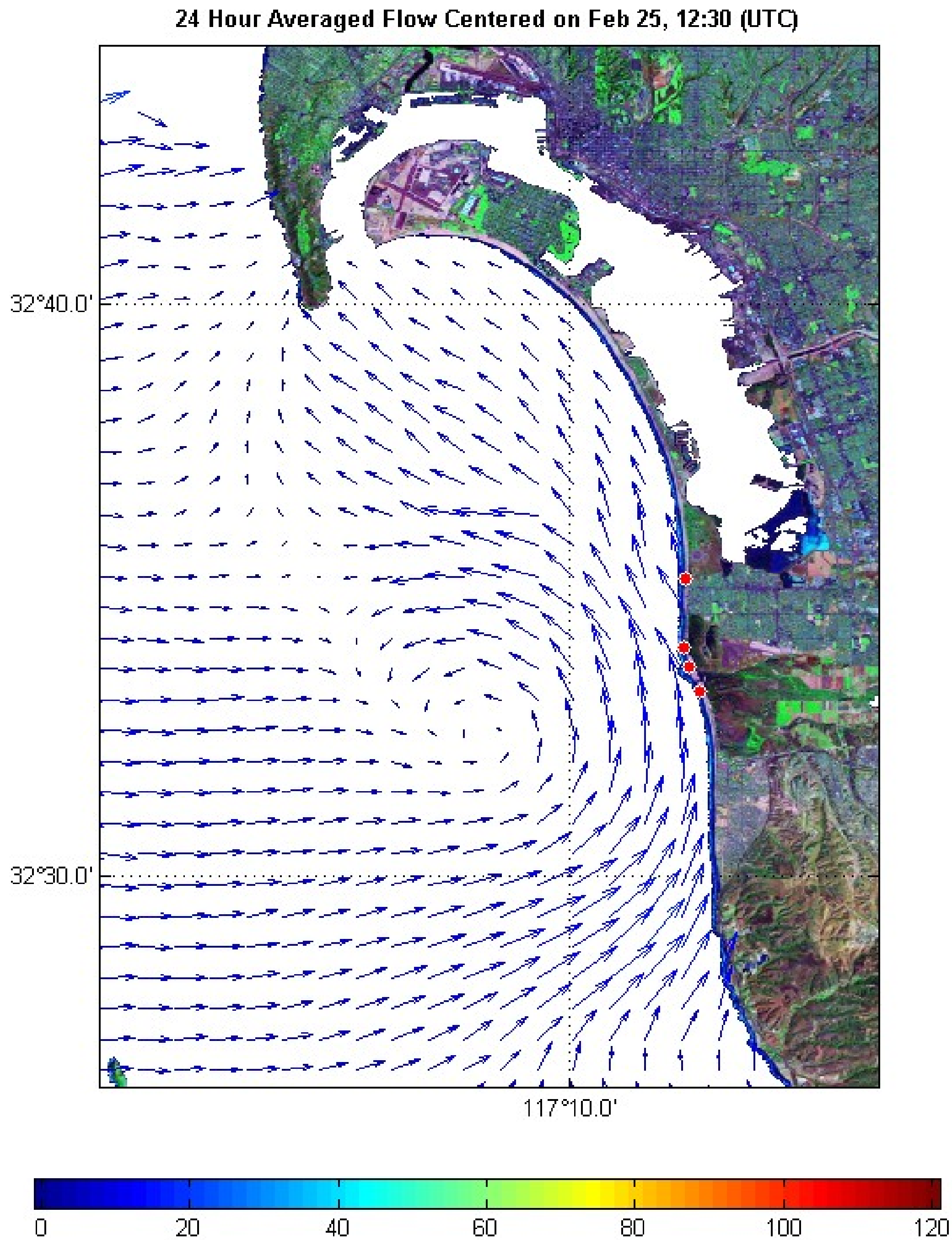


Figure 50. CODAR measurements of surface currents on February 25th during northward flow and peak discharge from the Tijuana River. All DEH samples taken exceeded AB411 standards and are indicated by the red dots.

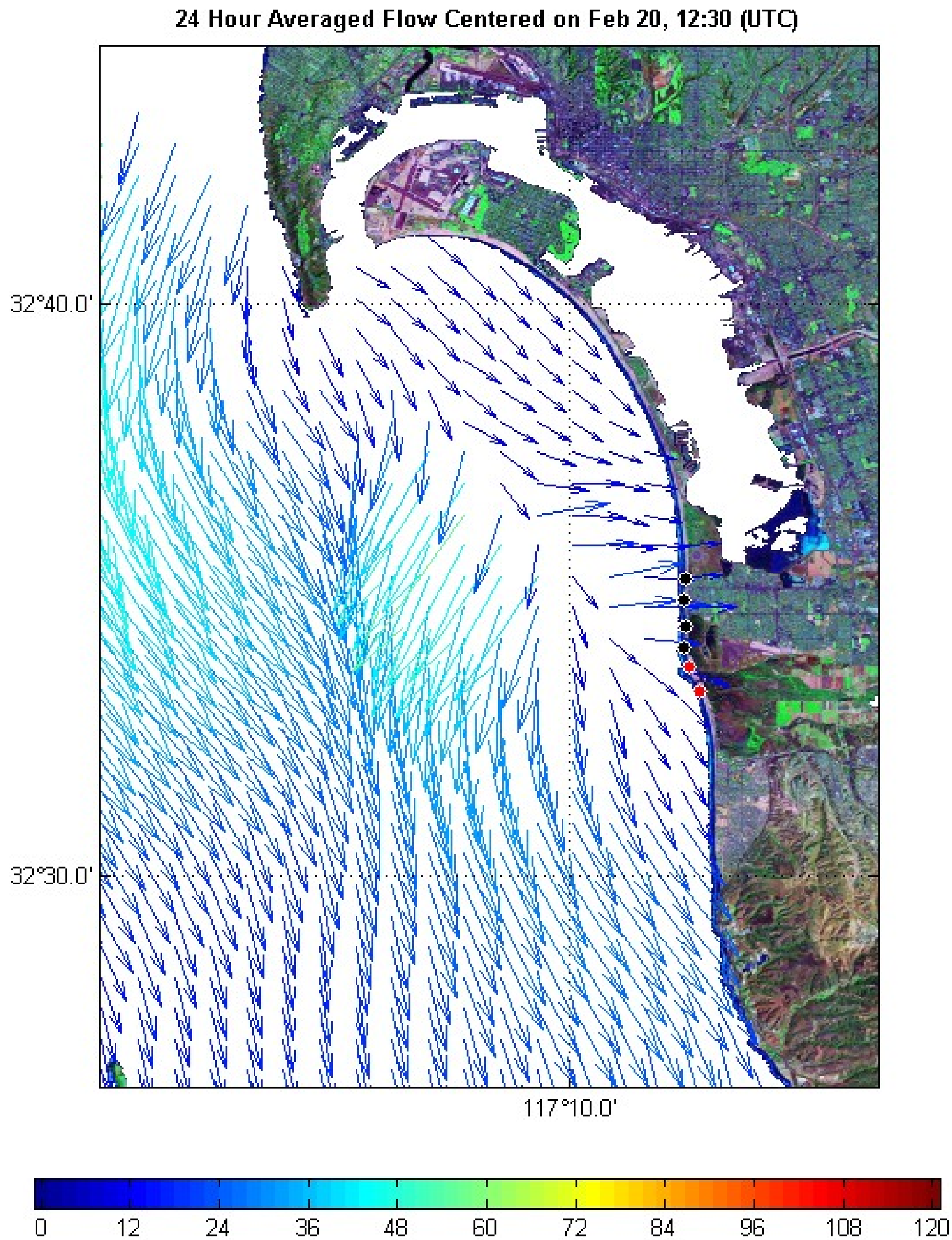


Figure 51. CODAR measurements of surface currents on February 20th, 2003, six days after rainfall. Currents were northward during rainfall but reversed directions a few days later which flushed out South Bay beaches and improved water quality.

Discharge from the Tijuana River often lags significant rainfall by only a few hours. Rain events started on February 12, 13, 14 & mid-day on the 25th. Flow from the Tijuana River increased almost immediatey and peaked just a few hours after the rainstorms. Alongshore flow conditions during all three discharge events was northward. This is a common observation as winter storm systems with precipitation usually approach with winds from the south, which subsequently drive northward ocean currents. As a result of northward flow along the coast during these rainstorms, AB411 exceedences were observed throughout South Bay beaches. As previously indicated, it may be expected that all beaches become polluted from local runoff for a couple of days after a rainstorm. However, continued contamination from non-local sources, such as the Tijuana River, are dependent upon ocean currents which advect the polluted water. Therefore, the amount of time ocean waters remain polluted beyond a couple of days is related to the amount of polluted water advected to a region from a non-local source (eg. A dry weather flow). South Bay beaches remained contaminated for approximately one week after the first two rainstorms in February while beaches were clean only four days after the rainstorm on March 16th. The difference between the first two storms and the third one is that, following the first two storms, alongshore flow was predominantly northward. However, the after third storm, alongshore flow switched to strongly southward throughout the region which helped flush out South Bay beaches and redirected the Tijuana River plume southward.

Rainfall at Imperial Beach pier, flow from the Tijuana River, alongshore flow and water quality from February through April 2004 are used to show the relationship between rainfall and water quality (Figure 52). The figure illustrates again the good correlation between rainfall measured at Imperial Beach pier and flow from the Tijuana River. During the first storm, on February 19th, alongshore flow was consistently southward and water quality measurements on the same day revealed that beaches to the north were clean (figure 53). Alongshore flow flow reversed direction by the 23rd during the second rainfall event, and beaches throughout the Southbay were found to be in exceedance (figure 54). Waters remained at elevated levels of FIB for at least four days as alongshore flow remained consistently northward. Clear skies ofetn follow rain events which allowed us to capture the extent of discolored water (from the river sediments) using OCM satellite imagery. An image, acquired on February 24th, shows plumes extending from the Tijuana Estuary throughout the Southbay. Figure 55 shows this image and overlays the surface current measurements to show how the plumes are being transported in the region.

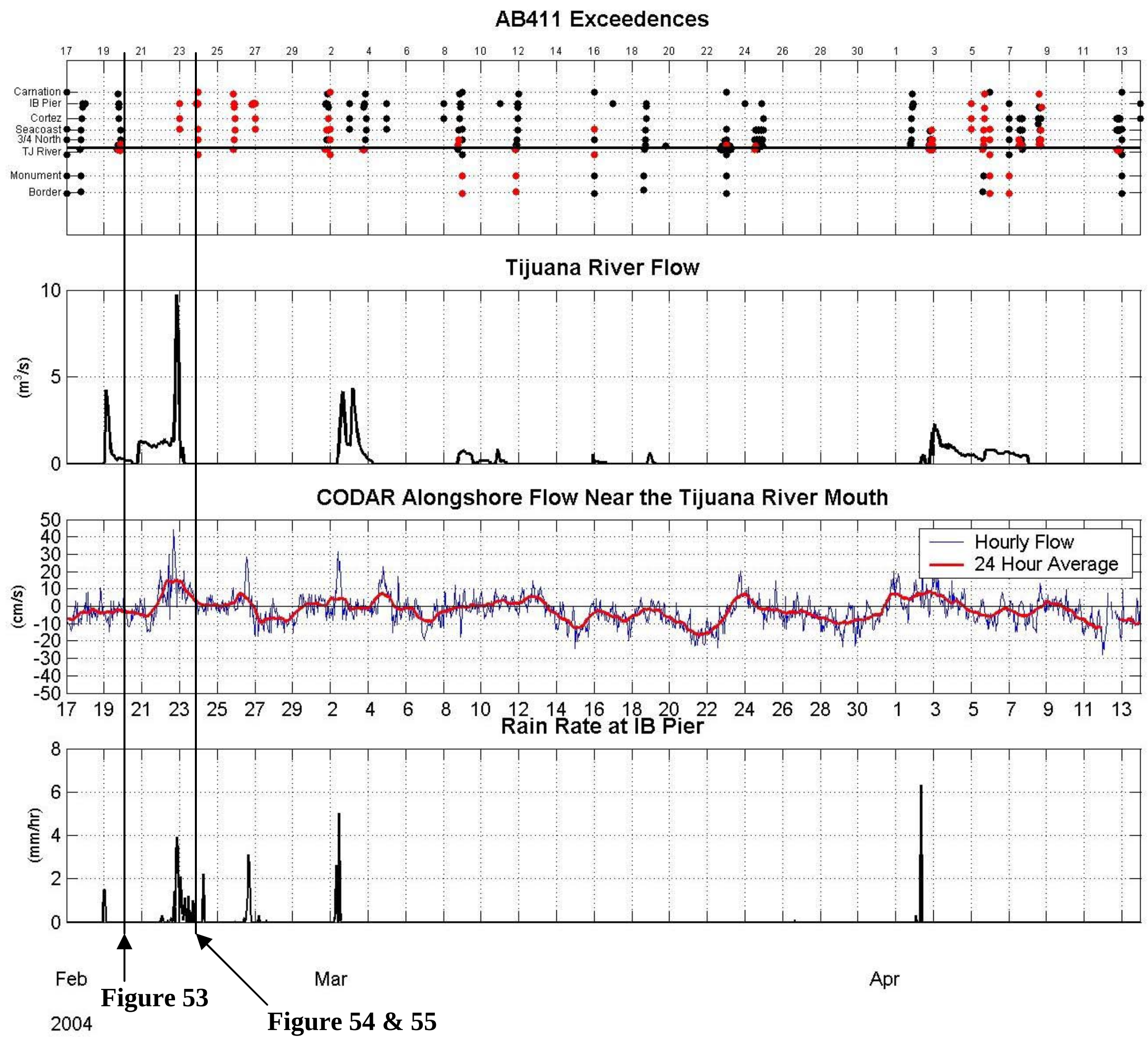


Figure 52. AB411 exceedances for DEH and IBEBMP samples (top). Sampling locations correspond to sites in Figure 43. All samples are plotted as either black (below AB411 standards) or red (above AB411 standards). Tijuana River flow measured by the IBWC (2nd from top). Alongshore flow measured by CODAR near the Tijuana River mouth where positive values indicate Northward flow and negative values indicate Southward flow (3rd from top). Rain rate measured at Imperial Beach pier (bottom).

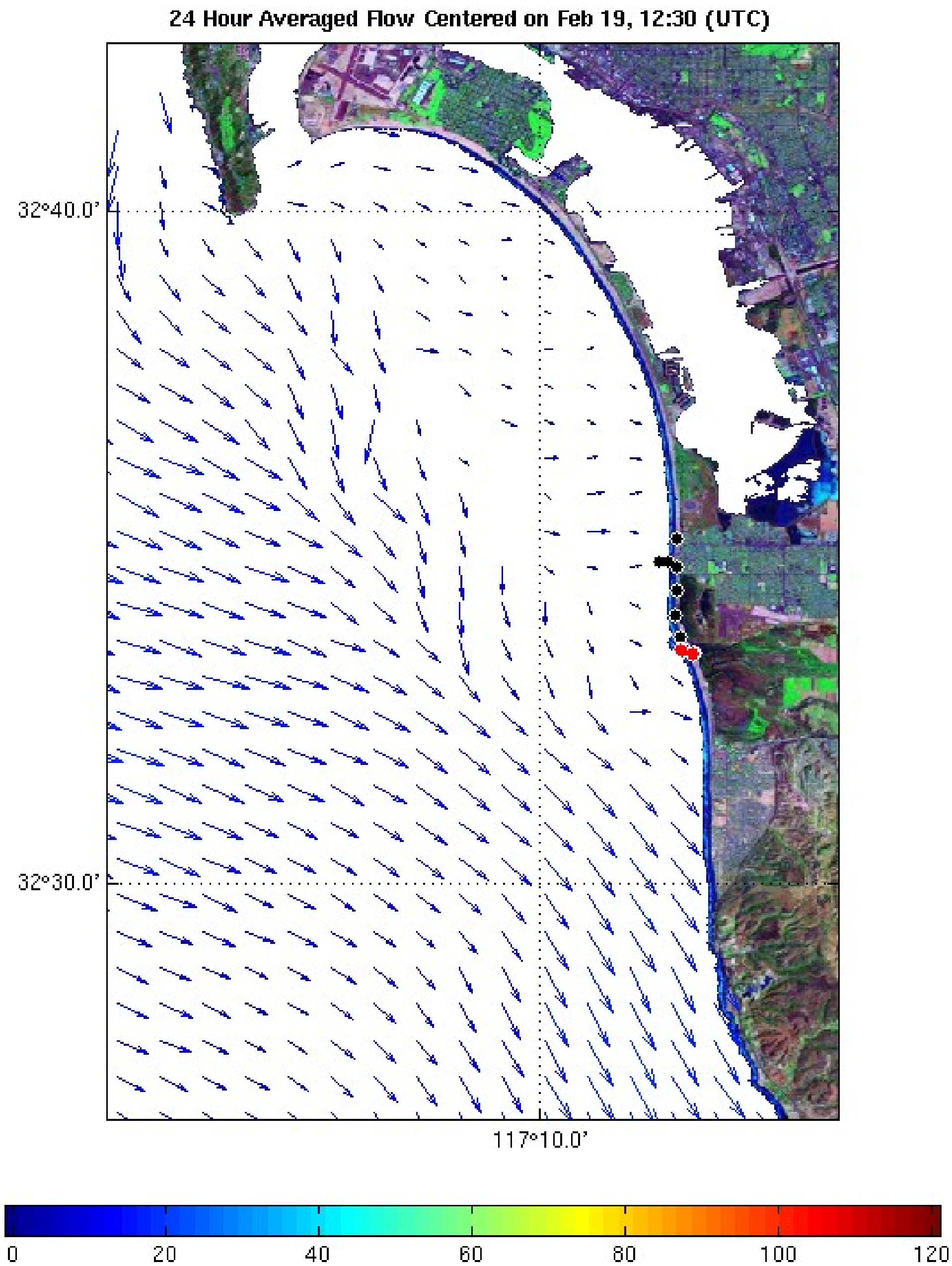


Figure 53. CODAR measurements of surface currents on February 19th during southward flow and peak discharge from the Tijuana River. Only samples south of the Tijuana River exceed AB411 standards (indicated by red dots) while other sites to the north are clean (indicated by black dots).

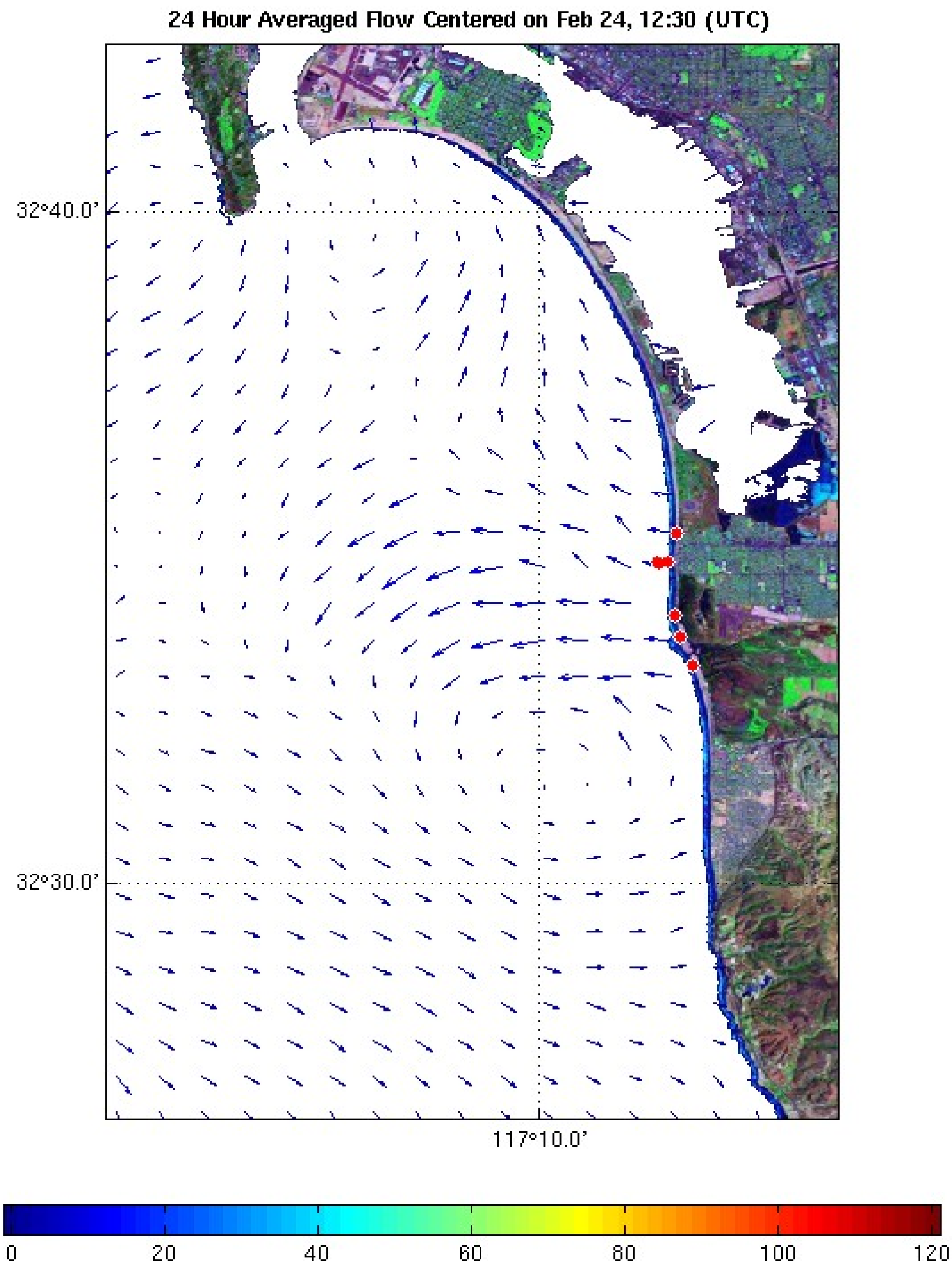


Figure 54. CODAR measurements of surface currents on February 24th following discharge from the Tijuana River during northward alongshore flow. All samples collected by the DEH and IBEBMP exceed AB411 standards (indicated by red dots).

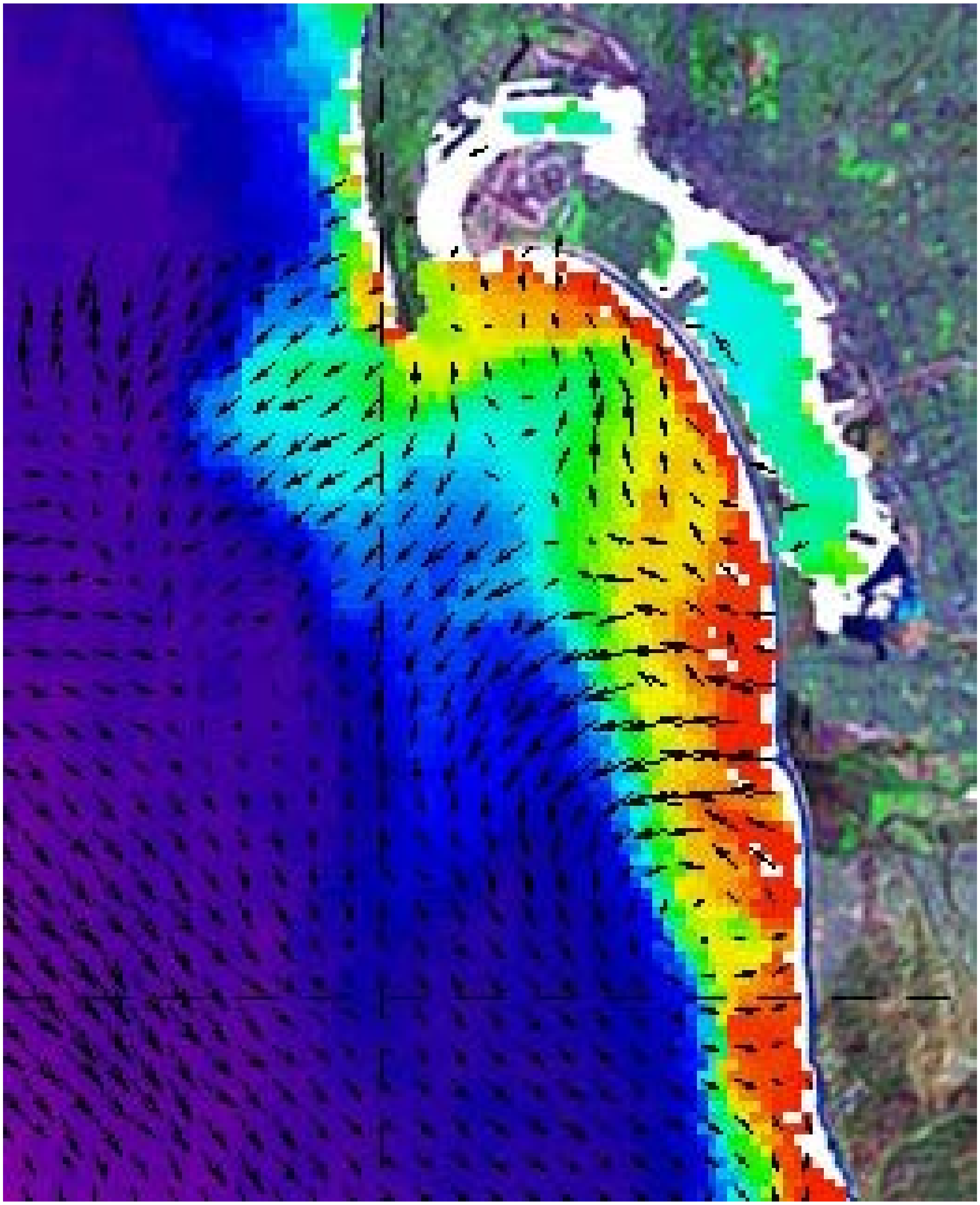


Figure 55. OCM ocean color image acquired on February 24th following discharge from the Tijuana River during northward flow near the river mouth. Warm colors indicate elevated values of turbidity and represent plumes from terrestrial runoff. CODAR vectors show northward flow along the coast from the international border throughout the South Bay. The Tijuana River plume is seen to extend up to at least Silver Strand if not all the way to Coronado.

Summary

This report summarizes the funded activities that Scripps was supported to conduct through the California Clean Beaches Initiative (CBI). The success of the development, deployment, and usage of data from the San Diego Coastal Observing System (SDCOOS) would not have been possible without open communication between Scripps, the City of Imperial Beach, and the San Diego County Department of Environmental Health. The extent of available data sources and online access would not have been possible without outside funding sources from NOAA, ONR, NSF, and State of California. We were able to leverage from existing projects for the backbone of wireless communications to the HF radar sites, installations of meteorological packages at Imperial Beach and Coronado Island, offshore ADCP measurements, integration of wave forecasts and tidal information, satellite imagery, and improved archival and retrieval capabilities. While the CBI program is formally at a close, we anticipate building from, and continuing SDCOOS with an eventual transition to Southern California wide Southern California Coastal Ocean Observing System (SCCOOS) www.sccoos.org. One goal of this report was to demonstrate that the infrastructure now in place provides a sound basis for generating data that will be used by a wide range of regional interests. An ongoing activity includes evaluation of the efficacy of the system by staff from the Department of Environmental Health. In response to the positive results they have found in working with SDCOOS, they have already begun to adapt their sampling and management strategies based upon the data from the system. We encourage all readers of this report to visit www.sdcoos.org to read about recent updates and additions to SDCOOS. We also encourage those interested in providing feedback to contact us directly.

Appendix 1.

South County Beaches Water Quality Summaries

The following is a collection of excerpts from recent San Diego County Department of Environmental Health media releases and water quality summaries related to the Southbay region.. They are included here to provide exmples of how SDCOOS is used by the DEH in asessing ocean conditions in relation to water quality at South Bay beaches.

- *DEH Media Release October 19, 2004*

WATER CONTACT CLOSURES FOR SOUTH COUNTY BEACHES CLOSURE EXTENDED TO INCLUDE SILVER STRAND AND CORONADO

Signs warning of sewage-contaminated water were posted this afternoon along the Silver Strand State Beach and Coronado shorelines. The extension of the water contact closure at the Tijuana Slough National Wildlife Refuge Shoreline was prompted by increased flows in Tijuana River following rain and observations, with supporting field measurements, that indicate flows from the rivermouth are moving north. The ocean shorelines at Border Field State Park, the Tijuana Slough National Wildlife Refuge and Imperial Beach were closed to water contact on Sunday, October 17th. Signs warning of sewage-contaminated water will remain posted at south county beaches until samples indicate the ocean waters are safe for recreational use.

- *Water Quality Summary*   *December 5 – 9, 2004*

The rain on Sunday, December 5th dropped 0.31 inches in San Ysidro and between 0.83 and 10.2 inches at the three Tijuana River watershed locations. This increased flows in the Tijuana River into the US from about 20 millions of gallons per day (MGD) to over 100 MGD for a few hours late in the day on December 5th. Since then river flows entering the US have dropped to 23 - 25 MGD.

Bacterial levels measured in the river in the Tijuana River Valley on Dec 7th showed total coliform levels over 5,000,000 (most probable number/milliliter) MPN/100mL and E. Coli over 1,000,000 MPN/100mL.

SDCOOS data showed strong (> .2mph (10 cm/sec)) northward flow at the rivermouth and along the shoreline following the arrival of the storm late on December 5th.

The County of San Diego Department of Environmental Health (DEH) extended the ocean water contact closure at the south end of Seacoast Drive north to include the Imperial Beach, Silver Strand State Beach and Coronado ocean shorelines on Monday morning December 6th.

Sample results from Imperial Beach on December 6th showed all three locations (Palm Ave, IB pier, Cortez Ave) exceeding state standards, and exceeding multiple indicators.

Although the alongshore current measured at the Imperial Beach pier turned to a strong southward flow on December 7th, the .54nm (1 km) offshore flow at the Tijuana River mouth only slowed to a neutral or non- north/south flow. Sample results from Imperial Beach on December 7th continued to show bacterial levels at all three locations (Palm Ave, IB pier, Cortez Ave) exceeding state standards, but not for multiple indicators. Sample results from Coronado (Central Beach and Avenida Del Sol) on December 7th also exceeded state standards for one indicator.

Southerly winds on December 8th caused the .54nm (1 km) offshore flow at the Tijuana River mouth to move strongly again to the north, but only brought the alongshore current direction at the Imperial Beach to neutral.

As of today, December 9th, the **SDCOOS** 24 hour average current shows a weakening NW direction flow from the rivermouth and no discernable direction at Silver Strand State Beach or Coronado. Samples were collected again today at Imperial Beach and Coronado and will be evaluated on Friday December 10th to determine if the water contact closure can be lifted for south county beaches.

- *Water Quality Summary   December 10 – 16, 2004*

Bacterial sampling of ocean waters in Imperial Beach and Coronado on Dec 9th showed bacterial levels had dropped to within state standards, and sewage contaminated water warning signs were removed at Imperial Beach, Silver Strand SB and Coronado on Dec 10th.

Although the last significant rain was on Dec 5th for the south county, flows in the Tijuana River continue to enter the US (averaging 11 MGD since Dec 11th) and fill the Tijuana estuary. The river diversion and pump station operated by CESPT (Tijuana's sewer agency) either remains off or is unable to capture all the flows in the river channel prior to entering the US. Extreme tidal swings since Dec 10th have enhanced the exchange of sewage-contaminated runoff in the estuary with ocean waters, but currents kept these flows to ocean waters south of the south end of Seacoast Drive.

Bacterial levels measured in ocean waters at the Tijuana Rivermouth on Dec 14th showed all indicators within state standards; however, the sample was collected just before high tide and may not be representative of the influence of river/ estuary on ocean waters during an outgoing tide.

Bacterial levels measured in the river in the Tijuana River Valley on Dec 14th showed total coliform levels over 15,000,000 MPN/100mL and E. Coli over 4,000,000 MPN/100mL at the Hollister Bridge.

On Wednesday afternoon, Dec 15th the County of San Diego Department of Environmental Health (DEH) received reports of discolored water and odors in ocean waters off Imperial Beach. Both the alongshore current measured at the Imperial Beach pier and the near shore current measured .54nm (1 km) offshore from the Tijuana

Rivermouth showed a moderate (> .1mph (5 cm/s)) northward flow for part of the day on the 15th despite a building NW swell. DEH extended the ocean water contact closure at the south end of Seacoast Drive north to include the Imperial Beach shoreline on Wednesday afternoon.

On Thursday morning, Dec 16th, the alongshore current measured at the Imperial Beach pier turned to a strong southward flow. The near shore flow at the Tijuana River mouth only slowed to a neutral or very weak south to north flow. Observations from the Imperial Beach Lifeguards noted improved appearance of water quality from the pervious day. DEH also collected samples at three locations (Palm Ave, IB pier, Cortez Ave) to correlate with the **SDCOOS** data and field observations.

- *Water Quality Summary   December 28, 2004 – January 03, 2005*

This latest storm started with rain on Tuesday, December 28th. The rainfall impacted the south county area later in the morning than the rest of the county but still dropped over 1.5 inches in San Ysidro and over 1.9 inches at the three Tijuana River watershed locations in 24 hours. More rain came on December 29th and totals for the 48 hour period exceeded 2.15 inches along the coast and 3.0 inches in the upper Tijuana watershed. Only small amounts of rain were measured in south county from the last rain on Jan 3rd.

The Tijuana River Diversion and Pumping Station, operated by officials in Mexico, resumed operation on Dec 25th, capturing all flows in the river channel and diverting them to Mexico Pump Station 1. The rains on Dec 28th caused flows to by-pass the diversion and enter the U.S. Flow rates in the Tijuana River increased from 21 cubic feet/second (cfs) (0.6 cubic meters/second (cms)) at 9:00 AM to more than 141 cfs (4 cms) at 9:15 AM. Daily flow rates in the river measured about 190 MGD for Dec 28th and over 600 MGD on Dec 29th. Since Dec 30th the flow rates in the Tijuana River entering the U.S. have dropped closer to 65 MGD.

The County of San Diego Department of Environmental Health (DEH) extended the ocean water contact closure at the Tijuana Rivermouth north to include the Imperial Beach, Silver Strand State Beach and Coronado ocean shorelines on Tuesday morning December 28th.

SDCOOS data showed strong (> .4mph (20 cm/sec)) northward flow along the shoreline at the Imperial Beach pier from December 28th - 30th. Alongshore current data and the time history of the depth averaged currents between Jan 1st and 2nd is in dis-agreement, but both show a south - north moving current again as of today, Jan 3rd, albeit much weaker (about .1mph (5 cm/s)).

Sample results from Imperial Beach through north beach Coronado on December 29th showed bacteria levels for all indicators exceeding state standards, and exceeding multiple indicators (> 16,000 coliforms and > 2,005 enterococci) at all locations. (Palm Ave, IB pier, Cortez Ave, Silver Strand x 2, Avd Del Sol, Central beach and north beach).

Sampling by DEH at these stations again on Jan 1st continued to show bacteria levels for all indicators exceeding state standards, and exceeding multiple indicators.

As of today, Jan 3rd, the **SDCOOS** 24 hour average current shows a weakening NW direction flow offshore from the rivermouth. Samples will be collected in Imperial Beach and Coronado on Jan 4th and Jan 5th to determine if the water contact closure can be lifted for south county beaches.

- *Water Quality Summary   January 03 – 06, 2005*

Moderate to heavy rain fell again on Tuesday, January 4th, increasing Tijuana River flows entering the US from about 212 cubic feet/sec (cfs) (6 cubic meters/ sec (cms)) to 530 – 706 cfs (15 - 20 cms) with short duration spikes over 3,530 cfs (100 cms). Daily flows were over 300 MGD on Jan 4 and dropped to about 150 MGD on Jan 5th. Bacterial levels in the river at the Dairy mart bridge measured > 3 million MPN/100mL for total coliform and > 600,000 MPN/100mL for e. coli on Jan 4th.

Although the **SDCOOS** data showed only a weak (.1mph (5 cm/sec)) northward flow along the shoreline at the Imperial Beach pier on Jan 4th, beach water quality samples collected that day exceeded state standards for multiple indicators at several magnitudes above the standards in Imperial Beach, and varied just below and above the standards at locations in Coronado.

Later on Jan 4 **SDCOOS** showed the alongshore current measured at the Imperial Beach pier slowing to a neutral/ non-direction flow and then slightly southward (< .1mph (5 cm/sec)) for Jan 5th and today. The nearshore data measured .54nm (1 km) offshore from the Tijuana Rivermouth and the 24 hour averaged current direction offshore have been unavailable since Dec 27th and cannot confirm the alongshore current since then.

Despite the slowing and slight reversal of alongshore current direction, samples collected by DEH from Imperial Beach north to Coronado north beach on Jan 5th showed bacterial levels exceeding state standards for multiple indicators at several magnitudes above the standards at all locations. A possible explanation is that the large volume of contaminated runoff pushed NW from the rivermouth earlier in the week had come into shore.

Tropical moisture is expected to bring significant rain and strong south - northward moving ocean currents on Friday, Jan 7th.

The ocean water contact closure for Imperial Beach, Silver Strand State Beach and Coronado ocean shorelines issued on December 28th by the County of San Diego Department of Environmental Health (DEH) extended remains in effect for south county beaches.

- *DEH Media Release* *January 19, 2005*

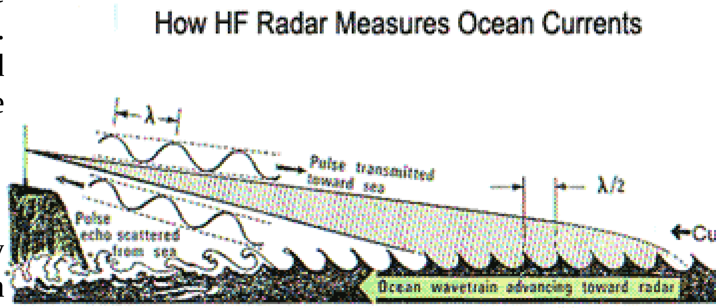
WATER CONTACT CLOSURE FOR IMPERIAL BEACH FLOWS AT TIJUANA RIVER MOUTH MOVING NORTH

The County of San Diego Department of Environmental Health has issued a water contact closure for the Imperial Beach shoreline. The extension of the water contact closure at the Tijuana Slough National Wildlife Refuge Shoreline was prompted by observations, with supporting field measurements, that indicate sewage contaminated flows from the Tijuana River mouth are moving north. The ocean shorelines at Border Field State Park and the Tijuana Slough National Wildlife Refuge were closed to water contact on December 28th, 2004 due to sewage contaminated flows from the Tijuana River entering ocean waters. Signs will remain in place until sample results indicate the ocean water is safe for recreational use. For more information on the Tijuana River, please call the U.S. International Boundary & Water Commission at 619-662-7600.

Appendix 2.

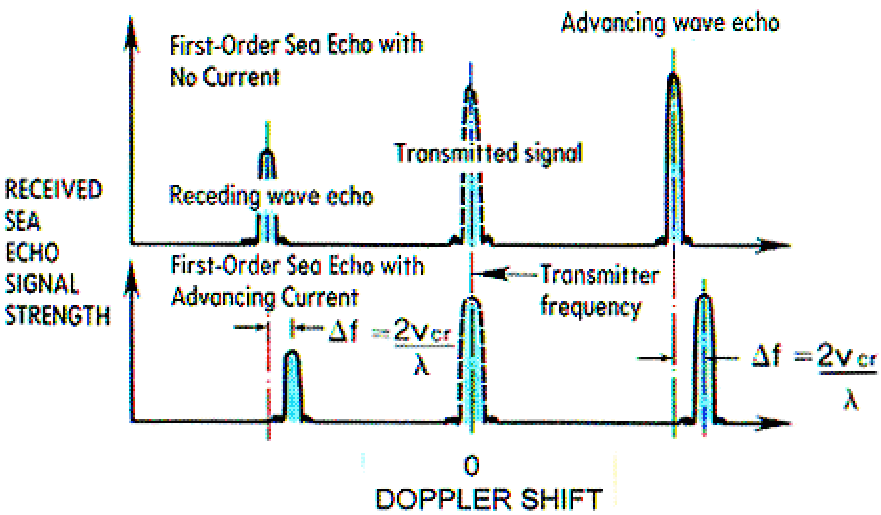
Technical details regarding HF radar principles of operation

Doppler Radar transmits radio waves in the 10 to 50MHz band and listens to the scattered signal from the surface waves that have wavelengths in the 15 to 3m range. System directly measures the speed of the waves that scatter the radar signal. Differences between the measured speed and the known speed of the waves are the ocean surface currents.



The Unique Nature of HF Radar

High-frequency (HF) radio formally spans the band 3-30 MHz (with wavelengths between 10 meters at the upper end and 100 meters at the lower end). For our radars, we extend the upper limit to 50 MHz. A vertically polarized HF signal is propagated at the electrically conductive ocean water surface, and can travel well beyond the line-of-sight, beyond which point more common microwave radars become blind. Rain or fog does not affect HF signals.



The ocean is a rough surface, with water waves of many different periods. When the radar signal hits ocean waves that are 3-50 meters long, the signal scatters in many directions. In this way, the surface can act like a large diffraction grating.

But, the radar signal will return directly to its source only when the radar signal scatters off a wave that is exactly half the transmitted signal wavelength, AND that wave is traveling in a radial path either directly away from or towards the radar. The scattered radar electromagnetic waves add coherently resulting in a strong return of energy at a very precise wavelength. This is known as the Bragg principle, and the phenomenon 'Bragg scattering'. At the SeaSonde's HF/VHF frequencies (4-50 MHz), the periods of these Bragg scattering short ocean waves are between 1.5 and 5 seconds.

What makes HF RADAR particularly useful for current mapping is that the ocean waves associated with HF wavelengths are always present. The following chart shows three typical HF operating frequencies and the corresponding ocean wavelengths that produce Bragg scattering.

25 MHz transmission -> 12m EM wave -> 6m ocean wave
12 MHz transmission -> 25m EM wave -> 12.5m ocean wave
5 MHz transmission -> 60m EM wave -> 30m ocean wave

$$\lambda_w = \frac{\lambda_t}{2\cos(\theta)}$$

Where :

λ_w = *Wavelength of Surface Waves*

λ_t = *Wavelength of Transmitted Signal*

θ = *Incident* ∟ *of the Signal*

So far three facts about the Bragg wave are known: its wavelength, period, and travel direction. Because we know the wavelength of the wave, we also know its speed very precisely from the deep water dispersion relation.

The returning signal exhibits a Doppler-frequency shift. In the absence of ocean currents, the Doppler frequency shift would always arrive at a known position in the frequency spectrum. But the observed Doppler-frequency shift does not match up exactly with the theoretical wave speed. The Doppler-frequency shift includes the theoretical speed of the speed of the wave PLUS the influence of the underlying ocean current on the wave velocity in a radial path (away from or towards the radar).

The effective depth of the ocean current influence on these waves depends upon the waves period or length. The current influencing the Bragg waves falls within the upper meter of the water column. So, once the known, theoretical wave speed is subtracted from the Doppler information, a radial velocity component of surface current is determined.

By looking at the same patch of water using radars located at two or more different viewing angles, the surface current radial velocity components can be summed to determine the total surface current velocity vector. Basic HF Radar for Current Mapping At a SeaSonde HF radar station there is one transmitting antenna and one receiving antenna unit. The antennas are connected to the radar transmit chassis and receive chassis, which are controlled by a small desktop computer.

The transmitting antenna is omni-directional, meaning that it radiates a signal in all directions. The receive antenna unit consists of three co-located antennas, oriented with respect to each other on the x, y, and z-axes (like the sensors on a pitch and roll buoy). It is able to receive and separate returning signals in all 360 degrees.

For mapping currents, the radar needs to determine three pieces of information:
1. Bearing of the scattering source (which we'll refer to as 'Target'),
2. Range of the Target, and
3. Speed of the Target

To determine bearing, range and speed of the Target, a time series of the received sea echo is processed.

The first determination is Range to target.
The distance to the patch of scatterers in any radar depends on the time delay of the scattered signal after transmission. The SeaSonde employs a unique, patented method of determining the range from this time delay. By modulating the transmitted signal with a swept-frequency signal and demodulating it properly in the receiver, the time delay is converted to a large-scale frequency shift in the echo signal. Therefore, the first digital spectral analysis of the signal extracts the range or distance to the sea-surface scatterers, and sorts it into range 'bins' (typically set to 32 bins, but capable up to 64 bins). In HF versions of the SeaSonde, these bins are typically set between 1 and 12 km in width. In the VHF version of the SeaSonde, these bins are typically set between 300 m and 1.5 km.

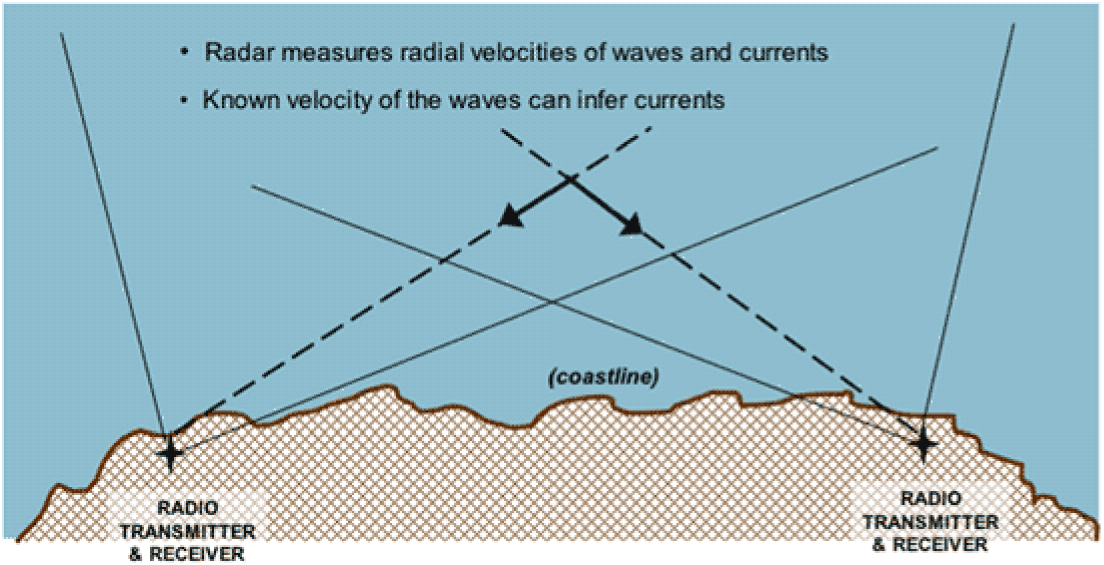
The second determination is Speed from Doppler of the target.
Information about the velocity of the scattering ocean waves (which includes speed contributions due to both current and wave motions) is obtained by a second spectral processing of the signals from each range bin, giving the Doppler-frequency shifts due to these motions. The length of the time series used for this spectral processing dictates the velocity resolution; at 12 MHz for a 256-second time-series sample, this corresponds to a velocity resolution ~4cm / s. (The velocity accuracy is a separate quantity; it can be better or worse than this depending on environmental factors.) The SeaSonde or any radar can measure only the velocity component from Doppler 'radial' to the radar from the target on the ocean, meaning that component pointing toward or away from the radar.

The third determination is the Bearing of the target.
After the range to scatterers and their radial speeds have been determined by the two spectral processing steps outlined above, the final step involves extraction of the bearing angle to the patch of scatterers. This is done for the echo at each spectral point (range and speed) by using simultaneous data collected from the three collocated directional receive antennas. The complex voltages from these three antennas are put through a 'direction-finding' (DF) algorithm to get the bearing. The particular, patented algorithm adapted and perfected for the SeaSonde is referred to as MUSIC. At the end of these three signal-processing algorithms, surface-current radial speed maps are available in polar coordinates. That is, the radial speeds on the ocean are specified vs range and bearing about the origin, which is the radar site.

Radial data is produced at intervals varying between 18 minutes for the low-frequency systems to 4 minutes at the upper frequencies. These data are then averaged over a user-selected time period (typically an hour), to create a radial vector map at the radar station. A computer called the central data combining station, located at the user’s office, connects to the radar station computer at user-selectable time intervals, and retrieves the radial vector map data files.

From radial speed map to total surface current velocity vector map
Radial speed maps from each radar site alone are not a complete depiction of the surface current flow, which is two-dimensional. This is why at least two radars are normally used to construct a total vector from each site's radial components. At the central data

combining station, the radial vector maps from multiple radar stations are merged to create a total velocity vector current map.



Appendix 3.

Contact information for questions regarding the content of this report

Mr. Hank Levien
City Engineer
City of Imperial Beach
825 Imperial Beach Blvd.
Imperial Beach, CA 91932
hlevien@cityofib.org

Dr. Eric Terrill, PhD
Scripps Institution of Oceanography
8861 Shellback Way, Keck Center
La Jolla, CA 92093-0213
eterrill@ucsd.edu

Mark Otero
Scripps Institution of Oceanography
8861 Shellback Way, Keck Center
La Jolla, CA 92093-0213
motero@mpl.ucsd.edu

Lisa Hazard
Scripps Institution of Oceanography
8861 Shellback Way, Keck Center
La Jolla, CA 92093-0213
ll@mpl.ucsd.edu

Clay Clifton
County of San Diego, Dept of Environmental Health
Land & Water Quality Division
Water Quality / Recreational Water Program
clay.clifton@sdcounty.ca.gov

Appendix 4.

Imperial Beach Enhanced Bacteria Monitoring Program Report

The following pages include the Imperial Beach Enhanced Bacteria Monitoring Program Report, in its entirety, submitted to the County of San Diego Department of Environmental Health on December 24th, 2004.

IMPERIAL BEACH ENHANCED BACTERIA MONITORING PROGRAM

Report to County of San Diego,

Department of Environmental Health

Prepared by

John Largier[1], Teresa Kacena, Leena Palekar, Eric Terrill,

Doug Bartlett, and Carolyn Scearce

Scripps Institution of Oceanography, University of California San Diego

24 December 2004

[1] Now at Bodega Marine Laboratory (University of California Davis), Bodega Bay, CA 94923. Email contact for correspondence: jllargier@ucdavis.edu

TABLE OF CONTENTS

1. INTRODUCTION

This final report outlines the work completed as part of the Imperial Beach Enhanced Bacteria Monitoring Program (IBEBMP), funded by The County of San Diego. Funding was provided to collect and analyze bacteria water samples in order to validate the San Diego Coastal Ocean Observing System (SDCOOS, sdcoos.ucsd.edu) as a tool for real-time beach water quality monitoring. Throughout the project an active dialogue between personnel from Scripps Institution and the County has been maintained and this is expected to continue following completion of the contract. Further, this report will be followed by a Clean Beach Initiative (CBI) report, which will include more detailed analysis of currents and ocean conditions monitored through SDCOOS. As the CBI report will also be submitted to the County, the focus in this IBEBMP report is on what fecal indicator bacteria (FIB) data were collected – where, when and why.

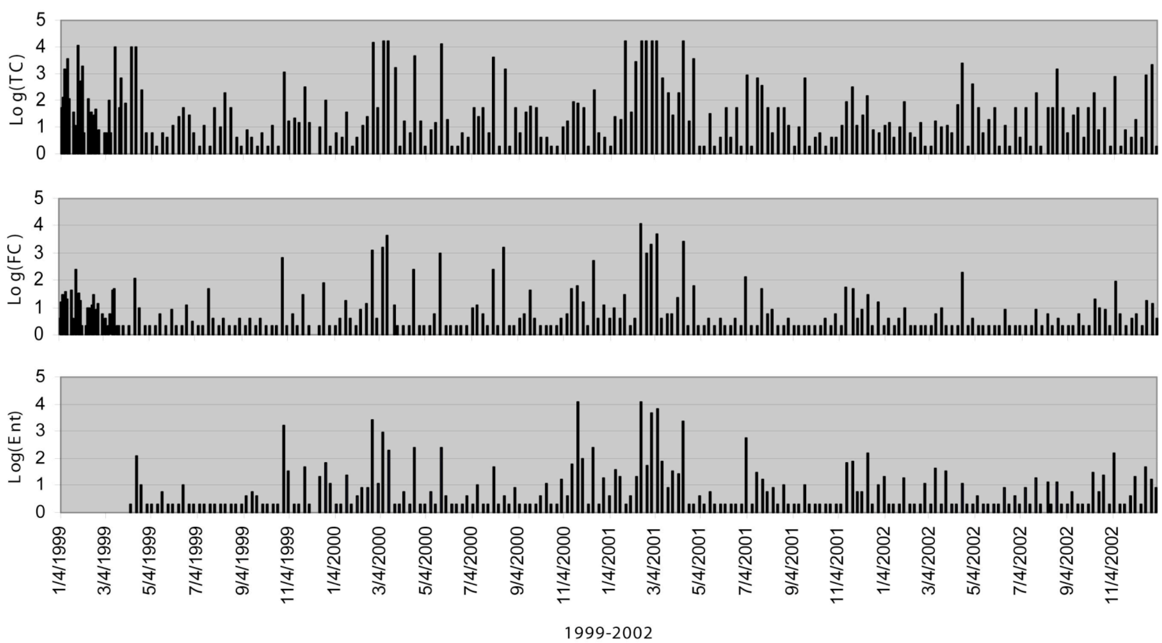


Figure 1-1: Fecal indicator bacterial levels observed at Seacoast Drive from 1999 to 2002 through routine weekly monitoring conducted by the City of San Diego's Metropolitan Wastewater Department under contract to IBWC. The IBEBMP was proposed to supplement the weekly monitoring conducted by IBWC/City and the County of San Diego by providing more detailed data for specific events.

The observed fecal bacteria contamination of waters along the Imperial Beach and adjacent shorelines (e.g., Figure 1-1) and the presence of identifiable sources of fecal bacteria (Figure 1-2) led to the plan to monitor transport patterns through SDCOOS and to conduct enhanced sampling of bacteria for a year. Through review of historical data (Searce 2004; Largier et al 2004) it became clear that land runoff is the primary source of high levels of fecal bacteria off Imperial Beach, specifically via outflow from the Tijuana River and Estuary. Similar results have been found for Huntington Beach, which is adjacent to the Santa Ana River (Kim et al 2004). In this IBEBMP, we also find that outflow from the Tijuana River and Estuary is the most notable source of bacterial contamination of nearshore waters off Imperial Beach. Thus, our attention was focused on obtaining FIB data that better describe the temporal and spatial nature of these contamination events – necessitating water sampling that: (i) is more frequent than the weekly County monitoring; (ii) is more rapid/synoptic than the weekly County monitoring; (iii) includes some additional stations; and (iv) is concurrent with oceanographic observations obtained through SDCOOS. These data demonstrate the central role of water-borne transport in accounting for observed FIB patterns along the Imperial Beach shoreline.

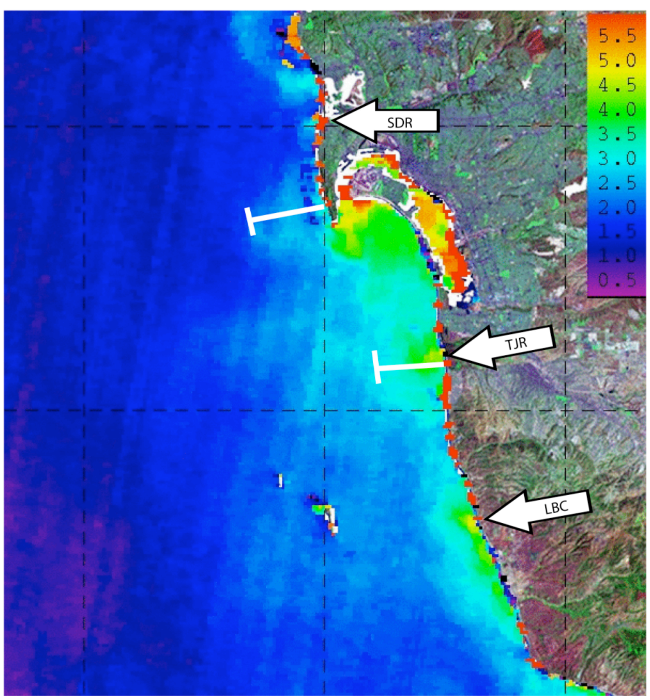


Figure 1-2: Ocean color image of chlorophyll-a with arrows indicating large-scale sources of freshwater flux to the San Diego region (SDR= San Diego River, TJR=Tijuana River, LBC= Los Buenos Creek). Additional offshore fluxes are via the Point Loma Ocean Outfall to the north (near the San Diego River) and the South Bay Ocean outfall to the south (near the Tijuana River), indicated by T-lines. The data are obtained from the Ocean Color Monitor sensor on board the OceanSat-1 satellite.

In both wet and dry seasons, FIB data were obtained using the same protocols as the County of San Diego Department of Environmental Health. These methods are outlined in Chapter 3. The results of previous studies are briefly reviewed in Chapter 2 and results from this work are presented in Chapter 4, with a summary in Chapter 6.

2. PREVIOUS STUDIES

Concurrent with this IBEBMP, a pair of reports was published that present a review of historical data in this region (Scearce 2004; Largier et al 2004). In these reports, the shoreline data collected by the City of San Diego were analyzed. These data are collected under contract to the IBWC (International Boundary and Water Commission), who operate the South Bay Ocean Outfall as part of the South Bay International Wastewater Treatment Plant. A requirement of their NPDES discharge permit is weekly FIB monitoring of shoreline stations extending from south of Tijuana to Coronado. These data and the analysis of pattern are described in detail in Scearce (2004) and Largier et al (2004). These studies addressed the same general question of beach contamination. In Scearce (2004), the aim was to relate FIB contamination events to environmental conditions (e.g., rain, river flow, wind, waves, tides). Largier et al (2004) presents a review of the IBWC FIB monitoring program and whether it is adequate in terms of identifying when or if South Bay Ocean Outfall wastewater impinges on the shoreline, resulting in FIB exceedances.

These studies were conducted concurrently with this IBEBMP and thus informed our choices in directing the enhanced monitoring effort. This review of historical data confirmed that beach FIB contamination events were most common and most severe following rain events (Figure 2-1), which usually occur during winter. Further, prior to effective dry-weather diversion of the Tijuana River, beach FIB events were also observed in association with river flow events. In recent years, river flow events are correlated with rain events as dry-weather flows are effectively diverted. In Figure 2-1, it is clear that highest levels are observed around the Tijuana mouth following rain, with levels dropping off strongly to the north and less strongly to the south. At the southernmost stations, the effect of the Los Buenos Creek outfall is evident in the high values during no-rain/no-flow conditions. In the absence of rain or flow events, and away from the influence of Los Buenos Creek, coliform levels are typically low (total coliform between 50 and 500; fecal coliform between 10 and 100), but enterococcus levels may be notable (between 10 and 100), suggesting that there may be additional localized enterococcus sources (e.g., at Carnation Avenue, S12).

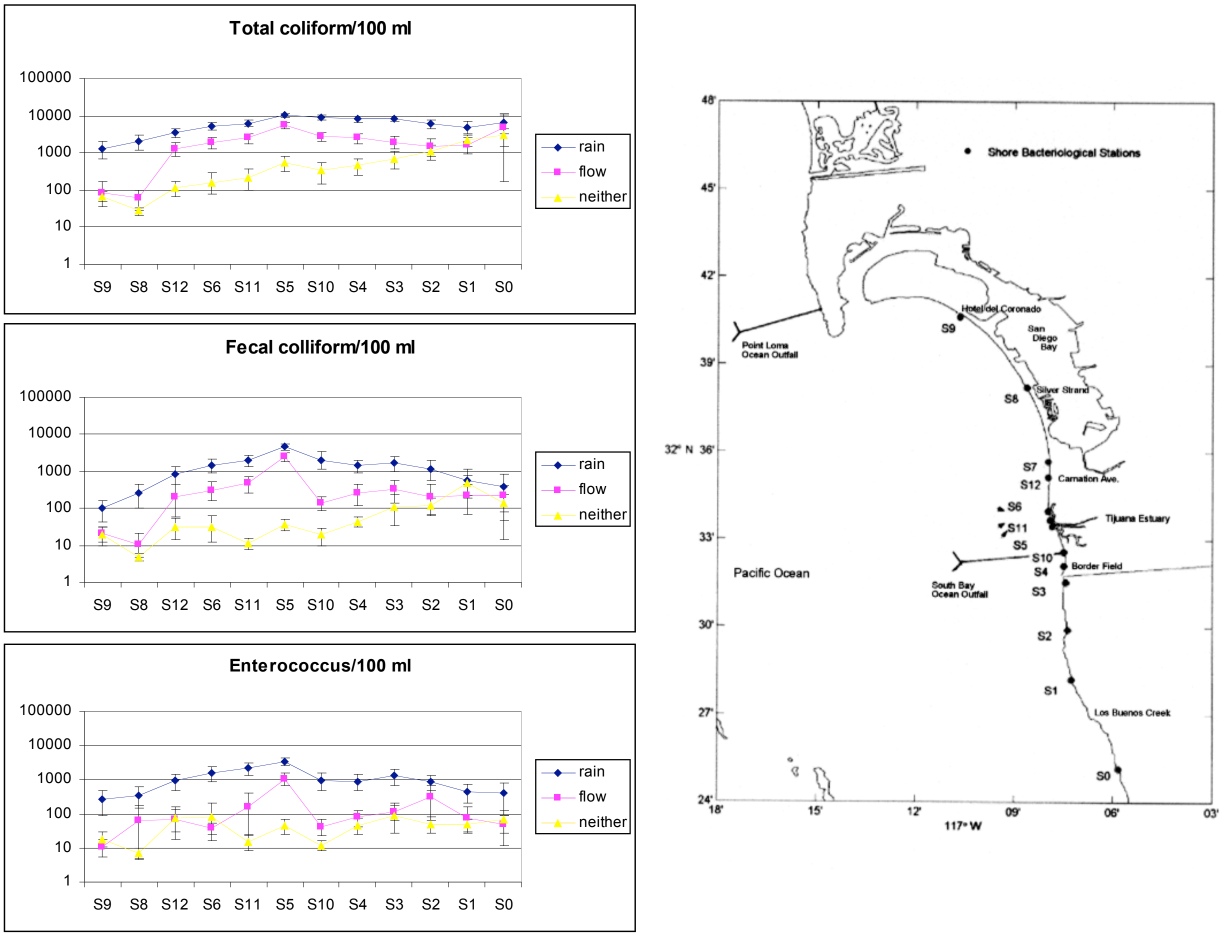


Figure 2-1: Bootstrap means with 95% confidence intervals of bacterial abundance under rain-influence, flow-influence, and no rain/no flow influenced conditions. Bacterial data is consecutively divided. First rain data were removed, including all data where the 5-day rain total was greater or equal to 2.5 mm. Flow data were next removed, including all data where flow from the Tijuana River was at least 0.01 m^3/s. No rain/no flow-influenced events include all remaining data. Bootstrap means were derived for each event type for each station and indicator by a process of sampling and replacement. Station positions shown in map. From Scearce (2004).

High FIB levels are typically widespread during rain (Figure 2-2), with only Coronado station S9 not exhibiting high values following rain. While high levels persist at the Tijuana River (station S5) for up to 5 days following rain, the rain effect is short-lived at stations further away from the mouth of the River – typically lasting only a day or two after rain (Figure 2-2). This pattern reflects the persistent outflow from the River long after stormwater flows have ended elsewhere in the region.

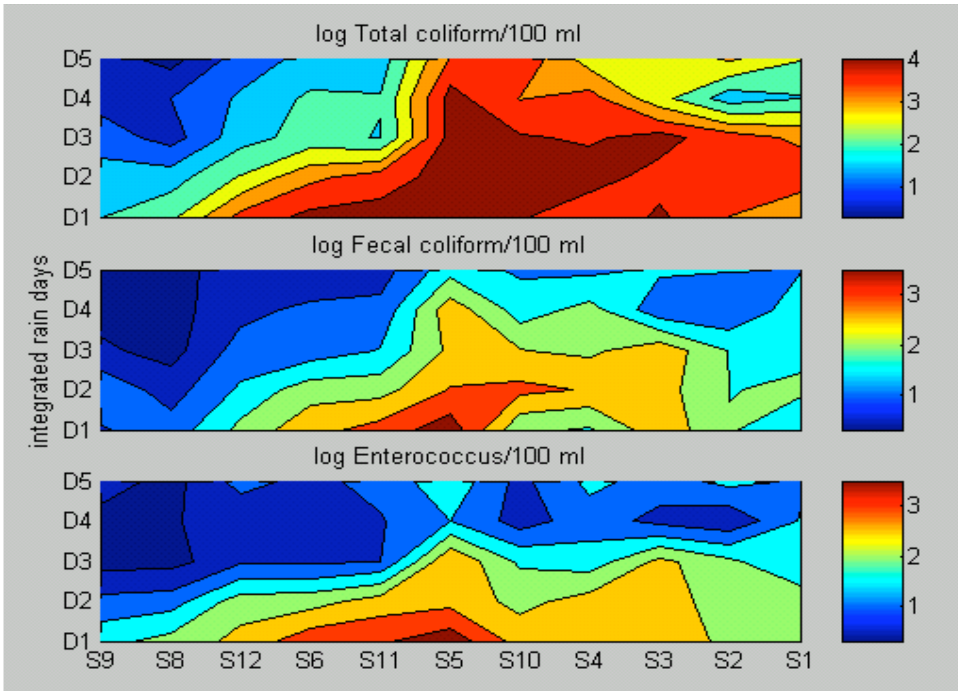


Figure 2-2: Log of median bacterial level observed at IBWC/City stations after rainfall events. Stations listed from north to south (see Figure 2-1 for positions). Cumulative rainfall of 2.5 mm used to identify rain-influenced events. Data is consecutively binned with increasing time from rainfall event: D1 includes all data from the day of rain; after removal of D1 data, D2 includes all data for which 2.5 mm of rain fell on the day of sampling plus day prior to sampling; data for D3, D4, and D5 are similarly obtained for longer periods after rain.

While beach contamination events were primarily associated with rain and river flow, there were a limited number of events observed during dry weather. Analysis of these dry-weather events points to occasions when wave-driven northward flow transports FIB to the beaches of Imperial Beach. Scearce (2004) thus argues for an association between south swell conditions and FIB levels and provides a few examples of events where there is a marked north-south trend in FIB levels during south swell (Figure 2-3). Scearce (2004) also suggests that there may be an association of FIB concentration with southerly winds.

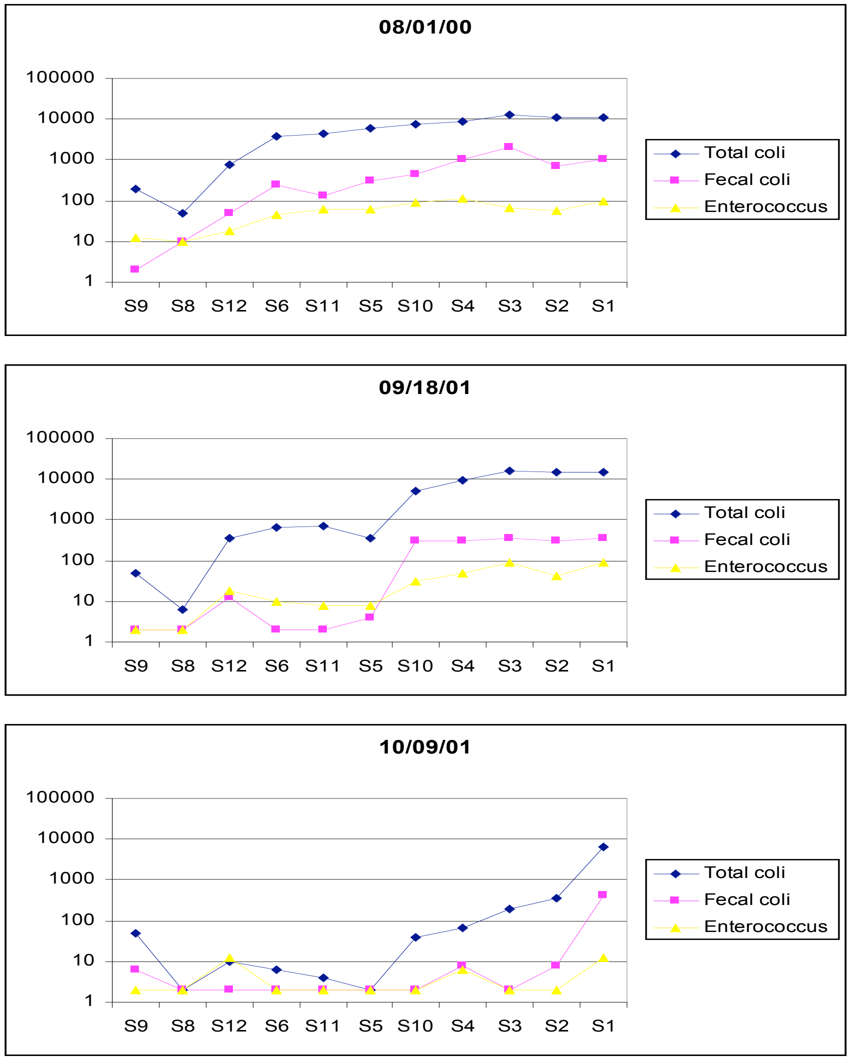


Figure 2-3: Examples of increased bacterial abundance observed during south swell under no rain/no flow conditions. 8/01/00 is an example of a day with high-energy waves from the south direction. 9/18/01 shows a day with lower wave energy, but more long-term swell. 10/09/01 shows a day where south swell has been occurring for several days but is beginning to decline. From Scearce (2004).

Further, during dry-weather conditions, tidal patterns are reported by Scearce (2004), indicating a tendency for higher levels of FIB during spring tides and higher levels of FIB following the ebb tide. On closer examination of the hour-to-hour variability in FIB levels, one can discern a pattern in which high values are observed at the mouth of Tijuana (station S5) on the outgoing tide, followed by moderately high values at stations immediately north of Tijuana mouth (stations S11 and S6) in the hours following low tide (Figure 2-4). These tidal pulses during dry weather suggest the FIB levels remain high in the estuary for weeks following rain. Thus, during spring tides one can expect FIB-rich waters to be exported from the backwaters of the estuary.

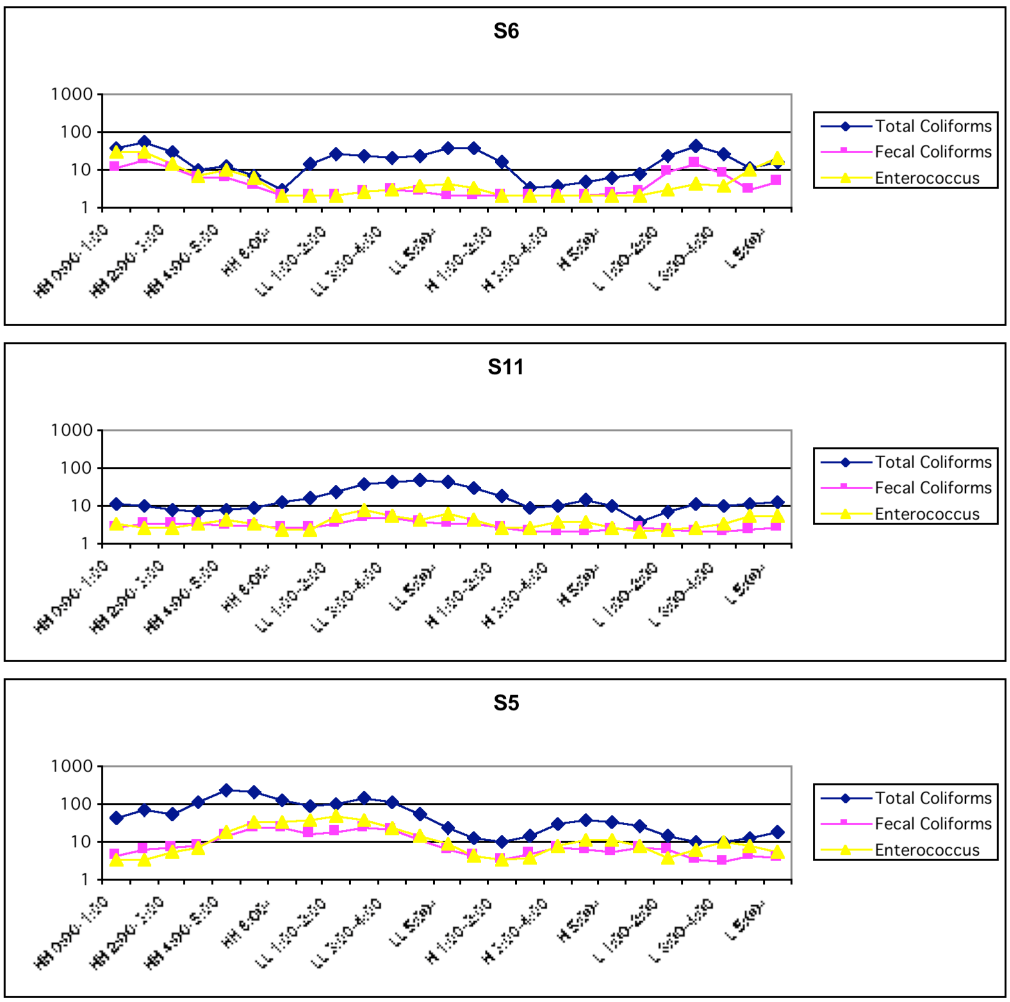


Figure 2-4: Median of bacterial abundance for data binned hourly according to tidal phase. Data shown for shoreline stations immediately north of Tijuana Estuary. Data were binned relative to the most recent tidal extreme occurring before bacterial sampling was identified. From Scearce (2004).

Tidal pulses of FIB have also been observed along the Huntington Beach shoreline, north of the Santa Ana River (Kim et al 2004). The very rapid sampling off Huntington Beach presents a more complete picture of FIB-rich waters being ejected from the river and then transported north along the beach by tidal currents (Figure 2-5). Wave-driven flow in the surfzone and alongshore mean currents offshore of the surfzone may interfere with or enhance this pattern of tidal pulses.

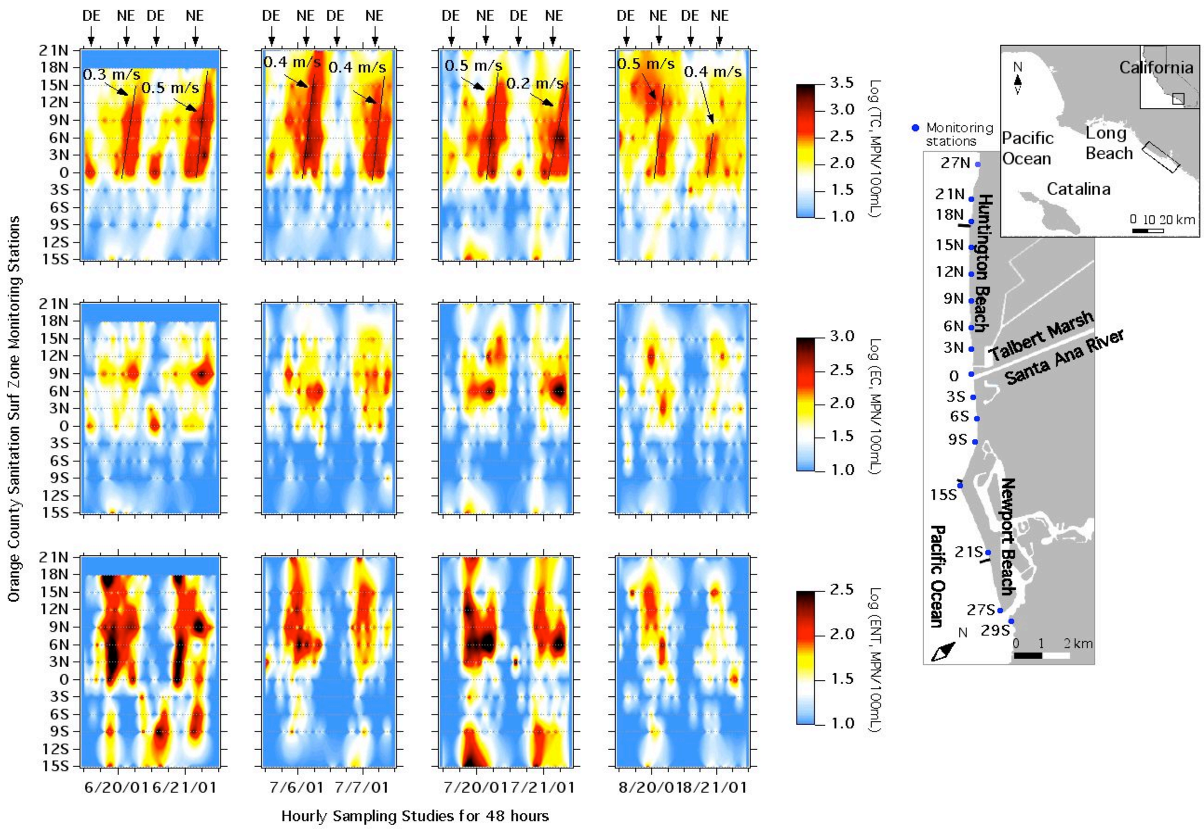


Figure 2-5: FIB levels observed along the Huntington Beach shoreline during 3 intense sampling efforts. Pulses of high total coliform, fecal coliform and enterococcus are observed traveling northwards along the shoreline to the north of the Santa Ana River, following tidal outflow from the River. From Kim et al (2004).

3. METHODOLOGY

3-1. Field Methods

The area examined in this study is the "South Bay" shoreline, extending from the US-Mexico Border along Imperial Beach and up through parts of Silver Strand State Beach and Coronado (Figure 3-1). The field sampling sites were selected from sites routinely sampled by the County of San Diego Department of Environmental Health for recreational water monitoring, in addition to sites selected for their proximity to the Tijuana Estuary (Figure 3-2). In addition, stations within the estuary were sampled on a few occasions (Figure 3-3). A list of field sites is given in Table 3-1. A total of 800 samples were collected from 42 different sites from July 2003 through July 2004. Each sample was analyzed for total coliforms, fecal coliforms, and enterococci.

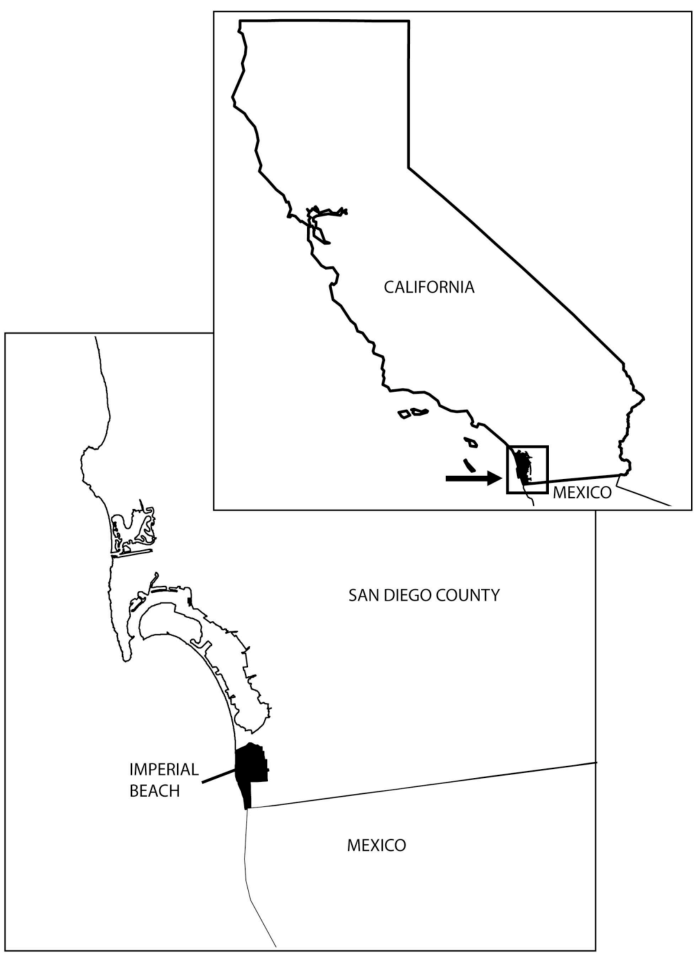


Figure 3-1: The study region in southern California, including the shorelines of Imperial Beach and adjacent areas in southern San Diego County.

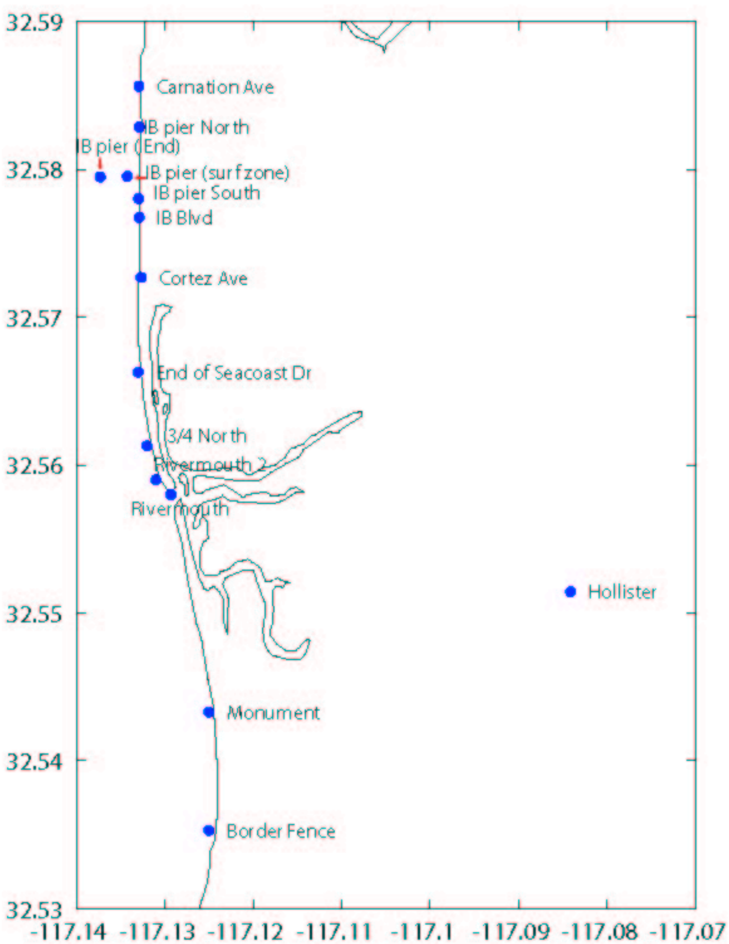


Figure 3-2: Field stations sampled frequently during IBEBMP, include a station at the "river mouth" and a station on the river on entering the estuary at Hollister Road. Station positions, names and identification numbers are listed in Table 3-1.

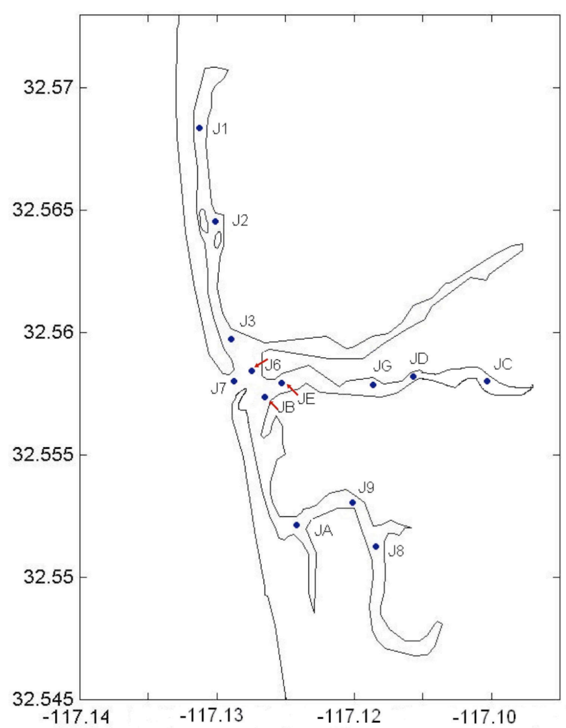


Figure 3-3: Field stations sampled within the Tijuana Estuary at high tide. Station positions, names and identification numbers are listed in Table 3-1. Sample days are listed in Table 3-2.

Station ID	Station Name	Latitude	Longitude
A0	Border Fence, N side	32.53530	-117.12500
B0	Monument Rd.	32.54330	-117.12500
L2	TJL225 (675 feet south C2)	32.55452	-117.12836
L0	TJL75 (225 feet south C2)	32.55564	-117.12807
C2	Tijuana Rivermouth (South)	32.55663	-117.12858
C4	Tijuana Estuary (South)	32.55610	-117.12643
M0	Hollister	32.55143	-117.08411
M1	Smuggler's Gulch	32.54395	117.08842
C0	Tijuana Rivermouth (North)	32.55620	-117.12930
C3	Tijuana Estuary (North)	32.55737	-117.12835
R0	TJR75 (225 feet north C0)	32.55738	-117.13076
R2	TJR225 (675 feet north C0)	32.55856	-117.13137
C1	Tijuana Rivermouth 2	32.55780	-117.13100
D0	3/4 mi. N of TJ River	32.56130	-117.13200
E0	End of Seacoast Dr	32.56630	-117.13300
F0	Cortez Ave	32.57269	-117.13268
H0	IB pier (Shore)-South	32.58040	-117.13322
H3	IB pier (Shore)-North	32.58004	-117.13293
H1	IB pier (middle-surf zone)	32.57955	-117.13420
H9	IB pier (End)	32.57946	-117.13728
PO	Palm Ave	32.58370	-117.13324
K0	Carnation Ave	32.58562	-117.13290
N1	Silver Strand S end (ocean side)	32.62620	-117.13959
N0	Silver Strand N end (ocean side)	32.63680	-117.14400
Q0	Avd. del Sol (Coronado)	32.67700	-117.17800
J1	Oneonta Slough (furthest)	32.56486	-117.13124
J2	Oneonta Slough (mid-furthest)	32.56338	-117.13032
J3	Oneonta Slough (mouth)	32.56066	-117.13062
J4	Estuary (north)	32.55915	-117.12872
J5	Estuary	32.55673	117.12787
J6	Estuary (center)	32.55553	-117.12700
J7	Estuary (center-mouth)	32.55585	-117.12804
J8	Southwest Slough (outermost)	32.55217	-117.12236
J9	Southwest Slough (outer-mid)	32.55141	-117.12392
JA	Southwest Slough (inner-mid)	32.55208	-117.12610
JB	Southwest Slough (mouth)	32.55450	-117.12650
JC	Main Slough (furthest)	32.55942	-117.11687
JD	Main Slough (mid)	32.55899	-117.11384
JE	Main Slough (mouth)	32.55748	-117.12331
JF	Oneonta Slough	32.56659	-117.13148
JZ	Oneonta Slough (mid)	32.56266	-117.13000
JG	Main slough (mid)	32.55935	-117.11649

Table 3-1: Names, identification numbers and location of all field sites sampled in the IBEBMP. Locations are obtained from GPS coordinates in decimal degrees and NAD 83 datum.

At each site, datasheets were used to record visual observations (Appendix 2). Observations include information on light levels, time since last rain, amount of rainfall, potential fecal sources within 25 meters, water color, odor and clarity, estimated swell height and direction, estimated wind speed and direction, station name and station identification number, latitude and longitude, bottle number, sample time (recorded in UTC) and sample identification number, and salinity and temperature measurements. Temperature and salinity were measured using a YSI 600 QS data logger coupled with a

YSI sonde (see www.osil.co.uk). Each bottle had a permanently inscribed number to identify it. All data have been captured in an Excel spreadsheet which is available on request.

Water samples were collected using a 2.5-meter PVC sampling pole with an attached hose clamp and autoclaved, sterile 250-ml polypropylene bottles. Samplers were required to wear nitrile gloves and rubber hip boots. This prevented cross contamination and minimized the exposure of sampling personnel to potentially contaminated water. The sampler waded into knee-deep water. On an incoming wave, the pole was extended, the bottle was plunged upside down approximately 10-15 cm below the surface, rotated 90 degrees, moved horizontally under the water and filled, leaving some airspace in the bottle for mixing. The sampler then capped the bottle immediately and placed the sample in a dark cooler with crushed ice. Whenever there was debris or sediment in the bottle, the sample was discarded and collected with a new, sterile bottle. A waterproof chain of custody (COC) form (Appendix 3) was filled out after each sample was collected. These forms were kept in a sealed Ziploc bag affixed to the outside of the ice chest. Samples were delivered to the microbiology (Bartlett) laboratory within six hours of collection. Upon transfer of the samples, the temperature within the ice chest was measured and recorded on the COC. The original COC was filed in the microbiology (Bartlett) laboratory and copies of the COC were filed with the data sheets in the field (Largier) laboratory.

Field sampling strategies were designed to address specific issues – e.g., background data, rain events, tidal efflux from Tijuana Estuary, or south swell events (see Table 3-2). Sample days were chosen in response to wave conditions (cdip.ucsd.edu), nearshore currents (sdcoos.ucsd.edu), and tidal conditions. Rain-related sampling was spatially widespread and repeated on subsequent days. Tide-related sampling was spatially limited and rapid in time. A station was included at the rivermouth, on the inside of the tidal channel where water flows out from the estuary (Figure 3-2). Concentrations at this station are often much higher than at “rivermouth 2”, which is the routine County site

Sampling Excursion Log

	Date	Times(PDT)	Number of Samples	Purpose
1	7/2/2003	9:00-15:15	10	Training with County
2	7/11/2003	8:45-14:30	13	Baseline/Temporal
3	7/17/2003	9:15-13:40	15	Baseline/Temporal
4	7/23/2003	9:15-13:00	26	Baseline/Temporal
5	8/20/2003	9:00-15:00	11	Baseline/Spatial
6	8/28/2003	6:30-11:30	10	Baseline/Spatial
7	9/5/2003	7:30-12:30	12	Baseline/Spatial
8	9/15/2003	10:30-15:30	16	Estuary sampling
9	9/29/2003	12:00-19:00	18	Tidal Study-8 hour
10	10/15/2003	12:30-16:30	9	SW Swell
11	10/16/2003	11:00-15:00	9	SW Swell
12	10/17/2003	10:00-14:00	9	SW Swell
13	11/7/2003	8:00-12:30	12	Prior to rain
14	11/12/2003	10:00-14:30	10	Post rain
15	11/14/2003	8:00-12:00	10	Post rain
16	11/20/2003	7:45-13:00	10	SW Swell
17	11/21/2003	8:00-13:00	10	SW Swell
18	12/12/2003	8:00-13:00	10	Baseline/Spatial
19	12/18/2003	9:00-13:00	10	Baseline/Spatial
20	1/15/2004	7:00-12:00	10	Baseline/Spatial
21	1/22/2004	9:00-15:00	18	Baseline/Prior to rain
22	1/29/2004	9:00-14:00	20	Baseline/Bight '03 trial
23	2/2/2004	10:00-15:00	14	Prior to rain
24	2/5/2004	8:00-16:00	23	Post rain/Tidal
25	2/12/2004	8:30-13:30	22	Tidal Study
26	2/17/2004	9:00-12:30	15	Prior to rain
27	2/19/2004	9:00-13:30	22	Post rain
28	2/23/2004	1:00-16:00	5	Post rain
29	2/25/2004	12:00-15:00	12	Post rain
30	2/26/2004	11:30-16:00	9	Post rain
31	3/1/2004	9:00-14:00	22	Post rain
32	3/3/2004	9:30-13:30	22	Post rain
33	3/8/2004	10:00-15:00	10	Post rain
34	3/11/2004	10:30-15:30	22	Post rain
35	3/18/2004	6:30-11:00	10	Baseline/Spatial
36	3/19/2004	6:30-12:00	15	Estuary sampling
37	3/22/2004	9:00-22:00	24	Tidal study- 12 hour
38	3/24/2004	4:00-16:00	24	Tidal study- 12 hour
39	4/1/2004	10:00-15:00	12	Prior to rain
40	4/2/2004	10:30-15:00	30	Post rain/Tidal pulse
41	4/5/2004	7:30-11:00	10	Split Samples/ post rain
42	4/7/2004	6:00-11:00	20	Tidal pulse
43	4/8/2004	6:30-11:00	15	Tidal pulse
44	4/12/2004	9:00-15:00	30	Tidal pulse
45	4/14/2004	13:00-18:15	13	Tidal pulse
46	4/21/2004	6:30-11:30	11	Tidal pulse
47	4/29/2004	13:00-17:00	12	Baseline/Spatial
48	5/17/2004	8:00-13:00	12	Baseline/Spatial
49	5/26/2004	7:30-12:30	10	Split Samples
50	6/9/2004	8:30-13:15	13	Spatial/Spring
51	6/21/2004	9:30-14:30	12	SW Swell
52	7/26/2004	15:30-20:30	18	Estuary sampling
53	7/28/2004	10:00-16:00	19	Temporal/Summer
54	7/30/2004	11:00-16:00	14	Temporal/Summer

Table 3-2: Dates and nature of sampling during IBEBMP.

outside the estuary and where estuarine outflow may have already been strongly diluted by mixing with ocean waters (Figure 3-4) – see also County studies at Los Penasquitos and San Elijo Lagoons (County of San Diego, 2003). Owing to difficulties in accessing stations south of the Tijuana mouth after rain, and owing to the focus on FIB levels at Imperial Beach, there is a spatial bias towards stations north of the mouth.

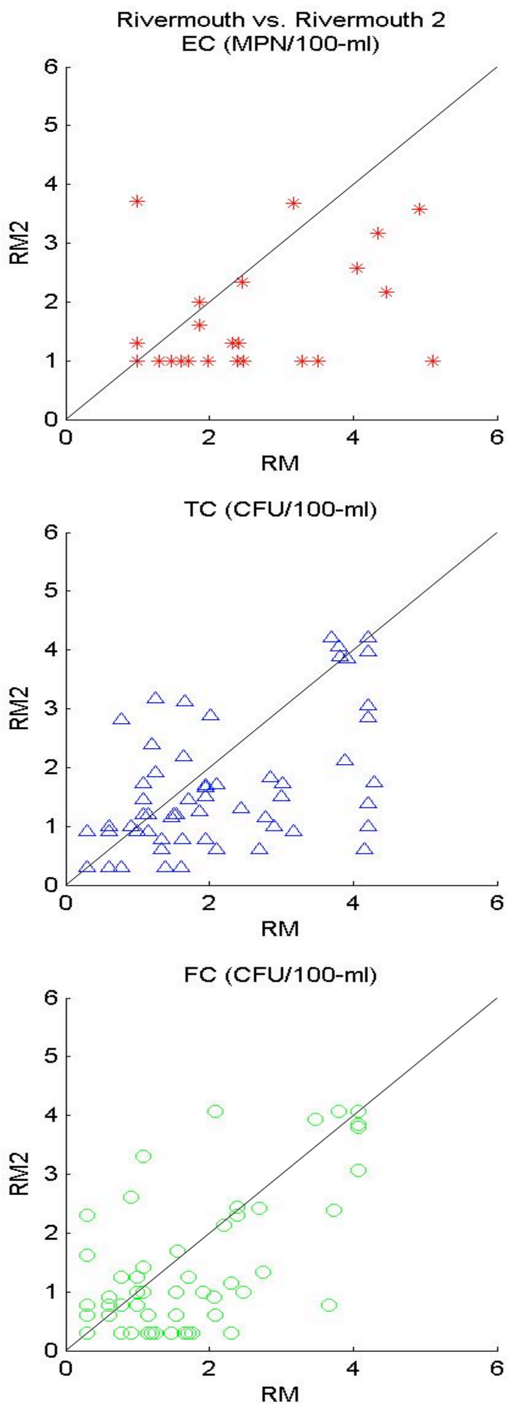


Figure 3-4: Comparison of FIB data from "Tijuana Rivermouth" station (RM) versus the "Tijuana Rivermouth 2" station (RM2) routinely sampled by the County. Rivermouth 2 is not in the entrance channel of the estuary; it is located further north on the ocean side or the northern spit (see positions in Figure 3-2 and Table 3-1). Samples plotted were collected within 15 minutes of each other.

FIB data from the IBEBMP and from the routine County sampling were compared (Figure 3-5). As the County sampling strategy is designed to address public health issues – specifically providing a basis for AB411 posting of the beach when contaminated – it does not suit the analysis of events. In particular, County data does not include information on the time of sampling, and data from multiple stations in the region may be obtained over the course of more than one day. For these reasons, our analysis was based on IBEBMP data. Special features of the IBEBMP data are samples obtained from the Imperial Beach pier, providing a cross-shore transect from shore to offshore (Figure 3-2), and samples obtained in the Tijuana Estuary (Figure 3-3).

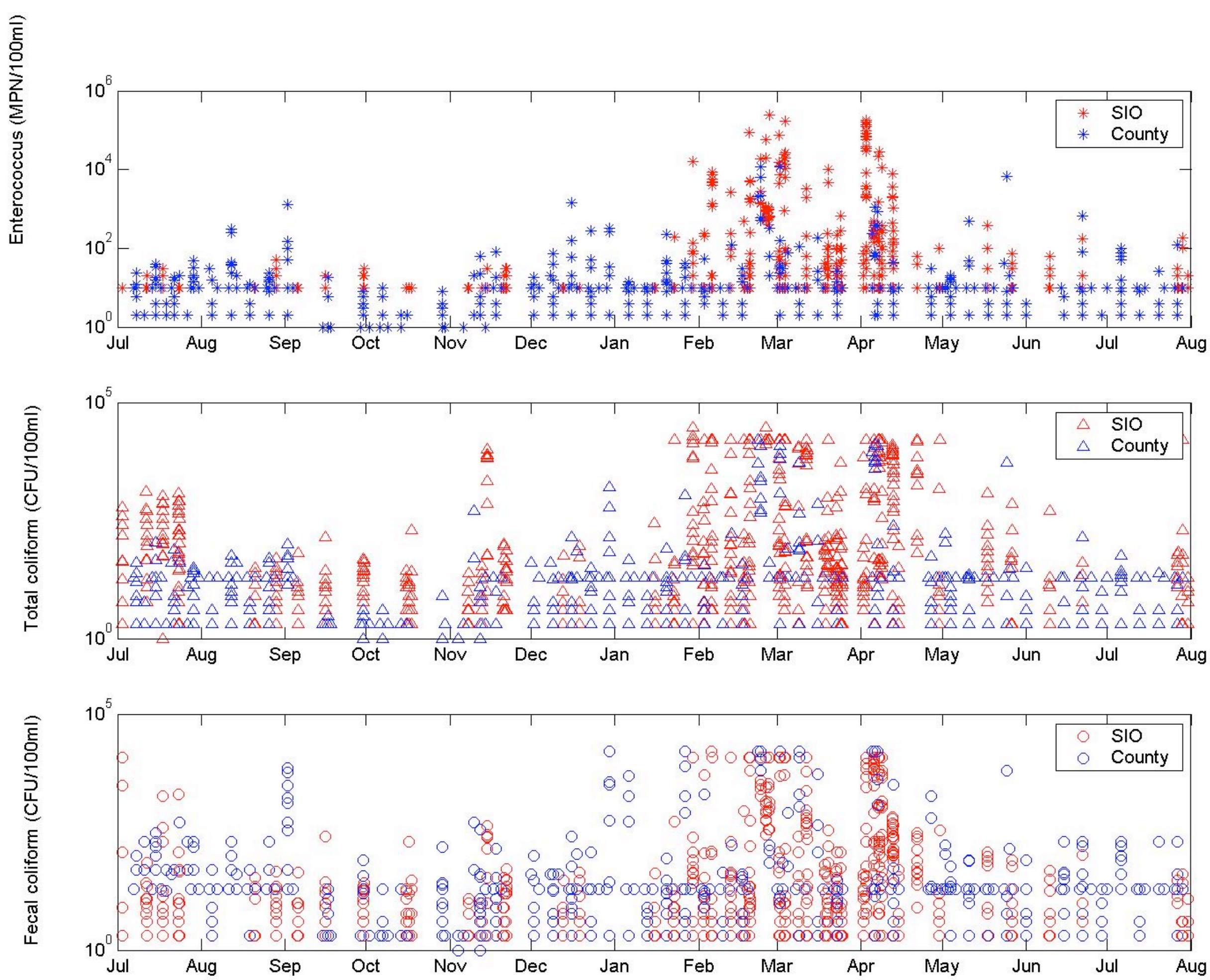


Figure 3-5: All FIB data collected by SIO (IBEBMP data) and County DEH from July 2003 through July 2004.

3-2. Bacteriological Analyses

Assays were performed for three types of bacterial indicators: total coliforms (TC), fecal coliforms (FC), and enterococci (EC). Methods used include membrane filtration for total and fecal coliforms and a defined substrate technology test kit, Enterolert (IDEXX Laboratories, Inc., Portland, ME), for enterococci. All analyses were performed using techniques as outlined in Standard Methods for the Examination of Water and Wastewater 20th Edition, or according to manufacturer's instructions.

Membrane filtration.

Membrane filtration was accomplished by using a six-filter-unit manifold connected to a combination of a 4-L and 2-L liquid trap and to a vacuum pump pulling at 1.9 psi. The filter units had been autoclaved while wrapped in double layers of brown paper bags. A stock of 20-L phosphate buffer (2mM $MgCl_2*H_2O$, 0.625mM KH_2PO_4) was prepared in advance and approximately 380-ml for each sample would be autoclaved and cooled 4-24 hours before sample arrival. All media for TC and FC assays were prepared in advance, poured, and solidified in 60 x 15-mm Petri dishes (Fisher, 08-757-13A). For TC growth, m-Endo agar plates were prepared by combining 51.0 g of pre-made powder (Difco, #273620) mixed (500rpm) and rapidly boiled on a hotplate (500 ^{o}C) with 1-L Milli-Q water and 20-ml 95% ethanol. For FC growth, mFC plates were prepared by mixing (300 rpm) 18.5 g pre-made mFC broth powder (Difco, #288330) with 5-ml 1% rosolic acid dye. The broth and dye were gently boiled (450 ^{o}C) in 500-ml Milli-Q and 7.5g granulated agar (Fisher, #BP1423-500) on a hotplate.

Two sets of three 50-ml conical tubes (Fisher, #06-443-18) were labeled 0.5, 5.0, and 50-ml indicating the aliquots of sample to be assayed for TC or FC. Tubes designated with 0.5 and 5.0-ml were prepared by filling them with 45-ml of sterile phosphate buffer. Aliquots of 0.5 and 5.0-ml sample were pipetted and dispersed in the buffer of their respective tubes. The 50-ml aliquot of sample was directly poured into a separately labeled conical tube without phosphate buffer. One set was filtered for TC in parallel to the second set filtered for FC. All sets were filtered in order of increasing sample volume. Sterile membrane filters (Pall Corporation, #66278) were aseptically placed on the bases of sterilized filtration units grid-side up. Each tube was shaken vigorously 25 times before pouring the contents through the membrane. The sides of the funnel were rinsed at least twice with 20-30-ml of sterilized phosphate buffer from a squirt bottle. Membrane filters were aseptically removed from the filter bases and placed grid-side up on m-Endo agar or mFC agar plates. Filters were reseated if bubbles occurred.

The m-Endo agar plates were inverted and placed in a dry incubator for 24 hours at 35^{o}C in an atmosphere of near saturated humidity produced by a moistened paper towel placed on the bottom of the incubator. MFC agar plates were stacked 9 at a time, inverted, wrapped in two layers of waterproof plastic Whirl-Pak bags (Nasco, #B00678WA), and submerged in a waterbath for 24 hours at 44.5 ^{o}C. The next day, plates were removed from incubation and observed under a magnification lens equipped with a fluorescent lamp. Positive TC colonies exhibited shiny, green metallic color. Non-typical colonies appeared clear, yellowish, pink, or red. Positive FC colonies appeared dark blue while non-typical colonies were usually gray, light blue, light green, yellow, light orange, and pink. All typical positive and non-typical colonies were recorded and positive colonies were calculated as CFU/100-ml in an Excel spreadsheet.

Enterococcus Assay.

Aliquots of 0.1, 1.0, and 10.0-ml from 250-ml of the sample were distributed separately into three 125-ml polypropylene bottles containing a total volume of 100-ml sterilized Milli-Q water (the 10-ml samples were added to 90-ml sterilized Milli-Q) and dissolved Enterolert reagent (IDEXX, #WENT200). The sample/reagent mixture was shaken, poured into 3 separately labeled Quanti-Trays/2000 (IDEXX, #WQT-2K), placed in the rubber insert (IDEXX, WQTSRBR-2K), and sealed in the Quanti-Tray Sealer (IDEXX, #WQTS2X-115). The sealed trays incubated at 41^{o}C for 22-24 hours. Trays were removed from the incubator 24 hours later and the number of positive blue fluorescent wells under a 6W, 365nm, UV light were counted.

Data Calculation, Quality Control, Quality Assurance.

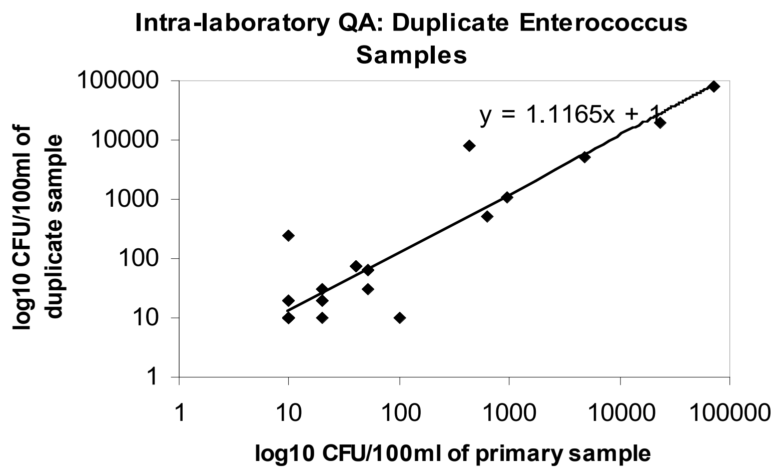
Final data reported were based on the method communicated by the San Diego City's Metropolitan Wastewater Department Marine Microbiology Laboratory. For the three different aliquots of sample, different rules applied to determine which aliquot best represented the bacterial abundance in that sample. Membranes with 20-80 TC and 20-60 FC colonies were accepted as a range of actual value, not an estimate. Any counts below this range were considered an estimate and the aliquot within the above countable range was reported. Where there were greater than 80 TC colonies, the CFU/100-ml was calculated as >16,000, >1600, and >160 CFU/100-ml in the 0.5, 5.0, and 50-ml sample aliquots, respectively. Where there were greater than 60 FC colonies, the CFU/100-ml was calculated as >12,000, >1200, and >120 CFU/100-ml in the 0.5, 5.0, and 50-ml sample aliquots, respectively. If all aliquots in a set were over-estimates then the CFU/100-ml of the 0.5-ml aliquot was reported for that sample. In cases where all aliquots of one sample produced only under- or over-estimates then the aliquot with the number of colonies closest to 80 TC/60 FC colonies was used for the estimation.

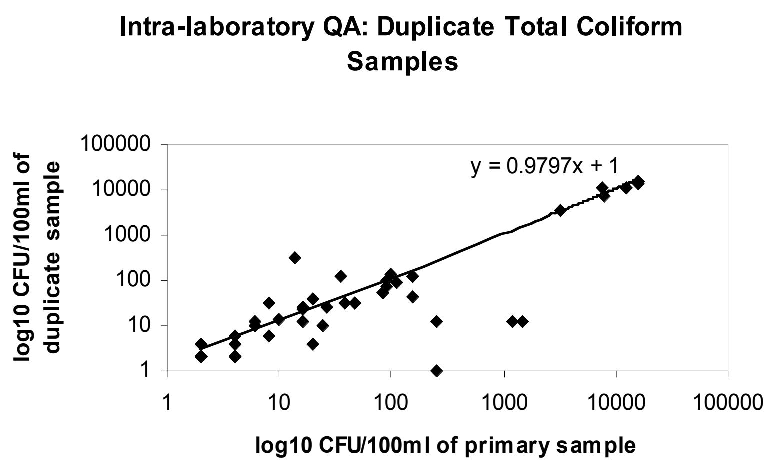
The MPN table provided by IDEXX was used to obtain a Most Probable Number for EC in each sample. Aliquots of 0.1, 1.0 and 10-ml that produced between 50-80% positive wells in the tray (48-78 wells) were considered actual values. If more than one of the aliquots for a sample showed 50-80% positive wells, the tray with the highest amount of sample was reported. If no trays were 50-80% positive, then the tray closest to the desired range was chosen for reporting.

Finally, a Microsoft Excel spreadsheet consisting of the samples' laboratory identification numbers, sample sites, dates, and data values were electronically transmitted to the field (Largier) laboratory for addition to the environmental and physical data correlating to each sample.

All assays required routine quality control analyses: buffer sterility, media test, and positive and negative controls. Two tubes or bottles of phosphate buffer were randomly selected for sterility check and inspected for cloudiness or precipitation for every batch prepared. The m-Endo and mFC plates with and without a sterile membrane filter were incubated at 35^{o}C and 44.5 ^{o}C, respectively, and checked for colonies for every sample batch. *Escherichia coli* was used as a positive control for the m-Endo and mFC plates. *Pseudomonas aeruginosa* represented the negative control for m-Endo plates, while *Enterobacter aerogenes* served as the negative control for mFC. Positive and negative biological controls were investigated every 25-30 samples.

Intra- and inter-laboratory quality assurance tests were performed to investigate variability and reliability of technique. Intra-laboratory quality assurance tests consisted of 60 duplicate samples taken periodically by sampling the same site twice with two separate sterile 250-ml polypropylene bottles within 5 minutes of each other. Both bottles were stored on ice and delivered simultaneously to the SIO laboratory for analysis. Slopes of trend-lines ranged from 0.98-1.1 indicating that the data varied similarly and were not significantly different (Figure3-6). Comparability between the City of San Diego Marine Microbiology Lab and the Bartlett laboratory at SIO was evaluated by results from split sampling methods. Two days of 10 samples were collected in 500-ml polypropylene bottles and divided (split) equally into two sterile 250-ml bottles and stored on ice. Within 30 minutes of each other, one of the 250-ml bottles was delivered to the City of San Diego Marine Microbiology Lab and the other delivered to SIO. All samples were processed as described above. The Wilcoxon signed-rank test was applied to the split sample data. The p-values for all three bacterial indicators were always greater than 0.05, indicating that the split-samples between the City of San Diego and SIO laboratories were not significantly different. These results also suggest no major variability between the split samples. Statistical (z), degrees of freedom (df), and probability (p) values are as follows: EC, $z=0.339$, $df=9$, $p=0.74$; TC, $z=0.730$, $df=9$, $p=0.47$; FC, $z=1.601$, $df=9$, $p=0.11$.





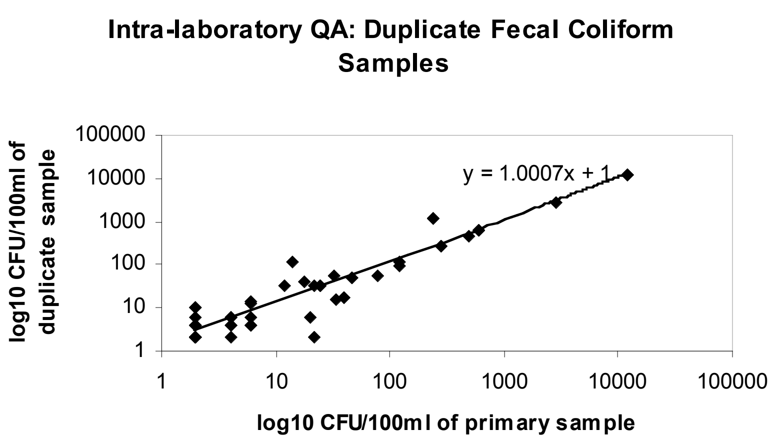
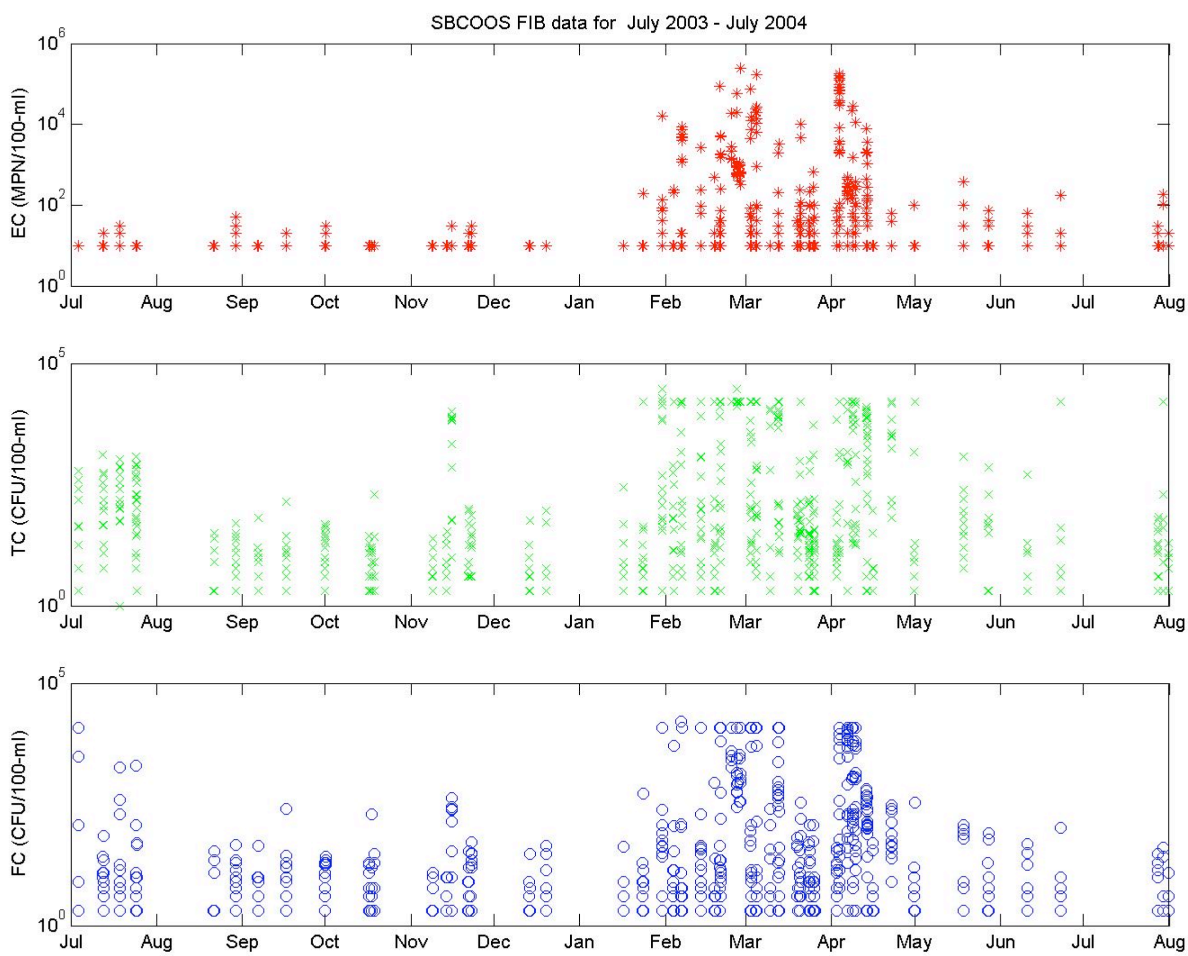


Figure 3-6: Intra-laboratory quality assurance: comparison of duplicates on log10 axes, with linear regression lines.

4. PATTERNS OF BACTERIA DISTRIBUTION

The seasonal and spatial patterns identified by Scearce (2004) and recognized by local and County personnel are clearly evident in the data collected through the IBEBMP. The seasonal pattern of high levels during the rainy season is evident in Figure 4-1, which provides an overview of all FIB data obtained through the IBEBMP.

Figure 4-1: All FIB data collected through the IBEBMP (July 2003 to July 2004). Highest values are observed in winter, following rain events.



Highest levels of enterococcus (Ent), total coliform (TC) and fecal coliform (FC) are in February, March, and April 2004, following a series of rain events (Figure 4-2). In addition, high TC and FC were observed in mid-November, following an early rain event. High values of Ent and TC in May, June and July 2004 were found at the Hollister Road bridge, where the Tijuana River approaches the estuary (however, it is not clear whether there is any active flow from the pools at Hollister into the estuary waters proper at this time). With the exception of high FC values in July 2003 (which are not accompanied by high TC values), exceedance of AB411 standards is only observed following rain. During the study period, levels are low in the absence of land runoff.

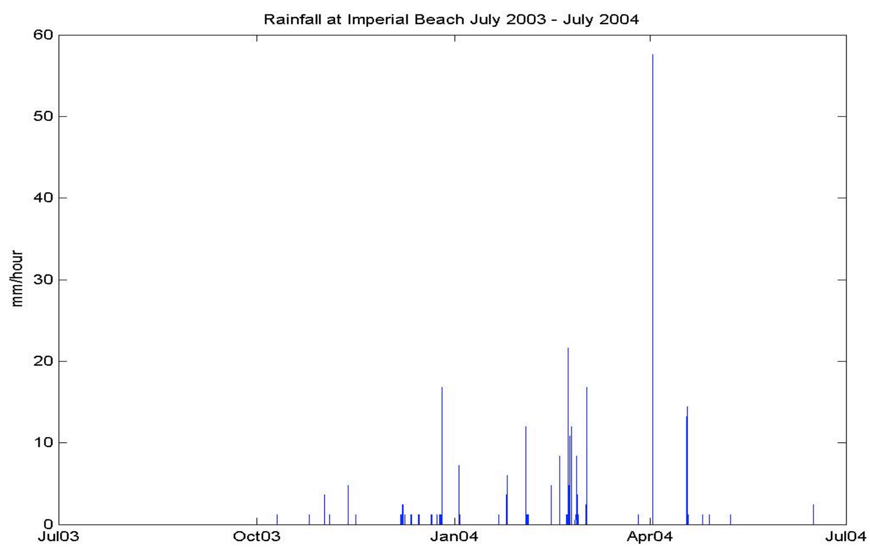


Figure 4-2: Rainfall at Imperial Beach from July 2003 to July 2004.

Aggregations of FIB data are confounded by the non-normal distribution of FIB values and the differences in frequency and times of sampling (some stations only sampled during specific events). Nevertheless, simple mean and median values are calculated and plotted for all stations, showing the spatial pattern of highest values in and near Tijuana Estuary, with lower values along the open coast at increasing distances from the mouth of the estuary (Figure 4-3). This spatial pattern is consistent with that described by Scearce (2004), based on routine IBWC/City data – see Figures 2-1 and 2-2.

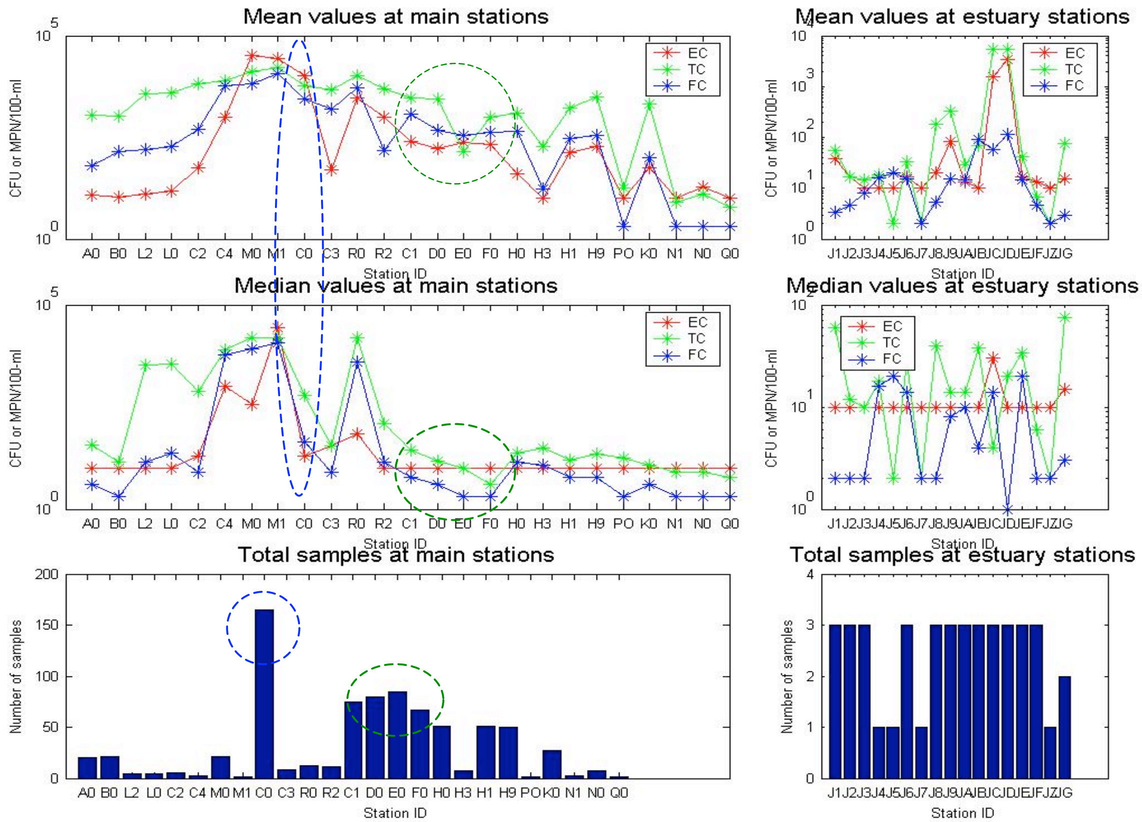


Figure 4-3: Mean and median values for all 3 FIB parameters at all stations sampled (see Table 3-1 for stations names and locations). Note that some stations were sampled more often than other stations, the number of samples at some stations are too few to give these statistics any confidence, and that bias may result from sampling some stations only under specific conditions. The rivermouth data are indicated by a blue dashed ellipse and the 4 key stations between the rivermouth and IB pier are indicated by a green dashed ellipse.

Rain events.

Recognizing that FIB contamination events are typically associated with runoff following rain events, the IBEBMP sampling was directed at specific rain events. In total, 17 days of rain-related sampling was conducted in November 2003 and January-April 2004. Data from November are plotted in Figure 4-4 as an example of the effect of rain. A widespread spatial survey was conducted on 7 November, and then repeated on 12 November, immediately following rain. FIB values remained low until after the 12 November sampling, presumably due to the long delay in runoff following the first (and small) rainfall of the season. However, the region was sampled again on 14 November, about 2 days after the rain, and high values of TC and FC were observed at the mouth and at stations north of the mouth, up to Cortez Ave (station F0). During the days following rain, northward currents were observed through SDCOOS radar mapping – thus explaining the northward spread of the high FIB levels. A similar pattern of contamination of beaches between the Tijuana mouth and Imperial Beach was observed following other rain events combined with northward coastal currents.

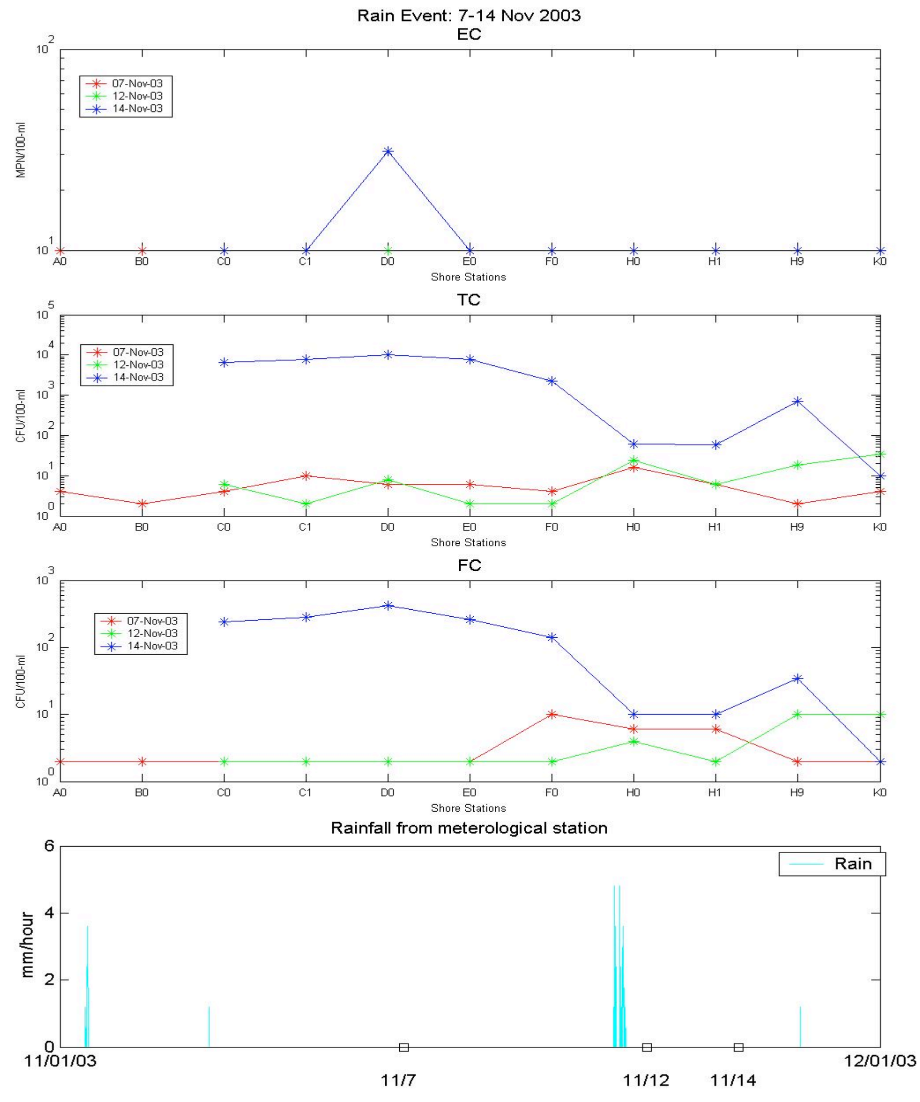


Figure 4-4: FIB levels on 3 days in November 2003: before rainfall (November 7), immediately following rainfall (November 12), and two days following rainfall (November 14).

A more complex pattern of FIB contamination is described by data from early March 2004 (Figure 4-5). Although the survey on 1 March was during a period of zero flow past the gauge on the Tijuana river, and preceded the rainfall later that day, high FIB levels are observed due to residual runoff from rainfall 5 days earlier.

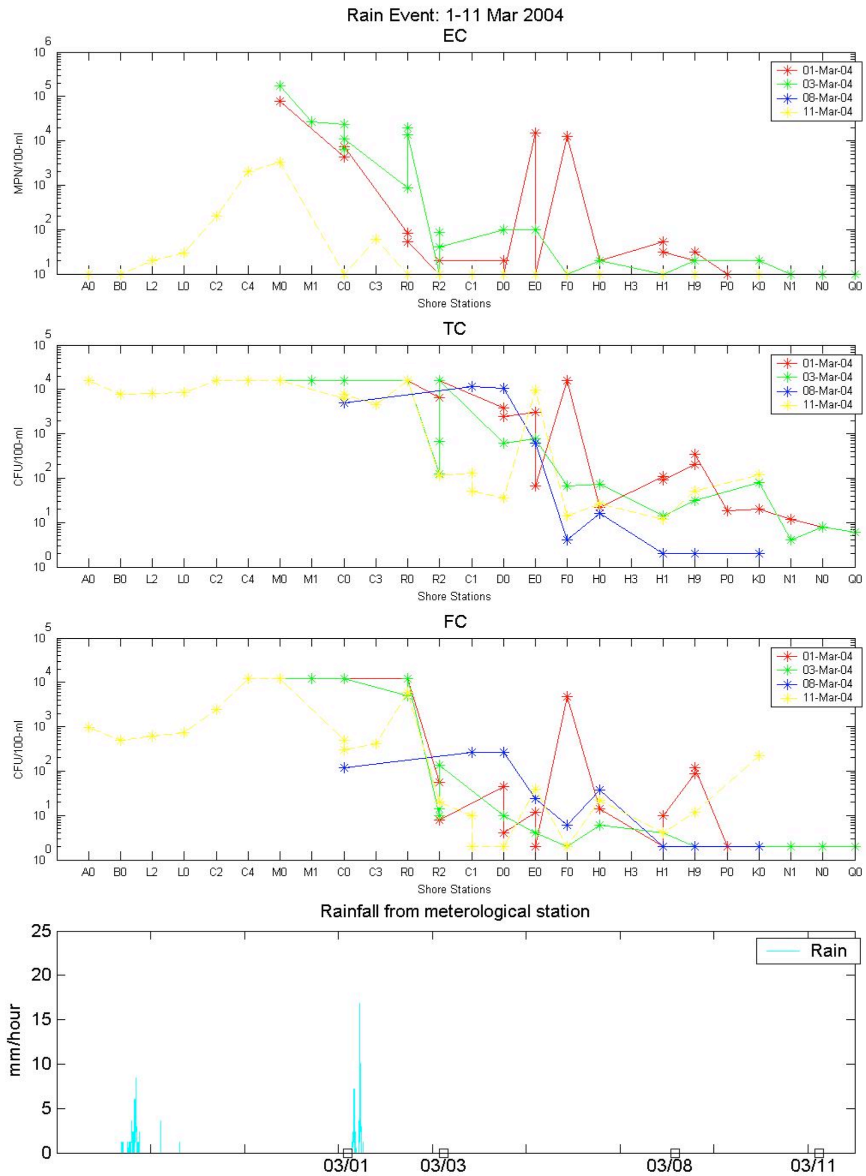


Figure 4-5: FIB levels on 4 days in March 2004, following rainfall on 1 March.

We sampled again on 3 March, two days after rain and with river flow continuing. As expected, very high values were observed in the estuary and high values were again found along the shorelines in the vicinity of the mouth. However, at Imperial Beach and north to Coronado, FIB values were not high – at this time, radar-mapped coastal currents were weakly southward. River flow was diverted again from 4 to 8 March, and we sampled a third time on 8 March, seven days after rain and following five days of diverted river flows. While FIB levels were a bit lower, the waters in the vicinity of the mouth were still contaminated (exceeding AB411 levels). Interpreting this as being due to a persistent contamination of the estuary and tidal export from the estuary, we returned to sample shorelines both north and south of Tijuana mouth and the estuary on 11 March. Very high FIB levels were observed in the estuary (e.g., Hollister) and at the mouth. Although high values were observed south of the mouth (e.g., Border Fence and Monument Road), the radar-mapped currents were northward at this time, suggesting that these southern sites were subject to a second FIB source located further south.

Estuary FIB levels.

The persistence of high FIB levels at the mouth of the estuary following early March rains prompted a survey of estuary waters during high tide on 19 March (Table 4-1). The outer estuary was filled with low-FIB ocean waters, but high FIB levels were found in the estuarine waters that had been pushed into the sloughs. In particularly high FIB and low salinity was observed in the Main Slough and at Hollister. However, high levels of Ent were also observed in South Slough and Oneonta Slough. During a tidal study on 22 March (Figure 4-6), elevated FIB levels were observed at spring low tide, when these estuarine back waters reached the mouth – however, note that these values did not exceed the AB411 standards. This combination of studies on 19 and 22 March indicate that high FIB levels may persist in Tijuana Estuary for up to 3 weeks following rain. However, it is not clear whether these FIB are due to inflow of contaminated waters or due to survival of bacterial populations in the estuary. A total of 3 estuary surveys were completed. The other two estuary surveys (15 September 2003 and 26 July 2004) found low levels of FIB throughout the estuary (Table 4-1), indicating that these FIB levels do not persist through the dry season.

Date	Station Name	ID	ID#	Lat	Lon	Bottle #	Sample Time (UTC)	Sample ID	Results						Temp	Salinity
									Entero (MPN)		Total (CFU)		Fecal (CFU)			
9/15/2003	Oneonta Slough (furthest)	J1	26	32.56486	-117.13124	076	17:58	J10915031758	<	10	=	10	<	2	19.03	33.51
9/15/2003	Oneonta Slough (mid-furthest)	J2	27	32.56338	-117.13032	041	18:06	J20915031806	<	10	=	12	=	2	18.99	33.08
9/15/2003	Oneonta Slough (mouth)	J3	28	32.56066	-117.13062	014	18:17	J30915031817	<	10	=	10	=	20	19.06	33.29
9/15/2003	Estuary (north)	J4	29	32.55915	-117.12872	040	18:25	J40915031825	<	10	=	18	=	16	18.38	33.58
9/15/2003	Estuary (center)	J5	30	32.55673	-117.12787	050	18:37	J50915031837	=	10	=	2	=	20	18.26	33.13
9/15/2003	Estuary (center)	J6	31	32.55553	-117.12700	072	18:48	J60915031848	<	10	=	28	=	28	17.91	33.57
9/15/2003	Estuary (center-mouth)	J7	32	32.55585	-117.12804	003	18:56	J70915031856	<	10	<	2	<	2	17.75	32.83
9/15/2003	Southwest Slough (outermost)	J8	33	32.55217	-117.12236	067	19:15	J80915031915	<	10	=	10	=	2	20.52	33.56
9/15/2003	Southwest Slough (outer-mid)	J9	34	32.55141	-117.12392	060	19:24	J90915031924	=	10	=	14	=	8	19.79	33.57
9/15/2003	Southwest Slough (inner-mid)	JA	35	32.55208	-117.12610	023	19:32	JA0915031932	<	10	=	12	=	10	19.35	33.50
9/15/2003	Southwest Slough (mouth)	JB	36	32.55450	-117.12650	021	19:41	JB0915031941	<	10	=	140	=	260	18.88	33.59
9/15/2003	Main Slough (mid)	JD	37	32.55942	-117.11687	011	20:08	JC0915032008	=	20	<	2	<	2	20.57	33.42
9/15/2003	Main Slough (furthest)	JC	38	32.55899	-117.11384	018	20:16	JD0915032016	<	10	=	10	=	2	21.09	33.51
9/15/2003	Main Slough (mouth)	JE	39	32.55748	-117.12331	032	20:39	JE0915032039	<	10	=	4	=	4	20.32	33.58
9/15/2003	Oneonta Slough (shore)	JF	40	32.56659	-117.13148	009	21:59	JF0915032159	<	10	=	6	=	2	23.60	33.50
3/19/2004	Oneonta Slough (furthest)	J1	26	32.57239	-117.12949	121	14:54	J10319041454	=	96	=	92	=	6	15.72	33.14
3/19/2004	Oneonta Slough (mid-furthest)	J2	27	32.56908	-117.13088	088	15:10	J20319041510	=	31	=	36	=	10	15.82	33.20
3/19/2004	Oneonta Slough (mouth)	J3	28	32.55946	-117.12888	013	15:37	J30319041537	<	10	=	32	<	2	15.81	33.22
3/19/2004	Southern slough (furthest)	J8	33	32.55130	-117.11929	095	16:02	J80319041602	=	41	=	500	=	12	15.89	33.06
3/19/2004	Southern slough (mid-furthest)	J9	34	32.55160	-117.12347	030	16:15	J90319041615	=	234	=	980	=	36	15.80	31.94
3/19/2004	Southern slough (mid)	JA	35	32.55208	-117.12610	120	16:26	JA0319041626	=	20	=	60	=	4	15.90	33.19
3/19/2004	Southern slough (mouth)	JB	36	32.55607	-117.12640	024	16:35	JB0319041635	<	10	=	38	=	4	15.89	33.17
3/19/2004	Southern slough (mouth)	JB	36	32.55607	-117.12640	155	16:36	JB0319041636	<	10	=	32	=	4	15.89	33.17
3/19/2004	Main slough (furthest)	JC	37	32.56261	-117.10469	038	17:20	JC0319041720	=	4721	>	16000	=	160	15.70	6.25
3/19/2004	Main slough (mid-furthest)	JD	38	32.56255	-117.10822	094	17:42	JD0319041742	=	10111	>	16000	=	340	16.44	16.16
3/19/2004	Main slough (mid)	JG	42	32.55935	-117.11649	062	17:55	JG0319041755	=	20	=	138	=	4	16.38	33.10
3/19/2004	Main slough (mouth)	JE	39	32.55665	-117.12628	082	18:16	JE0319041816	=	31	=	86	=	20	16.51	33.18
3/19/2004	Rivermouth	C0	9	32.55848	-117.12838	036	18:36	JG0319041836	=	63	=	34	=	8	16.53	33.31
3/19/2004	Estuary Center	J6	31	32.55553	-117.12700	040	18:50	J60319041850	=	31	=	52	=	4	16.72	33.26
7/26/2004	Oneonta Slough (furthest)	J1	26	32.56905	-117.13087	144	22:59	J10726042259	<	10	=	60	<	2	22.05	33.98
7/26/2004	Oneonta Slough (mid-furthest)	J2	27	32.56707	-117.13148	003	23:08	J20726042308	<	10	<	2	<	2	21.90	33.55
7/26/2004	Oneonta Slough (mid)	JZ	41	32.56266	-117.13000	101	23:18	JZ0726042318	<	10	=	2	=	2	21.58	33.57
7/26/2004	Oneonta Slough (mouth)	J3	28	32.55955	-117.12898	063	23:28	J30726042328	<	10	<	2	<	2	21.57	33.38
7/26/2004	Estuary Center	J6	31	32.55932	-117.12768	034	23:32	J60726042332	=	10	=	18	=	14	22.07	33.77
7/26/2004	Rivermouth Estuary (north)	C3	10	32.55768	-117.12906	002	23:40	C30726042340	<	10	=	2	=	2	22.90	33.59
7/26/2004	Rivermouth	C0	9	32.55718	-117.12850	052	23:45	C00726042345	=	20	=	20	=	2	21.56	33.54
7/26/2004	Rivermouth	C0	9	32.55718	-117.12850	015	23:47	C00726042347	<	10	=	40	=	10	21.56	33.54
7/27/2004	Southern slough (furthest)	J8	33	32.55230	-117.12218	066	0:01	J80726040001	<	10	=	40	=	2	23.54	33.61
7/27/2004	Southern slough (mid-furthest)	J9	34	32.55119	-117.12469	156	0:08	J90727040008	<	10	=	2	=	2	22.24	33.61
7/27/2004	Southern slough (mid)	JA	35	32.55231	-117.12621	137	0:13	JA0726040013	<	10	=	14	=	30	22.06	33.81
7/27/2004	Rivermouth Estuary (south)	C2	5	32.55568	-117.12754	152	0:21	C20726040021	<	10	=	4	<	2	22.18	33.63
7/27/2004	Main slough (furthest)	JC	37	32.55709	-117.11249	115	0:44	JC0726040044	=	30	=	4	=	14	24.37	33.56
7/27/2004	Main slough (mid-furthest)	JD	38	32.55760	-117.11521	006	0:50	JD0726040050	<	10	=	20	<	2	23.31	33.57
7/27/2004	Main slough (mid)	JG	42	32.55863	-117.11931	041	0:57	JG0726040057	<	10	=	12	=	2	22.23	33.70
7/27/2004	Main slough (mouth)	JE	39	32.55671	-117.12598	143	1:14	JE0726040114	<	10	=	34	=	20	22.04	33.60

Table 4-1: FIB levels in Tijuana Estuary, sampled in September 2003, March 2004 and July 2004. Locations of stations are listed in Table 3-1 and plotted in Figure 3-3. Water samples were collected from an 8-foot skiff, provided by Jeff Crooks at the Tijunana NERR. Access to the sloughs was only possible at high tide (waterlevels of 5' or higher).

Tidal pulses.

In the absence of rain and river inflow to Tijuana Estuary, FIB-rich waters may be exported from the Estuary by tidal action. This is suggested by an analysis of historical data in this region (Figure 2-4) and by high-frequency FIB sampling in the vicinity of Santa Ana River (Figure 2-5). The export of FIB-rich waters through tidal pulses was investigated by multiple surveys of FIB values in the ebb tide outflow from the Estuary and along the beaches adjacent to the mouth. These surveys required repeated rapid sampling of stations to discern the tidal signal, which may be as short as a few hours (and high-FIB patches are likely to extend less than a mile alongshore) – cf., Figure 2-5. Nine tidal surveys were completed.

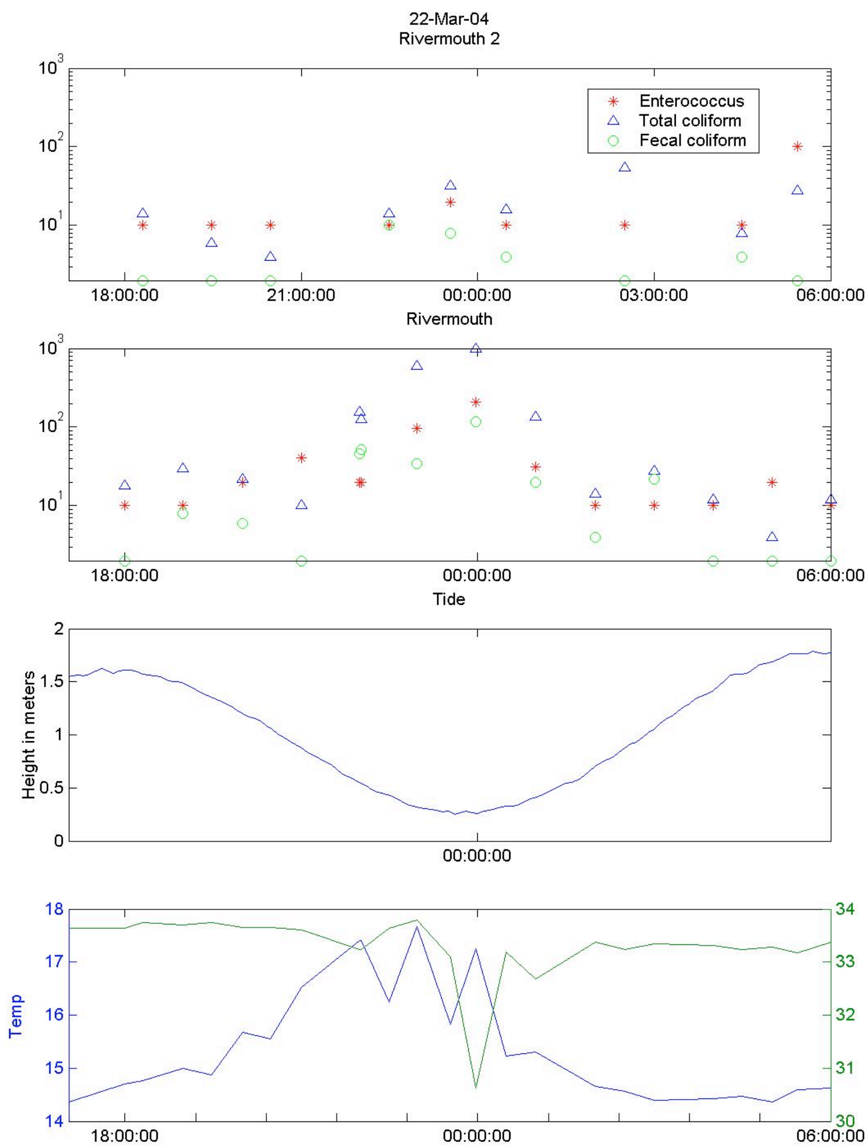


Figure 4-6: FIB levels over a 12-hour tidal cycle, showing low levels at high tide and increasing levels on the ebb tide. Highest FIB levels, lowest salinity and highest water temperature are observed at low tide.

On 22 March, following the 19 March survey of FIB in Tijuana Estuary, FIB levels were monitored hourly at the mouth of the Estuary (Figure 4-6), showing an increase in all 3 parameters with a maximum at low tide (end of the ebb tide outflow). The higher temperature and lower salinity of these waters indicated that these FIB had been transported from the inner Estuary. As the tide turned and ocean waters flowed back into the Estuary, salinity increased, temperature decreased and FIB levels returned to background coastal ocean values.

The "blob" of FIB-rich water that is exported from the Estuary on the ebb tide is subject to nearshore currents, determining whether this water is carried north or south, or offshore. Typically nearshore currents are oriented alongshore, and typically alongshore tidal currents are "upcoast" (towards Pt Loma) at low tide, i.e., following export of FIB-rich waters to the ocean. This phasing of tidal currents results in a tendency for transport of Tijuana Estuary outflow up the beach toward Imperial Beach. However, this tidal transport competes with mean alongshore flows and wave-driven surfzone flows. To obtain a more complete view of likely transport, it is necessary to combine data on tides, waves, and mean coastal currents. One example of effective northward tidal transport was observed on 21 April (a few days after light rain on 18 April), in spite of weak mean southward currents described by SDCOOS radar mapping. During weak southward mean flow, the northward tidal current pulse at low tide is strong enough to overcome the mean flow, resulting in a brief pulse of northward flow at the time of FIB sampling. The FIB observations are listed in Table 4-2. The first sample at ¾-mile north of the mouth was obtained about 1½ hours after low tide, with moderately elevated TC and Ent, but low values at Seacoast and Cortez. However, another 1½ hours later, levels at Seacoast had become elevated (and levels at ¾-mile were very high). High TC levels continued at ¾ -mile and Seacoast for another 1 ½ hours (i.e., up to 4 ½ hours following low tide) and then started dropping. A similar pattern suggesting northward transport of a tidal "blob" of FIB-rich water was observed on other days. A more complete analysis of FIB levels versus wave, tide and current data from SDCOOS will be reported in the CBI report.

Date	Station Name	ID	ID#	Bottle #	Sample Time (UTC)	Sample ID	Results						Temp	Salinity	Notes:
							Entero (MPN)		Total (CFU)		Fecal (CFU)				
4/21/2004	3/4 North	D0	14	044	13:50	D00421041350	=	63	=	3000	=	42	13.85	33.67	
4/21/2004	Seacoast	E0	15	038	14:17	E00421041417	<	10	=	114	=	8	13.80	33.70	
4/21/2004	Cortez	F0	16	046	14:44	F00421041444	<	10	=	66	=	24	13.69	33.71	
4/21/2004	3/4 North	D0	14	022	15:24	D00421041524	=	62	>	16000	=	220	13.86	33.65	
4/21/2004	Seacoast	E0	15	087	15:53	E00421041553	<	10	=	7000	=	134	13.70	33.57	
4/21/2004	3/4 North	D0	14	092	16:21	D00421041621	=	40	>	16000	=	300	14.04	33.56	
4/21/2004	Seacoast	E0	15	007	16:52	E00421041652	<	10	=	3200	=	78	14.06	33.59	
4/21/2004	Seacoast	E0	15	011	16:55	E00421041655	<	10	=	3600	=	54	14.06	33.59	Duplicate
4/21/2004	3/4 North	D0	14	020	17:26	D00421041726	<	10	=	15000	=	260	14.34	33.63	
4/21/2004	Seacoast	E0	15	106	17:55	E00421041755	<	10	=	1720	=	44	13.82	33.73	
4/21/2004	Cortez	F0	16	135	18:24	F00421041824	<	10	=	154	=	32	14.47	33.65	

Table 4-2: FIB levels on 21 April 2004, showing high values following tidal outflow from Tijuana Estuary and northward transport alongshore.

Imperial Beach pier sampling.

The FIB sampling in the IBEBMP allowed samples to be obtained from the base of IB pier as well as mid-pier (mid-surfzone) and pier end (beyond surfzone). This cross-shore transect provides data that can contrast FIB levels in the wave-driven surfzone with levels in offshore waters that are more susceptible to tidal and offshore current influences. During large rain events, when a large-scale river plume forms, FIB levels at the pier-end may be much higher than along the shoreline. But during drier weather, higher TC and FC levels are more likely to observed in the surfzone than offshore, consistent with small-volume land-based sources being entrained in the surfzone and transported by wave-driven surfzone currents.

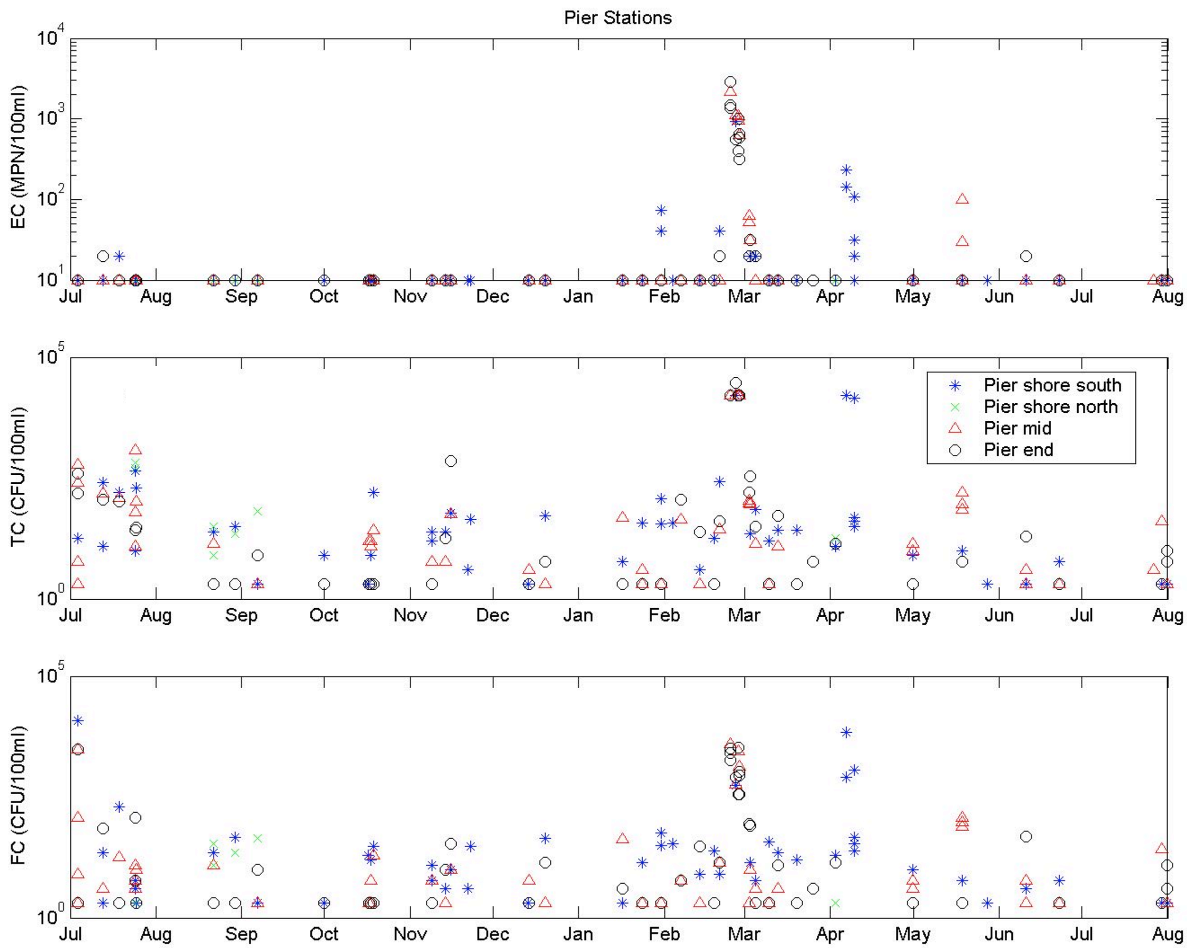


Figure 4-7: FIB data collected at Imperial Beach pier. "Pier shore north" is just north of the pier – this is the station routinely sampled by the county. In the IBEBMP, the station south of the pier was preferred, owing to interest in northward transport. In addition to shoreline sampling, samples were also collected from the middle and end of the pier.

South swell events.

Following the results reported by Scearce (2004), south swell events were targeted and sampled on six occasions in late fall (primarily October-November 2003). However, none of these days revealed a pattern suggesting long-distance surfzone transport as suggested in Scearce (2004). This limited number of samples does not argue against the existence of these events, but the lack of south-swell patterns in IBEBMP results suggests that these wave-driven events may not be as common as expected.

Background/other.

On several occasions, shoreline FIB sampling was conducted in the absence of any specific rain, tide, wind or swell conditions in order to obtain some background or reference data. These values were typically well below AB411 standards (Figure 4-1). In the IBEBMP there are no examples of widespread shoreline contamination, which one may expect to see if there were a south swell event, or onshore transport of wastewater from the South Bay Ocean Outfall. In this study, FIB exceedances appear to be associated with runoff following rain, or the tidal export of contaminated water from Tijuana Estuary.

5. SUMMARY

The large number of FIB water samples obtained through the IBEBMP has allowed improved description and understanding of contamination events associated with rain, estuary retention, and tidal outflow. The specific value of these data stems from the resolution of short time and space scales and the concurrent observation of currents and ocean conditions through SDCOOS. An important emerging pattern is the northward alongshore transport of FIB-rich waters along Imperial Beach shorelines under specific conditions of tide and currents following rain. A second important result is the persistence of high levels of FIB in Tijuana Estuary and associated tidal efflux of FIB-rich waters from the Estuary for weeks following rain events. Given the tendency for high FIB levels to be in the inner estuary, it is during spring tides that this FIB load will be most effectively delivered to the ocean shorelines. SDCOOS data on currents, waves, rain, and tide can be used to identify times when FIB contamination is likely to occur along Imperial Beach shorelines. Persistence of high FIB levels in the Estuary may be due to rogue inflows, groundwater seepage, or survival of bacteria in the waters or sediments of the Estuary.

This Imperial Beach Enhanced Bacteria Monitoring Program allows a link to be made between high FIB levels along Imperial Beach shorelines and oceanographic transport patterns. The link is examined in more detail in a companion report to the Clean Beach Initiative. This work supports the utility of real-time data on coastal currents in monitoring and anticipating contamination events along the Imperial Beach shoreline.

LITERATURE CITED

American Public Health Association. 1995.
Standard Methods for the Examination of Water and Wastewater. 19th edition, American Public Health Association, Washington DC.

American Public Health Association. 1998.
Standard Methods for the Examination of Water and Wastewater. 20th Edition. pages 9-69 to 9-70.

County of San Diego. 2003.
Impact of Rainstorms on Marine Recreational Water Quality of Beaches Adjacent to Lagoons in San Diego California. Dept Public Works & Dept Environmental Health, County of San Diego, 39pp.

Kim, J.H., S.B. Grant, C.D. McGee, B.F. Sanders and J.L. Largier. 2004.
Locating sources of surf zone pollution: a mass budget analysis of fecal indicator bacteria at Huntington Beach, California. *Environmental Science & Technology,* 38:2626-2636.

Largier J., L. Rasmussen, M. Carter and C. Scearce. 2004.
Evaluation of the South Bay International Wastewater Treatment Plant Receiving Water Quality Monitoring Program to Determine its Ability to Identify Source(s) of Recorded Bacterial Exceedances. Prepared for US Environmental Protection Agency, Region IX, San Francisco, CA.

Scearce, C. 2004.
Patterns, Sources and Transport of Shoreline Associated Fecal Indicator Bacteria in the Silver Strand Littoral Cell, San Diego, California. MS Thesis, Scripps Institution of Oceanography, UCSD, San Diego, CA.

Enterolert Instruction Manual.
IDEXX Laboratories Inc., One IDEXX Drive, Westbrook, Maine, 04092 USA

Zar, J.H., 1984.
Biostatistical Analysis. 2nd edition, pages 150-155.

APPENDIX 1. TABULATION OF FIELD DATA

This appendix lists all the data collected, with information on station, date, time, identification numbers, latitude, longitude, FIB levels, and water temperature and salnity. A more complete listing of data is contained in an Excel spreadsheet that is available on request.

	Date	Station Name	ID	ID#	Lat	Lon	Bottle #	Sample Time (UTC)	Sample ID	Lab #	Results						Temp	Salinity
											Entero (MPN)		Total (CFU)		Fecal (CFU)			
1	7/2/2003	Cortez	F0	16	32.57265	-117.13274	001	17:03	F00702031703	1	<	10	=	156	=	120	N/A	N/A
2	7/2/2003	IB Pier (End)	H9	20	32.57965	-117.13719	002	20:20	H90702032020	2	<	10	=	400	=	3000	N/A	N/A
3	7/2/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13374	004	20:54	H10702032054	4	<	10	=	600	=	120	N/A	N/A
4	7/2/2003	IB Pier (Shore-South)	H0	17	32.57910	-117.13278	005	17:35	H00702031735	5	<	10	=	18	=	12000	N/A	N/A
5	7/2/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13374	006	20:49	H10702032049	6	<	10	=	6	=	3000	N/A	N/A
6	7/2/2003	IB Pier (Mid-surf zone)	H1	19	32.57960	-117.13499	008	21:06	H10702032106	8	=	10	=	250	=	2	N/A	N/A
7	7/2/2003	Seacoast	E0	15	32.56633	-117.13229	009	16:45	E00702031645	9	<	10	=	44	=	8	15.80	35.10
8	7/2/2003	IB Pier (Mid-surf zone)	H1	19	32.57960	-117.13499	012	21:08	H10702032108	12	<	10	=	2	=	8	N/A	N/A
9	7/2/2003	IB Pier (End)	H9	20	32.57944	-117.13718	014	20:32	H90702032032	14	<	10	=	152	<	2	N/A	N/A
10	7/2/2003	Cortez	F0	16	32.57265	-117.13274	016	17:07	F00702031707	16	<	10	=	42	=	120	N/A	N/A
11	7/11/2003	Rivermouth	C0	9	32.55652	-117.12898	001	16:12	C00711031612	1	=	10	=	46	=	12	N/A	N/A
12	7/11/2003	Rivermouth 2	C1	13	32.55786	-117.13078	002	16:26	C10711031626	2	<	10	=	1300	=	26	N/A	N/A
13	7/11/2003	3/4 North	D0	14	32.56133	-117.13171	003	16:51	D00711031651	3	<	10	=	350	=	10	N/A	N/A
14	7/11/2003	Seacoast	E0	15	32.56617	-117.13271	005	17:15	E00711031715	4	=	10	=	550	=	6	N/A	N/A
15	7/11/2003	Cortez	F0	16	32.57270	-117.13275	006	17:32	F00711031732	5	<	10	=	18	=	12	N/A	N/A
16	7/11/2003	IB Pier (Shore-South)	H0	17	32.57914	-117.13274	007	18:00	H00711031800	6	=	10	=	250	=	22	N/A	N/A
17	7/11/2003	IB Pier (Shore-South)	H0	17	32.57914	-117.13274	009	18:03	H00711031803	7	<	10	=	12	=	2	N/A	N/A
18	7/11/2003	IB Pier (End)	H9	20	32.57948	-117.13729	012	18:19	H90711031819	8	=	20	=	114	=	70	N/A	N/A
19	7/11/2003	IB Pier (Mid-surf zone)	H1	19	32.57957	-117.13412	013	18:32	H10711031832	9	<	10	=	152	=	4	N/A	N/A
20	7/11/2003	Rivermouth	C0	9	32.55653	-117.12900	014	19:26	C00711031926	10	=	20	=	90	=	4	N/A	N/A
21	7/11/2003	Rivermouth 2	C1	13	32.55779	-117.13074	016	19:42	C10711031942	11	<	10	=	46	=	8	N/A	N/A
22	7/11/2003	3/4 North	D0	14	32.56128	-117.13174	017	19:56	D00711031956	12	<	10	=	6	<	2	N/A	N/A
23	7/11/2003	Seacoast	E0	15	32.56617	-117.13274	018	20:08	E00711032008	13	=	10	=	500	=	4	N/A	N/A
24	7/17/2003	Monument Road	B0	2	32.54354	-117.12498	052	16:44	B00717031644	1	<	10	=	156	=	1800	N/A	N/A
25	7/17/2003	Border Fence	A0	1	32.53542	-117.12401	054	17:19	A00717031719	2	<	10	=	58	=	2	N/A	N/A
26	7/17/2003	Cortez	F0	16	32.57266	-117.13268	051	18:03	F00717031803	3	<	10	=	250	<	2	N/A	N/A
27	7/17/2003	Cortez	F0	16	32.57266	-117.13268	055	18:08	F00717031808	4	<	10	=	1	<	2	N/A	N/A
28	7/17/2003	IB Pier (Shore-South)	H0	17	32.57930	-117.13271	009	18:32	H00717031832	5	=	20	=	500	=	200	N/A	N/A
29	7/17/2003	IB Pier (End)	H9	20	32.57948	-117.13731	010	18:56	H90717031856	6	<	10	=	102	<	2	N/A	N/A
30	7/17/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13339	008	19:13	H10717031913	7	=	10	=	126	=	18	N/A	N/A
31	7/17/2003	Rivermouth	C0	9	32.55666	-117.12943	057	16:19	C00717031619	8	<	10	=	1050	=	14	N/A	N/A
32	7/17/2003	Rivermouth 2	C1	13	32.55777	-117.13116	058	16:35	C10717031635	9	=	10	=	54	=	4	N/A	N/A
33	7/17/2003	3/4 North	D0	14	32.56124	-117.13202	060	17:03	D00717031703	10	=	10	=	126	<	2	N/A	N/A
34	7/17/2003	Seacoast	E0	15	32.56612	-117.13303	061	17:31	E00717031731	11	<	10	=	100	<	2	N/A	N/A
35	7/17/2003	Rivermouth	C0	9	32.55667	-117.12930	003	18:13	C00717031813	12	<	10	=	104	=	8	N/A	N/A
36	7/17/2003	Rivermouth 2	C1	13	32.55783	-117.13079	020	18:33	C10717031833	13	<	10	=	750	=	400	N/A	N/A
37	7/17/2003	3/4 North	D0	14	32.56134	-117.13189	002	18:58	D00717031858	14	=	30	=	350	=	6	N/A	N/A
38	7/17/2003	Seacoast	E0	15	32.56616	-117.13288	019	19:25	E00717031925	15	<	10	=	700	<	2	N/A	N/A
39	7/23/2003	IB Pier (End)	H9	20	32.57946	-117.13724	036	15:20	H90723031520	1	<	10	=	150	=	116	N/A	N/A
40	7/23/2003	IB Pier (Mid-surf zone)	H1	19	32.57953	-117.13382	038	15:36	H10723031536	2	<	10	=	1200	=	4	N/A	N/A
41	7/23/2003	IB Pier (Mid-surf zone)	H1	19	32.57953	-117.13382	030	15:40	H10723031540	3	=	10	=	12	=	6	N/A	N/A
42	7/23/2003	IB Pier (Shore-South)	H0	17	32.57929	-117.13280	034	15:59	H00723031559	4	<	10	=	10	=	4	N/A	N/A
43	7/23/2003	IB Pier (Shore-North)	H3	18	32.57978	-117.13288	026	16:08	H30723031608	5	<	10	=	500	<	2	N/A	N/A
44	7/23/2003	Cortez	F0	16	32.57263	-117.13280	025	16:31	F00723031631	6	<	10	=	200	=	4	N/A	N/A
45	7/23/2003	IB Pier (Shore-South)	H0	17	32.57927	-117.13282	029	16:52	H00723031652	7	<	10	=	450	=	6	N/A	N/A
46	7/23/2003	IB Pier (Shore-North)	H3	18	32.57980	-117.13288	033	17:01	H30723031701	8	<	10	=	650	=	2	N/A	N/A
47	7/23/2003	IB Pier (End)	H9	20	32.57946	-117.13728	039	17:25	H90723031725	9	<	10	=	52	=	6	N/A	N/A
48	7/23/2003	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13381	035	17:39	H10723031739	10	=	10	=	62	=	12	N/A	N/A
49	7/23/2003	Cortez	F0	16	32.57267	-117.13280	024	18:14	F00723031814	11	<	10	<	2	<	2	N/A	N/A
50	7/23/2003	Rivermouth	C0	9	32.55659	-117.12926	001	15:19	C00723031519	12	<	10	=	6	=	10	N/A	N/A
51	7/23/2003	Rivermouth 2	C1	13	32.55780	-117.13105	002	15:38	C10723031538	13	<	10	=	650	=	10	N/A	N/A
52	7/23/2003	3/4 North	D0	14	32.56123	-117.13201	004	16:03	D00723031603	14	<	10	=	68	=	10	N/A	N/A
53	7/23/2003	Seacoast	E0	15	32.56605	-117.13309	005	16:29	E00723031629	15	<	10	=	28	=	4	N/A	N/A
54	7/23/2003	Rivermouth	C0	9	32.55660	-117.12924	006	16:59	C00723031659	16	<	10	=	800	=	12	N/A	N/A
55	7/23/2003	Rivermouth 2	C1	13	32.55780	-117.13107	010	17:23	C10723031723	17	<	10	=	10	=	2000	N/A	N/A
56	7/23/2003	3/4 North	D0	14	32.56126	-117.13203	012	17:49	D00723031749	18	<	10	=	2	<	2	N/A	N/A
57	7/23/2003	Seacoast	E0	15	32.56613	-117.13300	014	18:17	E00723031817	19	<	10	=	2	=	50	N/A	N/A
58	7/23/2003	IB Pier (Shore-South)	H0	17	32.57930	-117.13273	031	18:55	H00723031855	20	<	10	=	200	=	2	N/A	N/A
59	7/23/2003	IB Pier (End)	H9	20	32.57952	-117.13720	027	19:17	H90723031917	21	<	10	=	30	<	2	N/A	N/A
60	7/23/2003	IB Pier (Mid-surf zone)	H1	19	32.57953	-117.13391	032	19:33	H10723031933	22	<	10	=	106	=	10	N/A	N/A
61	7/23/2003	Seacoast	E0	15	32.56643	-117.13282	022	19:48	E00723031948	23	<	10	=	800	<	2	N/A	N/A
62	7/23/2003	Rivermouth	C0	9	32.55663	-117.12922	016	19:07	C00723031907	24	<	10	=	44	=	46	N/A	N/A
63	7/23/2003	Rivermouth 2	C1	13	32.55779	-117.13103	017	19:21	C10723031921	25	<	10	=	150	<	2	N/A	N/A
64	7/23/2003	3/4 North	D0	14	32.56125	-117.13193	018	19:44	D00723031944	26	<	10	=	350	<	2	N/A	N/A
65	8/20/2003	Rivermouth	C0	9	32.55676	-117.12947	013	16:42	C00820031642	1	<	10	<	2	<	2	N/A	N/A
66	8/20/2003	Rivermouth 2	C1	13	32.55778	-117.13110	016	17:08	C10820031708	2	<	10	<	2	<	2	N/A	N/A
67	8/20/2003	3/4 North	D0	14	32.56129	-117.13194	031	17:40	D00820031740	3	<	10	<	2	<	2	N/A	N/A
68	8/20/2003	3/4 North	D0	14	32.56129	-117.13194	011	17:50	D00820031750	4	<	10	<	2	<	2	N/A	N/A
69	8/20/2003	Seacoast	E0	15	32.56634	-117.13312	027	18:27	E00820031827	5	<	10	<	2	<	2	N/A	N/A
70	8/20/2003	Cortez	F0	16	32.57267	-117.13315	014	18:56	F00820031856	6	<	10	<	2	<	2	N/A	N/A
71	8/20/2003	IB Pier (Shore-South)	H0	17	32.57907	-117.13271	022	19:43	H00820031943	7	<	10	=	24	=	22	N/A	N/A
72	8/20/2003	IB Pier (Shore-North)	H3	18	32.58004	-117.13293	039	19:56	H30820031956	8	<	10	=	8	=	12	N/A	N/A
73	8/20/2003	IB Pier (Shore-North)	H3	18	32.58004	-117.13293	026	20:04	H30820032004	9	<	10	=	32	=	34	N/A	N/A
74	8/20/2003	IB Pier (End)	H9	20	32.57955	-117.13735	010	20:35	H90820032035	10	<	10	<	2	<	2	N/A	N/A
75	8/20/2003	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13359	029	20:56	H10820032056	11	<	10	=	14	=	12	N/A	N/A
76	8/28/2003	Rivermouth	C0	9	32.55691	-117.12987	067	13:50	C00828031350	1	=	20	=	12	=	10	N/A	N/A
77	8/28/2003	Rivermouth 2	C1	13	32.55779	-117.13117	085	14:25	C10828031425	2	=	10	=	16	=	6	N/A	N/A
78	8/28/2003	Rivermouth 2	C1	13	32.55779	-117.13117	071	14:30	C10828031430	3	=	20	=	26	=	4	N/A	N/A
79	8/28/2003	3/4 North	D0	14	32.56133	-117.13207	040	14:56	D00828031456	4	=	52	=	4	=	6	N/A	N/A
80	8/28/2003	3/4 North	D0	14	32.56133	-117.13207	052	15:14	D00828031514	5	=	31	=	6	=	14	N/A	N/A
81	8/28/2003	Seacoast	E0	15	32.56633	-117.13306	072	15:55	E00828031555	6	=	10	=	8	=	8	N/A	N/A
82	8/28/2003	Cortez	F0	16	32.57273	-117.13316	061	16:40	F00828031640	7	=	20	=	2	=	20	N/A	N/A
83	8/28/2003	IB Pier (Shore-South)	H0	17	32.57885	-117.13290	076	17:37	H00828031737	8	<	10	=	32	=	46	N/A	N/A

84	8/28/2003	IB Pier (Shore-North)	H3	18	32.58001	-117.13290	041	17:57	H30828031757	9	=	10	=	22	=	22	N/A	N/A
85	8/28/2003	IB Pier (End)	H9	20	32.57948	-117.13727	050	18:35	H90828031835	10	<	10	=	50	<	2	N/A	N/A
86	9/5/2003	Monument Road	B0	2	32.54334	-117.12521	029	14:52	B00905031452	1	<	10	=	16	=	10	N/A	N/A
87	9/5/2003	Border Fence	A0	1	32.53551	-117.12435	065	15:15	A00905031515	2	<	10	=	12	=	2	N/A	N/A
88	9/5/2003	Cortez	F0	16	32.57263	-117.13324	070	16:20	F00905031620	3	<	10	=	4	=	2	N/A	N/A
89	9/5/2003	Cortez	F0	16	32.57263	-117.13324	056	16:25	F00905031625	4	<	10	=	2	=	4	N/A	N/A
90	9/5/2003	IB Pier (Shore-South)	H0	17	32.57891	-117.13306	064	17:03	H00905031703	5	<	10	=	2	=	2	N/A	N/A
91	9/5/2003	IB Pier (Shore-North)	H3	18	32.57997	-117.13308	046	17:17	H30905031717	6	<	10	=	64	=	44	N/A	N/A
92	9/5/2003	IB Pier (End)	H9	20	32.57952	-117.13733	073	17:43	H90905031743	7	<	10	=	8	=	10	N/A	N/A
93	9/5/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13413	080	17:57	H10905031757	8	<	10	=	2	<	2	N/A	N/A
94	9/5/2003	Rivermouth	C0	9	32.55644	-117.12848	077	16:29	C00905031619	9	=	10	=	8	=	4	N/A	N/A
95	9/5/2003	Rivermouth 2	C1	13	32.55785	-117.13094	085	16:52	C10905031652	10	<	10	=	10	=	8	N/A	N/A
96	9/5/2003	3/4 North	D0	14	32.56128	-117.13196	022	17:18	D00905031718	11	<	10	=	8	=	2	N/A	N/A
97	9/5/2003	Seacoast	E0	15	32.56633	-117.13309	068	18:03	E00905031803	12	<	10	<	2	=	2	N/A	N/A
98	9/15/2003	Oneonta Slough (furthest)	J1	26	32.56486	-117.13124	076	17:58	J10915031758	1	<	10	=	10	<	2	19.03	33.51
99	9/15/2003	Oneonta Slough (mid-furthest)	J2	27	32.56338	-117.13032	041	18:06	J20915031806	2	<	10	=	12	=	2	18.99	33.08
100	9/15/2003	Oneonta Slough (mouth)	J3	28	32.56066	-117.13062	014	18:17	J30915031817	3	<	10	=	10	=	20	19.06	33.29
101	9/15/2003	Estuary (north)	J4	29	32.55915	-117.12872	040	18:25	J40915031825	4	<	10	=	18	=	16	18.38	33.58
102	9/15/2003	Estuary (center)	J5	30	32.55673	-117.12787	050	18:37	J50915031837	5	=	10	=	2	=	20	18.26	33.13
103	9/15/2003	Estuary (center)	J6	31	32.55553	-117.12700	072	18:48	J60915031848	6	<	10	=	28	=	28	17.91	33.57
104	9/15/2003	Estuary (center-mouth)	J7	32	32.55585	-117.12804	003	18:56	J70915031856	7	<	10	<	2	<	2	17.75	32.83
105	9/15/2003	Southwest Slough (outermost)	J8	33	32.55217	-117.12236	067	19:15	J80915031915	8	<	10	=	10	=	2	20.52	33.56
106	9/15/2003	Southwest Slough (outer-mid)	J9	34	32.55141	-117.12392	060	19:24	J90915031924	9	=	10	=	14	=	8	19.79	33.57
107	9/15/2003	Southwest Slough (inner-mid)	JA	35	32.55208	-117.12610	023	19:32	JA0915031932	10	<	10	=	12	=	10	19.35	33.50
108	9/15/2003	Southwest Slough (mouth)	JB	36	32.55450	-117.12650	021	19:41	JB0915031941	11	<	10	=	140	=	260	18.88	33.59
109	9/15/2003	Main Slough (mid)	JC	37	32.55942	-117.11687	011	20:08	JC0915032008	12	=	20	<	2	<	2	20.57	33.42
110	9/15/2003	Main Slough (furthest)	JD	38	32.55899	-117.11384	018	20:16	JD0915032016	13	<	10	=	10	=	2	21.09	33.51
111	9/15/2003	Main Slough (mouth)	JE	39	32.55748	-117.12331	032	20:39	JE0915032039	14	<	10	=	4	=	4	20.32	33.58
112	9/15/2003	Oneonta Slough (shore)	JF	40	32.56659	-117.13148	009	21:59	JF0915032159	15	<	10	=	6	=	2	23.60	33.50
113	9/15/2003	Oneonta Slough (shore)	JF	40	32.56659	-117.13148	026	22:01	JF0915032201	16	=	20	=	12	=	10	23.60	33.50
114	9/29/2003	Cortez	F0	16	32.57262	-117.13307	007	19:20	F00929031920	1	=	10	=	48	=	2	N/A	N/A
115	9/29/2003	IB Pier (Shore-South)	H0	17	32.57891	-117.13290	005	19:44	H00929031944	2	<	10	=	8	<	2	N/A	N/A
116	9/29/2003	IB Pier (End)	H9	20	32.57942	-117.13728	021	20:05	H90929032005	3	<	10	<	2	<	2	N/A	N/A
117	9/29/2003	Seacoast	E0	15	32.56612	-117.13287	033	20:43	E00929032043	4	<	10	=	6	=	20	18.88	33.80
118	9/29/2003	Seacoast	E0	15	32.56612	-117.13287	081	20:50	E00929032050	5	<	10	=	10	=	6	18.88	33.80
119	9/29/2003	Rivermouth	C0	9	32.55709	-117.12890	026	19:08	C00929031908	6	=	10	=	10	<	2	17.62	33.34
120	9/29/2003	Rivermouth 2	C1	13	32.55777	-117.13073	018	19:38	C10929031938	7	<	10	=	8	=	4	17.59	33.10
121	9/29/2003	3/4 North	D0	14	32.56133	-117.13187	011	20:17	D00929032017	8	<	10	=	8	=	6	17.94	33.36
122	9/29/2003	3/4 North	D0	14	32.56129	-117.13197	023	21:53	D00929032153	9	<	10	=	8	=	4	18.51	33.73
123	9/29/2003	Rivermouth	C0	9	32.55721	-117.12993	050	22:23	C00929032223	10	=	10	=	22	=	10	19.35	33.53
124	9/29/2003	Rivermouth 2	C1	13	32.55775	-117.13096	060	22:42	C10929032242	11	<	10	=	4	=	18	19.58	33.61
125	9/29/2003	Rivermouth	C0	9	32.55713	-117.12990	008	23:18	C00929032318	12	<	10	=	32	=	12	19.94	33.64
126	9/29/2003	Rivermouth 2	C1	13	32.55775	-117.13138	022	23:38	C10929032338	13	=	10	=	16	=	10	19.75	33.56
127	9/30/2003	3/4 North	D0	14	32.56128	-117.13235	080	0:04	D00930030004	14	<	10	=	26	=	10	19.54	33.44
128	9/30/2003	Rivermouth	C0	9	32.55715	-117.12978	061	0:30	C00930030030	15	=	20	=	20	=	22	20.12	33.63
129	9/30/2003	Rivermouth	C0	9	32.55716	-117.12976	052	1:00	C00930030100	16	<	10	=	28	=	20	20.16	33.60
130	9/30/2003	Rivermouth	C0	9	32.55714	-117.12972	057	1:30	C00930030130	17	=	20	=	40	=	26	20.25	33.46
131	9/30/2003	Rivermouth	C0	9	32.55713	-117.12982	040	2:00	C00930030200	18	=	31	=	46	=	18	20.22	N/A
132	10/15/2003	Rivermouth	C0	9	32.55706	-117.12903	031	19:44	C01015031944	1	=	10	=	12	=	6	20.41	33.20
133	10/15/2003	Rivermouth 2	C1	13	32.55776	-117.13078	035	20:11	C11015032011	2	<	10	=	28	=	18	21.05	33.68
134	10/15/2003	3/4 North	D0	14	32.56133	-117.13177	030	20:47	D01015032047	3	<	10	=	12	=	12	20.15	33.68
135	10/15/2003	Seacoast	E0	15	32.56638	-117.13284	065	21:18	E01015032018	4	<	10	=	20	=	4	20.48	33.68
136	10/15/2003	Seacoast	E0	15	32.56638	-117.13284	076	21:25	E01015032125	5	<	10	=	4	=	4	20.48	33.68
137	10/15/2003	Cortez	F0	16	32.57271	-117.13303	070	21:54	F01015032154	6	<	10	=	2	=	2	20.64	33.74
138	10/15/2003	IB Pier (Shore-South)	H0	17	32.57924	-117.13306	064	22:23	H01015032223	7	<	10	=	2	=	20	20.43	33.93
139	10/15/2003	IB Pier (End)	H9	20	32.57944	-117.13724	009	22:57	H91015032257	8	<	10	=	2	=	2	N/A	N/A
140	10/15/2003	IB Pier (Mid-surf zone)	H1	19	32.57951	-117.13382	068	23:13	H11015032313	9	<	10	=	16	<	2	N/A	N/A
141	10/16/2003	Rivermouth	C0	9	32.55743	-117.13016	016	18:13	C01016031813	1	<	10	=	14	<	2	19.77	33.68
142	10/16/2003	Rivermouth 2	C1	13	32.55792	-117.13087	015	18:33	C11016031833	2	<	10	=	8	=	200	19.70	33.82
143	10/16/2003	3/4 North	D0	14	32.56133	-117.13172	039	18:59	D01016031859	3	<	10	=	2	<	2	19.75	33.79
144	10/16/2003	Seacoast	E0	15	32.56600	-117.13282	037	19:26	E01016031926	4	<	10	=	4	=	4	19.85	33.56
145	10/16/2003	Cortez	F0	16	32.57261	-117.13293	017	19:58	F01016031958	5	<	10	=	6	=	2	20.12	33.73
146	10/16/2003	IB Pier (Shore-South)	H0	17	32.57887	-117.13300	024	20:33	H01016032033	6	<	10	=	8	=	16	20.26	33.91
147	10/16/2003	IB Pier (End)	H9	20	32.57946	-117.13726	004	21:08	H91016032108	7	<	10	<	2	<	2	N/A	N/A
148	10/16/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13380	012	21:30	H11016032130	8	<	10	=	16	<	2	N/A	N/A
149	10/16/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13380	001	21:34	H11016032134	9	<	10	=	12	=	6	N/A	N/A
150	10/17/2003	Rivermouth	C0	9	32.55745	-117.13027	028	17:53	C01017031753	1	<	10	=	4	=	6	19.74	33.80
151	10/17/2003	Rivermouth 2	C1	13	32.55781	-117.13091	062	18:11	C11017031811	2	<	10	<	2	<	2	19.61	33.76
152	10/17/2003	Rivermouth 2	C1	13	32.55781	-117.13091	047	18:14	C11017031814	3	<	10	<	2	<	2	19.61	33.76
153	10/17/2003	3/4 North	D0	14	32.56132	-117.13175	027	18:39	D01017031839	4	<	10	<	2	<	2	19.79	33.67
154	10/17/2003	Seacoast	E0	15	32.56624	-117.13287	082	19:05	E01017031905	5	<	10	<	2	<	2	19.88	33.80
155	10/17/2003	Cortez	F0	16	32.57269	-117.13299	029	19:41	F01017031941	6	=	10	=	8	<	2	20.17	34.13
156	10/17/2003	IB Pier (Shore-South)	H0	17	32.57887	-117.13303	045	20:09	H01017032009	7	<	10	=	200	=	30	20.65	33.91
157	10/17/2003	IB Pier (End)	H9	20	32.57948	-117.13729	022	20:37	H91017032037	8	<	10	<	2	<	2	N/A	N/A
158	10/17/2003	IB Pier (Mid-surf zone)	H1	19	32.57957	-117.13356	018	20:53	H11017032053	9	=	10	=	26	=	20	N/A	N/A
159	11/7/2003	Monument Road	B0	2	32.54333	-117.12514	012	17:14	B01107031714	1	<	10	<	2	<	2	N/A	N/A
160	11/7/2003	Border Fence	A0	1	32.53530	-117.12426	083	17:40	A01107031740	2	<	10	=	4	=	2	N/A	N/A
161	11/7/2003	IB Pier (End)	H9	20	32.57956	-117.13744	029	19:21	H91107031921	8	<	10	<	2	<	2	N/A	N/A
162	11/7/2003	IB Pier (Mid-surf zone)	H1	19	32.57951	-117.13416	028	19:35	H11107031935	9	<	10	=	6	=	6	N/A	N/A
163	11/7/2003	Rivermouth	C0	9	32.55722	-117.12937	049	16:35	C01107031635	3	<	10	=	4	<	2	16.39	33.51
164	11/7/2003	Rivermouth 2	C1	13	32.55778	-117.13065	055	17:14	C11107031714	4	<	10	=	10	=	2	16.54	33.65
165	11/7/2003	3/4 North	D0	14	32.56124	-117.13176	026	17:47	D01107031747	5	<	10	=	6	<	2	16.70	33.70
166	11/7/2003	Seacoast	E0	15	32.56628	-117.13294	042	18:18	E01107031818	6	<	10	=	6	<	2	17.09	33.59
167	11/7/2003	Cortez	F0	16	32.57264	-117.13311	021	18:47	F01107031847	7	<	10	=	4	=	10	16.74	33.66
168	11/7/2003	IB Pier (Shore-South)	H0	17	32.57896	-117.13329	011	19:18	H01107031918	10	<	10	=	16	=	6	16.73	33.84

169	11/7/2003	IB Pier (Shore-South)	H0	17	32.57896	-117.13329	058	19:23	H01107031923	11	<	10	=	24	=	12	16.73	33.84
170	11/7/2003	Carnation	K0	22	32.58560	-117.13304	056	20:02	K01107032002	12	<	10	=	4	<	2	16.80	33.74
171	11/12/2003	Rivermouth	C0	9	32.55703	-117.12898	027	18:24	C01112031824	1	<	10	=	6	<	2	16.71	33.74
172	11/12/2003	Rivermouth 2	C1	13	32.55779	-117.13074	023	18:43	C11112031843	2	<	10	<	2	<	2	16.71	33.56
173	11/12/2003	3/4 North	D0	14	32.56129	-117.13174	031	19:17	D01112031917	3	<	10	=	8	=	2	16.73	33.50
174	11/12/2003	Seacoast	E0	15	32.56638	-117.13299	081	19:52	E01112031952	4	<	10	=	2	<	2	17.03	33.58
175	11/12/2003	Cortez	F0	16	32.57265	-117.13300	060	20:22	F01112032022	5	<	10	<	2	<	2	16.88	33.56
176	11/12/2003	Cortez	F0	16	32.57265	-117.13300	024	20:28	F01112032028	6	<	10	=	4	=	2	16.88	33.56
177	11/12/2003	IB Pier (Shore-South)	H0	17	32.57901	-117.13328	066	20:59	H01112032059	7	<	10	=	24	=	4	17.47	33.53
178	11/12/2003	IB Pier (End)	H9	20	32.57949	-117.13728	069	21:24	H91112032124	8	<	10	=	18	=	10	N/A	N/A
179	11/12/2003	IB Pier (Mid-surf zone)	H1	19	32.57951	-117.13399	022	21:40	H11112032140	9	<	10	=	6	<	2	N/A	N/A
180	11/12/2003	Carnation	K0	22	32.58563	-117.13319	003	22:11	K01112032211	10	<	10	=	34	=	10	17.27	33.73
181	11/14/2003	Rivermouth	C0	9	32.55708	-117.12915	026	16:07	C01114031607	1	<	10	=	6600	=	240	16.23	33.64
182	11/14/2003	Rivermouth 2	C1	13	32.55779	-117.13094	013	16:29	C11114031629	2	<	10	=	7800	=	280	16.23	33.42
183	11/14/2003	Rivermouth 2	C1	13	32.55779	-117.13094	011	16:34	C11114031634	3	=	10	=	7000	=	260	16.23	33.42
184	11/14/2003	3/4 North	D0	14	32.56128	-117.13177	036	16:59	D01114031659	4	=	31	=	10200	=	420	16.27	33.48
185	11/14/2003	Seacoast	E0	15	32.56636	-117.13294	051	17:27	E01114031727	5	<	10	=	7600	=	260	16.61	33.41
186	11/14/2003	Cortez	F0	16	32.57267	-117.13298	067	17:58	F01114031758	6	=	10	=	2200	=	140	16.62	33.43
187	11/14/2003	IB Pier (Shore-South)	H0	17	32.57895	-117.13308	018	18:28	H01114031828	7	<	10	=	60	=	10	16.91	33.48
188	11/14/2003	IB Pier (End)	H9	20	32.57949	-117.13728	058	18:59	H91114031859	8	<	10	=	700	=	34	N/A	N/A
189	11/14/2003	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13362	012	19:13	H11114031913	9	<	10	=	58	=	10	N/A	N/A
190	11/14/2003	Carnation	K0	22	32.58567	-117.13291	021	20:00	K01114032000	10	<	10	=	10	<	2	17.49	33.62
191	11/20/2003	Monument Road	B0	2	32.54340	-117.12509	028	15:54	B01120031554	1	<	10	=	6	=	2	15.34	34.01
192	11/20/2003	Border Fence	A0	1	32.53535	-117.12421	045	16:27	A01120031627	2	<	10	=	4	=	8	15.52	33.68
193	11/20/2003	Rivermouth	C0	9	32.55714	-117.12973	035	17:54	C01120031754	3	<	10	=	90	=	34	15.96	33.92
194	11/20/2003	Rivermouth	C0	9	32.55714	-117.12973	072	17:56	C01120031756	4	=	20	=	100	=	16	15.96	33.92
195	11/20/2003	Rivermouth 2	C1	13	32.55780	-117.13139	065	18:16	C11120031816	5	<	10	=	50	=	4	16.28	33.73
196	11/20/2003	3/4 North	D0	14	32.56126	-117.13196	076	18:40	D01120031840	6	<	10	=	18	=	8	16.25	33.65
197	11/20/2003	Seacoast	E0	15	32.56623	-117.13335	075	19:03	E01120031903	7	<	10	=	4	=	2	16.74	33.82
198	11/20/2003	Cortez	F0	16	32.57272	-117.13326	041	19:35	F01120031935	8	<	10	=	8	=	8	16.40	33.77
199	11/20/2003	IB Pier (Shore-South)	H0	17	32.57872	-117.13361	053	20:02	H01120032002	9	<	10	=	4	=	4	16.91	33.96
200	11/20/2003	Carnation	K0	22	32.58570	-117.13358	009	20:25	K01120032025	10	<	10	=	4	<	2	17.46	33.90
201	11/21/2003	Monument Road	B0	2	32.54341	-117.12508	082	16:16	B01121031616	1	<	10	=	4	=	4	15.99	33.98
202	11/21/2003	Border Fence	A0	1	32.53545	-117.12423	050	16:48	A01121031648	2	=	31	=	30	=	16	15.94	33.72
203	11/21/2003	Rivermouth	C0	9	32.55717	-117.12981	023	18:14	C01121031814	3	=	20	=	74	=	52	16.09	33.96
204	11/21/2003	Rivermouth 2	C1	13	32.55775	-117.13126	060	18:33	C11121031833	4	<	10	=	18	=	18	16.12	33.76
205	11/21/2003	3/4 North	D0	14	32.56134	-117.13202	058	18:57	D01121031857	5	=	31	=	30	=	16	16.04	33.80
206	11/21/2003	Seacoast	E0	15	32.56623	-117.13340	022	19:24	E01121031924	6	=	10	=	16	=	18	16.39	33.75
207	11/21/2003	Cortez	F0	16	32.57265	-117.13331	067	19:53	F01121031953	7	=	20	=	26	=	22	16.08	33.72
208	11/21/2003	Cortez	F0	16	32.57265	-117.13331	011	19:57	F01121031957	8	=	20	=	26	=	32	16.08	33.72
209	11/21/2003	IB Pier (Shore-South)	H0	17	32.57859	-117.13361	026	20:24	H01121032024	9	=	10	=	44	=	30	16.09	33.77
210	11/21/2003	Carnation	K0	22	32.58569	-117.13370	013	20:51	K01121032051	10	=	10	=	4	=	2	16.25	33.67
211	12/12/2003	Rivermouth	C0	9	32.55709	-117.12894	066	16:28	C01212031628	1	<	10	=	4	<	2	14.88	34.08
212	12/12/2003	Rivermouth	C0	9	32.55709	-117.12894	033	16:46	C01212031646	2	<	10	=	4	<	2	14.88	34.08
213	12/12/2003	Rivermouth 2	C1	13	32.55779	-117.13059	062	17:21	C11212031721	3	<	10	=	10	=	4	15.10	33.88
214	12/12/2003	3/4 North	D0	14	32.56129	-117.13154	017	17:52	D01212031752	4	<	10	=	2	=	2	14.98	33.53
215	12/12/2003	Seacoast	E0	15	32.56632	-117.13271	001	18:26	E01212031826	5	<	10	=	18	=	8	14.93	33.49
216	12/12/2003	Cortez	F0	16	32.57258	-117.13261	030	18:52	F01212031852	6	=	10	=	6	=	8	15.13	33.48
217	12/12/2003	IB Pier (Shore-South)	H0	17	32.57903	-117.13290	014	19:31	H01212031931	7	<	10	=	2	<	2	15.72	33.88
218	12/12/2003	Carnation	K0	22	32.58562	-117.13274	004	20:56	K01212032056	8	=	10	=	56	=	30	16.08	34.06
219	12/12/2003	IB Pier (End)	H9	20	32.57956	-117.13735	006	19:59	H91212031959	9	=	10	<	2	<	2	N/A	N/A
220	12/12/2003	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13413	085	20:20	H11212032020	10	=	10	=	4	=	6	N/A	N/A
221	12/18/2003	Rivermouth	C0	9	32.55680	-117.12890	060	17:02	C01218031702	1	<	10	=	90	=	30	14.06	34.50
222	12/18/2003	Rivermouth 2	C1	13	32.55768	-117.13082	033	17:22	C11218031722	2	<	10	=	6	<	2	14.61	33.95
223	12/18/2003	3/4 North	D0	14	32.56138	-117.13166	017	17:48	D01218031748	3	<	10	=	6	=	4	14.56	34.01
224	12/18/2003	Seacoast	E0	15	32.56568	-117.13282	085	18:16	E01218031816	4	<	10	=	4	=	4	14.72	34.05
225	12/18/2003	Cortez	F0	16	32.57266	-117.13269	004	18:53	F01218031853	5	<	10	=	4	=	6	15.42	34.04
226	12/18/2003	Cortez	F0	16	32.57266	-117.13269	001	18:56	F01218031856	6	=	10	<	2	=	6	15.42	34.04
227	12/18/2003	IB Pier (Shore-South)	H0	17	32.57862	-117.13265	023	19:28	H01218031928	7	<	10	=	52	=	44	15.30	33.15
228	12/18/2003	IB Pier (End)	H9	20	32.57949	-117.13731	013	19:56	H91218031956	8	<	10	=	6	=	14	N/A	N/A
229	12/18/2003	IB Pier (Mid-surf zone)	H1	19	32.57952	-117.13476	015	20:08	H11218032008	9	<	10	<	2	<	2	N/A	N/A
230	12/18/2003	Carnation	K0	22	32.58559	-117.13291	047	20:37	K01218032037	10	<	10	<	2	<	2	15.58	34.11
231	1/15/2004	Rivermouth	C0	9	32.55670	-117.12903	011	15:25	C00115041525	1	<	10	=	280	=	8	13.75	33.82
232	1/15/2004	Rivermouth 2	C1	13	32.55775	-117.13093	018	15:50	C10115041550	2	<	10	=	20	=	2	13.66	33.59
233	1/15/2004	3/4 North	D0	14	32.56129	-117.13174	045	16:12	D00115041612	3	<	10	=	8	=	2	13.71	33.51
234	1/15/2004	Seacoast	E0	15	32.56631	-117.13294	041	16:45	E00115041645	4	<	10	=	8	=	2	14.01	33.52
235	1/15/2004	Seacoast	E0	15	32.56631	-117.13294	071	16:57	E00115041657	5	<	10	=	6	=	4	14.01	33.52
236	1/15/2004	Cortez	F0	16	32.57277	-117.13287	048	17:25	F00115041725	6	<	10	=	2	=	4	14.34	33.59
237	1/15/2004	IB Pier (Shore-South)	H0	17	32.57904	-117.13315	073	17:57	H00115041757	7	=	10	=	6	=	2	14.44	33.73
238	1/15/2004	IB Pier (End)	H9	20	32.57956	-117.13689	059	18:23	H90115041823	8	<	10	<	2	=	4	N/A	N/A
239	1/15/2004	IB Pier (Mid-surf zone)	H1	19	32.57959	-117.13421	077	18:36	H10115041836	9	<	10	=	48	=	42	N/A	N/A
240	1/15/2004	Carnation	K0	22	32.58567	-117.13283	046	19:19	K00115041919	10	<	10	=	4	=	2	15.03	33.72
241	1/22/2004	Monument	B0	2	32.54327	-117.12464	039	18:15	B00122041815	1	<	10	=	2	<	2	N/A	N/A
242	1/22/2004	Border Fence	A0	1	32.53528	-117.12404	037	18:56	A00122041856	2	<	10	=	6	<	2	N/A	N/A
243	1/22/2004	Hollister	M0	7	32.55143	-117.08411	056	19:41	M00122041941	3	=	197	>	16000	=	520	N/A	N/A
244	1/22/2004	Seacoast	E0	15	32.56633	-117.13282	049	20:25	E00122042025	4	<	10	<	2	=	2	15.16	33.84
245	1/22/2004	Rivermouth	C0	9	32.55714	-117.12935	005	17:51	C00122041751	5	<	10	=	8	=	4	14.62	34.00
246	1/22/2004	TJR75	R0	11	32.55808	-117.13074	052	18:08	R00122041808	6	<	10	=	8	=	2	14.56	34.28
247	1/22/2004	TJR225	R2	12	32.56036	-117.13136	057	18:31	R20122041831	7	=	10	=	18	=	20	14.60	34.20
248	1/22/2004	3/4 North	D0	14	32.56128	-117.13158	061	18:48	D00122041848	8	<	10	=	6	=	8	14.60	34.02
249	1/22/2004	Seacoast	E0	15	32.56610	-117.13264	040	19:23	E00122041923	9	<	10	=	10	=	6	14.67	34.44
250	1/22/2004	Rivermouth	C0	9	32.55681	-117.12891	038	19:58	C00122041958	10	<	10	=	42	=	14	15.46	34.33
251	1/22/2004	Rivermouth 2	C1	13	32.55784	-117.13058	083	20:18	C10122042018	11	<	10	=	6	<	2	14.97	34.15
252	1/22/2004	3/4 North	D0	14	32.56129	-117.13168	016	20:43	D00122042043	12	<	10	=	2	<	2	15.15	33.96
253	1/22/2004	Cortez	F0	16	32.57268	-117.13274	054	21:34	F00122042134	13	<	10	=	2	<	2	15.16	33.85

254	1/22/2004	IB Pier (End)	H9	20	32.57953	-117.13723	042	22:01	H90122042201	14	<	10	<	2	<	2	N/A	N/A
255	1/22/2004	IB Pier (Mid-surf zone)	H1	19	32.57961	-117.13471	053	22:13	H10122042213	15	<	10	<	2	=	2	N/A	N/A
256	1/22/2004	IB Pier (Mid-surf zone)	H1	19	32.57961	-117.13471	002	22:15	H10122042215	16	<	10	=	4	<	2	N/A	N/A
257	1/22/2004	IB Pier (Shore-South)	H0	17	32.57877	-117.13333	044	22:00	H00122042200	17	<	10	=	38	=	14	15.33	33.76
258	1/22/2004	Carnation	K0	22	32.58571	-117.13326	072	22:42	K00122042242	18	<	10	=	2	=	8	15.86	33.79
259	1/29/2004	Rivermouth South	C2	5	32.55637	-117.12897	008	17:12	C20129041712	1	=	41	>	16000	=	120	N/A	N/A
260	1/29/2004	TJL75	L0	4	32.55549	-117.12907	034	17:32	L00129041732	2	=	10	=	7200	=	42	N/A	N/A
261	1/29/2004	TJL225	L2	3	32.55438	-117.12846	036	17:45	L20129041745	3	=	10	=	6600	=	26	N/A	N/A
262	1/29/2004	Monument	B0	2	32.54346	-117.12503	029	18:10	B00129041810	4	<	10	=	480	=	2	N/A	N/A
263	1/29/2004	Border Fence	A0	1	32.53540	-117.12428	025	18:35	A00129041835	5	<	10	=	260	=	2	N/A	N/A
264	1/29/2004	Hollister	M0	7	32.55136	-117.08398	064	19:13	M00129041913	6	=	15760	>	16000	>	12000	N/A	N/A
265	1/29/2004	Cortez	F0	16	32.57261	-117.13280	045	19:59	F00129041959	7	=	10	=	174	<	2	N/A	N/A
266	1/29/2004	Seacoast	E0	15	32.56619	-117.13291	073	20:18	E00129042018	8	=	10	=	42	=	44	15.36	33.72
267	1/29/2004	Rivermouth	C0	9	32.55663	-117.12900	062	17:12	C00129041712	9	=	132	=	30000	=	240	13.51	30.95
268	1/29/2004	TJR75	R0	11	32.55735	-117.13058	068	17:45	R00129041745	10	=	84	=	13400	=	82	14.85	33.30
269	1/29/2004	TJR225	R2	12	32.55857	-117.13178	035	18:10	R20129041810	11	<	10	=	66	=	2	14.96	34.23
270	1/29/2004	3/4 North	D0	14	32.56128	-117.13183	075	18:35	D00129041835	12	=	10	<	2	=	2	14.89	34.07
271	1/29/2004	Seacoast	E0	15	32.56639	-117.13297	026	19:04	E00129041904	13	<	10	=	2	=	4	15.02	33.81
272	1/29/2004	Rivermouth	C0	9	32.55659	-117.12907	009	19:38	C00129041938	14	=	20	=	19600	=	58	17.09	32.22
273	1/29/2004	Rivermouth 2	C1	13	32.55777	-117.13096	014	19:55	C10129041955	15	<	10	=	56	<	2	16.63	33.68
274	1/29/2004	3/4 North	D0	14	32.56129	-117.13177	065	20:24	D00129042024	16	<	10	=	2	=	4	15.42	33.76
275	1/29/2004	IB Pier (Shore-South)	H0	17	32.57879	-117.13301	010	21:14	H00129042114	17	=	41	=	36	=	32	15.80	33.58
276	1/29/2004	IB Pier (Shore-South)	H0	17	32.57879	-117.13301	071	21:17	H00129042117	18	=	74	=	118	=	58	15.80	33.58
277	1/29/2004	IB Pier (End)	H9	20	32.57946	-117.13722	001	21:15	H90129042115	19	<	10	<	2	<	2	N/A	N/A
278	1/29/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13463	018	21:28	H10129042128	20	<	10	=	2	<	2	N/A	N/A
279	2/2/2004	Rivermouth South	C2	5	32.55634	-117.12901	048	19:02	C20202041902	1	=	10	=	780	=	8	N/A	N/A
280	2/2/2004	TJL75	L0	4	32.55558	-117.12968	060	19:20	L00202041920	2	<	10	=	66	=	6	N/A	N/A
281	2/2/2004	TJL225	L2	3	32.55447	-117.12856	023	19:32	L20202041932	3	<	10	=	14	=	2	N/A	N/A
282	2/2/2004	Monument Road	B0	2	32.54350	-117.12516	004	20:05	B00202042005	4	<	10	=	6	<	2	N/A	N/A
283	2/2/2004	Border Fence	A0	1	32.53561	-117.12437	017	20:30	A00202042030	5	<	10	=	2	=	2	N/A	N/A
284	2/2/2004	Hollister	M0	7	32.55143	-117.08416	041	21:04	M00202042104	6	=	200	>	16000	=	5000	N/A	N/A
285	2/2/2004	Rivermouth	C0	9	32.55654	-117.12907	013	19:03	C00202041903	7	<	10	=	112	=	2	13.86	34.18
286	2/2/2004	TJR75	R0	11	32.55699	-117.13039	085	19:28	R00202041928	8	=	10	=	560	=	14	13.68	33.86
287	2/2/2004	TJR225	R2	12	32.55820	-117.13164	031	19:50	R20202041950	9	<	10	=	62	=	14	13.84	33.86
288	2/2/2004	3/4 North	D0	14	32.56128	-117.13189	082	20:15	D00202042015	10	<	10	=	4	=	4	15.46	33.80
289	2/2/2004	Seacoast	E0	15	32.56623	-117.13316	067	20:40	E00202042040	11	<	10	=	2	<	2	15.25	33.77
290	2/2/2004	IB Pier (Shore-South)	H0	17	32.57863	-117.13344	011	22:18	H00202042218	12	<	10	=	38	=	34	15.92	33.94
291	2/2/2004	Cortez	F0	16	32.57269	-117.13287	081	22:31	F00202042231	13	=	10	=	14	=	14	15.96	33.87
292	2/2/2004	Cortez	F0	16	32.57269	-117.13287	024	22:35	F00202042235	14	=	243	=	320	=	112	15.96	33.87
293	2/5/2004	Border Fence	A0	1	32.53545	-117.12395	022	16:28	A00205041628	1	<	10	=	3800	=	108	N/A	N/A
294	2/5/2004	Monument Road	B0	2	32.54346	-117.12486	058	16:59	B00205041659	2	<	10	=	820	=	12	N/A	N/A
295	2/5/2004	Hollister	M0	7	32.55147	-117.08411	076	17:38	M00205041738	3	<	10	>	16000	>	16000	N/A	N/A
296	2/5/2004	Carnation	K0	22	32.58553	-117.13258	006	18:16	K00205041816	4	<	10	=	6	=	6	N/A	N/A
297	2/5/2004	IB Pier (End)	H9	20	32.57943	-117.13725	027	18:45	H90205041845	5	<	10	=	114	=	6	N/A	N/A
298	2/5/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13469	002	18:58	H10205041858	6	<	10	=	44	=	6	N/A	N/A
299	2/5/2004	Cortez	F0	16	32.57264	-117.13258	152	19:22	F00205041922	7	=	20	=	4	=	2	N/A	N/A
300	2/5/2004	Rivermouth	C0	9	32.55682	-117.12871	091	16:46	C00205041646	8	<	10	=	18	=	4	13.78	33.57
301	2/5/2004	Rivermouth 2	C1	13	32.55776	-117.13057	072	17:08	C10205041708	9	<	10	=	1500	=	6	13.84	33.49
302	2/5/2004	Rivermouth 2	C1	13	32.55776	-117.13057	005	17:14	C10205041714	10	<	10	=	12	=	4	13.84	33.49
303	2/5/2004	3/4 North	D0	14	32.56130	-117.13151	077	17:44	D00205041744	11	=	10	=	14	=	2	14.07	33.55
304	2/5/2004	Rivermouth	C0	9	32.55674	-117.12843	090	18:23	C00205041823	12	=	20	=	14400	=	122	14.50	33.71
305	2/5/2004	Rivermouth 2	C1	13	32.55777	-117.13063	059	18:38	C10205041838	13	<	10	=	4	=	4	14.52	33.66
306	2/5/2004	3/4 North	D0	14	32.56129	-117.13158	046	19:04	D00205041904	14	<	10	=	80	=	4	14.47	33.73
307	2/5/2004	Seacoast	E0	15	32.56632	-117.13273	083	19:35	E00205041935	15	<	10	=	148	=	2	14.85	33.60
308	2/5/2004	Rivermouth	C0	9	32.55666	-117.12904	069	20:31	C00205042031	16	=	1396	>	16000	>	12000	15.76	32.39
309	2/5/2004	Rivermouth	C0	9	32.55663	-117.12907	003	21:00	C00205042100	17	=	1187	>	16000	>	12000	15.73	31.49
310	2/5/2004	Rivermouth	C0	9	32.55661	-117.12909	030	21:30	C00205042130	18	=	4786	>	16000	>	12000	16.32	29.65
311	2/5/2004	Rivermouth	C0	9	32.55654	-117.12910	051	22:00	C00205042200	19	=	3968	>	16000	>	12000	16.79	29.16
312	2/5/2004	Rivermouth	C0	9	32.55655	-117.12910	033	22:30	C00205042230	20	=	4870	>	16000	>	12000	17.37	27.29
313	2/5/2004	Rivermouth	C0	9	32.55656	-117.12907	015	23:00	C00205042300	21	=	8840	>	16000	>	12000	17.35	26.54
314	2/5/2004	Rivermouth	C0	9	32.55656	-117.12916	093	23:30	C00205042330	22	=	5630	>	16000	>	12000	17.56	26.07
315	2/6/2004	Rivermouth	C0	9	32.55654	-117.12906	113	0:00	C00206040000	23	=	7330	>	16000	>	12000	17.29	25.73
316	2/12/2004	Border Fence	A0	1	32.53537	-117.12430	134	16:48	A00212041648	1	<	10	=	8	=	6	N/A	N/A
317	2/12/2004	Monument Road	B0	2	32.54340	-117.12508	130	17:17	B00212041717	2	<	10	=	94	<	2	N/A	N/A
318	2/12/2004	Hollister	M0	7	32.55140	-117.08414	097	17:53	M00212041753	3	=	2590	>	16000	>	12000	N/A	N/A
319	2/12/2004	Carnation	K0	22	32.58565	-117.13275	105	18:32	K00212041832	4	<	10	<	2	<	2	N/A	N/A
320	2/12/2004	IB Pier (Shore-South)	H0	17	32.57874	-117.13300	092	18:50	H00212041850	5	<	10	=	4	=	8	N/A	N/A
321	2/12/2004	IB Pier (End)	H9	20	32.57946	-117.13725	114	19:15	H90212041915	6	<	10	=	24	=	30	N/A	N/A
322	2/12/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13407	123	19:28	H00212041928	7	<	10	=	2	<	2	N/A	N/A
323	2/12/2004	Cortez	F0	16	32.57265	-117.13279	098	19:50	F00212041950	8	<	10	<	2	<	2	N/A	N/A
324	2/12/2004	Seacoast	E0	15	32.56624	-117.13297	143	20:18	E00212042018	9	<	10	=	62	<	2	N/A	N/A
325	2/12/2004	3/4 North	D0	14	32.56128	-117.13170	133	20:44	D00212042044	10	<	10	<	2	<	2	N/A	N/A
326	2/12/2004	Rivermouth	C0	9	32.55653	-117.12884	008	17:00	C00212041700	11	=	243	>	16000	=	200	12.57	30.85
327	2/12/2004	Rivermouth 2	C1	13	32.55778	-117.13117	025	17:21	C10212041721	12	<	10	=	1120	=	14	13.90	33.59
328	2/12/2004	Rivermouth	C0	9	32.55667	-117.12886	071	17:30	C00212041730	13	=	95	=	8200	=	40	13.84	32.94
329	2/12/2004	Rivermouth	C0	9	32.55655	-117.12881	035	18:00	C00212041800	14	<	10	=	1180	=	38	14.57	33.32
330	2/12/2004	Rivermouth	C0	9	32.55657	-117.12883	026	18:30	C00212041830	15	=	62	=	460	=	44	15.15	33.49
331	2/12/2004	Rivermouth	C0	9	32.55655	-117.12882	009	19:00	C00212041900	16	<	10	=	100	=	18	15.62	33.41
332	2/12/2004	Rivermouth	C0	9	32.55655	-117.12882	139	19:02	C00212041902	17	=	10	=	138	=	40	15.62	33.41
333	2/12/2004	Rivermouth	C0	9	32.55656	-117.12880	040	19:30	C00212041930	18	<	10	=	38	=	8	15.88	33.91
334	2/12/2004	Rivermouth	C0	9	32.55659	-117.12881	016	20:00	C00212042000	19	<	10	=	26	=	4	16.37	33.98
335	2/12/2004	Rivermouth	C0	9	32.55661	-117.12885	149	20:30	C00212042030	20	<	10	=	6	=	2	16.17	33.90
336	2/12/2004	Rivermouth	C0	9	32.55660	-117.12882	109	20:59	C00212042059	21	<	10	=	24	=	30	16.15	33.93
337	2/12/2004	Rivermouth 2	C1	13	32.55777	-117.13100	053	21:15	C10212042115	22	<	10	<	2	<	2	15.66	33.75
338	2/17/2004	Rivermouth South	C2	5	32.55631	-117.12859	039	17:01	C20217041701	1	=	20	=	104	=	2	N/A	N/A

339	2/17/2004	TJL75	L0	4	32.55540	-117.12901	101	17:20	L00217041720	2	<	10	=	16	<	2	N/A	N/A
340	2/17/2004	TJL225	L2	3	32.55434	-117.12845	054	17:37	L20217041737	3	<	10	=	12	=	2	N/A	N/A
341	2/17/2004	Border Fence	A0	1	32.53540	-117.12414	057	17:58	A00217041758	4	<	10	=	2	=	2	N/A	N/A
342	2/17/2004	Monument Road	B0	2	32.54340	-117.12514	038	18:18	B00217041818	5	<	10	=	6	<	2	N/A	N/A
343	2/17/2004	Hollister	M0	7	32.55148	-117.08413	056	18:54	M00217041854	6	=	484	>	16000	=	880	N/A	N/A
344	2/17/2004	Cortez	F0	16	32.57268	-117.13304	075	19:45	F00217041945	7	<	10	=	20	=	4	14.88	33.65
345	2/17/2004	Rivermouth	C0	9	32.55672	-117.12873	122	17:09	C00217041709	8	=	10	=	160	=	6	14.14	33.91
346	2/17/2004	TJR75	R0	11	32.55734	-117.13066	064	17:33	R00217041733	9	<	10	=	4	<	2	14.06	33.68
347	2/17/2004	TJR75	R0	11	32.55734	-117.13066	100	17:37	R00217041737	10	<	10	=	2	<	2	14.06	33.68
348	2/17/2004	TJR225	R2	12	32.55863	-117.13134	034	17:54	R20217041754	11	<	10	<	2	=	2	14.17	33.65
349	2/17/2004	3/4 North	D0	14	32.56128	-117.13181	029	18:27	D00217041827	12	<	10	=	40	=	4	14.38	33.63
350	2/17/2004	Seacoast	E0	15	32.56623	-117.13300	065	19:01	E00217041901	13	<	10	=	6	=	2	14.71	33.67
351	2/17/2004	IB Pier (Shore-South)	H0	17	32.57856	-117.13330	117	20:19	H00217042019	14	<	10	=	18	=	24	15.59	33.68
352	2/17/2004	IB Pier (End)	H9	20	32.57949	-117.13728	073	20:17	H90217042017	15	<	10	<	2	<	2	N/A	N/A
353	2/19/2004	Hollister	M0	7	32.55145	-117.08412	106	17:01	M00219041701	1	=	85500	>	16000	>	12000	N/A	N/A
354	2/19/2004	Carnation	K0	22	32.58557	-117.13252	154	17:38	K00219041738	2	=	41	=	130	=	22	N/A	N/A
355	2/19/2004	IB Pier (End)	H9	20	32.57955	-117.13685	036	18:11	H90219041811	3	=	20	=	40	=	14	N/A	N/A
356	2/19/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13483	156	18:24	H10219041824	4	=	10	=	28	=	14	N/A	N/A
357	2/19/2004	IB Pier (Shore-South)	H0	17	32.57856	-117.13277	099	18:44	H00219041844	5	=	41	=	380	=	8	N/A	N/A
358	2/19/2004	Cortez	F0	16	32.57261	-117.13255	125	19:03	F00219041903	6	=	10	=	8	=	12	N/A	N/A
359	2/19/2004	Rivermouth 2	C1	13	32.55758	-117.13100	010	19:59	C10219041959	7	=	20	=	700	=	22	N/A	N/A
360	2/19/2004	Rivermouth 2	C1	13	32.55753	-117.13140	014	20:29	C10219042029	8	=	4800	>	16000	>	12000	N/A	N/A
361	2/19/2004	Rivermouth 2	C1	13	32.55753	-117.13140	086	20:36	C10219042036	9	=	5247	>	16000	>	12000	N/A	N/A
362	2/19/2004	3/4 North	D0	14	32.56125	-117.13184	063	21:00	D00219042100	10	=	10	<	2	=	4	N/A	N/A
363	2/19/2004	Seacoast	E0	15	32.56620	-117.13301	078	21:25	E00219042125	11	<	10	=	2200	=	10	N/A	N/A
364	2/19/2004	Rivermouth	C0	9	32.55703	-117.12859	150	17:00	C00219041700	12	<	10	=	34	<	2	14.17	33.89
365	2/19/2004	Rivermouth 2	C1	13	32.55780	-117.13065	108	17:15	C10219041715	13	=	20	=	16	=	6	14.13	33.68
366	2/19/2004	Rivermouth	C0	9	32.55706	-117.12856	045	17:30	C00219041730	14	<	10	=	8200	=	16	13.34	33.58
367	2/19/2004	Rivermouth	C0	9	32.55693	-117.12851	049	18:00	C00219041800	15	=	31	=	12400	=	44	14.18	33.60
368	2/19/2004	Rivermouth	C0	9	32.55680	-117.12848	155	18:32	C00219041832	16	<	10	=	106	=	8	14.60	33.75
369	2/19/2004	Rivermouth	C0	9	32.55689	-117.12836	094	19:00	C00219041900	17	=	20	=	1520	=	12	15.04	33.64
370	2/19/2004	Rivermouth	C0	9	32.55670	-117.12845	140	19:30	C00219041930	18	=	73	>	16000	=	160	15.55	33.40
371	2/19/2004	Rivermouth	C0	9	32.55663	-117.12863	128	20:00	C00219042000	19	=	250	>	16000	=	560	15.54	33.43
372	2/19/2004	Rivermouth	C0	9	32.55664	-117.12861	115	20:30	C00219042030	20	=	1483	>	16000	=	6200	16.03	33.25
373	2/19/2004	Rivermouth	C0	9	32.55658	-117.12857	068	21:00	C00219042100	21	=	1850	>	16000	>	12000	16.45	31.95
374	2/19/2004	Rivermouth 2	C1	13	32.55777	-117.13165	001	21:21	C10219042121	22	=	1785	>	16000	>	12000	16.56	32.33
375	2/23/2004	IB Pier (End)	H9	20	32.57944	-117.13721	064	21:16	H90223042116	1	=	1376	>	16000	=	1800	N/A	N/A
376	2/23/2004	Hollister	M0	7	32.55143	-117.08415	056	21:48	M00223042148	2	=	18600	>	16000	>	12000	N/A	N/A
377	2/23/2004	IB Pier (End)	H9	20	32.57949	-117.13728	084	22:30	H90223042230	3	=	2851	>	16000	=	3200	N/A	N/A
378	2/23/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13483	074	22:44	H10223042244	4	=	2187	>	16000	=	4000	N/A	N/A
379	2/23/2004	IB Pier (End)	H9	20	32.57948	-117.13728	043	23:29	H90223042329	5	=	1467	>	16000	=	2600	N/A	N/A
380	2/25/2004	Hollister	M0	7	32.55146	-117.08417	030	20:18	M00225042018	1	=	58300	>	16000	>	12000	N/A	N/A
381	2/25/2004	Carnation	K0	22	32.58562	-117.13277	149	20:58	K00225042058	2	=	638	=	15600	=	280	N/A	N/A
382	2/25/2004	Carnation	K0	22	32.58562	-117.13277	130	21:00	K00225042100	3	=	512	=	13200	=	280	N/A	N/A
383	2/25/2004	IB Pier (Shore-South)	H0	17	32.57876	-117.13286	035	21:21	H00225042121	4	=	933	>	16000	=	560	N/A	N/A
384	2/25/2004	IB Pier (End)	H9	20	32.57949	-117.13727	007	21:45	H90225042145	5	=	557	=	29200	=	800	N/A	N/A
385	2/25/2004	IB Pier (Mid-surf zone)	H1	19	32.57961	-117.13489	079	21:56	H10225042156	6	=	1119	>	16000	=	580	N/A	N/A
386	2/25/2004	Rivermouth	C0	9	32.55682	-117.12850	092	20:15	C00225042015	7	=	20140	>	16000	>	12000	16.40	10.04
387	2/25/2004	TJR75	R0	11	32.55745	-117.13058	110	20:40	R00225042040	8	=	882	>	16000	=	2800	15.03	33.30
388	2/25/2004	TJR225	R2	12	32.55857	-117.13125	044	21:07	R20225042107	9	=	857	>	16000	=	1400	15.05	33.30
389	2/25/2004	3/4 North	D0	14	32.56128	-117.13165	023	21:37	D00225042137	10	=	601	>	16000	=	1240	14.94	33.23
390	2/25/2004	Seacoast	E0	15	32.56635	-117.13291	126	22:18	E00225042218	11	=	554	>	16000	=	800	14.94	33.31
391	2/25/2004	Cortez	F0	16	32.57263	-117.13268	038	22:39	F00225042239	12	=	547	>	16000	=	900	15.08	33.33
392	2/26/2004	IB Pier (End)	H9	20	32.57909	-117.13737	084	19:50	H90226041950	1	=	1014	>	16000	=	3400	N/A	N/A
393	2/26/2004	IB Pier (Mid-surf zone)	H1	19	32.57954	-117.13422	099	20:02	H10226042002	2	=	959	>	16000	=	2800	N/A	N/A
394	2/26/2004	IB Pier (Mid-surf zone)	H1	19	32.57954	-117.13422	063	20:08	H10226042008	3	=	1081	>	16000	=	2800	N/A	N/A
395	2/26/2004	IB Pier (End)	H9	20	32.57949	-117.13728	086	21:39	H90226042139	4	=	399	>	16000	=	360	N/A	N/A
396	2/26/2004	IB Pier (End)	H9	20	32.57945	-117.13731	065	22:06	H90226042206	5	=	591	>	16000	=	900	N/A	N/A
397	2/26/2004	IB Pier (End)	H9	20	32.57946	-117.13728	004	22:35	H90226042235	6	=	657	>	16000	=	1040	N/A	N/A
398	2/26/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13420	116	22:49	H10226042249	7	=	631	>	16000	=	1340	N/A	N/A
399	2/26/2004	IB Pier (End)	H9	20	32.57949	-117.13724	029	23:03	H90226042303	8	=	318	>	16000	=	360	N/A	N/A
400	2/26/2004	Hollister	M0	7	32.55136	-117.08413	067	23:59	M00226042359	9	=	248900	>	16000	>	12000	15.96	0.35
401	3/1/2004	Silver Strand North	N0	24	32.63681	-117.14439	001	17:21	N00301041721	1	<	10	=	8	<	2	N/A	N/A
402	3/1/2004	Silver Strand South	N1	23	32.62620	-117.13959	064	17:44	N10301041744	2	<	10	=	12	<	2	N/A	N/A
403	3/1/2004	IB Pier (End)	H9	20	32.57951	-117.13729	043	18:12	H90301041812	3	=	20	=	200	=	86	N/A	N/A
404	3/1/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13475	108	18:24	H10301041824	4	=	52	=	110	=	2	N/A	N/A
405	3/1/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13475	074	18:26	H10301041826	5	=	63	=	94	=	2	N/A	N/A
406	3/1/2004	Hollister	M0	7	32.55148	-117.08415	056	19:07	M00301041907	6	=	76300	>	16000	>	12000	N/A	N/A
407	3/1/2004	IB Pier (End)	H9	20	32.57954	-117.13727	006	19:47	H90301041947	7	=	31	=	340	>	120	N/A	N/A
408	3/1/2004	IB Pier (Mid-surf zone)	H1	19	32.57957	-117.13480	031	19:58	H10301041958	8	=	31	=	90	=	10	N/A	N/A
409	3/1/2004	Palm Ave	P0	21	32.58370	-117.13324	059	20:20	P00301042020	9	=	10	=	18	=	2	N/A	N/A
410	3/1/2004	Carnation	K0	22	32.58562	-117.13290	122	20:41	K00301042041	10	=	10	=	20	<	2	N/A	N/A
411	3/1/2004	IB Pier (Shore-South)	H0	17	32.57870	-117.13304	100	21:08	H00301042108	11	=	20	=	22	=	14	N/A	N/A
412	3/1/2004	Cortez	F0	16	32.57268	-117.13276	089	21:32	F00301042132	12	=	12460	>	16000	=	4800	N/A	N/A
413	3/1/2004	Rivermouth	C0	9	32.55684	-117.12875	106	17:32	C00301041732	13	=	4410	>	16000	>	12000	14.97	19.96
414	3/1/2004	TJR75	R0	11	32.55732	-117.13055	115	17:55	R00301041755	14	=	84	>	16000	>	12000	14.49	29.97
415	3/1/2004	TJR225	R2	12	32.55854	-117.13139	128	18:18	R20301041818	15	=	10	=	6600	=	56	14.43	33.43
416	3/1/2004	3/4 North	D0	14	32.56127	-117.13171	078	18:51	D00301041851	16	=	20	=	3800	=	44	14.80	33.46
417	3/1/2004	Seacoast	E0	15	32.56639	-117.13300	068	19:27	E00301041927	17	=	15150	=	3000	=	12	15.12	33.56
418	3/1/2004	Rivermouth	C0	9	32.55667	-117.12910	101	20:15	C00301042015	18	=	7230	>	16000	>	12000	16.78	18.23
419	3/1/2004	TJR75	R0	11	32.55722	-117.13052	010	20:39	R00301042039	19	=	52	>	16000	>	12000	16.82	22.41
420	3/1/2004	TJR225	R2	12	32.55839	-117.13151	045	20:57	R20301042057	20	=	20	>	16000	=	8	15.14	33.51
421	3/1/2004	3/4 North	D0	14	32.56125	-117.13175	156	21:26	D00301042126	21	<	10	=	2400	=	4	15.41	33.49
422	3/1/2004	Seacoast	E0	15	32.56640	-117.13296	014	21:54	E00301042154	22	<	10	=	66	=	2	15.40	33.50
423	3/3/2004	Avenida del Sol	Q0	25	32.67781	-117.17733	036	17:30	Q00303041730	1	<	10	=	6	=	2	N/A	N/A

424	3/3/2004	Silver Strand North	N0	24	32.63671	-117.14429	082	18:00	N00303041800	2	<	10	=	8	=	2	N/A	N/A
425	3/3/2004	Silver Strand South	N1	23	32.62625	-117.13944	007	18:25	N10303041825	3	<	10	=	4	=	2	N/A	N/A
426	3/3/2004	IB Pier (Shore-South)	H0	17	32.57869	-117.13278	110	18:49	H00303041849	4	=	20	=	72	=	6	N/A	N/A
427	3/3/2004	IB Pier (End)	H9	20	32.57954	-117.13735	133	19:15	H90303041915	5	=	20	=	32	<	2	N/A	N/A
428	3/3/2004	IB Pier (Mid-surf zone)	H1	19	32.57957	-117.13465	040	19:31	H10303041931	6	<	10	=	14	=	4	N/A	N/A
429	3/3/2004	Smuggler's Gulch	M1	8	32.54395	-117.08842	126	20:03	M10303042003	7	=	27000	>	16000	>	12000	N/A	N/A
430	3/3/2004	Hollister	M0	7	32.55140	-117.08408	013	20:23	M00303042023	8	=	172300	>	16000	>	12000	N/A	N/A
431	3/3/2004	Carnation	K0	22	32.58565	-117.13292	120	21:01	K00303042101	9	=	20	=	80	=	2	N/A	N/A
432	3/3/2004	Cortez	F0	16	32.57268	-117.13271	147	21:20	F00303042120	10	<	10	=	68	=	2	N/A	N/A
433	3/3/2004	Rivermouth	C0	9	32.55687	-117.12888	076	17:44	C00303041744	11	=	23820	>	16000	>	12000	14.62	26.83
434	3/3/2004	Rivermouth	C0	9	32.55687	-117.12888	140	17:49	C00303041749	12	=	20140	>	16000	>	12000	14.62	26.83
435	3/3/2004	TJR75	R0	11	32.55740	-117.13052	094	18:14	R00303041814	13	=	886	>	16000	=	5000	14.96	33.60
436	3/3/2004	TJR225	R2	12	32.55855	-117.13119	149	18:32	R20303041832	14	=	10	=	126	=	10	14.75	33.67
437	3/3/2004	Rivermouth	C0	9	32.55690	-117.12889	023	18:55	C00303041855	15	=	6500	>	16000	>	12000	14.75	27.78
438	3/3/2004	TJR75	R0	11	32.55739	-117.13068	092	19:16	R00303041916	16	=	19180	>	16000	>	12000	14.39	22.40
439	3/3/2004	TJR225	R2	12	32.55849	-117.13128	038	19:29	R20303041929	17	=	86	=	660	=	14	14.58	33.46
440	3/3/2004	Rivermouth	C0	9	32.55692	-117.12843	030	19:50	C00303041950	18	=	10760	>	16000	>	12000	15.29	22.26
441	3/3/2004	TJR75	R0	11	32.55738	-117.13076	079	20:10	R00303042010	19	=	13960	>	16000	>	12000	15.99	20.20
442	3/3/2004	TJR225	R2	12	32.55856	-117.13137	035	20:37	R20303042037	20	=	41	>	16000	=	138	15.72	33.54
443	3/3/2004	3/4 North	D0	14	32.56122	-117.13173	130	21:09	D00303042109	21	<	100	=	620	=	10	15.78	33.53
444	3/3/2004	Seacoast	E0	15	32.56637	-117.13306	049	21:51	E00303042151	22	<	100	=	780	=	4	15.50	33.68
445	3/8/2004	Rivermouth	C0	9	32.55697	-117.12901	098	18:26	C00308041826	1	<	10	=	5000	=	120	16.31	33.93
446	3/8/2004	Rivermouth 2	C1	13	32.55779	-117.13068	085	18:47	C10308041847	2	<	10	=	11400	=	260	16.35	33.78
447	3/8/2004	3/4 North	D0	14	32.56130	-117.13161	041	19:17	D00308041917	3	<	10	=	10400	=	260	16.16	33.90
448	3/8/2004	Seacoast	E0	15	32.56632	-117.13272	015	19:54	E00308041954	4	<	10	=	620	=	24	16.39	33.85
449	3/8/2004	Cortez	F0	16	32.57264	-117.13258	033	20:22	F00308042022	5	<	10	=	4	=	6	16.49	33.89
450	3/8/2004	Carnation	K0	22	32.58561	-117.13272	002	21:07	K00308042107	6	<	10	<	2	<	2	17.45	33.70
451	3/8/2004	Carnation	K0	22	32.58561	-117.13272	083	21:10	K00308042110	7	=	10	<	2	=	4	17.45	33.70
452	3/8/2004	IB Pier (Shore-South)	H0	17	32.57874	-117.13289	044	21:39	H00308042139	8	<	10	=	16	=	38	17.69	33.90
453	3/8/2004	IB Pier (End)	H9	20	32.57944	-117.13731	048	21:59	H90308042159	9	<	10	<	2	<	2	N/A	N/A
454	3/8/2004	IB Pier (Mid-surf zone)	H1	19	32.57954	-117.13444	075	22:12	H10308042212	10	<	10	<	2	=	2	N/A	N/A
455	3/11/2004	Rivermouth Estuary (south)	C4	6	32.55610	-117.12643	058	18:53	C40311041853	1	=	1990	>	16000	>	12000	N/A	N/A
456	3/11/2004	Rivermouth South	C2	5	32.55663	-117.12858	139	19:07	C20311041907	2	=	200	>	16000	=	2400	N/A	N/A
457	3/11/2004	TJL75	L0	4	32.55564	-117.12807	060	19:22	L00311041922	3	=	30	=	8400	=	720	N/A	N/A
458	3/11/2004	TJL225	L2	3	32.55452	-117.12836	046	19:40	L20311041940	4	=	20	=	8000	=	620	N/A	N/A
459	3/11/2004	Border Fence	A0	1	32.53530	-117.12407	146	20:22	A00311042022	5	=	10	>	16000	=	940	N/A	N/A
460	3/11/2004	Monument Road	B0	2	32.54343	-117.12500	054	20:47	B00311042047	6	<	10	=	7600	=	500	N/A	N/A
461	3/11/2004	Monument Road	B0	2	32.54343	-117.12500	097	20:53	B00311042053	7	<	10	=	11000	=	480	N/A	N/A
462	3/11/2004	Hollister	M0	7	32.55148	-117.08416	008	21:35	M00311042135	8	=	3300	>	16000	>	12000	N/A	N/A
463	3/11/2004	Cortez	F0	16	32.57268	-117.13268	114	22:14	F00311042214	9	<	10	=	14	<	2	N/A	N/A
464	3/11/2004	IB Pier (End)	H9	20	32.57951	-117.13739	103	22:53	H90311042253	10	<	10	=	52	=	12	N/A	N/A
465	3/11/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13400	144	23:03	H10311042303	11	<	10	=	12	=	4	N/A	N/A
466	3/11/2004	Rivermouth Estuary (north)	C3	10	32.55737	-117.12835	115	18:50	C30311041850	12	=	61	=	4600	=	420	17.80	33.47
467	3/11/2004	Rivermouth	C0	9	32.55696	-117.12858	001	19:06	C00311041906	13	=	10	=	6200	=	500	17.67	33.54
468	3/11/2004	TJR75	R0	11	32.55757	-117.13062	148	19:27	R00311041927	14	<	10	>	16000	=	6000	16.88	33.56
469	3/11/2004	TJR225	R2	12	32.55866	-117.13120	108	19:50	R20311041950	15	=	10	=	112	=	20	16.92	33.32
470	3/11/2004	Rivermouth 2	C1	13	32.55775	-117.13078	071	20:08	C10311042008	16	<	10	=	130	=	10	17.08	33.37
471	3/11/2004	Rivermouth	C0	9	32.55698	-117.12854	127	20:45	C00311042045	17	<	10	=	7600	=	300	17.55	33.30
472	3/11/2004	Rivermouth 2	C1	13	32.55774	-117.13081	010	21:08	C10311042108	18	<	10	=	52	=	2	17.15	33.31
473	3/11/2004	3/4 North	D0	14	32.56123	-117.13164	014	21:34	D00311042134	19	<	10	=	36	=	2	17.20	33.35
474	3/11/2004	Seacoast	E0	15	32.56636	-117.13280	106	22:14	E00311042214	20	<	10	=	9800	=	40	17.09	33.39
475	3/11/2004	IB Pier (Shore-South)	H0	17	32.57867	-117.13303	131	22:53	H00311042253	21	<	10	=	26	=	22	17.41	33.40
476	3/11/2004	Carnation	K0	22	32.58561	-117.13276	078	23:30	K00311042330	22	<	10	=	120	=	220	17.45	33.46
477	3/18/2004	Border Fence	A0	1	32.53613	-117.12403	092	14:32	A00318041432	1	<	10	=	74	=	66	15.60	33.38
478	3/18/2004	Monument Road	B0	2	32.54336	-117.12491	110	15:13	B00318041513	2	<	10	=	14	=	4	15.63	33.38
479	3/18/2004	Rivermouth	C0	9	32.55696	-117.12902	133	16:42	C00318041642	3	=	41	=	124	=	46	15.85	33.40
480	3/18/2004	Rivermouth 2	C1	13	32.55777	-117.13068	126	16:57	C10318041657	4	=	10	=	82	=	42	15.53	33.35
481	3/18/2004	3/4 North	D0	14	32.56131	-117.13161	031	17:18	D00318041718	5	=	31	=	58	=	2	15.85	33.35
482	3/18/2004	Seacoast	E0	15	32.56635	-117.13277	153	17:41	E00318041741	6	<	10	=	24	=	2	15.67	33.41
483	3/18/2004	Seacoast	E0	15	32.56635	-117.13277	035	17:44	E00318041744	7	<	10	=	10	=	2	15.67	33.41
484	3/18/2004	Cortez	F0	16	32.57265	-117.13262	150	18:08	F00318041808	8	<	10	=	4	=	6	16.03	33.53
485	3/18/2004	IB Pier (Shore-South)	H0	17	32.57878	-117.13291	007	18:28	H00318041828	9	<	10	=	26	=	16	16.37	33.38
486	3/18/2004	IB Pier (End)	H9	20	32.57953	-117.13728	156	18:46	H90318041846	10	<	10	=	2	<	2	N/A	N/A
487	3/19/2004	Oneonta Slough (furthest)	J1	26	32.57239	-117.12949	121	14:54	J10319041454	1	=	96	=	92	=	6	15.72	33.14
488	3/19/2004	Oneonta Slough (mid-furthest)	J2	27	32.56908	-117.13088	088	15:10	J20319041510	2	=	31	=	36	=	10	15.82	33.20
489	3/19/2004	Oneonta Slough (mouth)	J3	28	32.55946	-117.12888	013	15:37	J30319041537	3	<	10	=	32	<	2	15.81	33.22
490	3/19/2004	Southern slough (furthest)	J8	33	32.55130	-117.11929	095	16:02	J80319041602	4	=	41	=	500	=	12	15.89	33.06
491	3/19/2004	Southern slough (mid-furthest)	J9	34	32.55160	-117.12347	030	16:15	J90319041615	5	=	234	=	980	=	36	15.80	31.94
492	3/19/2004	Southern slough (mid)	JA	35	32.55208	-117.12610	120	16:26	JA0319041626	6	=	20	=	60	=	4	15.90	33.19
493	3/19/2004	Southern slough (mouth)	JB	36	32.55607	-117.12640	024	16:35	JB0319041635	7	<	10	=	38	=	4	15.89	33.17
494	3/19/2004	Southern slough (mouth)	JB	36	32.55607	-117.12640	155	16:36	JB0319041636	8	<	10	=	32	=	4	15.89	33.17
495	3/19/2004	Main slough (furthest)	JC	37	32.56261	-117.10469	038	17:20	JC0319041720	9	=	4721	>	16000	=	160	15.70	6.25
496	3/19/2004	Main slough (mid-furthest)	JD	38	32.56255	-117.10822	094	17:42	JD0319041742	10	=	10111	>	16000	=	340	16.44	16.16
497	3/19/2004	Main slough (mid)	JG	42	32.55935	-117.11649	062	17:55	JG0319041755	11	=	20	=	138	=	4	16.38	33.10
498	3/19/2004	Main slough (mouth)	JE	39	32.55665	-117.12628	082	18:16	JE0319041816	12	=	31	=	86	=	20	16.51	33.18
499	3/19/2004	Rivermouth	C0	9	32.55848	-117.12838	036	18:36	JG0319041836	13	=	63	=	34	=	8	16.53	33.31
500	3/19/2004	Estuary Center	J6	31	32.55553	-117.12700	040	18:50	J60319041850	14	=	31	=	52	=	4	16.72	33.26
501	3/19/2004	Hollister	M0	7	32.55157	-117.08407	140	20:01	M00319042001	15	=	118	>	16000	=	72	N/A	N/A
502	3/22/2004	Rivermouth	C0	9	32.55696	-117.12904	019	17:00	C00322041700	1	=	10	=	32	=	6	14.34	33.63
503	3/22/2004	Rivermouth	C0	9	32.55694	-117.12907	107	18:00	C00322041800	2	<	10	=	18	=	2	14.71	33.63
504	3/22/2004	Rivermouth 2	C1	13	32.55766	-117.13055	076	18:18	C10322041818	3	<	10	=	14	<	2	14.77	33.75
505	3/22/2004	Rivermouth	C0	9	32.55686	-117.12924	142	18:59	C00322041859	4	=	10	=	30	=	8	14.99	33.70
506	3/22/2004	Rivermouth 2	C1	13	32.55767	-117.13054	130	19:28	C10322041928	5	<	10	=	6	<	2	14.88	33.75
507	3/22/2004	Rivermouth	C0	9	32.55687	-117.12912	072	20:00	C00322042000	6	=	20	=	22	=	6	15.67	33.65
508	3/22/2004	Rivermouth 2	C1	13	32.55765	-117.13064	134	20:28	C10322042028	7	<	10	=	4	<	2	15.55	33.66

509	3/22/2004	Rivermouth	C0	9	32.55688	-117.12886	105	21:00	C00322042100	8	=	41	=	10	=	2	16.53	33.61
510	3/22/2004	Rivermouth	C0	9	32.55684	-117.12917	022	21:59	C00322042159	9	=	20	=	154	=	46	17.40	33.24
511	3/22/2004	Rivermouth	C0	9	32.55684	-117.12917	077	22:01	C00322042201	10	=	20	=	124	=	52	17.40	33.24
512	3/22/2004	Rivermouth 2	C1	13	32.55449	-117.13098	154	22:29	C10322042229	11	=	10	=	14	=	10	16.24	33.63
513	3/22/2004	Rivermouth	C0	9	32.55662	-117.13000	023	22:58	C00322042258	12	=	96	=	600	=	34	17.67	33.79
514	3/22/2004	Rivermouth 2	C1	13	32.55759	-117.13088	006	23:32	C10322042332	13	=	20	=	32	=	8	15.83	33.10
515	3/22/2004	Rivermouth	C0	9	32.55649	-117.13018	070	23:58	C00322042358	14	=	209	=	1000	=	118	17.25	30.63
516	3/23/2004	Rivermouth 2	C1	13	32.55757	-117.13094	050	0:29	C10323040029	15	<	10	=	16	=	4	15.23	33.19
517	3/23/2004	Rivermouth	C0	9	32.55660	-117.13018	032	0:59	C00323040059	16	=	31	=	134	=	20	15.30	32.68
518	3/23/2004	Rivermouth	C0	9	32.55684	-117.12900	151	2:00	C00323040200	17	<	10	=	14	=	4	14.66	33.37
519	3/23/2004	Rivermouth 2	C1	13	32.55776	-117.13078	096	2:30	C10323040230	18	<	10	=	54	=	2	14.57	33.24
520	3/23/2004	Rivermouth	C0	9	32.55688	-117.12893	027	3:00	C00323040300	19	=	10	=	28	=	22	14.39	33.35
521	3/23/2004	Rivermouth	C0	9	32.55688	-117.12899	037	4:00	C00323040400	20	<	10	=	12	=	2	14.43	33.32
522	3/23/2004	Rivermouth 2	C1	13	32.55777	-117.13062	135	4:29	C10323040429	21	<	10	=	8	=	4	14.47	33.24
523	3/23/2004	Rivermouth	C0	9	32.55694	-117.12897	087	5:00	C00323040500	22	=	20	=	4	=	2	14.37	33.28
524	3/23/2004	Rivermouth 2	C1	13	32.55776	-117.13062	145	5:26	C10323040526	23	=	100	=	28	=	2	14.60	33.18
525	3/23/2004	Rivermouth	C0	9	32.55695	-117.12910	012	6:00	C00323040600	24	<	10	=	12	<	2	14.62	33.37
526	3/24/2004	Rivermouth	C0	9	32.55690	-117.12871	001	12:00	C00324041200	1	=	272	=	1320	=	54	15.26	32.86
527	3/24/2004	3/4 North	D0	14	32.56122	-117.13200	010	12:30	D00324041230	2	=	41	=	80	=	8	14.69	33.46
528	3/24/2004	Seacoast	E0	15	32.56636	-117.13313	148	12:59	E00324041259	3	<	10	<	2	<	2	14.38	33.48
529	3/24/2004	Rivermouth	C0	9	32.55677	-117.12932	014	13:32	C00324041332	4	=	677	=	5400	=	118	15.09	29.08
530	3/24/2004	3/4 North	D0	14	32.56116	-117.13200	008	14:01	D00324041401	5	=	97	=	160	=	8	14.52	33.24
531	3/24/2004	Seacoast	E0	15	32.56634	-117.13300	114	14:33	E00324041433	6	<	10	=	16	=	2	14.46	33.42
532	3/24/2004	Rivermouth	C0	9	32.55691	-117.12866	075	15:25	C00324041525	7	=	52	=	92	=	10	14.67	33.26
533	3/24/2004	3/4 North	D0	14	32.56120	-117.13182	136	15:50	D00324041550	8	=	10	=	38	=	6	14.65	33.36
534	3/24/2004	Seacoast	E0	15	32.56633	-117.13291	112	16:18	E00324041618	9	=	10	=	24	<	2	14.59	33.34
535	3/24/2004	Rivermouth	C0	9	32.55676	-117.12971	147	17:16	C00324041716	10	<	10	=	12	=	2	14.91	33.52
536	3/24/2004	3/4 North	D0	14	32.56128	-117.13174	149	17:44	D00324041744	11	=	100	=	36	=	2	14.87	33.47
537	3/24/2004	Seacoast	E0	15	32.56625	-117.13284	045	18:14	E00324041814	12	=	20	=	22	=	2	14.88	33.48
538	3/24/2004	Rivermouth	C0	9	32.55684	-117.12967	074	19:01	C00324041901	13	<	10	=	2	<	2	15.35	33.71
539	3/24/2004	3/4 North	D0	14	32.56131	-117.13171	101	19:29	D00324041929	14	<	10	=	2	<	2	15.41	33.55
540	3/24/2004	Seacoast	E0	15	32.56630	-117.13282	079	20:05	E00324042005	15	<	10	=	8	<	2	15.37	33.55
541	3/24/2004	Seacoast	E0	15	32.56630	-117.13282	078	20:08	E00324042008	16	<	10	=	4	<	2	15.37	33.55
542	3/24/2004	IB Pier (End)	H9	20	32.57951	-117.13726	089	20:53	H90324042053	17	<	10	=	6	=	4	N/A	N/A
543	3/24/2004	Rivermouth	C0	9	32.55683	-117.12961	058	20:48	C00324042048	18	=	10	=	2	=	2	15.52	33.68
544	3/24/2004	3/4 North	D0	14	32.56132	-117.13172	139	21:15	D00324042115	19	<	10	=	20	<	2	15.70	33.68
545	3/24/2004	Seacoast	E0	15	32.56634	-117.13286	131	21:48	E00324042148	20	<	10	=	2	<	2	15.51	33.58
546	3/24/2004	Rivermouth	C0	9	32.55678	-117.12962	115	22:28	C00324042228	21	<	10	=	14	=	2	16.92	33.49
547	3/24/2004	3/4 North	D0	14	32.56125	-117.13185	108	22:57	D00324042257	22	<	10	=	2	<	2	15.83	33.62
548	3/24/2004	Seacoast	E0	15	32.56630	-117.13293	060	23:24	E00324042324	23	<	10	<	2	<	2	15.42	33.66
549	3/24/2004	Cortez	F0	16	32.57260	-117.13269	144	23:49	F00324042349	24	<	10	<	2	<	2	15.43	33.64
550	4/1/2004	Rivermouth Estuary (north)	C3	10	32.55734	-117.12836	075	18:25	C30401041825	1	=	10	=	10	=	12	16.42	33.63
551	4/1/2004	Rivermouth	C0	9	32.55654	-117.12942	014	18:43	C00401041843	2	=	41	=	84	=	40	16.30	33.95
552	4/1/2004	Rivermouth	C0	9	32.55654	-117.12942	112	18:45	C00401041845	3	=	74	=	52	=	18	16.30	33.95
553	4/1/2004	Rivermouth 2	C1	13	32.55767	-117.13187	010	19:03	C10401041903	4	<	10	=	10	=	2	15.76	33.85
554	4/1/2004	3/4 North	D0	14	32.56126	-117.13184	105	19:28	D00401041928	5	<	10	=	6	=	4	15.66	33.74
555	4/1/2004	Seacoast	E0	15	32.56609	-117.13308	070	19:55	E00401041955	6	<	10	=	8	=	4	16.02	33.67
556	4/1/2004	Cortez	F0	16	32.57266	-117.13267	054	20:23	F00401042023	7	=	20	=	4	=	6	16.27	33.86
557	4/1/2004	Carnation	K0	22	32.58562	-117.13298	127	20:49	K00401042049	8	<	10	=	20	<	2	16.90	33.96
558	4/1/2004	IB Pier (Shore-South)	H0	17	32.57848	-117.13318	001	21:13	H00401042113	9	<	10	=	12	=	20	16.93	33.90
559	4/1/2004	IB Pier (End)	H9	20	32.57946	-117.13718	008	21:42	H90401042142	10	<	10	=	14	=	14	N/A	N/A
560	4/1/2004	IB Pier (Mid-surf zone)	H3	18	32.57956	-117.13509	081	21:54	H30401042154	11	<	10	=	18	<	2	N/A	N/A
561	4/1/2004	Hollister	M0	7	32.55140	-117.08413	123	22:48	M00401042248	12	=	41	=	6800	=	34	20.86	1.35
562	4/2/2004	Rivermouth 2	C1	13	32.55765	-117.13081	085	18:38	C10402041838	1	=	10	=	24	=	6	N/A	N/A
563	4/2/2004	3/4 North	D0	14	32.56129	-117.13174	038	19:00	D00402041900	2	<	10	=	14	=	14	N/A	N/A
564	4/2/2004	Seacoast	E0	15	32.56607	-117.13293	106	19:25	E00402041925	3	=	31	=	12	=	8	N/A	N/A
565	4/2/2004	3/4 North	D0	14	32.56129	-117.13181	035	19:54	D00402041954	4	<	10	=	124	=	26	N/A	N/A
566	4/2/2004	Rivermouth 2	C1	13	32.55750	-117.13108	098	20:28	C10402042028	5	=	3730	>	16000	=	7000	N/A	N/A
567	4/2/2004	3/4 North	D0	14	32.56127	-117.13190	007	20:52	D00402042052	6	=	30	=	1120	=	60	N/A	N/A
568	4/2/2004	Seacoast	E0	15	32.56611	-117.13308	103	21:19	E00402042119	7	=	2014	=	1460	=	38	N/A	N/A
569	4/2/2004	3/4 North	D0	14	32.56131	-117.13190	092	21:58	D00402042158	8	=	8010	>	16000	=	8800	N/A	N/A
570	4/2/2004	Rivermouth 2	C1	13	32.55748	-117.13113	046	22:26	C10402042226	9	<	10	>	16000	>	12000	N/A	N/A
571	4/2/2004	3/4 North	D0	14	32.56127	-117.13185	071	22:58	D00402042258	10	=	2282	>	16000	=	2800	N/A	N/A
572	4/2/2004	Rivermouth	C0	9	32.55693	-117.12864	019	18:30	C00402041830	11	=	1935	>	16000	=	200	N/A	N/A
573	4/2/2004	Rivermouth	C0	9	32.55693	-117.12864	142	18:44	C00402041844	12	=	3282	>	16000	=	4600	17.17	33.22
574	4/2/2004	Rivermouth	C0	9	32.55693	-117.12864	027	19:00	C00402041900	13	=	37700	>	16000	>	12000	16.87	28.66
575	4/2/2004	Rivermouth	C0	9	32.55695	-117.12864	022	19:15	C00402041915	14	=	29870	>	16000	>	12000	17.28	31.59
576	4/2/2004	Rivermouth	C0	9	32.55695	-117.12860	050	19:30	C00402041930	15	=	35400	>	16000	>	12000	16.99	25.41
577	4/2/2004	Rivermouth	C0	9	32.55698	-117.12862	083	19:45	C00402041945	16	=	66300	>	16000	>	12000	17.39	26.14
578	4/2/2004	Rivermouth	C0	9	32.55645	-117.12956	020	20:00	C00402042000	17	=	58800	>	16000	>	12000	17.01	20.42
579	4/2/2004	Rivermouth	C0	9	32.55693	-117.12864	107	20:15	C00402042015	18	=	83900	>	16000	>	12000	N/A	N/A
580	4/2/2004	Rivermouth	C0	9	32.55693	-117.12864	156	20:29	C00402042029	19	=	72800	>	16000	>	12000	17.55	22.51
581	4/2/2004	Rivermouth	C0	9	32.55693	-117.12864	033	20:31	C00402042031	20	=	82300	>	16000	>	12000	17.55	22.51
582	4/2/2004	Rivermouth	C0	9	32.55692	-117.12864	087	20:45	C00402042045	21	=	95900	>	16000	>	12000	17.96	23.36
583	4/2/2004	Rivermouth Estuary (north)	C3	10	32.55737	-117.12864	002	21:00	C30402042100	22	=	110	>	16000	=	380	19.43	32.69
584	4/2/2004	Rivermouth	C0	9	32.55696	-117.12862	135	21:15	C00402042115	23	=	51	>	16000	>	12000	18.40	18.28
585	4/2/2004	Rivermouth Estuary (north)	C3	10	32.55736	-117.12831	052	21:30	C30402042130	24	=	86	>	16000	>	12000	20.22	32.70
586	4/2/2004	Rivermouth	C0	9	32.55696	-117.12858	143	21:45	C00402042145	25	=	161600	>	16000	>	12000	18.18	14.16
587	4/2/2004	Rivermouth	C0	9	32.55648	-117.12955	041	22:00	C00402042200	26	=	178500	>	16000	>	12000	17.65	12.33
588	4/2/2004	Rivermouth	C0	9	32.55696	-117.12858	066	22:15	C00402042215	27	=	125900	>	16000	>	12000	17.71	12.03
589	4/2/2004	Rivermouth	C0	9	32.55648	-117.12956	011	22:30	C00402042230	28	=	139100	>	16000	>	12000	17.39	10.29
590	4/2/2004	Rivermouth	C0	9	32.55693	-117.12862	072	22:45	C00402042245	29	=	178500	>	16000	>	12000	17.60	9.98
591	4/2/2004	Rivermouth	C0	9	32.55695	-117.12862	044	22:59	C00402042259	30	=	161600	>	16000	>	12000	14.39	8.38
592	4/5/2004	Rivermouth	C0	9	32.55679	-117.12911	080	14:58	C00405041458	1	=	336	>	16000	=	6600	17.01	33.31
593	4/5/2004	Rivermouth	C0	9	32.55679	-117.12911	126	14:58	C00405041458	1.1	=	285	>	16000	=	3000	17.01	33.31

594	4/5/2004	Rivermouth 2	C1	13	32.55780	-117.13083	154	15:20	C10405041520	2	=	216	>	16000	=	8600	17.06	33.31
595	4/5/2004	Rivermouth 2	C1	13	32.55780	-117.13083	024	15:20	C10405041520	2.1	=	226	>	16000	=	4600	17.06	33.31
596	4/5/2004	3/4 North	D0	14	32.56131	-117.13161	036	15:46	D00405041546	3	=	284	>	16000	=	9400	17.08	33.23
597	4/5/2004	3/4 North	D0	14	32.56131	-117.13161	013	15:46	D00405041546	3.1	=	197	>	16000	=	6600	17.08	33.23
598	4/5/2004	Seacoast	E0	15	32.56636	-117.13273	082	16:19	E00405041619	4	=	490	>	16000	>	12000	17.14	33.19
599	4/5/2004	Seacoast	E0	15	32.56636	-117.13273	145	16:19	E00405041619	4.1	=	448	>	16000	=	11000	17.14	33.19
600	4/5/2004	Border Fence	A0	1	32.53539	-117.12398	023	15:01	A00405041501	5	=	20	=	980	=	40	N/A	N/A
601	4/5/2004	Border Fence	A0	1	32.53539	-117.12398	061	15:01	A00405041501	5.1	=	20	=	920	=	20	N/A	N/A
602	4/5/2004	Monument Road	B0	2	32.54345	-117.12499	012	15:40	B00405041540	6	=	10	=	800	=	86	N/A	N/A
603	4/5/2004	Monument Road	B0	2	32.54345	-117.12499	136	15:40	B00405041540	6.1	=	20	=	1500	=	62	N/A	N/A
604	4/5/2004	Cortez	F0	16	32.57263	-117.13249	120	16:48	F00405041648	7	=	171	>	16000	>	12000	17.13	33.34
605	4/5/2004	Cortez	F0	16	32.57263	-117.13249	114	16:48	F00405041648	7.1	=	288	>	16000	=	10000	17.13	33.34
606	4/5/2004	IB Pier (Shore-South)	H0	17	32.57830	-117.13267	113	17:05	H10405041705	8	=	141	>	16000	=	800	17.25	33.21
607	4/5/2004	IB Pier (Shore-South)	H0	17	32.57830	-117.13267	130	17:05	H10405041705	8.1	=	231	>	16000	=	6800	17.25	33.21
608	4/5/2004	Carnation	K0	22	32.58571	-117.13258	076	17:22	K00405041722	9	=	10	>	16000	=	200	17.22	33.47
609	4/5/2004	Carnation	K0	22	32.58571	-117.13258	155	17:22	K00405041722	9.1	=	10	=	11000	=	180	17.22	33.47
610	4/5/2004	Silver Strand	N0	24	32.63680	-117.14420	148	17:51	N00405041751	10	<	10	=	50	<	2	17.18	33.40
611	4/5/2004	Silver Strand	N0	24	32.63680	-117.14420	039	17:51	N00405041751	10.1	<	10	<	2	<	2	17.18	33.40
612	4/7/2004	3/4 North	D0	14	32.56121	-117.13201	030	13:03	D00407041303	1	=	171	>	16000	=	1040	N/A	N/A
613	4/7/2004	Seacoast	E0	15	32.56615	-117.13322	121	13:31	E00407041331	2	<	10	=	46	=	6	N/A	N/A
614	4/7/2004	Cortez	F0	16	32.57259	-117.13280	005	13:52	F00407041352	3	<	10	=	24	=	8	N/A	N/A
615	4/7/2004	3/4 North	D0	14	32.56127	-117.13184	031	14:43	D00407041443	4	=	10	=	5600	=	110	N/A	N/A
616	4/7/2004	Seacoast	E0	15	32.56625	-117.13303	055	15:10	E00407041510	5	<	10	=	46	=	8	N/A	N/A
617	4/7/2004	Cortez	F0	16	32.57262	-117.13262	118	15:31	F00407041531	6	<	10	=	20	=	6	N/A	N/A
618	4/7/2004	3/4 North	D0	14	32.56131	-117.13167	110	16:30	D00407041630	7	=	20	=	8400	=	180	N/A	N/A
619	4/7/2004	Seacoast	E0	15	32.56628	-117.13277	051	16:56	E00407041656	8	=	10	=	4200	=	60	N/A	N/A
620	4/7/2004	Cortez	F0	16	32.57256	-117.13256	028	17:25	F00407041725	9	<	10	=	36	=	2	N/A	N/A
621	4/7/2004	Rivermouth	C0	9	32.55661	-117.12945	141	13:03	C00407041303	10	=	21870	>	16000	>	12000	16.77	24.26
622	4/7/2004	Rivermouth 2	C1	13	32.55785	-117.13161	140	13:30	C10407041330	11	=	1483	>	16000	=	6200	16.66	33.33
623	4/7/2004	Rivermouth	C0	9	32.55661	-117.12944	152	14:00	C00407041400	12	=	28510	>	16000	>	12000	16.61	24.27
624	4/7/2004	Rivermouth 2	C1	13	32.55780	-117.13141	132	14:30	C10407041430	13	=	148	>	16000	=	1180	16.60	33.06
625	4/7/2004	Rivermouth	C0	9	32.55661	-117.12941	062	15:00	C00407041500	14	=	295	>	16000	=	5400	16.66	33.30
626	4/7/2004	Rivermouth 2	C1	13	32.55783	-117.13120	047	15:29	C10407041529	15	=	10	=	9200	=	240	16.59	33.15
627	4/7/2004	Rivermouth	C0	9	32.55669	-117.12939	137	16:00	C00407041600	16	=	52	>	16000	=	240	16.92	33.11
628	4/7/2004	Rivermouth	C0	9	32.55669	-117.12939	003	16:02	C00407041602	17	=	63	>	16000	=	1140	16.92	33.11
629	4/7/2004	Rivermouth 2	C1	13	32.55779	-117.13101	034	16:30	C10407041630	18	<	10	>	16000	=	200	16.81	33.29
630	4/7/2004	Rivermouth	C0	9	32.55672	-117.12930	006	17:00	C00407041700	19	<	10	=	8400	=	160	17.03	33.37
631	4/7/2004	Rivermouth 2	C1	13	32.55783	-117.13086	040	17:30	C10407041730	20	<	10	=	7000	=	134	16.93	33.48
632	4/8/2004	Seacoast	E0	15	32.56946	-117.13326	017	13:30	E00408041330	1	<	10	=	20	<	2	16.43	33.53
633	4/8/2004	3/4 North	D0	14	32.56120	-117.13212	089	14:01	D00408041401	2	=	20	=	1320	=	90	16.42	33.42
634	4/8/2004	Rivermouth	C0	9	32.55659	-117.12951	065	16:30	C00408041630	3	=	11370	>	16000	>	12000	16.54	27.01
635	4/8/2004	Rivermouth 2	C1	13	32.55777	-117.13153	079	14:54	C10408041454	4	=	372	>	16000	=	6200	16.55	33.18
636	4/8/2004	3/4 North	D0	14	32.56126	-117.13203	084	15:17	D00408041517	5	=	95	=	16000	=	1060	16.48	33.26
637	4/8/2004	Seacoast	E0	15	32.56627	-117.13306	029	15:53	E00408041553	6	=	41	=	6000	=	280	16.59	33.30
638	4/8/2004	Cortez	F0	16	32.57260	-117.13290	026	13:29	F00408041329	7	=	10	=	18	=	200	N/A	N/A
639	4/8/2004	IB Pier (Shore-South)	H0	17	32.57847	-117.13340	053	14:14	H00408041414	8	=	10	=	40	=	46	N/A	N/A
640	4/8/2004	Carnation	K0	22	32.58553	-117.13302	093	14:58	K00408041458	9	<	10	=	100	=	1400	N/A	N/A
641	4/8/2004	IB Pier (Shore-South)	H0	17	32.57825	-117.13309	090	15:26	H00408041526	10	=	20	=	48	=	24	N/A	N/A
642	4/8/2004	IB Pier (Shore-South)	H0	17	32.57825	-117.13309	109	15:29	H00408041529	11	=	31	=	32	=	34	N/A	N/A
643	4/8/2004	Cortez	F0	16	32.57261	-117.13268	009	16:29	F00408041629	12	=	10	=	360	=	14	N/A	N/A
644	4/8/2004	3/4 North	D0	14	32.56129	-117.13184	078	16:27	D00408041627	13	=	250	>	16000	=	5200	16.84	33.27
645	4/8/2004	Seacoast	E0	15	32.56636	-117.13288	116	17:00	E00408041700	14	=	285	>	16000	=	4400	16.91	33.29
646	4/8/2004	IB Pier (Shore-South)	H0	17	32.57836	-117.13295	133	18:00	H00408041800	15	=	108	=	14400	=	1160	16.71	33.55
647	4/12/2004	Seacoast	E0	15	32.56625	-117.13322	091	16:59	E00412041659	1	<	10	<	2	<	2	N/A	N/A
648	4/12/2004	Cortez	F0	16	32.57258	-117.13285	025	17:25	F00412041725	2	<	10	=	4	<	2	N/A	N/A
649	4/12/2004	Seacoast	E0	15	32.56628	-117.13316	147	17:59	E00412041759	3	<	10	<	2	<	2	N/A	N/A
650	4/12/2004	Cortez	F0	16	32.57262	-117.13274	060	18:30	F00412041830	4	<	10	=	8	<	2	N/A	N/A
651	4/12/2004	Seacoast	E0	15	32.56629	-117.13316	099	19:00	E00412041900	5	<	10	<	2	<	2	N/A	N/A
652	4/12/2004	Cortez	F0	16	32.57260	-117.13285	108	19:19	F00412041919	6	<	10	=	2	<	2	N/A	N/A
653	4/12/2004	Seacoast	E0	15	32.56622	-117.13300	058	20:37	E00412042037	7	<	10	<	2	<	2	N/A	N/A
654	4/12/2004	Cortez	F0	16	32.57259	-117.13271	139	20:59	F00412042059	8	<	10	<	2	<	2	N/A	N/A
655	4/12/2004	Seacoast	E0	15	32.56618	-117.13288	042	21:30	E00412042130	9	<	10	<	2	<	2	N/A	N/A
656	4/12/2004	Cortez	F0	16	32.57256	-117.13267	067	21:47	F00412042147	10	<	10	<	2	<	2	N/A	N/A
657	4/12/2004	Rivermouth	C0	9	32.55661	-117.12923	004	17:00	C00412041700	11	=	436	=	12400	=	600	18.83	30.02
658	4/12/2004	Rivermouth	C0	9	32.55661	-117.12923	144	17:02	C00412041702	12	=	7915	=	11200	=	660	18.83	30.02
659	4/12/2004	Rivermouth	C0	9	32.55661	-117.12927	128	17:15	C00412041715	13	=	84	=	9400	=	480	18.83	29.98
660	4/12/2004	Rivermouth	C0	9	32.55658	-117.12923	117	17:30	C00412041730	14	=	63	=	10000	=	400	19.04	29.72
661	4/12/2004	Rivermouth	C0	9	32.55661	-117.12925	045	17:45	C00412041745	15	=	1989	=	7800	=	320	19.26	30.21
662	4/12/2004	Rivermouth	C0	9	32.55656	-117.12920	149	18:00	C00412041800	16	=	2014	=	7600	=	360	19.56	30.09
663	4/12/2004	Rivermouth	C0	9	32.55653	-117.12922	056	18:15	C00412041815	17	=	2063	=	8200	=	124	20.04	30.95
664	4/12/2004	Rivermouth	C0	9	32.55654	-117.12921	131	18:30	C00412041830	18	=	3609	=	7400	=	260	20.36	29.75
665	4/12/2004	Rivermouth	C0	9	32.55655	-117.12921	153	18:45	C00412041845	19	=	1063	=	4800	=	220	20.73	29.91
666	4/12/2004	Rivermouth	C0	9	32.55654	-117.12924	094	19:00	C00412041900	20	=	281	=	5800	=	100	20.78	29.94
667	4/12/2004	Rivermouth	C0	9	32.55659	-117.12926	037	19:15	C00412041915	21	=	131	=	3200	=	220	21.17	30.02
668	4/12/2004	Rivermouth	C0	9	32.55657	-117.12921	119	19:30	C00412041930	22	=	143	=	1800	=	140	21.43	30.19
669	4/12/2004	Rivermouth	C0	9	32.55658	-117.12922	043	19:45	C00412041945	23	=	178	=	3600	=	440	21.88	29.64
670	4/12/2004	Rivermouth	C0	9	32.55658	-117.12920	124	20:00	C00412042000	24	=	139	=	200	=	260	22.06	30.00
671	4/12/2004	Rivermouth	C0	9	32.55659	-117.12922	095	20:15	C00412042015	25	=	30	=	2600	=	116	22.08	29.80
672	4/12/2004	Rivermouth	C0	9	32.55656	-117.12920	049	20:30	C00412042030	26	=	31	=	1040	=	112	22.26	29.71
673	4/12/2004	Rivermouth	C0	9	32.55657	-117.12921	057	20:45	C00412042045	27	=	41	=	820	=	104	22.84	30.09
674	4/12/2004	Rivermouth	C0	9	32.55657	-117.12922	102	21:00	C00412042100	28	=	10	=	580	=	78	23.62	30.14
675	4/12/2004	Rivermouth	C0	9	32.55656	-117.12922	129	21:15	C00412042115	29	<	10	=	480	=	26	20.52	33.25
676	4/12/2004	Rivermouth	C0	9	32.55652	-117.12920	138	21:30	C00412042130	30	<	10	=	130	=	10	20.43	33.20
677	4/14/2004	Rivermouth	C0	9	32.55677	-117.12894	003	20:16	C00414042016	1	<	10	=	90	=	36	21.59	29.74
678	4/14/2004	Rivermouth 2	C1	13	32.55764	-117.13149	005	20:30	C10414042030	2	<	10	=	32	=	50	17.66	33.81

679	4/14/2004	3/4 North	D0	14	32.56124	-117.13194	140	21:00	D00414042100	3	<	10	<	2	<	2	17.59	33.71
680	4/14/2004	Seacoast	E0	15	32.56632	-117.13311	076	21:33	E00414042133	4	<	10	=	6	<	2	18.03	33.60
681	4/14/2004	Cortez	F0	16	32.57262	-117.13287	080	21:54	F00414042154	5	<	10	=	2	<	2	17.59	33.69
682	4/14/2004	Rivermouth	C0	9	32.55677	-117.12899	082	22:46	C00414042246	6	<	10	=	6	=	6	18.23	33.48
683	4/14/2004	3/4 North	D0	14	32.56128	-117.13175	132	23:09	D00414042309	7	<	10	<	2	<	2	17.68	33.87
684	4/14/2004	Seacoast	E0	15	32.56632	-117.13284	028	23:36	E00414042336	8	<	10	<	2	=	4	17.84	33.72
685	4/14/2004	Seacoast	E0	15	32.56632	-117.13284	047	23:38	E00414042338	9	<	10	<	2	=	2	17.84	33.72
686	4/15/2004	Cortez	F0	16	32.57266	-117.13259	069	0:02	F00415040002	10	<	10	=	2	<	2	17.41	33.78
687	4/15/2004	3/4 North	D0	14	32.56128	-117.13168	113	0:38	D00415040038	11	<	10	<	2	<	2	17.90	33.74
688	4/15/2004	Seacoast	E0	15	32.56634	-117.13272	036	0:58	E00415040058	12	<	10	=	6	<	2	N/A	N/A
689	4/15/2004	Cortez	F0	16	32.57266	-117.13259	023	1:15	F00415040115	13	<	10	=	4	=	2	N/A	N/A
690	4/21/2004	3/4 North	D0	14	32.56130	-117.13194	044	13:50	D00421041350	1	=	63	=	3000	=	42	13.85	33.67
691	4/21/2004	Seacoast	E0	15	32.56648	-117.13289	038	14:17	E00421041417	2	<	10	=	114	=	8	13.80	33.70
692	4/21/2004	Cortez	F0	16	32.57265	-117.13283	046	14:44	F00421041444	3	<	10	=	66	=	24	13.69	33.71
693	4/21/2004	3/4 North	D0	14	32.56136	-117.13184	022	15:24	D00421041524	4	=	62	>	16000	=	220	13.86	33.65
694	4/21/2004	Seacoast	E0	15	32.56641	-117.13290	087	15:53	E00421041553	5	<	10	=	7000	=	134	13.70	33.57
695	4/21/2004	3/4 North	D0	14	32.56132	-117.13178	092	16:21	D00421041621	6	=	40	>	16000	=	300	14.04	33.56
696	4/21/2004	Seacoast	E0	15	32.56635	-117.13285	007	16:52	E00421041652	7	<	10	=	3200	=	78	14.06	33.59
697	4/21/2004	Seacoast	E0	15	32.56635	-117.13285	011	16:55	E00421041655	8	<	10	=	3600	=	54	14.06	33.59
698	4/21/2004	3/4 North	D0	14	32.56129	-117.13174	020	17:26	D00421041726	9	<	10	=	15000	=	260	14.34	33.63
699	4/21/2004	Seacoast	E0	15	32.56638	-117.13281	106	17:55	E00421041755	10	<	10	=	1720	=	44	13.82	33.73
700	4/21/2004	Cortez	F0	16	32.57259	-117.13271	135	18:24	F00421041824	11	<	10	=	154	=	32	14.47	33.65
701	4/29/2004	Rivermouth Estuary (north)	C3	10	32.55739	-117.12827	010	20:18	C30429042018	1	=	100	=	2	<	2	19.78	33.69
702	4/29/2004	Rivermouth	C0	9	32.55684	-117.12909	070	20:28	C00429042028	2	=	10	=	1460	=	16	20.73	29.58
703	4/29/2004	Rivermouth 2	C1	13	32.55778	-117.13105	138	20:43	C10429042043	3	=	10	=	8	<	2	17.28	33.90
704	4/29/2004	3/4 North	D0	14	32.56141	-177.13184	108	21:08	D00429042108	4	<	10	=	4	=	2	18.20	33.62
705	4/29/2004	Seacoast	E0	15	32.56629	-117.13293	139	21:35	E00429042135	5	<	10	=	2	<	2	17.77	33.61
706	4/29/2004	Cortez	F0	16	32.57259	-117.13271	026	21:59	F00429042159	6	<	10	<	2	<	2	17.73	33.80
707	4/29/2004	IB Pier (Shore-South)	H0	17	32.57866	-117.13287	008	22:26	H00429042226	7	<	10	=	8	=	10	18.29	33.67
708	4/29/2004	IB Pier (End)	H9	20	32.57949	-117.13727	144	22:53	H90429042253	8	<	10	<	2	=	2	N/A	N/A
709	4/29/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13463	060	23:05	H10429042305	9	<	10	=	10	=	4	N/A	N/A
710	4/29/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13463	053	23:07	H10429042307	10	<	10	=	14	=	6	N/A	N/A
711	4/29/2004	Seacoast	E0	15	32.56635	-117.13278	075	23:47	E00429042347	11	<	10	=	20	<	2	18.22	33.94
712	4/30/2004	Hollister	M0	7	32.55139	-117.08418	123	0:24	M00430040024	12	<	10	>	16000	=	340	N/A	N/A
713	5/17/2004	Border Fence	A0	1	32.53546	-117.12403	085	15:23	A00517041523	1	<	10	=	50	<	2	18.47	33.91
714	5/17/2004	Monument Road	B0	2	32.54345	-117.12497	107	15:53	B00517041553	2	<	10	=	34	=	2	18.39	33.61
715	5/17/2004	Hollister	M0	7	32.55129	-117.08395	019	16:23	M00517041623	3	=	370	=	1200	=	62	N/A	N/A
716	5/17/2004	IB Pier (Mid-surf zone)	H1	19	32.57953	-117.13448	103	16:57	H10517041657	4	=	30	=	160	=	78	N/A	N/A
717	5/17/2004	Rivermouth	C0	9	32.55678	-117.12933	095	17:42	C00517041742	5	<	10	=	16	=	6	18.75	33.44
718	5/17/2004	Rivermouth 2	C1	13	32.55784	-117.13090	116	17:57	C10517041757	6	<	10	=	240	=	6	18.80	33.62
719	5/17/2004	3/4 North	D0	14	32.56131	-117.13171	001	18:22	D00517041822	7	<	10	=	16	=	8	18.99	33.77
720	5/17/2004	Seacoast	E0	15	32.56615	-117.13279	127	18:46	E00517041846	8	<	10	=	28	=	2	19.20	33.66
721	5/17/2004	IB Pier (Shore-South)	H0	17	32.57857	-117.13290	081	19:12	H00517041912	9	=	10	=	10	=	6	18.89	33.73
722	5/17/2004	IB Pier (End)	H9	20	32.57948	-117.13730	014	19:34	H90517041934	10	=	10	=	6	=	2	N/A	N/A
723	5/17/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13425	045	19:45	H10517041945	11	=	100	=	90	=	120	N/A	N/A
724	5/17/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13425	105	19:50	H10517041950	12	=	10	=	72	=	96	N/A	N/A
725	5/26/2004	Border Fence	A0	1	32.53530	-117.12425	112	14:56	A00526041456	1	=	10	=	50	=	20	18.08	34.09
726	5/26/2004	Border Fence	A0	1	32.53530	-117.12425	009	14:56	A00526041456	1.1	=	10	=	44	<	2	18.08	34.09
727	5/26/2004	Monument Road	B0	2	32.54339	-117.12510	079	15:25	B00526041525	2	<	10	<	2	<	2	N/A	N/A
728	5/26/2004	Monument Road	B0	2	32.54339	-117.12510	017	15:25	B00526041525	2.1	<	10	=	2	=	2	N/A	N/A
729	5/26/2004	Seacoast	E0	15	32.56638	-117.13316	091	16:11	E00526041611	3	<	10	<	2	<	2	N/A	N/A
730	5/26/2004	Seacoast	E0	15	32.56638	-117.13316	058	16:11	E00526041611	3.1	<	10	=	2	<	2	N/A	N/A
731	5/26/2004	Rivermouth	C0	9	32.55682	-117.12923	153	16:51	C00526041651	4	=	74	=	700	=	82	N/A	N/A
732	5/26/2004	Rivermouth	C0	9	32.55682	-117.12923	133	16:51	C00526041651	4.1	=	31	=	200	=	60	N/A	N/A
733	5/26/2004	Rivermouth 2	C1	13	32.55759	-117.13113	131	17:02	C10526041702	5	=	41	=	66	=	10	N/A	N/A
734	5/26/2004	Rivermouth 2	C1	13	32.55759	-117.13113	067	17:02	C10526041702	5.1	<	10	=	32	=	4	N/A	N/A
735	5/26/2004	3/4 North	D0	14	32.56125	-117.13235	084	17:15	D00526041715	6	<	10	=	2	<	2	N/A	N/A
736	5/26/2004	3/4 North	D0	14	32.56125	-117.13235	056	17:15	D00526041715	6.1	<	10	<	2	=	2	N/A	N/A
737	5/26/2004	Cortez	F0	16	32.57263	-117.13323	129	17:42	F00526041742	7	<	10	<	2	<	2	N/A	N/A
738	5/26/2004	Cortez	F0	16	32.57263	-117.13323	094	17:42	F00526041742	7.1	<	10	=	2	<	2	N/A	N/A
739	5/26/2004	IB Pier (Shore-South)	H0	17	32.57849	-117.13339	149	18:20	H00526041820	8	<	10	<	2	<	2	N/A	N/A
740	5/26/2004	IB Pier (Shore-South)	H0	17	32.57849	-117.13339	049	18:20	H00526041820	8.1	=	10	=	2	<	2	N/A	N/A
741	5/26/2004	Carnation	K0	22	32.58561	-117.13326	109	18:41	K00526041841	9	<	10	=	2	=	6	N/A	N/A
742	5/26/2004	Carnation	K0	22	32.58561	-117.13326	004	18:41	K00526041841	9.1	<	10	=	2	=	4	N/A	N/A
743	5/26/2004	Silver Strand	N0	24	32.63658	-117.14464	078	19:17	N00526041917	10	<	10	=	2	<	2	N/A	N/A
744	5/26/2004	Silver Strand	N0	24	32.63658	-117.14464	042	19:17	N00526041917	10.1	=	73	<	2	<	2	N/A	N/A
745	6/9/2004	Border Fence	A0	1	32.53525	-117.12431	089	15:30	A00609041530	1	<	10	=	14	<	2	18.65	33.87
746	6/9/2004	Monument Road	B0	2	32.54333	-117.12528	119	16:03	B00609041603	2	<	10	=	12	<	2	18.66	33.74
747	6/9/2004	Hollister	M0	7	32.55142	-117.08414	057	16:32	M00609041632	3	=	63	<	2	=	32	N/A	N/A
748	6/9/2004	IB Pier (Mid-surf zone)	H1	19	32.57953	-117.13466	124	17:04	H10609041704	4	<	10	=	2	=	6	N/A	N/A
749	6/9/2004	Rivermouth	C0	9	32.55693	-117.12902	037	17:44	C00609041744	5	=	30	=	500	=	18	19.95	31.41
750	6/9/2004	Rivermouth 2	C1	13	32.55772	-117.13116	065	17:58	C10609041758	6	<	10	=	4	<	2	19.77	33.91
751	6/9/2004	Rivermouth 2	C1	13	32.55772	-117.13116	118	18:01	C10609041801	7	<	10	=	4	<	2	19.77	33.91
752	6/9/2004	3/4 North	D0	14	32.56133	-117.13194	120	18:23	D00609041823	8	<	10	=	2	<	2	19.81	33.89
753	6/9/2004	Seacoast	E0	15	32.56622	-117.13324	074	18:48	E00609041848	9	<	10	<	2	<	2	20.86	34.02
754	6/9/2004	Cortez	F0	16	32.57262	-117.13280	031	19:12	F00609041912	10	<	10	=	2	<	2	20.14	34.01
755	6/9/2004	IB Pier (Shore-South)	H0	17	32.57860	-117.13303	141	19:36	H00609041936	11	<	10	=	2	=	4	20.92	34.17
756	6/9/2004	IB Pier (End)	H9	20	32.57949	-117.13726	148	19:56	H90609041956	12	=	20	=	20	=	48	N/A	N/A
757	6/9/2004	IB Pier (Mid-surf zone)	H1	19	32.57958	-117.13452	150	20:06	H10609042006	13	<	10	=	4	<	2	N/A	N/A
758	6/21/2004	Border Fence	A0	1	32.53626	-117.12450	043	16:34	A00621041634	1	<	10	=	22	=	10	17.54	33.82
759	6/21/2004	Monument Road	B0	2	32.54333	-117.12514	035	17:01	B00621041701	2	<	10	=	2	<	2	18.07	33.81
760	6/21/2004	Hollister	M0	7	32.55143	-117.08415	093	17:33	M00621041733	3	=	171	>	16000	=	102	21.12	1.57
761	6/21/2004	Rivermouth	C0	9	32.55685	-117.12913	147	18:21	C00621041821	4	<	10	=	40	<	2	18.29	33.82
762	6/21/2004	Rivermouth 2	C1	13	32.55783	-117.13074	102	18:35	C10621041835	5	=	20	=	2	=	2	18.13	33.78
763	6/21/2004	3/4 North	D0	14	32.56134	-117.13184	077	18:56	D00621041856	6	<	10	<	2	<	2	18.09	33.79

764	6/21/2004	Seacoast	E0	15	32.56637	-117.13297	117	19:23	E00621041923	7	<	10	<	2	=	4	17.94	33.78
765	6/21/2004	Cortez	F0	16	32.57267	-117.13268	128	19:51	F00621041951	8	<	10	<	2	<	2	17.92	33.76
766	6/21/2004	Cortez	F0	16	32.57267	-117.13268	111	19:55	F00621041955	9	<	10	=	4	<	2	17.92	33.76
767	6/21/2004	IB Pier (Shore-South)	H0	17	32.57875	-117.13294	055	20:24	H00621042024	10	<	10	=	6	=	6	18.16	33.79
768	6/21/2004	IB Pier (End)	H9	20	32.57950	-117.13728	029	20:52	H90621042052	11	<	10	=	2	<	2	N/A	N/A
769	6/21/2004	IB Pier (Mid-surf zone)	H1	19	32.57957	-117.13418	051	21:06	H10621042106	12	<	10	<	2	<	2	N/A	N/A
770	7/26/2004	Oneonta Slough (furthest)	J1	26	32.56905	-117.13087	144	22:59	J10726042259	1	<	10	=	60	<	2	22.05	33.98
771	7/26/2004	Oneonta Slough (mid-furthest)	J2	27	32.56707	-117.13148	003	23:08	J20726042308	2	<	10	<	2	<	2	21.90	33.55
772	7/26/2004	Oneonta Slough (mid)	JZ	41	32.56266	-117.13000	101	23:18	JZ0726042318	3	<	10	=	2	=	2	21.58	33.57
773	7/26/2004	Oneonta Slough (mouth)	J3	28	32.55955	-117.12898	063	23:28	J30726042328	4	<	10	<	2	<	2	21.57	33.38
774	7/26/2004	Estuary Center	J6	31	32.55932	-117.12768	034	23:32	J60726042332	5	=	10	=	18	=	14	22.07	33.77
775	7/26/2004	Rivermouth Estuary (north)	C3	10	32.55768	-117.12906	002	23:40	C30726042340	6	<	10	=	2	=	2	22.90	33.59
776	7/26/2004	Rivermouth	C0	9	32.55718	-117.12850	052	23:45	C00726042345	7	=	20	=	20	=	2	21.56	33.54
777	7/26/2004	Rivermouth	C0	9	32.55718	-117.12850	015	23:47	C00726042347	8	<	10	=	40	=	10	21.56	33.54
778	7/27/2004	Southern slough (furthest)	J8	33	32.55230	-117.12218	066	0:01	J80726040001	9	<	10	=	40	=	2	23.54	33.61
779	7/27/2004	Southern slough (mid-furthest)	J9	34	32.55119	-117.12469	156	0:08	J90727040008	10	<	10	=	2	=	2	22.24	33.61
780	7/27/2004	Southern slough (mid)	JA	35	32.55231	-117.12621	137	0:13	JA0726040013	11	<	10	=	14	=	30	22.06	33.81
781	7/27/2004	Rivermouth Estuary (south)	C2	5	32.55568	-117.12754	152	0:21	C20726040021	12	<	10	=	4	<	2	22.18	33.63
782	7/27/2004	Main slough (furthest)	JC	37	32.55709	-117.11249	115	0:44	JC0726040044	13	=	30	=	4	=	14	24.37	33.56
783	7/27/2004	Main slough (mid-furthest)	JD	38	32.55760	-117.11521	006	0:50	JD0726040050	14	<	10	=	20	<	2	23.31	33.57
784	7/27/2004	Main slough (mid)	JG	42	32.55863	-117.11931	041	0:57	JG0726040057	15	<	10	=	12	=	2	22.23	33.70
785	7/27/2004	Main slough (mouth)	JE	39	32.55671	-117.12598	143	1:14	JE0726040114	16	<	10	=	34	=	20	22.04	33.60
786	7/27/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13470	083	2:50	H90727040250	17	<	10	=	4	=	N/A	N/A	N/A
787	7/27/2004	Hollister	M0	7	32.55157	-117.08407	151	3:20	M00727040320	18	<	10	=	68	=	N/A	N/A	N/A
788	7/28/2004	Rivermouth Estuary (north)	C3	10	32.55770	-117.12865	053	17:36	C30728041736	1	<	10	<	2	=	4	N/A	N/A
789	7/28/2004	Rivermouth Estuary (south)	C4	6	32.55742	-117.12867	076	17:42	C40728041742	2	<	10	<	2	<	2	N/A	N/A
790	7/28/2004	Rivermouth	C0	9	32.55703	-117.12912	140	17:48	C00728041748	3	=	10	<	2	=	2	N/A	N/A
791	7/28/2004	Rivermouth 2	C1	13	32.55777	-117.13081	060	17:57	C10728041757	4	=	10	=	8	<	2	N/A	N/A
792	7/28/2004	Rivermouth	C0	9	32.55707	-117.12914	030	18:05	C00728041805	5	<	10	<	2	=	2	N/A	N/A
793	7/28/2004	Rivermouth Estuary (north)	C3	10	32.55766	-117.12862	032	18:16	C30728041816	6	=	10	=	60	=	2	N/A	N/A
794	7/28/2004	Rivermouth	C0	9	32.55704	-117.12914	139	18:30	C00728041830	7	<	10	<	2	<	2	N/A	N/A
795	7/28/2004	Rivermouth	C0	9	32.55703	-117.12911	082	18:59	C00728041859	8	<	10	<	2	<	2	N/A	N/A
796	7/28/2004	Rivermouth	C0	9	32.55703	-117.12911	025	19:00	C00728041900	9	<	10	<	2	=	4	N/A	N/A
797	7/28/2004	Rivermouth 2	C1	13	32.55779	-117.13083	028	19:12	C10728041912	10	<	10	=	2	=	2	N/A	N/A
798	7/28/2004	3/4 North	D0	14	32.56134	-117.13209	110	19:31	D00728041931	11	<	10	<	2	=	2	N/A	N/A
799	7/28/2004	Seacoast	E0	15	32.56630	-117.13321	050	19:53	E00728041953	12	<	10	<	2	<	2	N/A	N/A
800	7/28/2004	Oneonta Slough (shore)	JF	40	32.56653	-117.13158	020	20:05	JF0728042005	13	<	10	<	2	<	2	N/A	N/A
801	7/28/2004	Cortez	F0	16	32.57253	-117.13297	121	20:30	F00728042030	14	<	10	<	2	<	2	N/A	N/A
802	7/28/2004	IB Pier (Shore-South)	H0	17	32.57841	-117.13302	099	20:48	H00728042048	15	<	10	<	2	<	2	N/A	N/A
803	7/28/2004	IB Pier (Mid-surf zone)	H1	19	32.57956	-117.13419	071	21:12	H10728042112	16	<	10	=	40	=	26	N/A	N/A
804	7/28/2004	IB Pier (End)	H9	20	32.57957	-117.13700	062	21:24	H90728042124	17	<	10	<	2	<	2	N/A	N/A
805	7/28/2004	Carnation	K0	22	32.58565	-117.13287	022	21:58	K00728042158	19	=	104	=	200	=	40	N/A	N/A
806	7/28/2004	Hollister	M0	7	32.55146	-117.08414	023	22:32	M00728042232	20	=	185	>	16000	=	40	N/A	N/A
807	7/30/2004	IB Pier (End)	H9	20	32.57954	-117.13709	010	17:57	H90730041757	1	<	10	=	10	=	12	N/A	N/A
808	7/30/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13421	006	18:08	H10730041808	2	<	10	<	2	=	2	N/A	N/A
809	7/30/2004	Rivermouth	C0	9	32.55704	-117.12916	156	18:53	C00730041853	3	=	10	<	2	=	4	20.78	33.75
810	7/30/2004	Rivermouth	C0	9	32.55700	-117.12914	041	19:01	C00730041901	4	<	10	<	2	=	2	20.76	33.65
811	7/30/2004	Rivermouth 2	C1	13	32.55784	-117.13078	070	19:17	C10730041917	5	<	10	<	2	=	4	21.03	33.79
812	7/30/2004	3/4 North	D0	14	32.56130	-117.13212	092	19:36	D00730041936	6	<	10	<	2	<	2	20.95	33.80
813	7/30/2004	3/4 North	D0	14	32.56130	-117.13212	063	19:41	D00730041941	7	<	10	<	2	<	2	20.95	33.80
814	7/30/2004	Seacoast	E0	15	32.56630	-117.13322	044	20:07	E00730042007	8	<	10	<	2	<	2	21.20	33.76
815	7/30/2004	Cortez	F0	16	32.57268	-117.13303	026	20:32	F00730042032	9	<	10	<	2	<	2	22.11	33.75
816	7/30/2004	IB Pier (Shore-South)	H0	17	32.57887	-117.13317	055	21:03	H00730042103	10	<	10	<	2	<	2	22.15	33.96
817	7/30/2004	IB Pier (End)	H9	20	32.57954	-117.13737	083	21:32	H90730042132	11	<	10	=	6	=	4	N/A	N/A
818	7/30/2004	IB Pier (Mid-surf zone)	H1	19	32.57955	-117.13428	002	21:44	H10730042144	12	<	10	<	2	<	2	N/A	N/A
819	7/30/2004	Carnation	K0	22	32.58558	-117.13300	014	22:22	K00730042222	13	=	20	=	12	=	4	23.70	33.91
820	7/30/2004	Silver Strand North	N0	24	32.63585	-117.14410	137	22:59	N00730042259	14	<	10	=	20	<	2	23.00	33.96

APPENDIX 2. FIELD DATA SHEET

The South Bay Coastal Ocean Observing System
Field Data Sheet

Date (mm/dd/yy): ______________
Names of collectors:__________________________
GPS # ________ GPS Time (GMT) ________ (arrival on site)

Weather conditions: Additional Comments:

Light:	Sunny	Partly Cloudy	Overcast
Last Rain:	>72 hours	<72 hours	<3 hours
Rainfall:	None	<0.1	>0.1

Potential fecal sources within 75 feet:		(If yes, #?, brief description if applicable)
Wildlife:	No	Yes_____
Domestic Animals:	No	Yes_____
Children (in diapers):	No	Yes_____
Other bathers:	No	Yes_____

Water Observations:

Color:	None	Brown (Silty)	White (Milky)	Gray	Other _______________
Odor	None	Musty	Chemical	Sewage	Other _______________
Clarity:	Clear	Transparent	Slightly cloudy	Opaque	Other _______________
Floatables:	None	Trash	Bubbles/Foam	Sheen	Other _______________
Deposits:	None	Sediment	Particulates	Fecal matter	Other _______________

Estimated swell height: ______feet direction: ______
Estimated wind speed: ______knots direction: ______

Sample Information:

Station name _____________ Sample Time _____________ Time zone: GMT (from GPS)
SIO Station ID ________ Sample ID ____________________ ([Stn#]mmddyyhhmm)
Station Lat 32.__________°
Station Lon 117.__________° Water Temp ____________°C
Salinity ____________

Put on gloves and collect sample before completing the rest of the data sheet

Bottle Number ____________ Chain of Custody completed? ☐
Lab ID L_______

Duplicate? Y N
If yes,
Time _________
Bottle number _________
Sample ID ______________
Lab ID L_______

Notes:

Date entered: Initials:

APPENDIX 3. CHAIN OF CUSTODY FORM

The South Bay Coastal Ocean Observing System
Chain of Custody Record

9500 Gilman Drive
La Jolla, CA 92093-0218
(858) 534-6304

Date: _______________
Sampler (s): ____________
First Sample taken at ________ PDT
Leave IB at (5 hours later) _______
Arrive at SIO at (5.5 hours later) _______

Lab ID	Time-GMT	Bottle #	Sample ID	Comments
L				
L				
L				
L				
L				
L				
L				
L				
L				
L				
L				

Lab ID	Time-GMT	Bottle #	Sample ID	Comments
L				
L				
L				
L				
L				
L				
L				
L				
L				
L				
L				

Relinquished by:	Received by:	Date:
Name:	Name:	Time:
Sign:	Sign:	Location:

Total Samples: _______________

Temperature upon arrival at lab: _______°C

Relinquished by:	Received by:	Date:
Name:	Name:	Time:
Sign:	Sign:	Location:

Lab Comments:

Page ____ of _____