



This document contains the overall and specific condition of the Puerto Rican estuary, San Juan Bay Estuary Partnership from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from <http://www.epa.gov/owow/oceans/nepccr/index.html>

National Estuary Program Coastal Condition Report

Chapter 7: Puerto Rico: San Juan Bay Estuary Partnership Coastal Condition

June 2007

CHAPTER 7

PUERTO RICO NATIONAL ESTUARY PROGRAM COASTAL CONDITION



San Juan Bay Estuary Partnership



Background

Located on the northern coast of the island territory of Puerto Rico, the San Juan Bay Estuary (Estuario de la Bahía de San Juan) is semi-enclosed by the surrounding mainland, mangroves, and wetlands and is linked to the Atlantic Ocean via a series of interconnected bays, channels, and lagoons. This estuarine system includes San Juan Bay; the Martín Peña, San Antonio, and Suárez channels; and the Condado, Los Corozos, San José, Torrecilla, and Piñones lagoons. Multiple tributaries flow into the San Juan Bay Estuary, the largest being the Puerto Nuevo River. Salt water

enters the Estuary from the Atlantic Ocean through the Boca del Morro to San Juan Bay, through El Boquerón to Condado Lagoon, and through Boca de Cangrejos to Torrecilla Lagoon. The limited flushing capacity and low tidal range of this estuarine system make the San Juan Bay Estuary susceptible to the retention of toxic pollutants (Martin et al., 1996).

For centuries, the San Juan Bay Estuary has provided a number of invaluable resources for the residents of Puerto Rico, including commercial port facilities, beaches, recreational parks, and natural and historic areas; however, the societal needs associated with the



growth of the surrounding population have resulted in the degradation of the natural resources of this system. Recognizing the constant threats to the Estuary, the Governor of Puerto Rico nominated San Juan Bay Estuary for inclusion into EPA's NEP in 1992, leading to the official creation of the San Juan Bay Estuary Partnership (SJBEP).

Environmental Concerns

One of the SJBEP's first tasks was to identify the priority problems of the San Juan Bay Estuary. To carry out this task, the SJBEP considered information from different scientific studies, expert scientific opinion, and public meetings and workshops. Based on these combined inputs, the SJBEP is addressing the following problems (listed in order of importance):

- Poor water circulation
- Illegal sanitary discharges
- Contamination by toxic substances and nutrients
- Lack of an ecosystem management plan
- Lack of community participation.

Population Pressures

The SJBEP study area is coincident with eight urban municipalities on the northeast coast of Puerto Rico. The population of these coastal municipalities (Bayamón, Carolina, Cantaño, Guaynabo, Loiza, San Juan, Toa Baja, and Trujillo Alto) was almost 1.18 million people in 2000 (Figure 7-1), and the population density was 5,055 persons/mi² (U.S. Census Bureau, 2001). This represents the highest population density observed for any of the 28 NEPs—more than 60% higher than the population density of the counties coincident with the HEP study area. Development and population pressures are especially strong surrounding the San Juan Bay Estuary, which has long served as a center of commerce and shipping in the Caribbean and is currently a center for commercial and recreational fisheries and recreational activities for the area's highly urbanized island community.

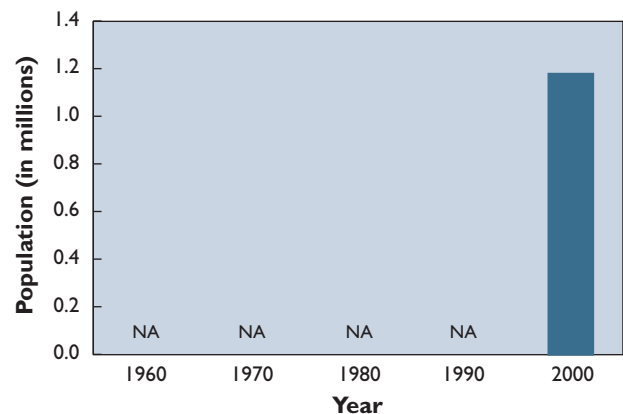


Figure 7-1. Population of the coastal municipalities coincident with the SJBEP study area, 1960–2000 (U.S. Census Bureau, 1991; 2001).

The following sections of this report discuss two different approaches for characterizing estuarine condition.

Approach 1 – The NCA provides unbiased, quality-assured data that can be used to make consistent “snapshot” comparisons among the nation’s estuaries. These comparisons are expressed in terms of the percent of estuarine area in good, fair, or poor condition.

Approach 2 – Each individual NEP collects site-specific estuarine data in support of local problem-solving efforts. These data are difficult to compare among NEPs, within regions or nationally, because the sampling and evaluation procedures used by the NEPs are often unique to their individual estuaries. However, these assessments are important because NEP-collected data can evaluate spatial and temporal changes in estuarine condition on a more in-depth scale than can be achieved by the NCA snapshot approach.

NCA Indices of Estuarine Condition—San Juan Bay Estuary

In the winter of 2002, EPA’s Region 2 conducted a survey in the San Juan Bay Estuary that focused on generating a comprehensive biological and chemical assessment of sediment throughout the Estuary (U.S. EPA, 2002b). In partnership with the NCA, a survey design and data-collection strategy that was compatible with EPA’s NEP assessment effort was employed. Thirty-four sites were visited during this survey for the SJBEP assessment. Additionally, Region 2 conducted an independent fish tissue contaminants survey in San José Lagoon—a coastal lagoon within the San Juan Bay Estuary system—and the data from this survey contributed to the fish tissue contaminants evaluation for this Estuary.

Based on the data collected during the Region 2 survey efforts, the overall condition of the San Juan Bay Estuary is rated poor (Figure 7-2). The water quality index for the Estuary is rated fair, and the sediment quality, benthic, and fish tissue contaminants indices are rated poor. Figure 7-3 shows the percent of estuarine area rated good, fair, poor, and missing for each parameter considered. Please refer to Tables 1-24, 1-25, and 1-26 (Chapter 1) for a summary of the criteria used to develop the rating for each index and component indicator.

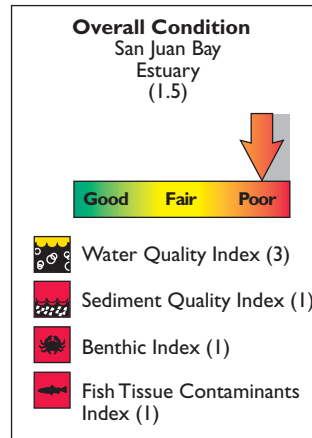


Figure 7-2. The overall condition of the SJBEP estuarine area is poor (U.S. EPA/NCA).

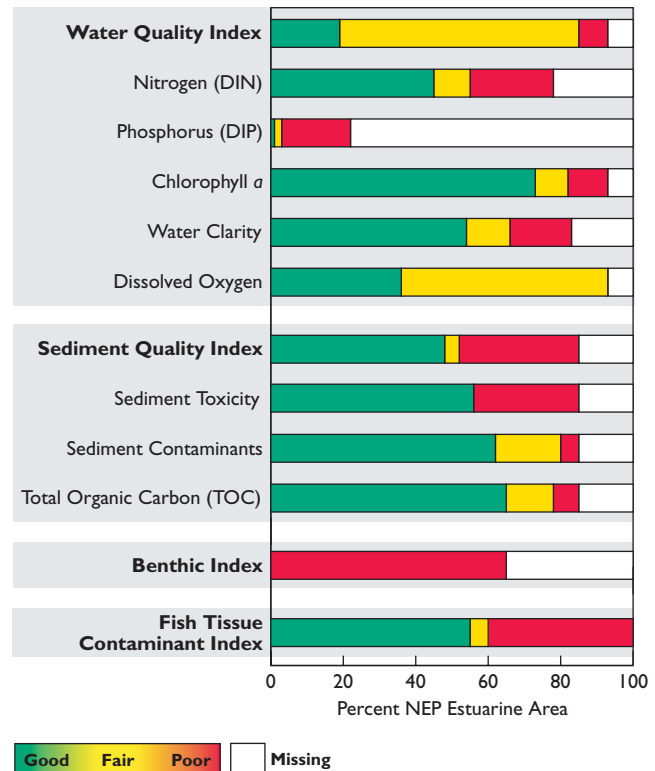


Figure 7-3. Percentage of NEP estuarine area achieving each ranking for all indices and component indicators — San Juan Bay Estuary.



Water Quality Index

The water quality index for San Juan Bay Estuary is rated fair because 74% of the estuarine area was rated fair or poor for water quality (Figure 7-4). This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. Threshold values used to determine the condition of individual water quality parameters were based on those used by the NCA for assessing tropical waters (see Chapter 1 for additional details), and all water quality component indicators were rated fair.

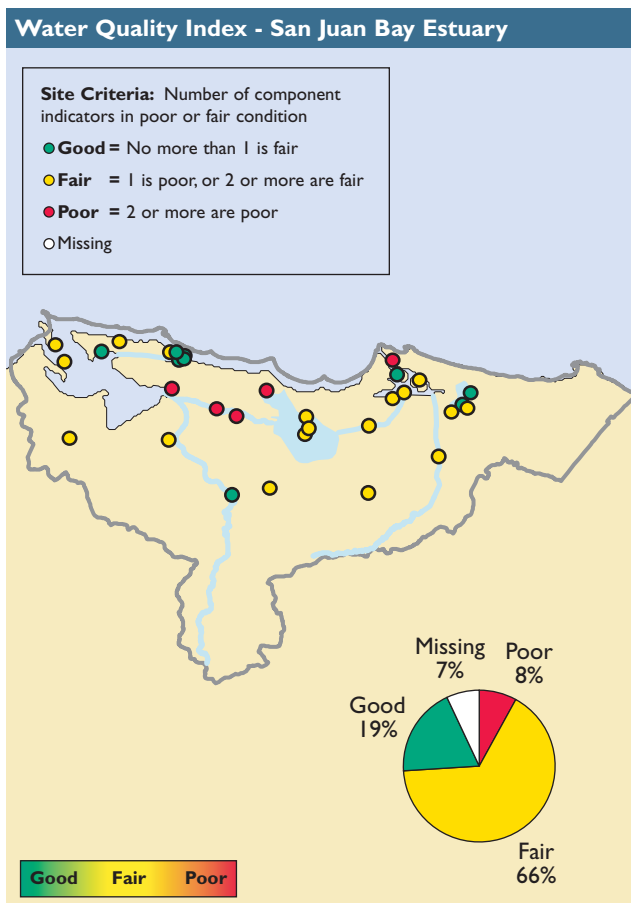


Figure 7-4. Water quality index data for San Juan Bay Estuary, 2002 (U.S. EPA/NCA).

Dissolved Nitrogen and Phosphorus | The San Juan Bay Estuary is rated fair for both DIN and DIP concentrations. With respect to DIN concentrations, 45% of the estuarine area was rated good, 10% was rated fair, and 23% was rated poor. Poor DIP levels occurred in 19% of the estuarine area, with 2% of the area rated fair and only 1% of the area rated good; however, NCA data on DIP concentrations were unavailable for 78% of the SJBEP estuarine area.

Chlorophyll *a* | Chlorophyll *a* concentrations in the San Juan Bay Estuary are rated fair. The NCA survey results showed good chlorophyll *a* conditions for 73% of the estuarine area, with 9% of the area rated fair and 11% of the area rated poor. NCA data on chlorophyll *a* concentrations were unavailable for 7% of the SJBEP estuarine area.

Water Clarity | Water clarity for the San Juan Bay Estuary is rated fair. For tropical waters, a range of 20% to 40% expected light penetration at 1 meter is considered fair. Measurements above this range are considered good, and those below are considered poor. In the San Juan Bay Estuary, only Secchi depth measurements were available to assess water clarity. A light extinction coefficient was calculated for each Secchi depth reading and compared to the light extinction coefficient of the expected or reference value (at 1 meter) appropriate for the region (Smith et al., 2006). These evaluations show that 54% of the estuarine area was rated good for water clarity, 12% was rated fair, and 17% was rated poor. Water clarity data were unavailable for 17% of the SJBEP estuarine area.

Dissolved Oxygen | The San Juan Bay Estuary is rated fair for dissolved oxygen concentrations. Estimates show that 57% of the estuarine area was rated fair, 36% of the area was rated good, and none of the area was rated poor. NCA data on dissolved oxygen concentrations were unavailable for 7% of the SJBEP estuarine area.



Sediment Quality Index

The sediment quality index for San Juan Bay Estuary is rated poor (Figure 7-5). This index was developed using NCA data on three component indicators: sediment toxicity, sediment contaminants, and sediment TOC. About one-third (33%) of the estuarine area was rated poor for sediment quality, and another 4% was rated fair. NCA data on sediment quality were unavailable for 15% of the SJBEP estuarine area.

Sediment Toxicity | The San Juan Bay Estuary is rated poor for sediment toxicity. Twenty-nine percent of the estuarine area was rated poor for this component indicator, and 56% of the area was rated good. NCA data on sediment toxicity were unavailable for 15% of the SJBEP estuarine area.

Sediment Contaminants | The San Juan Bay Estuary is rated fair for sediment contaminant concentrations. Five percent of the estuarine area was rated poor for sediment contaminants, and 18% of the area was rated fair. NCA data on sediment contaminant concentrations were unavailable for 15% of the SJBEP estuarine area.

Total Organic Carbon | TOC concentrations in the sediments of the San Juan Bay Estuary are rated good, with 65% of the estuarine area rated good for this component indicator. TOC concentrations were rated fair and poor in 13% and 7% of the estuarine area, respectively, and NCA data on this component indicator were unavailable for 15% of the SJBEP estuarine area.



Benthic Index

A benthic index has not been developed for Puerto Rico. As a surrogate for benthic condition, benthic samples from the San Juan Bay Estuary were examined using ecological community indicators that contribute to all of the benthic indices developed by the NCA for the Northeast Coast, Southeast Coast, and Gulf Coast regions, and benthic diversity was used directly to evaluate benthic condition. If benthic diversity was less than 75% of the observed mean diversity for all locations sampled in Puerto Rico during the NCA surveys, the site was rated poor.

The benthic index for the San Juan Bay Estuary is rated poor because 65% of estuarine area had low benthic diversity and was rated poor (Figure 7-6). Benthic diversity data were unavailable for the remaining 35% of the estuarine area. When the areas that were rated poor for benthic condition were compared with the areas rated poor for water and sediment quality, it was determined that all of the SJBEP areas with low benthic diversity were also rated poor for at least one other index. Eighty-three percent of the area with low benthic diversity co-occurred with both poor sediment and water quality condition; 10% co-occurred with only poor sediment quality conditions; and 7% occurred with only poor water quality conditions.

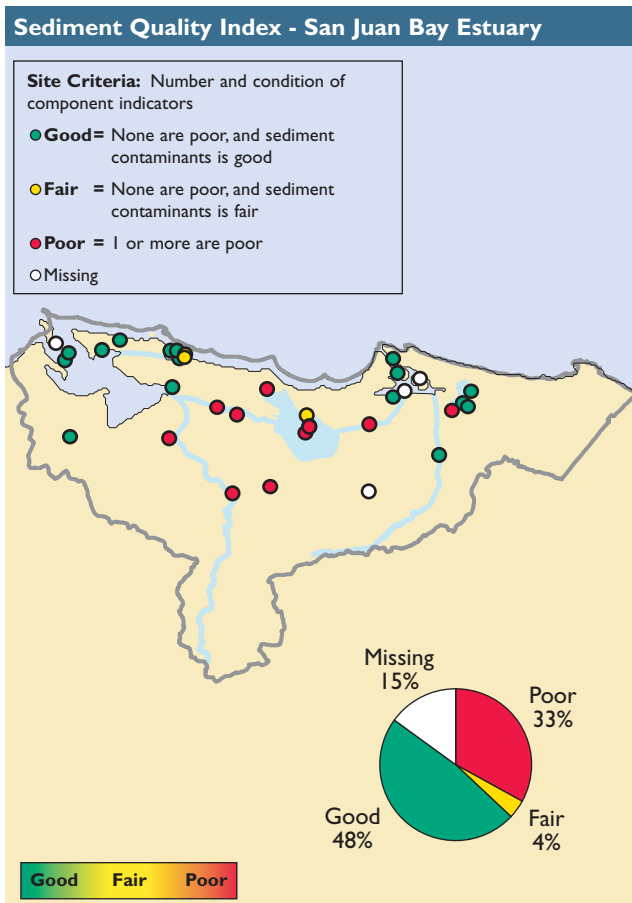


Figure 7-5. Sediment quality index data for San Juan Bay Estuary, 2002 (U.S. EPA/NCA).

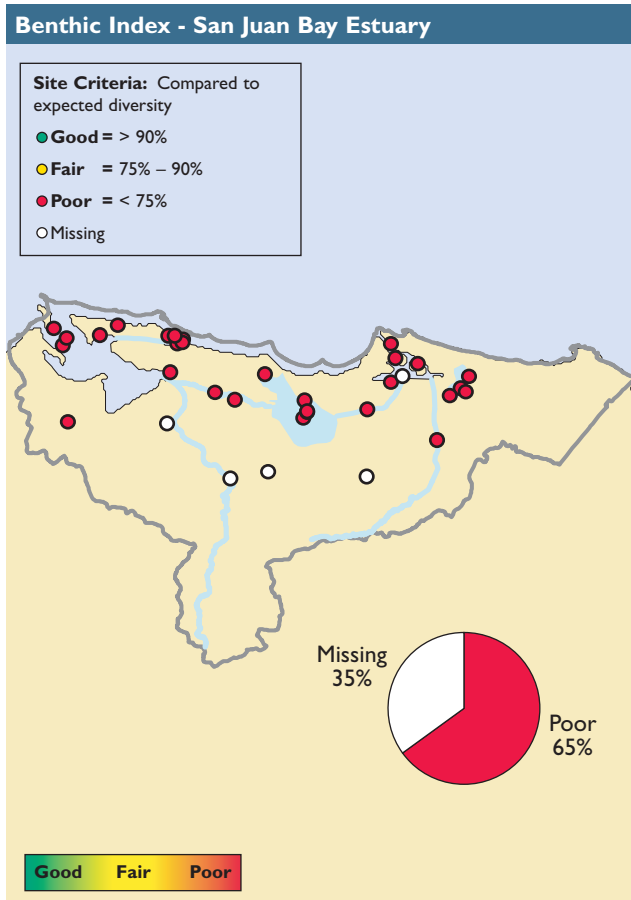


Figure 7-6. Benthic index data for San Juan Bay Estuary, 2002 (U.S. EPA/NCA).

Fish Tissue Contaminants Index

The results from a separate survey conducted in the San José Lagoon, one of the larger coastal lagoons within the San Juan Bay Estuary, were used as a surrogate for the NCA’s fish tissue contaminants evaluation. The goals of the San José Lagoon survey were to evaluate whether toxic compounds were present in edible fish and shellfish tissues and to develop risk-based human health consumption advisories for the Lagoon. The survey design partitioned the Lagoon into four quadrants that were as equal in size as geographically possible. Trawls were conducted in each of these quadrants to collect tissue samples from four target species: blue crab (*Callinectes sapidus*), yellowfin mojarra (*Eugerres cinereus*), striped mojarra (*Eugerres brasilianus*), and snook (*Centropomus sp.*). Five individuals of each species were culled for contaminant analysis. Finfish

fillets (with skin) and separate crab tissue and hepatopancreas samples were used for analysis (U.S. EPA, 2000d).

Based on the concentrations of contaminants found in fish and crustacean tissues during the San José Lagoon survey, the fish tissue contaminants index for the San Juan Bay Estuary is rated poor because 40% of all samples analyzed for contaminants exceeded EPA Advisory Guidance values (Figure 7-7).

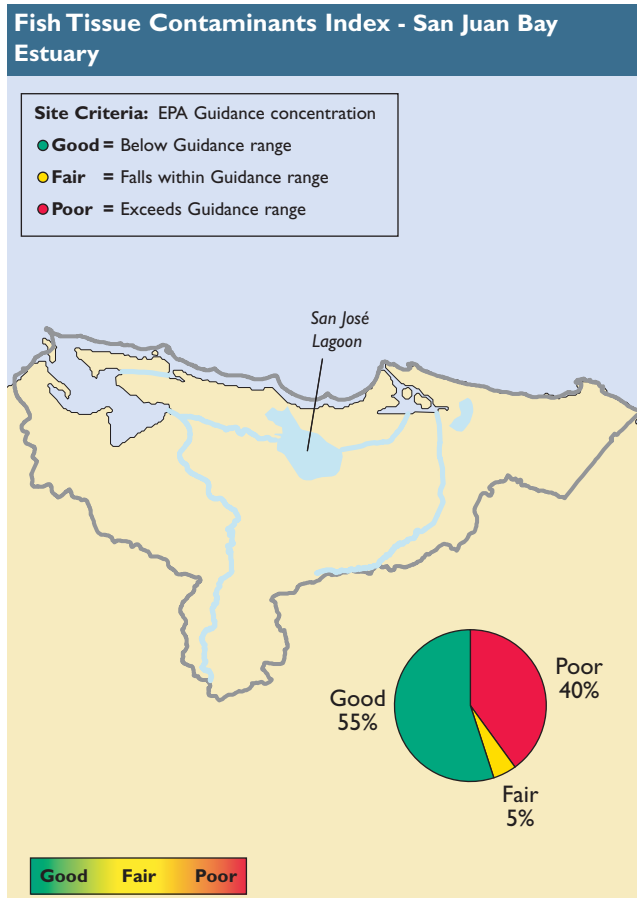


Figure 7-7. Fish tissue contaminants index data for San Juan Bay Estuary, 2002 (U.S. EPA/NCA).



HIGHLIGHT

Getting the Message to the People—The San Juan Bay Estuary Partnership Educational Outreach Efforts

The SJBEP has been working very hard in the area of educational outreach. Several projects have been implemented to increase public awareness of the Estuary and its ecological importance.

Bay Day Festival of the Estuary

The SJBEP held its first Bay Day Festival of the Estuary: Two Windows, Land and Sea (Festival del Estuario: Dos Ventanas, Tierra y Mar) in May 2003. A large number of people participated in the festival, which included more than 30 environmental art exhibitions and presentations; diving and kayaking lessons; and environmental arts and crafts workshops, as well as a number of activities specifically designed for children. Numerous local artists participated in the festival, which received significant coverage from various media, including television, radio, and newspaper. The event also provided the setting for the expansion and continuation of cooperative efforts and collaborations between federal and local government agencies, community groups, and the SJBEP.

Teacher Training Workshops

Workshops developed and presented on environmental topics train local teachers about the effective use of San Juan Bay Estuary environmental education curriculum and related educational materials. In October 2004, one workshop for private school science teachers drew more than 100 participants. These one-day workshops take place periodically and have the support of the Department of Education, which sent out an official announcement to the schools located around San Juan Bay Estuary. The workshops provide a session on the use and application of the curriculum and feature information on the ecological values of the San Juan Bay Estuary system, environmental threats to the Estuary, and proposed solutions. Workshops also include environmental games and presentations by representatives from the Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, Solid Waste Management Authority Agency, Highway and Transportation Agency, and the group working on restoration of the Cucharillas marsh.



This fish and wildlife exhibit shows species that are in danger of extinction (Susan Rivera,SJBEP).

School Day for the San Juan Bay Estuary

The School Day for the San Juan Bay Estuary encourages students to complete a project related to the Estuary. Students from the municipalities coincident with the SJBEP study area are invited to participate and submit abstracts of possible projects. The participating schools then plan an environmental activity that focuses on conservation efforts for the Estuary, and these activities are normally completed in April as part of the Earth Day celebration. Past student projects have involved a variety of activities, including beach cleanups, recycling, theater plays, monologues, and poster- and wall-painting contests. These activities create awareness about the importance of protecting, restoring, and conserving the San Juan Bay Estuary.

Volunteer Program

Long-term public support and participation in Estuary protection and restoration activities is necessary and critical for the successful implementation of the SJBEP's *Comprehensive Conservation and Management Plan for the San Juan Bay Estuary* (SJBEP, 2001). A volunteer program was created to encourage and facilitate active involvement by citizens in the Estuary's restoration process. University students participating in this program are encouraged to work with the SJBEP, using the SBJEP's objectives as potential subjects for developing their own research. These environmental volunteers will provide the resources needed to complete many of the SJBEP's proposed projects.



Outdoor activities accomplished during the 2005 Teacher Training Workshop included teachers kayaking or paddling to several areas of the Estuary, providing a first-hand, unforgettable experience for most of the participants (SJBEP).

San Juan Bay Estuary Partnership Indicators of Estuarine Condition

A Long-Term Environmental Indicator Program (LTEIP) has been proposed for the San Juan Bay Estuary to help assess the effectiveness of the area's conservation and restoration efforts. The indicators monitored by the LTEIP will be divided into four groups: Water-Sediment Quality, Biological Productivity and Respiration, Biota Distribution, and Biota-Pollutant Interactions. An important component of the LTEIP will be the preparation and dissemination of educational material as part of the SJBEP's outreach component. Other monitoring efforts have been proposed in the SJBEP's CCMP (SJBEP, 2001) to focus on the consequences of such events as petroleum spills, discharges from boats and ships, and high-temperature cooling water releases from thermoelectric plants. These events reduce the capacity of the Estuary's waters to retain oxygen.

Water and Sediment Quality

The SJBEP uses both chemical and bacteriological indicators to evaluate point and non-point sources of contamination. The most common indicators reported in the SJBEP CCMP are concentrations of nitrogen and phosphorus, dissolved oxygen, fecal coliform bacteria, and toxic substances (e.g., mercury, lead, arsenic, PCBs). Although the SJBEP does not monitor for these indicators directly, the indicators have been monitored for previous studies conducted by independent consultants, EPA, and the Puerto Rico Environmental Quality Board (EQB), as well as for previous studies supported by the SJBEP. Some of these indicators are currently evaluated for the Puerto Rican Water Quality Standards to define designated uses for different waterbodies.

The most common and widespread impairments to the Estuary's waters are nutrient enrichment/eutrophication and fecal contamination caused primarily by sewage discharges through non-point sources. Malfunctioning on-site septic systems, illegal connections to storm sewers, and direct discharges from unsewered areas are some of the current non-point sources of nutrients and fecal contamination related to sewage discharges into the San Juan Bay Estuary and its tributaries.

Nutrient and dissolved oxygen concentrations have been used to assess water quality in the San Juan Bay Estuary. No evidence of use impairments due to nitrogen and phosphorus loads have been reported in most of the San Juan Bay Estuary since point-source discharges from the Puerto Nuevo STP outfall into the Estuary were eliminated in 1985 (Tetra Tech, Inc., 1992). Dissolved oxygen levels in the Estuary's eutrophic waters vary widely depending on the time of day. This variation in dissolved oxygen concentrations is typically found in the San José and Los Corozos lagoons; however, the control of oxygen-consuming substances from industrial point-source discharges has gradually improved the dissolved oxygen levels in some areas of the Estuary (Webb and Gómez-Gómez, 1998).

Fecal coliform concentrations in most areas of the Estuary remain above the levels required to meet water quality standards (SJBEP, 2001), and as a result, the SJBEP sponsored a study to determine the public health risks from direct and indirect contact activities (e.g., bathing, fishing) in areas where fecal coliform concentrations were measured. These concentrations were measured in single samples collected at 16 sites in the Estuary. Although the fecal coliform concentrations measured in samples from six of the sites exceeded water quality standards, the study concluded that risk levels associated with water contact activities were within acceptable levels. The study also interviewed area residents about their fish-consumption habits and found that, although more than 40% of the people interviewed consumed food from Estuary waters, none reported any illnesses as a result of this consumption (Seguinot-Barbosa & Vázquez, 1999).

The San Juan Bay Estuary is also affected by other types of pollutants (e.g., metals, oils, and other substances) that gain access to the Estuary through storm sewers or runoff. The total volume of runoff can be much greater than the volume from other sources, causing significant contribution of contaminants (Horsley & Witten, Inc., 1995). Furthermore, the urbanization of drainage basins, removal of in-stream and bank vegetation, and alteration of streams and rivers due to channelization contribute to erosion and sedimentation rates in the area, as well as to the degradation of water quality in the Estuary and its tributaries. In the upper part of the watershed, erosion

accounts for an average loss of 4 inches of soil per year, much of which enters the Estuary (Webb and Gómez-Gómez, 1998).

PCBs, the pesticide DDT (and its metabolites DDD and DDE), the common elasticizing agent bis(2-ethylhexyl)phthalate, lead, and mercury are the most abundant contaminants in the sediments of the SJBEP system. Figures 7-8 and 7-9 show the trends in the sedi-

ment contaminant concentrations from 1925 through 1995 (SJBEP, 2001). Although the occurrence of these contaminants in San Juan Bay Estuary sediments is expected to decrease with time, toxic pollutants in the surface bottom sediments of some areas may persist at relatively high concentrations for some time. The average sediment deposition rate for the San Juan Bay Estuary (excluding Martín Peña Channel) is about two

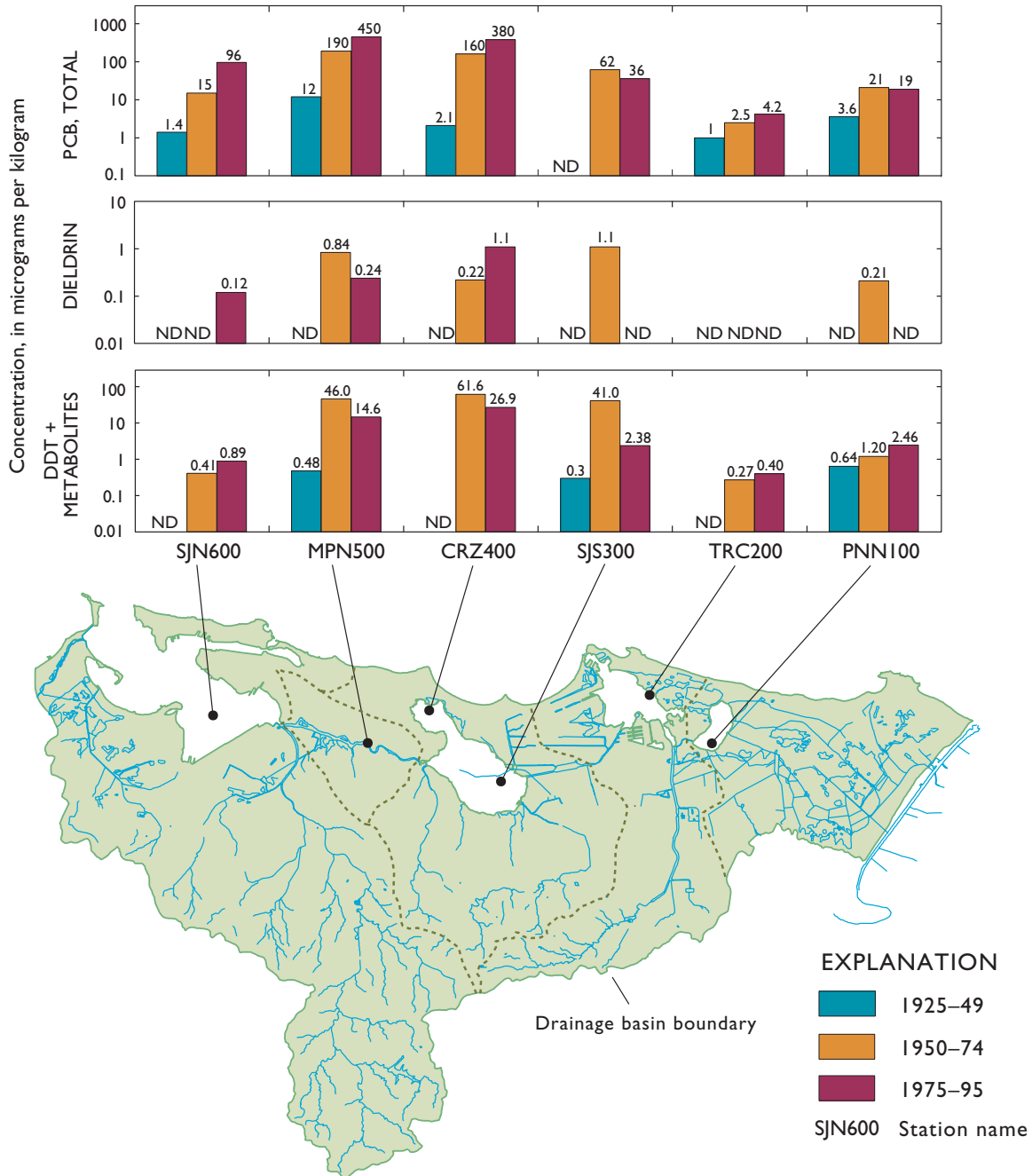


Figure 7-8. Sediment concentrations (µg/kg) of PCB, dieldrin, and DDT and its metabolites at different locations in the San Juan Bay Estuary and during different time periods (SJBEP, 2001).

San Juan Bay Estuary Partnership

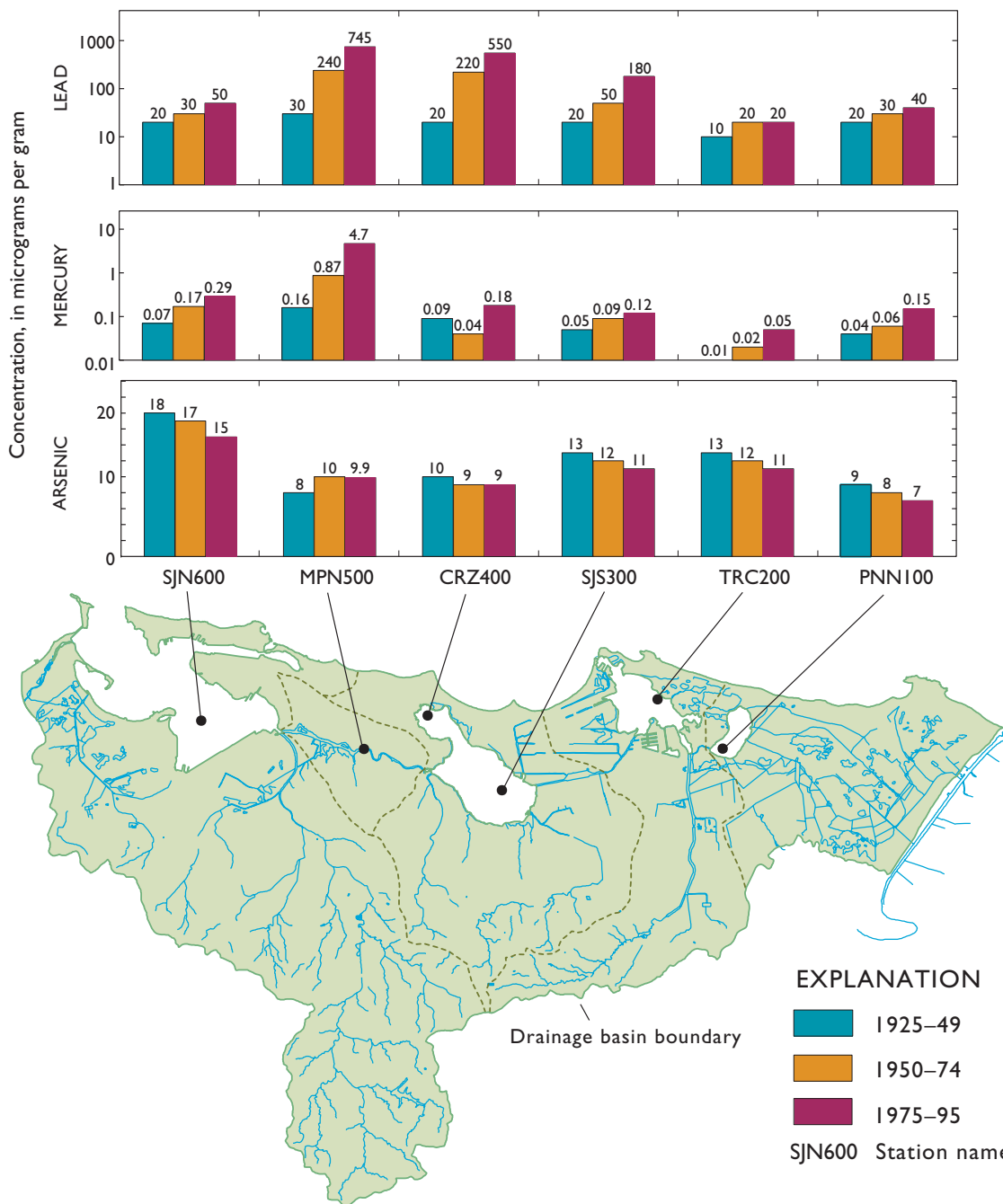


Figure 7-9. Sediment concentrations ($\mu\text{g}/\text{kg}$) of mercury, lead, and arsenic at different locations in the San Juan Bay Estuary and during different time periods (SJBEP, 2001).

inches per decade; therefore, contaminated sediments will need significant time to be buried by incoming, less-contaminated sediments (Webb & Gómez-Gómez, 1998). For these reasons, Webb & Gómez-Gómez (1998) concluded that contaminated sediments in such areas of the estuary as the Martín Peña Channel and the San José and Los Corozos lagoons present a potential

threat to human health; however, EPA reviewed this assessment and concluded that, based on the confined nature of the contaminated sediments, there was no threat to human health by direct contact (U.S. EPA, 1996). This determination certified that a CERCLA removal action, consisting of identifying and remediating hazardous waste sites, was not warranted.

Habitat Quality

Swamps, marshes, mangroves, aquatic vegetation, coral reefs, and sandy beaches are some of the habitats that are found in the San Juan Bay Estuary, which harbors very rich and diverse aquatic communities. Marshes and mangroves support a great variety of juvenile fish and invertebrates and provide food and nesting habitat for many different bird species. Marshes also play an important role in the cycle of nutrients and filter contaminants that have been washed into the Estuary from the upper parts of the basin by runoff. The preservation of marsh and mangrove habitats is clearly included as an objective in the SJBEP CCMP (SJBEP, 2001).

Table 7-1 shows the area of marsh and mangrove habitats, as well as the change in area between 1936 and 1995, in different locations within the Estuary. The area between the Torrecilla and Piñones lagoons showed a

significant net increase based on an increase in the mangrove area; however, this increase could be due to the succession of one kind of mangrove habitat by another, and not necessarily due to an improvement in the original habitat. This was the only area around San Juan Bay Estuary that exhibited a positive gain in total marsh and mangrove acreage between 1936 and 1995 (SJBEP, 2001).

Puerto Rico has one of the most diverse ecosystems of seagrass and SAV in the North Atlantic Ocean. Table 7-2 shows the areal coverage of these habitats, which are very important in supporting biodiversity and a variety of other ecological resources. For example, these habitats provide nutrients and primary energy for different fish species. The SJBEP places high emphasis on improving the overall condition of these habitats by improving the San Juan Bay Estuary’s water quality (SJBEP, 2001).

Table 7-1. Trends in the Acreage of San Juan Bay Estuary Marsh and Mangrove Habitats Over Time (SJBEP, 2001)

Location	Time Period	Mangrove Area (Acres)	Marsh Area (Acres)	Total Change (Acres)
San Juan Bay and Condado Lagoon	1936	458	1,327	1,785
	1995	329	566	895
	% change	-28%	-57%	-50%
Martín Peña Channel	1936	1,029	578	1,607
	1995	327	197	524
	% change	-67%	-84%	-73%
San José Lagoon to Suárez Channel	1936	704	68	772
	1995	327	197	524
	% change	-54%	+190%	-32%
Torrecilla and Piñones areas	1936	2,790	1,904	4,694
	1995	4,561	1,101	5,662
	% change	+63%	-42%	+21%

Table 7-2. Areal Extent of Seagrass (acres) and Surface Water (mi²) in the San Juan Bay Estuary (SJBEP, 2001)

Habitat	San Juan Bay	Condado Lagoon	San José Lagoon	Torrecilla Lagoon
Surface water area (mi ²)	4.56	0.15	2.11	0.95
Seagrass area (acres)	31	35	0	0.1

Living Resources

In 1998, the SJBEP supported a study to investigate the levels of seven heavy metals in the tissue of mojarra, blue crabs, and false mussels taken from the San José and Corozos lagoons. This study found that the concentrations of mercury and lead in some samples were above the standards recommended by the FDA. Although the average mercury concentration in mojarra was below the FDA standard, two samples had concentrations that exceeded the FDA standard. In addition, the average lead concentration in mojarra exceeded the lead standard. None of the blue crab samples exceeded the standard for mercury or lead; nevertheless, the regular consumption of blue crabs, particularly the hepatopancreas tissue, from these lagoons poses a potential public health problem resulting from elevated PCB levels in the tissue. Concentrations in some samples of false mussels exceeded the standard for lead, but not the standard for mercury; however, false mussels are typically not consumed by humans (Delgado-Morales et al., 1999).

Environmental Stressors

The discharge of nutrients and bacteria from septic systems and illegal sewer connections impacts water quality in the San Juan Bay Estuary; therefore, monitoring septic system performance and/or the number of illegal sewer connections may provide insight into ways of resolving the problem. At the present time, information about the number of septic systems functioning properly or malfunctioning, as well as how frequently these on-site systems are maintained, is not available. Illegal connections of sanitary sewers to storm sewers, as well as direct discharges of sewage, have been reported throughout the Estuary and its watershed; however, this condition is most common in the communities closest to the Estuary (Puerto Rico EQB, 1989; 1994; 1996). In a study performed by the Puerto Rico EQB from 1986 to 1989, almost 40% of the structures surveyed in the communities adjacent to the Martín Peña Channel were found to discharge raw sewage into storm sewers or directly into the Estuary or its tributaries (Puerto Rico EQB, 1989). The SJBEP CCMP recommends the construction of a sanitary sewer system that would connect to the existing regional STPs for those communities bordering the Estuary (SJBEP, 2001). As shown



The green heron (*Butorides virescens*) is a common resident of the San Juan Bay Estuary. This small, gray-green waterbird forages mostly in shallow waters, such as mangrove swamps, searching for small fish and invertebrates (SJBEP).

by a similar effort undertaken in the Condado Lagoon during the 1960s and 1970s (Rivera-Cabrera, 1990), a sanitary sewer system is expected to be the most effective and efficient way of eliminating illegal storm sewer connections and direct sewage discharges to the Estuary.

Current Projects, Accomplishments, and Future Goals

The SJBEP has implemented 41 projects—10 new projects financed by grants from past years, 14 new projects financed in this fiscal year, and 17 projects that were in progress and scheduled to be completed during the 2004–2005 fiscal year. Simultaneously, the SJBEP has been able to finalize 15 projects from past years, complying with 11 actions proposed in the Partnership's CCMP (SJBEP, 2005). The SJBEP will base its future goals on goals already established in the CCMP, which are divided into three areas of concern:

- **Improve the water and sediment quality of San Juan Bay Estuary to ensure suitability for fishing and swimming and to promote other compatible recreational and commercial activities** – The SJBEP will accomplish part of this goal through the LTEIP, which will provide the NEP with data to inform the public about the health of the Estuary and to take corresponding actions. The SJBEP is also actively working as a new member of the Ecological Corridor Commission of San Juan, which was created as part of the Law of the San Juan Ecological Corridor in 2003 (Law 206) to oversee the acquisition of parcels of land and transform them into an ecological corridor of approximately 1,000 acres.
 - **Enhance and maintain an ecosystem that supports an optimum diversity of living resources on a sustained basis** – The SJBEP will continue to implement 18 actions conceptualized to fulfill this important goal through its Volunteer Program. In 2006, the SJBEP will implement 6 of the 18 actions and will build partnerships to reinforce future conservation projects.
 - **Maximize public involvement in the implementation of the CCMP** – Nine projects have been approved by the SJBEP Board of Directors to support 100% of the actions under this area of concern, and the SJBEP Volunteer Program will help to achieve this goal.
- The following new activities were implemented during 2005 to enrich the SJBEP and its CCMP:
- **Integrated Media and Communications Program** – In 2002, 84% of the Estuary's local residents interviewed did not recognize the word or concept of an “estuary” (Personal communication, Bauza-Ortega, 2006). In order to resolve this challenge, the Partnership conducted a focus group study in which a comprehensive media plan was developed. The integrated media approach outlined in the plan conveyed a message of restoration and conservation for the Estuary using multiple resources, including electronic media (e.g., interactive Web page), traditional media (e.g., newsletter, radio programs), and monthly seminars.
 - **Christmas Card Competition** – During this project, Puerto Rico elementary school students learned about San Juan Bay Estuary and helped promote the SJBEP's mission through the development of a Christmas card exhibit. One card design, selected by a jury, was printed and delivered to all members of the SJBEP mailing list and contacts.
 - **Collaboration with the Enlace del Caño Martín Peña Project** – This project is responsible for dredging the Martín Peña Channel, relocating people affected by dredging activities, constructing new homes, and developing and implementing the complex educational strategy that requires relocating people who have lived in a particular community for decades. The SJBEP collaborates with the Enlace Project in the educational phase and has completed several important activities through the years, such as theater workshops, community concerts, contests, publications, and technical support and environmental consulting through the staff scientist.
 - **Annual Audubon Society Bird Census** – For the past nine years, the annual Audubon Society Bird Census has helped identify bird species density in the SJBEP study area. Local species data are updated through this annual census.

Conclusion

Based on data from the NCA estuarine survey, the overall condition of the San Juan Bay Estuary is rated poor. Although the Estuary's water quality index is rated fair, the sediment quality, benthic, and fish tissue contaminant indices are rated poor. The data used by the SJBEP to assess water quality in the Estuary indicate that bacterial contamination caused by the discharge of sewage from non-point sources is a concern in the area and has negatively affected water quality. A variety of toxic chemicals have been detected in Estuary sediments

and may persist at relatively high concentrations for some time. The development of a maritime and air transportation infrastructure, as well as of residential and industrial areas, have caused significant modification and loss of important habitats in the Estuary. Most of these modifications have occurred in the western half of the Estuary basin, where the pressures of urban growth and development on the San Juan Bay Estuary are greatest. The SJBEP is focusing its attention on developing a strong outreach program to inform the local population about conditions in the Estuary.



The green iguana (*Iguana iguana*), locally known as "gallina de palo", is an invasive species that was introduced into Puerto Rico from Central and South America by the pet trade in the 1970s. The SJBEP plans to study the ecology of the green iguana and evaluate its potential for negative impact to the local biodiversity (SJBEP).