

CHAPTER SIX: RESEARCH AND MONITORING PROGRAM

INTRODUCTION

The international scope of the Tijuana River watershed, the diversity of habitats, and the range of human and physical problems facing the Reserve make it an area rich for study in both the life and social sciences. Tijuana River NERR (National Estuarine Research Reserve) is situated in close proximity to several biological research institutions. Most significant among them is the Pacific Estuarine Research Laboratory (PERL) at San Diego State University (SDSU). The long-standing, mutually beneficial relationship between PERL and the Reserve has contributed greatly to the scientific understanding of the region's estuarine ecosystems and to the science of wetland restoration. To further this relationship, two noteworthy changes reflected in this plan are the inclusion of PERL on the Management Authority and the identified need for the addition of a research coordinator to improve the research and monitoring program.

The Reserve's research and monitoring programs are guided by national plans that identify goals, priorities, and implementation strategies for these programs, as well as research needs specific to the Tijuana River NERR. This approach, when used in combination with the education and outreach programs, helps ensure the availability of scientific information that has long-term, system-wide consistency and utility for managers and members of the public to use in protecting or improving natural processes in their estuaries. This chapter describes the mission and goals of the research and monitoring programs of the Tijuana River NERR and concludes with a plan of action to promote and encourage research to the extent possible without compromising resource protection.

I. MISSION

The research and monitoring mission at Tijuana River NERR is to:

Contribute to an improved understanding of estuarine processes and dynamics that will benefit the management of the Reserve, Tijuana Slough NWR and regional coastal ecosystems and (through monitoring) to improve the ability of resource managers to detect, quantify, and predict both short and long-term changes in the health and viability of estuarine ecosystems through monitoring.

II. GOALS

- Goal 1: Improve the availability of research findings as a basis for more informed coastal ecosystem management decisions.
- Goal 2: Provide opportunity for research that improves the available scientific information for use in the protection of coastal ecosystem integrity, biodiversity, and endangered species habitat.
- Goal 3: Foster understanding of impacts from activities occurring within and outside Reserve boundaries and study options to mitigate damages from those activities, with a particular emphasis on the restoration of ecological habitats.
- Goal 4: Fund and staff a research program at the Reserve that encourages broad-view (watershed and regional scope) and interdisciplinary research of estuarine ecosystems.
- Goal 5: Enhance involvement of research institutions in the region to promote research within the Reserve and its watershed and to further coordinate their research agendas.
- Goal 6: Characterize and monitor the environment of estuarine habitats of the Tijuana River NERR.
- Goal 7: Expand the existing monitoring plan that records physical and biological parameters relevant on national, regional, and local scales and can be used to influence decision making related to estuarine resources.
- Goal 8: Involve the public in monitoring as a means to augment the amount of data collected and promote citizen involvement in stewardship.

III. POLICIES

A. INTEGRATING NERR SYSTEM GOALS AND REFUGE SYSTEM GOALS INTO TIJUANA RIVER NERR'S RESEARCH PROGRAM

The research program at Tijuana River NERR is designed to fulfill the NERR System goals as defined in the Code of Federal Regulations. The NERR System goals are to:

- Address coastal management issues identified as significant through coordinated estuarine research within the NERR System;
- Promote federal, state, public, and private use of one or more reserves within the NERR System when such entities conduct estuary research; and
- Conduct and coordinate estuarine research within the NERR System, gathering and making available information necessary for improved understanding and management of estuarine areas. “Conservation of the Nation’s Coasts and Estuaries: A Strategic Plan for the National Estuarine Research Reserve System,” [NOAA, 1995])

The research program at Tijuana River NERR also incorporates FWS’s research mission: to understand endangered species and their habitats, without harm to the species or its habitat. Research results are the foundation upon which habitat or species recovery plans are developed.

B. SETTING PRIORITIES FOR RESEARCH AT TRNERR

Research by independent or Reserve staff scientists may be conducted in the Reserve on any topic consistent with the NERR goals and NWR, and may be funded from any source. In practice, the topics investigated at the Reserve are typically those that have been prioritized and funded by NOAA or FWS, or those selected for study by PERL.

NOAA is a significant source of research funding for both independent and NERR staff researchers. NOAA encourages coordinated research among reserves and other scientists by preferentially funding research proposals on specific estuarine topics that it has identified as national priorities. This unified approach promotes the exchange of research findings among reserves, state and federal agencies, and members of the academic research community.

1. NERR System Research Priorities

The NERR System currently funds a total of 42 research fellowships focused on improving coastal zone management while providing students with hands-on training in ecological monitoring. Areas of scientific study supported by these fellowships are:

- non-point source pollution
- biodiversity and effects on invasive species
- estuarine ecosystem restoration
- sustaining estuarine ecosystems

2. NWR System Research Priorities

FWS funding for research at the Tijuana River NERR is limited. Small investigation can be funded by Refuge at the discretion of the Refuge manager. Highest priority is given to projects that:

- Have direct implications for management of Refuge resources;
- Have management implications for federal trust resources (migratory birds, endangered species, marine mammals, and inter-jurisdictional fisheries, and wetlands); and
- Are part of long-term programs that have high probability of significantly increasing the body of scientific knowledge and understanding of relationships with regional management implications.

C. CRITERIA FOR EVALUATING RESEARCH PROPOSALS

Should funding be made available to the Reserve for research, the most important criterion for evaluating research proposals will be confirmation that the research topic addresses one or several stated research goals of the Reserve as identified in this management plan.

D. ACCESS FOR RESEARCHERS AND RESEARCHER RESPONSIBILITIES

Qualified scientists, students, non-profit research organizations, and local, state, or federal agencies are among the entities that have conducted research at Tijuana River NERR. Any researcher with adequate scientific qualifications and financial support may request permission to conduct research within Tijuana River NERR, and such requests are typically granted, if they meet the compatibility.

Projects that involve manipulation of habitat require advance approval by the research committee of the Management Authority. By federal regulation, projects known to be destructive to habitat or otherwise counter to Tijuana River NERR goals are not permitted. Projects that have been approved must be discontinued if they are determined by the research committee to be destructive.

All visiting researchers are asked to complete a form briefly summarizing their work and research site(s) within the Reserve to avoid duplicative projects, or incompatible projects at the same site. To ensure access, researchers are requested to contact the appropriate operating agency whenever they intend to visit the Reserve.

All researchers are responsible for complying with the terms of their special use permits to utilize Reserve study areas, including removal of all sampling devices and property from the Reserve upon the completion of their study. Researchers must submit an annual progress report to the Reserve manager by January 15 of each year covering activities of the preceding calendar year. A final report must also be submitted.

All publications that result from work conducted at Tijuana River NERR must acknowledge the assistance of the Reserve, and the land-owning agency and any funding provided by the Reserve or its member agencies. For graduate programs where the Reserve is a primary study area, candidates will provide one copy of the thesis/dissertation to the Reserve library. Five reprints of the each journal article resulting from work at the Reserve will be provided to the Reserve manager.

IV. EXISTING CONDITIONS AND PERCEIVED NEEDS

A. RESEARCH PROGRAM

1. Introduction

Research at Tijuana River NERR has addressed critical management issues such as the impacts of sewage on fish and plant communities, effects of sedimentation on habitats, and wetlands dynamics to improve the planning for restoration projects. Research is conducted by non-staff investigators and is coordinated by the Reserve and Refuge managers. Tijuana River NERR provides administrative, physical, and informational support for estuarine research by scientists and students from universities, research institutions, and other organizations. The Reserve also offers access to long term estuarine monitoring results from Tijuana River NERR and other estuaries in the NERR System.

The following are summaries of research and monitoring activities conducted at the Tijuana River NERR since 1986:

TABLE 7: Publications Based on Research Conducted at TRNERR

| <u>YEAR</u> | <u>SUBJECT</u> | <u>INSTITUTION</u> | <u>RESEARCHER</u> |
|-------------|---------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------|
| 1986 | Influence of mima mounds on vegetation patterns | SDSU | Cox, Zedler |
| 1986 | Wetland habitat use by the endangered Belding's Savannah sparrow | SDSU | White |
| 1986 | Catastrophic flooding and distributional patterns of Pacific cordgrass | SDSU | Zedler |
| 1986 | Temporal variability of salt marsh vegetation: the role of low-salinity gaps and environmental stress | SDSU | Zedler, Beare |
| 1986 | Catastrophic events reveal the dynamic nature of salt marsh vegetation | SDSU | Zedler, Covin, Nordby, Williams, Boland |
| 1986 | The ecology of Tijuana Estuary: an estuarine profile | SDSU | Zedler, Nordby |
| 1987 | Stress tolerance of three coastal dune perennials | SDSU | Fink |
| 1987 | Soil morphology of the Tijuana River National Estuarine River Reserve | SDSU | Mayer, Greenwood |
| 1988 | Salt marsh restoration: Lessons from California | SDSU | Zedler |
| 1989 | Bird use of the Tijuana River Estuary (Unpublished) | SDSU | Kus, Ashfield |
| 1989 | Endangered plant recovery: Experimental approaches with <i>Cordylanthus maritimus</i> ssp. <i>maritimus</i> . | SDSU | Fink, Zedler |
| 1989 | Effects of dune over-wash during the January 18, 1988 storm at the Tijuana Estuary | SDSU | Fink |
| 1989 | Ecology and conservation of the endangered least Bell's vireo | FWS | Franzreb |
| 1989 | Marsh Restoration Plan | SDSU* | Zedler |
| 1990 | Status of the Belding's Savannah sparrow at the Tijuana Estuary | Army Corps of Engineers | Kus |
| 1990 | Status of the least Bell's vireo at the Tijuana River | Army Corps of Engineers | Kus |
| 1990 | Light-footed clapper rail census and study, 1990 | SDSU | Zembal |
| 1991 | Site Profile for Tijuana Estuary | SDSU* | Zedler |
| 1991 | The importance of nitrogen in a southern California coastal dune slack community | SDSU | Vourlitis, Zedler |
| 1991 | Responses of fishes and benthos to hydrologic disturbances in Tijuana Estuary and Los Penasquitos Lagoon | SDSU | Nordby, Zedler |
| 1991 | Habitat use and breeding status of the least Bell's vireo at the Tijuana River | IBWC | Kus |
| 1991 | The effects of host quality on a phytophagous insect and its predators | SDSU | Johnson |

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|------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------------------------------------------|
| 1991 | Tijuana Estuary Tidal Restoration Program: Draft Environmental Impact Report/Environmental Impact Statement. | California Coastal Conservancy, FWS | Entrix, Inc., PERL, and PWA, Ltd. |
| 1991 | Factors controlling algal abundance in shallow coastal lagoons | | Fong |
| 1991 | Catastrophic events and interannual variability at Tijuana Estuary | SDSU | Zedler |
| 1991 | The challenge of protecting endangered species habitat along the southern California coast | SDSU | Zedler |
| 1992 | Removal of metals by wetland Mesocosms subjected to different hydroperiods | SDSU | Sinicrope, Busnardo, et al |
| 1993 | Canopy architecture of natural and planted cordgrass marshes: Selecting habitat evaluation criteria | SDSU | Zedler |
| 1994 | Limited response of cordgrass (<i>Spartina foliosa</i>) to soil amendments in constructed salt marshes | SDSU | Gibson, Zedler and Langis |
| 1994 | Pulsed-discharge wastewater wetlands: the potential for solving multiple problems by varying hydroperiod | SDSU | Zedler, Busnardo, Sinicrope, Langis, Gersberg and Baczkowski |
| 1994 | Salt marsh restoration: lessons from California | SDSU | Zedler |
| 1994 | Microbial water quality of the Tijuana Estuary | SDSU | Gersberg, Dodge, Parsons and Zedler |
| 1995 | Innovative management of California wetlands | SDSU | Zedler and Nyden |
| 1996 | Coastal mitigation in southern California: The need for a regional restoration strategy | SDSU | Zedler |
| 1996 | Damage to cordgrass by scale insects in a constructed salt marsh: effects of nitrogen additions | SDSU | Boyer and Zedler |
| 1997 | Factors affecting re-establishment of an endangered annual plant at a California salt marsh | SDSU | Parsons and Zedler |
| 1997 | Influence of physical processes on the design, functioning and evolution of restored tidal wetlands in California | SDSU | Haltiner, Zedler, Boyer, Williams and Callaway |
| 1997 | Food web analysis of southern California coastal wetlands using multiple stable isotopes | SDSU | Kwak and Zedler |
| 1997 | Differential effects of salinity and soil saturation on native and exotic plants of a coastal salt marsh | SDSU | Kuhn and Zedler |
| 1997 | Using tidal salt marsh mesocosms to aid wetland restoration | SDSU | Callaway, Zedler and Ross |

* Funding Received From NOAA

TABLE 8: Research Projects Conducted at TRNERR

| YEAR | SUBJECT | INSTITUTION | RESEARCHER |
|-------------|----------------------------------------------------------------------------------------------------|-----------------------------|-------------------|
| 1986 | The ecology of Tijuana Estuary: an estuarine profile | SDSU | Zedler, Nordby |
| 1987 | Tijuana Estuary enhancement hydrologic analysis | Coastal Conservancy | Williams, Swanson |
| 1987 | Soil morphology of the Tijuana River National Estuarine River Reserve | SDSU | Mayer, Greenwood |
| 1987 | Artificial Coastal Wetlands: Can They Duplicate Natural Ecosystem Functions? | SDSU* | |
| 1987 | Stress Tolerance of Three Coastal Dune Perennials | SDSU | Fink |
| 1988 | The Integration of Simulation and Salt Marsh Monitoring for Improved Management at Tijuana Estuary | SDSU* | |
| 1988 | Physical factors and competitive interactions affecting salt marsh vegetation | SDSU | Griswold |
| 1989 | Border Field State Park Coastal Dune Ecosystem Assessment and Research | SDSU | Fink, Zelder |
| 1989 | Wastewater Wetlands: Pulsed Discharges to Protect Coastal Water Bodies | SDSU*, California Sea Grant | |
| 1989 | Linkages: Among Estuarine Habitats and with the Watershed | SDSU* | Zedler, et al |
| 1989 | Effects of dune over-wash during the January 18, 1988 storm at the Tijuana Estuary | SDSU | Fink |
| 1989 | Ecology and conservation of the endangered least Bell's vireo | FWS | Franzreb |
| 1989 | Marsh Restoration Plan | SDSU* | PERL |
| 1990 | Assessing the Sources and Loading of Pollutants Affecting Tijuana Estuary | SDSU* | Zedler |
| 1990 | Using Wastewater Wetlands to Protect Tijuana Estuary from Sewage Pollution | SDSU* | Zedler |
| 1990 | Status of the Belding's Savannah sparrow at the Tijuana Estuary | Army Corps of Engineers | Kus |
| 1990 | Status of the least Bell's vireo at the Tijuana River | Army Corps of Engineers | Kus |
| 1990 | Light-footed clapper rail census and study, 1990 | SDSU | Zembal |
| 1990 | Wetland Boundary Determination for the Naval Outlying Landing Field, Imperial Beach | SDSU | Winfield |
| 1990 | Accelerating the Development of Restored and Natural Wetlands | SDSU* | Zedler |
| 1991 | Accelerating the Development of Ecosystem Functions in Restored and Natural Wetlands | SDSU* | Zedler |
| 1991 | Ecosystem Responses to Changes in Tidal and Sewage Inflows to Tijuana Estuary | SDSU* | Zedler |
| 1991 | Methods to Improve Restoration of Pacific Estuarine Ecosystems | SDSU* | Zedler |

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|------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------|
| 1991 | Habitat use and breeding status of the least Bell's vireo at the Tijuana River | IBWC | Kus |
| 1991 | Comparisons of constructed and natural salt marshes of San Diego Bay | SDSU | Zedler, Langis |
| 1991 | Assessing the effects of sewage inflows on Tijuana Estuary | SDSU | Zedler, Langis, Nyden, Busnardo |
| 1991 | Factors Controlling Alga Abundance in Shallow Coastal Lagoons: A Combined Modeling and Experimental Approach | SDSU | Fong |
| 1991 | The Importance of Nitrogen in a Southern California Coastal Dune Slack Community | SDSU | Vourlitis |
| 1992 | Improved Restoration of Southern California Coastal Wetland Habitats | SDSU | |
| 1992 | Ecosystem Response to Changes in Tidal and Sewage Flows to Tijuana Estuary | SDSU* | |
| 1992 | Restoring Tijuana Estuary: Salt Marsh Mesocosms with Tidal Flow and Freshwater Treat | SDSU* | PERL |
| 1992 | Methods to Improve Restoration of Pacific Estuarine Ecosystems | SDSU* | |
| 1992 | The Effects of Decreased Salinity on Juvenile California Halibut | SDSU | Baczkowski |
| 1992 | Removal of Nitrogen and Phosphorus by Wetland Mesocosms Subject to Different Hydroperiods | SDSU | Busnardo |
| 1992 | Removal of Metals by Wetland Mesocosms Subject to Different Hydroperiods | SDSU | Sinicrope |
| 1993 | Tidal Restoration Research | SDSU | |
| 1993 | Restoring Tijuana Estuary: Salt Marsh Mesocosms with Tidal Flow and freshwater Treatments | SDSU* | Zedler |
| 1993 | Improved Restoration of Southern California coastal Wetland Habitats | SDSU | Zedler, Williams |
| 1993 | Effect of Sea Level Rise on Southern California Wetlands and Wetland-Dependent Species | National Biological Survey | Powell, Zedler |
| 1994 | Impacts of Non-Point Source Pollution on the Salt Marsh at Tijuana Estuary | SDSU | |
| 1994 | Patterns of Epibenthic Algal Mats Under Different Hydrologic Conditions in Southern California Salt Marshes | SDSU | Ross |
| 1995 | The effects of salinity and soil saturation on plants in the high intertidal marsh | SDSU | Kuhn |
| 1996 | Species composition and size structure of fish assemblages in southern California coastal wetlands: the role of stream size | SDSU | Desmond |

* Funding Received From NOAA

TABLE 9: Ecological Monitoring Conducted at TRNERR

| | | | |
|--------------|----------------------------------------------------------------|----------------|-------------------|
| Annually | California Least Tern Breeding Colony Monitoring | FWS | |
| Annually | Light Footed Clapper Rails | FWS (Carlsbad) | Zembal |
| Annually | Belding's Savanna Sparrow Populations | FWS | |
| Annually | Herpetofaunal Survey | FWS | UCSD personnel |
| Periodically | Small mammal trapping survey | FWS | Pavelka, Mitchell |
| Annually | Benthic Invertebrates | FWS | |
| Annually | Vegetation | FWS | |
| Annually | Hydrological monitoring/Nutrients/etc. | FWS | |
| 1986 | Monitoring and manipulation of phytoplankton dynamics | SDSU | Fong |
| 1990 | Long-term dynamics of salt marsh vegetation at Tijuana Estuary | SDSU | Griswold, Zedler |
| 1996 | Tijuana Estuary Monitoring Project | SDSU* | |

* Funding Received From NOAA

2. Administration of the Research Program

The research and monitoring committee of the Tijuana River NERR Management Authority prepares an annual research plan. This annual research plan ensures that research conducted on the Reserve is compatible with resource protection, is scientifically sound, is compatible with the education and interpretation programs, and whenever possible, is contributory to NERR's and FWS's goals. The Research and Monitoring Committee also makes recommendations for research to be funded by NOAA or the operating agencies. The research committee chair acts as a liaison with the director of PERL and other researchers to identify and encourage research areas wherein additional research would benefit the management of the Reserve.

The research committee of the Tijuana River NERR Management Authority periodically convenes special advisory groups of regional and national scientists on an ad hoc basis. These groups provide expert assistance in planning and implementation of Reserve projects. The research and monitoring committee reviews applications from researchers to use Reserve facilities and to assess the functioning and staffing needs of the research and monitoring programs.

At each meeting of the Management Authority, time is allocated for a presentation on the status and results of Tijuana Estuary research and monitoring. This enables the operating agencies to adjust their management practices based on relevant and current research.

Monitoring of wildlife within the Refuge and Reserve is performed by FWS staff, who divide their time between seven NWR in the San Diego NWR Complex. There is currently no staff position at the Reserve that specifically attends to the coordination and implementation of the research and monitoring program; a research coordinator has been identified as a program need.

3. Review and Approval of Projects and Research Permits

Research proposals that involve on-site activities at the Tijuana River NERR are sent to the Reserve manager who currently is responsible for coordinating the research committee review. This review permit applications on a case by case basis has become overly burdensome for both the Reserve and Refuge managers. A modified application process, with two month-long application periods per year, is under development.

4. Information, Facilities, and Equipment Support for All Researchers

Dissemination of information about ongoing and completed research is one the most important functions of any NERR. Tijuana River NERR actively shares technical information with specialized audiences through several means. The Reserve anticipates that this important function will be improved with the addition of the Research Coordinator.

Tijuana River NERR facilitates research by making information available about historic conditions in the ecosystem, and by maintaining visual and quantified records of selected aspects of the Reserve's natural system. Reserve background information includes aerial photographs, GIS maps, publications, and reprints. Data collected from on-site research, and parallel data from other Reserves, are available to visiting researchers.

5. Relationship with the Research Community

Tijuana River NERR is fortunate to be located near several universities and research institutions that conduct extensive research in fields relating to estuarine resources. Since the designation of Tijuana Estuary as a NERR, most research activities have been conducted and/or coordinated by PERL or other departments at SDSU. This on-going relationship between the Reserve and

SDSU has been mutually beneficial. Both parties agree that a Research Coordinator is needed to properly implement Reserve research and monitoring programs.

6. Role of Pacific Estuarine Research Laboratory (PERL)

The NERR has a long standing relationship with PERL, which was formed in 1984 when PERL began research projects along Monument Road. It has since become an internationally recognized research program. In 1997 SDSU designated the Tijuana River NERR as an auxiliary field station. (See Accomplishments Section) PERL has also gained recognition for translating research information to aid decisionmakers. The EPA and Environmental Law Institute recognized that role with a National Wetland Award for use of scientific knowledge in wetland conservation. PERL's director, Dr. Joy Zedler, was instrumental in the original designation of Tijuana Estuary for protection and has maintained a strong program researching the estuarine ecosystem. PERL has also had a long-term role in the monitoring of the estuary, through the NOAA-funded monitoring program, and unfunded work with water quality data loggers.

With the ratification of this plan, a two-year term seat will be added to the Management Authority for a research institution. PERL will be the first institution to fill this seat.

PERL has a staff of 14 researchers, 11 of whom conduct 50 per cent or more of their research at Tijuana River NERR. PERL has collaborated with Tijuana River NERR on a number of important management decisions, including co-authoring the EIR/EIS for the Tidal Restoration Plan, which is a significant, long term management tool used by the Management Authority and the operating agencies.

In early 1997, PERL received a large award to conduct restoration research at the Tijuana Estuary. Various aspects of the research are underway, and a portion of the award could best be spent at a large (20+ acre) excavated restoration site as called for in the Tijuana Estuary Tidal Restoration Plan.

7. The Tijuana River Watershed Management Project

The Tijuana River Watershed Management Project is a cooperative effort between San Diego State University (SDSU) and Colegio de la Frontera Norte (COLEF) that supports the development of a comprehensive GIS for the Tijuana River Watershed. Startup funding for the project was supplied by NOAA with assistance from other project partners.

The Watershed Management project consists of five components: GIS Database Development, Community Outreach, Education, Scientific Research, and Watershed Management. The GIS will be used to study a wide range of subjects such as environmental impacts of land use activities. Numerous research initiatives have been identified by SDSU and its partners to be coordinated with the Watershed Management Project. These include: environmental and toxics risk assessment, water and air pollution analysis, multiple species habitat modeling, evaluation of services and infrastructure needs, and land use analysis.

This project provides opportunities for the Tijuana River NERR to integrate its programs with others in the watershed. In supporting this project, the funding partners are promoting proactive protection of the Tijuana River NERR.

8. Application of Research Results for Resource Protection

Research results need to be applied to Reserve operations through review of environmental impact reports, attendance at hearings and council meetings, and writing of letters to inform decisionmakers of relevant information. This type of information transmission is currently done based on research results from the Reserve, but it is unorganized, and the NERR is not always credited with this activity. The translation of scientific findings into specific applications for management or public policy making is typically not required of researchers. It constitutes extra activity that may or may not carry some kind of recognition or compensation.

Thus, an important objective for the NERR is to facilitate development of an endowment that could fund some translation of research results. Findings of pure and applied research should be further extended to the policy-making arena. Position papers should be developed and distributed among local researchers at Tijuana River NERR and among other NERRs.

9. Research Program Needs

The Research Committee has identified that a research coordinator is essential for developing and implementing a research and monitoring programs. The primary function of this position would be providing support for estuarine research by scientists and students from universities, research institution, and other agencies. Visibility of the Reserve and credibility of the research program will be improved by the efforts of research coordinator networking with other scientists studying in the region and the state.

The research coordinator would:

- strengthen the relationship with SDSU and other institutions;
- serve as a point of contact for researchers using the Reserve;
- assist researchers in the development of research projects;
- maintain a Reserve research data base;
- aid in disseminating research results;
- identify funding opportunities for research at the Reserve;
- maintain GIS program of the Reserve for managers and researchers.

B. MONITORING PROGRAM

1. NERR Monitoring

The monitoring strategy at Tijuana River NERR is based on the understanding that physical, chemical, and biological aspects of habitats and communities of organisms are excellent indicators of a vast array of ecological factors. Chronic disturbance, predation, and competition are expressed through change in habitat quality, species composition, population abundance and distribution. Accordingly, Tijuana River NERR monitors critical habitat parameters and the dynamics of selected communities to gain insights into the ecosystem health.

The Reserve is also participating in the NERR national monitoring program by developing an inventory and continuing record of Reserve biotic and abiotic conditions, which can be used by researchers and by coastal ecosystem managers to track long-term trends. One function of the Tijuana River NERR monitoring program is to provide benchmark information to researchers, coastal communities, and ecosystem managers. Degrees of change in regional estuarine ecosystems can be measured by comparison to known, regularly monitored conditions in the Reserve. The Inventory and Monitoring Plan for Tijuana River NERR is modeled on the strategic plan developed for the NERR System.

The NERR System has recently developed a system-wide monitoring program that would simultaneously provide critically needed, standardized information on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional or local concern. This program is designed to enhance the value and vision of the NERR System as a network of national reference sites. The program has three components which will be implemented in phases, depending on funding:

- **Abiotic Parameters:** Each Reserve will monitor a uniform suite of physical and chemical processes that either impact or reflect the health of estuarine ecosystems. These will include basic water quality indicators, atmospheric conditions, and specific processes such as tidal and groundwater flow and

contaminants. Where possible, existing data collected by other agencies will be incorporated.

- **Biodiversity:** Across the NERR System, each site will monitor two fundamental features of its estuarine ecosystem: (i) basic community structure in major estuarine habitat types (e.g. uplands, emergent wetlands, benthos, etc.); and (ii) population trends of important "target species" including those of commercial, recreational, or conservation significance (e.g. SAV, marsh plants, wading birds, endangered species, etc.).
- **Land Use Patterns:** In recognition of the profound influence of land and water use on estuarine resources, the NERR System monitoring program will compile existing and new data on major patterns of habitat classification and use within NERR System watersheds. Data gathered from a variety of state and federal sources will be updated periodically and used to monitor significant changes in watershed uses and impacts on Reserve resources.

Information generated by the NERR System monitoring system will be compiled electronically at a central data management "hub," and will be disseminated to all Reserves, CZM programs, OCRM and other users. Each Reserve will have constant electronic access to all system-wide data and summary statistics on environmental trends at the national, regional, or site-specific levels.

The NERR System Monitoring Program is scheduled for implementation in three phases: 1) water quality and weather, 2) biological population and communities, and 3) coastal watershed land-use patterns. Presently water quality is being monitored in the 21 sites of the NERR System and a Centralized Data Management Office (CDMO) is being established at the North Inlet-Winyah Bay NERR. The CDMO will facilitate information exchange among the Reserves in the NERR System, state coastal zone management programs and OCRM. At this time, PERL maintains and monitors the water quality dataloggers at the Reserve.

2. Past Monitoring

Monitoring efforts completed at the Reserve include:

- Extensive sampling of surface and bottom water salinity. This included 12 stations throughout the estuary. Work ended when PERL's funding from the then National Biological Service (now Biological Resources Division of USGS) terminated.
- Intermittent sampling of fecal and total coliforms terminated at the same time as the above sampling and for the same reason.

- Extensive sampling of salt marsh plant species took place from 1979 through 1988. The monitoring program then shifted to a more intensive sampling of selected, low, mid and high marsh sites.
- During the biological surveys that were conducted for the EIR/EIS for the Tidal Restoration of Tijuana Estuary (ENTRIX, 1991), there were widespread sampling efforts for plants, insects, herpetofauna, mammals, and birds. These efforts ended when funding terminated.
- From time to time, graduate students have conducted systematic sampling of invertebrates, fish larvae, birds and other organisms during their thesis research. Of necessity, such efforts end when the thesis is complete.

3. Available Inventory Information

A comprehensive inventory of physical and biotic resources was completed in 1992 by Joy B. Zedler, Christopher S. Nordby, and Barbara E. Kus. The Ecology of Tijuana Estuary - A National Estuarine Research Reserve. This work synthesizes and interprets the growing data base of the estuary's diverse biota. Research at Tijuana River NERR is also described extensively in Tidal Wetland Restoration: A Scientific Perspective and Southern California Focus, also by Dr. Joy Zedler.

There is also a substantial body of work produced by scientists working individually over the years on a wide range of topics. Results from these research activities are maintained in the Reserve library.

4. Current Monitoring Activities

The systematic long-term monitoring at Tijuana River NERR currently consists of the following surveys:

- water quality
- salt marsh vegetation
- salt marsh soil salinity
- fish
- invertebrates
- birds

The surveys are performed by PERL researchers with substantial funding from NOAA.

5. Monitoring Activities Needs

The following needs have been identified for the monitoring program at Tijuana River NERR:

- Update data dictionary for Reserve GIS
- Modify GIS program to improve its utility to Reserve and Refuge managers
- Centralize and organize monitoring results

V. RESEARCH AND MONITORING PLAN OF ACTION

GOAL 1. Foster understanding of impacts from activities occurring within and outside the Reserve's boundaries and study options to mitigate damages from those activities, with a particular emphasis on the restoration of ecological habitats.

Objective 1a: Perform timely assessment of changes created by significant unforeseen natural events or human activity. Create a mechanism for responding to these changes.

Objective 1b: Encourage study of the effects of recreation on habitats.

Task

- Perform an assessment of user motivation for activities that cause damage to habitats.

Objective 1c: Utilize and improve upon existing Geographic Information System (GIS) in the Tijuana River watershed to develop a more advanced research and monitoring program.

Task

- Monitor habitat changes within the Reserve in order to plan for restoration of up to 500 acres of transitional and upland habitat.

GOAL 2. Provide opportunities for compatible research that improves the available scientific information for use in the protection of coastal ecosystem integrity, biodiversity, and endangered species habitat.

Objective 2a: Encourage and facilitate projects that focus on identified sets of national and site-specific priorities.

Tasks

- Prepare and distribute an annual description of NOAA and FWS-sponsored research within the Reserve.
- Maintain and distribute a list of state contributions available as matching funds for research opportunities.
- The NERR Management Authority shall institute a mechanism to write letters of support for projects that will facilitate research at the NERR.
- Implement protocols to establish the following: a) a policy for the management of research activities within the Reserve, including the Tijuana Slough Wildlife Refuge, b) guidance for researchers seeking to use the Reserve for their studies, and c) insurance that Reserve resources are not adversely impacted by research activities. (See attached Protocols)

Objective 2b: Make necessary innovations to encourage scientists to carry out management oriented research at the Reserve, including developing long term relationships with research institutions.

Tasks

- Coordinate and streamline procedures for the review and approval of research proposals and permits.
- Seek funding at the national level for research and monitoring proposals of national significance.
- Provide access to a national estuarine information exchange program.
- Encourage joint U.S.-Mexico estuarine research projects.
- Identify sources of funding for research at the Reserve.

GOAL 3. Improve the availability of research information as a basis for more informed coastal ecosystem management decisions.

Objective 3a: Provide resource managers and coastal ecosystem decisionmakers with access to Tijuana River NERR research and baseline information, including computerized and Geographic Information System.

Tasks

- Develop methods for standardizing data collection at the Reserve.
- Conduct polls of researchers to indicate how their work may be translate into improved management of resources.
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- Create an electronic database of the Reserve library to facilitate searches by researchers, managers, and the general public.

Objective 3b: Fund a series of research reports that provide results of research that bear on management issues. The papers will address all three major goals of the NERR System: to improve restoration, rehabilitation, protection and preservation of the coastal bio-region.

GOAL 4. Fund and staff a research program at the Reserve that encourages broad-view (watershed and regional scope) and interdisciplinary research of estuarine ecosystems.

Objective 4a: Develop a job description and obtain funding for a full-time Research Coordinator at the Reserve. The primary function of this position would be to facilitate graduate level research & proposals, assist and track technical aspects of research, and improve communication within the NERR System and with external partners so as to optimize NERRs efforts.

Objective 4b: Integrate interdisciplinary research, scientific information, education, and compatible uses, so that the NERR will have appropriate guidance for long-term operations and daily management.

GOAL 5: Enhance involvement with research institutions in the region to promote research with the Reserve and its watershed and to further coordinate their research agendas.

GOAL 6: Characterize and monitor the environment of estuarine habitats under the management of the Reserve using the Reserve's GIS system.

Objective 6a: Complete data collection, field inventory, and habitat assessment necessary to update the data dictionary for the GIS system .

Tasks

- Seek funding for the following surveys and research:
 1. Bird usage -- Annual survey focusing on trends
 2. Aerial imagery of habitat types
 3. Water quality -- Sampling and sustained monitoring of salinity, pathogens, contaminants, or nutrients.
 4. Groundwater and surface water hydrology
 5. Monitoring erosion (e.g. beach erosion) and sedimentation in the Reserve.

GOAL 7: Expand the existing monitoring plan such that it records physical and biological parameters relevant on national, regional, and local scales and can influence decision making relating to estuarine resources.

Tasks

- Map exotic species and delineate their boundaries.
- Implement contaminant monitoring with particular emphasis on heavy metals and organics.
- Evaluate contaminants in primary prey species of Clapper Rails and Least Terns.
- Monitor extent of user activity and its impact on Reserve resources.
- Install vehicle counting devices.

Goal 8: Involve the public in monitoring as a means to augment the amount of data collected and promote citizen involvement in stewardship.