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**Environmental Monitoring and Aquatic Ecological Risk
Assessment of Common Contaminants for Everglades
National Park, Biscayne National Park, and Big Cypress
National Preserve :**

Critical Information Need for the Comprehensive Everglades Restoration Plan

August 2004



United States Department of the Interior
NATIONAL PARK SERVICE

South Florida Ecosystem Office
950 N. Krome Avenue
Homestead, Florida 33030-4443



September 21, 2004

Mr. Todd Kellison
BNP
Biscayne National Park
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Homestead, FL 33033

Dear Todd:

Recently we invited you to participate in a Scientific Review Panel (SRP) for a project entitled "Environmental Monitoring and Aquatic Ecological Risk Assessment of Common Contaminants." On behalf of ENP, we thank you for your support and hope that you are willing to participate in this endeavor. In forming this advisory panel, ENP wants to create an independent forum consisting of experts, in which a free exchange of ideas, thoughtful and constructive criticism, and sound decision-making are encouraged in achieving successful completion of the project.

During the last decades, land management practices and flood control in South Florida may have exposed National Park Service (NPS) trust resources to contaminants of urban and agricultural origin. Although the Comprehensive Everglades Restoration Plan (CERP) includes several water-quality restoration features, the fate of contaminants, such as pesticides and trace metals, is uncertain and poor-quality water may be discharged into NPS lands. We wish to expand our knowledge base on which to evaluate the potential risk that contaminants may pose to restoration. This three-year project proposes to monitor and assess concentrations, temporal and spatial variations, and potential impacts of contaminants to aquatic and marine natural resources in areas where surface water is discharged into protected ecosystems. The project will provide a baseline from which to evaluate present and future conditions and provide data for developing a long-term monitoring program for contaminant exposure resulting from restoration projects that may affect natural resources in ENP, BNP, and BCNP.

Nick Aumen and Joffre Castro, ENP technical leads, are organizing the SRC and coordinating its efforts. In consideration of the diverse geographical location of the various SRC members and to minimize disruption of their daily activities, we are planning to conduct our business via email and, if necessary, by carefully scheduled teleconferences. Should there be enough support and interest from the SRP, we will be more than glad to consider scheduling a meeting at the ENP offices in Homestead, Florida, to visit the park and the project PIs' laboratories (FIU).

Presently, ENP has received a Statement of Work (SOW) from the Florida International University (FIU), which is being reviewed by ENP's technical leads. Equally important to ENP is your review and comment on the SOW, which has been included with this letter. Although all comments are greatly appreciated, the following questions have been formulated to guide you in the SOW evaluation process.

- Are the scope, objectives, and methods of the project clearly stated in the SOW?
- Is the technical information provided in the SOW sufficient to assess the adequacy of the proposed project to meet the goals and objectives?
- Are the methods proposed reasonable and justifiable?
- Are the schedule, tasks, and deliverables adequate for this type of project?
- Are the laboratory facilities adequate to meet the needs of the project?
- Will the project provide the necessary type, quality, and quantity of data to achieve its goals and objectives?
- Are there any critical issues which have not yet been considered in the SOW that may adversely impact the success of the project?
- What are the overall quality, feasibility, originality, and creativity of the proposed project?
- Is the professional experience of the PIs consistent with the requirements and needs of the project?
- Is the requested funding sufficient and justifiable, given the scope and objectives of the project?
- Does the SOW adequately address QA/QC issues to ensure that a threshold level of quality is achieved in the analytical work and in the analysis and interpretation of data?

Please return your review and comments to Joffre Castro by October 18, 2004. We will compile all the comments and address them as necessary. Once satisfactory responses have been prepared, we will schedule a phone conference to discuss the reviews. In the meantime, feel free to contact us at your convenience.

Thank you for your valuable contribution,

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Environmental Monitoring and Aquatic Ecological Risk Assessment of Common Contaminants for Everglades National Park, Biscayne National Park and Big Cypress National Preserve: *Critical Information Need for the Comprehensive Everglades Restoration Plan*

A proposal submitted to :

Department of Interior, National Park Service, Everglades National Park, South Florida Natural Resource Center.

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Total Proposed Project Period: 3 years,
Beginning Date: Sept 1, 2004
Ending Date: August 31, 2007

Requested Funding: \$2,112,970

Components	PHASE I	PHASE II	PHASE III
ENVIRONMENTAL MONITORING	\$454,996	\$469,998	\$478,171
ECOLOGICAL RISK ASSESSMENT	\$235,944	\$243,259	\$230,602

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PROJECT SUMMARY

The Comprehensive Everglades Restoration Plan (CERP) outlines a series of construction projects and water management changes to increase regional water supplies and restore the hydrological paths in the Everglades to pre-1900 conditions under the following overarching goal: **improving water, improving habitat, and making development compatible with the ecosystem**. Although the quantity of water has been thoroughly addressed in the restoration management plans, the *quality* of water is an issue that has generated disagreement among scientist and the agencies involved in the restoration processes. The most recent GAO report to Congress on South Florida Ecosystem Restoration (US GAO, 2003) clearly indicated that among the 200 restoration projects within CERP, the assessment of contaminants other than nutrients and mercury was not adequately addressed and constituted a significant gap with potential to hinder the availability of adaptive management tools required for the successful restoration of South Florida. In particular, the presence of contaminants, and the risk associated with their presence in waters that will be re-distributed and spread through the entire ecosystem was mentioned as one of the areas where information was not adequate or no plans were in place for future assessment.

The limited data generated in the last preliminary monitoring effort and screening level ecological risk assessment (SERA) in support of CERP (Rand and Carriger 2004; Fernandez, 2004) demonstrated several relevant findings and data gaps. Surface water concentrations for endosulfan (organochlorine insecticide) and chlorpyrifos (organophosphate (OP) insecticide) presents a potential acute risk to arthropods in C-111, Joe Bay, Highway Creek and Card Sound. The results also indicate that the pink shrimp may be one of the most sensitive species to endosulfan and that endosulfan sulfate (oxidation product), the major persistent residue of endosulfan, accumulates in native fish from the Southern Everglades where tissue residue concentrations reached up to 196 ng/g (dry weight). The SERA identified two data gaps needed to conduct a definitive ecological risk assessment (ERA) in ENP, BNP and BCNP- intensive analytical exposure monitoring for contaminants and toxicity (effects) studies with field samples.

To fill in these data gaps and to be able to provide much needed environmental assessment guidelines for scientists and managers involved in the restoration effort, this three year project will focus on achieving three major goals: a) Assessing the identity, occurrence, and spatial and temporal distributions of common organic and inorganic contaminants in sediment/soil, surface water and biota from ENP, BNP and Big Cypress National Preserve (BCNP); b) conducting a comprehensive suite of laboratory assays to determine the potential detrimental effects of field-collected sediment and waters to freshwater and estuarine fish and macroinvertebrates; and c) produce a definitive ecological risk assessment (ERA) for ENP, BNP and BCNP, under the current U.S.EPA framework (U.S.EPA, 1998, ECOFRAM, 1999), based on the collected exposure data from the contaminant monitoring, and the ecotoxicological assessment.

PROBLEM STATEMENT

After decades of continuous efforts to drain the Everglades and to convert the "river of grass" into agricultural land, the Federal Government in cooperation with the State of Florida enacted legislation, starting in the 1980s and throughout the 1990s, to protect this fragile environment for future generations. Noteworthy among them are the Settlement Agreement and Consent Decree (1991) and the Comprehensive Everglades Restoration Plan. The first established interim and long-term phosphorous concentration limits and the second created a framework that provides guidance for restoring, protecting, and preserving the Everglades ecosystem.

Prior to development, the Everglades were characterized as an oligotrophic, rainfall-driven ecosystem, where atmospheric inputs were the major external source of contaminants to the ecosystem. Construction and operation of the Central and Southern Florida Flood Control project (1963) has provided a network of canals and levees that has substantially altered water flows and water quality in the Greater Everglades. For example, since the mid-1960's structures on L-31W and C-111 canals have manipulated Taylor Slough water levels resulting in altered timing and distribution of flows into Taylor Slough. Taylor Slough waters flow into mangrove creeks within 4 km of Florida Bay. The wetland due south of C-111 in the "panhandle" area of Everglades National Park (ENP) is of particular concern because it constitutes a primary pathway for freshwater to reach near shore embayments (e.g., Long Sound, Highway Creek, Joe Bay) along Florida Bay that are nursery ground for juvenile fish and invertebrates that are commercially and recreationally important.

The consequence of all these changes is that the quality of surface waters in South Florida ecosystems has significantly declined over the last century (Science Subgroup, 1996). Changes of land usage to accommodate agricultural practices, water management practices to provide irrigation and flood control along with the accelerated urban development have introduced ecosystem scale problems potentially jeopardizing the sustainability of valuable resources in areas such as Everglades National Park, Biscayne National Park and the Big Cypress National Preserve. Excess phosphorus, mercury, and other contaminants contaminate the region's surface water and groundwater to the point that intervention was deemed necessary to restore these ecosystems at risk and to guarantee their preservation. The Comprehensive Everglades Restoration Plan (CERP), approved by Congress in 2000, takes into account that the Everglades, Florida Bay, Biscayne Bay and the Florida Keys are very complex ecosystems and the connections between them are not yet fully understood by scientists (US ACOE, 1999). The plan outlines a series of construction projects and water management changes to increase regional water supplies and restore the hydrological paths in the Everglades to pre-1900 conditions under the following overarching goal: ***improving water, improving habitat, and making development compatible with the ecosystem.***

To achieve this, approximately 1.7 billion gallons of water a day now sent to tide will be delivered to the Everglades first, followed by urban needs and agricultural use. This will result in considerably more fresh water making its way to Florida Bay thorough Taylor Slough and South Biscayne Bay through the C-111 basin and the coastal wetlands and

tidal creeks east of the L-31E canal. Successful sheet flow restoration also depends on the "decompartmentalization" of the conservation areas to the north of Everglades National Park and Florida Bay and the implementation of the Modified Waters and the Biscayne Bay Wetland Projects affecting the C-111 draining basin. Although the quantity of water has been thoroughly addressed in the restoration management plans, the *quality* of water is an issue that has generated controversy among scientist and the agencies involved in the restoration processes.

The most recent GAO report to Congress on South Florida Ecosystem Restoration (US GAO, 2003) clearly indicated that among the 200 restoration projects within CERP, the assessment of contaminants other than nutrients and mercury was not adequately addressed and constituted a significant gap with potential to hinder the availability of adaptive management tools required for the successful restoration of South Florida. In particular, the presence of contaminants, and the risk associated with their presence in waters that will be re-distributed and spread through the entire ecosystem was mentioned as one of the areas where information was not adequate or no plans were in place for future assessment. Two additional areas of information were also specifically addressed in the report. First, modifications of the C-111 drainage system will introduce impacted waters to the southern Everglades and Florida Bay. Much of the effort in contaminant work has in these areas have been devoted to inorganic nutrients and mercury and only a small portion of funding has been dedicated to the assessment of organic contaminants, mainly pesticides or trace metals.

Numerous studies and reports have documented the increasing trends in anthropogenic impact along South Florida environments where, in general, higher-than-expected concentrations of contaminants have been inevitably attributed to agricultural or urban runoff transported by the large network of canals. Thus far there have been a limited number of contaminant monitoring studies in South Florida including BCNP, the southern Everglades, south Biscayne Bay and northeast Florida Bay that have focused on determining the concentrations of chemical contaminants (other than mercury and nutrients) present in different environmental media (water, sediment, tissue). For example, the South Florida Water Management District (SFWMD) began monitoring pesticides in water and bottom sediment in South Florida canals in the mid-1980's (Pfeuffer, 1985, 1991). Recent analyses indicates that atrazine, alpha-endosulfan, beta-endosulfan, endosulfan sulfate, were the most frequently detected pesticides in canal waters and DDE, DDD, atrazine, and endosulfan sulfate were the most frequently detected pesticides in sediment samples between 1991 and 1995 (Miles and Pfeuffer, 1997). Several of the sampling sites were located in the Everglades Agricultural Area (EAA) and others in the Homestead Agricultural Areas (HAA) adjacent to Everglades National Park. For example, detectable endosulfan residues (alpha and beta, and sulfate) in the C-111 (at S178) were consistently present in surface water from 1991-1995 and occasionally exceeded FDEP and U.S.EPA water quality criteria (Miles and Pfeuffer, 1997). Surface water samples collected independently by NOAA south from the SFWMD sampling sites confirmed these findings (Scott et al., 1994). Residues of endosulfan sulfate were also consistently found by SFWMD in sediment samples at S178 along with lower concentrations of the alpha and beta isomers. All three residues were also found in sediment samples from structures S177

and S18C in the C-111. The U.S.EPA in 1995 also monitored contaminants in surface water, sediment and biota in C-111 and creeks of Northeast Florida Bay (Goodman et al., 1999). Endosulfan residues were detected in sediments of C-111, and in sediments of Shell and Trout Creeks.

NOAA also conducted a contaminant study of C-111 and Florida Bay from 1993-1997, but it was limited in chemical/tissue monitoring for Florida Bay and in evaluating cause (exposure)-effect (toxicity) relationships for contaminants (Scott et al., 2002). It did however; indicate the presence of low levels of endosulfan (total), atrazine, chlorpyrifos and chlorothalonil (fungicide) in surface waters of canals adjacent to agricultural areas that drain into C-111 and in northeast Florida Bay waters. The study reported that Florida Bay waters occasionally exceeded U.S. EPA marine water quality criterion for endosulfan. Waters from canal sites also had detectable concentrations of endosulfan that sporadically exceeded U.S.EPA freshwater quality criterion. Detectable endosulfan (total) residues were also found in sediment and oysters while chlorpyrifos was detected in fish tissue. Toxicity tests with in-place sediment and copepods and bivalves indicated potential adverse effects but the causative agent (s) was not determined. Toxicity studies with native species under controlled conditions were not conducted at environmentally relevant concentrations. Data from NOAA's National Status and Trends (NS&T) Program Mussel Watch Project further indicated that the mean annual concentrations of endosulfan (II) residue in tissues (oysters) sampled from Joe Bay were higher than the NS&T 85th percentile (i.e., top 15 % of the concentration data set with over 280 sites nationwide) (Cantillo et al., 1999). Other areas of South Florida have also been noted as potentially impacted by organic contaminants and the report by Pait et al. (1992) ranked Biscayne Bay as an estuarine drainage area with one of the highest ratings in the Nation for intensity of application of the more hazardous pesticides (endosulfan, chlorpyrifos).

The findings of these studies strongly suggest that agricultural runoff and urban runoff are adversely impacting DOI trust resources in South Florida but little to no information is available for contaminants within NPS jurisdictional areas. As an example, a review of the data produced by the South Florida Water Management District showed that several pesticides were routinely been detected in sediments and surface waters from canals along the ENP boundaries (Figure 1)

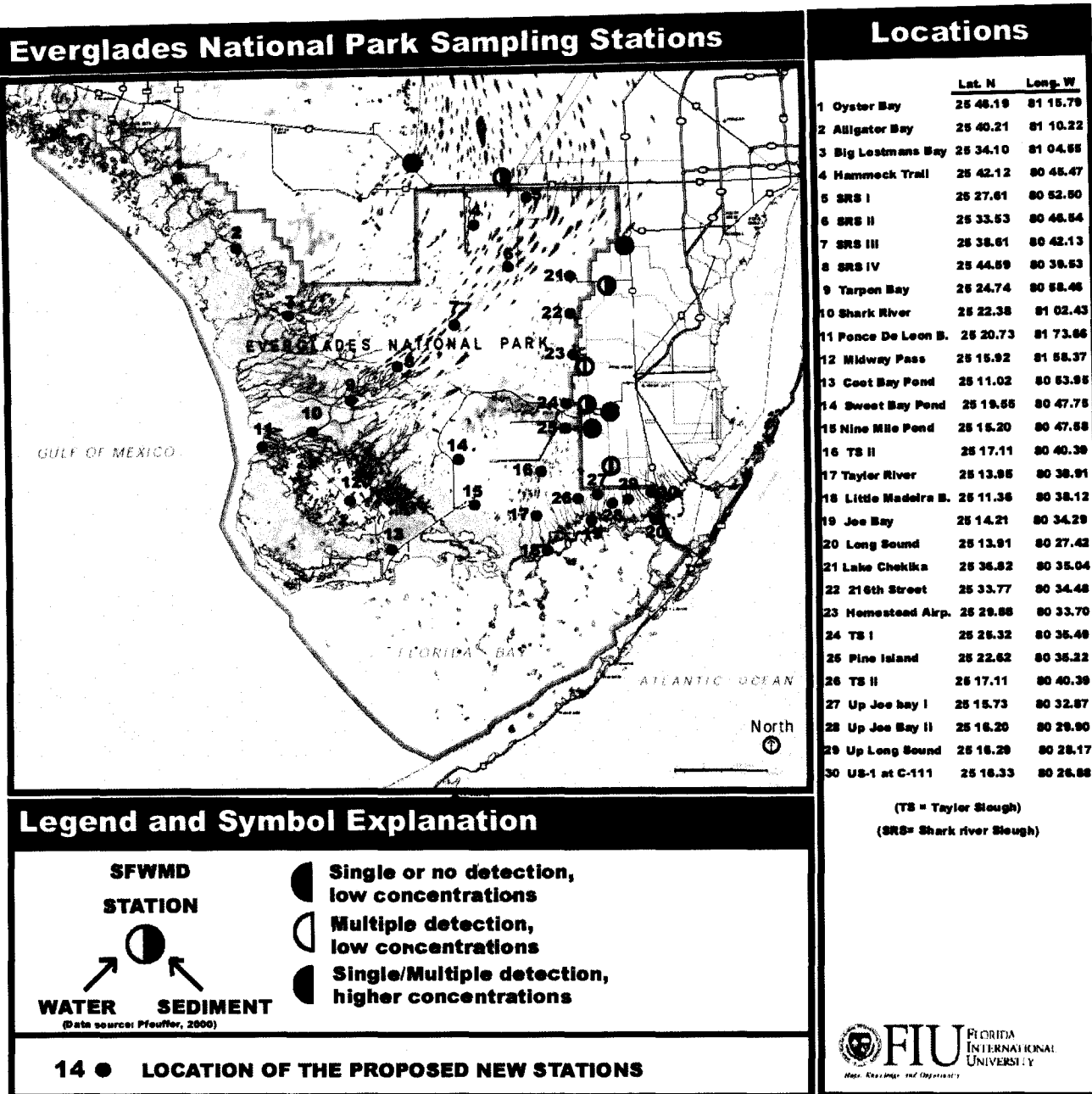


Figure 1.- Distribution of common contaminants summarized from the SWFMD database.

Based on these data and results from several other studies, Rand & Carriger (2004) conducted a preliminary survey of contaminants and produced a screening level ecological risk assessment (SERA) for the C-111 basin with respect to a selected group of contaminants of potential concern (DOI-FIU Cooperative Agreement 1443CA5280-01-007). The SERA showed that, based on the limited contaminant occurrence data published for surface water, and the documented toxicity of endosulfan (organochlorine insecticide) and chlorpyrifos (organophosphate insecticide) there was an acute risk to arthropods in the C-

111 system, Joe Bay, Highway Creek and Card Sound. Figure 2 provides a synoptic view of the risk associated with these chemicals at the S-178 structure in the form of Joint Probability Curves (JPC). Endosulfan exposure in C-111 also presented an acute risk to fish. Species sensitivity distributions (SSDs) indicated that pink shrimp may be one of the most sensitive species to endosulfan. Atrazine was also ubiquitous in surface waters but generally present at low concentrations.

S-178/Station C

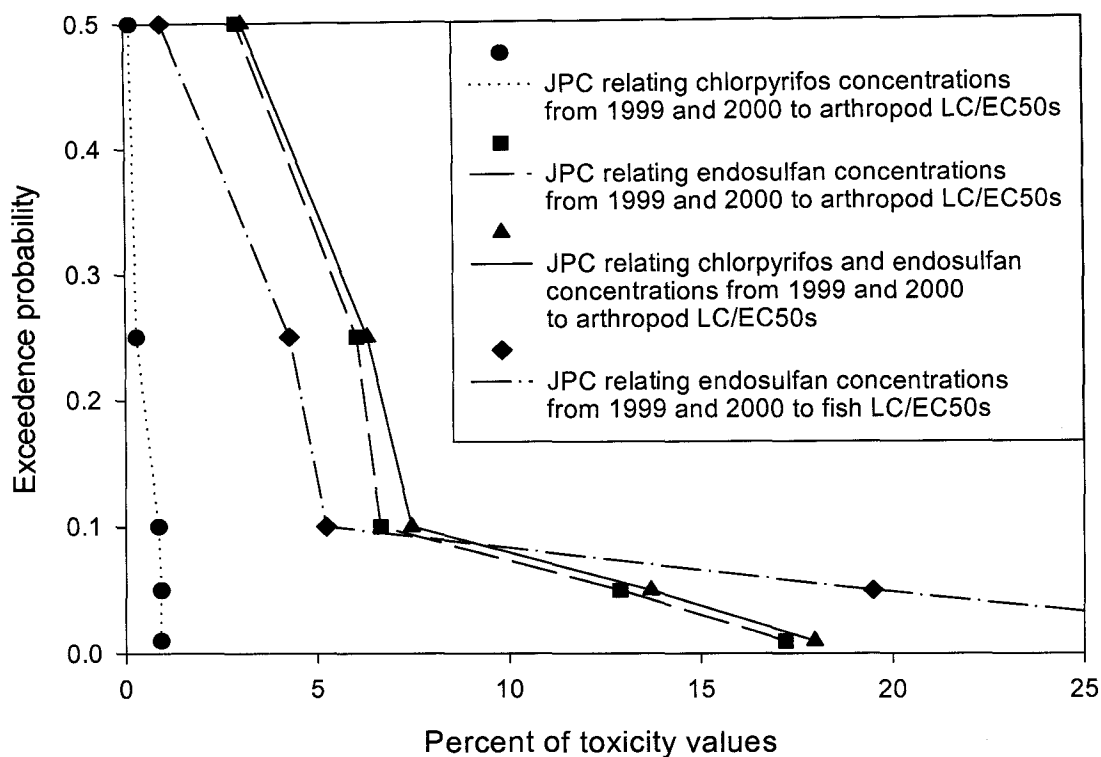


Figure 2.- Joint Probability Curves describing the effects of chlorpyrifos and endosulfan to arthropods in for site S-178.

A part of the SERA our field monitoring of contaminants in sediment indicated several important findings (Fernandez, 2004). Of the organochlorine compounds, PCBs, and PAHs monitored within ENP soils/sediments only DDT (mainly in the form of the stable metabolite 4,4'-DDE, Figure 3) was in exceedence of Florida Sediment Quality Assessment Guideline (FL-SQAG) threshold effect levels (TEL or the concentration below which adverse effects are not expected to occur). Analysis of ENP sediments showed the presence of the α and β isomers of endosulfan and endosulfan sulfate (persistent oxidation metabolite) in 27, 50 and 64 % of the samples, respectively at concentrations ranging from < MDL to 2.25 ng/g (dry wt). Although these concentrations are relatively low and despite the fact that there is no SQAG for endosulfan (or the sulfate), accumulation in fish (up to 196 ng/g dry weight basis) is quite evident from the data (Figure 4).

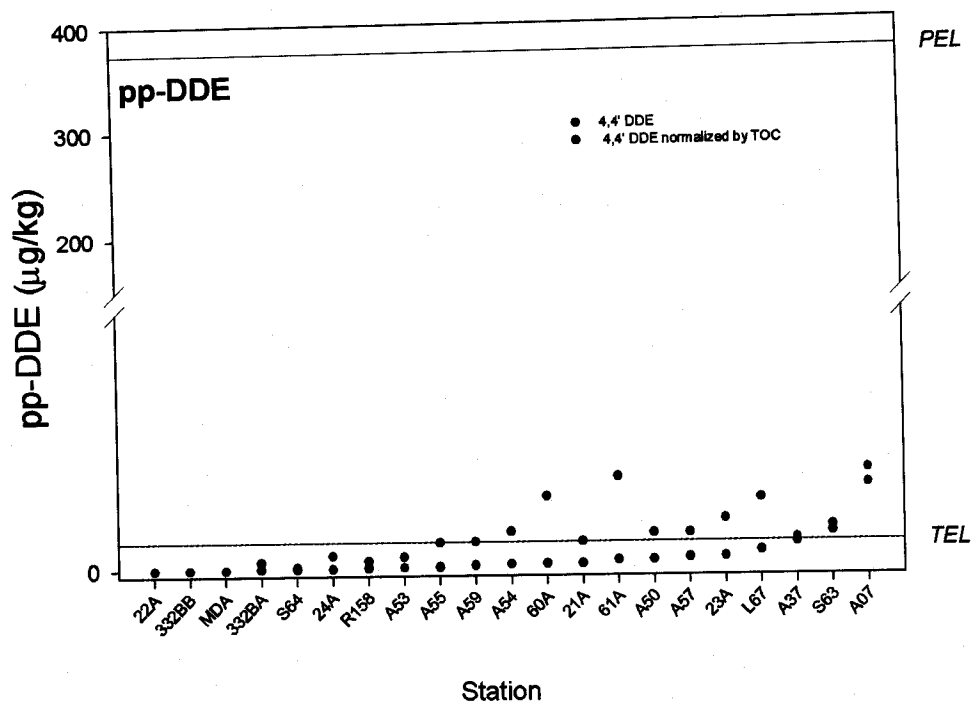


Figure 3.- Ranked concentrations of p,p'-DDE in sediments collected from ENP.

Spatial trends in the tissue residue data showed areas of particular concern like the eastern boundaries of Everglades National Park (Frog Pond) that are clearly influenced by the presence of the Homestead Agricultural Area (Figure 5).

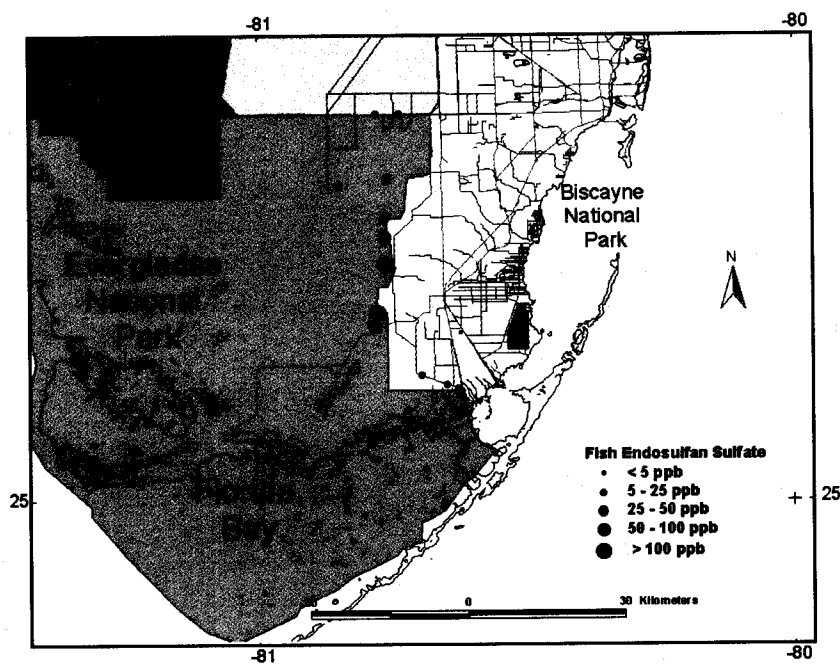


Figure 4.- Occurrence of endosulfan sulfate in fish collected within ENP.

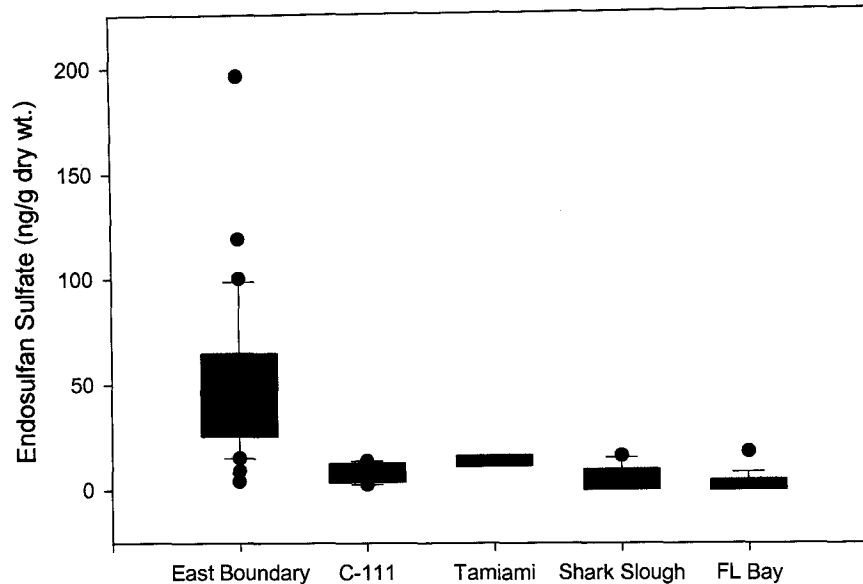


Figure 5.- Occurrence of endosulfan sulfate in fish tissue grouped by collection areas.

Of the metals determined lead exceeded the Florida SQAG probable effect levels (PEL or the concentration above which adverse effects are expected to be frequently observed) in one of the samples near Chekika and chromium levels ranked above the TEL criteria near the 322B impoundments. Other elements identified as having an increased anthropogenic signature were arsenic and copper.

Based on all the available literature and the results from the limited chemical monitoring conducted for ENP and BNP the SERA defined several important data gaps affecting progress in the restoration effort:

- Intensive monitoring is needed on contaminants
- Toxicity studies with fish and macroinvertebrates are needed to evaluate the effects of the environmental exposures.
- Bioconcentration studies should be conducted to understand the transfer of contaminants through the food chain and to evaluate the potential effects of the observed body burdens.
- Assessment guidelines should be developed to protect resources at stake.

PROJECT OBJECTIVES

Land management practices and flood control in South Florida will likely expose National Park Service (NPS) trust resources to contaminants from urban and agricultural origin. Trust resources in Everglades National Park (ENP), Biscayne National Park (BNP), and Big Cypress National Preserve (BCNP) include federally listed threatened and endangered species, fishery, and wildlife resources. Even with the use of storm water treatment areas, designed to remove phosphorus, the fate of pesticides, herbicides, and other anthropogenic chemicals during treatment is uncertain, and water routed around the system may be discharged into DOI lands. Additionally, changes in water delivery to national park lands in South Florida are planned under Everglades Restoration projects. Little baseline information exists on which to evaluate the potential risk that contaminants may pose to restoration success. However, the few pieces of information that are available clearly indicate that waters, sediments, and fish within ENP have recognizable signatures of anthropogenic effect, in particular near the areas where water exchange with urban and agricultural areas exists. This work plan describes a three-year program to assess the concentrations, temporal and spatial variations, and potential impacts of contaminants in areas where surface water is or will be discharged into ENP, BNP and BCNP. It also extends into the assessment of the risk associated with exposures of aquatic natural resources to contaminants. The definition of contaminants in this work includes trace metals, organic contaminants from urban and agricultural origin but exclude nutrients and mercury. While the plan will provide a baseline on which to evaluate existing conditions, it will also provide the data on which to develop a long term monitoring program for contaminants exposure resulting from Everglades restoration projects that may affect natural resources in ENP, BNP, and BCNP.

The overarching goals of this project are:

- To help identify and fill-in existing water quality data needs and gaps,
- To carry out a synoptic and strategic sampling to understand the fate and transport of contaminants of concern,
- To establish ecotoxicologic baseline for the evaluation of CERP and non-CERP restoration-project impacts.
- To recommend exposure criteria guidelines to protect resources at stake through the process of Environmental Risk Assessment

ANTICIPATED RESULTS

It is anticipated that successful completion of the proposed work will produce the following results in a wide variety of deliverables:

Environmental Assessment

Analytical data reports will be generated along the duration of the project. Is expected that such data will be available in electronic form for easy dissemination. Ranges of concentrations (mean, median and maximum environmental concentrations) for each contaminant and the 90th-centile exposure estimates for each contaminant in freshwater and estuarine/marine sites from the three year monitoring will be presented. When available, comparative displays of the exposure data against environmental assessment criteria will be presented. Distribution maps, in the form of geocoded layers will be produced to describe the presence, levels and trends of all contaminants analyzed during the project. When deemed necessary by the project team, and in consultation of the NPS project manager, high resolution data will be generated to address particular areas or contaminants of concern. This task is targeted to produce more detailed spatial or temporal assessments than the park-wide effort. It is anticipated that all contaminants having elevated 90th-centile exposure concentrations in surface water and/or sediment will go into Tier 2 probabilistic ecological risk assessment.

Effects Assessment (Acute & Chronic Toxicity)

All acute and chronic toxicity data for contaminants from the literature on each group of aquatic organisms (e.g., phytoplankton, macrophytes, zooplankton, and fish) will be used to prepare species sensitivity distributions (SSDs) for each aquatic group. The concentration associated with the 10th centile for acute sensitivity from the acute SSDs (e.g., LC50s, EC50s) for each group will be presented. The 10th centile for chronic sensitivity from the chronic SSDs (i.e., NOECs) for each group will also be presented. This will provide us with information on the most sensitive aquatic group to each contaminant and the most toxic contaminant. When the n value for toxicity test results for an aquatic group is large for a contaminant it is assumed that the toxicity data used in the SSD will cover the range of sensitivities for those species in an aquatic system. The PRA approach also provides information on relevant scientific data gaps. For example, the results of the PRA may indicate that certain native species are sensitive and additional toxicity testing is needed to bracket the range of sensitivities.

Risk Characterization

For calculations of the PAFs (i.e., for single contaminant exposures) and msPASFs (i.e., for multiple contaminant exposures) for acute risk we will compare the 90th centile exposure concentration with the SSDs for acute toxicity (LC50, EC50) and for chronic risks we will compare the median exposure concentration (50th centile) with the SSDs for chronic toxicity (NOECs). We will then determine the potentially affected fraction (for single

contaminant PAFs and multiple contaminant action msPAFs) of species that are adversely effected from:

- single contaminants found at sites (in sediment and/or water) when acutely exposed to the 90th centile exposure concentration,
- joint action of contaminants when multiple contaminants are found at sites (in sediment and/or water) and acutely exposed to the 90th-centile exposure concentration of each at the same time,
- single contaminants when chronically exposed to the 50th-centile exposure concentration,
- joint action of contaminants when multiple contaminants are found at sites (in sediment and/or water) and chronically exposed to the median-centile exposure concentration of each at the same time.

Exceedences above the 10th-centile of an SSD will be noted for acute and chronic risks to COPECs. The probability of exceeding the 10th-centile of the SSD will be determined. It is anticipated that at certain sites a percentage of certain species groups will be acutely and chronically adversely affected by exposure to single contaminants at the 90th and 50th centile exposure concentrations, respectively. Furthermore, acute and chronic exposures at certain sites in saltwater and fresh water to the joint action of multiple contaminants will increase the percentage of adversely effected species.

Joint probability curves (JPCs) will also be constructed for sites and years for contaminants that show an overlap in distributions for effects and exposures. This will provide the percent of time the percent of different species groups will be adversely effected at different sites by single and the joint action of multiple contaminants. Analysis of the predicted adverse ecological effects will be related to the assessment endpoints. For example, we will be able to predict that at site A in BNP, x% of the phytoplankton populations would be adversely effected y% of the time in 2004 by COPEC Z. In our previous screening level probabilistic ecological risk assessment for Everglades National Park we generated several informative JPCs for management based on the limited data for environmental exposures in Joe Bay, Highway Creek and Card Sound and the readily available acute toxicity literature values for estuarine species.

Natural variation is an inherent characteristic of ecological systems and the factors that influence the systems (e.g., weather, salinity dilution). We will discuss uncertainties in exposure and effects analysis and risk characterization.

The ERA using probabilistic methods has proven to be an effective tool to interpret data from existing contaminant exposure monitoring programs and to identify relevant data gaps needed to answer questions for regulatory management decisions. Information gaps will be summarized.

PROPOSED STATEMENT OF WORK

Because the objectives of the project clearly indicate the need of conducting a comprehensive environmental assessment as well as identifying both the contaminants of concern and the risk associated with their occurrence, the scope of the proposed work is divided into major components. The screening level environmental monitoring program includes all the aspects of sample collection and analysis to generate an inventory of the occurrence, spatial and temporal distributions of chemical contaminants in three major environmental compartments (water, sediment/soil and biological tissue) in areas of ENP, BNP and BCNP identified as potentially affected by anthropogenic activities as a result of present or post-restoration water deliveries. The second component of the proposed study includes the assessment of the exposure-effect relationships for model biological resources inhabiting ENP, BNP and BCNP and the final integration of all chemical and biological data into an ecological risk assessment document to be used for management purposes. The specifics of each component are described in the following sections of the proposal.

ENVIRONMENTAL MONITORING

This section of the plan describes a three-year monitoring effort to assess the temporal and spatial variation of pesticides, and trace metals in ENP, BNP, and BCNP.

The analysis will include at least all compounds target by the CERP document on contaminant monitoring (Appendix II) plus additional analytes such as, PCB congeners, PAHs, chlorinated herbicides, and trace metals from urban and agricultural origin. Exceptions to the list will be Toxaphene, which will be semi-quantitatively determined as potentially present/absent based on the distribution patterns observed in the samples and total Aroclors which will be calculated only if an Aroclor-like pattern is observed in the sample. The SOW also excludes nutrients and mercury, which are being intensely studied and monitored by other projects. Nutrients, and in particular phosphorous, are being addressed by the Consent Degree. Mercury is being intensely studied by programs such as the Mercury Science Program, Aquatic Cycling of Mercury of the Everglades, Everglades Mercury TMDL Pilot Study, Mercury Transfer through an Everglades Aquatic Food Web, among others. The work will provide a baseline on which to evaluate existing conditions and a framework to develop a long-term monitoring program for contaminants of concern, which could be introduced into the parks by the implementation of restoration projects. Examples of such projects are water delivery along US-41 (Modified Water Delivery Project); construction of pumps and retention areas along the eastern boundary of the ENP (C-111 Project); C-111 Spreader Canal (CERP); and Biscayne Bay Coastal Wetlands (CERP) projects. These projects are likely to affect the quality, quantity, and delivery rates of water and contaminants into the National Park Service trust resources.

The tables below indicate the preliminary list of stations, sampling frequencies, and analyses for the monitoring program.

AREA	Number of Sites	Matrix	Sampling Frequency	Analyses	Total Samples
EVERGLADES NATIONAL PARK (30 Waters, 30 Sediment/soils, 20 Tissues)					
Tamiami Trail	4	Water	3/year	A, B, D, E, F, G, L	12
	4	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	4
	3	Fish	2/year	A, B, C, D, K	6
Shark River Slough	3	Water	3/year	A, B, D, E, F, G, L	9
	3	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	3
	2	Fish	2/year	A, B, C, D, K	4
L-31 Area	5	Water	3/year	A, B, D, E, F, G, L	15
	5	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	5
	3	Fish	2/year	A, B, C, D, K	6
Homestead Agricultural Area	2	Water	3/year	A, B, D, E, F, G, L	6
	2	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	2
	2	Fish	2/year	A, B, C, D, K	4
C-111 Basin	6	Water	3/year	A, B, D, E, F, G, L	18
	6	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	6
	3	Fish	2/year	A, B, C, D, K	6
Taylor Slough	3	Water	3/year	A, B, D, E, F, G, L	9
	3	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	3
	2	Fish	2/year	A, B, C, D, K	4
ENP	2	Water	3/year	A, B, D, E, F, G, L	6
	2	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	2
	1	Fish	2/year	A, B, C, D, K	2
Florida Bay	4	Water	3/year	A, B, D, E, F, G, L	12
	4	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	4
	3	Fish	2/year	A, B, C, D, K	6
Manatee Bay	1	Water	3/year	A, B, D, E, F, G, L	3
	1	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	1
	1	Fish	2/year	A, B, C, D, K	2
BISCAYNE NATIONAL PARK (11 Waters, 11 Sediment/soils, 9 Tissues)					
Nearshore	5	Water	3/year	A, B, D, E, F, G, L	15
	5	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	5
	3	Fish	2/year	A, B, C, D, K	6
BB Wetlands Project	3	Water	3/year	A, B, D, E, F, G, L	9
	3	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	3
	3	Fish	2/year	A, B, C, D, K	6
BB Water Reuse Project	3	Water	3/year	A, B, D, E, F, G, L	9
	3	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	3
	3	Fish	2/year	A, B, C, D, K	6
BIG CYPRESS NATIONAL PRESERVE (7 Waters, 7 Sediment/soils, 7 Tissues)					
WCA-3	2	Water	3/year	A, B, D, E, F, G, L	6
	2	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	2
	2	Fish	2/year	A, B, C, D, K	4
Tamiami Canal	3	Water	3/year	A, B, D, E, F, G, L	9
	3	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	3
	3	Fish	2/year	A, B, C, D, K	6
West Boundary	2	Water	3/year	A, B, D, E, F, G, L	6
	2	Sediment/Soil	1/year	A, B, C, D, E, F, H, I, J	2
	2	Fish	2/year	A, B, C, D, K	4
TOTAL SAMPLES PER YEAR					264

KEY	ANALYSIS DESCRIPTION
A	Polynuclear Aromatic Hydrocarbons (PAHs) + Extended (Alk-PAHs)
B	Organochlorine Scan (Pesticides and PCBs)
C	Metal Scan (Trace and Major Elements)
D	Organophosphate Scan (Pesticides)
E	Nitrogen Herbicides (Triazines)
F	Phenoxy Acid Herbicides

G	Pharmaceutical Scan (Caffeine)
H	Total Organic Carbon (TOC)
I	Dry Weight
J	Grain Size Distribution
K	Lipid Weight
L	Major Anions and Cations (IC)

At ENP, 30 sites will be sampled for both water and sediment/soil and 20 for tissue, and there will be 160 samples per year. At the BNP, 11 sites will be sampled for both water and sediment/soils and 9 for tissue, and there will be 62 samples per year. At the BCNP, 7 sites will be sampled for water, sediment/soils, and tissue, and there will be 42 samples per year. Table 2 provides a description of the analysis that will be conducted for every site and on every matrix.

Sampling Strategy and Site Selection

Several essential projects are likely to affect the quantity, quality, and delivery rates of water and thus associated contaminants to NPS lands. The changes in water delivery along US-41 (Modified Water Delivery), the construction of pumps and retention ponds along the east boundary of ENP (Modified Water Delivery), the C-111 Spreader Canal Project (CERP) and the Biscayne Coastal Wetlands Project (CERP), which is to benefit from wastewater reuse.

Increased flow through the structures along Tamiami trail will likely introduce water from the water conservation areas with a more agricultural "chemical signature" that will be reduced in nutrients but may still contain traces of herbicides and pesticides. As an example, a constant background of atrazine (average 25 ppt, median 21 ppt) has been regularly detected for the last three years of the SFWMD pesticide monitoring program at control structure S12C. In addition, the fast urban development along the southern portions of Dade County west from the Florida Turnpike will likely introduce additional more "urban" contaminants to the eastern Everglades of ENP.

Although much of the area along the L-31N Canal have been targeted for land acquisition, the likelihood that these areas will retain their agricultural use is small. New urban development along Krome Avenue from Kendall to Homestead will bring changes in the land use and create an increased environmental pressure for drinking water and generation of wastewater. Since the water budget for ENP will likely depend on the amount of reuse-waters delivered to Biscayne Bay, an increasing amount of "impacted waters" will be needed to maintain the head levels in the eastern sections of the park. Pumping stations located along the L-31N canal and their retention ponds create an opportunity for contaminants to enter the park and interact with biological resources at risk. This scope of work also includes substantial monitoring for areas in Biscayne National Park that will be affected by the implementation of CERP.

Much of the work needed in the next three years is related to the C-111 spreader canal system. This project, by far, proposes the largest number of modifications in terms of both construction and water delivery. Furthermore, most of the detections of pesticides in waters, sediment and biota produced in the last decade for the Southern Everglades are linked with the areas of potential effect of this project. Among all compounds, endosulfan and endosulfan sulfate have been routinely detected in the SFWMD monitoring program at S177 and S178. Additional data generated by NOAA have indicated that waters, sediments and wildlife tissue have trace amounts of the insecticide in areas as far south as Manatee Bay, Joe Bay, Taylor River, and Long Sound. Since no indication of endosulfan contamination has been reported yet for areas north from S177, the need for future work should concentrate on the determination of the sources, spatial extent and temporal variations of the endosulfan inputs present within the areas affected by the C-111 spreader project. Both long term and high-resolution sampling may be required to accomplish this goal. Furthermore, the construction of a stormwater treatment area north from S18C requires an initial assessment of the presence of this and other contaminants prior to the construction to be able to provide performance measurements to assess future changes. Substantial components of the proposed work target areas both inside ENP and in the areas of the C-111 basin that will be affected by the new hydrological conditions.

Based on the implementation of these changes and the existing water delivery mechanisms the following stations or areas are proposed for the monitoring sites. Some of the stations coincide with the work conducted under de cooperative agreement 1443CA5280-01-007, others correspond to sites visited by the Coastal Everglades LTER project and others are located at or near sites where ENP personnel conduct regular sampling. In addition to these sites new stations are proposed to target specific changes within CERP.

Everglades National Park Sediments (30 sites once a year)

Sites recommended for inclusion are as follows (See Figure 6 for descriptions):

- a) US-41 Tamiami Trail (4 stations)
- b) ENP East Boundary (L-31 and HAA) (7 stations)

Sites 22, and 23 and other locations where existing and future pump stations/retention ponds are located.

- c) ENP Keep station R-158 as a reference site, add a second site in the western areas of the park. (2 sites)
- d) C-111 Spreader canal (6 stations)
 - Keep the existing stations
 - Extend north to the location of the new C-111

- e) Taylor Slough, keep stations 53 and FBTR
- f) Joe Bay, keep station FBJB. This site is similar to the NOAA NS&T location.
- g) Long Sound Keep station by US-1.
- h) Manatee Bay; add a reference site.
- i) Keep the LTER station 37 as reference site.
- j) Develop a station at Flamingo.

Tissue residues in fish ENP (20 sites every six months)

Preliminary data indicate that fish are good accumulators of contaminants. Most of the samples collected at the east boundary of the park contained residues of endosulfan sulfate in concentrations between 4 and 59 ng/g and measurable concentrations of pp-DDE. Since fish are among the first steps in the Everglades food chain, it is recommended that the monitoring continue in this matrix.

Stations for tissue collection should include 2 sites along the US-41 boundary (67 and 63), 2 stations along the east boundary (22, 23), a reference station inside the park (37), 2 stations along Taylor Slough (53 and FBTR), 2 stations in the C-111 area (55,61) and locations in Joe Bay (FBJB) and Long Sound (FBLS).

Additional sites should be developed near S178 and in the areas of the proposed new construction for the C-111 spreader canal.

Water analyses ENP (30 sites quarterly)

Despite the fact that water measurements provide a snapshot assessment of contamination, water quality is still among the few parameters where limited criteria for contaminant levels are available. In addition, water concentrations are required to assess potential for bioaccumulation. For these reasons, and due to the seasonal changes in South Florida hydrology, a quarterly assessment is recommended. A set of 30 sample sites will be developed for this project to coincide with: a) locations across the main water delivery into ENP (Tamiami Trail and C-111 basin); b) locations where modified waters are introduced to ENP (L-31/C-111 canal pump stations); and c) locations along the major water circulation pathways inside the park and their connections to the estuarine systems (Taylor Slough, Shark River Slough, the creeks entering northeast Florida Bay and Flamingo), d) locations established by other monitoring programs.

Sediment Contamination BNP (11 sites once a year)

The sites in Biscayne National Park will be selected in areas affected by water and sediment transport from CERP related projects. Both inshore (wetlands, tidal creeks, new canals and/or STAs) and near shore locations will be sampled. An near-shore estuarine transect (<300 meters at 5 sites) will be sampled between Black Point and Turkey Point with stations located at major freshwater inputs such as the Princeton, Military and Mowry canals. A second transect will be developed along the wetlands and tidal creeks to cover areas of present and future water delivery modifications including those to be affected by the introduction of reused waters.

Tissue residues in fish BNP (9 sites every six months)

Fish collections will be conducted at the estuarine and freshwater locations designated for sediment samples. However, due to the seasonality of the water levels in the wetland/tidal creek transect, fish tissue may be collected from the freshwater canals feeding the wetlands instead.

Water analyses BNP (11 sites quarterly)

Same as for the fish collection, surface waters will be sampled at the estuarine locations, submerged groundwater wells, the freshwater inputs and/or the wetlands or tidal creeks covered along the sediment sampling.

Sediment Contamination BCNP (7 sites once a year)

Stations will be developed in consultation with ENP/BCNP personnel at locations that will be affected by modified water delivery due to CERP implementation. It is expected that sites along US-41, US-94, Road 839, and along the Levee 28 Tie-Back Canal will be included in the program.

Tissue residues in fish BCNP (7 sites every six months)

Stations will be developed in consultation with ENP/BCNP personnel at locations that will be affected by modified water delivery due to CERP implementation.

Water analyses BCP (7 sites quarterly)

Sites will be selected to address prevalent water flows and to assess changes proposed by CERP modifications such as the location of culverts along Tamiami trail and the increased water deliveries from WCA-3. When possible, and after consultation with the funding agency, locations will be developed at sites where other monitoring efforts are presently conducted (Collier County and SFWMD).

ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment (ERA) will be conducted in ENP, BNP and BCNP for each year of the three year study based on the analytical exposure monitoring data for that year. The ERAs will be summarized and compared. Each ERA will consist of the first three segments of the U.S.EPA ERA framework (U.S.EPA, 1998): Problem Formulation, Analysis and Risk Characterization. Problem formulation will define the contaminants (e.g., specific metals, other inorganics and organics) of potential ecological concern (COPECs or stressors) and the plan for analyzing and characterizing the risk. Data on stressor characteristics (physical-chemical, environmental degradation and persistence), toxicological effects of COPECs, potential ecosystems at risk, ecosystem(s) and receptor(s) characteristics will be synthesized for this segment. From this data, measurement (i.e., measures of effect or endpoints) and assessment endpoints (i.e., what environmental value we are trying to protect) and conceptual models will be developed to prepare the final product of Problem Formulation-the Analysis Plan (risk hypothesis will be evaluated). Conceptual model flow diagrams will use information on the ecosystems at risk, stressor characteristics, biological (toxicological) effects and relationship between endpoints to define exposure and effects scenarios. Conceptual models for exposure and effects will be developed and lead to a set of questions. The Analysis Plan will include measures to be used to assess risk hypothesis (such as benchmarks). It will show how data will be used to estimate risk. The second segment of the ERA will be Analysis and it will characterize and examine two major components of risk; exposure and effects. The exposure data from contaminant monitoring will provide information to make this ERA site-specific. Risk characterization will be the final segment. This will provide potential risk estimates to the ecological entities listed as assessment endpoints based on occurrence and magnitude of exposures and the severity of adverse toxicological effects resulting from such exposures. A two-tiered ecological risk characterization approach was suggested by ARAMDG (SETAC, 1994) and endorsed by the U.S.EPA (ECOFRAM, 1999) that uses a stepwise approach progressing from the simple and conservative Hazard Quotient (HQ, tier 1) screening approach to more complex and more refined resource-intensive methods like probabilistic risk assessment (PRA, tier 2). The HQ approach is used as a screening method to select COPECs for the probabilistic aquatic ecological risk assessment. The latter two-tier approach will be endorsed in this ERA.

For risk characterization, two HQ approaches will first be used. One HQ approach will be based on a comparison of the response concentration for the most sensitive species in a toxicity test (e.g., EC50: effective concentration for 50% of test sample population based on a sublethal endpoint from an acute test; or acute LC50: lethal concentration for 50% of test sample population based on survival from an acute test; or NOEC: no observed effect concentration from a chronic test; these are called TRVs: toxicity reference values or TBCs: toxicological benchmark concentrations) to the maximum actual measured environmental concentration (AEC) of the contaminant(s) in surface water or sediment. When the quotient of the maximum exposure concentration to the toxicity value is greater than 1, an adverse effect (i.e., high hazard) is expected to occur. The latter HQ approach was the earliest method used by the U.S.EPA in the pesticide registration process for chemical companies under the Federal Insecticide Fungicide Rodenticide Act (FIFRA) to determine acute and

chronic risks and whether a new pesticide should be approved for registration, cancelled or be placed under a restricted use classification (Urban and Cook, 1986). We will use a conservative HQ of ≥ 0.5 and assume that any contaminant with this HQ will be a COPEC and proceed to tier 2. The second HQ approach will use a screening benchmark. Screening benchmarks are concentrations of chemicals that are believed to constitute thresholds for potential toxic effects of some ecological receptor exposed to a chemical in some medium. U.S.EPA Water Quality Criteria (WQC) and NOAA Screening Quick Reference Tables (or SQuiRTs) for sediments are commonly used as screening benchmarks because exceedence of one of these values constitutes cause for concern. Florida Department of Environmental Protection (FDEP) also has developed sediment quality assessment guidelines (FDEP SQAG) for certain contaminants which will be used. Measured concentrations of the contaminants in surface water will be compared to U.S. EPA WQC, and sediment concentrations will be compared to NOAA SQuiRT and FDEP values that are available. HQ exceedences in tier 1 will be used to screen COPECs for Problem Formulation and for a more refined and precise probabilistic aquatic ecological risk assessment in tier two (i.e., PRA).

In tier two for risk characterization of single chemicals, a probability distribution of AECs in surface water and sediment will be compared to a probability distribution of species effects (response) data as determined from laboratory single-species acute and chronic toxicity tests and field studies (Solomon, 1996). The PRA approach has been widely used over the last 10 years for pesticides (Giesy et al., 1999, 2000b; Hall et al., 1994a,b; Solomon et al., 1996) and metals. The objectives of the risk characterization will be to determine the probability that actual exposure concentrations of the COPECs from the different sites of ENP, BNP and BCNP will exceed concentrations that will allow survival, growth, development and reproduction of aquatic organisms.

A summary of some of the specifics in each of the three segments is described below.

Assessment Endpoints

U.S. EPA (1998) provides three criteria for selection of assessment endpoints (i.e., actual environmental value(s) that are to be protected): 1) ecological relevance, 2) susceptibility to the known or potential stressors, and 3) relevance to management goals. This leads to the following four general Assessment Endpoints for freshwater and estuarine sites that we will consider for this ERA in ENP, BNP, BCNP :

- 1) Survival and production of algae, periphyton and seagrasses provide habitat, food and energy for consumers and control the diversity of consumers within the different ecosystems. For example, one of Biscayne and Florida Bays major ecological attributes that is both an indicator of health and important to society is the seagrass community. They are a productive base for the food web, habitat for higher trophic levels and a regulator of water quality (i.e., through nutrient uptake, binding of sediments by their roots and trapping of particles through their leaf canopy).

- 2) Survival and production of macroinvertebrates (e.g., pink shrimp) which provide food in and on sediments. They are a component of the diet of gamefish and wading birds, and are also an indicator of the Bay's productivity.
- 3) Survival and production of invertebrate herbivores that exert functional control over the primary producers.
- 4) Survival and production of fish that exert functional control over the primary producers and primary consumers (herbivores).

The specific assessment endpoint is the protection of at least 90 % of the species 90 % of the time (10th centile from species sensitivity distributions) from acute and chronic contaminant exposures (Solomon et al., 1996). A total of four general assessment endpoints are described above. Assessment endpoints will be considered in light of both single contaminant and multiple contaminant exposures. These endpoints are in keeping with the management goals set forth by the Science Subgroup (1996).

Conceptual Model

Defining the spatial and temporal exposure distribution and risk of the contaminants in freshwater and saltwater sites will be a major objective of the ERA. Site conceptual exposure and effects models will therefore be illustrated and include both how direct and indirect (secondary, food chain) exposures and effects occur at the different sites.

Measurement endpoints (e.g., survival, growth, reproduction) are measurable ecological responses to a contaminant that can be correlated with or used to protect the assessment endpoint (U.S. EPA, 1998). These are the focus of the ERA and they link the assessment endpoint and attributes measured to the characterization of risk potentials. The development of a measurement endpoint requires (1) an applicable ecological component (e.g., guild) as identified above that is representative of the assessment endpoint, and (2) a toxicity reference value representing the level at which the valued characteristic is or is not adversely affected.

According to the U.S.EPA framework (U.S.EPA, 1992, 1998), the considerations for selecting or formulating measurement endpoints are ecological relevance, susceptibility to the effects associated with the stressors (COPECs) and policy goals and societal values. Given the latter considerations and based on our previous probabilistic ecological risk assessment (submitted to Everglades National Park; Rand and Carriger, 2004) conceptual models for the ENP, BNP and BCNP risk assessment may lead, as an example, to the following questions (as risk hypothesis) including measurement endpoints:

- What is the likelihood that the contaminant concentrations in water and sediment in the different regions of Biscayne Bay and tributary basins will be high enough to cause acute effects? (Assessment endpoint- #1, 2, 3 and 4. Measurement endpoint of effect: survival of test organisms in acute laboratory tests.)

- What is the likelihood that the contaminant concentrations are high enough and stable in water and sediment to cause chronic effects on survival, growth, and/or reproduction of organisms? (Assessment endpoint- #1, 2, 3 and 4. Measurement endpoint of effect: survival, growth, and reproduction of test organisms in chronic laboratory tests and field studies.)
- All questions will be addressed in light of single and multiple contaminant exposures in water and sediment. If acute or chronic toxic effects of the contaminants on aquatic organisms are possible, the following questions will apply:
 - At what sites and when are the effects likely to be greatest?
 - Which species are at greatest risk?
 - If some species are likely to be affected, are these species critical food organisms, such that, for example, reductions in invertebrate populations will affect fish growth and survival?

Analysis

In this ERA, a conceptual site exposure model will establish the complete exposure pathway (i.e., based on environmental fate and transport processes) that will be evaluated to establish the relationships between measurement endpoints and assessment endpoints. In developing the conceptual model the major objective will be to trace COPECs and their potential exposures within an ecosystem by simplifying site-specific food webs.

Using the guild concept, a model will be produced. Such a conceptual model will be used in the assessment to:

- 1) evaluate which guild is most at risk for exposure to a COPEC given an evaluation of taxonomic sensitivities to the COPEC(s);
- 2) select representative receptors of concern.

The following section describes the analysis for the ecological risk assessment. To evaluate the significance of ecological effects, the characteristics of the COPECs in ENP, BNP and BCNP will be reviewed and summarized to assess the possible pathways for their fate and transport. This information will be utilized to gain a picture of possible exposure pathways. The understanding of what segments of the aquatic community in ENP, BNP and BCNP that could be potentially susceptible to each of these COPECs will be specified in our assessment endpoints. Ecological effects information from single-species laboratory toxicity tests will be reviewed and synthesized using literature searches and review documents for this purpose. Exposure values and effects data for all COPECs will be summarized on spread sheets and then integrated to create a risk characterization for each site. Any uncertainties that arise from the analyses and available or missing data will be discussed. We will include all relevant exposure and effects data for all ecosystems evaluated.

Exposure Analysis

The probabilistic part of the ERA (see Risk Characterization below) for a COPEC will compare a probability distribution of AECs (in surface water and sediment) to a probability distribution of all species effects toxicological data (or species sensitivity distribution, SSD). The extent of overlap between the exposure distribution (at sites) and the SSDs (from toxicity data) is proportional to the risk or the probability of exceeding an exposure concentration associated with a particular probability of effects of the COPEC.

For exposure, data on the concentrations of the COPECs in water and sediment in ENP, BNP and BCNP will be obtained by using actual measured concentrations (AMCs) in surface water and sediment from the three-year monitoring study. However, the sediment toxicity database is limited for certain contaminants. In these cases sediment concentrations for COPECs will be converted to pore water concentrations so that we may compare distributions of pore water concentrations to aquatic toxicity data for risk characterization.

Procedures for using exposure data for the ERA will follow those used in other peer-reviewed probabilistic aquatic ecological risk assessments (Giddings et al., 2000a,b; Hall et al., 1998, 1999, 2000; Solomon et al., 1996) and the SERA we just submitted to Everglades National Park for the C-111 and northeast Florida Bay and south Biscayne Bay (Rand and Carriger, 2004).

In Tier 2, the 90th centile (exceedence of a value only 10 % of the time) and median exposure concentration will be calculated as benchmarks for acute and chronic risks, respectively, and the corresponding concentrations will be compared for each year and sampling site (Solomon et al., 1996). For example, any sample taken during a specific time frame and at a site has a 90% chance (for acute risk) of being below the estimated ninetieth centile concentration if the values in the distribution are unbiased and accurately represent the concentrations found over that time period and location (Giddings et al., 2000b). The 90th centile assumes that 90% of any samples taken over the specified duration will be below that benchmark value if it is derived from an unbiased distribution of all possible sample times. To determine the 90th centile and median exposure concentration regression may be used for small data sets and running averages for large data sets. However, our prior experience has shown that exposure data do not fit the log logistic model well. Therefore, when this occurs the reported 90th centile (and median) exposure estimates will be determined using the nonparametric analyses below for the exposure data.

The nonparametric method is as follows:

- Let $X_1, \dots, X_N$ be a random sample and $X(1), X(2), \dots, X(N)$ be order statistics.
- Let $np = 0.9(n + 1)$.
- Then, the 90th percentile = $X(n_1) + (np - n_1)(X(n_2) - X(n_1))$
- where n_1 is the integer part of np and $n_2 = n_1 + 1$. When np is greater than N , we let the 90th percentile equal $X(N)$.

Effects Analysis

For effects, acute (e.g., LC50s, EC50s) and chronic (e.g., NOECs) toxicity data for water and sediment exposures to freshwater and saltwater species will be used to develop distribution curves for each contaminant. The acute and chronic toxicity curves will demonstrate the species sensitivity distributions (SSDs) for aquatic plants (e.g., phytoplankton), invertebrates (e.g., mollusk and non-mollusk) and fish to the COPECs to characterize susceptibility at the different sites. All SSDs will be assumed to fit a log-logistic distribution and the tenth centiles on each effects SSD will be estimated individually for each species distribution assessed. The tenth centile of a SSD (i.e., concentration estimated to protect 90 % of the species) has been established as a threshold for effects on populations (SETAC, 1994). The implied assumption of this approach is that protecting a large percentage of organisms will also preserve ecosystem structure and function. Although log-normal distributions have been utilized in many North American ERAs (Solomon et al., 1996; Hall et al., 1998; Giesy et al., 1999; Giddings et al., 2000b; Hall et al., 2000), "there are no theoretical grounds" for choosing log-normal or log-logistic (de Zwart, 2002). The preference for logistic probability density functions (PDFs) in this assessment is based on their mathematical tractability, particularly in the risk characterization for joint action of mixtures (Traas et al., 2002). In addition, the extended tails of the logistic distribution can give lower target effect concentrations imparting greater conservatism to the analysis (Aldenberg and Slob, 1993).

Acute (LC50/EC50) and chronic (NOEC) laboratory toxicity data for water and sediment exposures for COPECs will be collected and analyzed. Acute toxicity data will be taken from databases maintained by the U.S.EPA (i.e., AQUIRE database and the USEPA One Liners database; (Montague, 2002)), criteria documents (e.g., USEPA Water Quality Criteria) and the literature. Due to a paucity of chronic information from AQUIRE for contaminants, chronic data values will be taken from published papers and various government-monitoring reports. When a pesticide formulation is used in a toxicity test and it contains less than 80 % of the active ingredient the data will be excluded from the SSD (Crommentuijn et al., 1997).

Only toxicity endpoints that could be clearly related to changes in population structure such as growth, reproduction, and survival will be used and a species will only be represented once in each distribution. When multiple data are available for a single species endpoint, the geometric mean of that data will be taken (Solomon et al., 2001). If life-stage information is available for a species, the most sensitive life stage, based upon the geometric means for a concentration, will be chosen as an endpoint for effects analysis.

After gathering all data for aquatic species with toxic endpoints for each COPEC, species data will then be separated into freshwater and saltwater species and further subdivided into fish, phytoplankton, macrophytes, arthropods, molluscs, and other invertebrates (e.g. zooplankton). For a distribution to be considered for analysis, at least four suitable species toxic values have to be available (Aldenberg and Slob, 1993). For fish, arthropods, and other invertebrates, test durations within the 24- to 96-hr duration are acceptable and will be included in the acute SSDs. The endpoint for adult

mollusks is generally based upon shell growth. This is usually not a sensitive endpoint so in cases where the value is above the water solubility of the contaminant, mollusks will be excluded from plotting but used to calculate rank (n) in the assessment of all species. Likewise, all endpoints above the water solubility of the contaminant will not be given a plotting position but used for the calculation of rank (n) (ECOFRAM, 1999). This has been done with acute effects data for macrophytes and phytoplankton when dealing with insecticides due to their general tolerance (Solomon et al., 2001). Plant and algae toxicity tests within the 144 to 168-hr duration for exposure will be included for all contaminants. If acute toxicity endpoints within this time frame are not available, acute toxicity tests from 24 hours to 14 days will be used for algae and macrophytes, but only when 144- to 168-hr measurements are missing for a single species.

Risk Estimation

An integration of the distribution curves for exposure and effects analysis will be conducted for the specified assessment endpoints as a basis for the characterization of risk posed by the environmental concentrations measured. The 90th centile of the AECs for exposure will be compared to the 10th centile of the SSDs for acute risk and the 50th centile of the AECs will be compared to the 10th centile of SSDs for chronic risks to aquatic organisms (SETAC, 1994; Traas et al., 2002). Risk quotients (or margin of safety) will be determined for each exposure data set by using the ratio of the 10th centile concentration for the SSD to the 90th centile for the environmental exposure distribution.

When the centile from the exposure data is applied to a SSD, a potentially affected fraction (PAF) of species number will be derived for each contaminant. Exceedences above the 10th centile of a SSD will be noted for acute and chronic risk. The PAF or fraction of species affected that is calculated from the SSD at a concentration (Klepper and Van de Meent, 1997) allows one to determine that "a certain fraction of species is expected to be (potentially) affected above its acute or chronic effect level at a given environmental concentration" (Traas et al., 2002). The PAF approach will allow us to assess the potential risk of single as well as the joint action (multiple substance PAF or msPAF) of contaminants and compare different sites and time intervals within ENP, BNP and BCNP (Traas et al., 2002). We used the latter approach in our screening level probabilistic aquatic ecological risk assessment for Everglades National Park. The PAF and msPAF approaches are described below.

The last step in the single chemical PRA approach will be to generate joint probability curves (JPC) or exceedence profiles for each exposure scenario assessed (Solomon et al., 2000). The JPC characterizes "the relationship between the magnitude of effect and the probability of occurrence for that effect" (ECOFRAM, 1999). With robust exposure and effects distributions, the JPC can be used to determine the proportion of toxicity values exceeded over the duration of the monitoring period. Constructing a JPC entails comparing a vertical axis for an exposure distribution (i.e., the cumulative probability of an observed or predicted exposure concentration) to a vertical axis for an effects distribution (i.e., the probability of an effect level) using a regression model. Concentration is the shared independent variable between the two axes.

The following estimated centile concentrations will be extrapolated from an exposure distribution and compared to a distribution of effects to create a JPC: the 99th centile, the 95th centile, the 90th centile, the 75th centile, and the 50th centile concentration estimate. After the 90th centile exposure estimate is subtracted from 100, we can state that for 10% of the measured concentrations, x% of the toxicity values would be surpassed (Solomon et al., 2000). The x% will be determined from where the 90th centile estimated concentration from the exposure distribution intersects the response axis of an effects distribution. The closer a JPC is to the axes, the lower the potential risk implied (Solomon et al., 2000). The JPC is a good approach to show how changes in environmental concentrations of a contaminant (due to natural degradation or management practices) would affect the risk.

JPCs will be created to display risk of contaminants (COPECs) at sites that had exceedences in the first tier (HQ) of the assessment. The area under JPC curves along with risk quotients derived from the centiles will be utilized to rank spatial and temporal risk scenarios for ENP, BNP, and BCNP sites for each contaminant. The JPCs will thus provide the percent of time that a percent of species (e.g., arthropods, fish, etc.) would be potentially affected. Risks to various species (e.g., arthropods, fish, etc.) at various sites will be evaluated for individual COPECs.

METHODS

Analytical Chemistry

The proposed project will be conducted over three years in three phases. During Year 1 (Phase I), Year 2 (Phase II) and Year 3 (Phase III) detailed chemical monitoring in ENP, BNP and BCNP will be conducted in sediment/soil, surface water and fish tissue and will consist of analyses of organic contaminants (e.g., pesticides, PCBs, PAHs), trace metals, soil/sediment characteristics (e.g., TOC, dry weight, grain size).

A summary of the methods is presented in the following sections. Given the variety of chemicals that can potentially impact the study up to 10 methods could be applied for a particular sample. Since space limitation prevents a full discussion of all the analytical methods only the most relevant highlights are presented below.

1. *Organochlorinated Pesticides and Polychlorinated Biphenyls (OCs)*

15-20 g of Fish tissue or 30-40 g of sediment/soil are spiked with the appropriate surrogate and/or precision and recovery standards, dried with anhydrous sodium sulfate (Na_2SO_4) and extracted using a DIONEX -200 accelerated solvent extraction system with methylene chloride (CH_2Cl_2). The sample extracts are then concentrated and cleaned up by silica gel/alumina chromatography and gel permeation chromatography, and to eliminate matrix interferences and analyzed by high-resolution gas chromatography with electron capture detection (HRGC/ECD) on a 30 meter, 0.25 mm i.d., 0.25 μm phase thickness DB-5 fused silica capillary column. When granted, confirmation of present analytes is conducted by

high-resolution gas chromatography- mass spectrometry (HRGC/MS) for 10% of the collected samples. This pesticide screen is particularly optimized to target specific compounds previously reported in the area such as endosulfan I, endosulfan II and endosulfan sulfate.

2. Polynuclear Aromatic Hydrocarbons (PAHs)

15-20 g of fish tissue or 30-40 g of sediment/soil are spiked with the appropriate perdeuterated surrogates and/or precision and recovery standards, dried with anhydrous sodium sulfate (Na_2SO_4) and extracted using a DIONEX -200 accelerated solvent extraction system with methylene chloride (CH_2Cl_2). The sample extracts are then concentrated and cleaned up by gel permeation chromatography, and silica gel/alumina chromatography to eliminate matrix interferences. Sample extracts are then analyzed by high-resolution gas chromatography- mass spectrometry (HRGC/MS) in electron impact (EI) mode using selected ion monitoring (SIM) on a 30 meter, 0.25 mm i.d., 0.25 μm phase thickness DB-5MS fused silica capillary column.

3. Organonitrogen Herbicides (ONP)

30-40 g of sediment/soil will be spiked with the appropriate surrogates and/or precision and recovery standards, dried with anhydrous sodium sulfate (Na_2SO_4) and extracted using a DIONEX -200 accelerated solvent extraction system with a mixture of methanol:water 9:1. The sample extracts will then be concentrated using a rotary evaporator, reconstituted to 30 mL of reagent water and cleaned up by solid phase extraction using Oasis HLB polymeric cartridges. Sample extracts will then be analyzed by high-resolution gas chromatography- mass spectrometry (HRGC/MS) in electron impact (EI) mode using selected ion monitoring (SIM) on a 30 meter, 0.25 mm i.d., 0.25 μm phase thickness DB-5MS fused silica capillary column. As an alternative a flame photometric or nitrogen-phosphorous detector is used for the quantitative determination.

4. Phenoxy Acid Herbicides (PACh)

40 g of sediment/soil will be spiked with the appropriate surrogates and/or precision and recovery standards, the pH adjusted to <2 and extracted using a DIONEX -200 accelerated solvent extraction system with a mixture of acetone and acetic acid (8:2). The sample extracts will then be concentrated using a rotary evaporator, reconstituted to 30 mL of reagent water and cleaned up by solid phase extraction using Oasis HLB polymeric cartridges. Upon elution, concentration and solvent exchange the sample extracts are analyzed by LC/MS-ESI in the negative mode.

5. Trace Metals Analysis

Metal analyses will be performed according to the Standard Operation Procedures (SOPs) developed in our laboratory and U.S EPA method 1638. Soil/sediment and fish tissue, are processed by a microwave digestion protocol and the determination of the eleven element

selected is done using inductively coupled plasma mass spectrometry (ICP/MS). Generally, a representative sample of up to 0.5 g is digested in 10 mL of concentrated nitric acid using microwave heating with a CEM Microwave Digestion System Model Mars 5. After cooling, the digested samples are transferred to a 100-mL volumetric flask and diluted to volume with DI water. The sample is then transferred to a 125-mL polyethylene bottle and allowed to settle overnight prior to analysis. QA/QC procedures will be strictly followed (see below) and method of internal standards will be used for quantification.

6. Organophosphorous Pesticides (OPs)

15-20 g of fish tissue or 30-40 g of sediment/soil are spiked with the appropriate perdeuterated surrogates and/or precision and recovery standards, dried with anhydrous sodium sulfate (Na_2SO_4) and extracted using a DIONEX -200 accelerated solvent extraction system with a mixture of methylene chloride and acetone (1:2). The sample extracts are then concentrated and cleaned up by a combination of florisil chromatography and gel permeation chromatography to eliminate matrix interferences. Sample extracts are then analyzed by high-resolution gas chromatography-mass spectrometry (HRGC/MS) in electron impact (EI) mode using selected ion monitoring (SIM) on a 30 meter, 0.25 mm i.d., 0.25 μm phase thickness DB-5MS fused silica capillary column.

Toxicity tests

During each phase single-species toxicity tests will be conducted with sediment samples from each collection site from the analytical monitoring part of the study. There will be a total of 48 separate soil/sediment samples per year (ENP: 30, BNP: 11, BCNP: 7) for the first two years. Toxicity tests with sediment will only be conducted the third year when samples are collected for contaminant analyses. For each sediment sample, three species will be used for testing with eight replicates per sample and an untreated control (i.e., a reference formulated sediment from USGS, Columbia, Mo that FIU Ecotoxicology laboratory has prepared & used successfully in sediment testing with background historical control data for 4.5 years). Native species will be used, when possible. A two-tier testing approach will be followed in which acute sediment tests will be conducted first followed by full chronic tests. For acute sediment (fresh-and salt- water) tests, two benthic invertebrates will be used along with one water column invertebrate species (total=144 tests). Acute tests will be ten days in duration for the benthic species (freshwater, *Hyalella azteca* and *Chironomus tentans*; saltwater, *Ampelisca abdita* and *Leptocheirus plumulosus*) and four days in duration for the water column organisms (freshwater, *Daphnia* sp.; saltwater, *Mysidopsis bahia*). Acute tests will use mortality as the endpoint. Chronic sediment tests will use two benthic species (as above from fresh- and salt-water) and will be twenty-eight days in duration. Growth and survival will be the main endpoints in chronic tests.

The following criteria will be used to go from acute to chronic sediment tests:

1. Presence of a correlation between mortality and chemistry results,

2. Mortality at a site in an acute test is >25% (when controls <10%),
3. Concentration of a foreign chemical substance is present in a concentration at or near its acute toxicity value or at or above its sediment quality criteria (NOAA, Florida SQAG), and
4. More than one chemical is present (regardless of criteria and concentration) at a site,
5. A chemical is persistently present.

Toxicity tests will be conducted with surface water, when water samples collected from a site contain concentration(s) of a contaminant (i.e., organic or inorganic) present that is at or near its acute toxicity value for the most sensitive species or is above its water quality criteria (U.S.EPA Water Quality Criteria). For acute water tests an invertebrate (freshwater, *Daphnia* sp.; saltwater, *Mysidopsis bahia*) and a fish (freshwater, fathead minnow (*Pimephales promelas*); saltwater, sheepshead minnow (*Cyprinodon variegatus*) species will be used with two replicates per sample site and an untreated control. Algae species will be tested when the chemical present has a specific mode of action that targets a plant system (i.e., photosynthesis). Acute water tests will be four days in duration (algae tests will be five days in duration). Acute tests will use mortality as the endpoint. To go from acute to chronic (short-term) water tests, similar criteria will be used as above for sediment except that for criteria #3. U.S.EPA water quality will be used instead of sediment criteria. Chronic tests will consist of a seven day invertebrate test and a seven day fish test. Survival, developmental abnormalities and growth will be the main endpoints in chronic tests.

An automated flow-through water delivery system will be used for all sediment and water tests to maintain low ammonia concentrations and consistent dissolved oxygen levels. Test temperature in chambers will be maintained with a water bath at $\pm 1.0^{\circ}\text{C}$. Temperature, dissolved oxygen, and conductivity will be measured daily in all tests. The photoperiod will be automatically controlled by the system with a 16-hour light followed by 8-hour period. Comparisons of sites will be conducted with analysis of variance (ANOVA) using a multiple comparisons test.

Short term bioconcentration tests (30 days) with fish will be conducted when chemistry results indicate the presence of persistent chemicals (e.g., endosulfan) in water. This will consist of exposing a native fish species for 30 days to a spiked environmental concentration of the chemical in water (i.e., highest concentration found in monitoring program) followed by a 14-day period in which fish will be placed in clean untreated water to observe depuration (i.e., excretion). Chemical residues in fish and water will be monitored during the treatment and post-treatment period and bioconcentration factors will be determined.

All the above sediment and water toxicity test procedures including the bioconcentration tests are consistent with American Public Health Association (APHA)/USEPA/American Society for Testing and Materials (ASTM) procedures (Rand, 1995).

PROJECT SCHEDULE AND DELIVERABLES

The tentative schedule for the project is presented in Figure 7. All the dates and task durations stated in the table are the best estimate available during the preparation of the SOW and are contingent on the timely issue of appropriate permits, factors restricting collection such as severe weather or restricted access to the site and the assumption of a September 1st, 2004 starting date. It is expected that the milestones and benchmarks will be periodically reassessed in consultation between the DOI Unit Lead and the Project Team during the regular planning meetings. Deviations of the schedule will be noted and provided as part of the progress reports to be delivered during the duration of the project.

Assuming that the project will start in September 2004, the description and scheduling for the deliverables are as follows:

Literature Review (Dec04): A comprehensive, yet exhaustive review of the available literature regarding contaminants and environmental risk assessment will be conducted at the beginning of the project.

Semi Annual Report 1 (March 05): will include results of distribution curves for monitoring (exposure) data, acute toxicity test results/chronic results. It will also include a summary of all parameters analyzed for each sample, provided as a tabulated report describing the sample identification, collection site, collection date, analytical method used, and the numerical values of the parameters measured in the sample. Data will be flagged according to the method's QA/QC criteria. Target turnaround time for analytical reports is 60 days from sample collection. It is anticipated that both laboratories will seek DOH accreditation in the early stages of the project. Completion of this task will depend on the number of methods and parameters involved in the chemical and biological assessment.

Annual Report 1 (Sept 05): Summary of analytical data, distribution curves for exposure data, acute and chronic test results (and bioconcentration test results), Phase I of probabilistic risk assessment indicating hot spots (i.e., sites with high risk), contaminants of concern, and JPCs for sites. This will include results of hazard quotient approach. It will also provide an interpretation of the data generated from the monitoring program during the Phase I. These technical reports, which are supplemented by the semiannual reports, will include summarized tables of the major findings, distribution maps, and comparative assessment with available environmental quality criteria. The annual reports also provide recommendations for changes to be implemented in the next phases of the project.

Semi Annual Report 2 (March 06): will include results of analytical monitoring data at sites-year 2, distribution curves for monitoring (exposure) data, acute and chronic test toxicity test results and bioconcentration results. This progress report will contain a description of the activities completed, stating the difficulties associated with the sample collection/analysis, and include any suggested changes of the SOW, to be agreed upon by the PM and the PI's, based on the results.

Annual Report 2 (Sept 06): Summary of analytical data, distribution curves for exposure data, acute and chronic test results (and bioconcentration test results), Phase II probabilistic risk assessment indicating hot spots (i.e., sites with high risk), contaminants of concern and JPCs for sites. It will also provide an interpretation of the data generated from the monitoring program during the Phase II. These technical reports, which are supplemented by the semiannual reports, will include summarized tables of the major findings, distribution maps, and comparative assessment with available environmental quality criteria. The annual report for Phase II will also provide recommendations for changes to be implemented in the Phase III of the project.

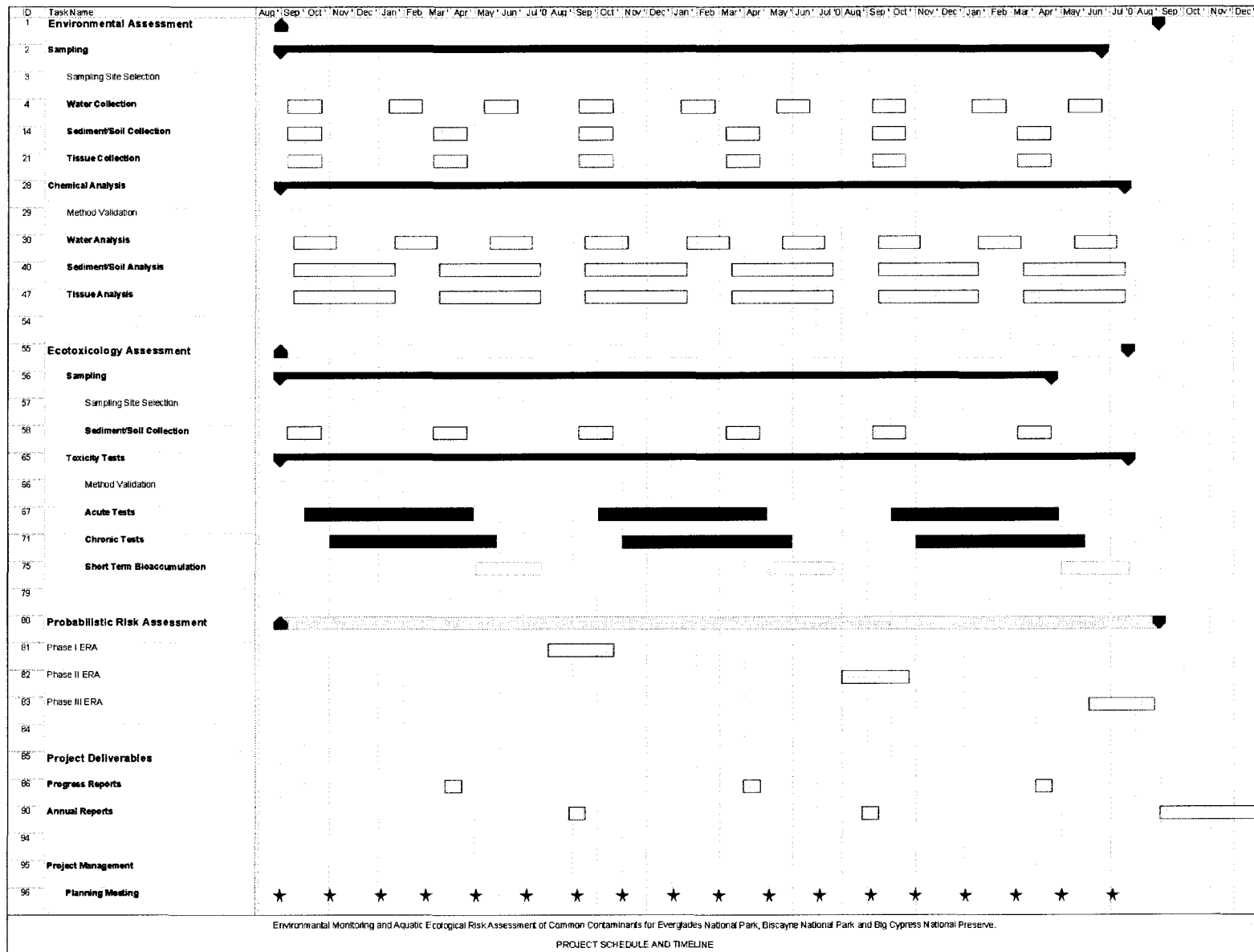
Semi Annual Report 3 (March 07): will include results of analytical monitoring data at sites-year 3, distribution curves for monitoring (exposure) data, acute and chronic test toxicity test results and bioconcentration results. This progress report will contain a description of the activities completed, stating the difficulties associated with the sample collection/analysis, and include any suggested changes of the SOW, to be agreed upon by the PM and the PI's, based on the results.

Annual Report 3 (Sept 07): Summary of analytical data, distribution curves for exposure data, acute and chronic test results (and bioconcentration test results), Phase III of probabilistic risk assessment indicating hot spots (i.e., sites with high risk) and contaminants of concern. It will also contain an interpretation of the data generated from the monitoring program. These technical reports, which are supplemented by the semiannual reports, will provide summarized tables of the major findings, distribution maps, and comparative assessment with available environmental quality criteria.

Final Report (December 07). Final report will include all exposure, toxicity, and bioconcentration data, curves and JPCs, and probabilistic risk assessment comparing Phase I, II, and III for contaminants of concern, sensitive species and risk at all sites. Additionally, this report will provide a full compilation of all the findings from the contaminant-monitoring program. The report will integrate the interpretation generated by all tasks of the project into the probabilistic risk assessment model and will provide guidelines and recommendations for management purposes. Since the final report is likely to become a working management document it is expected that it will be generated with substantial input from the PM and other interested parties within ENP, BCNP and BNP. The final report will be completed within 4 months of the annual report produced in Phase III.

All deliverables will be sent to the DOI-NPS Unit Lead as both hard-copy and electronic versions. All data generated by the project will be stored in electronic form at FIU until the final project report is approved for release and the project is completed. It is expected that the data will be available for dissemination to the regulatory and scientific community once the project is completed.

Figure 7. Milestones and proposed schedule for the project



QUALITY MANAGEMENT PLAN

To ensure quality performance and compliance with deadlines, the following quality control procedures will be implemented throughout the project:

- Quarterly meetings will be scheduled with PI(s) to review project progress, document major findings and, discusses needs and potential problems,
- Biannual reports will be promptly reviewed by Project Manager and discussed with PI(s),
- Annual reports will be reviewed by Project Manager and submitted to Park staffers for peer review,
- A TRC (Technical Resources Committee) will be convened twice to review and critique project goals, objectives, and findings. The TRC will be composed of leading ecotoxicologists and other scientists involved in assessing ecological adverse effects of pesticides and insecticides on fish, invertebrates, and wildlife habitat.
- Final report will be submitted for external peer review.
- All the of sediment and water toxicity-test procedures, including the bioconcentration tests, will be implemented according and consistent with the American Public Health Association (APHA)/USEPA/American Society for Testing and Materials (ASTM) procedures. Both labs will arrange to seek for DOH accreditation for non-standard methods developed in house.

Laboratory quality control and assurance (QA/QC) protocols will be followed from the time of sample collection. Chain of custody for samples collected in the field will created and maintained throughout the sample processing and completed at the time of sample reporting. All samples will be assigned unique identification codes in the field and are tracked at all times using the SERC LIMS computer system. All containers required for the sample collections will be purchased as pre-cleaned, pesticide grade certified jars to prevent any potential contamination. Due to the diverse suite of parameters to be measured and the different functionality of the contaminants, separate sample replicates will be collected for each analytical group. When required, sample preservatives will be added to the collection jars in the laboratory prior to the sample collection. To ensure that collection protocols are uniform with other monitoring programs, the field sample collection methods described in the U.S. Geological Survey, National Field Manual for the Collection of Water-quality Data will be adapted for the site specific collections. Sample preservation is the driving force during the field collections. When permitted by the collection location, the mode of access, and the distance from the closest road, all samples will be kept refrigerated and in the dark from the time of collection to the arrival to the laboratory facilities at FIU. Once on site, all samples will be catalogued, separated according their analytical protocol and logged in at the sample receipt facility of the FIU Field Operation Center (FOC). Chain of custodies will be completed by the sample custodian and, samples will be stored under refrigeration, as required, before they are distributed to the different analytical facilities.

Since 10-to-14 different analytical methods will be employed, a set of common QA/QC procedures are described in the following table (Table 3) to represent the typical process to assure data quality and consistency. To assess the method's performance, a set of quality-control and performance samples will be analyzed as part of every batch of approximately 20 samples or less.

QA/QC Element	Control Limit Criteria	Frequency
Instrument Calibration	Minimum of 4 standards; correlation coefficient of > 0.99 or % RSD within $\pm 15\%$ for all target compounds.	Initial and after any failures of continuing calibrations.
Instrument Blank	Instrument free of interfering contamination or perform necessary maintenance.	Prior to analysis of all analytical batches.
Continuing Calibration Verification (CCV)	Percent difference for all response factors within $\pm 20\%$ of initial calibration; no single analyte greater than 30% or recalibrate and reanalyze back to last passing CCV.	Once every 12 hours during the analytical sequence and/or at the end of analytical sequence.
Surrogate Recovery	<i>Method specific criteria</i> (i.e 50-120% based on method performance at validation)	All samples
Method Blanks	No analytes $> 3\text{-}5$ MDL.	All samples.
Replicates	<i>Method specific criteria</i> (i.e. RPD $\leq 25\%$ for all analytes $> 10 \times$ MDL based on method performance at validation)	One- two per QC batch (up to 20 samples).
Matrix or Blank Spike, Matrix or Blank Spike Duplicate (when applicable)	<i>Method specific criteria</i> , % recovery of fortified analytes within the method performance range (i.e. 70-120% for $>80\%$ of the analytes and RPD for the spike recoveries within $< 30\%$ for all analytes).	One-two per QC batch (up to 20 samples).
Standard Reference Material (if applicable)	When available, standard reference materials (SRM) from a third party will be processed and analyzed with every analytical batch. When no SRM exists, performance evaluation (PE) samples could be used. <i>Method specific criteria</i> (i.e 80% of the analytes within $\pm 1\sigma$ of the certified range)	One per QC batch.

Table 3.- Typical QA/QC requirements for the chemical analysis.

This summary provides a generic example of the typical QA/QC requirements used for most analytical methods. Each method, however, has its own set of criteria that are established for each analyte based on matrix specific performance assessed at method validation time. In general, the analysis of blanks is intended to document that the analytical protocol is free from interferences while the analysis of performance samples such as Blank Spike and Matrix Spike samples are used to assess the precision of the method with the analysis of fortified samples. When available, the analysis of standard reference materials or thirty party certified solutions will be analyzed to test for method accuracy. Method detection limits will be statistically calculated for all media for the appropriate methods.

PROJECT MANAGEMENT

Project management and coordination includes all facets of overall supervision of the study, ensuring that scientific objectives and quality assurance are met, and budget and time control are strictly maintained. The proposed organizational diagram of the personnel and its responsibilities is shown in Figure 8. Dr. Gardinali will represent FIU as Principal Investigator (PI) and be responsible for method validation and chemical analysis and field sampling during Phases I, II and III. Dr. Gardinali will oversee the operation of the analytical group personnel that include three team leaders in specific areas of the project. Adolfo Fernandez (MS) will be in charge to coordinate, organize and conduct all the aspects of sample collection and transport to the analytical facilities. Mr. Fernandez will also supervise the field personnel and is responsible for the documentation regarding site selection, GIS data generation and upkeep and to coordinate with the NPS Unit Lead the logistics of site access and permitting. Tatiana Trejos (MS) will be in charge of the analysis of inorganic constituents such as trace metals, major and minor ions and all the ancillary parameters required for the samples. Ms. Trejos is also responsible for the supervision of one graduate research assistant conducting the sample preparation and extractions. Luis Arroyo (MS) will be team leader in the area of organic contaminant analysis. He will be in charge of all the analytical work required for the analysis of pesticides, herbicides and toxic chemicals and will be responsible for the upkeep and upgrade of the instrumentation housed in the laboratory. Mr. Arroyo will also supervise a graduate assistant in charge of all the sample preparation steps for the analysis of organic contaminants. Two undergraduate assistants will also be hired to help the daily lab operations such as glassware cleaning, sample homogenization and sub-sampling and data transcription.

Dr. Rand will ensure that appropriate data are extracted and collected for the ecological risk assessment and that all data are compiled correctly. Dr. Rand will work closely with graduate students to review and interpret biological-toxicity and chemical data. He will also be responsible for the general overseeing, conduct and interpretation of the ecotoxicological studies including the risk assessment. Pamela Bachman (PhD Candidate) will be the lab manager for the ecotox lab operations. Ms. Bachman will oversee all the aspects of the daily operations required to conduct the acute and chronic toxicity tests as well as the bioconcentration studies. She will supervise and assist a graduate research assistant who will be dedicated to the lab work. Additional staff in the form of

undergraduate assistants will be available to help with the daily operations of the lab such as culturing, feeding, lab cleanup and data transcription. The team will also hire a post-doctoral associate with experience in the field of risk assessment who will be responsible to generate, in close collaboration with the PI, the ERA's required for all three phases of the project.

In addition to the lab personnel, the budget includes a line item for the services of the Southeast Environmental Research Center's (SERC) QA/QC officer and its working group. The purpose of this access is to provide independent data review by personnel not related to the project. The QA/QC officer will, at his/her discretion, conduct data audits, lab visits and lab personnel interviews to assess the operation of the laboratories under the proper QA/QC compliance. The two PI's will meet on a routine basis to discuss results of ecotoxicity tests and chemical analysis and to ensure that schedules are met during all phases of the project. In addition, the Analytical and Ecotoxicology group will hold a monthly meeting to address any problems encountered during the study and to decide and implement the possible corrective actions.

Similarly, the DOI-NPS Project manager and the PI's will hold planning meetings every two months to assess the progress, discuss changes or implement modifications of the original SOW.

Additional management steps such as the creation of a peer review panel and the circulation of the reports for comments and recommendations are routinely scheduled throughout all three phases of the project as described in the QA/QC sections.

NEEDS AND REQUIREMENTS

FACILITIES

Both the analytical facilities at the Southeast Environmental Research Center (SERC) and the Department of Chemistry and Biochemistry are available for this study. For the trace organics, Dr. Gardinali's laboratory is equipped with two GC/MS systems, four capillary GCs with a variety of detectors (ECD, FPD, NPD, PID and FID) as well as a GC/AED (atomic emission detector). In addition, the Advanced Mass Spectrometry Facility (AMSF) is equipped with LC/MS, GC/MS with CI/NCI capabilities and two ICP/MS instruments are available for this study. However, due to the large number of samples and the variety of parameters/analysis that will be measured for each sample additional capacity is required to provide the turnaround times stated in this SOW. For this reason, and to assure that the team will be able to handle the workload funding for purchasing/upgrading three instruments is included in the budget. General laboratory space available in both SERC and the Chemistry Department in support of the analytical work for the project is approximately 2000 sq. feet and will be dedicated exclusively to this project. With the exception of fish traps that will be purchased at the beginning of the project and helicopter time, all equipment required for the collection, storage, extraction and analysis of the water sediments and tissue samples, with the exception of consumables, is presently available to the PI's and operational.

Ecotoxicological studies will be performed at the state-of-the-art Ecotoxicology Laboratory Building (3000 sq. ft.) at the FIU Biscayne Bay Campus. This facility is equipped to conduct soil, freshwater, saltwater, and sediment ecotoxicity studies. The laboratory contains a temperature controlled environmental chamber, and a toxicity exposure room with soil and sediment toxicity systems and computer controlled water-flow exposure systems to deliver replicated chemical exposures at five different concentrations plus controls. Due to the required throughput, funds for acquiring additional water systems for the ecotox lab are included in the budget. The laboratory has natural full-strength saltwater (from Biscayne Bay at 30-31 ppt) and an automated system to create different estuarine natural waters. A culture room for freshwater, estuarine, saltwater, and soil organisms is also available. The instrument and prep room is equipped with muffle furnaces, spectrophotometers, balances, water quality meters, microscopes, water baths, shakers and incubators. The lab is also capable of conducting microcosm level studies. Dr. Gary M. Rand will be in charge of all ecotoxicology studies.

PERMITTING

The PI's will make every effort in providing DOI-NPS with all information required to obtain the required permits for the water, sediment, and fish collections. It is expected, however, that the NPS will make every effort to provide such permits in a timely manner to allow the collection of samples to proceed as scheduled in the proposal. Under no circumstances FIU personnel will collect samples, deploy or retrieve sampling equipment unless the proper permits are in place. In addition, since most of the access roads to the collection sites are gated and locked it is the responsibility of the DOI-NPS to provide the FIU field crew with the required keys to have access to the stations.

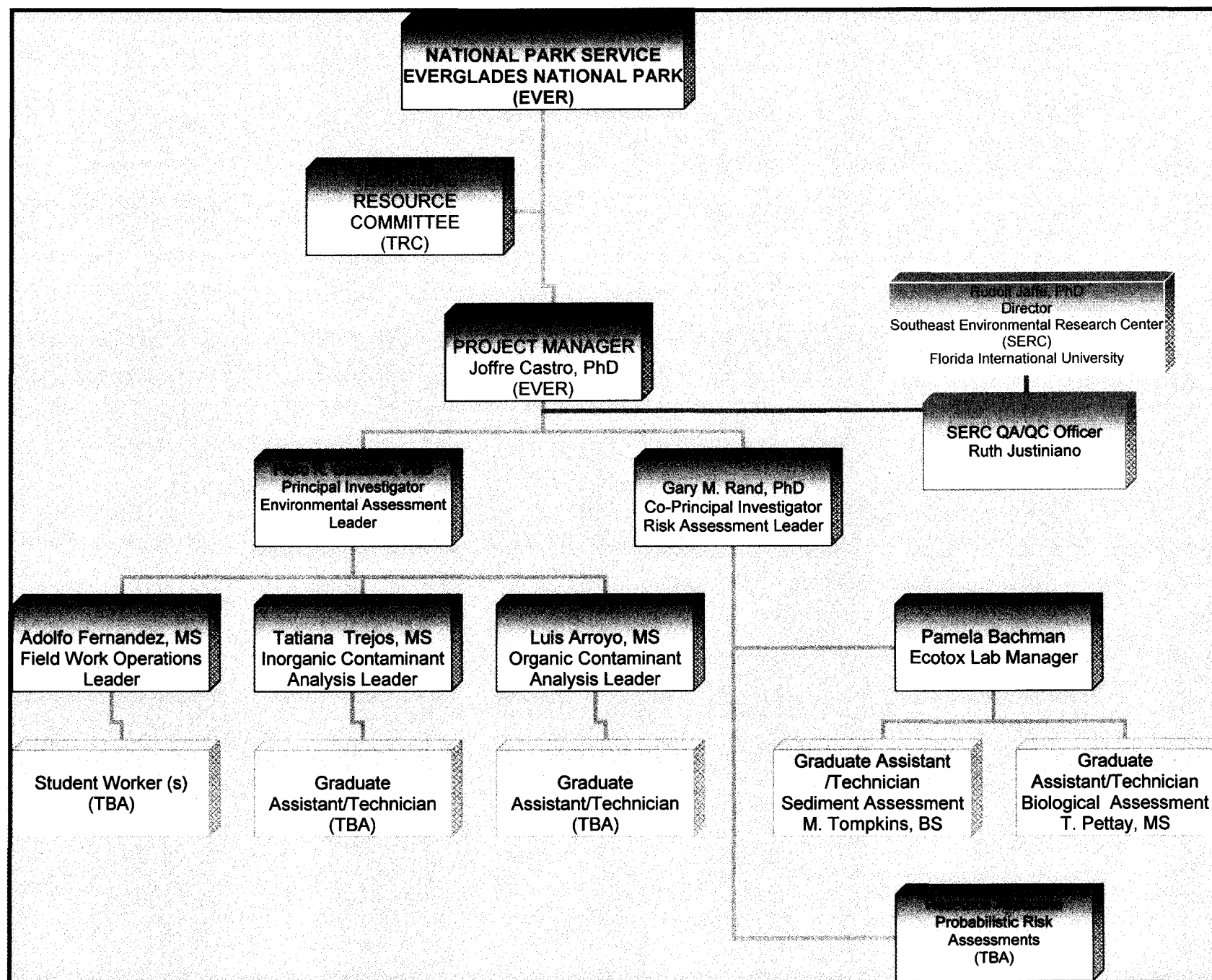


Figure 8. Organizational chart for the project personnel.

FUNDING

The funding required for the contaminant monitoring is estimated at **\$455,000/year** plus a cost of living increase for each subsequent year. The monitoring requested funding for the three-year period is **\$1,403,165**. The cost associated with the Probabilistic Risk Assessment is **\$235,944/year** with subsequent increases to accommodate cost of living increases and equipment replacement costs (see table below). The risk assessment requested funding for the three-year period is **\$709,805**. The total cost for the project is **\$2,112,970**. The breakdown by phase and component is illustrated in the table below.

The budget includes all expenditures required for the collection, sample preservation and storage, chemical analysis, reporting and generation of the electronic data for dissemination. Deliverables include analytical data reports with full QA/QC in both hard copy and electronic forms, including metadata. Chemical reports are produced twice a year within 90 days of sample collections and analytical reports with 120 days of sample collection. The budget includes an allowance per year for replacement/upgrade of capital equipment required to provide the sample throughput required in the SOW, and the purchase of additional water-distribution systems (~\$15,000) for the toxicology assessment if required by the workload. The overhead rate for this scope of work was calculated at 20% as stated by the agreement between DOI-ENP and FIU. The human resources needed for the project are described in the organizational chart provided in the Project Management section of the proposal.

Components	PHASE I	PHASE II	PHASE III
ENVIRONMENTAL MONITORING	\$454,996	\$469,998	\$478,171
ECOLOGICAL RISK ASSESSMENT	\$235,944	\$243,259	\$230,602
TOTAL REQUESTED			\$2,112,970

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APPENDIX I
Biographical sketches

PIERO R. GARDINALI

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EDUCATION

Degree	Institution	Field	Dates
Ph.D.	Texas A&M University	Chemical Oceanography	1991-1996.
M.Sc.	Universidad Simón Bolívar	Analytical Chemistry	1986-1989
B.S.	Universidad Simón Bolívar	Chemistry	1981-1986

FULL-TIME ACADEMIC EXPERIENCE

Florida International University	Assistant Professor of Chemistry	2/98-present
Texas A&M University	Instrument Lab Manager-	9/96-12/97
Texas A&M University	Research Assistant	6/91-8/96

Refereed Publications

1. Gardinali, P., Plasencia, M., and Maxey, C. (2004). "Occurrence and Transport of IRGAROL 1051 and its Major Metabolite in Coastal Waters from South Florida". *Marine Pollution Bulletin*. (In press).
2. Lenwood W. Hall, Jr. , William D. Killen and Piero R. Gardinali (2004) "Occurrence of Irgarol 1051 and its major metabolite in Maryland waters of Chesapeake Bay ", *Marine Pollution Bulletin*, Volume 48, Issues 5-6, March 2004, Pages 554-562
3. Piero R. Gardinali, José L. Sericano and Terry L. Wade. (2004) "Uptake and depuration of toxic halogenated aromatic hydrocarbons by the American oyster (*Crassostrea virginica*): a field study ", *Chemosphere*, Volume 54, Issue 1, January 2004, Pages 61-70.
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6. Annavarapu, S., Foran, C. M., Gardinali, P. Metzger, C., and Willett, K. L. (2004) "Characterization of Bioassays and Chemical Contaminants in Largemouth Bass (*Micropterus salmoides*) and Sediments Collected at Two sites in the Mobile Bay National Estuary". *Archives of Environmental Contamination and Toxicology* 46(4): 502-510, May 2004

7. Gardinali, P., Sericano, J., and Wade, T. (2004). "Depuration of Highly Toxic Chlorinated Compounds by the American Oyster (*Crassostrea Virginica*): A field Study. *Chemosphere*, 54:51-70.
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12. Willett, K.L., Gardinali, P.R., Lienesch, L.A., and Di Giulio, R.T. (2000). "Comparative Metabolism and Excretion of Benzo(a)pyrene in Two Species of Ictalurid Catfish" *Toxicological Sciences*, 58: 68-76.
13. Mora, M.A., Laack, L. L., Lee, M.C., Sericano, J., Presley, R., Gardinali, P.R., Gamble, L. R., Robertson, S., and Frank, D. (2000). "Environmental contaminants in blood, hair, and tissues of ocelots from the Lower Rio Grande Valley, Texas, 1986-97". *Enviromental Monitoring and Assessment*, 64: 477-492.
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20. Willett, K. L., Gardinali, P. R., Sericano, J. L., Wade, T. L. and Safe, S. H. (1997) "Characterization of the H4IIE rat hepatoma cell bioassay for evaluation of environmental samples containing polynuclear aromatic hydrocarbons (PAHs)", *Archives of Environmental Contamination and Toxicology*, 32:1-8.
21. Wade, T., Chambers, L., Gardinali, P., Sericano, J., Jackson, T., Tarpley, R., and Suydam, R. (1997) "Toxaphene, PCB, DDT, and Chlordane analyses of Beluga Whale blubber", *Chemosphere*, 34(5-7):. 1351-1357.
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26. Jaffe, R., Leal, I., Alvarado, J., Gardinali, P., and Sericano, J. (1995) "Pollution Effects of the Tuy River on the Central Venezuelan Coast: Anthropogenic Organic Compounds and Heavy Metals in *Tivela mactroidea*", *Marine Pollution Bulletin* 30(12): 820-825.
27. Jaffe, R., Espino, R., Benitez, F., and Gardinali, P. R., (1995) "Pollution Chronology of Lake Valencia, Venezuela", *Bulletin of Environmental Contamination and Toxicology* 54: 930-936.
28. Gardinali, P. R. and Wade, T. L. (1995). "Determination of Organochlorinated Compounds in Coral Eggs". in *Reef Research Rendezvous, A report on Science in the Flower Garden Banks National Marine Sanctuary*, S. Gittings and D. Hagman Eds., Gulf of Mexico Foundation, pp 11-12.
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Proceedings

1. "Harmful algal blooms in the gulf of Mexico and the photochemical by-products of brevetoxin" Ron C. Hardman*, William J. Cooper, Daniel G. Baden, Andrea J. Bourdelais, and Piero Gardinali. Proceedings of the 10th International Conference on Harmful Algae (XHAB2002), St. Pete Beach, Florida, October 21-25, 2002.

2. "Phototransformation of Irgarol 1051, a new antifouling agent, under natural environmental conditions". Plasencia, Manolo D.; Gardinali, Piero R*. Proceedings ACS Natl. Meet., Am. Chem. Soc., Div. Environ. Chem. (2001), 41(1), 323-327.
3. Willett, K., Gardinali, P. and Safe, S. (1996) "Induction equivalency factors for halogenated aromatic hydrocarbons and polynuclear aromatic hydrocarbons using the H4IIE rat hepatoma bioassay", Organohalogen Compounds, 29: 375 -379.
4. Gardinali, P.R., and Wade, T.L. (1996) " Levels of toxic polychlorinated biphenyls, dibenzo-p-dioxins and dibenzofurans in biotic and abiotic samples from Galveston Bay, Texas, U.S.A.", Organohalogen Compounds, 29: 6-11.
5. Jackson, T. Wade, T., Sericano, J., Wong, J., Gardinali, P., Chambers, L., Chambers, H., and Brooks, J. (1994) "Galveston Bay: Temporal Distributions of Organochlorine Contaminant Concentrations in Oysters", Organohalogen Compounds. 20: 133-136.

PRESENTED PAPERS and LECTURES

1. "Assessing the pollution chronology of sediments in South Florida estuaries by a combination of chemical analysis and fluorescence screening". Alvarez-Fraga, L; Gardinali, P Poster PT100, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
2. "Determination of caffeine and other personal care product ingredients, in coastal environments from the Florida Keys". Azua, A; Gardinali, P Poster PW114, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
3. "Regional distribution of organic contaminants and trace metals in fish tissue from Everglades National Park". Fernandez, A; Jaffe, R; Gardinali, P; Rand, G; Cai, Y; Cejas, M; Perry, W., Poster PH117, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
4. "Trace determination of 1-aminopropanone, a marker for wastewater contamination, by liquid chromatography with fluorescence detection (LC-FL)". Singh, Simrat P; Gardinali, Piero Poster PH130, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
5. "Paleo-reconstruction of hydrocarbon contamination sources due to the presence of major roads and their contribution to the pollution loads of wetlands in the Florida Keys and the Southern Everglades". Cejas, M; Gardinali, P Poster PW200, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
6. "Evaluation of an Atmospheric Pressure Ionization Mass Spectrometry (API-LC/MS) method for the determination of triazine-based herbicides in complex environmental matrices". Arroyo, L; Wu, J; Gardinali, P. Poster PW204, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
7. "Bioassay Directed Chemical Analyses of Biscayne Bay Sediments" Wu, J., Annavarapu, S; Willett, KL; Gardinali, PR. Platform 080, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.
8. "New Method for the Rapid Determination of Triazine Herbicides and Irgarol 1051 in Soils and Sediment by ASE-SPE-GC/MS". Wu, J; Gardinali, P Poster PH129, Society of Environmental Toxicology and Chemistry (SETAC), 24th Annual Meeting, Austin Texas, November 10-13, 2003.

9. Multidisciplinary Tools to Solve Environmental Problems in South Florida" Florida International University, October 17th 2003.
11. "Caffeine, as a specific marker for wastewater contamination, in coastal environments: lessons learned from the Florida Keys", Piero R. Gardinali*, Arlette Azua and Joseph N. Boyer 31st Scientific Meeting of the ASSOCIATION OF MARINE LABORATORIES OF THE CARIBBEAN, Port of Spain, Trinidad, July 14-18, 2003.
12. "The chemical risks of smooth sailing: the controversy around new antifouling additives and coral reefs in the Florida Keys", Gardinali, P.R. and Maxey, C. 31st Scientific Meeting of the ASSOCIATION OF MARINE LABORATORIES OF THE CARIBBEAN, Port of Spain, Trinidad, July 14-18, 2003.
13. "Using a combination of in vitro bioassays to assess toxicity of estuarine sediments". Annavarapu, S., Gardinali, P. R., and Willett, K.L. SETAC Mid-South Region Annual Meeting, Vanderbilt University, July 2003. (1st place Platform Award).
14. "New Method For The Rapid Determination Of Triazine Herbicides In Soils And Sediment By ASE-SPE-GC/MS", Jianghong Wu and Piero Gardinali . South Florida ACS -FAME2003, Orlando Fl, May 10th 2003.
15. "Environmental Analysis Of Polar Herbicides In Complex Organic-Rich Matrices By High Performance Liquid Chromatography Atmospheric Pressure Ionization Mass Spectrometry (HPLC-API-MS)" Luis Arroyo and Piero Gardinali . South Florida ACS -FAME2003, Orlando Fl, May 10th 2003.
16. "Occurrence and transport of IRGAROL 1051, a new antifouling herbicide, and its major metabolite in coastal waters from Biscayne Bay and the Florida Keys". Piero R. Gardinali*, and Charles Maxey. Joint conference on the Science and Restoration of the Greater Everglades and Florida bay Ecosystem (GEER). Palm Harbor, Florida, April 13-18, 2003 (Oral Presentation).
17. "Distribution and Occurrence of Inorganic and Organic Contaminants in Sediments from Everglades and Biscayne National Parks" Adolfo Fernandez, Piero Gardinali*, Rudolf Jaffe, Yong Cai, Gary Rand and Mark Cejas. Joint conference on the Science and Restoration of the Greater Everglades and Florida bay Ecosystem (GEER). Palm Harbor, Florida, April 13-18, 2003 (Poster).
18. "Determination of Caffeine, a specific marker for wastewater contamination, in coastal environments from the Florida Keys". Piero R. Gardinali*, Arlette Azua and Joseph Boyer. Joint conference on the Science and Restoration of the Greater Everglades and Florida bay Ecosystem (GEER). Palm Harbor, Florida, April 13-18, 2003.
19. SERC Brown Bag Seminar Series. "The chemical risks of smooth sailing: the controversy around new antifouling additives", Florida International University, April 9, 2003.
20. "Screening of Phenoxy Acid Herbicides in the Everglades and Biscayne Bay National Parks: A concern in Environmental Forensics". Luis Arroyo and Piero Gardinali*. 55th Annual Meeting of the American Academy of Forensic Sciences, Chicago, Illinois, February 17-22, 2003.
21. Invited Speaker at the Public Workshop for the Biscayne Bay Coastal Wetland Project. Deering Estates, October 29, 2002.
22. "Harmful algal blooms in the gulf of Mexico and the photochemical by-products of brevetoxin" Ron C. Hardman*, William J. Cooper, Daniel G. Baden, Andrea J. Bourdelais, and Piero Gardinali. 10th International Conference on Harmful Algae (XHAB2002), St. Pete Beach, Florida, October 21-25, 2002.

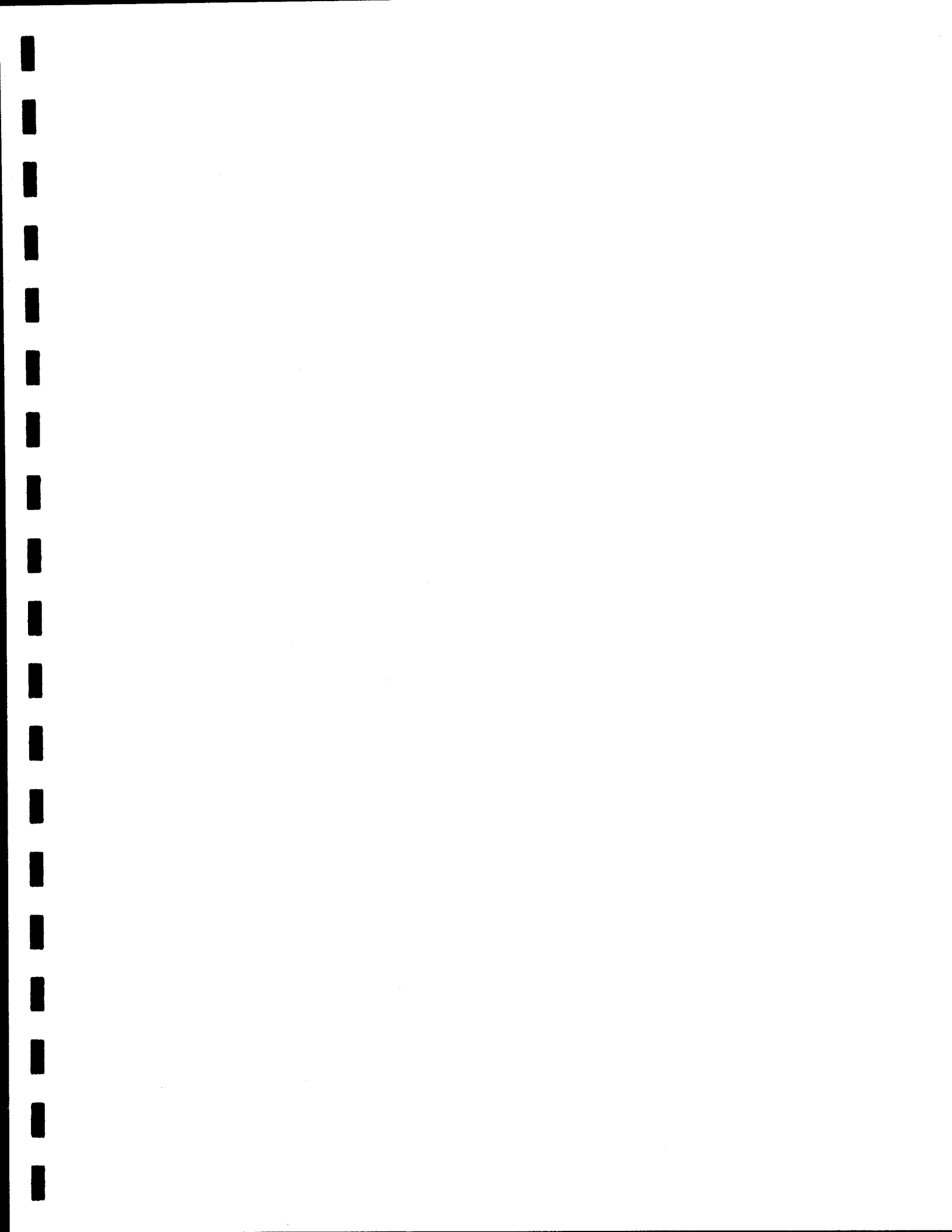
23. Invited speaker at the South Florida ACS National Chemistry Week Meeting at Flamingo Gardens "The chemistry of dirt, green chemistry, and the environment" October 19, 2002. See article on C&E News at <http://pubs.acs.org/cen/acsnews/8050/8050acsnews.html>.
24. Determination of Phenoxy Acid Herbicides in Organic Rich Sediments by ASE-SPE and Electrospray Ionization-Mass Spectrometry. Luis Arroyo and Piero Gardinali*. P138. Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
25. Occurrence and spatial distribution of inorganic and organic contaminants in coastal areas of Southwest Florida. Loreta Alvarez-Fraga, Mark Cejas, Yong Cai, and Piero Gardinali*. P143 Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
26. Partition of the herbicide IRAGROL 1051 to sediments collected from impacted waterways in South Florida. Ingrid Zamora and Piero Gardinali*. P213. Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
27. Occurrence and transport of IRGAROL 1051 and its major metabolite in coastal waters from South Florida. Piero Gardinali* and Charles Maxey. P214. Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
28. Bioassays and contaminants in largemouth bass and sediments collected from Mobile Bay. Kristine Willett*, Christy Foran, Christine Metzger and Piero Gardinali. P358. Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
29. "Assessment of estuarine sediment toxicity using a combination of *in vitro* bioassays" Annavarapu, S., Metzger, C. U., Khan, S. I., Gardinali, P. R., and Willett, K.L. South Central Society of Toxicology Meeting, Jefferson, AR. October, 2002. (Poster).
30. Distribution and occurrence of inorganic and organic contaminants in sediments from Everglades and Biscayne National Parks. Adolfo Fernandez, Mark Cejas, Gary Rand, Rudolf Jaffe, Yong Cai and Piero Gardinali*. P759. Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
31. Trace determination of caffeine in coastal waters from the Florida Keys. Arlette Azua and Piero Gardinali*. P419. Society of Environmental Toxicology and Chemistry (SETAC), 23rd Annual Meeting, Salt Lake City, Utah November 12-17, 2002.
32. Guest Speaker at the "II Escuela Tematica de Quimica Ambiental", Universidad de los Andes, Facultad de Ciencias, Merida, Venezuela, October 21 - 26, 2001.

Plenary Lecture I: "Fate and transport of Hydrophobic Contaminants in Aquatic Environments" (Comportamiento, Transporte y Destino de Contaminantes Hidrofobicos en Ambientes Aquaticos).

Plenary Lecture II: " Environmental Chemsitry of Organic Pollutants: From DDT to Estrogen" (Quimica Ambiental de Contaminantes Organicos: de DDT a Estrogeno)." (Oral presentation)
33. "Importancia de la presencia de metabolitos toxicos de compuestos aromaticos policiclicos (PACs) en peces INTEVEP-PDVSA, Caracas, Venezuela, October 26, 2001.
34. "Determination of Caffeine in Surface Waters LC/MS". P. Gardinali and X. Zhao, South Florida ACS - FAME2001, Orlando FL, May 11th 2001. (Oral Presentation)

35. "Comparative photocatalyzed Degradation of IRAGROL 1051, M1, and Atrazine Under natural Environmental Conditions". P. Gardinali and M. Plasencia, 22nd Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Baltimore, MD, November 14, 2001 (Poster).
36. "Trace Determination of Caffeine in Surface Waters by Liquid Chromatography - Atmospheric Pressure Chemical Ionization Mass Spectrometry (LC-APCI-MS)". P. Gardinali and X. Zhao, 22nd Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Baltimore, MD, November 13, 2001 (Poster).
37. "Effects of MTBE on Soil Organisms". S. Mahabir, G. Rand, P. Gardinali, and K. Jaychandran, 22nd Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Baltimore, MD, November 12, 2001 (Poster).
38. "Photo-transformation of IRGAROL 1051(TM), a new antifouling boosting agent, under simulated natural conditions". P.R. Gardinali, and M.D. Plasencia, , 21st Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Nashville, TN, November 13, 2000 (Oral Presentation).
39. "Determination of haloacetic acids in ground and surface waters by negative ion electrospray ionization LC/MS" Zhao, X., and Gardinali, P., South Florida ACS -FAME2000, Orlando FL, May 12th 2000. (Poster)
40. "Evaluation of the atomic emission detector (AED) for the fast screening of organochlorinated compounds in environmental samples: Benefits and limitations"., Rao, C., and Gardinali, P., South Florida ACS - FAME2000, Orlando FL, May 12th 2000. (Oral Presentation)
41. "Distribution of irgarol 1051, a new antifouling agent, in surface waters from Biscayne Bay, Florida", Poppel, C., and Gardinali, P., South Florida ACS -FAME2000, Orlando FL, May 13th 2000. (Oral Presentation)
42. "Differential benzo(a)pyrene metabolism and excretion in two related fish.", Willett, K.L., P. Gardinali, J. Rogers, and R. Di Giulio. Toxicologist 54(1):376. Society of Toxicology Meeting in Philadelphia, March 2000. (Oral Presentation)
43. "Determination of Benzo(a)pyrene metabolites in fish bile by atmospheric pressure chemical ionization mass spectrometry" P.R. Gardinali, K.L. Willett, and R.T. Di Giulio, 20th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Philadelphia, PA, November 16, 1999 (Oral Presentation).
44. "Benzo(a)pyrene metabolism and excretion in Channel Catfish and Brown Bullhead" K.L. Willett, J. Rogers, P.R. Gardinali, and R.T. Di Giulio, 20th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Philadelphia, PA, November 15, 1999 (Oral Presentation).
45. "Occurrence of IRGAROL 1051, a new antifouling agent, in coastal waters from the U.S." P.R. Gardinali, M.D. Plasencia, and J. Sericano, 20th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Philadelphia, PA, November 16, 1999 (Poster).
46. SERC- Brown Bag Seminar, "Detection of BaP metabolites in fish and their potential applications as indicators of contaminant exposure", FIU September 1999.

47. "Differential Phase I And Phase II Enzyme Activities In Brown Bullhead And Channel Catfish Exposed To PAHs" Willett, K, Rogers, J, Gardinali P., and Di Giulio, R., 10th Annual Symposium on Pollutant Responses in Marine Organisms (PRIMO 10), Williamsburg, VA April-May, 1999. (Oral Presentation)
48. "Determination of Irgarol 1051, A New Marine Antifouling Agent in Shipyards and Marinas Near the Miami River Area", Gardinali, P. and Plasencia, M. , South Florida ACS -FAME99, Orlando Fl, May 1999. (Oral Presentation)
49. "Detection of BaP Metabolites in Biological Fluids by Atmospheric Pressure Chemical Ionization Mass Spectrometry", Gardinali, P., Willett, K, and Di Giulio, R., South Florida ACS -FAME99, Orlando Fl, May 1999. (Oral Presentation)
50. Environmental Engineer Graduate Seminar Series, "Environmental fate of IRGAROL 1051, a new antifouling agent", FIU November 1998.
51. "Environmental contaminants in Ocelots of the Lower Rio Grande Valley, Texas, 1986-1997" M.A. Mora, L. Laack, M.C. Lee, J. Sericano, P.R. Gardinali, and D. Frank, 19th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Charlotte, NC November 17, 1998 (Poster).
52. "Contribution of PAHs, PCBs, and PCDD/PCDFs to the 2,3,7,8-TCDD Induction Equivalents (IEQs) in Environmental Samples" P.R. Gardinali and T.L. Wade, 18th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), San Francisco, CA, November 17, 1997 (Poster).
53. "Levels of toxic PCBs, PCDDs and PCDFs in biotic and abiotic samples from Galveston Bay, Texas" P.R. Gardinali and T. L. Wade, 17th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), Washington, D.C., November 20, 1996 (Poster).
54. "Chemical Analysis and In-vitro EROD Activities in Extracts from the American Oyster" P.R. Gardinali, K.L. Willett, J.L. Sericano, S.H. Safe, and T.L. Wade, Second SETAC World Congress, Vancouver, Canada, November 14, 1995 (Poster).
55. "Depuration of Highly Toxic Chlorinated Compounds by the American Oyster *Crassostrea Virginica* : A field Study" P.R. Gardinali, J.L. Sericano, and T.L. Wade, 15th International Symposium on Chlorinated Dioxins and Related Compounds, DIOXIN '95, Edmonton, Canada August 21, 1995 (Oral Presentation).
56. "Characterization of the Organochlorinated Pollutants in the Houston Ship Channel Area, a Source of Contamination for Galveston Bay, Texas" P.R. Gardinali, J.L. Sericano, J.M. Wong and T.L. Wade. 1995 Gulf of Mexico Symposium, Corpus Christi, Texas, March 30, 1995. (Poster).
57. "Determination of Organochlorinated Compounds in Coral Eggs". P.R. Gardinali and T.L. Wade. Night on the Flower Gardens 95', Houston Natural Sciences Museum, Houston Texas, March 3, 1995 (Poster).
58. "A complete method for the quantitative analysis of planar, mono, and di-ortho PCBs, polychlorinated dibenzo-p-dioxins, and furans in environmental samples". P.R. Gardinali, T.L. Wade, L. Chambers and J.M. Brooks, DIOXIN 94', Kyoto Japan, November 25, 1994 (Oral Presentation).
59. "Comparison between surrogate and internal standard based calculations for the determination of chlorinated compounds using gas chromatography with electron capture detection". P.R. Gardinali, J.M. Wong, J.L. Sericano, 208th American Chemical Society National Meeting, Washington D.C. August 24, 1994 (Oral Presentation).



GARY M. RAND, Ph.D.

Department of Environmental Studies and
Southeast Environmental Research Center
Florida International University
North Miami, FL 33181, USA.

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Web: <http://serc.fiu.edu/fiuwww/ecotox.htm>

Education

NIH Postdoctoral Fellow in Toxicology,	1977-1979,	North Carolina State University
Ph.D.,	1976,	Texas A& M University
M.S.,	1972,	C. W. Post College of Long Island University
B.A.,	1966,	Hunter College of the City University of N.Y.

Professional Background

Associate Professor, Dept. of Environmental Studies/Southeast Environmental Research Center, FIU. August, 1996-Present.

Senior Scientist, Ecological Services Inc. November, 1994-July, 1996.

Director/Vice President, Toxikon Environmental Sciences. June, 1989- November, 1994.

Environmental Toxicologist, Florida Power & Light Co. April, 1987-June, 1989.

Manager, Environmental Toxicology, FMC Corp. August, 1982-March, 1987.

Corporate Toxicologist, Occidental Chemical Corp. February, 1979-August, 1982.

Professional Affiliations

American Association for the Advancement of Science

Charter Member- Society of Environmental Toxicology and Chemistry

Editorial Board- Biomarkers, Ecotoxicology, Non-linearity in Biology, Tox. & Medicine

Workshops: Organized and chaired ten workshops on aquatic and avian toxicology.

Books

Rand, G.M. and Petrocelli, S.R. (Editors). 1985. FUNDAMENTALS OF AQUATIC TOXICOLOGY: METHODS AND APPLICATIONS. Hemisphere Publishing Corporation, N.Y. Textbook/reference book. Recipient of honorable mention award for best Life Sciences book in 1985 at the Tenth Annual Professional and Scholarly Book Awards sponsored by the Association of American Publishers.

Rand, G.M. (Editor). 1995. FUNDAMENTALS OF AQUATIC TOXICOLOGY: EFFECTS, ENVIRONMENTAL FATE AND RISK ASSESSMENT. Second Edition. Taylor and Francis, Washington, D.C.

Rand, G. M. and Lewis, M.A. FUNDAMENTALS OF AQUATIC TOXICOLOGY. Third Edition In Preparation.

Rand, G.M., Lewis, M.A., and Calo, P. (Editors). CURRENT TOPICS IN ECOTOXICOLOGY AND ENVIRONMENTAL CHEMISTRY. Book series in preparation. First book published on Genetics and Ecotoxicology (1998).

PRESENTATIONS/PUBLICATIONS

Rand, G.M. and Gardinali, P. 2004. South Florida Ecosystem. *Ecotoxicology* 13: 179-184.

Pfeuffer, R.J. and Rand, G.M. 2004. South Florida Ambient Pesticide Monitoring Program. *Ecotoxicology* 13: 195-206.

Rand, G.M. et al. 2004. Sediment Toxicity in the St. Lucie River Watershed and Everglades Agricultural Area. *Ecotoxicology* 13: 261-274.

Rand, G. M. and Carriger, J.F. Sediment Risk Assessment of South Florida Canals. Paper presented at the 19th Annual International Conference on Soils, Sediment and Water. October 20-23, 2003. Paper submitted to Soil & Sediment Contamination.

Rand, G.M. and Carriger, J.F. Screening Level Probabilistic Aquatic Ecological Risk Assessment of Canal C-111 and Adjacent Coastal Areas. Paper presented at the Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem. April 2003. Palm Harbor, FL. Paper in preparation for Human & Ecol. Risk Assess.

Rand, G. M. 2004. Fate and Biological Effects of the Insecticide- Miticide Chlorfenapyr in Outdoor Aquatic Microcosms. *Ecotoxicology & Environmental Safety* 58: 50- 60.

Rand, G.M. and Wheat, J.V. A Diluter Control System for Flow-Through Toxicity Studies with Aquatic Organisms. Submitted to Water Research.

Rand, G.M. et al. Physiological Performance Measures and Tolerance Limits for Estuarine Indicator Species in South Florida. Invited paper presented at 23rd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2002. Salt Lake City, UT.

Carriger, J.F., Rand, G.M. et al. Probabilistic Aquatic Ecological Risk Assessment of Pesticides in the C-111 Canal System in South Florida. Paper presented at 23rd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2002. Salt Lake City, UT.

Rand, G.M. Aquatic Risk Assessment of Adult Mosquito Control Agents. Invited paper at the Florida Keys National Marine Sanctuaries Mosquito Control workshop. Sponsored by DEP and NOAA. October 15 2002. Marathon, FL. Paper in preparation for Archives of Environ. Contam. & Toxicol.

Rand, G.M. Overview of Ecotoxicology and Risk Assessment in South Florida Ecosystems. Invited paper at the Contaminants and Biogeochemistry Workshop for Greater Everglades Ecosystem Restoration (GEER). Sponsored by U.S.G.S. May 29 2002. Ft. Lauderdale, FL.

Rand, G.M. et al. 2003. An Automated Overlying Water-Renewal System for Sediment Toxicity Studies. *Environ. Pollut.* 122: 169-175.

Rand, G.M. et al. 2003. Sediment Toxicity in Central and South Florida Ecosystems. *Bull. Environ. Contam. and Toxicol.* 70: 494-501.

Rand, G.M. et al. Sediment Toxicity in the Central and South Florida Ecosystem. Paper presented at 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2001. Baltimore, MD.

Rand, G.M. et al. Initial Hazard Assessment of South Florida Ecosystems. Paper presented at 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2001. Baltimore, MD.

Lounsbury-Billie, M.J., Rand, G.M. et al. Mercury and Trace Metal Concentrations in Osprey Populations in Florida Bay. Paper presented at 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2001. Baltimore MD. Paper in preparation.

Mahabir, S.P., Rand, G. M. et al. Effects of MTBE on soil organisms. Paper presented at 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2001. Baltimore MD.

Lee, T.A., Rand, G. M. et al. Effect of Irgarol 1051 on the Relationship between the Sea Anemone *Aiptasia pallida*, and its' Zooxanthellae Algae. Paper presented at 22nd Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 2001. Baltimore MD.

Lounsbury-Billie, M.J., Rand, G.M. et al. Trace Metal Concentrations in Osprey Populations in Everglades National Park. Paper presented at Greater Everglades Ecosystem Restoration Science Conference. December 2000. Naples, FL.

Rand, G.M. et al. Assessment of Sediment Toxicity in the St. Lucie River Watershed and Everglades Agricultural Area. Paper presented at Greater Everglades Ecosystem Restoration Science Conference. December 2000. Naples, FL.

Rand, G.M. et al. Initial Hazard Assessment of Sediment Toxicity in St. Lucie River Watershed and Everglades Agricultural Area. Paper presented at 21st Annual Meeting of the Society of Environmental Toxicology. November 2000. Nashville, TN.

Rand, G. M. 2002. Hazard Assessment of Resmethrin: I. Effects and Fate in Aquatic Systems. *Ecotoxicol.* 11: 101-111.

Rand, G.M. 2001. Hormesis and Ecological Risk Assessment. *Human and Experim. Toxicol.* 20: 525-526.

Rand, G. M. and Carriger, J. F. 2001. U.S. Environmental Law Statutes in Coastal Zone Protection. *Environ. Tox. & Chem.* 20: 115-121. Invited paper. Special Annual Review edition on Coastal Ecosystems

Rand, G. M. et al. 2001. The Use of Outdoor Freshwater Pond Microcosms: III. Responses of Phytoplankton and Periphyton to Pyridaben. *Environ. Tox.* 16: 96-103.

Rand, G. M. et al. Linking Exposure, Toxicological Effects and Risk Management To Sustainable Restoration of Aquatic and Wildlife Ecosystems in South Florida. Paper presented at the 1999 Florida Bay and Adjacent Marine Systems Science Conference. November 1999. Key Largo, FL.

Rand, G. M. Comparative Aquatic Hazard Assessment of Resmethrin. Paper presented at 20th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 1999. Philadelphia, Pa.

Glickfield, G. J. and Rand, G. M. Modeling Exposure to Ethion and Bromacil in St. Lucie County's C-25 Canal and Indian River Lagoon. Paper presented at 20th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 1999. Philadelphia, Pa. Paper in preparation.

Rand, G. M. et al. Fate and Effects of the Insecticide/Miticide, Pyridaben Using a Freshwater Outdoor Microcosm System. Paper presented at the 19th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 1998. Charlotte, N.C.

Pierce, R. H., Henry, M. S. and Rand, G. M. Hazard Assessment of Mosquito Insecticides in South Florida. Paper presented at the 19th Annual Meeting of the Society of Environmental Toxicology and Chemistry. November 1998. Charlotte, N.C.

PAMELA M. BACHMAN

SUMMARY OF QUALIFICATIONS

Well-versed in exposure and testing techniques for aquatic toxicology. Laboratory management skills, teaching & educational program development background, and eight years experience in aquaculture and aquatic animal husbandry. Extensive field knowledge of fresh water, marine and terrestrial ecosystems of South Florida.

EDUCATION

2003-Present Florida International University, Miami, FL
Ph. D. Student, Department of Biological Sciences

2004 (pending) Nova-Southeastern University Dania, FL
M.S. Biological Oceanography

1991 University of Connecticut Storrs, CT
B.S. Ecology & Evolutionary Biology

RELEVANT PROFESSIONAL EXPERIENCE

2002-Present Ecotoxicology & Risk Assessment Laboratory,
Florida International University, North Miami, FL

Laboratory Manager/Technician

Coordinate day-to day operations of aquatic toxicology research laboratory. Conduct flow-through, static and static-renewal toxicity tests. Culture and maintenance of freshwater, estuarine and saltwater vertebrates and invertebrates. Assure compliance with university and federal regulations for safety, testing and animal care and use; GLP and QA/QC. Operation and maintenance of specialized equipment and automated systems for culture & testing.

1999-2002 Department of Environmental Studies, Florida
International University Miami, FL

Laboratory Manager/Graduate Assistant Coordinator

Developed of laboratory and field course curriculum. Oversaw instructors and training of instructors for undergraduate laboratory classes. Assured laboratory compliance with workplace health and safety standards. Coordinated construction of new laboratory space. Administered budget and inventory.

Prior to 1999 Varied, Florida and New England

Outdoor/Environmental Education Specialist & Program Developer

Designed and implemented programs and served as instructor for various national and local environmental/outdoor education providers including National Audubon Society, Fairchild Tropical Garden (Miami, FL) and YMCA. Skilled at curriculum development; fostering group dynamics and leadership skills; working with special needs students; and working in extreme field conditions.

TECHNICAL AND COMPUTER SKILLS

Laboratory Skills: Gas Chromatography & Mass Spectrometry; Flow Cytometry; Fluorometry; Osmometry; Organic extractions; Microtox; Hematology; Dissection and vivisection; Confocal Microscopy; Use of proportional diluters and overlying water renewal systems for aquatic toxicology; taxonomy (South Florida).

Field Skills: SCUBA certified; U.S. Coast Guard Training for Operation of Oceanographic Vessel (ORV); Small boat handling; Various fish collection techniques including seine, cast and gill netting; Plankton and invertebrate sampling; Water and Sediment sampling.

Animal Culturing & Husbandry: Collection, breeding and maintenance of fresh water, marine and estuarine fish and invertebrates; Egg stripping, artificial fertilization, and artificial insemination of fish; Design, construction and maintenance of aquaculture systems.

Computer Skills: Windows 98, 2000, NT & XP; Microsoft Office Suite; SPSS, SAS; Statistica.

Programming Languages: VB 6 and VB. Net

LANGUAGES

French: Written & Verbal

Spanish: Working Verbal

Michael S. Tompkins

SUMMARY: • Magna Cum Laude graduate with BS in Environmental Studies and a Minor in Chemistry.

EDUCATION: **Bachelor of Science in Environmental Studies, December 2003**
Florida International University, Miami, Florida
Graduated Magna Cum Laude with a GPA of 3.7 on a 4.0 scale

Upper Division Courses taken included:

Ecology of Biotic Resources (A)	Ecology of South Florida (A)
U.S. Environmental Policy (A)	Ecotoxicology (B+)
Water Resources (A)	Soils and Ecosystems (A)
Intro to Environmental Economics (A)	Statistics I (B)
Quantitative Analysis (B+)	Ecology (B)
Ecological Risk Assessment (A-)	

M.S. Environmental Studies, January 2004 to present
Received Cristina Mendoza Fellowship 2004

EXPERIENCE: **Graduate Research Assistant, January 2003 to Present**
SERC Ecotoxicology Lab Florida International University

- Culture and maintain freshwater and marine vertebrate and invertebrate test species.
- Setup and maintain flow-through exposure systems.
- Conduct toxicity tests with freshwater and marine species in both sediment and water matrices.
- Assist in ecological risk assessment research and data analysis

TATIANA TREJOS , BSc , Lic., M.Sc.

**WORK
EXPERIENCE**

1994 - 1996 University of Costa Rica San José, CR

Undergraduate Teaching Assistant

Analytical Chemistry, Physical Chemistry and Food Analysis courses

1996 - 1997 University of Costa Rica San José, CR

Research Assistant

Research in simultaneous elemental analysis at trace levels with a microelectrode system.

Research of the chemistry of the asphalt and correlation with their physical properties.

1997-1998 University of Costa Rica San José, CR

Assistant professor

Professor at the Department of Physical Chemistry.

1997-1998 GUTIS Pharmaceutical Lab. San José, CR

Chemist

Quality Assurance Department

1998-2001 Organismo de Investigacion Judicial . Heredia, CR

Forensic Chemist

Chemist of the Chemical and Toxicology Departments.

Experience in the following areas: Drugs and Toxicology, Fire Debris and Alcohol, Paint, Gunshot Residues, Explosives and Trace Evidence.

Main tasks performed in the Forensic Laboratory:

Chemistry of the Drug and Toxicology Department (2001)

Member of the Quality Assurance Program United Nations-OIJ

Coordinator of the Residues Department (Fire Debris, Explosives, Alcohol and Paint)

Professor of the Basic Courses for Investigators (Trace Evidence)

2002 - 2004 Florida International University Miami, FL

Research Assistant

Research on elemental analysis of glass and paint at International Forensic

Research Institute using ICP-MS, LA-ICP-MS, SEM-EDS and refractive index.

1999-2003 Main tasks performed at IFRI:

Elemental analysis of samples using ICP-MS, LA-ICP-MS and SEM-EDS

Elemental analysis of real casework samples

Assistance on the preparation of proficiency tests

Support on the training forensic examiners on glass analysis

Design of a database for elemental analysis and refractive index of glass

2004 Organismo de Investigacion Judicial . Heredia, CR

Forensic Chemist

Supervisor of the Trace Evidence Unit, Chemistry Department.

Training support on different areas

President

Costarrican Asociation of Forensic Sciences (Asociacion Costarricense de Profesionales en Ciencias Forenses, ACCF)

OTHER EXPERIENCE ON INSTRUMENTAL ANALYSIS

More than three years of hands on experience on the following instruments:

Organic analysis by GC/FID, GC pyr / FID, GC/NPD, GC/MS, HPLC/DAD, LC/MS, UV/VIS and FTIR.

Inorganic analysis by ICP/OES, ICP/MS, LA/ICP/MS, SEM/EDS, XRF, FTIR, micro/FTIR.

EDUCATION

1997 Universidad de Costa Rica San Jose, CR

Bachelor in Chemistry

Chemistry Department

1998 Universidad de Costa Rica San Jose, CR

Licentiatute in Chemistry

Chemistry Department

2000-2001 Universidad de Costa Rica San Jose, CR

Graduate Student

Graduate student of the Master Degree in Industrial Pharmacy

Pharmacy Department

2003 Florida International University Miami, FL

Master of Science in Forensic Science

Chemistry Department

OTHER STUDIES

1998-2000 Organismo de Investigación Judicial San José, CR

Theoretical and Hands on course: Atomic Absorption Spectrometry

Theoretical and Hands on course: HPLC and GC Columns

Basic Course in Forensic Chemistry given by DEA

Basic course in use of firearms

Theoretical and Hands on course: Gas Chromatography

Theoretical and Hands on course: LC/MS

Theoretical and Hands on course: ICP-OES

Theoretical and Hands on course: Explosives

2000 University of Glasgow Scotland, UK

Training Programme in the analysis of drugs in biological specimens
Department of Forensic Medicine and Science

2004 Florida International University Miami, FL

Workshop on Forensic Analysis of Paint

PATENTS AND
PUBLICATIONS

Posters:

1. ACS 221st National Meeting, **Orlando, FL** "*Sample Introduction of Materials of Forensic Interest Using Laser Ablation for Inductively Coupled Plasma Mass Spectrometry Analysis of Metals.*" J.R. Almirall, S. Montero, A. Hobbs, T. Trejos, L. Morris, and S. Gross.
2. 16th meeting of the International Association of Forensic Sciences IAFS, **Montpellier, France.** *Comparison of Solution External Calibration, Solution Isotope Dilution and Laser Ablation as Tools in the Analysis of Glass Fragments by Inductively Coupled Plasma Mass Spectrometry*, T. Trejos, S. Montero and J.R. Almirall, September 16-22 2002.
3. Forensic Science Symposium, 21st century Forensic Sciences in South Florida, **Miami, FL.** *Comparison of Solution External Calibration, Solution Isotope Dilution and Laser Ablation as Tools in the Analysis of Glass Fragments by Inductively Coupled Plasma Mass Spectrometry*, T. Trejos, S. Montero and J.R. Almirall, January 18 2003.
4. 16th meeting of the International Mass Spectrometry Conference (IMSC), **Edinburgh, Scotland.** Study of the effects from size and distribution of particles entering a plasma and elemental fractionation on the quantification of glass samples during LA-ICP-MS. T. Trejos and JR Almirall, September 2003
5. Plasma Winter Conference, Fourt Lauderdale, FL. Microhomogeneity considerations for the forensic analysis of glass by laser ablation-ICP-MS. T. Trejos and JR Almirall, January 2004.
6. 56th Annual Meeting, American Association of Forensic Science. **Dallas, TX.** Elemental Analysis of Materials by Laser Ablation Inductively Coupled Plasma (LA- ICP-MS) for Forensic Applications; Instrumental Considerations, JR Almirall and T. Trejos, February 2004
7. 56th Annual Meeting, American Association of Forensic Science. **Dallas, TX.** Elemental Analysis of Paints by LA-ICP-MS, A. Hobbs, T. Trejos and JR Almirall, Febrero 2004

Oral presentations at Scientific meetings:

1. VII ENFSI Paint and Glass WG Meeting, **Madrid, Spain.** *Elemental Analysis of Glass and Paint by ICP-MS, ID-ICP-MS and LA-ICP-MS*, T.

- Trejos, S Montero, A. Hobbs and J.R. Almirall, September 18-20 2002.
2. 55th Annual Meeting of the American Academy of Forensic Sciences, **Chicago, IL**. *Evaluation of Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) as a Tool for the Elemental Analysis and Discrimination of Glass Evidence*. T. Trejos and JR Almirall, February 17-22 2003
 3. NITECRIME group meeting , **Viena, Austria**, *Forensic Analysis of Paints by LA-ICP-MS*, T. Trejos, A. Hobbs and JR Almirall, April 28-30 2003
 4. FAME Florida American Chemical Society, Florida Section. **Orlando, FL**. *Evaluation of the Homogeneity of Glass Samples by LA-ICP-MS*. T. Trejos and JR Almirall, 8-10 May 2003.
 5. 30th Annual Meeting FACCS, **Fort Lauderdale, FL** Application of Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) to the "Fingerprinting" of Trace Evidence, T. Trejos and JR Almirall. October 19 - 23, 2003
 6. 56th Annual Meeting, American Association of Forensic Science (AAFS), **Dallas, TX**. Sampling considerations in the analysis of glass fragments by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), T. Trejos and JR Almirall, February 2004.

Papers:

1. T Trejos, S Montero, JR Almirall. *Analysis and Comparison of Glass Fragments by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) and ICP-MS* *Journal of Analytical and Bioanalytical Chemistry*, 2003, 376, 8: 1255-1264
2. T. Trejos and J.R. Almirall, *Effect of fractionation on the elemental analysis of glass using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)*, *Analytical Chemistry*, March 2003.
3. JR Almirall, T. Trejos, A. Hobbs, K. Furton. . *Trace elemental analysis of glass and paint samples of forensic interest by ICP-MS using Laser Ablation solid sample introduction*, *SPIE proceedings* 2003
4. T. Trejos and J.R. Almirall. *Homogeneity study of the elemental composition of glass by LA-ICP-MS*, submitted 2004, *Talanta*
5. T. Trejos and J.R. Almirall. *Glass analysis by LA-ICP-MS: Does fragment size really matter?*, submitted 2004, *Talanta*
6. T. Trejos. *Forensic Analysis of Glass and Paints by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)*. Thesis, Florida International University (FIU), 2003

LANGUAGES

English and Spanish

REFERENCES

Available upon request

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San José, Costa Rica
América Central

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E-mail larroyo@orgoma.com

LUIS ARROYO , BSC , LIC. , M.SC.

WORK EXPERIENCE

2004-Organismo de Investigacion Judicial, Departamento de Ciencias Forenses (DCF), San Jose, CR

Project supervisor for the Environmental Forensic unit at the DCF.

2002-2003 Florida International University Miami, FL
Research Assistant

Research on herbicides in sediments and fish tissue at the Southeast Environmental Research Center SERC, FIU

1996 - 2001 Bioanalytical Orgoma S.A San José, CR
Customer Engineer

Sales and Analytical Support for Agilent Technologies Instruments including HPLC, GC with special detectors (NPD, FPD, uECD), GC/MSD, UV-VIS, FT-IR (Thermo-Nicolet Instruments Co.), GFAAS, ICP-OES, AAS (GBC Scientific Equipment Ltd).

1995-1996 University of Costa Rica San José, CR
Assistant professor

Professor at the Department of Analytical Chemistry (Fundamentals of Food Analysis, Laboratory of Instrumental Methods of Analysis and Qualitative and Inorganic Chemistry)
Professor in charge of the Instrumental Room at the Chemistry Department

1992-1996 University of Costa Rica San José, CR
Research Assistant

Assistant of the Plasma and Chromatography Laboratory of the Electrochemistry and Energy Research Center. (CELEQ)
Assistant at the Lubricant and Fuels Laboratory. Electrochemistry and Energy Research Center. (CELEQ)

EDUCATION

December 2003 Florida International University Miami, FL
Master of Science in Forensic Science
Chemistry Department

2000-2001 Universidad de Costa Rica San Jose, CR
Graduate Student
Graduate student of the Master Degree in Industrial Pharmacy
Pharmacy Department

1995 Universidad de Costa Rica San Jose, CR
Licentiate in Chemistry
Chemistry Department

OTHER STUDIES

1992-1993 Universidad de Costa Rica San Jose, CR

Central American Electroanalysis of Trace Metals Course. Electrochemical and Energy Research Center (CELEQ)
Central American Electroanalysis of Trace Metals Course, part II.
Electrochemical and Energy Research Center (CELEQ) Theoretical and Analytical Quality Assurance Course, Series NCR NE 45000.
Lubricants and Fuel Oils Analysis. Electrochemical and Energy Research Center (CELEQ)

1996 Hewlett Packard Co Atlanta, GA
Course H 4043 A: HP 6890-5973 MSD: Chemstation and Instrument Operation

1997 Nicolet Instruments Co Mexico. DF
FTIR training course

1998 Hewlett Packard Co Bogota, Colombia
Seminar: Environmental Solutions with Hewlett Packard

1998 Bioanalytical Orgoma S.A San José, CR
Training course on GC's of Hewlett Packard: 6890, 6850, Micro-GC's, 1100 LC/MSD, operation, maintenance and troubleshooting.

1999 Bioanalytical Orgoma S.A San José, CR
Training course on Capillary electrophoresis given by Dr. Ron Majors (Hewlett Packard Co.).

2000 Hewlett Packard Co Mexico, DF
Training course on Petrochemical Industry HP GC 6890 solutions

2001 GBC Scientific Equipment Chicago, IL
Training course on Atomic Absorption Spectroscopy (AAS) and Graphite Furnace Atomic Absorption Spectrometry (GFAAS)

PATENTS AND PUBLICATIONS

Posters:

23rd SETAC Annual Meeting, Determination of Phenoxy Acid Herbicides in Organic Rich Sediments by ASE-SPE and Electrospray Ionization-Mass Spectrometry, Salt Lake City, Utah. November 2002. Luis Arroyo and Piero Gardinali

55th Annual Meeting of the American Academy of Forensic Sciences (AAFS), Chicago, Screening of Phenoxy Acid Herbicides in the Everglades and Biscayne Bay National Parks: A concern in Environmental Forensics. Luis Arroyo and Piero, Gardinali , February 17-22 2003

American Chemical Society, Florida Section, Environmental Analysis of Polar Herbicides in Complex Organic Rich Matrices by HPLC Atmospheric Pressure Ionization-Mass Spectrometry (HPLC-API-MS), Luis Arroyo and Piero Gardinali May 8-10 2003

16th meeting of the International Mass Spectrometry Conference (IMSC), Edinburgh, Scotland. "Screening of polar herbicides in complex environmental matrices by accelerated solvent extraction (ASE), solid phase extraction (SPE) atmospheric pressure ionization mass spectrometry (API-LC/MS) L. Arroyo and P.R. Gardinali, September 2003

Papers:

Arroyo, L. Thesis: "Determination of Lead and Cadmium in Drinking Waters of Santa Barbara de Heredia Community" Revista Ingenieria y Ciencia Quimica, del Colegio Federado de Quimicos e Ingenieros Quimicos de Costa Rica. 1995

Arroyo, L. Thesis: "Environmental Analysis of Polar Herbicides in Complex Organic-Rich Matrices by High Performance Liquid Chromatography Atmospheric Pressure Ionization Mass Spectrometry (HPLC-API-MS)", Florida International University, Miami FL, 2003

Conferences and meetings:

16th meeting of the International Association of Forensic Sciences, Montpellier, France, September 16-22 2002.

VII ENFSI Paint and Glass WG Meeting, Madrid, September 18-20 2002.

English and Spanish

LANGUAGES

Available upon request

REFERENCES

Adolfo Fernandez
Southeast Environmental Research Center
and
Department of Environmental Studies
Florida International University
Miami, Florida 33199

EDUCATION

August 2004

M.Sc. Environmental Studies, Florida International University, Miami, Florida.

April 2000

B.S. Environmental Studies, Florida International University, Miami, Florida.

EMPLOYMENT RECORD

2001-2004

Research Assistant, Department of Environmental Studies and Southeast Environmental Research Center, Florida International University

2000-2001

Teaching Assistant, Department of Environmental Studies, Florida International University

2000

Intern, the Nature Conservancy of the Florida Keys, Key West Florida.

1997-2000

Lab Assistant, Department of Environmental Studies, Florida International University.

SELECTED PUBLICATIONS

1. Fernandez, A. (2004), Distribution and occurrence of inorganic and organic contaminants in sediments and whole fish tissue of Everglades and Biscayne National Parks. M. Sc. Thesis, Florida International University, Miami Florida.
2. Jaffe, R., Gardinali, P., Cai, Y., Sudbury, A., Fernandez, A., Hay, B. J. (2003), Organic compounds and trace metals of anthropogenic origin in sediments from Montego Bay, Jamaica: assessment of sources and pathways, Environmental Pollution 123: 291-299.

RECENT PRESENTATIONS

1. Regional distribution of organic contaminants and trace metals in fish tissue from Everglades National Park. A. Fernandez, R. Jaffe, G. Rand, Y. Cai, M. Cejas, W. Perry. 24th Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), November 13, 2003 (Poster).
2. Distribution and occurrence of inorganic and organic contaminants in sediments and whole fish tissue from Everglades and Biscayne National Parks. A. Fernandez, R. Jaffe, G. Rand, Y. Cai, M. Cejas Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem (GEER) April 13-18, 2003. (Poster).
3. Distribution and occurrence of inorganic and organic contaminants in sediments from Everglades and Biscayne National Parks. A. Fernandez, R. Jaffe, G. Rand, Y. Cai, M. Cejas. 23rd Annual Meeting, Society of Environmental Toxicology and Chemistry (SETAC), November 20, 2002 (Poster).

TECHNICAL EXPERIENCE

- Very familiar with the ecology and geochemistry of South Florida ecosystems.
- Experienced in planning and conducting sampling excursions for water, soil/sediment, and tissue collections in terrestrial, freshwater, and marine environments.
- Experienced in the organization and preparation of samples for analysis of organic and inorganic contaminants.
- Proficient in instrumental analysis, maintenance and troubleshooting for GC-MS, GC-ECD, GC-FID, and ICP-MS.
- Proficient in data analysis software including HP-Chemstation, EZChrom elite, and Perkin Elmer Elan.
- Experienced in the organization and presentation of data for regional scale projects using GIS.

APPENDIX II
List of target analytes

LIST OF PESTICIDES AND HERBICIDES

pesticide	surface water	sediment
chlorinated (phenoxy acid) herbicides		
2,4-D	X	X
2,4,5-T	X	X
2,4,5-TP (silvex)	X	X
urea herbicides and imidacloprid		
diuron	X	X
linuron	X	X
imidacloprid	X	-
organonitrogen and phosphorus pesticides		
alachlor	X	X
ametryn	X	X
atrazine	X	X
azinphos methyl (guthion)	X	X
bromacil	X	X
butylate	X	-
chlorpyrifos ethyl	X	X
chlorpyrifos methyl	X	X
demeton	X	X
diazinon	X	X
disulfoton	X	X
ethion	X	X
ethoprop	X	X
fenamiphos	X	X
fonophos	X	X
hexazinone	X	X
malathion	X	X
metalaxyl	X	-
methamidaphos	-	X
metolachlor	X	X
metribuzin	X	X
mevinphos	X	X
monocrotophos	-	X
naled	X	X
norflurazon	X	X
parathion ethyl	X	X
parathion methyl	X	X
phorate	X	X
prometryn	X	X
simazine	X	X

pesticide	surface water	sediment
organochlorine pesticides		
aldrin	X	X
alpha BHC	X	X
beta BHC	X	X
delta BHC	X	X
gamma BHC (lindane)	X	X
carbophenothion (trithion)	X	X
chlordane	X	X
chlorothalonil	X	X
cypermethrin	X	-
p,p'-DDD	X	X
p,p'-DDE	X	X
p,p'-DDT	X	X
dicofol (kelthane)	X	X
dieldrin	X	X
alpha endosulfan	X	X
beta endosulfan	X	X
endosulfan sulfate	X	X
endrin	X	X
endrin aldehyde	X	X
heptachlor	X	X
heptachlor epoxide	X	X
methoxychlor	X	X
mirex	X	X
permethrin	X	-
toxaphene	X	X
PCB-1016	X	X
PCB-1221	X	X
PCB-1232	X	X
PCB-1242	X	X
PCB-1248	X	X
PCB-1254	X	X
PCB-1260	X	X
trifluralin	X	X

- not analyzed
 compounds in red have a
 Water Quality Class I or III
 criterion