

**WATER RESOURCES MONITORING
AND
RESEARCH RECOMMENDATIONS
FOR THE BARATARIA UNIT,
JEAN LAFITTE NATIONAL HISTORICAL PARK**

Jill Baron, Ph.D., Applied Research Branch
National Park Service Water Resources Division
Fort Collins, CO 80523
(303) 491-1968

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Introduction

The Barataria Unit of Jean Lafitte National Historic Park is an aquatic and wetland/estuarine ecosystem whose ecological integrity and behavior are directly tied to hydrologic processes and water quality. In order to ably manage the Barataria Unit it is necessary to develop an understanding of the forces, both natural and human-caused, that influence dominant hydrologic and biogeochemical cycles. Park managers have chosen to explore the use of ecosystem models as a tool for understanding and managing the Barataria Unit. Since ecological understanding can best be acquired through study of natural processes along the time scale at which they occur, and since ecological simulations are only as good as the information and understanding upon which they are based, it is absolutely necessary to initiate and maintain a water resources monitoring program.

Suggestions for this monitoring program are made below. These suggestions were identified during the June 2-4, 1992 water quality management meeting organized by park resource management staff and including the Southwest Regional Water Resources Coordinator and Regional Chief Scientist, JELA management staff, Water Resources Division personnel, and several local wetlands scientists. While introduced in this document, complete details regarding techniques, personnel required, equipment, development of quality assurance plans, or vandalism-proofing are not discussed here. These can be obtained from additional documents or technical assistance requested from WRD.

It is important that the park identify a priori how the results of each monitoring effort will be used. One legitimate use is to document a problem in order to act to resolve it. Park managers may want to follow up on the results of monitoring for sewage

inputs, for example, by initiating action to reduce this input. Another legitimate use for monitoring data is to provide parameterization or validation data for models. An important use of monitoring results is to follow up on the results of management actions, in order to ensure the intended results were achieved. By identifying to what use each datum will be put, park managers can also evaluate periodically how well objectives are being met, and the efficacy of the monitoring program. Monitoring need not go on indefinitely if the results suggest termination is warranted.

Water resources monitoring recommendations have been separated from water resources research projects by subjective delineation. Techniques that: a) provide unequivocal evidence of change from a particular driving force (whether natural, such as wind storms, or human-caused, such as sewage influx); b) allow park managers to greatly increase their understanding of major hydrologic and biogeochemical processes important to the Barataria Basin; c) allow park managers to assess the effectiveness of particular management actions (follow-up monitoring); and d) provide the necessary information to support the NRPP modeling effort are placed into the monitoring category. Techniques that: a) have not yet been proven as unequivocal tools for enhancing resource management; or b) may increase understanding of park resources, but then again, may not, are placed in a "research" category. Monitoring and research topics are listed below in no order of priority.

Water Resource Monitoring Recommendations for Specific Issues

Issue: Sewage Inflow

Discussion: There is uncontestable evidence that untreated human sewage is entering the Barataria Unit from several sources. The sewage treatment plant for the Town of Westwego seems to be a large point source, and the fecal coliform/fecal streptococcus bacteria ratio has remained very high, even after supposedly larger capacity treatment facilities were installed. Human sewage and other forms of untreated wastewater may also be moving into the Unit from poorly maintained sewage lines of the City of New Orleans, from poorly- or non-functioning septic tanks of inholdings throughout the Unit and from the village of Crown Point.

Management Concern: Raw sewage is a human health hazard. It also makes for an unpleasant visitor experience by causing noxious odors and unsightly water. Nutrient inputs can affect marsh animal and vegetation community composition.

Recommended Monitoring: Weekly monitoring of areas of sewage influx along the boundaries and within the Barataria Unit. Samples should be collected and analyzed for coliform bacteria, dissolved oxygen, phosphate, nitrate, and ammonium. One or more control sites should also be established and monitored weekly to maintain a baseline for the Barataria Unit. Ten percent of samples collected should be replicates, and a quality control effort will use these to address the confidence associated with sample collection results.

Equipment Needed: Boat, sample bottles, access to qualified analytical laboratory, data sheets, computer data management system.

Necessary Ancillary Data: Continuous water level and meteorological information.

Personnel requirements: Sample collection: 0.5 days/wk; laboratory preparation: 0.5 days/wk; data entry and quality assurance: 1.0 days/wk.

Issue:**Pump Inflows**

Discussion: Large pumps are either already built or are being built to pump excess storm drainage water from the New Orleans urban area into the Barataria Basin.

Management Concern: This water may contain untreated sewage, metals, organic toxins, and anything else that washes off the streets of New Orleans.

Recommended Monitoring: Points of pumped water influx along the Barataria Unit boundaries ideally should be monitored whenever pumps are active. This is logistically impractical. An alternative is to install automated samplers that collect water at discrete intervals (such as once per day). Samples should be collected and analyzed for phosphate, nitrate, and ammonia. A suite of metals (such as lead, mercury, cadmium, zinc) can be analyzed inexpensively with inductively-coupled plasmography, ICP). Organic compounds may be too expensive to analyze for regularly; analyses for them can be scheduled for when resource managers suspect high likelihood of their detection. Analyses for fecal coliform bacteria, while desirable, must be initiated within 24 hours of their collection, so daily information on them cannot be obtained from samples collected by the automated samplers. Instead, water could be collected for bacterial analyses on the day that the sample bottles are changed each week. If automated samplers are used, samples collected during periods when pumps are not flowing can be analyzed to detect ambient water quality in the absence of storm sewer overflows. Ten percent of samples collected should be replicates, and a quality control effort will use these to address the confidence associated with sample collection results.

Automated samplers will not be able to capture results of discrete pump episodes. Park managers may wish to prepare for intensive sampling of large storm events to determine the magnitude of input pollutants from a given storm.

Equipment Needed: Boat, sample bottles, automated samplers, access to qualified analytical laboratory, data log, computer data management system.

Necessary Ancillary Data: Continuous water level and meteorological information. Is there some way you could develop a relationship with the New Orleans pump operator people so they could alert you when pumps are to be activated?

Personnel requirements: Sample collection: 0.5 days/wk; laboratory preparation: 0.5 days/wk; equipment maintenance 0.5 days/wk, data entry and quality assurance: 1.0 day/wk.

Issue: Concentrated salt brine and radiation leakage from abandoned oil and gas wells within the Barataria Unit

Discussion: Although these pollutants have not been substantiated within the Barataria Unit, other oil and gas wells in organic sediments of the Gulf Coast have produced waters so saline as to destroy surrounding vegetation. Some research has shown a positive relation between chloride concentration and radioactivity.

Management Concern: "Gaps" created by brines can enhance erosion of freshwater and estuarine wetlands.

High concentrations of uranium and its decay products have also been detected seeping from abandoned wells. Except for workers directly handling high quantities of radioactive material from these wells (such as at refineries or at active wells), the radioactivity does not seem to pose a health hazard.

Recommended Monitoring: After capping abandoned wells, well location should be permanently marked. Bulk sediment samples should be collected in concentric circles of increasing size around each pad once a year and analyzed for specific conductivity and major ions. If significantly high concentrations are detected, a more rigorous sampling program should be initiated, with the intent of documenting leakage to develop sufficient justification for additional well remediation. Sampling for radioactivity need not occur unless highly saline brines are detected. If the park pursues sampling for radioactivity, ²²⁶Ra (radium) is a relatively stable isotope of uranium that serves as an indicator.

Equipment Needed: Boat, sample bottles or plastic sample bags, access to qualified analytical laboratory, data log, computer data management system.

Necessary Ancillary Data: Continuous water level and meteorological information.

Personnel requirements: Sample collection and preparation: 1.0 days/yr; data entry and quality assurance: 1.0 days/yr.

Issue:

Increased salinity within wetlands and dredged and maintained boat and pipeline canals may expose freshwater areas to increased salinity.

Discussion: With increasing wetland erosion south of the Barataria Unit, and regional subsidence, historic salinity gradients are being replaced by more abrupt salinity increases. These may be further enhanced by wind-induced tides or storm surges. Man-made canals in the Barataria Unit may serve as conduits for this salt water. There are at least two other possible causes of increased salinity in Barataria waters and wetlands. Both result from man-caused alteration of the hydrologic cycle by decreasing the ratio of freshwater loss from the Basin via flushing versus freshwater loss via evaporation or transpiration.

1. In the absence of historically higher freshwater infusions from Mississippi River flooding, Barataria wetlands rely on rain for freshwater inputs. This lower volume of freshwater translates to less flushing capability, greater buildup of salts that are not flushed, and a greater proportion of the overall hydrologic budget lost via evapotranspiration, a process that concentrates salts.

2. Canal construction resulted in small levees bordering the canals. These may have created a checkerboard of closed wetland basins where at least surface sheet flow is impeded. As in 1), above, the absence of flushing allows increasingly concentrated salts and this may be further exacerbated by water loss through evapotranspiration.

Management Concern: Salt-intolerant freshwater communities may be at risk from increased salinity. Intolerant communities may be replaced by more salt-tolerant communities. An alternative possibility is that attached freshwater wetlands may erode to be replaced with floating marshes, and finally with open water, resulting in a net loss of wetland. Proposed man-made barriers at the outlets of each canal might not decrease salinity, and also might have unanticipated ramifications for the Barataria Unit.

Recommended Monitoring: An extensive monitoring program should be initiated throughout the Barataria Unit.

Canals: Specific conductivity and temperature should be measured at canal inlets, outlets, and several intervals in-between. Ideally, conductance should be intensively measured at discrete depth intervals (e.g. every 10 cm at 1 hour intervals) from surface to canal bottom at each location. This may not be economically feasible. An alternative suggestion is to collect specific conductance from top and bottom waters using automated meters with data loggers, and collect a full profile manually each week when the data logger and meters are serviced.

Wetlands: Very little is known of salinity gradients from the periphery of a wetland to its interior, nor of gradients that may occur with increasing depth within different types of wetlands. This information will be valuable for determining whether there is direct interchange of canal water with inland waters, whether evapotranspiration is contributing to increased salinity, or whether different vegetation types are associated with different

salinities. A minimum recommended monitoring program will consist of specific conductance and temperature collected with remote dataloggers along one or more transects from the exterior to the interior of several wetland areas within the Barataria Unit. As with canals, it is highly desirable to monitor conductivity at two or more depths at each sample point. A more ambitious sampling program will include analyses (weekly at first, subsequent frequency determined after analyses of temporal variance) for major ions (calcium, magnesium, sodium, potassium, hydrogen, ammonium, chloride, sulfate, nitrate, carbonate, phosphate). Major ions can be used in many ways, for example, the calcium to magnesium ratio indicates whether water was of marine or terrestrial origin.

Equipment Needed: Boat, sample bottles, specific conductivity meters coupled with two or more channel data loggers, conductivity check samples for weekly calibration, access to qualified analytical laboratory, data logger, computer data management system.

Necessary Ancillary Data: Continuous water level and meteorological information. While not necessary, a geographic information system would be nice for displaying and interpreting results.

Personnel requirements: Equipment installation will be a big task. Afterwards, regular sample collection, equipment maintenance and service, and preparation: 2.0 days/wk; data entry and quality assurance: 1.0 days/wk.

Issue: Rising water levels within wetlands and dredged and maintained boat and pipeline canals may increase total area of floating marsh, and make wetlands more susceptible to erosion.

Discussion: For complex reasons, many Louisiana wetlands are sinking. It is important to develop the causes and consequences of rising water levels on vegetation type and even vegetation retention. It is not known, for example, whether floating marshes between open water and attached wetlands represent a natural continuum that is stable over time, or whether they are increasing in size with regional subsidence.

Management Concern: Floating wetlands may be more vulnerable to tropical storms than attached wetlands. Floating mats could become detached and drift away, causing loss of land area and increased open water. Nutria herbivory, resulting in "eatouts", can complicate this problem further.

Recommended Monitoring: An extensive water level monitoring program should be initiated throughout the Barataria Unit. Stage height recorders ideally should be co-located with conductivity recorders along transects east from Lake Salvador toward Bayou des Familles. Siting should be coordinated, if at all possible, with Tom Doyle's monitoring efforts so he can directly relate his results back to water levels.

Equipment Needed: Stage height recorders, stilling wells, and data loggers, equipment for downloading data loggers, field data books, computer data management system.

Necessary Ancillary Data: Meteorological information. Vegetation community information (collected by FWS-Doyle). A geographic information system will be most useful for displaying information.

Personnel requirements: Equipment installation will be a big task. Afterwards, regular equipment maintenance and service, 2.0 days/wk; data entry and quality assurance: 1.0 days/wk.

Issue: Canals as conduits for industrial pollutants into the Barataria Unit.

Discussion: The Harvey Canal, along the east and south boundaries of the Barataria Unit, drains from heavily industrialized and commercial areas of New Orleans. A study in 1988 found contaminated bottom sediments from the Harvey Canal and also elevated levels of dissolved mercury in Lake Salvador (Demcheck 1991). High concentrations of metals were not found within the park area itself. The herbicide atrazine, which can be aerially transported, was found to be widely distributed throughout the Barataria Basin in the 1988 study.

Management Concern: Metals and synthetic organic compounds constitute an unnatural intrusion of serious pollutants that can be extremely toxic to aquatic organisms and their predators.

Recommended Monitoring: Ideally, the State Department of Environmental Health, the U.S. Fish and Wildlife Service, or the U.S. Geological Survey will conduct this monitoring at no cost to the park. If, however, no further trace element or organic constituent monitoring will be conducted (this is hard to believe), JELA may want to initiate analyses in canals inside park boundaries closest to sources of these metals. Sources include the InterCoastal Waterway and the Harvey Canal, and maybe Lake Salvador (?). Biological indicators might be appropriate tools for this task.

Equipment Needed: For metals: Proper sampling for metals require stringent adherence to protocols. This includes maintaining very clean sampling technique and acidifying samples immediately after collection to prevent metal adsorption onto sample bottle walls. This is not a casually-undertaken sampling program, and it is recommended that the park let some other entity with experience in metals monitoring take on this responsibility.

For biological indicators: A toxicologist will be required to collect initial samples and train JELA personnel.

Necessary Ancillary Data: Continuous water level and meteorological information. If biological indicators are used, species lists or community indices will be necessary. While not necessary, a geographic information system would be nice for displaying and interpreting results.

Personnel requirements: Properly trained technicians are required. Sample collections for metals once per year should be sufficient to determine whether there is a trend. The Water Resources Division has in-house expertise in the use of biological indicators for monitoring and may be available for training.

Issue: Lake Salvador Shoreline Erosion

Discussion: Wave action along the eastern edge of Lake Salvador has caused lake waters to break through shoreline vegetation in one area into the Segnette Waterway. The State of Louisiana has committed to building an impermeable barrier at this breakthrough site to prevent further wetland loss.

Management Concern: Unimpeded wave-caused erosion could rapidly eat into the Barataria wetlands, increasing open water at the expense of wetlands. This is the reason for building the control structure. However, it is not known what effect the structure will have on adjacent, unprotected, shoreline. Park staff need to monitor this situation to detect renewed erosion that may occur on either side of the structure. Revegetation efforts that occur in conjunction with erosion control must also be monitored to chart their effectiveness.

Tools Needed: Regular site photographs from both lake and park side, vegetation surveys, markers denoting edges of open water or index locations. While not necessary, a geographic information system would be valuable for displaying and interpreting results.

Personnel

One and a half FTE (skilled field technician) are sufficient to service equipment, collect samples, prepare them for analysis, and address quality assurance of the data from all the monitoring described above. This is, however, merely the beginning. With a weather station and stage height recorders JELA will be awash in data to levels heretofore unseen. The data need to be managed and above all, interpreted in order for them to be of use for resource management. A full-time M.S. or Ph.D. level wetlands hydrologist is recommended to develop and manage the monitoring program, build the data base and, along with it, the understanding necessary to make informed resource management decisions. This person will become the Barataria Unit natural resources expert and could provide the necessary communication between JELA and other federal and university researchers working in the region.

Equipment

Meteorologic and hydrologic information are necessary ancillary data for addressing nearly every water quality or erosion problem described above. It is therefore strongly recommended that at least one automated weather station and at least several automated stage height recorders be installed in the Barataria Unit.

The location of the weather station may be dictated by where it will be safe from vandalism, but otherwise, you either want to place it a) where it will provide the most representative information for the unit; or b) where it will provide information pertinent to the most sensitive resources and their management. If these two needs are incompatible, you may want to consider purchasing two weather stations.

Sensors mounted on the weather station should include wind speed and direction

(10 m standard height above ground), precipitation, barometric pressure, temperature and humidity. I suggest hourly collection frequency on the premise that: a) rapidly changing conditions can be detected; and b) too frequently collected data can always be aggregated for analyses or reporting purposes, but information collected with insufficient frequency cannot be used to interpret finer time-scale events. There are several companies that make high quality, low maintenance, weather stations, including Campbell Scientific and Omnidata. You will need to inquire specifically about the durability of these instruments in salty, wet, windy environments.

It is important to record water stage height in the different wetland vegetation types to try to develop relations between water levels and vegetation. This is detailed on page 10.

Stage height recorders monitor the height of water relative to a standard height that you will determine. The stage can be recorded at either regular intervals (e.g. hourly), or whenever a stage change occurs (the magnitude of change that triggers the electrical impulse being determined by you). We have had great success with one and two channel Omnidata Datapods. The second channel of a datapod could be hooked up to a specific conductivity probe to record simultaneous changes in stage height and conductance. Multi-channel recorders could be explored for collecting conductivity at more than one water depth.

Strip chart recorders have been the industry standard for many years. A timer moves a pen across graph paper to record continuous changes in stage height. Strip chart recorders have low power and maintenance requirements, but require someone to read off the data (either manually or with a scanning device) to store in computer format. This is time consuming and introduces additional sources for error. Electronic data

loggers eliminate this source of error, and are not much, if any, more expensive, than strip chart recorders. Our experience has shown us they require low power and even less maintenance than strip chart recorders. An additional benefit of electronic dataloggers is their ability to record more than one type of information (e.g. stage height and specific conductivity). The only drawback is that when they break down, they need to be serviced by the manufacturer; some problems with strip chart recorders can be fixed with hand tools, although many parts for the strip chart recorders are specialized and must be ordered from the manufacturer.

Quality Assurance Plans

A primary objective of long term monitoring is to detect and interpret trends over multi-year periods, taking into account seasonal and annual variation. To meet this objective, an accurate and regular assessment of data quality is important. Quality control programs are the means by which confidence can be assigned to all phases of a monitoring program by allowing the investigator (and all other users of the data) to assess the precision, accuracy, and reproducibility of each datum collected.

Quality assurance measures are simply the checks, balances, and standards applied to sample collection, sample transport, sample analysis, data entry, data synthesis, and interpretation. Plans developed before monitoring is initiated help to ensure that adequate thought has gone into developing high quality, reproducible information. It includes such common sense elements as regular calibration of instruments (ranging from once per year for weather stations and stage height recorders to before and after each use of some sensitive chemical probes), collection of sufficient numbers of sample replicates and blanks to allow statistical evaluation of variability

introduced at the different stages of analysis, rapid assessment of data provided by analytical laboratories to catch potential errors, and data entry procedures that include routine checks against mistakes.

Vandalism- and Pest-Proofing

There is no manual on this kind of protection. Common sense, trial and error, and experience are really the only suggestions I can make. Some ideas that have worked for us in Rocky Mountain National Park are mentioned below.

Equipment is less likely to be vandalized if undetected. Paint things marshy colors; make them difficult to get to and into; don't allow them to be visible from waterways. The weather station may need to be located in a fenced enclosure in an area with constant supervision (like someone's backyard, or a park maintenance area). We have had success placing descriptive interpretive signs on equipment that cannot be hidden.

Many animals like to gnaw on plastic or wiring; I don't know if this is a problem in the Barataria Unit. Enclosing equipment in metal no-rust boxes, or placing equipment high on metal or wooden poles is sometimes successful. Wiring for probes and water level recorders can be enclosed in corrugated metal conduit inside metal or pvc stilling wells.

Potential Water Resources Research Topics

The more understanding park resource managers have about the natural processes that occur in park ecosystems, the better prepared they will be to prevent or mitigate human-caused disturbances. The following research topics were briefly raised

during the water quality management team meeting June 2-4. Addressing them will add to the body of information about the Barataria Unit, and I think should be considered for funding during the next 5-10 years.

Analysis of Water Chemistry Under Wetland Vegetation

How similar/different is it spatially? Temporally? Are there gradients that can be related to regional salinity gradients? How coupled are water chemical dynamics with hydrologic fluxes?

Thorough Analysis of Hydrologic Patterns and Pathways

What are hydrologic retention times in different parts of the Unit? What are flow patterns in the canals? This information will be particularly valuable for hydrologic modeling activities.

The Application of Biological Indicators for Monitoring Wetland Condition

While there is no substitute for direct chemical evidence of change, such as can be obtained from the monitoring recommended above, biological indicators may provide evidence of the biological consequences of change. They can also signal the need for more expensive water chemical testing. Considering the economic importance of the Barataria Basin to Gulf of Mexico fishing industry, the park should consider supporting or augmenting existing research into estuarine food chain organisms and their responses to changing water quality and quantity.