

abundance (or at minimum presence/absence) for amphibian, reptiles, and small mammals on various habitats in Louisiana. Similar to that of breeding birds, density estimates are available for various broad habitat types. By tracking programs that add acres of a habitat, an estimate of its impact on the amphibian, reptiles, and small mammal communities can be made. Research projects directed towards specific species, whether funded through the SWG process or not, will continue to provide valuable data at a local scale for these faunal species of concern.

2. Aquatic Habitats and Species

a. Freshwater

Due to the diverse nature of the freshwater ecosystems and the lack of recent fish population data on the species of conservation concern listed in this strategy, the starting point of the monitoring efforts will focus around enumeration and identification of population structure and habitat types.

The initial monitoring efforts will focus on areas in southeast Louisiana in the Pearl, Mississippi, and Pontchartrain Basins. These basins represent habitat types for 77% of the listed species of conservation concern. Of all species listed, 40% occur only in these basins. New initiatives would focus on the Alabama shad and its reintroduction. Information needed on species occurrence within these basins include species trends and abundance with emphasis on several species of darters (channel, freckle and pearl). Since species occurrence has been documented for the shiners, monitoring the populations of the Blunt face and Bluenose shiners and the effects of habitat changes on their populations is essential. An established monitoring framework has been devised for the Gulf sturgeon and partnerships with MDWFP and USFWS have been established and will continue to aid in monitoring the recovery of this species.

Systems such as the Red, Mississippi, and Ouachita Basins serve as a major conduit for the inflow of invasive fish and mussel species into the waters of Louisiana. Monitoring efforts will be geared toward identifying trends in the current range and abundance of these species, particular the Asian carp and Zebra mussel, and what impact they are having on native species.

Due to the locks and dams on the Red River and the impoundment of the Sabine River at Toledo Bend, initial taxonomic surveys are needed to identify populations in these systems. Impoundments and the effects of navigational and flood control projects lead to habitat alterations and LDWF will partner with the COE to monitor their effect on species of conservation concern.

Coastal basins such as the Mermentau, Barataria, and Calcasieu offer unique and ever changing habitats. Coastal restoration projects such as Davis Pond and Caernarvon have been documented from a marine aspect but the impacts on freshwater species and habitats are relatively unknown. Long-term monitoring of these areas is essential. The effects of

barrier placements in streams and river bottoms to protect from saltwater intrusion and the impacts on the freshwater habitat and species must be monitored.

Habitat degradation in several portions of the Terrebonne, Vermillion-Teche, and Mermentau Basins has led to a reduction in fish species. Due primarily to land use practices, these basins struggle due to poor water quality. LDWF will continue to partner with LDEQ to monitor long term water quality within these basins. Data will provide indices to show the direction the habitat is heading and allow managers the opportunity to work towards corrective measures. Very little recent data exist on the proposed listed species of conservation concern. Initial monitoring efforts should be geared toward identifying: species occurrences, species abundance, habitat preference associated with each species, available habitat, and effects of habitat changes on these species.

Monitoring will be structured in 5 to 10 year increments with reevaluation of goals and objectives after 5 years. In the development of the CWCS, monitoring strategies were written to address freshwater aquatic species found in each river basin and are listed in Table 8.2.

For crustaceans and molluscs, intensive inventories are needed to better understand the distribution and status of each species. Additional life history studies need to be completed as well, especially for crustaceans. To stop the declines of species of concern, we will attempt to manage at the ecosystem level instead of at the local level, since water quality and other issues are frequently affected by factors outside the immediate area.

b. Marine

The status of the various marine species of conservation concern are closely related to habitat threats in the coastal ecosystem, especially marsh loss and degradation, and therefore may be some of the first species to exhibit population declines. Table 4.1 provides a list of marine species of concern and their associated habitats. Habitat threats are at a critical level in the coastal zone, and LDWF Marine Fisheries Division has decided to prioritize these habitat threats rather than having a species-oriented focus. Data developed through this process will provide indices to community structure within and across habitats, and trends in population abundances by habitat type.

Fixed-location stations, stratified by habitat type, are established in each study area, and fishing gear appropriate to that station is used to collect physical, chemical and biological data, as appropriate. Sampling gear is deployed and data collected and recorded according to standard protocol established in the Marine Fisheries Division Field Procedures Manual.

The basic framework for marine/estuarine monitoring in Louisiana was established in 1968 with the Gulf-wide Cooperative Gulf of Mexico Estuarine Inventory (GMEI) and Study (Perret 1971, Perret et al. 1971), and further refined with the implementation of the watershed-based Coastal Study Area (CSA) management system for penaeid shrimp (White and Boudreaux 1977) that also was adapted for finfish monitoring in 1985. Other

Table 8.2 Monitoring needs for individual aquatic basins in Louisiana.

Atchafalaya Basin

Monitor population trends of species of conservation concern
 Develop long-term water quality monitoring sites
 Develop long-term monitoring sites for species of conservation concern

Barataria Basin

Monitor the effects of freshwater diversions in the basin

Calcasieu Basin

Monitor annual salinity wedge in the river above the salt water barrier

Mermentau Basin

Monitor population trends of species of conservation concern
 Develop long-term water quality monitoring sites
 Develop long-term monitoring sites for species of conservation concern

Mississippi Basin

Sampling is needed to identify trends in range and abundance of invasive species
 Monitor trends of invasive species catch in commercial fisheries landings

Ouachita Basin

Conduct pre-impoundment taxonomic survey of proposed impoundments
 Conduct sampling to identify trends in range and abundance of invasive species
 Monitor trends of invasive species catch in commercial fisheries landings

Pearl Basin

Develop long-term water quality monitoring sites
 Develop long-term monitoring sites for species of concern
 Develop protocol for gear-type to ensure sampling is repeatable
 Partner with academia to monitor populations of species of conservation concern

Pontchartrain Basin

Monitor the effects of freshwater diversions in the basin

Red Basin

Conduct pre-impoundment taxonomic survey of proposed impoundments
 Conduct sampling to identify trends in range and abundance of invasive species
 Monitor trends of invasive species catch in commercial fisheries landings
 Monitor the effectiveness of mitigation features
 Monitor the effects of navigation and flood control projects on species of conservation concern

Sabine Basin

Evaluate the impacts of dam operations on fish populations

Terrebonne Basin

Develop long-term water quality monitoring sites
 Develop monitoring protocols to determine population trends of species of conservation concern
 Develop long-term monitoring sites for species of conservation concern
 Sampling is needed to identify trends in range and abundance of invasive species

Vermilion-Teche Basin

Sampling is needed to identify trends in range and abundance of invasive species

long-term projects collecting species/habitat data within the overall study area are the Caernarvon (1987 to present) and Davis Pond (1994 to present) Freshwater Diversion Monitoring Projects located in CSA 2 and 3, respectively. All projects rely on sampling with standardized gear over a range of habitats to characterize biological and environmental conditions. The general system for data collection established in 1968 has been used continuously since that time. The focus of the GMEI and CSA projects was primarily to document and monitor the importance of Louisiana's estuaries as contributors to Gulf of Mexico recreational and commercial fisheries. In their implementation all collected taxa were recorded, thus establishing a long-term data sequence for the various habitats and fish and invertebrate species in Louisiana coastal habitats.

Many marine and estuarine species are not well known, and long-term trends in their abundance are seldom well-described. It will be necessary to identify methods to monitor and verify status of cryptic species by periodically confirming presence, habitat use, life history characteristics, etc. This type of monitoring must be in addition to and linked to the evaluation of more well-known species for validation of trends seen in both types of monitoring programs.

Habitats are rapidly changing in the Louisiana coastal zone, due to a multiplicity of factors, both natural and anthropogenic. Methods to evaluate those changes and their effects on the aquatic and terrestrial populations that depend on them will be important in understanding trends in productivity of the habitats and the dynamics of the populations. This may require such methods as remote sensing, environmental constant data recorders, etc. to evaluate the rates and magnitude of these changes.

A variety of conservation efforts is underway to protect, enhance, or modify coastal wetlands. These projects will also affect their associated aquatic habitats and the fauna associated with those habitats, sometimes in ways that are not predictable or that are poorly understood at present. Special purpose assessment and monitoring studies must be developed and maintained to assess the performance of these actions on the maintenance of both the terrestrial and aquatic ecosystems involved in those actions.

Areas may be identified for habitat conservation and/or restoration purposes through a variety of assessment procedures. Selection criteria may include species diversity (current or potential), unique nature of the habitat in the state or region, and areas recognized by previous national or state prioritization processes (e.g., CWPPRA).

c. Coastal Restoration

To date 467 coastal restoration projects (Appendix Q) have been constructed under the authority of the Louisiana Department of Natural Resources/Office of Coastal Restoration and Management/Coastal Restoration Division at an approximate cost of \$500 million. Funding for these projects comes from a variety of sources including: the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA), the Water Resources Development Act (WRDA), and the state of Louisiana Wetlands Trust Fund.

These projects use a variety of techniques to achieve their goals. A complete list of projects including cost, size, and type can be found in the Coastal Restoration Annual Project Reviews (Stead and Hill 2004). Often times the projects result in a change in habitat type (open water to marsh, salt marsh to intermediate marsh, non vegetated area to planted area, etc.). While the primary goals of these projects generally are ecosystem restoration, secondary benefits include enhancement of critical fish and wildlife habitat.

Most coastal restoration projects are constructed through the CWPPRA program, where design and implementation is overseen by the LDNR/OCRM in cooperation with the following federal agencies: COE, USDA, U.S. Department of Commerce (Commerce), USDI, and the EPA. Typically, concerns regarding fish and wildlife habitat are resolved during the engineering and design phase. During this time, the various federal agencies have the opportunity to comment on project aspects that may have an impact on species they regulate. For example, the NMFS, under Commerce, will oversee project impacts on essential fish habitat, while the USFWS will address project impacts on other fish and wildlife issues. Furthermore, the LDNR/OCRM has implemented measures to examine the ecological impacts of projects. Through the "Ecological Review" process, the projects' ecological benefits can be assessed during the design phase of a project. By having engineers work with ecologists in the project design phase, the likelihood of a project successfully achieving its intended ecological goals is improved.

The Biological Monitoring Section of LDNR/OCRM/CRD is responsible for the management of all biological monitoring activities associated with coastal restoration projects. This includes monitoring plan development and implementation (data collection and storage, statistical analysis, quality control and data interpretation), and report generation. These activities provide a scientific evaluation of the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to coastal wetlands loss in Louisiana. Data collected are used to determine the success or failure of existing projects, to determine if existing projects require modifications, and to support future decisions on selection of proposed coastal restoration projects. Currently over 40 variables are measured at over 3,000 locations. Data types include: hydrography, vegetation, sediment elevation, shoreline change, soil properties, and elevation. Although these stations are currently distributed by project location, LDNR/OCRM/CRD is transitioning towards a large-scale programmatic monitoring effort called Coastwide Reference Monitoring System (CRMS-Wetlands). Implementation of CRMS-Wetlands will provide a cost-effective means of evaluating individual projects and the collective effects of projects at the hydrologic basin and ecosystem scale. Information gathered by the program will be used for planning activities, adaptive management, and predicting future changes in Louisiana's coastal ecosystems with an increased degree of accuracy, and will help guide future management decisions.