CHAPTER 5

Species Population Protection

Priority Problems

The overall health of the Galveston Bay estuary, as measured by its diversity of species and the populations of its major recreational and commercial species, is generally considered to be good. However, populations of selected species within the estuary have experienced declines, with the primary suspected causes being loss of habitat, fishing, impingement/entrainment, and other types of human intervention. Because species within the estuarine environment are dependent on one another for maintenance of the food chain, the preservation of species populations is critical to the ecological health of the Galveston Bay system. Habitat preservation is the most essential requirement for effective protection of species populations, as the fate of species is closely linked to that of habitat. As is the case with habitat management, species population management is best carried out from a broad ecosystem perspective to ensure that an optimal variety and distribution of habitats are protected, as needed by the numerous species which are present within the estuary.

Management Goals and Objectives

Species Population Protection Task Force members initiated the development of objectives for the species population component of the Galveston Bay Plan. During Round 4 Task Force meetings, Task Force members established the following high-priority management goals:

- Reverse the declining population trend for affected species of marine organisms, and maintain the populations of other economic and ecologically important species.

- Eradicate or reduce the population of exotic/opportunistic species which threaten desirable native species, habitats, and ecological relationships.

These initial management goals were further defined and are now the six species population protection (SP) objectives and ten SP actions set forth in the Galveston Bay Plan :

Objective SP-1:	At a minimum, maintain fish and crustaceans at population levels within 50% of the 1975-1985 mean levels
Action SP-1.	Implement a bay-wide effort to strengthen species management
Objective SP-2:	At a minimum, maintain oyster population levels within 50% of the 1983-1993 mean levels
Action SP-2.	Return oyster shell to designated locations within the bay
Action SP-3.	Promote the development of oyster reefs using alternate materials.
Action SP-4.	Set aside a portion of reef habitat as scientific research areas or preserves.
Objective SP-3:	Reduce bycatch within the estuary by 50% by the year 2007, accounting for seasonal patterns
Action SP-5.	Encourage continued development of gear to reduce commercial bycatch
Action SP-6.	Conduct educational programs concerning catch and release.
Objective SP-4:	Reduce current levels of fish mortality caused by impingement/entrainment by 50% by 2007
Action SP-7.	Investigate potential measures to reduce impingement and entrainment
Objective SP-5:	Increase the populations of endangered and threatened species
Action SP-8.	Develop management plans for endangered and threatened species
Objective SP-6:	If feasible, by the year 2005, reduce abundance's by 10% for selected exotic species, including nutria and grass carp
Action SP-9.	Improve enforcement of prohibitions against the introduction of exotic species
Action SP-10.	Identify and implement techniques for the control of problem exotic species

Data Information Needs

The goal of Plan Objectives 1, 2, 3, 4 and 5 is to reverse the decline in population abundance for affected Bay organisms and maintain populations of economic and ecologically important species. Information needed to assess this management goal

includes:

- Identification of commercial, recreational and ecologically important species of concern,
- Identification of indicator measures for identified species of concern,
- Status of and trends in abundance and distribution of identified species of concern.

The status of the abundance and distributions of identified species of concern provides a direct measurement for assessing whether Plan Objectives 1 through 4 are having their desired effect. Information on trends provides a means for evaluating whether progress is being made toward meeting these objectives. Measurements of the extent and quality of required or preferred habitats also provide a reasonable means to indirectly assess the potential for maintenance or recovery of identified species of concern.

Plan Objective 5 calls for maintaining and enhancing abundance of threatened and endangered Bay species. Information needed to assess this management objective include:

- Identification of threatened and endangered Bay species,
- Identification of indicator parameters for identified threatened and endangered species,
- Status of and trends in abundance and distribution of identified threatened and endangered species.

The status of the abundance and distribution of identified threatened and endangered species provides a direct measurement for assessing whether these species are recovering in accordance with Plan Objective 5. Information on trends provides a means for evaluating whether progress is being made toward meeting this objective.

Threatened and endangered species have already been identified by the USFWS. Whenever possible, direct measurements of abundance for threatened and endangered species of concern is the recommended metric. If direct measurements are not feasible, the use of reliable indicator species is highly recommended. In addition, measurements of the extent and quality of required or preferred habitats provide a means to assess the potential for recovery of these special status species.

The goal of Plan Objective 6 is to maintain and reduce abundance of exotic, nuisance species. Information needed to assess this management objective include:

- Identification of exotic nuisance Bay species,
- Identification of indicator parameters for identified exotic nuisance species,

- Status of and trends in abundance and distribution of identified exotic nuisance species.

The status of the abundance and distribution of identified exotic nuisance species provides a direct measurement for assessing whether these species are being controlled in accordance with the plan objective. Information on trends provides a means for evaluating whether progress is being made toward meeting this objective. The two most important exotic nuisance species have already been identified by GBNEP: nutria and grass carp.

Task Force members agreed that an assessment of ecosystem condition required the evaluation of the status and trends in the abundance and distribution of several selected indicator species as well as a suite of physical and chemical parameters. Recommended physical and chemical parameters were considered in the development of the Water /Sediment Quality monitoring plans.

Monitoring activities must provide information to evaluate whether progress toward these management objectives is being made. The species population protection component of the regional monitoring program must provide data to assist in:

- Determining whether severe alterations in populations and communities are occurring,
- Identifying potential causes of alterations in populations and communities,
- Evaluating alternative actions to mitigate identified adverse impacts to important populations and communities.

The following monitoring objectives were used to develop the monitoring strategy:

Phytoplankton

- Determine the status of and trends in primary productivity,
- Determine the status of the abundance and distribution of dominant phytoplankton,

Benthic Invertebrates

- Determine the status of and trends in the abundance and distribution of dominant species.

Selected Fish and Shellfish

- Determine the status of and trends in relative abundance (i.e., catch per unit effort [CPUE]) and distribution of selected species,
- Determine the status of and trends in abundance of food (use estimates from phytoplankton data),

- Determine the status of and trends in the areal extent and quality of nursery and feeding habitats.

Selected Birds and Reptiles

- Determine the status of and trends in abundance and distribution of selected species,
- Determine the status of and trends in the areal extent and quality of required habitat.

Assessments of the abundance of species populations of concern will be based on the weight of evidence from measurements of species of concern or indicator species abundance and the extent, quality of required or preferred habitats. From identified Plan objectives and information needs, it is clear that the species population component of the regional monitoring program must provide both local and bay-wide status and trend data.

Programmatic Monitoring

Environmental monitoring will be the ultimate source of answers to the effect of the plan on living resources in the bay. However, during plan implementation and the intermediate years before meaningful environmental information is available, programmatic monitoring will provide the only means for assessing plan progress. Examples of programmatic actions which may be tracked are:

- New species management plans adopted by the Galveston Bay Interagency Advisory Committee,
- Progress in obtaining funding for the oyster shell return program,
- Creation of oyster reefs using alternative materials,
- Quantity of oyster reef habitat as research area or preserve,
- Identification of gear and devices for reducing by-catch and the level of implementation within the commercial fishery,
- Conduct surveys to assess the effect of catch and release educational programs,
- Implementation of technology to reduce impingement and entrainment,
- Number of management plan developed and adopted for endangered or threatened species, and
- Identified and implemented techniques for the control of exotic species.

Environmental Monitoring

Because it is not feasible to measure all environmental parameters, a limited set of indicator parameters were identified as candidate monitoring parameters for the species population component of the regional monitoring program. These candidate indicators and species of concern are shown in Table 5-1. These suggested indicator species were selected because they represent important commercial, recreational, and ecological groups. Phytoplankton abundance and community structure will

TABLE 5-1. CANDIDATE INDICATORS AND MEASUREMENTS FOR SPECIES PROTECTION

Candidate Indicator	Candidate Measurement
Ecologically Important Species / Communities	
• Plankton community	Chlorophyll-a ; pheophytin-a(See Water Quality)
• Benthos	Community structure (See Sediment Quality)
• Shellfish	
- white shrimp	Abundance and distribution
- brown shrimp	Abundance and distribution
- blue crabs	Abundance and distribution
• Finfish	
- Atlantic croaker	Abundance and distribution
- gulf menhaden	Abundance and distribution
- anchovy	Abundance and distribution
• Birds	
Colonial waterbirds	Abundance and distribution
Shorebirds	Abundance and distribution
Wintering waterfowl	Abundance and distribution
• Alligator	Abundance and distribution; # nests
Commercially and Recreationally Important Species	
• Shellfish	
- eastern oyster	Areal extent of reefs; distribution; density; size
- white shrimp	Abundance and distribution; size; weight
- brown shrimp	Abundance and distribution; size; weight
- blue crabs	Abundance and distribution; size; weight
• Finfish	
- Atlantic croaker	Abundance and distribution; size; weight
- black drum	Abundance and distribution; size; weight
- red drum	Abundance and distribution; size; weight
- gulf menhaden	Abundance and distribution; size; weight
- sand seatrout	Abundance and distribution; size; weight
- spotted seatrout	Abundance and distribution; size; weight
- sheepshead	Abundance and distribution; size; weight
- southern flounder	Abundance and distribution; size; weight
Commercial By-catch	*CPUE # and biomass; by-catch / shrimp biomass ratios*
Impingement / Entrainment	*Abundance;survival*
Introduced Exotic Species	
• grass carp	Abundance and distribution
• nutria	Abundance and distribution
Threatened and Endangered Species	
• brown pelican	Abundance and distribution
• piping plover	Abundance and distribution
• sea turtles	Sightings
• snowy plover	Abundance and distribution
• diamondback terrapin	Abundance and distribution

provide information characterizing primary productivity and the quantity and quality of the base of the aquatic food web. Benthic macro-invertebrate abundance and community structure will provide information to characterize an important guild of primary consumers that serve as key prey items for many shrimp, crab and fish predators in the Bay. Benthic macro-invertebrates are closely associated with Bay sediments and infaunal data can be used to infer the toxicity of Bay sediments. Selected finfish and pelagic macroinvertebrates are not only commercially important but represent intermediate consumers in the system. Bird, reptile, and mammal data will provide managers with information on the top consumers in the system.

Phytoplankton

Phytoplankton plays an important role as a primary producer in estuarine ecosystems. Phytoplankton communities are susceptible to a number of anthropogenic influences such as excess or deficient nutrient input and changes in salinity. Because of the relatively short life span and high growth potential of this indicator, changes in environmental quality can lead to rapid changes in abundance. For these reasons, phytoplankton provide an excellent indicator of ambient conditions. Phytoplankton monitoring does not directly assess any objective but provides valuable supportive information for Objectives 1 through 4.

Phytoplankton biomass will be estimated through the measurement of chlorophyll-a and pheophytin-a concentrations using spectrophotometric analysis. Chlorophyll-a samples will be collected as a Tier One water quality parameter at all open bay stations 4 times a year. Sampling and analytical protocols are those listed in the TNRCC *Draft Water Quality Procedures Manual* (TNRCC, 1993) and the most recent edition of *Standard Methods for Examination of Water and Wastewater (*APHA, 1992). Determinations of cost and data value from HPLC analytical techniques will be evaluated. Recent publications (Buskey and Schmidt, 1992 and Wright, et al., 1991) suggest that HPLC measures of phytoplankton pigments can be used to estimate the relative composition of major taxonomic groups in the samples. The ability to conduct community structure evaluations of phytoplankton is desirable. However, there are not current programs to perform these evaluations. This will be recommended as a parameter for future consideration.

Phytoplankton communities in Galveston Bay show considerable seasonal and long-term variability and are characterized by a series of small blooms that occur throughout the year (Buskey and Schmidt, 1992). This variability may be influenced by any number of factors including light availability, nutrients , and water temperature. Because of this variability it is recognized that quarterly sampling for chlorophyll pigments, as recommended in the water quality sampling section of this plan, is not in itself adequate to characterize phytoplankton communities in the system. The use of continuously recording *in situ* fluorometers at fixed sites will be pursued as a supplement to the recommended monitoring.

The TWDB has plans to upgrade their existing network of data sondes, with new sondes equipped with *in situ* fluorometers. This will be accomplished through attrition, replacing older instrumentation which is taken out of service with

upgraded sondes. This will enable continuous, *in situ* measurement of chlorophyll concentration, integrated electronic storage of the data, and simultaneous collection of associated water column data (such as, transmissivity, dissolved oxygen, depth, temperature, and conductivity). Because both fluorometric and spectrophotometric methods measure chlorophyll-a concentrations, the resulting data are comparable. However, samples analyzed using different techniques should not be combined for statistical analyses.

Benthics (see Sediment Quality)

Fish and Shellfish Monitoring

A number of independent monitoring efforts are conducted in Galveston Bay for selected species of marine organisms. The three major programs are the TPWD Coastal Fisheries Program, the NMFS Baseline Production Program, and the TNRCC Nekton Sampling Program. The program objectives and sampling plans for each of these programs were evaluated against plan objectives. Although each of these programs provides valuable information for the assessment of bay living resources, the TPWD Resource Monitoring Program was selected as being best suited for evaluating the stated objective.

On a monthly basis 20 trawl, 30 oyster dredge, and 20 bag seine samples are collected in Galveston Bay. Additional trawl and seine samples are collected in the Gulf Intracoastal Waterway, beach, and offshore sites. Sampling sites are selected randomly from a grid system to ensure an equal chance of sampling each section of shoreline and open bay water. The appropriate sampling technique is selected based on the time of the year and location of the sampling station. Sampling techniques are described in the Marine Resource Monitoring Operations Manual (TPWD, 1993). All organisms greater than 5 mm in length are identified to species level and counted. Samples are analyzed for species identification, number of specimens, size, weight, sex, and maturity are recorded for selected individuals.

A stated objective of the TPWD Coastal Fisheries Resource monitoring Program is to assess annually the status of finfish, shrimp, crab, and oyster populations and associated environmental variables in the coastal waters. Available monitoring data support the viability of management objectives 1 and 2. Existing data indicate that, for selected commercially and recreationally important species, current monitoring efforts allow managers to detect changes from present overall mean abundance— plus or minus 50 percent — with acceptable statistical power (power = 0.8). In addition, current efforts allow detection of 10% or greater trends in mean population abundance's over a ten-year interval (L. McEachron and A. Green, TPWD, personal communication).

Oysters are an economically and ecologically important species in Galveston Bay. Because of their sessile nature, changes in the abundance and distribution of oysters provide an excellent means for assessing environmental conditions in an area. TPWD is the only agency conducting routine monitoring of oyster condition in Galveston Bay. As part of their Resource Monitoring Program samples are collected from known oyster reefs. Monthly sampling is based on counting live organisms

collected from a series of 30-second oyster dredge trawls. Counts of oyster spat, encrusting organisms, and the percentage of live and dead oysters are recorded. Standing crop estimates are made from the number of organisms collected on a per-effort basis.

GBNEP also sponsored a survey of the location, extent and areal extent of oyster reef habit. This was accomplished using acoustic profiling techniques described by Powell et al. 1994. It is recommended that the Galveston Bay Program sponsor regular but infrequent surveys, possibly every 10-15 years, be conducted for areal extent using this technique.

Bird Populations

The Galveston Bay estuary is home to a number of important bird species throughout the year. The area also produces important nesting and wintering habitat for a large number of migratory species. Birds fill a variety of roles in the trophic structure of an ecosystem and may, depending on the species, be primary consumers, secondary consumers, or top carnivores. Because of their diversity and the wide open range of ecological roles filled by birds, monitoring of this group is essential to measuring the health of the estuary. Three guilds of birds have been selected for monitoring for abundance and distribution. These guilds are; colonial nesting waterbirds, shorebirds, and migratory waterfowl.

Several existing bird surveys are conducted in the Galveston Bay system. The TPWD and U.S. Fish and Wildlife Service (USFWS) conducts an annual survey of colonial nesting waterbirds along the Texas coast. These surveys are conducted during a two-week period beginning the last week of May. Ground counts are made by two to four persons viewing the colony from boat or on foot. Standardized procedures have consistently been followed during the censuses and established data forms have been used since 1986. This survey provides quantitative information on total numbers of individuals, numbers of active colonies, and the mean number of individuals per colony. This data set is well suited to multivariate data analysis. (Slack, et al., 1992)

The USFWS, Clear Lake office, has conducted irregular monthly surveys of shorebird feeding habitats continuously since 1980. A strength of the program is the use of multiple observations during the year, which allows for increased reliability of annual population estimates. (Slack et al., 1992). Past surveys have only been conducted in one area, the Bolivar Flats, this limits the information on spatial distribution of shorebirds in the estuary. This program has been discontinued, but it is the recommendation of the Monitoring Work Group that it be reinstated and expanded. Expanding the surveys to other locations will increase the availability of data on spatial distribution. Three proposed areas are continuation at Bolivar Flats, and expansion of the program to San Luis Pass and the Big Reef area. It is also recommended that the surveys be conducted at regular intervals during the year to reduce temporal sampling biases.

The TPWD, in conjunction with the USFWS, has conducted an annual Mid-winter Waterfowl survey since 1973. This survey consists of one systematic scheme of sampling along transects and another less systematic sampling scheme of counting birds in general locations. These data provide information on abundance of waterfowl by species and by transect, or by general location within the surrounding waters of the Galveston Bay system.

Data from each of these monitoring programs was evaluated as part of a program to characterize the status and trends of selected endemic resources of the bay ecosystem. The objectives were to evaluate the validity of available data sets for use in the characterization of living resources and to conduct analyses of selected avian populations and assemblages. (Slack, et al., 1992) A discussion of the data set validity and results for each of these data collection programs is given in this document. A number of recommendations are made which would improve the statistical power of the programs' data collection efforts. All of these recommendations will be considered for implementation of further data collection efforts.

Reptiles

The American alligator (*Alligator mississippiensis*) is a large, wetland dependent, commercially important, vertebrate predator. As such, alligator populations are greatly influenced by a variety of human activities including loss of wetlands, pollution, and hunting. It is for this reason that the alligator was selected as an indicator species in the GBRMP.

The TPWD is responsible for regulating annual alligator harvest in Texas (Slack, et al., 1992). This requires information on the present status of alligator populations and their recruitment rates. To obtain this information, the TPWD conducts night counts of alligators and helicopter surveys of alligator nests along the Texas coast. Surveys were conducted annually from 1980 to 1984 and triennially since 1985. Established transects are located in the marshes adjacent to East Bay and Trinity Bay. Night counts are made along transects of variable lengths using observers to count individuals. Nest count transects are made from a height of 90 meters along transects spaced at 1.5 km intervals. Surveys are conducted in May when the height of marsh vegetation is low.

By-catch

There are no ongoing monitoring programs to address Objective 3, reducing by-catch. Without new gear and/or devices being implemented, the value of frequently scheduled by-catch studies is questionable. The Monitoring Work Group recommends that requirements and trends in implementation of new gear and devices be monitored to trigger actual by-catch studies in the future or that by-catch studies be conducted on an infrequent basis, i.e. every 2 years. The TPWD has adopted a by-catch protocol which is based on the GBNEP by-catch study conducted by the NMFS. This protocol will be evaluated for comparability to the NMFS protocol. If found to be comparable, future by-catch monitoring programs could be conducted by the TPWD or NMFS.

Impingement / Entrainment

Objective 4 calls for reductions in levels of fish mortality caused by Impingement/Entrainment by 50% by 2007. Two separate monitoring elements will be used to assess this goal. The TNRCC routinely collects impingement data from intakes at one HL&P power station and one major chemical industry (G. Guillen, TNRCC, personal correspondence). These data have utility as a baseline measure of impingement at those and other sites with similar impingement reduction technology. When improved technology is implemented, continuation of data collection should provide useful information in assessing impingement reductions. Similar monitoring may be implemented at other plants to provide additional information.

HL&P is conducting studies to measure the effectiveness of newly installed pumping systems and other impingement/entrainment reduction methods in reducing entrained organism mortality. Development and implementation of proven technology to reduce impingement/entrainment will be tracked as an assessment of Objective 4.

Endangered, Threatened and Candidate Species

There are no existing monitoring efforts specifically for endangered species. Threatened and endangered monitoring for bird species will generally be covered within other monitoring programs. For example, Slack, et al, 1992, reports that brown pelican and piping plover sightings were commonly reported in the TCWS and Shorebird Surveys of Bolivar Flats data sets. Brown pelicans were reported infrequently in the TCWS and Shorebird Survey of Bolivar Flats, and piping plovers were frequently reported in the Shorebird Surveys at Bolivar Flats.

Current monitoring for sea turtles is by public reporting of sightings in the bay. A possible extension of this program would involve the establishment of public access points in areas where sea turtles have been observed (e.g., based on Manzella and Williams, 1992, as referenced in Tetra Tech, 1994b). These displays would encourage public participation by requesting visitors to record the amount of time they spent in an area, any turtles observed, and other pertinent information. In addition to public sightings there are some more intensive studies utilizing telemetry to track movements of individual turtles. Information from the tagging program can be used to select target areas for establishing public information displays.

The Texas diamondback terrapin and the southeastern snowy plover are currently listed as Category 2 candidate species. Candidate 2 species are taxa for which available information would indicate a listing of endangered or threatened may be appropriate, but for which conclusive data to support such a listing is not currently available (USFWS, 1991b). Further biological research and field study are needed to ascertain the true status of these species. Information on the southeastern snowy plover may be obtained from the shorebird populations monitoring program, but there is no current methodology for monitoring the Texas diamondback terrapin.

Data indicate that drowning in crab traps is a major threat. One possible monitoring technique would be to establish a public information/reporting system for reporting their occurrence in crab traps. This is a monitoring need that will be addressed.

Introduced Exotic Species

Some exotic/opportunistic species, such as nutria and grass carp, threaten desirable native species, habitats, and ecological relationships. Significant populations of nutria, a large beaver-like rodent which strips vegetation within freshwater and brackish water marshland, and grass carp, which strip aquatic vegetation, have been reported in the Trinity River and San Jacinto River portions of the estuary. Monitoring for introduced exotic species will be required to assess the effectiveness of techniques for attaining 10% reductions, by the year 2005, in populations of problem exotic species. Current monitoring for these species is not adequate to proved information needed to assess this plan objective.

In 1992 and 1993 the TPWD and Texas A&M University (TAMU) conducted a survey for grass carp in the lower Trinity River. The purpose of this survey was to address concerns over the presence of growing grass carp populations and possible predation on smooth cord grass in the estuary (Webb, et al., 1994). Results of this survey indicate the probable presence of a reproducing population of grass carp in the study area. During the 1992 sampling period, viable eggs but no larvae were found; in the 1993 survey viable eggs and recently-hatched larvae were found in substantial numbers. Additionally, a significant commercial fishery for grass carp exists on the river and fish kill data have documented juvenile grass carp in the Bay system.

Adult grass carp from commercial fishing efforts were examined for a number of characteristics including ploidy. In a sample size of 153 adult grass carp examined for ploidy, 85% were found to be diploid and 15% were triploid. During the 1992-93 surveys no juvenile or adult grass carp were collected using conventional fish collection techniques including gill nets and electrofishing. The absence of grass carp from this sampling effort would indicate the difficulty in effectively monitoring grass carp using traditional collection techniques. Suggestions for future monitoring include tracking studies, annual monitoring of adults, and periodic sampling for juveniles.

An informal group including representatives from the SCS, TPWD-Coastal Fisheries, TPWD-Inland Fisheries, TAMU, the Galveston Bay Foundation and GBNEP has met to discuss possible monitoring and control strategies. At this meeting it was recommended that the first step, in assessing the distribution of grass carp in the Galveston Bay system, be development of a map documenting sites of grass carp identifications. The TPWD-Coastal Fisheries office has agreed to compile this data from a review of fish kill reports and fisheries data base reports. This should be available by January 1995.

A similar group will be convened to address the issue of nutria populations. There is no current monitoring program to assess nutria populations. Monitoring the size

of nutria populations over any large area is difficult due to the habitat these animals are found in and their behavior (Greg Linscombe, Louisiana Department of Wildlife and Fisheries, personal communication). Nutria have a small home range and their densities fluctuate greatly depending on habitat type (Kinler et al., 1987). Mark and recapture methods are therefore only useful for small areas of continuous habitat. It is recommended that population monitoring focus on tracking changes in the relative abundance of nutria by developing an index based on some measure of their activity in selected areas.

Except during periods of extreme cold, nutria are most active at night (Kinler et al., 1987). Changes in their relative abundance could be monitored using transect or point count methods by spotlighting at night. However, in areas of dense vegetation, visual counts would be extremely difficult and could provide inconclusive or misleading data. Alternatively, an index could be established based on some other indicator of their activity such as scat counts, active trail counts, or evidence of feeding activity (Kinler et al., 1987). It is recommended that the TPWD in conjunction with the Galveston Bay Program office, undertake a special study to identify effective techniques best suited to the Galveston Bay estuary.