

**SCIENCE REVIEW
OF THE
INLAND AND COASTAL FISHERIES
DIVISIONS,
TEXAS PARKS AND WILDLIFE
DEPARTMENT**

**CONDUCTED BY
THE AMERICAN FISHERIES SOCIETY**

JANUARY 31, 2005

Executive Summary

Consistent with the priorities established by the Texas Parks and Wildlife Department's (TPWD) planning efforts, TPWD requested an independent peer review of its fisheries programs by the American Fisheries Society, the principal professional organization of fisheries scientists in the United States. The review was conducted for the purpose of "determining whether TPWD is using the best, most efficient techniques for monitoring, managing, and protecting its aquatic natural resources." The specific objectives were to (1) evaluate the scientific basis and application of all key methodologies employed to obtain scientific information for management decisions; (2) ascertain the opinions and insights of staff on the use of, and gaps in, the science available for monitoring and managing fisheries resources with regard to how well science is incorporated into management decision processes; and (3) evaluate existing processes for ongoing evaluation of science-based activities while proposing modifications as needed to improve such evaluation, thereby leading to the most effective use of data in management decision making.

The review, conducted by a four-member team of fisheries scientists, included a review of background materials provided by TPWD, a site visit involving interviews with TPWD staff, follow-up communications with staff as needed to clarify issues, and administration of an opinions and insights survey electronically to over 100 TPWD fisheries personnel. The review focused on the scientific aspects of data acquisition regarding the resource, habitat, and constituents.

The Inland Fisheries Division has developed an impressive set of Fisheries Assessment Procedures that are conceptually sound and are generally accepted within the fisheries science community. These procedures are regularly updated using an effective protocol that considers inputs from all levels of Division staff. Data obtained from the Fisheries Assessment Procedures, in combination with results from research projects and other special studies, provide a scientific basis for making fisheries management decisions for Texas's broad expanse of reservoirs, lakes, and streams. Standardized procedures are mainly effective for sport fish species and include fishery-dependent and fishery-independent sampling, habitat assessment, and genetic analysis. Data collected under standardized assessments flow through an efficient information conduit and are checked repeatedly for quality. The data are then sufficiently analyzed and archived for easy access. Fish stocking needs are identified using the results of standardized assessments, and stockings are prioritized through a series of criteria standards. Although standardized sampling by itself is typically not sufficient for precise characterization of some resource attributes, in TPWD's case it is augmented by a good balance of special studies and research efforts to provide staff with the data to make informed management decisions. To increase the precision of the data collected by standard assessments, reallocation of effort would be required. In contrast to the well-developed sampling protocols for sport fish species, the standardized assessments place little emphasis on non-sport fish resources, including imperiled species, stream fishes, and other aquatic biota. The recent reassignment of personnel to Inland Fisheries from the former Resource Protection Division may provide the additional staff time and capability

necessary for the Inland Fisheries Division to better address this aspect of the agency's mission. The formidable amount of inland water within Texas requires a sizable staff; the Inland Fisheries Division has done a commendable job in acquiring first-rate personnel with a wide range of expertise. There appears to be adequate support at all levels for continued training and staff development regarding fisheries assessment procedures.

The Coastal Fisheries Division has developed and implemented a commendable, scientifically sound assessment program that provides information to establish coastwide management regulations for the major recreational and commercial species. The Division's fishery-dependent and fishery-independent databases are among the largest and longest running programs of their kind in the United States. The Division has the personnel and technical capabilities to perform a variety of special studies when the need arises. Appropriate sampling procedures are fully communicated to staff through comprehensive, standard operating manuals that are revised annually to reflect needed changes. A rigorous quality control program helps to ensure that sampling is performed appropriately. Data are carefully checked for accuracy, archived at a central location, and readily available to biologists, administrators, and the public. Fishery assessment data confirm the unique biological features of various Texas coastal areas, suggesting that future assessment and management activities may be most appropriate at the regional or bay-specific level. The Division is also faced with developing future programs that pay greater attention to species that are neither commercially nor recreationally important, address a broader range of habitat variables, and more thoroughly analyze existing databases. To accomplish these changes, either a reallocation of effort or additional staff members will be needed, as existing personnel appear fully committed at present. The Review Team offers several suggestions as to where effort could be reallocated. The full incorporation of the talents of former Resource Protection Division personnel has the potential to help accomplish actions that will improve the Division's resource management and conservation capabilities.

In addition to habitat assessments undertaken as a part of standardized fishery surveys by each Division, investigations of fish kills, pollution, and harmful algal blooms are conducted by the TPWD Kills and Spills Team (KAST) in well-coordinated efforts with other appropriate state and federal agencies. KAST has developed broad procedures to scientifically assess the resource issues of both the Inland and Coastal divisions. Assessment protocols, as laid out in a comprehensive (although yet incomplete) procedures manual, have been developed, with high priority on obtaining accurate, precise data that are defensible for restitution purposes. Because of insufficient funding and personnel limitations, the threshold for site investigations has been modified; the effects of this change on scientific quality of data should be evaluated. As incomplete sections of the procedures manual are developed, additional attention should be given to the requirements for assessing events associated with unusual hydrodynamic conditions and events that are ongoing through time or widespread in space as well as to emergency protocols for addressing major fish kills.

Both fisheries divisions of the Texas Parks and Wildlife Department are national leaders in their commitment to the human dimensions component of fisheries management. In each Division, a professional position is designated as a focal point for human dimensions matters. Standardized assessment of human dimensions attributes of coastal and inland anglers, conducted with scientific rigor at 4-year or shorter intervals, has provided consistent trend data. Together with complementary data from other internal and external sources, these assessments provide information on stakeholder participation and opinion that is incorporated into agency decision making. Whereas the demographics of Texas' human population are changing, and response rates to surveys have declined, the precision and accuracy of standardized surveys should be periodically re-evaluated. Human dimension specialists have the expertise necessary to contribute to an elevated level of attention to scientific assessment and the application of human dimensions attributes, to assist field staff, and to coordinate human dimensions programs of the divisions.

The response of the TPWD fisheries staff to the review team's survey of opinions and insights was commendable. Although responses were anonymous, it was possible to categorize respondents as Inland or Coastal and as administrative or nonadministrative. Background questions revealed that most personnel in each category hold advanced degrees and spend the majority of their time conducting science-based activities related to fisheries management. Strong consensus was evident within each group on many issues. Notable differences in the distribution of responses between Inland and Coastal divisions and between administrative and nonadministrative respondents were evident on some questions. There appeared to be general agreement between the opinions of the staff and the findings of the Review Team on many issues directly related to acquisition of scientific data.

Throughout the agency, the need for comprehensive, up-to-date standardized assessment procedures is recognized. Research projects and special studies commonly evaluate existing or potential assessment techniques. Consequently, the procedures are continually revised in light of field experiences and new technologies. Procedures for assessment of inland and coastal resources, habitats, and users should all be revisited on a defined schedule. Comprehensive reviews should evaluate whether the procedures as a whole meet the spectrum of information needs. In both divisions, administrative structure and operational procedures are in place for evaluation of the scientific validity of data upon which management decisions can be made. Each division's administrative team evaluates the need for further information and prioritizes recommendations for further investigation. Working relationships between divisions and among sections within divisions are generally good, and effective channels of communication between field personnel and administrative staff facilitate inputs to evaluation at all levels. The Inland Fisheries Division has developed a long-range plan tied closely to the TPWD Land and Water Resources Conservation and Recreation Plan to guide decision making. The Coastal Fisheries Division should similarly develop a long-range plan.

TPWD's Inland and Coastal Fisheries divisions have developed a well-defined set of protocols for obtaining comprehensive, scientifically sound data on fish populations,

habitats, and constituents. Assessments made under these protocols are generally effective in producing the data needed for science-based management of inland and coastal recreational and commercial fisheries. The limitations of the data acquired by standardized sampling are generally recognized, and procedures are in place for internal evaluation and refinement of assessment protocols. When statistically precise data could not be obtained through standard protocols, time and staffing were generally identified as the limiting factors. The recommendations made in this report were developed with consideration of how better data might be obtained more efficiently. The incorporation of the personnel and programs of the former Resource Protection Division into the Inland and Coastal Fisheries divisions poses opportunities to enhance each division's habitat assessment capabilities and to give additional attention to nonrecreational and noncommercial aquatic species.

Ultimately, scientifically sound management depends on incorporating accurate, precise data into scientific models that predict outcomes and best-management strategies. Some evidence of success in this process was encountered during the review process, but evaluation of the application of scientifically sound data to management decision making was beyond the scope of our assignment, which focused on data acquisition. Staff responses to our survey expressed considerable confidence in the soundness of the scientific basis of management decision making for both inland and coastal fisheries.

Acknowledgments

We wish to thank the various personnel of Texas Parks and Wildlife for their assistance to the Review Team throughout the project. The efficient conduct of this science review would not have been possible without the great dedication of TPWD staff to the effort.

In particular, we wish to thank Gary Saul and Ken Kurzawski for their liaison roles in facilitating the science review. Furthermore, Ken's assistance in establishing the site visit and in coordinating review of the draft report was of tremendous value to the Review Team.

Throughout the Science review process, the TPWD points of contact provided valuable guidance. We wish to thank them—Dick Luebke and Dave Terre (representing Inland Fisheries), Mark Fisher and Lance Robinson (representing Coastal Fisheries), and Ken Kurzawski (representing TPWD). Their guidance on conduct of the project, their review of materials—especially the staff opinions and insights survey—and their assistance in identifying contacts to clarify issues after the site visit were invaluable contributions to the Review Team's effectiveness.

We appreciate the inputs of administrative and field staff from throughout the agency who contributed at various points to the science review. A large group of administrative personnel initially provided guidance to the science review coordinator on scope and process for the science review and identified resource materials for the Review Team. Staff, from executive director to field professionals, participated in the site visit. The high response rate on the opinions and insight survey by personnel ranging from division directors to field professionals was remarkable. As the Review Team sought to clarify issues during report preparation, numerous staff members responded to inquiries on questions specific to their expertise. For their dedication to the science review, their availability as the Review Team needed them, and their candid inputs, we are appreciative of each individually.

The American Fisheries Society also expresses its gratitude to each member of the Review Team as well as to their employers for allowing them to participate. Members' in-depth review of background materials, conduct of the week-long site visit, analysis of findings, and preparation of the report required substantial time commitments, often with tight deadlines. For their dedication to the science review, their availability as Team obligations arose, and their candid inputs to the review, we are deeply appreciative.

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I. Introduction

The state of Texas has an abundance of inland and coastal waters that support a spectrum of living resources. Texas Parks and Wildlife Department (TPWD) is one of three trustees of Texas' natural resources and has the responsibility for managing fish and other aquatic resources in public waters of the state. Management is accomplished through the Inland Fisheries Division and the Coastal Fisheries Division consistent with TPWD's mission "to manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing, and outdoor recreation opportunities for the use and enjoyment of present and future generations." Both divisions have a long history of fisheries management complemented by a separate Resource Protection Division, the aquatic components of which recently were melded into the existing Inland and Coastal divisions.

The Inland Fisheries Division has responsibility for 1.7 million acres of freshwater reservoirs and 80,000 miles of streams and rivers. Goals of the Inland Division include providing quality angling while protecting and enhancing freshwater resources. Whereas most inland fishing occurs on the state's 800 public reservoirs, well-developed assessment programs, research, and special studies are conducted to prescribe localized, reservoir-specific management with emphasis on sustaining quality game fish populations and their prey base. Management is accomplished through an integrated use of harvest regulations, stocking of fish produced primarily at Inland's five hatcheries, and habitat enhancement. Stream and river fisheries have received less emphasis because of their limited importance for fishing, their disproportional distribution due to geographic gradients of rainfall, and access limitations. Incorporation of expertise from the prior Resource Protection Division, which has statewide experience in stream resources, is anticipated to provide greater capability for dealing with stream resources and other environmental issues. Inland Fisheries research personnel currently collaborate with other agencies in addressing issues associated with threatened and endangered aquatic species, which may comprise up to 25% of the state's native freshwater fish species. In its overall fisheries resource assessment and management, the Inland Fisheries Division collaborates with other Texas agencies as well as those of adjacent states and the federal government.

The Coastal Fisheries Division has responsibility for 4 million acres of coastal waters, including nine major bays and estuaries, and the contiguous Gulf of Mexico to a distance of 9 nautical miles offshore. Goals of the Coastal Division include sustainable harvests of commercial and recreational resources, balanced food webs, and conservation of marine biodiversity. Based on well-established assessment programs and research, coastwide fishing regulations are implemented to optimize use of stocks. Supplemental stocking of some recreationally important fishes, which are produced at Coastal's three hatcheries, is conducted for enhancement or remedial purposes. Ecosystem approaches facilitate knowledge of and attention to the spectrum of biological components and habitats. Sea turtle conservation is the principal threatened/endangered species concern. Incorporation of expertise from the prior Resource Protection Division is anticipated to provide greater capability for dealing with environmental issues. The Coastal Fisheries

Division collaborates with other Texas agencies as well as those of other states and the federal government in the assessment and management of its resources.

Science-based management is frequently mentioned as a priority in documents describing TPWD programs. Among TPWD goals for the coming decade, elaborated in the TPWD Land and Water Resources Conservation and Recreation Plan (2002, pages 74–75) are to “improve fishing on inland and coastal waters” and to “improve science and data collection.” Specific to the latter goal is an objective to “undertake a comprehensive review of all scientific and conservation programs.” Consistent with the subobjective to “review assessment and monitoring functions for fish and wildlife populations,” TPWD requested an independent peer review of its science-based management by the American Fisheries Society, the principal professional organization of fisheries scientists in the United States.

The review was conducted for the purpose of “determining whether TPWD is using the best, most efficient techniques for monitoring, managing, and protecting its aquatic natural resources.” The specific objectives were to (1) evaluate the scientific basis and application of all key methodologies employed to obtain scientific information for management decisions; (2) ascertain the opinions and insights of staff on the use of, and gaps in, the science available for monitoring and managing fisheries resources with regard to how well science is incorporated into management decision processes; and (3) evaluate existing processes for ongoing evaluation of science-based activities while proposing modifications as needed to improve such evaluation, thereby leading to the most effective use of data in management decision making.

II. Procedures and Methods

To conduct the review, the executive director of the American Fisheries Society established the following Review Team:

James S. Bulak, South Carolina (state agency)

Greg L. Summers, Oklahoma (state agency)

Michael J. Van Den Avyle, Georgia (federal agency)

Richard L. Noble, North Carolina, Review Coordinator (university [retired])

Jessica Geubtner, Maryland, American Fisheries Society Liaison.

To facilitate communication between the Review Team and the agency, TPWD appointed five points of contact, representing both divisions. These individuals served as advisors, sources of information, and conduits to staff who could address specific questions.

Whereas comprehensive scientific fisheries management is based on integration of data regarding the resource, habitat, and users, four assessment programs were reviewed to achieve Objective 1: (1) Inland Fisheries Division’s procedures for fishery-independent and fishery-dependent assessment; (2) Coastal Fisheries Division’s procedures for fishery-independent and fishery-dependent assessment; (3) the assessment procedures of the Kills and Spills Team, which were developed for use in both Inland and Coastal divisions; and (4) the procedures for human dimensions assessment, likewise

applicable to both divisions, which includes numerous surveys done cooperatively with Texas A&M University.

Objective 1 was achieved through a “team-as-a whole” review of materials provided by TPWD subsequent to a meeting of key TPWD personnel and the review coordinator. Key materials were procedures manuals and examples of reports based on data collected according to procedure manual protocols. After individual review of background materials by review team members, a 3-day site visit was held in Austin and San Marcos. Interviews were scheduled with staff over the spectrum of TPWD, from executive director to field personnel, with primary focus on Objective 1. During the site visit and thereafter, additional materials were provided to the Review Team to clarify processes. Lists and examples of research projects and special studies were provided to indicate how basic assessment is complemented. Whereas the results of research projects and special studies commonly lead to publication in peer-reviewed outlets, the Review Team did not undertake further review of these projects.

Objective 2 was achieved by developing and administering a questionnaire to staff of the Inland and Coastal divisions. A broad range of questions was developed by the Review Team based on team members’ experience in fisheries management as well as issues identified upon review of documents and during the site visit. Following review by TPWD points of contact for clarity and their assistance in identifying all appropriate personnel to query, the questionnaire was administered electronically by the American Fisheries Society liaison to identified staff with assurance of anonymity. Survey results were summarized in four categories: Inland and Coastal administration (manager V and above) and Inland and Coastal nonadministrative professionals (mostly field personnel).

Objective 3 was achieved through examination of organizational charts and interviews during the site visit. This evaluation focused on processes used by the agency for evaluation of its basic standardized assessment protocols and resultant data in each of the four program areas. Information on functional relationships was obtained primarily from senior staff. Perceptions of field personnel regarding evaluation procedures were also expressed during the site visit. Post-site visit follow-ups with administrative personnel were conducted as needed.

III. Objective 1: Evaluate the scientific basis and application of all key methodologies employed to obtain scientific information for management decisions.

For each of the four assessment programs, the Review Team evaluated whether the protocols address the appropriate questions, whether the best technologies are being employed, whether assessments provide precise, accurate data efficiently, and whether critical components of the resource are being overlooked or underemphasized. Substantial background materials were provided to the Review Team and a high level of participation occurred in the site visit. New information continually surfaced, suggesting that even upon completion of the review, the findings of the Review Team’s intensive effort are probably incomplete and may involve some misperceptions or misinterpretations.

For each assessment program, this report summarizes the findings and presents recommendations for refinement of the assessment programs and their utilization. The findings for each of the programs were that they are scientifically sound and, when combined with research projects and special studies, form a strong scientific basis for management of the fisheries resources.

III. A. Inland Fisheries

The Inland Fisheries (IF) Division has developed a standardized sampling design for assessment of Texas public waters. The Fishery Assessment Procedures (FAP) manual is a consolidation of protocols for sampling reservoirs and streams that is used to provide scientifically valid and defensible data on the status of fish populations, habitats, and angler attributes with which to manage the state's freshwater resources. It was the commission of the Review Team to examine these procedures and evaluate the scientific basis and application of all key activities and methodologies and to discuss any issues that could hinder this process. The Review Team reviewed the FAP manual and recent reports based on standardized assessment procedures and conducted on-site interviews with a representative cross section of IF staff.

Findings:

- **Organization**
 - Inland Fisheries Division is divided into five functional groups: Administration, Fisheries and Habitat Management, Research, Education and Outreach, and Hatcheries.
 - There are three management regions, each divided into districts under the direction of a regional supervisor. The management staff is responsible for monitoring and regulating all freshwater resources.
 - The research station located at the Heart of the Hills Fisheries Science Center is commissioned with providing research findings on a statewide basis where unique problems exist and to develop new techniques to enhance fisheries resources.
 - Five freshwater production fish hatcheries are located in strategic areas of the state and are responsible for providing the fish needed for stocking as determined by management staff.
 - The production hatchery in Athens doubles as an education and outreach station. The Texas Freshwater Fisheries Center provides public relation and education functions through a multifunctional visitor center.
- **General aspects of the assessment program**
 - IF staff has, through a series of various iterations over more than 25 years, assembled an impressive FAP manual that they feel meets their evaluation needs. The procedures are conceptually sound and are generally accepted by the fisheries scientific community.

- The FAP manual emphasizes population assessment in public reservoirs, which usually are sampled on a 4-year rotation. Trends in sport fish and forage density, size structure, and fish condition are supplemented by assessment of age and growth and largemouth bass genetics. Assessment of structural habitat characteristics and angler access facilities is also required as a part of each survey. Creel surveys are optional, and vegetation surveys are required only if noxious or problematic vegetation is present.
- The FAP manual is equally well developed for stream sampling, which is conducted on an optional basis at the discretion of District staff. However, only electrofishing is required for stream and river sampling. Other standardized stream procedures, though elaborated in the FAP manual, are optional. Because of limited access points to streams and rivers, coupled with private property rights issues, stream assessment is restricted to segments accessible to the public.
- Standardized sampling is conducted utilizing randomization and with consideration of adequate sample sizes to attain target levels of precision. A recent in-house study has revealed that precision targets are frequently not met due to high variability and/or failure to attain necessary sample sizes.
- Analysis of reservoir data from the FAP uses descriptive metrics such as length-frequency, relative weight, and proportional stock density. There does not appear to be any uniform method of interpreting these metrics. Minimal effort has been given to developing dynamic population models using metrics derived from standard sampling.
- The IF staff appears to understand that the data collected by standardized assessment procedures (FAP) necessarily entail smaller than desired sample sizes and therefore inherently poor precision. The staff perceive these data to be of primary value for (1) identifying problems that should be addressed by the more rigorous efforts of special studies and research and (2) demonstrating to the public that all reservoirs and lakes are being regularly monitored and evaluated.
- The IF administration is not satisfied with the precision of the data currently acquired according the FAP (coefficient of variation [CV] = 20%). However, administrators also expressed concern that at current staffing levels they cannot afford the amount of effort required to provide better precision. This is a problem that plagues many state fisheries agencies. The IF field staff was more or less content with the current precision attained under the FAP, understanding the limitations of data use.
- Electrofishing appears to provide most of the data that are generally used to characterize sport fish and forage status. IF does not appear to be using gill-net and trap-net data in making management decisions, despite recognition that these gears provide the best data on certain species of high interest. Furthermore, the utility of the data does not appear to be proportional to the amount of effort undertaken to obtain it. Research and

- special projects material provided to the Review Team contained minimal information regarding species collected in gill nets or trap nets.
- Gizzard and threadfin shad are recognized as important forage species for reservoir sport fishes. Findings from the SDAFS multistate project (“shadathon”) show that electrofishing is an inefficient method for evaluating the status of shad forage, especially threadfin shad abundance. The FAP manual does not include any other assessment approaches for this important component of reservoir systems.
 - Although reservoir productivity appears to be an important indirect consideration in management decisions, IF has no standard protocol for evaluating any aquatic trophic levels below secondary consumers (thereby emphasizing top-down management). As the methods of evaluating shad populations are questionable, productivity estimates of lower forms (thereby including bottom-up processes) can be essential in choosing proper management strategies for both forage and predator sport fish populations.
 - The objectives of using randomly selected sampling sites in the FAP are unclear. Randomization allows certain statistical analyses and conclusions that would not be possible using other forms of sample site selection, but analyses of this kind were not seen in the reports using FAP data.
 - Different perceptions exist within IF regarding the relative amount of time spent on FAP. In response to a specific question posed throughout the site visit, the percentage of field staff time spent on FAP was estimated as 50% by the Management and Research Director, 20–25% by the regional directors, and 65–75% by the district biologists. This discrepancy could be critical if unilateral decisions are made regarding assignment of extra responsibilities to field staff as they are needed or in judgments as to whether the expected balance of time spent on duties other than FAP is or is not being attained.
- Fishery-dependent sport fish harvest assessment
 - An elaborate, but optional, standardized creel survey program has been developed to assess active and passive fishing using a combination of access point and roving surveys. Estimates are used to monitor trends, and the statistical precision of estimates is typically low. Decisions to conduct creel surveys are made jointly by staff at the district, region, and program levels, and a biometrician and biologists with training in creel surveys provide assistance with design, scheduling, and analysis.
 - It is apparent that some IF field employees do not understand the basics of creel surveys and their analysis. There are no details of creel survey theory or analysis in the FAP manual. Some of the IF staff envision that the creel data are turned in, someone performs the analyses, and then the results are returned. If a district biologist had done a creel survey as part of his graduate work, then the basic components of creel surveys are understood (pressure, catch rate, harvest, precision, etc.). However, there were some IF field staff who knew very little about how the creel data

were analyzed but had participated in their collection. This could lead to biased data from poor field decisions being made when atypical situations are encountered.

- Habitat monitoring
 - As the role of habitat has become better understood in reservoir fisheries management, procedures for sampling physical and chemical conditions, structural habitat, and aquatic vegetation have been developed and added to the FAP manual. The field staff appears to be insufficiently trained, especially in structural habitat assessment, for survey data to be either precise or accurate.
 - When noxious or problematic vegetation is detected in routine fisheries surveys, follow-up surveys, either preliminary or comprehensive, are conducted according to standardized field procedures. There appears to be no integration of GIS technology into the identification and assessment of vegetation control.
 - Vegetation management appears to be conducted to facilitate access rather than to enhance fish populations.
 - While vegetation control has required a postapplication evaluation, habitat enhancement has not required a follow-up investigation to evaluate success.

- Fisheries research and special studies
 - IF is exemplary in providing time and effort toward encouraging special studies by their management staff. The review process of these proposed projects includes not only administrative input but peer evaluation as well.
 - IF administration is outstanding in supporting Division interests in GIS, research, and special studies. The compendium of past projects, both research and special studies, was exemplary. Administration maintains a good balance between supporting these issues and supporting the politically motivated ones.
 - FAP are complemented by special studies conducted in the districts and by research projects conducted by the research staff, usually in conjunction with district staff. There is a good balance within the special studies between evaluating and upgrading FAP and the other projects directed at making particular management decisions.
 - There is a clearly defined procedure to propose and develop special projects. However, there was disappointment expressed by some district biologists who did not understand why a special project of their design was not given high enough priority to be performed in their district. A perception exists in the field that low-profile projects tend to get less support from administration.

- Data management
 - There is good flow with regard to FAP data, from the point of collection to the point of retrieval. Everyone understands the required protocols. Data

editing is logical, definitive, and thorough. A competent system of retrieving archived data is in place for staff use at all levels. However, the paper forms that are currently being used for field recording are slowing the flow of data.

- Unlike FAP data, much of the research data are not centrally archived, nor can staff other than research readily access them.
- The maintenance of hatchery stocking records needs improvement. Some personnel indicated that hatchery stocking locations appear to be entered inconsistently and that entered data are not verified.
- Fish stockings
 - Through the process of initial the FAP and follow-up either with special studies or research, management decisions regarding regulations are based on sound, rigorous data. However, the management of stocking and habitat manipulation does not entail the same rigor of data collection with which to justify decisions in those areas. Hatchery fish stockings are based largely on imprecise data collected by FAP.
 - While fish stockings use a significant portion of the IF budget, no formal follow-up investigations to evaluate their success are required. IF stocking criteria, which prioritize statewide stockings, do not address evaluation.
 - Increasing the percentage of largemouth bass with Florida alleles to 20% in selected Texas reservoirs through stocking is a main objective of the reservoir management program. This objective was established under a previous administration but continues to be a Division priority. Investigations are ongoing to evaluate whether this goal provides the intended improvements to bass fishing.
- Other issues
 - Although field staff would benefit from further training in creel survey and structural habitat assessment technologies, training is regularly provided at annual workshops to orient staff to new or refined approaches in FAP.
 - The stated mission of IF extends to the breadth of aquatic resources, but assessment and management efforts focus on reservoirs, which support most inland fishing. IF does not adequately address its stated mission with regard to non-sport fish and nonreservoir fisheries. Recently, the IF staff has been enhanced with personnel who were in Resource Protection and who have experience with both streams and nongame populations. The Division has an opportunity through this recent reorganization to successfully complete its mission.
 - Although IF does have a T&E coordinator, most aquatic T&E work is done outside the Division. IF does not have a coordinated way of assessing nongame species that would contribute to T&E classification/reclassification.
 - Inland Fisheries Division has a good number and variety of “go to” people

to satisfy the needs of the Division (e.g., genetics, GIS, statistics, human dimensions, T&E, etc.).

- There is little knowledge by most IF employees of what role the recently integrated Resource Protection staff will have in meeting the overall objectives of the Division. The Resource Protection staff is currently doing business as they had in the past, although interaction among staff with varied responsibilities is occurring through colocation in some districts.
- As with most current natural resource agencies, the Division administration proclaims that they are “product oriented.” In addition, the IF strategic plan states that they will strive to produce more “products” for the public. In a time when participation in freshwater fishing is declining, business doctrine suggests that more time be spent on customer service to better evaluate and address constituent needs. With our changing culture, the traditional product-oriented idea of “if we build it, they will come” is no longer a sound business principle in promoting fishing participation.

Recommendations:

The overall evaluation of the scientific basis of management by IF is quite favorable. But, as with any institution, continuing to strive for improvement is a necessary part of organizational growth. IF’s understanding of this principle is quite apparent in their request for this review. To this end, we offer several suggestions for consideration based on our on-site interviews and review of provided materials.

- If additional funding becomes available in the future, it would benefit IF to increase the number of fisheries districts, thereby allowing for an increase in size of FAP data collections. This increase would improve precision and at the same time not require special studies and/or research to make defensible management decisions.
- IF should develop a more standardized approach to fish stockings and habitat manipulations. Stockings based on robust criteria will allow for better allocation of hatchery production and alleviate, to some degree, undesirable stockings that are politically motivated.
- IF should consider altering FAP gill-net procedures to include smaller mesh sizes, while possibly eliminating some larger mesh sizes, to more adequately assess shad forage. Often data from catches in larger meshes are not being used to make management decisions.
- Although most IF aquatic vegetation work is directed toward control and removal, more detailed evaluation procedures using GIS prior to treatment would probably lead to improved efficiency and possible cost savings.
- IF should develop an electronic field data recording protocol.
- IF should include detail regarding creel survey procedures and analysis in the FAP manual (see the Coastal Division manual as a model).
- IF should evaluate the utility of data on lower trophic levels in understanding

system dynamics and undertake appropriate acquisition of basic data through routine assessment or special studies when needed for management.

- IF should reevaluate the use of FAP trap-net data. If they are not being used regularly in management decision making, IF should consider making this procedure optional.
- IF should fully integrate GIS technology into aquatic vegetation control. This should allow for more accurate status assessment as well as more precise evaluation of treatment effects.
- If statistical evaluation is being performed on FAP data, IF should include these metrics in the annual reports. However, if regular statistical analysis of FAP data within lakes, between lakes, and between years is not essential, then administration should consider dropping randomized sampling sites. Standard sampling sites could be more efficient when trying to maximize number of fish in a sample for length-frequency, relative weight, and relative abundance analyses. Keeping the minimum number of units of effort relatively high and the amount of time in a single unit of effort low will ensure that a wide diversity of habitats are sampled to reach quotas.
- IF should include the stocking criteria protocols in the FAP manual and consider periodic review of the criteria and procedures.
- IF should develop a better system to record and verify hatchery stocking data and develop a more rigorous approach to the evaluation of stocking success.
- IF should develop, through appropriate, *divisionwide* communication, a specific mission, goals, and duties for the former Resource Protection staff. These objectives should also include ways in which task sharing with management, research, and culture staff might improve the efficiency of all sections.
- IF should develop a more active concern for all the aquatic biota of Texas, including establishing a stream assessment section within IF. This stream assessment group could not only be responsible for stream and river sport fish evaluation but also be a part of nongame species and T&E assessment. Whereas the former Resource Protection staff has experience in these areas, it is logical that this section be expanded or merged with existing personnel to cover these issues.
- IF should archive its research data and summaries in a Web-based data retrieval system similar to the one used with FAP data.
- IF should complete a time–efficiency study on its staff regarding FAP collections, analysis, and reporting.
- IF should consider building more customer service time into staff requirements. Activities such as participating in town meetings, marketing local fishing information, and better sharing FAP information are just a few proven examples of things that improve customer retention. Additionally, IF should investigate the business principle of customer relationship management (CRM) as an avenue of customer service.
- Although communication within the IF Division is good, it should continue to look for ways to improve the dissemination of information from the top down. This has the potential of alleviating some of the “disappointment” and

“uncertainty” expressed in the field interviews.

III. B. Coastal Fisheries

The Coastal Fisheries Division utilizes a suite of fishery-independent and fishery-dependent assessments to scientifically characterize the status of commercially and recreationally important species. Each type of assessment is designed to give coastwide estimates for target species. The assessments provide trend data on the current status of natural resources and are a factor in the setting of coastwide regulations of commercially and recreationally important species. A variety of interstate collaborations, grants, and applied research efforts are used to augment information obtained from the assessments and address specific, high-priority topics. If local management questions arise, special studies are designed and implemented. To assess the effectiveness and accuracy of science-based management in Texas, the Review Team was provided copies of the assessment protocols and a variety of reports, conducted on-site interviews with a cross-section of Division staff, and obtained additional inputs through follow-up contacts with appropriate agency personnel. A summary of major findings is provided.

Findings:

- Organization
 - The Management and Resources Section conducts field assessments, investigates resource issues of regional significance, and performs fish enhancement and hatchery activities, including studies on hatchery operations and assessments of stocking success. The coast is divided into two regions and each region is subdivided into four ecosystem units.
 - The Science and Policy Section is responsible for designing and overseeing the coastwide assessments and advancing coastwide management recommendations. The section also conducts applied research of statewide significance at the Perry R. Bass field station, utilizing its technical expertise in age and growth, life history metrics, and genetics.
 - The Water and Habitat Resources Sections were recently added due to the merger with the Resource Protection Division, which possessed expertise in habitat, geographic information systems, lotic resources, and water quantity. This merger has the potential of diversifying and increasing the capabilities of the Coastal Division as the Management and Science sections concentrate on recreational and commercial species management.
 - Management decisions involve an administrative team comprised of representatives of the various sections, who incorporate findings from basic assessments, special studies, and constituents.

- General aspects of the assessment program
 - The Division has developed a commendable, scientifically sound annual assessment program, resulting in estimates for which statistical precision is reported. The precision of the data obtained has proven adequate to

justify coastwide management decisions for the major recreational and commercial species.

- Fishery-independent sampling is conducted annually using gill nets, bag seines, bay and Gulf trawls, and oyster dredges. A fishery-dependent sport fish harvest monitoring program is also conducted annually, estimating total landings and fishing success for recreationally important species. Commercial fishery landings are monitored annually through a mandatory self-reporting system for licensed seafood and bait dealers. Regularly scheduled intercept surveys of shrimp and finfish dealers are also conducted to augment commercial landing information.
 - Standardized sampling is the primary activity of personnel at the ecosystem level. Field personnel estimate that the time commitment for standardized fishery-dependent and fishery-independent sampling is approximately 80–85% of available time.
 - A rigorous quality control program was implemented in 1993 to ensure that field sampling is conducted uniformly, correctly, safely, and efficiently. The quality control program requires the involvement of all levels of management staff.
- Fishery-independent resource monitoring
 - Coastal Fisheries has an extensive, long-term (20+ years) assessment program providing important resource trend data. Data trends were last published in 2000 for the period 1975–1997.
 - Fishery-independent sampling, conducted annually using a variety of gears, seeks to assess the fish community as a whole while providing statistically precise data on species of major interest. Each gear type has greater efficiency for certain species, though all sampled specimens are identified and enumerated. The major gear types and the resultant primary information are as follows:
 - Gill nets – abundance and size of adult finfish, especially trout and drum
 - Bag seine – abundance, size, and diversity of juvenile finfish and macrocrustaceans
 - Bay trawl – abundance and size of shrimp and crabs
 - Gulf trawl – movement, growth, and abundance of shrimp in marine waters
 - Oyster dredge – oyster abundance and recruitment
 - A habitat characterization is done with each assessment type. Except for an IBI analysis in a recent report on the Texas shrimp fishery, little evidence of the use of habitat data was noted.
 - Standardized assessments use widely accepted procedures that are comprehensively described in an operations manual providing a readily available reference for employees. After a staff review, the operations manual is revised annually to reflect needed procedural changes.
 - Analytical methods are adequately described in the summary reports.

- Sample sites are randomly determined each year within each ecosystem to achieve the desired goal of a coastwide assessment. Sampling frequency has been evaluated to give an efficient mix of acceptable precision requirements and available manpower. Sampling strategy is designed to produce precise coastwide estimates of a few economically important species. Standard errors for the primary recreational species range from 10% to 20% of the estimate. Regional estimates would have less precision than coastwide estimates.
- Analysis of the precision associated with various sample sizes is efficiently addressed in an in-house report, “Sample Size Analysis of Coastal Fisheries Resource Monitoring Program.” The findings indicate that current assessment strategies are scientifically sound and represent a balance between available resources and reasonable statistical precision for economically important species.
- Fishery-dependent sport fish harvest assessment
 - Coastal Fisheries has a well-developed assessment program of sport fish harvest. The program, initiated in 1974, is the largest and longest running program of its kind in the United States. Data trends were last published in 2002 for the period 1974–1998.
 - The bay–inshore recreational fishery is responsible for more than 90% of total effort and landings. The fishery-dependent assessment program emphasizes bay and inshore fishing in the proximity of bays.
 - The assessment program uses a scientifically sound statistical method of annually estimating daytime landings, catch per unit of effort, and size, by species, for bay and Gulf private boat anglers and party boat anglers.
 - Standardized assessments use widely accepted procedures that are comprehensively described in an operations manual providing a readily available reference for personnel. Procedures for fishery-dependent sampling are reviewed and adjusted annually.
 - A stratified random design ensures that manpower is efficiently utilized. Sample sizes were set to detect a 50% difference in fishing pressure and landings estimates 80% of the time at the 95% confidence level.
 - Data are manually entered on paper forms in the field, and then keyed. After data are edited according to a defined process, they are added to a central database.
 - A detailed description of statistical procedures for deriving reporting estimates is provided in the summary report. Standard errors of estimates are reported, providing the reader good information on the confidence associated with the reported estimates.
- Commercial landings assessment
 - Commercial fishery landings are monitored annually through a mandatory self-reporting system for licensed seafood and bait dealers. Regularly

scheduled intercept surveys of shrimp and finfish dealers are also conducted to augment commercial landing information.

- Shrimp comprise roughly three-quarters of the weight of commercial landings and account for more than 80% of the exvessel value of commercial landings. Therefore the shrimp fishery is the principal source of landings data.
 - Seafood and bait dealers are required to submit monthly reports listing water body, total weight, and price paid for each purchased species.
 - The amount of inaccurate or incomplete reporting is unknown and must be considered constant when making comparisons.
 - Data trends were last published in 2004 for the period 1981–2001. The report compiles the information for each year and inspects trends. Long-term trends in total seafood landings have remained nearly constant over time.
- Database
 - Fishery-independent and fishery-dependent survey data are entered into a relational database by regional management staff. A regional editor and management staff check the accuracy of data entry before the data are released.
 - Science and Policy Division staff check the accuracy of landings data prior to entry into a central database by regional management staff. A regional editor and management staff check the accuracy of data entry before the data are released.
 - Assessment data are centrally stored in a timely and accurate fashion, allowing professional staff to access the entire database from remote locations.
 - Standard programs provide valuable descriptive summaries of the assessment data, which are stored as raw data.
 - The database provides opportunities to conduct coastwide as well as ecosystem-level modeling to examine potential management strategies.
 - Applied research, special studies, and collaborations
 - Standardized fishery-dependent and fishery-independent assessments may be supplemented by special studies and research to help formulate management decisions.
 - The need for special studies often arises at the local management level (i.e., ecosystem). The ability of ecosystem staff to undertake special studies is sometimes limited by the available manpower.
 - Within the Science Section, trained professional staff at Perry R. Bass Research Station conduct a population genetics research program. Efforts are directed toward conserving genetic resources, species identifications, stock structure, and genetic tagging. Collaboration of the research staff with universities appears minimal.

- Statewide age and growth analysis is conducted at Perry R. Bass Research Station using a state-of-the-art image analysis system. Life history investigations are also performed at this location.
- Within the Management and Resources Section, hatchery biologists conduct research on hatchery production and genetics. The hatchery program contracts with in-state universities to conduct genetic investigations. A main focus has been development of a genetic tag for stocked red drum.
- The effectiveness of hatchery augmentation of coastal stocks has been a primary area of investigation by the Management and Resources Section. Whether hatchery stockings have truly augmented or replaced natural reproduction is still technically unresolved.
- Although basic standardized resource assessments provide information on the breadth of inshore communities, the only threatened, endangered, or nonrecreational species that are given any significant attention are sea turtles. Apparently, there is nothing on the immediate horizon to expand efforts to address this important group of resources.
- The Division has produced a highly commendable number of peer-reviewed publications and an impressive list of Management Data Series Reports. Few examples were found of reports specifically designed to inform the public of resource status and the resultant management and regulatory recommendations.
- In 2002, a special report was issued on the status of the Texas shrimp fishery. Significantly, the report compiled historic assessment data to generate indices of biotic integrity to address the condition of resource communities in Texas inshore coastal waters. This compilation of historic assessment data to address specific questions was an excellent use of the assessment database.
- In addition to its contracting with universities, the Division has established collaborative efforts with interstate groups and federal agencies responsible for natural resource management. These collaborations increase the effectiveness and efficiency of natural resource management efforts.

Recommendations:

The Coastal Fisheries (CF) Division has done an excellent job of creating and developing a long-term, resource assessment database. There is always a need to reevaluate existing programs in the face of ever-changing technology, environment, and societal values. In the spirit of advancing ideas that may improve the acquisition of data and application of science to natural resource management, the following recommendations are advanced.

Whereas the time of professional field staff is consumed in the collection of data under standardized assessment protocols, little time appears to be left for other investigations and analyses that could improve management decision making. Resource

assessment data and the unique features of various Texas bays suggest that regional management will become more applicable to natural resources in the future. Modification of protocols, schedules, working relationships, and priorities should be considered. Some suggestions follow:

- CF should consider decreasing the frequency of annual coastwide surveys of recreational sport fish landings, which can occupy approximately 40% of a field biologist's effort. For example, a triennial design would detect long-term trends relative to harvest and free up time for special studies of regional significance. An annual survey does not seem to be required to meet management goals.
- CF should develop a flow chart that defines the relative importance of the biological, economic, and societal data that are needed to make a regulation recommendation for each species. This process would help define the importance of each assessment type in making a management decision. It is not clear to the Review Team how the assessment data are used in making a management decision. If a certain type of assessment is "marginally important" or is largely duplicated by another gear type, then CF should consider eliminating that type of assessment to allow more assessment efforts at the local scale or toward species not effectively sampled by the current assessment procedure.
- CF should continue to refine the annual fishery-independent monitoring assessment program. Potential areas of evaluation are
 - Whether it is necessary to continue to annually survey with all five types of gear. If trends could be assessed with less effort, then manpower could be directed toward special and/or regional efforts.
 - Whether it is necessary to use gill nets in both spring and fall. Summary reports suggest that spring sampling alone adequate to detect trends in major recreational species.
 - Whether shrimp harvest management decisions are actually based on gulf trawl surveys, which are costly to conduct. Gulf season opening dates are generally fairly constant, but they are adjusted based on bay trawl data. It is not clear how Gulf trawl data are used to adjust the Gulf shrimping season.
 - Whether the reporting of a coastwide abundance estimate for oysters is useful. Oyster monitoring data define the vitality of the various reefs. Reef closings are shell transplant efforts that are based on reef-specific conditions. Perhaps reef-specific abundance estimates should be reported.
 - Whether quality assurance and control procedures to ensure the accurate measurement of water quality parameters should be included.
 - Whether the gathering of meteorological data is critical to assessment trend data. The reports supplied to the Review Team did not clearly show the importance of gathering this information. CF should evaluate the option of using meteorological data gathered by various weather services, which would free up some field time.
 - Whether to evaluate trends statistically rather than descriptively in summary reports. For example, it was reported that "mean length

decreased slightly to 499 mm,” when the previous year’s mean length was 500 mm.

- CF should increase efforts to understand the relation between resource status and habitat. The expertise of Resource Protection staff could be used to develop a database relating the condition of biota to habitat.
- CF should increase its emphasis on habitat and nonrecreational species. Existing assessment data provide an initial opportunity to define the status of coastal aquatic resources, as required by the Federal State Wildlife Grant Program. At present, the Division identifies only sea turtles as an aquatic species of conservation need.
- CF should continue to evaluate technology that will allow direct entry of sample data into a database. If suitable technology is found, this will decrease data entry time and reduce transcription errors.
- Regarding landings data, the level of inaccurate or incomplete reporting is unknown. CF should investigate whether this problem affects the statistical accuracy or precision of trend data and whether underreporting is creating an underestimate of the value of commercial landings.
- While the Division should be commended for an institutionalized quality assurance program, it should consider reducing the time allocated to this effort. At the field level, the perception exists that oversight efforts are excessive. CF should reallocate some of this effort to special projects.
- The assessment database offers additional opportunities for data mining. The long-term monitoring program has accumulated a tremendous amount of information, which, because of personnel limitations, has not been fully analyzed. For example, CF could produce an atlas of coastal fishes documenting the existence, abundance, occurrence, and stability of these resources.
- CF should continue to address the question whether hatchery stockings provide a cost-effective increase in population abundance in coastal waters. Substantial resources have been allocated to augmenting populations of red drum and spotted seatrout with hatchery stockings. While the survival of hatchery-reared fish has been documented, the research hypothesis that hatchery stockings increase abundance has not been conclusively proven.
- CF should refine its organizational structure so that all studies of hatchery augmentation are under the direction and oversight of the science director. Presently, both the Enhancement (i.e., hatchery) and Science sections are conducting independent evaluations that are not well coordinated. For example, the Enhancement Section has contracted with a university for genetic assessments while substantial in-house genetic resources exist within the Science Section.
- In general, most applied science is done within the Division. CF should evaluate developing further collaborative opportunities with universities. That has the potential to increase funding and expertise that can be applied to a priority need.
- CF should consider implementing a system in which management biologists would recommend regional or ecosystem-level regulations based on scientific input from the science director, local knowledge, and the manager’s perception of logistical constraints.

- CF should formalize regular communications between the sections. In the past, communications between the Management/Resources and Science sections have been based on an “as-needed approach.” With two new divisions and a perceived need to more fully discuss regional issues, a more rigorously defined process for sharing information would seem to be beneficial. Within this process, CF should formalize an annual process that seeks input from all professionals and identifies priority special studies.
- CF should consider producing technical reports for the public when regulation modifications are under consideration. Such reports should document the use of science-based data in the decision-making process.

III. C. Kills and Spills

Both the Inland and Coastal divisions indicate that habitat is a key issue in resource management. In addition to habitat assessments undertaken as a part of standardized fishery surveys by each division, investigations of fish (and wildlife) kills, pollution affecting fish and wildlife, and harmful algae blooms are conducted by the TPWD Kills and Spills Team (KAST) in conjunction with appropriate state and federal agencies. KAST activities are elaborated in the KAST procedures manual dated February 1997, which was revised in October 2003. The procedures manual is comprehensive, addressing investigation, documentation, restitution, and recovery projects. The Review Team focused on the assessment and documentation of pollution spills, fish kills, and harmful algal blooms as elaborated in the procedures manual, discussed during the site visit, and further explored through communication with TPWD personnel. In some cases, such as water quality investigations, KAST follows TCEQ’s protocols, which were not specifically reviewed by the Review Team.

Findings:

- Comprehensive and thorough standardized procedures have been, or are in the process of being, developed to assess the causes and extent of fish kills. These procedures are applicable to both inland and coastal waters.
- Development of procedures and responsibilities for investigation has been coordinated with other responsible state and federal agencies to ensure standardization of assessments and proper apportionment of responsibilities.
- Fish (and wildlife) kill investigations follow AFS Special Publication 30 (*Investigation and Monetary Values of Fish and Freshwater Mussel Kills*), the longstanding and recently updated standard for the fishery profession.
- KAST activities are conducted primarily in response to a 1985 legislative mandate, and data are generated and entered into the PRISM database to meet that mandate. The PRISM database, being thorough and current, is a valuable resource for anticipating events based on past incidences. Use of the PRISM database is primarily by KAST personnel and associated administrators; it is less utilized by fishery biologists responsible for particular districts and ecosystems.

- Whereas data may ultimately be used to obtain restitution, their accuracy and precision are given high priority and the collection and reporting processes are detailed. For litigation purposes, emphasis is placed on being certain of the sources of pollution and the causes of kills. Standard protocols include determination of a “conclusive” cause or source, and best efforts are made to be definitive.
- Standardized assessment procedures are tailored to individual short-term events rather than an event ongoing through time or broadly occurring through space.
- A checklist facilitates decisions on whether a site investigation is warranted. The response threshold for investigations has been modified due to insufficient funding and personnel. Events that meet the checklist point system threshold still are typically being investigated, but non-KAST personnel (e.g., district fishery biologists/ecosystem leaders or enforcement officers) may need to follow up on some cases in the absence of KAST professionals.
- KAST personnel have intensive training upon recruitment, followed by periodic updates on procedures and methods. District fisheries biologists and ecosystem leaders assist in KAST assessments as needed and available. Their training in KAST procedures is less formal, but they usually work in conjunction with trained KAST members.
- Procedures for assessing harmful algal blooms through collection of both living and preserved samples are well elaborated. Unlike spills and kills, however, assessment is aimed at determining presence/absence in an initial response. Biological and gross physicochemical samples (up to three) from up to 10 sites are considered adequate based on experience. Failures of the protocol to detect the presence of harmful algae have occurred, usually in response to unusual hydrodynamic events.
- The KAST procedures manual is updated periodically in response to suggestions from field personnel and/or standard protocols (e.g., the update of AFS standards). Inputs from co-located fishery biologists are informally or incidentally obtained.
- Interaction between KAST personnel and inland and coastal fishery biologists is anticipated to increase as personnel from the former Resource Protection Division are incorporated into the Inland and Coastal Fisheries divisions. Personnel are expected to increasingly co-locate and collaborate. However, regional offices sometimes differ in location.
- Assessments and documentations of kills and spills according to established procedures have typically been sufficient to justify restitution where appropriate and to facilitate recovery efforts when feasible.

Recommendations:

The Kills and Spills Team has developed broad procedures that are well suited to assessing the resource issues of both the Inland and Coastal divisions. Some suggestions for additions and refinements follow.

- The KAST procedures manual is intended to be thorough and detailed. Portions of the Manual that are incomplete or are in draft stages should be completed and adopted.
- The effects of altering the response threshold for investigations should be evaluated, both in terms of the quantity and quality of investigations, i.e., whether all qualifying events are being investigated, and whether events are properly investigated when non-KAST personnel have to respond. KAST should ensure that such personnel are adequately trained to obtain data consistent with KAST procedures.
- To the extent feasible, standardized protocols should be developed to address sampling requirements for assessing events that are associated with unusual hydrodynamic conditions, ongoing through time, or broadly occurring through space.
- Although harmful algal bloom data, unlike spills and kills data, are not collected for restitution purposes, their reliability should be evaluated. Biological and gross physicochemical samples from three (or fewer) subjectively chosen sites may be insufficient, even for initial assessment aimed at the establishment of presence/absence.
- KAST staff should consider developing emergency protocols regarding a *major* kill due to harmful algal blooms. Since these blooms have the potential to cause substantial economic crises at highly valued recreational waters (e.g., Lakes Fork or Texoma), it would seem that there is a need for structured procedures in the event of a major kill. Not only should rapid biological assessment be outlined (who, what, when, and where), but prompt communication strategies with designated stakeholders and media should also be considered.
- KAST should utilize the PRISM database more broadly. Its use, which is now primarily in response to the legislative reporting mandate, should be expanded to routine incorporation into water quality and fisheries management.
- Reorganization of TPWD to absorb and integrate the former Resource Protection Division into the Inland and Coastal Fisheries divisions offers new opportunity for closer working relationships between KAST personnel and fishery biologists at the district, region, and ecosystem levels. Efforts should be made to co-locate personnel to the extent feasible, to integrate assessment activities as appropriate, and to utilize personnel and other resources jointly in order to expand capabilities in assessment and management.

III. D. Human Dimensions

Information on human dimensions (HD) applicable to inland and coastal fisheries is obtained by TPWD through a combination of the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (a federal survey), which is conducted at 5-year intervals; a contracted state survey of demographics, participation, attitudes, and management preferences of Texas anglers (hereafter termed the Ditton survey), which is conducted at 4-year (or shorter) intervals; components of creel surveys conducted as part of routine assessments; special studies (both contracted and agency conducted); and direct stakeholder contacts (e.g., public hearings and scoping meetings). Together, these

assessments provide information on stakeholder participation and opinions at the statewide and coastwide levels as well as the local water body and ecosystem levels that are incorporated into agency decision making. The Review Team examined the Ditton survey in detail and in conjunction with the national survey, lists of special studies, and HD components of standardized creel surveys.

Findings:

- The combination of assessments provides comprehensive information on the sportfishing constituencies of both the Coastal and Inland Fisheries divisions.
- Consistency over time in the federal and Ditton surveys provides valuable trend data on recreational fishing.
- The Ditton survey includes a breadth of components, including angler characteristics, motivations, attitudes, and participation assessed with consistency over time, but it also has the flexibility to incorporate assessments relative to contemporary issues.
- The Ditton survey is conducted under a stratified random sampling design to increase its precision and ensure balance between inland and coastal anglers. No measure of precision is indicated in the Ditton study. Large sample size, reasonable response rate, and subjection to peer review suggest that precision is adequate. However, the response rate has declined, suggesting a possible reduction in precision.
- Although the Ditton survey provides consistency with earlier surveys, it has possible biases of concern. Only in-state, annually licensed anglers are polled. Nonresident, senior, and lifetime license-holders are not included. As demography changes, the resulting impacts are not assessed by this survey.
- Whereas trends established by the Ditton survey have been consistent, routine collection of the survey data as frequently as at 4-year intervals may be providing less useful information than special studies that are aimed at evaluating biases or focused on more specific questions.
- Division administrators with HD expertise, working in conjunction with staff HD specialists and the contractor, coordinate in the evaluation and modification of the Ditton survey prior to its periodic administration. Issues identified by field personnel are highlighted for possible inclusion in the Ditton survey or pursuit through special studies. The years between the standardized Ditton surveys are frequently used for directed HD studies focused on either specific resources or issues.
- The findings of the Ditton survey, coupled with those of the federal survey and special studies, are incorporated into division and agency decision making by the respective Division management teams. For example, HD assessments of recreational participants indicate low Hispanic participation and the need for better access. These have been incorporated into agency priorities.
- HD assessments of the fisheries divisions have primarily focused on fishing publics. Beyond the information available through the federal survey, standardized assessment data are not being systematically sought on the human dimensions of the general public pertinent to Texas fisheries. TPWD has, in

- recent years, contracted special studies of broader environmental awareness, which include aquatic issues. With increasing emphasis on habitat protection and nongame species by the agency, the characteristics of a broader constituency relative to aquatic resources are important to setting of priorities by the divisions.
- The broadly-administered federal and Ditton surveys and intervening special studies have been supplemented with routine components of creel/angler surveys and add-ons to creel surveys when special issues arise. Such surveys, conducted as a part of routine creel surveys, have been minimized so as not to detract from the data collection primarily aimed at catch and effort.
 - Coastal Division field staff are specifically trained to ensure consistency in the administration of HD questions, which are added to the routine annual angler surveys. Inland Division staff, who have used standard HD questions as a part of standardized creel surveys, conduct creel surveys optionally and are subject to little formal training in HD investigations.
 - With the assistance of the divisional HD specialist in conception and design, focused HD investigations may be contracted or occasionally conducted by existing field personnel as special projects. Scientific rigor in project design and peer review of reports are utilized to ensure quality studies. Lists of technical reports and special projects indicate that special HD projects by field personnel are seldom undertaken.
 - Although TPWD obtains standardized HD data from the Ditton survey and federal survey and more specific data through research and special studies, their HD requirements are being met on a piecemeal basis.
 - HD data, license data, lifestyle information, and other pertinent consumer data are not archived into an accessible, usable data warehouse where relationships between HD findings can be further explored. To some extent, the fisheries divisions are data rich and analysis poor relative to HD.
 - The Texas shrimp fishery exemplifies the incorporation of human dimensions information into resource management in the commercial arena. Socioeconomic aspects of the fishery were investigated through a spectrum of assessment procedures that considered the broad dimensions of the fishery.
 - The fisheries divisions of Texas Parks and Wildlife Department have been national leaders in their commitment to the human dimensions component of fisheries management. In each division, a professional position is designated as a focal point for human dimensions matters, though both were vacant during the science review site visit. These positions have the potential to contribute to an elevated level of attention to scientific assessment (and application) of human dimensions attributes, to assist field staff, and to coordinate the HD programs of the Inland and Coastal divisions.

Recommendations:

Human dimensions assessment, applicable to both divisions, has been well developed over more than a decade. Opportunities to develop an even stronger program exist, and the following recommendations are advanced for consideration:

- The decline in response rate for the standard Ditton surveys suggests that precision would also decline if the number of questionnaires administered were held constant. As the next standard survey is developed, anticipated precision should be evaluated in light of the anticipated response rate.
- Biases in the Ditton survey should be evaluated through special studies. Whereas the survey is limited to in-state, annually licensed anglers and excludes nonresident, senior, and lifetime license-holders—for whom the trends are probably different from those of in-state licensed anglers—the overall consistency in the trends indicated by the standard Ditton survey may be misleading.
- Whereas the trends established by the Ditton survey have been so consistent, increasing the interval between the standardized surveys should be considered. The time and expense saved could be reallocated to special studies, e.g., the evaluation of biases.
- Whereas field staff conduct some HD studies and the HD components of standard creel surveys are administered by them, those staff, especially in the Inland Fisheries Division, should be better trained to ensure efficiency and accuracy in HD data collection.
- With increasing emphasis on habitat protection and nongame resources by the agency, the characteristics and attitudes of a broader constituency relative to aquatic resources are important to the setting of priorities by the divisions. Although some information is available from broader surveys, specific needs for HD data on nonanglers should be evaluated and plans developed and implemented for obtaining such information.
- A comprehensive HD assessment program should be developed that looks to meeting future needs as well as ascertaining current attitudes and opinions. Balance should be sought between standardized surveys and special studies to acquire HD data.
- Declining participation indicates a need for all state fish and wildlife agencies to develop a thorough customer evaluation system. TPWD should consider developing a data warehouse, through a specific informational platform, that would allow investigation of the relationships among HD parameters. The warehouse should be dynamic and current, so that the potential effects of decisions could be easily evaluated. The database should include not only demographic information on fishing and hunting participants but also nontraditional HD data such as lifestyles, census, economic status, GIS, and others. Such a database would also facilitate HD data mining, which would allow probability analysis in all aspects of customer participation. Full utilization of the database by the fisheries divisions should have a significant positive effect on the marketing of agency programs and the recruitment and retention of constituents.

IV. Objective 2: Ascertain the opinions and insights of selected TPWD staff on use of, and gaps in, science available for monitoring and managing fisheries resources to determine how well science is integrated into management decision processes.

The survey, consisting of three background questions, 31 closed-end statements with five agree/disagree options, and four open-end questions, was distributed electronically to 106 staff. Individuals were categorized according to division and job classification (administration = manager V and higher; nonadministration = professionals in positions below manager V). A total of 94 responses (an overall response rate of 88%) was received as follows:

Division	Staff	Number Surveyed	Number of Responses
Coastal	Admin	14	10 (71%)
Coastal	Non-admin	32	30 (96%)
Inland	Admin	19	15 (79%)
Inland	Non-admin	41	39 (95%)
Total		106	94 (88%)

A background question regarding educational background (highest degree earned) for respondents to the survey (shown as the percentage of respondents in each row) allowed characterization of the survey participants by category as follows:

Division	Staff	Number of Responses	High School	Assoc. Degree	BS	MS	PHD
Coastal	Admin	10	0	0	30	30	40
Coastal	Non-admin	30	0	0	33	60	7
Inland	Admin	15	0	0	20	60	20
Inland	Non-admin	39	0	3	19	66	13
Total		94	0	1	26	59	15

The final background question allowed characterization of how staff perceived the percentage of time they personally devoted to science-based activities and the application of scientific information to fisheries management (reported as the percentage of respondents in each category) as follows:

Division	Staff	Number of Responses	<10%	10-25%	25-50%	50-75%	>75%

Coastal	Admin	10	0	40	10	20	30
Coastal	Non-admin	30	0	17	13	40	30
Inland	Admin	15	0	33	20	33	14
Inland	Non-admin	39	0	3	33	32	33
Total		94	0	16	23	33	28

The 31 closed-end statements emphasized the scientific aspects of standardized assessment but also addressed other scientific dimensions of fisheries management. Responses to the closed-end statements are provided in Appendix 1.

The four open-end questions also addressed perceptions of the breadth of science-based management—strengths and impediments in the acquisition and application of scientific data—and anticipated long-term priority issues, including their ability to be addressed scientifically. Responses to the open-end questions are provided in Appendix 2.

No attempt was made to interpret the findings; however, there appeared to be strong consensus within each group on many issues. Notable differences in the distribution of responses between the Inland and Coastal divisions and between administrative on nonadministrative respondents were evident on some questions. Nevertheless, there appeared to be general agreement with the findings of the Review Team on most issues directly related to the acquisition of scientific data.

V. Objective 3: Evaluate processes for ongoing evaluation of science-based activities; propose modifications as needed to improve this evaluation and allow for the most effective use of data in management decisions.

Processes for science-based fishery management range from (1) routine assessment of aquatic resources, habitats, and users through (2) integration of the data collected by routine assessment with data from other sources (e.g., historical information, special studies, scientific literature, etc.) to (3) incorporation of data comprehensively for management decision making in light of fiscal constraints, public pressures, and agency priorities. The focus of the Review Team was to examine processes used by the agency for evaluation of its basic standardized assessment manuals and resultant data. Specific attention was given to the processes of evaluation used for routine human dimensions, spills and kills, and inland and coastal fisheries assessment procedures. Interviews during the site visit, coupled with supplemental inputs from administrative staff, served as the basis for the Team’s evaluation.

Findings:

- The agency is concerned with the defensibility of its results in the courts. Review processes for assessment and interpretation have been developed to ensure that results are scientifically defensible. Throughout the agency, the need for standardized assessment procedures is recognized, as is the importance of revising the procedures in light of field experiences and new technologies.
- For each of its standardized assessment procedures, periodic review is undertaken relative to the overall goals of the assessment program. These periodic reviews are supplemented by short-term (usually annual) evaluation of operational needs.
- Inland Fisheries has continually revised and updated its standardized assessment procedures since 1975. In 1997, a committee approach was adopted to ensure review of all components of the procedures manual on an ongoing basis. Revision of existing procedures is largely reactive, being based on comments and suggestions from field personnel received and considered on an annual basis. For new procedures and major changes, the respective committee actively solicits input from throughout the Division, including Resource Protection personnel.
- Inland Fisheries further evaluates the effectiveness of its assessment procedures through peer review of survey reports. Oral presentation and evaluation of annual reports at the regional level are followed up by presentations and critique at the Divisional staff meeting.
- Coastal Fisheries has continually revised and updated its standardized procedures for resource assessment and harvest monitoring since their implementation in the mid-1970s. The science director's office annually solicits suggestions for modifications of the procedures manuals and receives inputs spontaneously as problems are noted by field staff. Annual review by broad-based committees is employed to formally evaluate potential revisions.
- In 1993, Coastal Fisheries established a Quality Control Committee and subsequently implemented an action plan conducted under a quality control program field operations manual. This manual addresses data acquisition for standard field assessments only. A broad-based, 12-member committee annually reviews the manual.
- Despite widespread staff suspicion that commercial landings data are biased, evaluation of that bias has not been conducted. The process by which such an evaluation would be developed and prioritized is unclear to the Review Team.
- Research projects (both Inland and Coastal) and special projects (primarily Inland) commonly include studies that evaluate existing or potential assessment techniques. The results of such projects are used to modify standard procedures.
- The Kills and Spills Team procedures, developed in 1997, were revised in 2003 in response to TPWD's strategic plan emphasis on environmental protection, the changing requirements of regulatory agencies, and new issues and technologies. Until such time as another major revision is needed, updates will be made in response to suggestions from field personnel.
- The standardized human dimensions (Ditton) survey, which serves both Inland and Coastal divisions, is reevaluated in advance of each survey (at 2–4 year intervals). Inputs for revision are provided by Coastal and Inland Division human dimensions specialists, based in part on issues brought up by field personnel

during intervening years. Revisions are coordinated closely with the contractor, who includes recommendations for revision as a part of reporting.

- Evaluations of standardized procedures are done primarily by those most involved with the operations conducted under the guidance of the respective manual. Specialists from elsewhere in the agency are sometimes included (e.g., Resource Protection specialists involved in the development of stream fisheries procedures) to provide a broader base of expertise.
- It is recognized that fishery management decisions cannot always be made on the basis of standardized assessments alone, especially for inland fisheries for which the precision of assessment data is low. Each division's administrative team (senior staff) evaluates the need for further information and prioritizes recommendations for further investigation through more intensive special studies or directed research projects. Such projects are expected to be of a quality to lead to publication in the primary literature and consequently meet the standards of peer review for scientific journals.
- In both divisions, administrative structure and operational procedures are in place for evaluation of scientific validity of the data on which management decisions can be made. Working relationships between divisions and among sections within divisions are generally good, and channels of communication between field personnel and administrative staff are extant and operational to facilitate inputs at all levels.
- The Inland Fisheries Division has developed a long-range plan that is closely tied to the TPWD Land and Water Resources Conservation and Recreation Plan. The Inland Fisheries plan appears to guide decision making. The Coastal Fisheries Division has no such plan.
- Consistent with its priority on scientifically sound management decisions, the agency has included external evaluation of its procedures and processes through this formal review and the use of subject matter specialists.

Recommendations:

The spectrum of assessments utilized by for resource assessment is subject to a variety of specific evaluations with a range of rigor and formality. Some suggestions for refinement of evaluation processes are as follows:

- Procedures for assessment of inland and coastal resources, habitats, and users should be revisited on a defined schedule. Comprehensive reviews should evaluate whether the procedures as a whole meet the spectrum of information needs. Procedures for each assessment should be reviewed proactively on an annual basis, rather than primarily in response to sporadic suggestions from the field, as currently occurs for some procedures.
- Evaluations of standardized procedures are done primarily by those most involved with the operations conducted under the guidance of the respective manual. Such evaluations should directly involve a broader base of expertise. Updates to procedures should be performed with input not only from those directly using them but also from a spectrum of personnel from the divisions. Such an approach

- would not only capitalize on breadth of expertise but also contribute to the integration and complementation of assessments.
- Coordination across divisions should be increased, particularly with regard to KAST assessments and other habitat assessment procedures conducted under the former Resource Protection Division.
 - Attention should be given to quality control in the implementation of procedures used for inland fisheries and KAST assessments.
 - A process should be developed to evaluate the extent of bias in commercial landings data.
 - The standardized human dimensions (Ditton) survey should address recommendations for revision provided by the contractor as a part of reporting.
 - TPWD should more fully utilize inputs from managers in establishing priorities for special studies. Such inputs should identify undefined relationships in need of clarification for management ultimately to be science based.
 - TPWD should conduct the necessary studies of management effects and develop appropriate models that are scientifically justified, so that when scientifically sound assessment data and research or special study results are incorporated, management is comprehensively science based.
 - Like the Inland Fisheries Division, the Coastal Fisheries Division should develop a long-range plan to guide decision making.

VI. Summary and Conclusions

TPWD's Inland and Coastal Fisheries divisions have developed a well-defined set of protocols for obtaining comprehensive, scientifically sound data on fish populations, habitats, and constituents. Throughout this review process, the Review Team was impressed with the professionalism and dedication of TPWD staff to achieving established objectives of assessment programs. Assessments made under these protocols are generally effective in producing the data needed for science-based management of inland and coastal recreational and commercial fisheries. Procedures are in place for internal evaluation and refinement of assessment protocols.

When statistically precise data could not be obtained through standard protocols, time and staffing were generally the limiting factors. The recommendations made in this report were developed with strong consideration as to how better data might be obtained more efficiently.

The incorporation of personnel and programs of the former Resource Protection Division into the Inland and Coastal Fisheries divisions poses an immediate challenge and an opportunity. Two important opportunities are to enhance each division's habitat assessment (and management) capabilities and to give additional attention to nonrecreational and noncommercial aquatic species. Each Division will be challenged to work toward integration of former Resource Protection personnel into the spectrum of assessment and management while continuing interactions across division lines.

This review focused on the data acquisition step of science-based management. Scientifically sound management decisions are, first and foremost, dependent on scientifically sound assessment data. The Inland and Coastal divisions have emphasized the acquisition of such data through comprehensive assessment programs and have complemented those data with special studies to fill information gaps. Ultimately, scientifically sound management depends on incorporating accurate, precise data into predefined scientific models, mathematical or conceptual, that predict outcomes. Some evidence of success in the latter step was encountered during the review process, but evaluation of the application of scientifically sound data to management decision making was beyond the scope of our assignment. Nevertheless, the staff responses to our survey expressed considerable confidence in the scientific basis of management decision making for both inland and coastal fisheries.