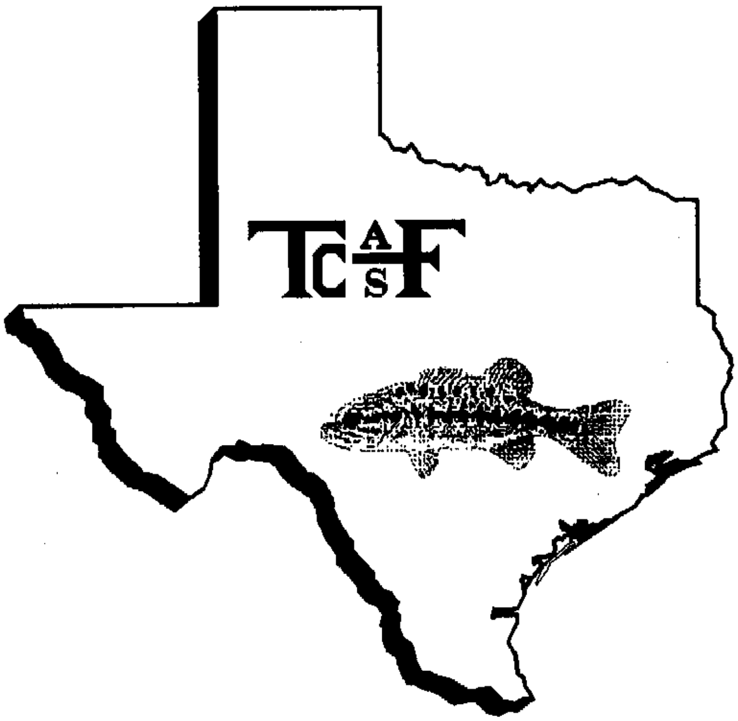
ANNUAL PROCEEDINGS
of the
TEXAS CHAPTER

AMERICAN FISHERIES SOCIETY



San Marcos, Texas
21 - 23 January 2001

VOLUME 23

TEXAS CHAPTER

AMERICAN FISHERIES SOCIETY

The Texas Chapter of the American Fisheries Society was organized in 1975. Its objectives are those of the parent Society - conservation, development and wise use of recreational and commercial fisheries, promotion of all branches of fisheries science and practice, and exchange and dissemination of knowledge about fishes, fisheries, and related subjects. A principal goal is to encourage the exchange of information among members of the Society residing within Texas. The Chapter holds at least one meeting annually at a time and place designated by the Executive Committee.

MEMBERSHIP

Persons interested in the Texas Chapter and its objectives are eligible for membership and should apply to:

Texas Chapter, American Fisheries Society
Secretary-Treasurer
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Annual membership dues are $8 for Active Members and $5 for Student Members.

ANNUAL PROCEEDINGS OF THE TEXAS CHAPTER AMERICAN FISHERIES SOCIETY

Annual Meeting
21-23 January 2001
San Marcos, Texas

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2002

Published by:
Texas Chapter, American Fisheries Society
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Austin, Texas 78744

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Technical Papers Presented at the Annual Meeting and Peer-Reviewed for Publication

PAST TEXAS CHAPTER PRESIDENTS AND MEETING LOCATIONS

DATE	PRESIDENT	LOCATION
1976		College Station
1976	Ed Bonn	Lake Brownwood
1977	Jim Davis	San Antonio
1978	Bill Rutledge	San Marcos
1979	Bobby Whiteside	College Station
1980	Richard Noble	Arlington
1981	Charles Inman	Austin
1982	Gary Valentine	Kerrville
1983	Don Steinbach	Lake Texoma, OK
1984	Gary Matlock	Port Aransas
1985	Maury Ferguson	Junction
1986	Brian Murphy	San Marcos
1987	Joe Tomasso	Kerrville
1988	Dick Luebke	Abilene
1989	Mac McCune	San Antonio
1990	Bobby Farquhar	Lake Texoma, OK
1991	Gene McCarty	Galveston
1992	Bill Provine	Kerrville
1993	Barbara Gregg	Port Aransas
1994	Loraine Fries	Lake Travis
1995	Pat Hutson	College Station
1996	Mark Webb	Pottsboro
1998	Katherine Ramos	Athens
1999	John Prentice	Corpus Christi
2000	Paul Hammerschmidt	Bossier City, LA
2001	Charles Munger	San Marcos
2002	Gordon W. Linam	Junction

TEXAS CHAPTER AWARDS

Eight awards may be presented annually. Only members in good standing may make nominations. If nominations reviewed by the Awards Committee are found to be inadequate in one or all categories, awards need not be given. If multiple nominations are received and more than one nominee is considered outstanding, multiple recipients are permissible. The awards and their associated criteria are:

Outstanding Fisheries Worker of the Year - The nominees must be Chapter members in good standing. There are six specialization categories: Administration, Culture, Education, Management, Research, and Technical Support. An award may be presented in each area of specialization. All nominations must be accompanied by supporting data on contributions to one particular area of focus.

Special Recognition in Fisheries Work - The nominees do not have to be Chapter members. They may be individuals or organizations that have made substantial contributions to fisheries in Texas.

Outstanding Presentation at the Annual Meeting - The basic requirements are:

a. The presentation must be made by one of the authors.
b. At least one of the authors must be a Chapter member in good standing.
c. Members of the current Awards Committee shall be ineligible.

The award is for the presentation, not a manuscript or paper. Criteria for evaluation, made by the Awards Committee, and their relative values are:

a. Introduction - 10 points
b. Methods - 10 points
c. Organization - 10 points
d. Originality - 15 points
e. Technical Merit - 20 points
f. Delivery - 15 points
g. Visual Aids - 15 points
h. Other considerations - 5 points

Judges will evaluate each presentation immediately after it is given. They will not confer until after the last presentation. The decision will be made based on relative rankings assigned by the judges.

Scholarship Selection - Selection of scholarship recipients is made by members of the Scholarship Selection Committee. University representatives nominate students from their institutions for scholarship consideration. Selection is based on the following criteria:

a. Academic excellence
b. Professional activities
c. Promise of future professional involvement and significant contribution to the field of fisheries science.

TEXAS CHAPTER AWARDS RECIPIENTS

1977 Fish Culture - Don Steinbach (TAMU)
Fisheries Management - Edward Bonn (TPWD)
Fisheries Administration - David Pritchard (TPWD)
Fisheries Research - John Prentice and Richard Clark (TPWD)

1978 Fish Culture - Pat Hutson (TPWD)
Fisheries Education - Clark Hubbs (UT)
Fisheries Research - Clark Hubbs (UT)
Special Recognition - Edward Lyles (USFWS)

1979 Fish Culture - Robert Stickney (TAMU)
Fisheries Education - Richard Noble (TAMU)
Fisheries Management - Gary Valentine (SCS)
Fisheries Research - Phil Durocher (TPWD)
Special Recognition - Charles Inman (TPWD)

1980 None

1981 Fish Culture - Billy White (TPWD)
Fisheries Education - Bobby Whiteside (SWTSU)
Fisheries Management - Steve Smith (TUGC)
Fisheries Research - Al Green (TPWD)
Special Recognition - Jim Davis (TAMU)

1982 Fish Culture - Roger McCabe (TPWD)
Fisheries Research - Clell Guest (TPWD)
Special Recognition - Bob Hofstetter (TPWD)

1983 Special Recognition - Robert Kemp (TPWD)

1984 None

1985 Fisheries Education - Donald Wohlschlag (UTMSI)
Fisheries Research - Connie Arnold (UTMSI)

1986 Fisheries Management - Billy Higginbotham (TAES)
Fisheries Research - Robert Colura (TPWD)

1987 Fish Culture - Kerry Graves (USFWS)
Special Recognition - The Sportsmen's Club of Texas
Best Presentation - Kerry Graves (USFWS)

1988 Honorable Mention (culture) - Loraine Fries (TPWD)
Fisheries Research - Gary Garrett (TPWD)
Special Recognition - Kirk Strawn (TAMU)
Best Presentation - Joe Fries (USFWS)
Honorable Mention (presentation) - Catherine Dryden (TAMU)

1989 Fish Culture - Robert Vega (TPWD)
Fisheries Management - Joe Kraai (TPWD)
Fisheries Administration - Gary Matlock (TPWD)
Fisheries Research - Roy Kleinsasser and Gordon Linam (TPWD)
Honorable Mention (research) - Bob Edwards (UTPA)
Best Presentation - Robert Smith (TAMU)

1990 Fish Culture - Glen Alexander and David Campbell (TPWD)
Fisheries Management - Dave Terre (TPWD)
Fisheries Administration - Gene McCarty (TPWD)
Best Presentation - Joe Kraai (TPWD)
Scholarships - Tommy Bates (TAMU:1989), Michael Brice (TTU)

1991 Fish Culture - Jake Isaac (TPWD)
Fisheries Management - Mark Webb (TPWD)
Fisheries Administration - Pat Hutson (TPWD)
Fisheries Research - Ronnie Pitman (TPWD)
Special Recognition - The Wetland Habitat Alliance of Texas
Best Presentation - Mark Stacell (TPWD)
Scholarships - Jim Tolan (CCSU), Michelle Badough (SWTSU)

1992 Fish Culture - Camilo Chavez (TPWD)
Fisheries Education - Brian Murphy (TAMU)
Fisheries Management - Ken Sellers (TPWD)
Fisheries Research - Bob Colura (TPWD)
Special Recognition - Bobby Farquhar, Andy Sansom, and Rudy Rosen (TPWD)
Best Presentation - Maurice Muoneke (TPWD)

1993 Fisheries Management - Bruce Hysmith (TPWD)
Special Recognition - Joe Martin and Steve Gutreuter (TPWD)
Best Presentation - Jay Rooker (UTMSI)
Scholarships -Erica Schlickeisen (SWTSU), Brian Blackwell and Nancy McFarlen (TAMU)

1994 Fish Culture - Ted Engelhardt (TPWD)
Fisheries Management - Steve Magnelia (TPWD)
Fisheries Administration - Dick Luebke (TPWD)
Special Recognition - Bob Howells (TPWD)
Best Presentation - Travis Kelsey (SWTSU)
Scholarships - Kathyrn Cauble (SWTSU), Howard Elder and Kim Jefferson (TAMU)

1995 Fish Culture - Robert Adami (TPWD)
Fisheries Education - Bill Neill (TAMU)
Fisheries Management - Spencer Dumont (TPWD)
Fisheries Administration - Roger McCabe (TPWD)
Fisheries Research - Maurice Muoneke (TPWD)
Special Recognition - Tom Heffernan and Robin Reichers (TPWD)
S. Ken Johnson (TAMU)
Best Presentation (s) - Robert Weller (TTU), Robert D. Doyle (ACE)
Scholarships - Jay Rooker (UTMSI), Robert Weller (TTU), Gil Rosenthal (UT),
John Findiesen and Karen Quinonez (SWTSU)

1996 Fisheries Education - Billy Higginbothan (TAMU)
Fisheries Management - Gary Garrett (TPWD)
Fisheries Administration - Gene McCarty (TPWD)
Fisheries Research - Ivonne Blandon (TPWD)
Special Recognition - Reeves County Water Improvement Board
Best Presentation (s) - Craig Paukert (OSU), Gene Guilliland (ODWC)
Scholarships - Chad Thomas (SWTSU), Anna-Claire Fernandez (UTMSI),
Kenneth Ostrand, Dawn Lee Johnson
Technical Support - Jimmy Gonzales (TPWD)
Honorable Mention (technical support) - Eric Young (TPWD)

1997/1998 Fish Culture - Tom Dorzak (TPWD)
Fisheries Education - Robert Ditton (TAMU)
Special Recognition - Fred Janssen, Chris Cummings, Dan Lewis, Dan Strickland, and Gary Graham (TPWD), Jim Davis (TAMU)
Best Presentation (s) -Timothy Bonner (TTU) and Gene Wilde (TTU)
Scholarships - Tony Baker and Allison Anderson (TAMU), Patrick Rice (TAMU-Galveston), Laurie Dries (UT)

1999 Fisheries Administration - Lorraine Fries (TPWD)
Special Recognition - Pat Hutson (TPWD, retired)
Best Presentation (s) - Gene R. Wilde and Kenneth G. Ostrand (TTU)
Scholarships - Scott Hollingsworth and William Granberry (TTU), Brian Bohnsack and Michael Morgan (TAMU)

2000 Fisheries Research - Gene R. Wilde (TTU)
Best Presentation - J. Warren Schlechte, coauthors - Richard Luebke, and T.O. Smith (TPWD)
Best Student Presentation - Scott Hollingsworth, coauthors - Kevin L. Pope and Gene R. Wlide (TTU)
Special Recognition - Emily Harber, Joe L.Hernandez, Robert W. Wienecke, and John Moczygemba (TPWD), Joe N. Fries (USFWS)
Scholarships - Mandy Cunningham and Calub Shavlik (TTU), Laurieanne Lancaster(SHSU)

2001 Fisheries Administration - Ken Kurzawski (TPWD)
Fisheries Education - Kevin pope (TTU)
Fisheries Management - Brian Van Zee (TPWD)
Fisheries Research - Reynaldo Patino (TTU)
Fisheries Student - Timothy Bonner (TTU)
Technical Support - David DeLeon (TPWD)
Special Recognition - Rhandy Helton, Rosie Roegner, and Walter D. Dalquest (TPWD)
Best Presentation (s) - to be award at the 2002 meeting
Scholarships, Undergraduate - Mandy Cunningham, and Cody Winfrey (TTU)
Scholarship, Graduate - Abrey Arrington (TAMU), and Laurianne Dent (SHSU)

Abbreviations:
ACE - Army Corps of Engineers
CCSU - Corpus Christi State University
ODWC - Oklahoma Department of Wildlife Conservation
OSU - Oklahoma State University
SCS - Soil Conservation Service
TAES - Texas Agricultural Extension Service
TAMU - Texas A&M University
TPWD - Texas Parks and Wildlife Department
SHSU - Sam Houston State University
SWTSU - Southwest Texas State University
TTU - Texas Tech University
TUGC - Texas Utilities Generating Company
USFWS - US Fish and Wildlife Service
UT - University of Texas at Austin
UTMSI - University of Texas Marine Science Institute
UTPA - University of Texas/Pan American

PANEL DISCUSSION - "VALUES AND THE AQUATIC ENVIRONMENT"

GORDON LINAM, *Moderator*

Economic Values Associated with Aquatic Environments

RICHARD WOODWARD *(Department of Agriculture Economics, Texas A&M University, College Station, Texas 77843)*

Religious Values and the Environment

TERRI MORGAN *(Texas Baptist Christian Life Commision, 333 North Washington, Dallas, Texas 75246)*

Social Values Associate with the Environment

FRANK SHOCKLEY *(College of Forestry, Stephen F. Austin State University, P. O. Box 6109, Nacogdoches, Texas 75962)*

TECHNICAL SESSION ABSTRACTS

Influence of Stream Discharge Levels on Production of Larval Arkansas River Shiners and Peppered Chubs

BART W. DURHAM AND GENE R. WILDE *(Department of Range, Wildlife, and Fisheries Management, Texas Tech University, Lubbock, Texas 79409)*

We used drift nets to collect larval and juvenile fishes from the Canadian River, Texas at two sites. Young-of-year fishes were collected throughout the reproductive season, May through September. Collections comprised five species: Arkansas River shiner (43% of total), flathead chub (1%), peppered chub (14%), plains minnow (8%), and red shiner (34%). We removed otoliths from 219 Arkansas River shiners and 157 peppered chubs to estimate their ages. We assumed a 3-d incubation period for eggs, allowing us to estimate spawning dates. Flow data were obtained from United States Geological Survey gauging station No. 07227500. Our age estimates indicated that, in general, successful production of Arkansas River shiner and peppered chub occurred during the early portion of the spawning season when river discharge was greatest.

Persistence and New Additions to the Introduced Fishes of the Upper San Antonio River, Bexar County, Texas

ROBERT J. EDWARDS *(Department of Biology, The University of Texas-Pan American, Edinburg, Texas 78539)*

The fish fauna of the upper San Antonio River, Bexar County, Texas includes ten introduced species (*Astyanax mexicanus*, *Hypostomus* sp., *Poecilia reticulata*, *P. latipinna*, *Xiphophorus helleri*, *Belonesox belizanus*, *Cichlasoma cyanoguttatum*, *Oreochromis mossambicus*, *O. aurea*, and *Tilapia zilli*). A recent sample (7 August 2000) from this environment contained nine of the ten known introduced species, as well as two additional species (the vermiculated highfin catfish *Pterygoplichthys disjunctivus*, and the Amazon molly *Poecilia formosa*), that were, heretofore, not found from this location. The only fish known to have been introduced but not taken in this collection was *Belonesox belizanus*, a species introduced in the early 1960s and not captured or observed for more than 30 years and believed to be extirpated. The introduced fishes appear to be having a substantial impact upon the native fishes of this river. Introduced species made up 61% of the species, 17% of the individuals, and 62% of the biomass of the sample. It further appears that urban influences have had a major impact upon the conditions leading to the present fish assemblage.

Environmental Characteristics Associated with Fish Assemblage Structure of Five Coves During Fall and Spring in Lake Texoma

FRANCES P. GELWICK *(Department of Wildlife and Fisheries Sciences, 210 Nagle Hall, Texas A&M University, College Station, Texas 77843-2258)*
WILLIAM MATTHEWS *(Department of Zoology, Sam Noble Oklahoma Museum of Natural History, 2401 S. Chautauqua Ave, Norman, Oklahoma 73072)*

The relative influence of biotic and abiotic environmental variables on the structure of fish assemblages generally is related to the disturbance regime of the system. Habitats characterized by frequent disturbances are less likely to reach equilibrium conditions at which effects of biological interactions should be most evident. Although environmental conditions generally are considered to be less variable in lentic than lotic systems, reservoirs such as Lake Texoma have large fluctuations in water conditions over time. Previous electrofishing surveys indicated that littoral assemblages in wooded, vegetated, and bare shoreline microhabitats differed from each other, but only in fall and winter and that seasonal differences occurred only in vegetated and open habitats. Because coves might provide somewhat more defined and closed habitats than open shoreline, we hypothesized that cove assemblages would be less influenced by abiotic factors and more strongly influenced by biotic interactions. Consecutive fall and spring samples were made using openwater and shoreline overnight gill netting, daytime electroshocking, and seining. Species abundances were standardized within each gear type, and unique effects of gear type were statistically removed to compare overall assemblage structure among five coves. Overall, fish assemblages differed more among coves than between seasons,

primarily related to differences in structure (brush, logs, stumps versus bare shoreline) and substrate (hard clay ledges versus sloping sand beachs or mud slopes). However, evidence indicated that interactive segregation, especially among predators (e.g., blue and channel catfish, largemouth and spotted bass, striped and white bass) may also contribute to differences in assemblage structure.

Native Fishes Research and Management in Texas During 2000

GARY P. GARRETT *(Texas Parks and Wildlife, HC 7 Box 62, Ingram, Texas 78025)*
ROBERT J. EDWARDS *(The University of Texas -Pan American, Edinburg, Texas 78539)*
NATHAN ALLAN *(U.S. Fish and Wildlife Service, Austin, Texas 78758)*

Devils River minnow *Dionda diaboli*: An intensive inventory of the Devils River was completed in July 2000. These data, coupled with results from artificial stream studies, will be used to determine habitat requirements and conservation needs. Pecos pupfish *Cyprinodon pecosensis*: The last location for Pecos pupfish in Texas suffered greatly from the drought. A salt cedar eradication program was initiated by the Fort Worth Zoo in order to preserved what little water remains. A brood stock from Salt Creek was stocked into a 1.7-ha ciénega-like pond constructed under a first-ever conservation agreement with a private landowner in west Texas. Additional fish were moved to the Fort Worth Zoo as insurance against total loss. Comanche Springs pupfish *C. elegans*: Ongoing surveys at the San Solomon Ciénega indicate large populations of both Comanche Springs pupfish and Pecos gambusia *Gambusia nobilis*. Unfortunately, nearby Phantom Lake Springs have failed. Leon Springs pupfish *C. bovinus*: Phase II of the Diamond Y Draw renovation was completed in March 2000. Results indicate the project has successfully repatriated Leon Springs pupfish to its only remaining habitat in the wild. A continuous flow monitoring gauge has been installed at Diamond Y Spring to document springflow trends.

Fish Assemblages of Champion Lake, Trinity River Wildlife Refuge, Texas

TIM OHMAN, FRANCES P. GELWICK, STUART MARCUS, AND MIKE BLESSINGTON *(Texas A&M University, Department of Wildlife and Fisheries Sciences, 210 Nagle Hall, College Station, Texas 77843)*

Fishery information is deficient on most Federal lands. The purpose of this study was to survey the diversity of the fishes present at Champion Lake of the Trinity River National Wildlife Refuge (NWR), Texas. Champion Lake is a recent (February 2000) acquisition by the U.S. Fish and Wildlife Service. No fisheries work had been conducted on Champion Lake previously. Champion Lake had been part of a corporate hunting club. The study area is part of Pickett's Bayou, which is part of the Trinity River flood plain system. Pickett's Bayou is located in Liberty County, 45 miles northeast of Houston, Texas. The sampling occurred on 4 November 2000. Boat electrofishing was conducted in Champion Lake and length and weight data were collected for 15 species of fish, six of which had not been collected at Trinity River NWR before. These data and data collected at Anders Pond at Trinity River NWR (1995, 1996, 1998) were compared for species diversity and similarity using the Jackard Index. The Jackard Indices indicated a difference between Anders Pond and Champion Lake.

Habitat-Specific Growth Rates of Juvenile Red Snapper *Lutjanus Campechanus* in the Northwestern Gulf of Mexico

BERT W. GEARY, JOSH O. HARPER, AND JAY R. ROOKER *(Department of Marine Biology, Texas A&M University at Galveston, 5007 Avenue U, Galveston, Texas 77551)*

Stocks of the commercially and recreationally important red snapper *Lutjanus campechanus* are under increasing pressure in the Gulf of Mexico, prompting a need to determine factors important in regulating growth and survival. Differentiating growth and mortality rates associated with nursery habitats used by red snapper is critical in delineating essential fish habitat. The objective of this study was to determine growth rates of age-0 red snapper associated with the Freeport Rocks Bathymetric High (FRBH). Replicate trawl surveys were taken semi-monthly May-September of 2000 on low-profile shell ridges (i.e., FRBH), adjacent mud bottom, and at the interface between the two habitats in nearshore waters off Freeport, Texas. A total of 360 red snapper, ranging from 18 to 82 mm standard length, was used to measure growth rates among these habitats. Daily growth increments from sectioned sagittal otoliths allowed us to age individual fish from which we determined hatch dates and separated cohorts. Cohort-specific growth rates were determined using age-length data. In addition, we measured the widths of outer growth increments to compare recent growth rates of red snapper from these habitats.

Spatial and Temporal Patterns of Habitat Use by Fishes Associated with *Sargassum* Mats in the Northwest Gulf of Mexico

DAVID WELLS AND JAY R. ROOKER *(Department of Marine Biology, Texas A&M University at Galveston, 5007 Ave U. Galveston, Texas 77551)*

Distribution and abundance of fishes associated with *Sargassum* mats in the northwest Gulf of Mexico were examined off Galveston (northern waters) and Port Aransas (southern waters), Texas from May to August 2000. A total of 37 species (17 families) was identified from larval purse seine collections. Individuals from seven species composed over 97% of the catch: greater amberjack *Seriola dumerili*, blue runner *Caranx crysos*, gray triggerfish *Balistes capriscus*, sergeant major *Abudefduf saxatilis*, planehead filefish *Monacanthus hispidus*, chain pipefish *Syngnathus louisianae*, and sargassum fish *Histrio histrio*. Temporal patterns were observed for several taxa. *Monacanthus hispidus, S. louisianae*, and *H. histrio* were more abundant in early summer (May-June), while *C. crysos* and *A. saxatilis* were more prominent late in the season (July-August). Dominant taxa generally were more abundant in northern waters and both abundance and diversity increased as a function of distance from shore. Detailed early life history information (age, growth, hatch-date distribution) of one dominant member of the fish assemblage, *S. dumerili*, was discussed.

Trophic Ecology of Fauna Associated with *Sargassum* Mats in the Northwest Gulf of Mexico

JASON P. TURNER, JAY R. ROOKER, AND GRAHAM A. J. WORTHY *(Department of Marine Biology, Texas A&M University, 5007 Ave. U, Galveston, Texas 77551)*
SCOTT A. HOLT *(Marine Science Institute, The University of Texas at Austin, 750 Channelview Drive, Port Aransas, Texas 78373)*

Fatty acid and stable isotope signatures were determined for flora and fauna associated with floating *Sargassum* mats in the northwest Gulf of Mexico. The goals of the study were 1) identify the origin(s) of organic matter utilized by the mat community and 2) determine trophic relationships of associated fauna. Samples of representative taxa (primary producers to apex predators) were collected using several types of gear (plankton nets, hook-and-line, purse seine) and sub-samples were removed for biochemical analysis. Fatty acids were isolated using chloroform/methanol extractions and signatures were determined using gas chromatography. Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotopes were quantified for the same taxa using standard techniques of mass spectrometry. Concentrations of fatty acids will be analyzed to investigate differences among taxa and to identify salient patterns in trophic pathways within the *Sargassum* community. In addition, $\delta^{13}C$ and $\delta^{15}N$ values of fauna inhabiting the mat were more similar to phytoplankton than *Sargassum*, suggesting that phytoplankton make a major contribution to organic matter assimilated by invertebrates and fishes.

Importance of Shell-ridge Zones in the Northwest Gulf of Mexico as Nursery Habitat of Red Snapper *Lutjanus Campechanus*

JOSH O. HARPER, JAY R. ROOKER, AND ANDRÉ M. LANDRY *(Department of Marine Biology, Texas A&M University at Galveston, 5007 Avenue U, Galveston, Texas 77551)*

We evaluated Freeport Rocks Bathymetric High (FRBH), a relic barrier island and shell-ridge system off of Freeport, Texas, as nursery habitat for juvenile red snapper *Lutjanus campechanus*. During seven trips from May 2000 to September 2000, we sampled three habitat types associated with FRBH: shell-ridges crest, shell ridge-mud bottom interface, and adjacent mud bottom. A total of 2,352 juvenile red snapper was captured during the field season. Newly-settled red snapper (15-30 mm standard length) were abundant on shell-ridge habitats and temporal patterns in habitat use were pronounced. Densities were highest in July and varied among habitat types: shell-ridge (240 red snapper/ha), interface (144 red snapper/ha), and mud bottom ridge (180 red snapper/ha). Trends also were observed between inshore and offshore sides of the shell-ridge.

Evaluation of Simple Random Sampling Procedures for General Monitoring of Fishes in Texas Reservoirs

SPENCER C. DUMONT *(Texas Parks and Wildlife, 5325 North 3rd Street, Abilene, Texas 79603)*

Evaluation of simple random sampling procedures was initiated to determine precision of catch per unit effort (CPUE) estimates and determine sampling effort required to reliably estimate catch rate and population structure indices for selected fish species in Texas reservoirs. Fishes were collected with electrofishing, gill nets, and trap nets. The median relative standard error (RSE) was 21 for largemouth bass *Micropterus salmoides*, 41 for crappie *Pomoxis* spp., and ranged from 32 to 39 for gill netted species. The percentage of surveys where RSE was 25 or less (RSE_{25}) ranged from 7% for hybrid striped bass to 63% for largemouth bass. Only largemouth bass were sampled with an RSE_{25} in the majority of Texas reservoirs. Very few surveys estimated CPUE with an RSE of 15 or less (RSE_{15}) for any species (range 0-15%). Median sampling effort required to estimate largemouth bass and spotted bass CPUE with an RSE_{25} was 14 and 48 5-min stations, respectively. Median sampling effort required to obtain an RSE_{25} for CPUE of gill netted species ranged from 12 to 22 net-nights. Median sampling effort required to estimate CPUE with an RSE_{15} was approximately three times the effort needed to achieve an RSE_{25} for all species. There was a significant negative correlation between RSE and CPUE for all species and, for largemouth bass, there also was a significant negative correlation between longitude and RSE: RSE decreased from west to east in Texas reservoirs. There was no correlation between RSE and reservoir size for any species. Fifty or more stock-length fish were collected from 6% of spotted bass surveys and ranged up to 64% of largemouth bass surveys. Only largemouth bass and hybrid striped bass had 50 stock-length fish in at least half the surveys. Few surveys collected 100 stock-length fish (range 0-28%). For general monitoring of important species in Texas reservoirs, sampling to achieve an RSE_{25} would be an adequate level of precision and would provide at least 50 stock-length fish for population structure indices in most surveys. For fisheries field studies, sampling to achieve an RSE_{15} would be more desirable and would provide at least 100 stock-length fish in most surveys. A stratified random sampling design may prove more effective, particularly for gill and trap netted species, spotted bass *M. punctulatus* and largemouth bass in reservoirs with limited littoral habitat or with low catch rates. Sampling effort should be determined on an individual reservoir basis to account for variation in sampling effectiveness within and among reservoirs, allowing for objective-oriented sampling of important species.

Evaluation of Fertilization of Florida Largemouth Bass Fingerling Rearing Ponds at the A. E. Wood Fish Hatchery

GERALD KURTEN AND JEFF GRANT *(Texas Parks and Wildlife, 505 Staples Road, San Marcos, Texas 78666)*

Water quality and nutrient concentrations were measured in six Florida largemouth bass *Micropterus salmoides floridatus* fingerling-rearing ponds to evaluate the existing fertilization regimen. All ponds were filled with water (day 1) and stocked with fish (day 7) at the same time in early spring of 2000. Fertilization rates and timing and sampling for water quality and zooplankton were also identical. Ponds were managed similarly to ponds used for successfully rearing of largemouth bass fingerlings at the A.E. Wood fish hatchery for the past 10 years. Ponds received an initial dose of 57 kg/ha cottonseed meal, 0.08 mg/L P with phosphoric acid and 0.3 mg/L N with Uran on the day the pond was started filling with water and 8 d before stocking 10-day-old largemouth bass fry. On day 4, ponds received 227 kg/ha cottonseed meal, 0.16 mg/L P and 0.6 mg/L N. Thereafter, ponds received the initial fertilization rate twice weekly until 1 week before pond harvest. Temperature, dissolved oxygen and pH were measured in the morning and afternoon each day. Phosphorus, ammonia-nitrogen, nitrate-nitrogen, chlorophyll *a*, pheophytin and zooplankton were measured twice weekly. Phosphorus concentrations were highly variable, but generally increased to a maximum average of 0.25 mg/L by day 10 and declined below detectable levels by day 20. Ammonia-nitrogen concentrations peaked at day 10 at 0.2 mg/L and fell below detectable levels by day 25. Nitrate-nitrogen concentrations peaked at day 7 at 1.5 mg/L and returned to near 1.0 mg/L by day 19 and remained at this level until pond harvest. Chlorophyll *a* concentrations peaked at around 30 µg/L on day 10, then declined and rose again to similar concentrations around day 27. Pheophytin concentrations were extremely variable but highest around day 30. The ratio of chlorophyll *a* to pheophytin declined from 1.7 to 1.5 from day 10 to day 40. Cladoceran densities peaked at densities of around 700 organisms/L around day 20 and declined to low levels by day 30. Copepod nauplii densities were similar to cladoceran densities except that maximum average densities were only near 100 organisms/L and occurred about 10 d earlier. Adult copepod densities peaked at an average density of 50 organisms/L on day 25. Rotifers were nearly absent from three ponds, but rose briefly to densities near 500 organisms/L at day 15 in the other ponds. Dissolved oxygen followed a pattern similar to chlorophyll *a* with maximum concentrations around days 10 and 30. Dissolved oxygen minima were never less than 6

mg/L. The pH of culture ponds averaged 9.5 and reached maximum levels of near 10 at around day 30. The fertilization regime generally provided low levels of inorganic nutrients compared to previously reported fish culture pond fertilization programs. However, zooplankton densities were some of the highest reported.

Mycobacterium marinum Infection in Humans

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Mycobacterium marinum, a non-tuberculous mycobacterium organism, has been isolated from a wide variety of aquatic habitats. It is known to infect over 150 species of fish, causing a chronic progressive systemic infection which is most commonly characterized histopathologically by a granulomatous inflammation in the liver, kidney, and spleen. In humans, it occasionally causes a syndrome referred to as "fish tank granuloma" or "fish handler's disease." The clinical manifestation of the disease is usually in the form of localized cutaneous erythematous pustules which exude a thick white-yellow fluid. Immunocompromised individuals may risk the development of a systemic infection. Without an adequate history, the condition presents a diagnostic and therapeutic challenge to the general practitioner. Epidemiologically, the two major risk factors for infection are associated with exposure to *M. marinum* infested waters and the presence of superficial epidermal abrasions which serve as a portal of entry for the orgamism. This discussion focuses on the clinical manifestation and epidemiology of the disease in Texas.

Parasites of the Major Ichthyofauna of Yellowstone Lake

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Fifty cutthroat trout *Onchorynchus clarki bouvieri* (Richardson), 12 lake trout *Salvelinus namaycush* (Walbaum) and 10 longnose suckers *Catostomus catostomus griseus* (Forster) from Yellowstone Lake, Wyoming were examined for internal and external parasites over a period of 12 years from 1985 through 1996. In 1999, 38 cutthroat trout, 3 lake trout, and 11 longnose suckers were examined specifically for the eye fluke, *Diplostomum spathaceum*. Most of the cutthroat trout had at least five species of parasites which included protozoans and helminths. The maximum number of parasite species found in a *O. clarki bouvieri* specimen was nine. Parasites added to the known list following this study for cutthroat trout from Yellowstone Lake were: *Myxosoma* sp., *Diphyllobothrium ditremum*, *D. dendriticum*, *Diplostomum baeri*, *D. spathaceum*, *Posthodiplostomum minimum*, and (most recently) *Myxobolus cerebralis*. These data were compared with a previous survey (1971) and to all known parasites for cutthroat trout in Wyoming and in North America. There were 21 species of parasites and 1-2 fungal species found to affect cutthroat trout of the lake. It is believed that the lake trout was only recently introduced into Yellowstone Lake, probably within the last 9-20 years. Since that time, lake trout have been affected, although not in high numbers, by some of the indigenous parasites (*Diphyllobothrium*, in particular). For the longnose suckers, six species of parasites (*Trichophrya catostomi*, *D. spathaceum*, *Crepidostomum farionus*, *Truttaedacnitis truttae*, *Lernea cyprinacea*, and *Ligula intestinalis*) were observed from the limited number of specimens collected. Commentary on the fish species, the history of Yellowstone National Park, the ecology of Yellowstone Lake, as well as discussion of the taxonomy, life cycle, and pathogenicity of each of the parasites are presented.

Use of Real World Problem Analysis as a Learning Tool for Undergraduate Students

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Real world problem analysis can be an effective learning tool to convey the scientific process and concepts of fisheries ecology to students. We used a local issue that was controversial among environmentalists, residents, and land developers. A landowner wanted to develop a stretch of land adjacent to a highway in College Station, Texas. However, this piece of land lies in the floodplain of Carter's Creek, which is a major tributary of the Navasota River. Environmentalists did not want the habitat disturbed and opposed any development, while some residents wanted development without adverse effects on the environment. In an effort to facilitate suitable conditions for commercial development, an engineer developed three options with different levels of channelization. Students analyzed the proposed development options and decided how to most effectively evaluate the situation based on sound evidence. This exercise was intended to help students develop their skills as ecologists, familiarize them with the types of issues they may face when they graduate, and get them more involved in their careers. Students initially viewed the problem from a conservationist standpoint, ignoring for human development but learned to integrate human needs with those of the environment. The students gained a better understanding of stream ecology and how changes in the environment can affect wildlife.

Texas Nature Trackers: Can citizen volunteers expand our insights on declining aquatic species?

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Over the last two decades the use of volunteers to gather information on water quality has been adopted by many agencies. In 1997, Texas Parks and Wildlife (TPW) began an effort to use citizen volunteers to systematically gather information about freshwater fauna in the state, focusing first on amphibians and freshwater mussels. The resulting Texas Amphibian Watch and Texas Mussel Watch are part of a group of TPW citizen science programs jointly known as Texas Nature Trackers. Approximately 100 volunteers have been trained for each program. Data have been received from over 30 mussel watchers and over 20 amphibian watchers. Notable contributions to date include the monitoring of rare spring-dwelling *Eurycea* salamanders in the Texas Hill Country, identification of a living population of mussels in the lower San Marcos River, and several findings of relatively rare mussel shells. Several volunteers are teachers who enhance the actual field work with curriculum activities. Additional opportunities to use volunteers to monitor fish species of concern will be investigated in the future.

Aquatic Exhibits at the Texas Freshwater Fisheries Center

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Texas Parks and Wildlife (TPW) has created visitor centers, Sea Center and Texas Freshwater Fisheries Center (TFFC), with aquatic exhibits for coastal and inland species and invited the public to view and learn about endemic fishes and their habitats. Differences between aquatic environments and the terrestrial world are illustrated. The public learns about Texas outdoors, and TFFC is an excellent and effective public relations tool, which contributes to the enhancement of the TPW image. The TFFC displays 43 species of fish, plus waterfowl, amphibians and reptiles, including alligators. Exhibits have been enhanced since opening day in November 1996 and continue to be expanded and updated. This facility has over a quarter of a million visitors over the past four years and visitor satisfaction has been outstanding.

An Evaluation of Spring Flows to Support the Upper San Marcos River Spring Ecosystem, Hays County, Texas

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The upper San Marcos River spring ecosystem in central Texas is fed by the Edwards Aquifer and provides habitat for a diverse aquatic community. An instream flow study was undertaken to determine the water quantity and quality needs of this spring ecosystem. Instream habitat modeling revealed spatial variation in habitat and spring flow relationships for selected aquatic macrophytes. Spring flows between 125 and 200 ft^3/s, of sufficient duration, maintain average habitat conditions for these macrophytes in all study segments and spring flow water quality. Empirical water quality data indicated a downstream trend of increasing temperature in warm months and decreasing temperature during cool months. As spring flow declined, modeled maximum daily water temperatures increased during hot summer months. Violations of Texas State Water Quality Standards were predicted to occur in hot summer months at spring flows between 60 and 160 ft^3/s, depending on downstream distance from the spring source. Spring ecosystem characteristics can only be maintained by a variable spring flow regime similar in duration, magnitude and frequency to the historical record, including peak flows needed for flushing, scouring, sediment transport, and channel maintenance.

Annual Proceedings of the Texas Chapter, American Fisheries Society 23:9-14, 2001

Contribution of Stocked Florida Largemouth Bass During Drought Conditions InThree West Texas Reserviors

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Abstract.--The percent contribution of stocked Florida largemouth bass *Micropterus salmoides floridanus* fingerlings to their year class was determined in three reservoirs in the semi-arid region of west Texas. This region experiences periodic droughts, with several consecutive years of declining water levels and reductions in largemouth bass habitat and recruitment in many reservoirs. This study was designed to investigate largemouth bass stocking during low water conditions. Florida largemouth bass fingerlings carrying a unique allele (marked bass) were stocked in spring 1996 at an average rate of 132/ha in three reservoirs that were at least 4 m below conservation pool and had experienced declining water levels for at least 12 months prior to the stocking. Electrofishing samples in the fall of 1996 and 1997 and electrophoretic analysis were used to determine the percent contribution of stocked fish to the 1996 cohort. In O. C. Fisher Reservoir, marked bass comprised 77% of age-0 largemouth bass sampled in 1996 and 84% of age-1 bass sampled in 1997. In Twin Buttes North Pool, marked bass comprised 0% of age-0 bass sampled in 1996 and 5% of age-1 bass sampled in 1997. Twin Buttes South Pool was intermediate to the other two reservoirs with 13% of age-0 bass sampled in 1996 and 9% of age-1 bass sampled in 1997 being marked. Adult largemouth bass densities were higher in Twin Buttes North and South Pools than in O. C. Fisher, which may explain some of the variability in the contribution of stocked fish to the natural cohort. There was no significant difference in size between stocked and naturally produced largemouth bass in any reservoir ($P = 0.05$). Results indicate stocking under low water conditions was successful in altering the genetic composition of a year class of largemouth bass in at least one of the three reservoirs; however, contribution to actual year class strength could not be determined from this study. The variability of the results emphasizes the need to understand factors responsible for success and failure of such stockings.

Fingerling Florida largemouth bass *Micropterus salmoides floridanus* are commonly stocked to supplement natural recruitment (Boxrucker 1986) or to influence the genetic composition of the population (Kleinsasser et al. 1990). While many studies have evaluated stocking, results often are conflicting and reservoir-specific conditions likely play a role in the success or failure (Terre et al. 1993). Texas reservoir types are diverse (Dolman 1990) and the quality of largemouth bass habitat can vary widely. Reservoirs in the semi-arid region of west Texas have specific characteristics that may influence the success of supplemental stocking programs. Many reservoirs in this region experience extreme water level fluctuations because most were constructed on intermittent rivers to supply municipal water (Kraai 1990). Droughts are common and water levels may drop 2 – 3 m/year for several years or rise 3 – 5 m in a few months. Growth of terrestrial vegetation often occurs in exposed substrate which, when inundated, provides nursery habitat for larval and juvenile fishes (Kraai 1990). Fish populations respond to this "new reservoir" effect with strong year classes of both sport and forage species. Information on the most effective use of stocked fish is lacking because little is known about the effectiveness of supplemental stocking in either periods of declining water levels with little or no cover or periods of high water levels with abundant cover.

Discrimination between stocked and native fishes is essential for measuring the benefits of supplemental stocking programs (Murphy and Kelso 1986). Electrophoretically detectable genetic markers have provided fisheries managers with an efficient mechanism to evaluate stocking success (Seeb et al. 1986; Maceina et al. 1988; Koppleman et al. 1992). These genetic markers allow large numbers of marked fish to be stocked at little additional cost (Terre et al. 1993).

A prolonged drought period beginning in the early 1990s reduced the water level in many west Texas reservoirs, providing the opportunity to evaluate supplemental stocking under these conditions. The objective of this study was to determine the contribution of supplementally stocked Florida largemouth bass to their year class in three west Texas reservoirs during low water conditions.

Methods

Three reservoirs experiencing low water conditions were chosen for this evaluation: O. C. Fisher Reservoir, and the North and South Pools of Twin Buttes Reservoir. Low water conditions were defined as the reservoir being at least 4 m below conservation pool and having declining water levels during the previous 12 months. Under these conditions, there was no flooded terrestrial vegetation in the reservoir at the time of stocking. All three reservoirs are located within a 17-km radius of San Angelo, Texas and have similar morphology and water chemistry (Dennis and Farquhar 1997, 1999). Surface area at the time of stocking was estimated from engineering curves of elevation vs. surface area.

O. C. Fisher is a 2,202-ha reservoir located on the North Concho River and was approximately 810 ha at stocking (Table 1). Twin Buttes Reservoir, located on the South and Middle Concho Rivers, consists of two pools that are connected by a 5.1-km equalization channel. When the water level is at or above 587 m above mean sea level, the equalization channel connects the two pools. Below 587 m, fish passage is restricted, although there is minimal flow from the South Pool into the North Pool. The North Pool is 2,865 ha at conservation pool and was 708 ha at stocking. The South Pool is 810 ha at conservation pool and was 405 ha at stocking.

Habitat in all three reservoirs at time of stocking consisted of proportionally similar amounts of rock and gravel shoreline, mud bank, and small amounts of rip-rap along all three dams. Standing dead trees and stumps occupied < 5 % of the littoral area, and there was no flooded terrestrial vegetation or aquatic vegetation in any study reservoir at time of stocking.

Texas Parks and Wildlife stocking rates for reservoirs between 810 and 4,047 ha is 124 fingerling largemouth bass/ha. Stocked fish for this study were identifiable as they carried a unique allele (Ryan et al. 1996) that can be identified throughout their life using electrophoretic examination of liver or fin tissue. None of the three reservoirs had been stocked previously with bass carrying this allele. Stocking was conducted at a single site on each reservoir in May 1996 (Table 1). While the target-stocking rate was 124/ha, actual rates based on reservoir size at stocking varied from 109/ha to 154/ha (Table 1). Total lengths of fingerlings stocked ranged from 31 mm to 47 mm with a mean of 39 mm (Table 1).

Largemouth bass from the 1996-year class were collected in the fall of 1996 and 1997 to determine the contribution of stocked bass to their year class. Sampling consisted of day and night electrofishing using a boat-mounted electrofisher producing pulsed DC current. Sampling was conducted throughout each reservoir in all available habitats in an effort to collect 50 bass from the 1996 year-class. All largemouth bass collected were measured for total length and those suspected of being from the appropriate cohort were retained until otoliths could be removed and the age of each bass verified. Liver samples from all largemouth bass identified as being from the 1996 year-class were collected and electrophoretically analyzed to identify those that carried the unique allele (i.e. marked bass).

Percent contribution of stocked bass and mean total lengths of marked and unmarked bass from the 1996 year-class were calculated from the fall 1996 and 1997 samples within each lake. Student's t-test was used to compare mean lengths between marked and unmarked fish within each lake for each sample year ($P = 0.05$).

Results and Discussion

Water levels at time of stocking were 4.2 – 10.0 m below conservation pool and continued to decline through August 1996 (Figure 1). A rain event in late August 1996 produced a small rise in O. C. Fisher (0.5 m) and Twin Buttes South Pool (0.6 m) and a substantial rise in Twin Buttes North Pool (5.3 m). This rise occurred 4.5 months after stocking and flooded large amounts of terrestrial vegetation in Twin Buttes North Pool. Habitat in O. C. Fisher and Twin Buttes South Pool remained virtually unchanged throughout the study. After this increase, water levels declined in O. C. Fisher and Twin Buttes North Pool throughout the remainder of study. Twin Buttes South Pool maintained a more constant water level that was regulated by the equalization channel. A temporary dam was constructed in the equalization channel to facilitate a construction project, raising the water level in the South Pool approximately 1.2 m from March 1997 through the end of the study. This dam further restricted fish passage between the north and south pools; however, limited movement between the two pools may have been possible.

Age-0 largemouth bass collected from the reservoirs in fall 1996 ranged from 46 to 61 (Table 2). The percentage of marked fish in the samples was highly variable, ranging from 77% in O. C. Fisher Reservoir to 0 and 13% in Twin Buttes North and South Pools, respectively. There was no significant difference in the mean total length between marked and unmarked age-0 largemouth bass within any reservoir ($P = 0.05$).

In 1997, reduced catch rates for age-1 largemouth bass in all reservoirs reduced the sample size to approximately half of that of 1996 (Table 2). Percent contributions in 1997 were similar to those of 1996 (Table 2). The percentage of marked fish in the sample from O. C. Fisher remained relatively high at 84% while the percentage of marked bass in Twin Buttes North and South Pools remained low at 5 and 9%, respectively. As in 1996, there was no significant difference in mean total length between marked and unmarked fish in any reservoir in 1997 ($P = 0.05$).

Table 1.--Reservoir size and mean total length, range, number and stocking rate of genetically marked Florida largemouth bass. Reservoir surface area at stocking was based on engineering models of elevation and surface area.

		Reservoir		
		O. C. Fisher	Twin Buttes North	Twin Butte South
Surface area (ha)				
Conservation pool		2,202	2,865	810
At stocking		810	708	405
Stocking date and size and number of fish stocked				
May 9, 1996	38.1 mm (31-44)		14,800	
May 16, 1996	42.2 mm (37-47)	66,400	62,400	62,400
May 17, 1996	37.4 mm (33-41)	41,400		
Stocking rate (number/ha)		133	109	154

Table 2.--Sample size (N), mean total length (TL; ±SD) and percent contribution of genetically marked and naturally produced (unmarked) Florida largemouth bass from three west Texas reservoirs. All t-tests comparing marked and unmarked fish within a reservoir were not significant ($P \leq 0.05$).

	Age-0			Age-1		
Reservoir	N	Mean TL (SD) (mm)	Percent contribution	N	Mean TL (SD) (mm)	Percent contribution
O. C. Fisher						
Marked	47	138 (21.4)	77	26	319 (48.6)	84
Unmarked	14	130 (30.2)		5	326 (14.2)	
Twin Buttes North						
Marked	0		0	1	300	5
Unmarked	49	119 (19.4)		21	281 (28.9)	
Twin Buttes South						
Marked	6	124 (7.4)	13	2	271 (36.8)	9
Unmarked	41	130 (19.5)		20	280 (22.6)	

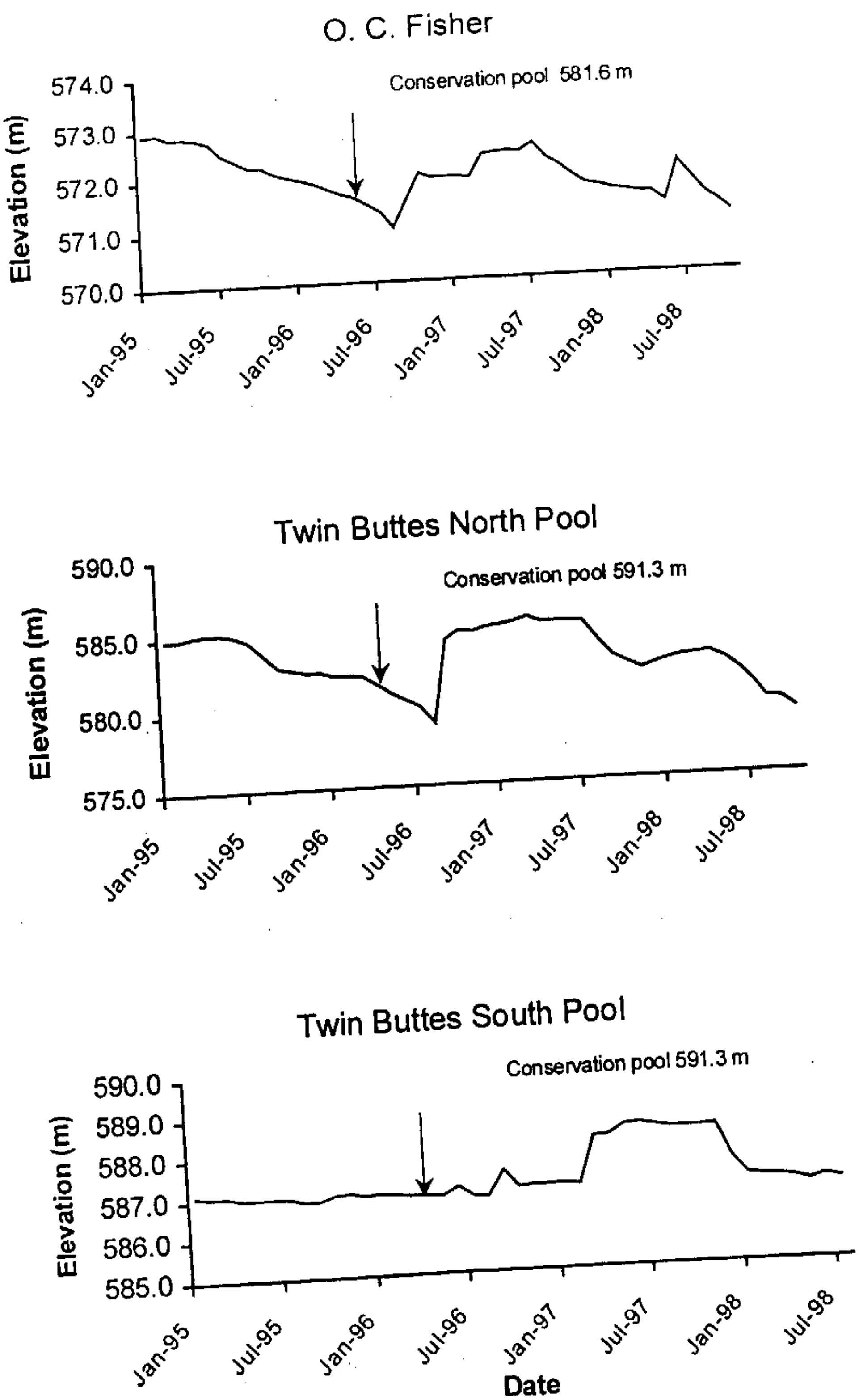

FIGURE 1.-- Water level (meters above mean sea level) history of reserviors used in the stocked Florida largemouth bass contribution study. Arrows indicate stocking dates.

Conditions such as water levels, habitat, and size and quality of stocked fish were seemingly similar in all three reservoirs; however, the percent contribution of stocked fish was highly variable. This variation is consistent with studies conducted elsewhere in Texas and other states. The high percent contribution in O. C. Fisher agrees with Boxrucker (1986) who found stocked bass comprised 72 and 76% of a year class for two growing seasons, although he used a stocking rate of 450/ha, which is over 3 times the rate used in this study. The lower contributions to the year classes in both pools of Twin Buttes (0-13%) are similar to that found by Ryan et al. (1996) who reported that genetically marked bass raised in nursery ponds comprised 0.0-6.7% of their year class in two east Texas reservoirs.

One possible explanation for the higher percent contribution in O. C. Fisher may be lower density of adult largemouth bass, thus reduced natural reproduction as well as less competition for available food. Texas Parks and Wildlife management surveys indicated total catch-per-unit-effort for largemouth bass in O.C. Fisher was 10.7/h in 1996 (Dennis and Farquhar 1997). Catch rates in both pools of Twin Buttes have been much higher, ranging from 75.3/h in 1995 to 50.7/h in 1998 (Dennis and Farquhar 1999). Greater bass densities in both pools of Twin Buttes may have led to higher natural recruitment of bass and thus lower percent contribution of stocked fish, perhaps coupled with higher mortality of stocked bass due to predation by resident adult bass. Terre et al. (1993) found largemouth bass densities and recruitment affected stocking success, with higher percent contribution (41-45%) in reservoirs with low natural recruitment and much lower percent contribution (1-7%) in reservoirs with higher bass densities and better natural recruitment.

The success of supplemental largemouth bass stockings can be influenced by several factors, including available habitat in the reservoir, year class strength, and characteristics of the largemouth bass population the year of stocking. In west Texas, low water levels and lack of protective nursery cover are factors limiting recruitment (Kraai 1990). This was likely the case in all three reservoirs since very little such habitat was available during this study.

An evaluation of stocking success must consider the goals or objectives of the stocking program. Largemouth bass may be stocked to supplement natural recruitment, especially when weak year classes are suspected, or to alter the genetic composition of the bass population within a reservoir. The results of this study indicate that stocking under low water conditions can influence the genetic composition of the population; however, it does not address actual contribution to abundance. If the primary goal is to alter the genetic composition of a fish population, stocking for several consecutive years under low water conditions may have a substantial influence in reservoirs such as O. C. Fisher where a large percentage of the year class was comprised of stocked fish. Whether these stocked fish increased the abundance of age-0 largemouth bass in the reservoir or displaced naturally produced fish is unknown from this study; however, the genetic composition of the 1996-year class was changed by the stocking. The lower contribution of stocked fish in both pools of Twin Buttes makes it less likely that the stockings would have much effect there on either abundance or genetic composition.

This study demonstrates the need for further research concerning the effectiveness of supplemental stocking in reservoirs with fluctuating water levels. While the results of this study were consistent within a reservoir, the variability among reservoirs confirms that many factors contribute to the effectiveness of supplemental stocking as a management tool. Traditionally, reservoirs have been stocked under high water conditions to take advantage of increased habitat. If naturally produced year classes are strong in high water level years, the effectiveness of stocking may be minimal; however, if these reservoirs also have experienced a severe decline in densities of adult largemouth bass, stockings may have an effect on both the genetic composition and the year class strength. In this study, it is unknown if stocked fish actually increased densities of largemouth bass, merely replaced naturally produced fish or suppressed abundance of the cohort. The variability in contribution of stocked fish in seemingly similar reservoirs indicates the need for thorough evaluation of all stocking programs. Future stocking evaluations should be designed to determine why stocked fish contribute to a cohort as well as determine the effect of stocked fish on abundance.

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Acknowledgments

The contributions of the abstract authors, manuscript authors, and the Editorial Committee (Aaron Barkoh, Dave Buckmeier, and Joe Fries) towards the preparation of this Proceedings is gratefully acknowledged.

The entire Chapter is appreciative to the many contributors who donated auctionable and raffleable goods, money, and services for the 2001 meeting in San Marcos, Texas.

Citation:

Author(s). 2002. Title. Pages ___ *in* A. Barkoh, editor. Annual Proceedings of the Texas Chapter, American Fisheries Society, Volume 23. Texas Chapter, American Fisheries Society, Austin, Texas.